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Capa: Saracura-matraca (*Rallus longirostris*), fotografada na Via Expressa Sul, Florianópolis, Santa Catarina, num manguezal urbano enquanto procurava caranguejos. Nesse volume, Vieira reporta um interessante caso de incremento populacional da espécie associado à expansão dos manguezais na ilha de Santa Catarina. No entanto, a autora apresenta dados apoiando a classificação da espécie como globalmente vulnerável em função do declínio geral da área ocupada por manguezais na América do Sul. Foto: Bianca P. Vieira.

Cover: Mangrove Rail (*Rallus longirostris*) photographed along the southern expressway in Florianópolis, Santa Catarina, while searching for crabs in an urban mangrove. In this volume, Vieira reports on an interesting case of increasing population sizes of this species associated with mangrove expansion on the Island of Santa Catarina. However, the author presents data supporting the classification of the Mangrove Rail as Vulnerable at a global level due to overall decline of the area covered by mangroves in South America. Photo: Bianca P. Vieira.

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ARTICLE

Cannibalism by Brown Booby (*Sula leucogaster*) at a small tropical archipelago

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ABSTRACT: Cannibalism is the total or partial consumption of a conspecific's body or eggs, and it has been reported for many bird taxa, particularly carnivorous, colonial species, and those species that ingest fragmented prey. Here we report cannibalism by Brown Booby (*Sula leucogaster*) at Saint Peter and Saint Paul Archipelago, offshore Brazil. We discussed possible causes for this behavior such as opportunistic feeding, colony sanitation and space competition for nesting places.

KEY-WORDS: chick mortality, opportunistic feeding, Saint Peter and Saint Paul Archipelago, seabirds, Sulidae.

INTRODUCTION

Direct cannibalism refers to the consumption of a living conspecific or its eggs (Stanback & Koenig 1992) and indirect cannibalism refers to scavenging on a conspecific whose death was due to other causes, including the action of predators (Riehl 2006). Cannibalism occurs in a wide range of animal taxa, from Protozoa to mammals, and has been reported for nearly every major vertebrate group, but it is infrequent in most species in which it occurs (Stanback & Koenig 1992, Pfennig 1997). Cannibalism in birds occurs primarily in species that are carnivorous, colonial, and that feed on fragments of prey rather than the whole prey (Stanback & Koenig 1992). Therefore, among wild birds, raptors and seabirds are the groups more prone to cannibalism (Stanback & Koenig 1992, Markham & Watts 2007, Andrew & Munro 2008). Among seabirds, cannibalism has been reported in gulls, pelicans, terns, frigatebirds and boobies (Stanback & Koenig 1992, Humphries *et al.* 2006, Gubiani *et al.* 2012, Hayward *et al.* 2014).

The Brown Booby (*Sula leucogaster*) is the most widely distributed Sulidae species, occurring in tropical and subtropical seas around the world (Nelson 2005). Typically, Brown Boobies capture fish and squids by plunge-diving (Harrison *et al.* 1983, Naves *et al.* 2002), but also feed on fishery discards (Krul 2004). The Brown Booby is monogamous and usually lays two eggs. Similarly to some other Sulidae species, the Brown Booby shows obligate siblicide (Anderson 1990, Drummond 2001, Nelson 2005, but see Tershy *et al.* 2000). Only one chick fledges, either because the parents only feed one chick or because the first-hatched chick or the parents eventually ejects the younger chick from the nest. Here we provide evidence for direct and indirect cannibalism involving chicks and adults Brown Booby at Saint Peter and Saint Paul Archipelago (SPSPA breeding colony), offshore Brazil.

METHODS

Study Area

The SPSPA (00°55'10"N, 29°20'33"W) is about 1,100 km from the Northeastern mainland Brazilian coast. It originates from a Meso-Atlantic elevation based at 4,000 m depth and comprises 15 rocky islets covering an area of 17,500 m^2. Belmonte is the largest islet, about 100 m long, 50 m wide and the highest point of the archipelago is 18 m above sea level (Vaske-Jr *et al.* 2010). SPSPA is located in an oligotrophic area, directly influenced by the South Equatorial Current, flowing from east to west, and the Equatorial Undercurrent, which flows in the opposite direction and with core located about 80 m depth (Travassos *et al.* 1999). Approximately 580

Brown Boobies, 390 Brown Noddies (*Anous stolidus*) and 320 Black Noddies (*A. minutus*) breed in SPSPA (Both & Freitas 2004, Neves *et al*. 2013). The number of Brown Boobies is fairly constant year round and about 90% of these birds occur on Belmonte Islet, in a dense monospecific colony (Barbosa-Filho & Vooren 2010) while other islets are used mainly for roosting by this species (Naves *et al*. 2002, Both & Freitas 2004, Barbosa-Filho & Vooren 2010). Flyingfishes are key prey species for tuna, sharks and seabirds (Mancini & Bugoni 2014), while the abundant fishery resources are explored by a commercial fishery of regional importance based on the mainland (Vaske-Jr *et al.* 2005).

Observations

Research expeditions to SPSPA occurred in August 2011, January 2012, May-June 2014 and July 2015. Initially, we observed two Brown Booby pairs (including the parents of a dead chick) pecking rapidly and repeatedly on the dead nestling, although we did not notice consumption of the body. This aggressive behavior suggested that cannibalism could occur at this colony and, therefore, a behavioral experiment was developed to study the occurrence of cannibalism. We collected fresh chick carcasses resulting from natural mortality in their original nests or close to them. To assess propensity for cannibalism, we carried out seven experimental trials. We placed a dead chick next to paired Brown Boobies defending a nest site without eggs or chicks. We carried out experimental trials opportunistically whenever a dead chick was found, and observed and recorded with photography and video the reaction of the receiving pairs towards the dead chick. We paid particular attention to whether receiving birds swallowed the chick carcass, and the age and sex of cannibals. We determined sex of adults by vocalizations or the colors of the head, skin or bill, and determined age by plumage colors (Harrison 1983). Finally, we estimated the age of the dead chicks following Barbosa-Filho & Vooren (2010), and then used age to estimate body mass of ingested chicks (Coelho *et al*. 2004).

RESULTS

Experimental Trials

Trial 1 (19 August 2011). We collected one 3-week old chick (~300 g) found dead close to its original nest and placed it on the ground, in front of a Brown Booby pair that was defending an empty nest. Both birds observed the chick for a few seconds. The male approached the chick and moved it closer to the female, which immediately swallowed the chick.

Trial 2 (19 August 2011). We found a dead 3-week old chick (~300 g) and placed it on the ground next to a pair, different from the previous pair. The pair soon approached the chick and the female swallowed it (Figure 1).

FIGURE 1. Cannibalism of a dead chick by a female Brown Booby (*Sula leucogaster*) at Saint Peter and Saint Paul Archipelago, Northeastern Brazil. (Photo: F. M. Neves)

Trial 3 (11 January 2012). We observed a breeding male Brown Booby at 10:10 h (GMT-2), close to its own 4-week old dead chick (~400 g). This male continually moved soil, small stones, and the chick around the nest in a manner similar to nest-building behavior. With the chick out of the nest, this behavior continued and a small hole was dug in the ground. By 12:00 h, the pair was in the nest and the dead chick was at the same place, close to the nest. Shortly after, we removed the chick from the vicinity of the pair. The parents became restless, as did the neighboring boobies.

Trial 4 (11 January 2012). We placed the dead chick (the same specimen used for trial 3) in a nearby nest occupied by a pair without chick or egg. The receiving pair began to peck at the chick as soon as they perceived its presence. A nearby nearly-fledged, flightless chick got involved and exhibited aggressive behavior towards the receiving pair and other birds around, including the parents of the dead chick. The nearly-fledged chick persistently attempted to swallow the dead chick for about 10 min (Figure 2), but was unsuccessful due to its small size relative to the dead chick and its gape width limitation. When the nearly-fledged chick finally stopped its attempts, the juvenile's mother immediately grabbed the dead chick and tried to swallow it for about 1 min, again unsuccessful due to gape limitation. The dead chick was then left on the ground.

Trial 5 (11 January 2012). We moved the dead chick (from trials 3 and 4) to another nest occupied by a pair without chick or egg. Both adults pecked and shook the chick vigorously for 2 min, the female acting more aggressively, and then set it aside without trying to swallow it.

Trial 6 (15 May 2014). We placed an adult Brown Booby carcass on the other side of booby nests, away from birds. About 2 min later a female grabbed the carcass and tried to swallow it repeatedly, but was unsuccessful due to gape limitation. She left the carcass on the ground and a wave washed it away from the colony.

Trial 7 (31 May 2014). We found a dead chick (~300 g) and placed it near a nest occupied by a pair without chick or egg. A female pecked at the chick and tried to swallow it, but was unsuccessful due to gape limitation. Male and female continued pecking the dead nestling, but lost interest over time.

Apart from the trials explained above, during a 1-month expedition, two spontaneous cannibalistic events were recorded. On 20 July 2015, a female pushed out their younger nestling (3 days old; <100 g) and promptly, an adjacent breeding pair caught the still alive chick, and the male swallowed it (Figure 3). On 27 July 2015, a breeding male caught and swallowed a 1-week old nestling (<100 g) from the adjacent nest, while researchers were sampling the adult attending the nest, which did not last more than 5 minutes.

Overall, from seven trials and two spontaneous observations, we report seven cannibalistic events by Brown Booby individuals at SPSPA.

FIGURE 2. A nearly-fledged Brown Booby (*Sula leucogaster*) attempting to swallow a dead chick from an adjacent nest at Saint Peter and Saint Paul Archipelago, Brazil. (Photo: F. P. Marques)

FIGURE 3. Brown Booby (*Sula leucogaster*) breeding pair fighting for a 3-days old chick, which was pushed out of the nest by the adjacent breeding female. The fight ends with the male swallowing the chick. Chronological sequence of the events from left to right. (Photo: G. T. Nunes)

DISCUSSION

Cannibalism in sulid species was recorded a single time in the Nazca Booby (*Sula granti*) in more than 15 years of research at Galapagos Islands (Humphries *et al*. 2006). However, Brown Booby cannibalism at SPSPA was reported previously in two unpublished sources. The first report was part of a Ph.D. thesis, which included a Brown Booby diet study at SPSPA and one chick was observed in a female regurgitate, sampled between 1999-2001 (Kohlrausch 2003). The second report was from expedition diaries (Expedition No. 164, and report by C.J.A. Costa-Jr., A. Cavalcante and C.M. Vooren), which described a female with a broken wing that ate a live chick when it was ejected from the nest by its parents in August 2004. Thus, cannibalistic behavior had been previously observed at our study site, apparently under natural circumstances, i.e. without an intentional delivery to potential cannibals as in our trials.

Many hypotheses have been suggested to explain cannibalism in birds. In the broken winged female case, cannibalism could have occurred due to acute food limitation (Ingram 1959, Stanback & Koenig 1992, Nishimura 2010), because the female was flightless and food deprived. Cannibalism has been associated with food shortage in other species, such as the Long-tailed Jaeger (*Stercorarius longicaudus*) (Vooren & Chiaradia 1989), the Australian Pelican (*Pelecanus conspicillatus*), the Australian White Ibis (*Threskiornis molucca*) (Andrew & Munro 2008), the Peruvian Pelican (*P. thagus*) (Daigre *et al*. 2012), and the Socotra Cormorant (*Phalacrocorax nigrogularis*) (Gubiani *et al*. 2012).

In our observations (trials 1, 2, 4, 6, 7, and the two events of spontaneous cannibalism), as well as in the case reported by Kohlrausch (2003), in which Brown Booby chicks were consumed or there was attempted consumption, a possible explanation could be an opportunistic feeding behavior by females to restore energy during breeding. In seabirds, including sulids, males and females generally share breeding duties equally (Nelson 2005, Lormee *et al*. 2005, Weimerskirch *et al*. 2006). However, at SPSPA, female Brown Boobies are mostly responsible for feeding chicks (80% of the time, compared to males, Kohlrausch 2003). In the SPSPA, the Brown Booby breeds throughout the year and there has been no report of yearly variation in the occurrence of breeding (Both & Freitas 2001, Barbosa-Filho & Vooren 2010). Furthermore, in SPSPA, seabirds and marine pelagic fish rely on the same prey species (flyingfish), but the overlap in their trophic niches was limited, most likely due to an overabundant food resource (Mancini & Bugoni 2014).

The availability of food for seabirds at the SPSPA is probably constant and predictable through the year (Barbosa-Filho & Vooren 2010). SPSPA slows the Equatorial Undercurrent, increasing residence time of nutrients around the archipelago and generating subsurface vortices (Araujo & Cintra 2009). This process increases local primary productivity and allows a great abundance of flyingfish, large pelagic fishes and intense fisheries around the SPSPA (Vaske-Jr *et al*. 2003, 2008, Viana *et al*. 2012). Thus, food shortage does not seem to be driving cannibalistic behavior. The 'icebox hypothesis' (Alexander 1974), alternatively, considers that a marginal offspring is a potential feeding resource and that its consumption confers breeding advantage to the parents (Ingram 1959). Filial cannibalism (consumption of all or part of the young by the parents) may be an adaptive strategy where energetic requirements trigger cannibalism (Klug & Bonsall 2007). However, cannibalism seems to contribute only a marginal increment to the breeding success of the Nazca Booby, and Humphries *et al.* (2006) did not observe family members consuming chicks because the similar size of siblings precludes such behavior. At SPSPA, most cannibalistic birds were females, and in one instance (trial 1), the male offered the dead chick to the female, in line with the food deprivation hypothesis, which could help offset energetic costs of egg production. The exceptions were the two spontaneous cannibalism events recorded in July 2015, when males swallowed chicks, which suggests that this hypothesis does not explain all cannibalistic events at SPSPA.

Furthermore, cannibalism may be a density-dependent behavior (Fox 1975, Nishimura 2010). At high nest densities, egg cannibalism and social stress increase in gulls (Burger 1980, Brouwer & Spaans 1994), and disputes over territories are frequent in booby colonies (Alves *et al.* 2004, Nelson 2005). The SPSPA Brown Booby population increased from 334 birds in 2000-2001 (Barbosa-Filho & Vooren 2010) to 588 birds in 2011-2014 (Neves *et al.* 2013, Mancini *et al.* unpublished data) and no emigration has been documented (Barbosa-Filho & Vooren 2010). In this colony there is an average distance between nests of 1 m, while in the Rocas Atoll, northeastern Brazil, for instance, nests are 11 m apart on average (Kohlrausch 2003). Furthermore, average nest diameter of SPSPA is ~20% smaller than Rocas Atoll nests (Kohlrausch 2003). Some additional observations of the authors on the Brown Boobies at SPSPA also suggest space limitation. Fights over territory in the nest surroundings are intense and common, resulting in injured adults or chick death. Furthermore, boobies frequently establish nests in low, marginal areas, close to the area of wave action, i.e., low quality areas with reduced breeding success. In both spontaneous events reported here, cannibalized chicks belonged to nests adjacent to cannibals. All this suggests that cannibalism could be a density-dependent behavior, and eating chicks from adjacent nests would be a way of eliminating adjacent nests.

On the other hand, an alternative hypothesis is that cannibalism could have a colony sanitation role. The ingestion of nestling fecal sacs by adult birds in nests, as well as the removal of egg shells, feces and dead nestlings, is a well-known phenomenon (Blair 1941, Kirkpatrick *et al.* 2009). This behavior could be important in partially closed nests, and could be potentially essential in crowded places such as at the SPSPA, where the only potential scavenger is the crab (*Grapsus grapsus*). However, as far as we know, cannibalism in seabirds has not been suggested as playing a role in sanitation of colonies, which requires further investigation.

Finally, constant human presence in the archipelago since 1998, when the "ProArquipelago Program" was established by the Brazilian Navy, may be influencing this behavior. Since then, the island has been permanently inhabited by small groups of researchers and mariners (usually four). Additionally, researchers, sailors and fishermen often feed boobies left-over fish parts, and individuals with a propensity for cannibalistic behavior may have interpreted the dead chicks thrown close to the nests (our trials) as a food offer by humans, despite this does not explain the spontaneous cannibalism events reported. In summary, explanations for the natural cannibalism reported previously, as well as our 'unnatural' trials, which result in cannibalistic attempts, remain elusive, and further experimental studies should be carried out to address why Brown Boobies from this area differ from sulids elsewhere.

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Associations between birds and social wasps in the Pantanal wetlands

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ABSTRACT: Nesting associations between birds and wasps may increase reproductive success of birds because the stings of these insects serve to protect the offspring against predators. The predation of wasps by birds is known from elsewhere and usually birds feed on the wasps during flight. Here we report on nest associations between birds and social wasps and comments on wasp nest predation by birds in the Brazilian Pantanal wetlands. The study was conducted in the sub-region known as "Pantanal de Poconé", state of Mato Grosso, Brazil. We recorded seven associations involving four bird species: *Paroaria capitata*, *Myiozetetes similis*, *M. cayannensis* and *Columbina talpacoti*, and four wasp species: *Polybia sericea*, *P. ruficeps xanthops*, *Chartergus globiventris* and *Parachartergus fraternus*. One successful nest of *M. cayannensis* (14.2%) was associated to *P. sericea* wasps. On the other hand, 42.8% of the bird nests were abandoned, and 42.8% were preyed upon. Additionally, a direct event of wasp nest predation was recorded, in which a group of *Melanerpes candidus* attacked a nest of *P. ruficeps xanthops*. Other ten wasp nests were found with marks of predation made by birds. These were nests of *Synoeca surinama* (n = 2), *P. chrysothorax* (n = 2), *P. ruficeps xanthops* (n = 3), *P. sericea* (n = 2) and *P. jurinei* (n = 1), suggesting that social wasps may constitute an additional element in the diet of insectivorous birds. We concluded that: 1) associations with wasps did not prevent predation of bird nests against the variety of predators in the region, and 2) the predation of social wasps by birds can contribute to population control of these social insects in the Pantanal. Further studies may shed additional light on this bird-wasp relationship.

KEY-WORDS: Animal behavior, bird nests, bird-wasp interactions, wasp colonies.

INTRODUCTION

Nest predation is usually the main cause of reproductive failure in birds (Ricklefs 1969; Oniki 1979, Lopes & Marini 2005). One of the strategies used by birds to minimize or avoid predation is the construction of nests near colonies of ants, wasps and bees (Hymenoptera) (Haemig 2001). The social hymenopterans more commonly seen in association with birds are wasps, Vespidae (Hansell 2000). The swarming behavior and the painful stings of wasps protect the birds' offspring against predators (Dejean & Fotso 1995, Brightsmith 2000, Beier &Tungbani 2006, Bologna *et al.* 2007). However, the effectiveness of nest defense is variable among wasp species (Richards 1978, Hansell 2000).

In the Neotropical region, the association between nesting birds and social wasps is prominent for species of *Cacicus* (Icteridae), for which the association with wasps is regarded as an adaptation to avoid nest predation (Feekes 1981, Robinson 1985, Sick 1997, Somavilla *et al.* 2013). On the other hand, wasp predation by birds (Sutton 1939, Gibo 1978, Raw 1997, Sick 1997) is considered a rare event in the neotropics. Birds generally feed on wasps during flight and there are few reports of attacks on wasp nests (Gibo 1978, Henriques & Palma 1998).

Here we describe the nesting associations between birds and social wasps (Hymenoptera: Vespidae) in a North Pantanal region and present our observations on social wasp nest predation by birds to advance further the knowledge on the ecology of interactions between birds and social insects.

METHODS

The Pantanal is the largest seasonally flooded wetland area of the planet and it is located in the center of South America, covering parts of Brazil, Bolivia, Paraguay and Argentina. In Brazil, it is present in the states of Mato Grosso and Mato Grosso do Sul (Silva & Abdon 1998). This study was conducted in Retiro Novo Farm (16°15'12"S, 56°22'12"W), located in the municipality of Poconé, state of Mato Grosso, Brazil. From 25 August 2011 to 11 April 2012, the vegetation was searched for a total of 1,024 hours of sampling effort in order to seek bird nests (according to Martin & Geupel 1993) in a mosaic covering the forest formations locally known as "cambarazal", "landizal" and "pombeiral", and in natural grasslands (see Nunes da Cunha *et al.* 2010). After locating bird nests, we recorded the occurrence of wasp nests in the same plant. Here, we considered an association when both nests were located in the same tree and having between them a distance shorter than 1 m (see Wunderle & Pollock 1985). The distance between the bird and wasp nests and the height of the nests from the ground was obtained with a measurement tape. A sample of wasp individuals was collected using an insect net. The voucher specimens were deposited in the collections of the Museum of Zoology, Universidade Estadual de Feira de Santana (MZFS), Feira de Santana, Bahia, and Zoological Collection of Universidade do Estado de Mato Grosso (CZUNE), Cáceres, Mato Grosso. Bird nests were monitored through brief visits with three-day regular intervals in order to minimize nest disruption. Each nest was accompanied until reproductive success, predation or even desertion (Lopes & Marini 2005, Duca & Marini 2008). We considered as successful a bird's nest in which at least one nestling left the nest. Predated nests were those recorded with contents missing during the monitoring interval (i.e., eggs or nestlings).

RESULTS

We recorded a total of 155 active nests belonging to 37 species of birds, and 308 nests belonging to 14 social wasp species (Almeida *et al.* 2014). However, we found only seven nesting associations involving four bird species and four species of wasps (Table 1). *Polybia* was the most frequent wasp genus in the seven associations (71.4%).

Bird nests were on average 0.5 ± 0.4 m distant (max = 1.0 m; min = 0.1 m) from wasp nests, and the associations were recorded in cambarazal edges (n = 5) and in natural grasslands (n = 2). Considering bird nests associated with wasps, only one nest (14.2%), belonging to *Myiozetetes cayannensis* associated to *Polybia sericea*, was successful. The loss of brood was caused by nest abandonment (42.8%) when they were still under construction, and predation (42.8%) (Table 1).

In all cases reported here (n = 7), the wasp nests were positioned above the bird nests, which were on average 2.2 ± 1.6 m from the soil (max = 5.9 m; min = 1.1 m), while the wasp nests were on average 2.9 ± 2.0 m from the soil (max = 6.2 m; min = 1.6 m). In six of the seven associations, the wasp nests were well developed, showing a selection by the birds to nest close to social wasp colonies.

In the second half of October 2011, we found two nesting association attempts made by *M. cayannensis* with *Chartergus globiventris* and *Parachartergus fraternus* simultaneously on the same tree. In the first attempt, the bird was building the nest at about 0.1 m from a nest of *P. fraternus* and 1.9 m from a nest of *C. globiventris*. However, the bird nest was abandoned for unknown causes. Ten days later, the bird started building another nest and at similar distances (about 1 m) between the two wasp nests. However, the nest was again abandoned. It is likely that the birds were attacked by wasps when they build their nests close to the wasp nests. This might have occurred because during the construction of the nests the wasps were not approachable. For *Myiozetetes*, there are association records to *Chartergus* (Sick 1997).

TABLE 1: Species of birds and social wasps in nesting associations at Retiro Novo Farm, Pantanal de Poconé, state of Mato Grosso, from August 2011 to April 2012. DN (m): Distance in meters (m) between the nest of the bird and the nest of the wasp; HA (m): Height of bird nests from the ground; HV (m): Height of wasp nests from the ground; Nest fate: AB = abandoned; PR = preyed upon; SU = successful. Asterisk (*) indicates the nest associated with two wasp colonies.

Bird species	Wasp species	DN (m)	HA (m)	HV (m)	Nest plant support	Nest fate
Paroaria capitata	*Polybia sericea*	1.0	1.6	1.8	*Bactris glaucescens*	PR
*Myiozetetes similis**	*Chartergus globiventris*	1.0	5.9	6.2	*Vochysia divergens*	
	Parachartergus fraternus	1.0		6.1		AB
Myiozetetes cayannensis	*Polybia ruficeps xanthops*	0.1	1.9	1.9	*Licania parvifolia*	AB
Myiozetetes cayannensis	*Parachartergus fraternus*	0.2	1.4	1.8	*Erythroxylum anguifugum*	AB
Myiozetetes cayannensis	*Polybia sericea*	0.4	2.1	2.1	*Cissus spinosa*	SU
Myiozetetes cayannensis	*Polybia sericea*	0.1	1.6	1.8	*Vochysia divergens*	PR
Columbina talpacoti	*Polybia ruficeps xanthops*	0.5	1.1	1.6	*Vochysia divergens*	PR

In the present study, we recorded the association of *M. similis* with *C. globiventris* and *Parachartergus fraternus*; as well as of *M. cayannensis* with *P. ruficeps xanthops*, *P. fraternus* and *P. sericea*. In the 2009 breeding season, at the same area of this study, a nest of *Crotophaga ani* (Cuculidae) was observed in association with wasps (M. M. Evangelista, pers. comm.), as well as a nest of *Sporophila collaris* (Thraupidae) and one of *Arundinicola leucocephala* (Tyrannidae) during the breeding season of 2010 (D. Grangero, pers. comm.).

We observed predation of wasp nests by the White Woodpecker *Melanerpes candidus* (Picidae) on a nest of *P. ruficeps xanthops*. On 26 January 2012, at 14:03, seven individuals of this woodpecker attacked a nest located 1.5 m above the water surface amidst the leaves of *Ludwigia* sp. (Onagraceae). While one White Woodpecker was feeding on larvae in the nest, the others birds were vocalizing perched about 10 m from the nest. Each individual remained for about two minutes in the nest, and after the attack of the birds, we found the wasp nest partially destroyed with part of larvae left. On the same day, at 14:40 h, one *M. candidus*, possibly from the same flock, attacked a nest of *P. sericea* located about 40 m from the preyed nest of *P. ruficeps xanthops*. However, the attacks were discontinued. On 5 April 2012, another nest of *P. sericea* on the edge of a cambarazal was preyed upon by *M. candidus*. We also observed that nests of *Synoeca surinama* (n = 2), *P. chrysothorax* (n = 2), *P. ruficeps xanthops* (n = 3), *P. sericea* (n = 2) and *P. jurinei* (n = 1) had predation marks (pecking) made by birds.

DISCUSSION

Nesting associations between birds and social wasps are not due to chance and there are evidences that the birds select their nesting sites near wasp nests (Dejean & Fotso 1995). Recent records of associations between bird nests and wasp colonies in Brazil indicate that the bird and wasp species involved in this relationship are varied and species-rich (Cazal *et al.* 2009, Somavilla *et al.* 2013, Menezes *et al.* 2014, Sazima & D'Angelo 2015, present paper). Further studies may shed additional light on this bird-wasp relationship and its ecological importance.

Despite our low sample size of bird nests associated with wasps, we can conclude that associations with wasps did not prevent predation of bird nests, and this may be related to the variety of predators in the region (Pinho 2005), such as birds (Clark *et al.* 1983), mammals (Wray & Whitmore 1979) and snakes (Oniki 1979, Navarro *et al.* 1992), which explored different environments and layers of vegetation, besides having different predation strategies. In Costa Rica, nests of *Campylorhynchus rufinucha* (Troglodytidae) associated with *Polybia rejecta* had a greater reproductive success than non-associated wasps (Joyce 1993). In this latter case, the most important predator was the monkey *Cebus capucinus* (Cebidae).

The reduced number of bird species found in association with wasps in the present study corroborates the data presented by Hansell (2000), who stated that this is a rare event. In addition, we suggest that social wasps could not provide the necessary protection against the variety of nest predators in the Pantanal wetlands.

The use of social wasps by White Woodpecker as food was previously recorded in the Paraná River floodplain, Argentina, where the diet of this bird was basically composed of ants (*Acromyrmex* spp.) and wasps (*Polybia scutellaris*) (Patterer *et al.* 2003). Predation on a *Polybia paulista* nest by *M. candidus* was recorded by Sazima (2014), who pointed out that this bird employed a subtle tactic that minimized and latter prevented wasp attacks. Although this species of woodpecker is well known for attacking wasp nests (Sick 1997), our study presents new information about social wasp species preyed by *M. candidus*.

It seems that a great number of bird species are not adapted to withstand numerous stings during an attack on a wasp nest (Raw 1997). However, there are also records indicating that birds are the main predators of wasp nests (Strassmann 1981). In the present study, nevertheless, we noted that birds, especially *M. candidus*, prey upon nests of very aggressive wasps such as *Polybia sericea*.

Social wasp nests were recorded profusely in our studied area (n = 308) (Almeida *et al.* 2014). Thus, wasps may be an additional element in the diet of insectivorous birds, especially woodpeckers (Picidae), which feed mainly on hymenopterans (Sick 1997). In addition, predation of social wasps by birds can play an important role in population dynamics of this insect group, contributing to population control (Henriques & Palma 1998).

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Effects of environmental enrichment in a captive pair of Golden Parakeet (*Guaruba guarouba*, Psittacidae) with abnormal behaviors

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ABSTRACT: Abnormal behaviors (e.g., feather plucking and pacing) are commonly observed in captive animals. Environmental enrichment techniques have been used to improve animal welfare by promoting the reduction of such behaviors and stimulating the display of typical behaviors. The present study examined the effects of environmental enrichment techniques in a captive pair of the endangered Golden Parakeet (*Guaruba guarouba*, Psittacidae), which presented feather-plucking behavior. Different objects of environmental enrichment were presented to birds between February and July 2008. Behavioral analyses were performed by comparing pre enrichment, enrichment introduction and after enrichment phases. At each phase, a total of 42 hours of behavioral data were collected through the scan method with instantaneous recording at sampling intervals of 30 seconds. The results showed that the behavioral diversity of the parakeets increased (e.g. "social behavior" 14.00 ± 3.01, df = 2, N = 21, p = 0.19; "locomotion" 25.52 ± 3.14, df = 2, N = 21, p = 0.01) whereas feather plucking ("individual abnormal behavior") decreased with the use of enrichment (0.10 ± 0.07, df = 2, N = 21, p = 0.78). However, abnormal behavior was again observed after removing enrichment objects. Although environmental enrichment did not eliminate completely the display of abnormal behaviors, the introduction of objects had a positive effect on increasing behavioral diversity of the animals and, consequently, improving animal welfare.

KEY-WORDS: Animal behavior, animal welfare, captivity, feather plucking, psittacine.

INTRODUCTION

The life of animals in captivity has many differences when compared to animals that live in a natural environment. Captive animals are protected from competitive interactions, receive adequate food, have sexual partners chosen, do not need to escape from predators and are not affected by environmental changes (Young 2003). Thus, captivity becomes an unattractive and predictable environment for animals, as they must deal daily with the lack of challenges that might affect their welfare, which may result in abnormal behaviors such as self-injury (Dixon *et al.* 2008). The animal has needs to express its normal behavior but due to the inappropriate environment it tries to reduce its frustration through the repetition of behaviors with no apparent function, called stereotyped behaviors (Meehan *et al.* 2003, Meehan *et al.* 2004, Latham & Mason 2007). Numerous studies on captive animals showed that captivity can result in behavioral problems (Bashaw *et al.* 2001, Bachmann *et al.* 2003, Garner *et al.* 2004, Torrey & Widowski 2006, Clubb & Vickery 2006, Harlander-Matauschek *et al.* 2007, Dixon *et al.* 2008) such as feather plucking. This kind of intensified preening can result from chronic stress associated with excessive self-comforting or physical health disorders (Garner *et al.* 2003) and a sterile and predictable environment (van Zeeland *et al.* 2009).

Environmental enrichment is a process that creates a complex and interactive environment, allowing the captive animal to display natural behaviors while promoting new challenges and offering opportunity for choice and control of its environment (Swaisgood & Shepherdson 2005). Environmental enrichment techniques are used to solve and even prevent the appearance of behavioral disorders (Baer 1998, Meehan *et al.* 2004, Garner *et al.* 2006) by reducing the stress caused by captivity and improving physical, mental and social welfare of animals (Young 2003).

The Golden Parakeet, *Guaruba guarouba*, is an endemic parrot from Brazil, which inhabits upland forests and it is found between northern Rondônia and Mato Grosso, Amazonas, Pará, and western Maranhão (Belmonte & Silveira 2005, Laranjeiras & Cohn-Haft 2009). Measuring about 34 cm, it has yellow-golden plumage with green flight feathers (Sick 1997). The species is considered vulnerable and is a common target for illegal trade (IUCN 2014). According to the Golden Parakeet Management Plan (RIOZOO 1998) proposed by IBAMA - Instituto Brasileiro do Meio Ambiente e Recursos Renováveis, captive individuals can present certain infectious and parasitic diseases, nutritional and behavioral problems. One of the most common abnormal behaviors in captive parrots is feather plucking (Garner *et al.* 2006, Lumeij & Hommers 2008, Jayson *et al.* 2014), which may be a result of social isolation, poor diet, diseases, infections or lack of stimuli in the environment (Young 2003, Rubinstein & Lightfoot 2012).

This study aimed to evaluate the effects of environmental enrichment techniques in a pair of *Guaruba guarouba*, which exhibited abnormal behavior of feather plucking, in order to decrease or eliminate this behavior and consequently improve their welfare.

METHODS

This study was conducted from February to July 2008, with a pair of *Guaruba guarouba* kept in an enclosure outside the public view, at Fundação Zoo-Botânica de Belo Horizonte – FZB-BH, Minas Gerais, Brazil. The two individuals arrived at FZB-BH in September 2007, from a conservationist breeding facility in the state of Maranhão, Brazil, already showing feather plucking behavior. The enclosure measured 3.82 m long, 2.94 m wide and 1.91 m high with cemented walls and floor, front and roof of wire mesh and 1/3 covered with asbestos tile. There were also two perches and some strings for locomotion within the enclosure.

The birds' diet was balanced and included fruits, vegetables (such as apple, banana, papaya, carrots, peppers and others) and free access to water. Individuals received food twice a day, at 08h30min and 13h30min, but no food was available after 15h30min. According to veterinarians of FZB-BH, the pair had good physical health without any disease or infection.

An ethogram was created to include behavioral data displayed by parrots (Table 1) after observing animals through the *ad libitum* sampling method (Martin & Bateson 2007), for 10 hours, during a week.

As the birds had a high degree of feather plucking, we

TABLE 1. Ethogram of behaviors performed by a pair of Golden Parakeet (*Guaruba guarouba*) at the Fundação Zoo-Botânica de Belo Horizonte, Brazil.

Behavior	Descriptions
Resting	Bird remains in resting position, alone or side by side with its partner.
Social behavior	Bird cleaning feathers of the other. Bird offering his head to the other or feeds the partner with its beak.
Vigilance	Bird is alert, guiding his head in sideways movements directing towards sounds or stimulus.
Exploring	Bird walking in over stimulus object. Bird trying to catch something like twigs, objects and other environmental stimuli without eating.
Pecking	Bird gnawed repeatedly, chewing the ID ring itself or components of the environment as the canvas enclosure, rope, perch, walls or feeder.
Manipulating and feeding	Bird holding some object, food, branch, etc. Bird watching and/or eating the object.
Locomotion	Bird moving by any form of locomotion from one place to another (walking or flying).
Vocalization	Bird performing any type of vocalization.
Preening	Bird cleaning and arranging its feathers using the beak. Bird passing beak alternately and repeatedly against the substrate. Scratching the beak or other body parts with its feet.
Individual Abnormal Behavior	Bird showing excessive feather preening (tearing off).
Mutual Abnormal Behavior	Bird showing excessive partner's feather preening (tearing off).
Not Visible	Bird is not visible to the observer.
Others	Other behaviors not described in the ethogram.

chose to use an environmental enrichment methodology developed in FZB-BH. The methodology consists in presenting several different stimuli over 4 consecutive days, in consecutive weeks, resulting in a rapid increase in behavioral diversity, and the possible solution for displaying abnormal behaviors of self-mutilation such as feather plucking (C. Cipreste *pers. comm.*).

We collected behavioral data using the scan method with instantaneous recording at sampling intervals of 30 seconds. Data collection were carried out from Monday to Friday, only once a day, in alternating times between 07h30min and 16h00min, so they could cover all periods of the individuals' activity. The study was divided into three phases: pre enrichment (before the presentation of environmental enrichment), enrichment introduction (during the introduction of enrichment items), and after enrichment (after the removal of environmental stimuli from the enclosure). According to methodology developed in FZB-BH and previously applied to other species (C. Cipreste *pers. comm.*), the study was conducted over 21 consecutive weeks without interval between the three phases.

First phase data were collected on Mondays for 120 minutes. Second phase data were collected from Monday to Thursday with duration of 30 minutes per day. Third phase data were collected on Fridays for 120 minutes. The birds did not receive environmental enrichment from Friday to Sunday. This study resulted in 42 hours of data collection in each phase, totaling 126 hours of behavioral data.

Some environmental enrichment items used were: tree branches with leaves; cinnamon pendants; pendants of rawhide chew bone with edible aniline; branches with fruit kebabs; coconut bowls with dry grass and fig; zucchini filled with fruit pieces; ice blocks with fruit juice and/or gelatin and fruit pieces; pineapple leaves with/without fruit pieces; hollowed wooden wheel filled with mashed banana and honey; baskets of twisted popsicle sticks dyed with edible aniline with mashed fruits, honey or vanilla essence, hanging cardboard boxes with dry grass and one of the following: fruit, clove, walnuts, hazelnuts or Brazil nuts. Other fruits used in enrichments depended on the availability of the FZB-BH kitchen and fruiting period. Usually, they were not part of the diet of birds (such as persimmon, strawberry, kiwi, grape and others) but were used to improve the attraction degree for the enrichment items.

Enrichment was done as follows: from Monday to Thursday several tree branches with leaves, accompanied by some of the other items mentioned above were inserted in the enclosure. The sequence of use of each item was random, but no item was repeated during the week. All items were chosen to stimulate foraging behavior and locomotion besides providing positive social interactions as, most of the time, the parrots remained inactive and frequently the social interactions resulted in feather plucking.

Due to the non-normality of the data generated by the behavioral samplings (tested with the Anderson-Darling test; Zar 1999), we compared the occurrence of behaviors through means among the three phases of the study using the Friedman Test, with a *post-hoc* Tukey Test (Zar 1999). For each phase, the mean of a given behavior was calculated as the total number of records obtained with that type of behavior by the total number of records obtained for all types of behavior. Standard errors were also estimated among the three phases of the study. All analyzes were performed by the Minitab v.12 and BioEstat v.3 programs, at significance level of 95 %.

RESULTS

All behavioral data collected in 126 hours of study and statistical significance of all behavioral categories during the three phase of study are shown in Table 2. The most frequent behaviors displayed during the pre-enrichment phase were (mean ± standard error of the number of records): "resting" (345.40 ± 12.10), "manipulating and feeding" (43.62 ± 7.20) and "vigilance" (26.76 ± 3.74). The less frequent behaviors displayed at the same phase were: "exploring" (0.00 ± 0.00), "individual abnormal behavior" (0.29 ± 0.14) and "mutual abnormal behavior" (1.29 ± 1.05). In the second phase, during the introduction of environmental enrichment, the most frequent behaviors displayed were: "resting" (252.50 ± 20.60), "exploring" (60.70 ± 11.40) and "manipulating and feeding" (54.14 ± 7.05). The less frequent behaviors displayed at this phase were: "individual abnormal behavior" (0.10 ± 0.07), "others" (0.24 ± 0.14) and "mutual abnormal behavior" (0.29 ± 0.21). Finally, after the enrichment phase the most frequent behaviors were: "resting" (326.20 ± 12.20), "manipulating and feeding" (38.95 ± 6.91) and "locomotion" (26.24 ± 2.45). The less frequent behaviors were: "exploring" (0.00 ± 0.00), "individual abnormal behavior" (0.14 ± 0.08) and "mutual abnormal behavior" (0.33 ± 0.25).

Only five behaviors differed significantly among the three phases of study. The behavior "resting" had the highest frequency displayed during the pre-enrichment phase, decreasing significantly during the use of enrichment and increased back again during the third phase (Friedman = 12.67, $p < 0.01$, Table 2). The pair did not exhibit the behavior "exploring" in the pre-enrichment but this behavior was significantly expressed during the enrichment and, after removing the stimuli, this behavior was not displayed anymore (Friedman = 31.50, $p < 0.01$, Table 2). The behavior "locomotion" was less expressed in the first phase of the study, increased significantly during the use of environmental enrichment and also after its removal (Friedman = 9.02, p < 0.01, Table 2). The behavior "vocalization" was displayed during the stimuli phase, decreasing by almost half after removal of enrichment items, but remained higher when compared to the first phase (Friedman = 7.12, p < 0.01, Table 2). The behavior "preening", decreased on the second phase but increased after the removal of stimulus (Friedman = 8.02, p = 0.02, Table 2).

All other behaviors were not significantly different among the three study phases. However, we observed that "mutual abnormal behavior" and "individual abnormal behavior" decreased over the use of enrichment stimuli and increased slightly after the withdrawal of stimulus (Friedman = 0.17, p = 0.92 / Friedman = 0.50, p = 0.78 respectively, Table 2). The behaviors "manipulating and feeding" and "vigilance" increased during the phase of the stimulus and fell after removal of the items (Friedman = 2.17, p = 0.34 / Friedman = 5.02, p = 0.08, respectively, Table 2). The behavior "pecking" decreased after removal of enrichment items and had a larger drop during the stimuli (Friedman = 3.88, p = 0.14, Table 2). Finally, the behavior "social interaction" increased during the use of environmental enrichment and even more after withdrawal (Friedman = 3.31, p = 0.19, Table 2).

TABLE 2. Mean ± standard error of the number of behavioral records and Friedman Test results for the exhibited behaviors of a pair of Golden Parakeet (*Guaruba guarouba*) during three phases: pre enrichment, enrichment introducing and after enrichment, at FZB-BH, along 21 weeks between February and July 2008 (df = 2, N = 21, α = 0.05).

Behavior	Pre enrichment	Enrichment introducing	After enrichment	Friedman	p
RE	345.40 ± 12.10	252.50 ± 20.60	326.20 ± 12.20	12.67	< 0.01*
SB	10.48 ± 1.97	14.00 ± 3.01	18.43 ± 3.11	3.31	0.19
VI	26.76 ± 3.74	35.67 ±3.95	26.52 ± 2.98	5.02	0.08
EX	0.00 ± 0.00	60.70 ± 11.40	0.00 ± 0.00	31.50	< 0.01*
PE	13.10 ± 2.35	8.05 ± 1.09	11.19 ± 1.82	3.88	0.14
MF	43.62 ± 7.20	54.14 ± 7.05	38.95 ± 6.91	2.17	0.34
LO	17.81 ± 2.05	25.52 ± 3.14	26.24 ± 2.45	9.02	0.01*
VO	3.00 ± 0.77	12.14 ± 2.45	6.38 ± 1.35	12.07	<0.01*
PR	16.67 ± 2.62	16.52 ± 2.30	25.19 ± 2.77	8.02	0.02*
IAB	0.29 ± 0.14	0.10 ± 0.07	0.14 ± 0.08	0.50	0.78
MAB	1.29 ± 1.05	0.29 ± 0.21	0.33 ± 0.25	0.17	0.92
NV	0.10 ± 0.10	0.14 ± 0.14	0.00 ± 0.00	0.07	0.96
OT	1.48 ± 1.38	0.24 ± 0.14	0.38 ± 0.33	0.02	0.99

RE = resting, SB = social behavior, VI = vigilance, EX = exploring, PE = pecking, MF = manipulating and feeding, LO = locomotion, VO = vocalization, PR = preening, IAB = individual abnormal behavior, MAB = mutual abnormal behavior, NV = not visible, OT = others

* = Significant differences, p < 0.05. (The means obtained for each behavior was the number of behavior's records divided by the number of all behavioral records. The standard error was the sample standard deviation divided by the square root of the sample size.)

DISCUSSION

In pre enrichment phase, birds remained inactive most of the time but a reduction in such inactivity was noticeable after insertion of enrichment items, since the birds began to interact with stimuli, a pattern that has been observed in other captive birds (Azevedo & Faggioli 2001, Meehan & Mench 2002, Andrade & Azevedo 2011). The birds increased movement because of their interaction with enrichment items and kept moving even after removal. This suggests that they might keep seeking for novelties in the enclosure once stimulated.

Some studies have demonstrated that the use of environmental enrichment techniques reduces stereotyped behaviors and increases behavioral repertoire of captive birds (Mason 1995, Meehan *et al.* 2003, Meehan *et al.* 2004, Andrade & Azevedo 2011). In the present study, environmental enrichment increased behavioral diversity of birds, although they continued showing feather plucking behavior. According to Swaisgood & Shepherdson (2005), sometimes environmental enrichment techniques cannot fix completely but just reduce the display of abnormal behaviors, as such behaviors can be persistent, depending on how long they have been in place or what stimulus was applied (Mason *et al.* 2007).

An increase of the category "preening" was significant after removing the stimulus and birds started plucking feathers again even before the study completion. Feather plucking may be considered an exaggerated kind of preening (Meehan *et al.* 2003). Thus, results suggesting a small increase in abnormal behaviors, both individual and mutual, could have been caused by increased "preening" carried out by birds after removing enrichment from the enclosure. We used an overexposure stimuli technique that might have over-stimulated the "preening" behavior and according to Newberry & Estevez (1997), overstimulation can produce stronger responses than natural stimulation.

Despite a few records of positive social interactions before the introduction of enrichment, most of the interactions shown by the Golden Parakeets resulted in mutual mutilation. However, the number of positive social interactions increased with the introduction of stimulus and after its removal. The use of social enrichments in environments with individuals of the same or different species can result in positive interactions (Bayne 2005). For Sandos (1999), the use of environmental enrichment techniques for captive birds decreases the attacks among individuals, since they spend more time interacting with the enrichment.

It was noticed an increase of alert behaviors during the exposure of the stimuli, whereas this situation was different from the birds routine. One of the objectives of the introduction of environmental enrichment stimuli was to create new challenges and novelties to Golden Parakeets as in the natural environment. Schaap (2002) studied *Sarcophilus harrisii* (Mammalia: Dasyuromorphia: Dasyuridae) with abnormal behavior and noted an improvement in their state of alert after the use of environmental enrichment.

The increase of vocalization was a result of using stimuli suggesting that the pair kept a closer interaction during enrichments. Apparently, vocalizations were used as alert, wakefulness and, sometimes, to request food from the partner. According to Ueno (2007), vocalizations of *Anodorhynchus hyacinthinus* (Psittaciformes: Psittacidae) characterize the emotional state of the bird, ranging from hostility to fearfulness. Nonetheless, further studies about specific vocalizations of Golden Parakeet would be necessary to verify similar findings.

It is important to mention that the enclosure's location in the extra sector within the FZB-BH might have influenced our results. The extra sector (outside the public view) shows no close characteristic to a natural environment and lacks fundamental stimulus for the development of typical behaviors of the *G. guarouba*. Therefore, we cannot eliminate the possibility that the cause of feather plucking is somehow related to the enclosure's location, once individuals have reached the FZB-BH already with this behavioral problem. Other individuals of the same species have been previously maintained in the same enclosure without presenting feather plucking. Dixon *et al.* (2008), studying *Gallus gallus* (Galliformes: Phasianidae), described that a small and sterile enclosure results in the incidence of abnormal behaviors. For Gaskins & Hungerford (2014) sometimes the enclosure size is less important than cage complexity for maintaining the animal welfare.

At the present study we focused on attempting to eliminate abnormal behaviors of a captive pair of parakeets using environmental enrichment techniques that increased their behavior diversity. Even though the abnormal behavior of feather plucking was not eliminated, the increased activity of the animals helped on reducing the display of such behaviors, which characterizes a possible improvement of the pair's welfare. We suggest that these individuals continue to participate in a weekly environmental enrichment program that creates variations on their normal routine and allows them to express more natural and diverse behavior.

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ARTICLE

Uncovering titbits for the ladies: Dusky-legged Guan males stomp out food for their females

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ABSTRACT: Guans (Cracidae) are vegetarians that feed mostly on fruits but also consume leaves, flowers, and occasionally invertebrates. They forage mostly by picking food while perched or walking on the ground. I describe here Dusky-legged Guan (*Penelope obscura*) males that stomp to uncover food in piles of plant litter on the ground. Besides feeding on uncovered titbits, the males feed their mated females that join them on the piles, both by placing food directly in bill or stomping out food that the closely following females pick. Stomping on litter piles to uncover food seems an uncommon and previously unrecorded foraging behaviour. Additionally, uncovering food for following females may be regarded as a type of courtship feeding.

KEY-WORDS: *Penelope obscura,* foraging behaviour, courtship feeding, male-female relationships, Atlantic rainforest, South-eastern Brazil.

INTRODUCTION

Guans (Cracidae) are Neotropical galliform birds that forage singly, in pairs, or small groups, mostly perched on vegetation, although some species or populations forage on the ground as well (del Hoyo 1994, Sick 1997, Zaca et al. 2006, Ottoni *et al.* 2009). Guans are vegetarians that feed on fruits (their staple diet), leaves, flowers, and occasionally invertebrates (del Hoyo 1994, Merler *et al.* 2001, Mikich 2002, Muñoz *et al.* 2007, Zaca *et al.* 2006, Parrini & Raposo 2008). While foraging on the ground, guans do not rake (scratch) the substrate with their feet as several other galliforms do, locating the food by sight instead (Sick 1997). However, some cracids occasionally scratch the ground to uncover food (del Hoyo 1994). A recent study indicates that the Dusky-legged Guan (*Penelope obscura*) feeds on human leftovers in sites close to, or within, urbanised areas (Ottoni *et al.* 2009).

I describe herein the foraging behaviour of Dusky-legged Guan males that stomp to uncover food hidden among piles of plant litter on the ground. Besides feeding on the uncovered titbits, the males feed their mated females that join them, both by placing food directly in bill or stomping out the food for the closely following females.

METHODS

The Dusky-legged Guan male-female foraging interactions were recorded at the edge of the montane Atlantic forest (22°25'54"S, 44°36'55"W, 1.143 m above sea level) in the Itatiaia range in South-eastern Brazil. This type of foraging behaviour was observed twice in September 2011, and once in September 2013. Throughout the observations, I used the "*ad libitum*" sampling method, which is adequate to record rare events (Altmann 1974). Digital photos of the guan foraging interactions are housed as vouchers in the Museu de Zoologia, Universidade Estadual de Campinas (ZUEC).

RESULTS

The ensuing description is based on the best-documented observation (15 September 2011 at mid-afternoon). A male Dusky-legged Guan was atop a pile of plant litter stomping on it with the right or the left feet (Figure 1a). This stomping caused the litter to move or slide and uncovered food such as fallen fruits, fresh plant fragments, and insects, which the bird located visually and picked with the bill. After about five min of such activity by the male, a female approached the pile and began to pick food that she located visually, but displayed no stomping. Within the first minute of such foraging, the female raised the feathers of her crest and neck, stretched her dewlap, and closely approached the male (Figure 1b). The male fed her twice, placing food directly in her bill while she was crouched with neck extended upwards (Figure 1c). This direct feeding occurred shortly after she approached the male and close to the end of foraging on the litter pile. After the first direct feeding, the female began to follow the stomping male, most of the time partially hidden under his tail (Figure 1d). At the onset of her following, the male occasionally picked a food piece and put it in front of the female or on her path (Figure 1e). Most of the time, however, the male stomped on the pile and the female picked the uncovered food right at his feet and under his vent and tail (Figures 1e-f). Eleven min elapsed from the male stomping on the pile and his leaving followed by the female (14:43-15:07 h).

FIGURE 1. A Dusky-legged Guan (*Penelope obscura*) male stomping out food and feeding his mated female. The male lifts his left leg while stomping on a pile of plant litter to uncover food (a); the female (on the left) joins the foraging male – note raised feathers on her head and neck (b); the male (on the left) feeds the female (yellow f), which is crouched with her neck extended upwards (c); the male continues to stomp on the pile uncovering food and sometimes picking and dropping it in front of the closely following female, partially hidden under his tail (d); the male stomps on the litter and the female picks food close to his feet (e); the male stomps on the edge of the pile, the female still following and picking food (f). The couple left shortly after.

DISCUSSION

Stomping on litter piles to uncover food seems an uncommon and previously unrecorded foraging behaviour for the Dusky-legged Guan, and other guans as well. Besides picking food while perched or on the ground, no other type of foraging behaviour seems reported for guans, although some cracids occasionally scratch the ground to uncover food (del Hoyo 1994, Sick 1997, Mikich 1996, Zaca *et al*. 2006, Ottoni *et al*. 2009). Stomping differs from scratching (raking), since when the bird stomps, it touches heavily the substrate with toes widely stretched and the legs do not move backwards. In contrast, most galliforms such as guineafowl and junglefowl scrape away the substrate such as leaf litter and soil to uncover or unearth food (*e.g.,* Martínez 1994, Arkive 2014a, b). Stomping seems to be performed only atop a pile of plant litter, and thus it would be rarely displayed. This apparently unusual behaviour may be a variation of scratching displayed by some cracid species (del Hoyo 1994, Sick 1997). Stomping or foot-paddling is part of the foraging repertoire of some gull species and causes earthworms to surface (Tinbergen 1962, Donnell 2008), a function superficially similar to that recorded here for the Dusky-legged Guan. Stomping behaviour by this guan may be restricted to few individuals, populations, or circumstances, as already commented for the foraging tactics of other bird species (*e.g.,* Sazima 2008, Sazima & Olmos 2009, D'Angelo & Sazima 2014).

Stomping to uncover food and the associated feeding of a following female appears to be a type of courtship feeding. In several bird species courtship includes the male offering food to the female (*e.g.,* Burton 1985, Sick 1997), and Cracinae have a ground display courtship, with males feeding females (Frank-Hoeflich *et al.* 2007). Most probably, a Dusky-legged Guan female approaching a stomping male and leaving with him after feeding for a while indicates a mated pair. I recorded a copulating pair on 17 October 2007 at the same site I observed the presumed courtship feeding. Additionally, I recorded two females with very young chicks on 22 and 23 November 2007, which agrees with an account on reproduction of the Dusky-legged Guan in South-eastern Brazil (Vasconcelos *et al.* 2006). Thus, at the study site breeding of this guan may occur as follows: courtship and mating in September-October, nesting in October-November, and rearing chicks in November-December.

I suggest here that stomping out food is an unusual type of foraging and when it is displayed in presence of a following female, this type of foraging may function as courtship behaviour. Additional studies focused on the natural history of the Dusky-legged Guan and other cracids (particularly Penelopinae) would test this assumption.

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ARTICLE

Solar worship: the Rufous-tailed Jacamar sunbathes on the ground

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ABSTRACT: Sunbathing is a comfort behaviour widespread among birds, but remains inadequately documented for jacamars (Galbulidae). Herein I briefly describe and illustrate sunbathing by the Rufous-tailed Jacamar (*Galbula ruficauda*) on a dirt road in the Atlantic forest of Southeastern Brazil. A female with worn tail tip displayed sunning behaviour after 9 min of dustbathing. The bird crouched on the ground with its back oriented towards the sun, spread the wings and remained in this posture for about 3 min, raising its head from time to time to watch flying insects. The sunning session ended with the bird ejecting a chitinous pellet. Afterwards, it flew to a perch where it preened for about 5 min before starting to chase flying insects. Sunbathing by the Rufous-tailed Jacamar is similar to that displayed by puffbirds and some woodpeckers while on the ground. Because the jacamar preened its plumage after dustbathing and sunning, it is likely that the main functions for these behaviours on the sandy ground were feather maintenance and parasite removal.

KEY-WORDS: *Galbula ruficauda*, comfort behaviour, sunning, dustbathing, Atlantic forest, Southeastern Brazil.

INTRODUCTION

Sunning or sunbathing is a comfort behaviour widespread among birds (Kennedy 1969, Mueller 1972, Burton 1985). While sunbathing, birds may display a trance-like state or condition (Mueller 1972, Cade 1973, Blem & Blem 1992) and I observed that, while in this trance, several bird species such as doves, thrushes, and flycatchers allow a close approach. Sunning can have several functions, including thermal regulation, feather maintenance, gaining vitamin D, parasite removal, and soothing irritated skin from emergence of new feathers (Kennedy 1969, Mueller 1972, Blem & Blem 1993, Clayton *et al.* 2010). Although recorded for several species of Piciformes such as woodpeckers and puffbirds (Rasmussen & Collar 2002, Winkler & Christie 2002), sunbathing remains inadequately documented for jacamars, Galbulidae (Tobias 2002). In a detailed account on life history of the Rufous-tailed Jacamar (*Galbula ruficauda*), there is no mention to sunning (Skutch 1963).

METHODS

I report here on a female Rufous-tailed Jacamar sunning on a dirt road (23°20'40"S, 44°50'38"W, 9 m. a. s. l.) in a stretch of the Atlantic forest at Ubatuba, São Paulo, Southeastern Brazil, on 17 December 2014, in the late afternoon. Throughout the observation, I used the "*ad libitum*" sampling method, which is adequate to record rare events (Altmann 1974). Digital photos of the jacamar displaying dustbathing, sunning, and regurgitating behaviours are housed as vouchers in the Museu de Zoologia, Universidade Estadual de Campinas (ZUEC).

RESULTS

I noticed a female jacamar with worn tail tip landing on the ground of a dirt road at the edge of a forest stretch at 16:33 h (air temperature 29°-30°). Immediately upon landing, the bird began a dustbathing session that lasted about 9 min (16:33-16:42 h), but was briefly interrupted three times because of people and a motorcycle moving on the road. The bird dustbathed with quick movements of one wing and the corresponding body side touching the ground and stirring the sand. It interchanged the left and right body sides and wings while dustbathing. The dust was scattered on the ruffled feathers on the back by downwards and upwards wing movements (Figure 1a). Aside from these interchanging side movements, I observed that the bird also interchanged its feet to scratch the ground backwards while dustbathing.

After dustbathing, the jacamar began sunning itself for 3 min (16:42-16:45 h). While sunning, the bird crouched on the ground with its back oriented towards the sun with its spread wings touching the ground (Figure 1b). It fluffed the plumage a little, but the feathers remained neatly arranged on the body. The bird raised its head from time to time to watch flying insects and directed the head towards the potential prey (Figure 1c). It held the bill at an angle of about 45° to 80° while watching insects flying nearby, but resumed the sunning posture afterwards without leaving the ground. The sunning session ended as the bird turned its body, opened its bill widely and ejected a chitinous pellet (Figure 1d) that contained insect remains. Afterwards, it perched on a branch and preened the feathers for about 5 min (16:46-16:51 h) before starting to chase flying insects.

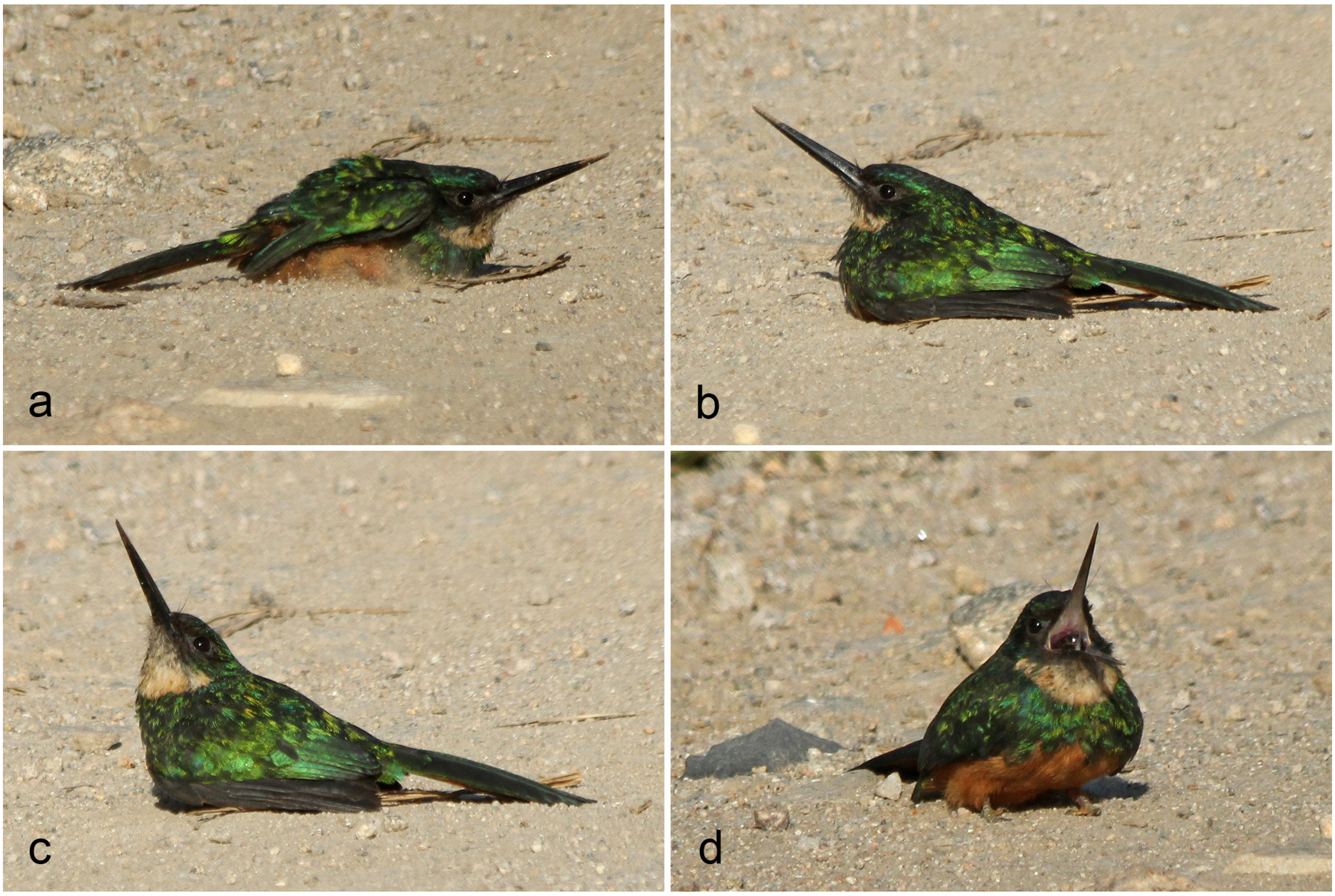

FIGURE 1. A female Rufous-tailed Jacamar (*Galbula ruficauda*) on a dirt road (23°20'40" S, 44°50'38" W, 9 m. a. s. l.) in a stretch of the Atlantic forest at Ubatuba, São Paulo, Southeastern Brazil. The bird dustbathes with movements of wings and belly towards the substrate, raising dust that accumulates on its feathers (a); after dustbathing, the bird sunbathes crouched on the ground with spread wings and back oriented towards the sun (b); the bird raises the head to watch flying insect but continues sunning, (c); opening its mouth widely, the bird regurgitates a chitinous pellet and ends the sunning session (d).

An additional record of a sunning Rufous-tailed Jacamar was obtained near the Rio Cachoeirinha (20°42'30"S, 48°51'00"W, 475 m a. s. l.), Olímpia, São Paulo, Southeastern Brazil, on 21 April 2010 at 14:31 h (D. L. Lucas Bessa, pers. comm.). The bird's feathers were wet and it oriented the chest towards the sun while perched on a twig (Figure 2). Its wings were more spread than those of the individual I recorded on the ground.

FIGURE 2. A female Rufous-tailed Jacamar (*Galbula ruficauda*) recorded near the Rio Cachoeirinha (20°42'30" S, 48°51'00" W, 475 m a. s. l.), Olímpia, São Paulo, Southeastern Brazil, sunbathes on a twig, its plumage wet and the chest oriented towards the sun. Photo by D. L. Lucas Bessa.

DISCUSSION

Sunning by jacamars seems to be poorly documented, if at all (Tobias 2002), and I am unaware of additional reports on this comfort behaviour among the Galbulidae except for a photograph of a sunbathing Rufous-tailed Jacamar perched on a branch after rain (Parasram 2009). The posture of the wings is similar to that which I recorded for the jacamar sunning on the ground, as is the direction of the back towards the sun (Parasram 2009).

What called my attention in the ground sunbathing jacamar was the head turning towards flying insects while the bird was sunning. While perched and hunting, most jacamar species direct their attention upwards and hold the bill at an angle of about 45° (Tobias 2002), and the sunning bird reported here was no exception even if unwilling to leave the ground.

Compared with the sunning posture recorded for Piciformes such as woodpeckers (Winkler & Christie 2002), the wings of jacamars tend to be less spread and the tail is not spread, a trait observed for another galbulid, the Three-toed Jacamar, *Jacamaralcyon tridactyla* when perched (T. A. Mello Júnior pers. comm.). The Acorn Woodpecker *Melanerpes formicivorus* sits with wings partially spread while sunbathing and apparently falls asleep (= trance?) for a few minutes (Koenig *et al.* 1995). I did not observe the jacamar orienting the side of the head towards the sun as some woodpeckers and several bird species do (Burton 1985, Winkler & Christie 2002, pers. obs.). These differences may be due to the very small sample of sunning jacamars (Parasram 2009, this paper) or they are characteristic of galbulids. Further natural history-oriented observations would clarify this subject.

Dustbathing is recorded among galbulids (Tobias 2002), but I was unable to find an adequate description of this behaviour. Some species of woodpeckers of the genus *Colaptes* dustbathe stirring the soil with the bill (Kilham 1975, pers. obs.), whereas I recorded ground scratching with the feet during the dustbathing of the jacamar, a behaviour that may seem unexpected for a bird with small feet (Tobias 2002). Galbulids regularly regurgitate pellets of chitinous parts of insects (Tobias 2002), but again I was unable to find information about under which circumstances they display this behaviour. Ejecting pellets of undigested food is a behaviour often observed in several bird species after sessions of preening or resting (pers. obs.).

The presumed or demonstrated functions of sunning include thermal regulation, feather maintenance, gaining vitamin D, parasite removal, and soothing irritated skin from emergence of new feathers (Kennedy 1969, Mueller 1972, Blem & Blem 1993, Clayton *et al.* 2010). Although some or all of these functions are possible explanations for sunning, only control of feather parasites has been experimentally demonstrated (Blem & Blem 1993, Clayton *et al.* 2010). Dustbathing possibly has some of the functions suggested or demonstrated for sunning, *e.g.*, feather maintenance and parasite removal (Kelso 1978, Juana 1992, Sick 1997). Because the jacamar preened the plumage after dustbathing and sunning, it seems likely that the main functions for its behaviour on the sandy ground were feather maintenance and parasite removal (Kelso 1978, Juana 1992, Blem & Blem 1993, Clayton *et al.* 2010).

Sunning behaviour may be actually rare among jacamars, but there remains the possibility that some field ornithologists do not pay proper attention to widespread and "commonplace" behaviours such as feather maintenance, bathing, scratching, and other comfort behaviours (see Kelso 1978, Sazima 2011).

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ARTICLE

Bee in the nose: raptors let or let not stingless bees enter their nostrils

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ABSTRACT: Relationships between birds and social insects include birds following ants, birds nesting close to active colonies of wasps or bees, and nesting inside termitaria. A little known relationship between birds and colonial insects is that of stingless bees (Meliponina) entering the nostrils of hawks and owls. Herein I report on a stingless bee entering the nostrils of the Roadside Hawk (*Rupornis magnirostris*), and on avoiding behaviours displayed by the same hawk species and a Burrowing Owl (*Athene cunicularia*) in presence of stingless bees hovering in front of their faces. The bees probably were seeking mucus inside the raptors' nostrils, as already reported for a few birds of prey. Avoiding behaviour seems a novelty in this relationship between raptors and bees. The role stingless bees play in the lives of some bird species remains little known, and merits closer attention by field ornithologists and apidolologist.

KEY-WORDS: *Rupornis magnirostris*, *Athene cunicularia*, Meliponina bees, mucus foraging, avoiding behaviour.

INTRODUCTION

The relationships between birds and social insects include birds that follow ants, birds that nest on branches close to active colonies of wasps or bees, and birds that nest inside active or vacant termitaria (Myers 1935, Willis & Oniki 1978, Brightsmith 2000, Quinn & Ueta 2008, Sazima & D'Angelo 2015. A little known relationship between birds and colonial insects is that of stingless bees (Meliponina) entering the nostrils of hawks and owls to take mucus (Lobato *et al.* 2007). However, this relationship remains little known and I am unaware of any reference on the subject other than the short report by Lobato *et al.* (2007) and a brief mention of this raptor-bee relationship based on claims by indigenous people in Northern Brazil (Santos & Antonini 2008). Therefore, I report herein on a stingless bee entering the nostrils of the Roadside Hawk (*Rupornis magnirostris*), and on avoiding behaviours displayed by the same hawk species and a Burrowing Owl (*Athene cunicularia*) in presence of stingless bees hovering in front of their faces.

METHODS

I recorded two encounters of stingless bees with hawks at an urban recreational park (22°48'42"S, 47°04'26"W, 587 m a.s.l) in Campinas, São Paulo, Southeastern Brazil, on 19 November 2007 and 22 February 2015 at midmorning (8:59 and 9:35 h respectively). Additionally, I recorded an encounter of a stingless bee with an owl at the campus of a local university (22°49'23"S, 47°04'01"W, 620 m a.s.l) in Campinas, on 3 January 2010 at late morning (10:32 h). I observed the birds through a 70-300 mm telephoto lens mounted on a camera from a distance of 2-5 m. I used the "*ad libitum*" and "sequence" observational samplings (Altmann 1974), which are adequate to record rare or fortuitous events. Bee's sizes were estimated by enlarging the digital photos to actual measurements of the raptors' bill length taken from museum specimens (3 adult hawks, 1 young owl) and measuring the total length of the insects with a flexible scale directly on the screen. Digital photos of the hawks and the owl interacting with stingless bees are on file in the Museu de Zoologia, Universidade Estadual de Campinas (ZUEC).

RESULTS

One encounter between an unidentified, small (*ca.* 4 mm) Meliponina bee and an adult Roadside Hawk began with the bee hovering in front and above the cere of the bird (Figure 1a), then landing on the left nostril (Figure 1b) and performing brushing movements with its forelegs to scrape what seemed dry mucus. Afterwards, the bee moved to the right nostril (Figure 1c), where it performed

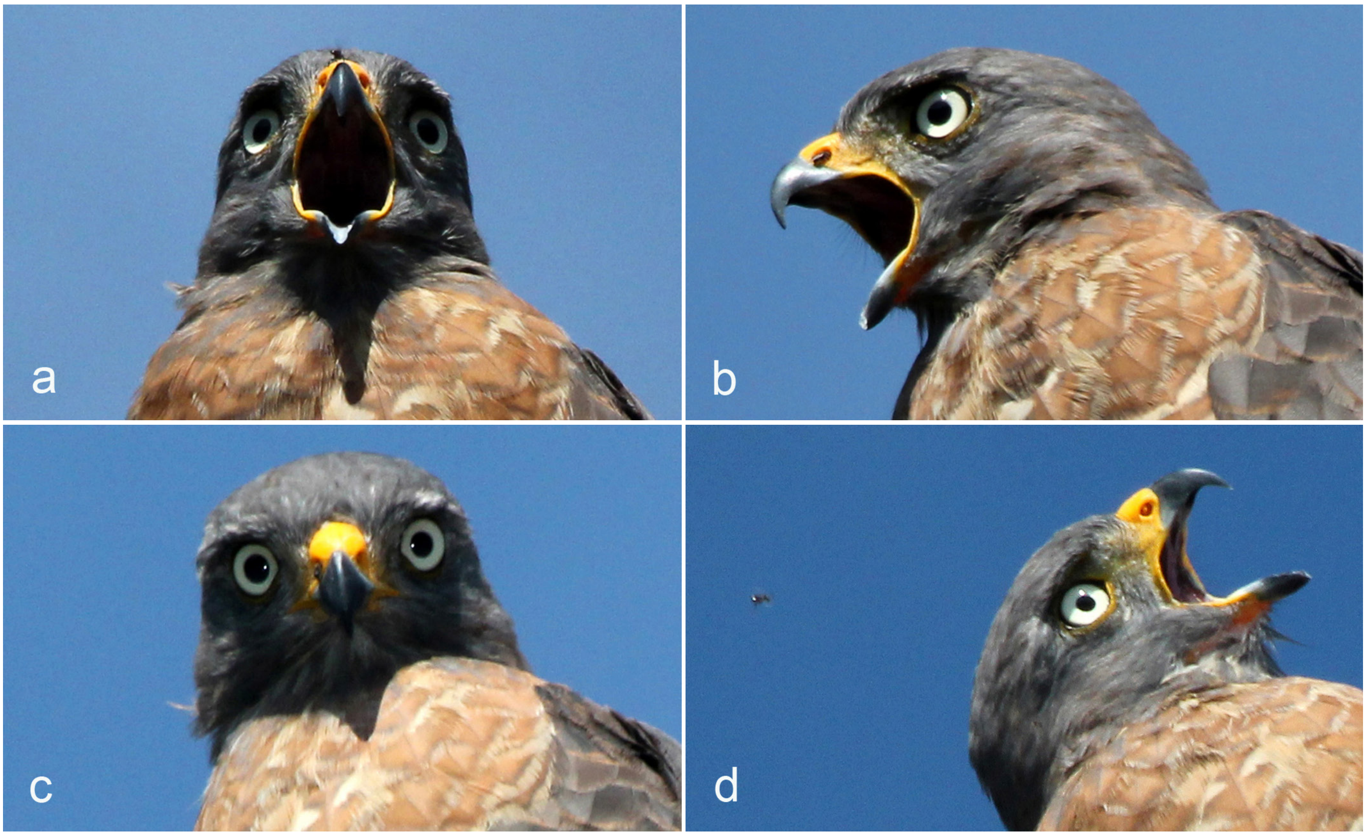

FIGURE 1. A stingless bee (Meliponina) visits the nostrils of an adult Roadside Hawk (*Rupornis magnirostris*). The bee hovers close to the cere (a) and then alights in the left nostril (b); the bee is now in the right nostril (c), and hovers again near the hawk's head (d).

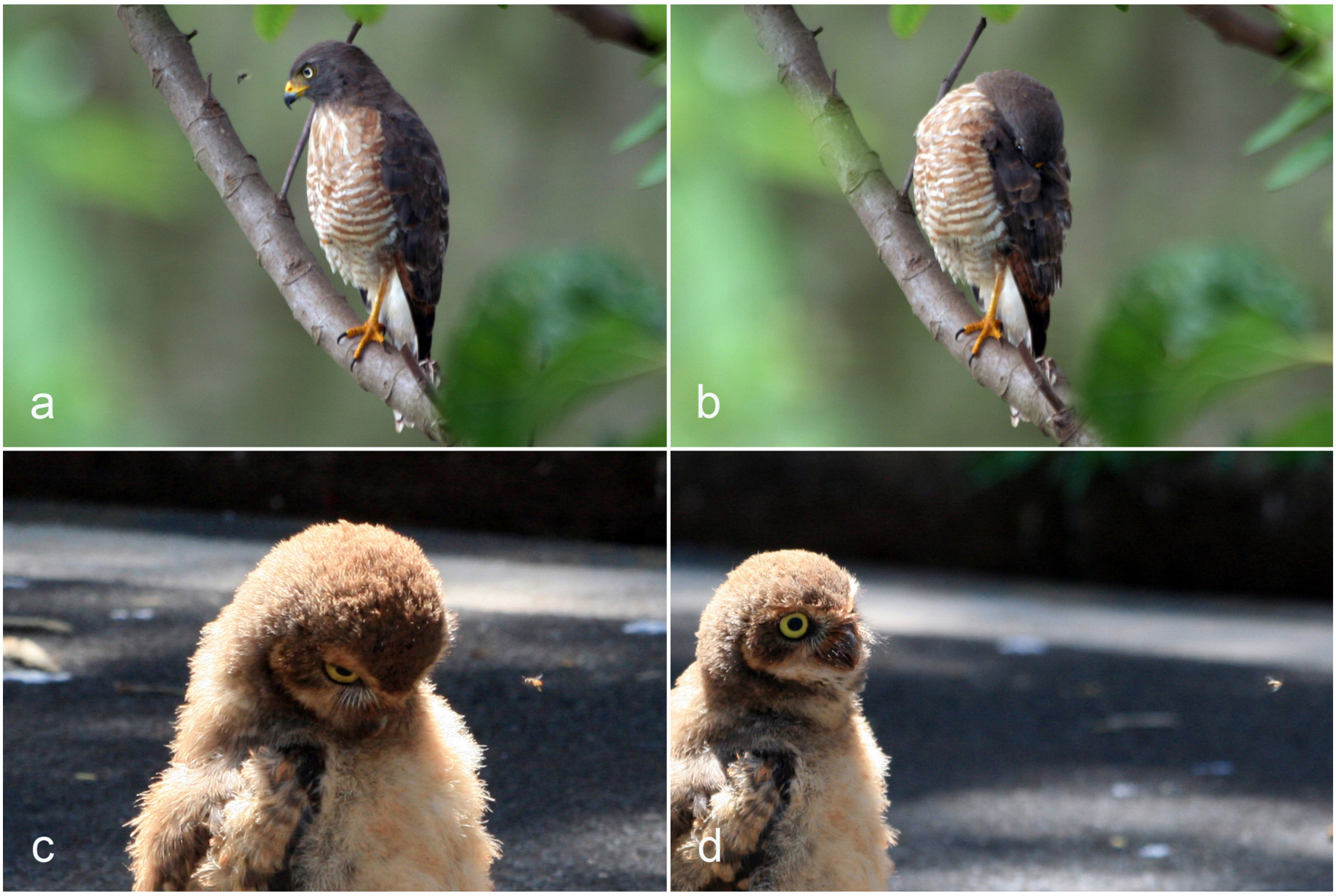

FIGURE 2. Stingless bees (Meliponina) approaching an adult Roadside Hawk (*Rupornis magnisrostris*) and a young Burrowing Owl (*Athene cunicularia*), and the birds' response. Upon noticing the hovering bee (a), the hawk hides most of its bill among the wing coverts (b). The owl watches the bee closely (c), and bill-snaps at the bee, which retreats (d).

similar leg movements. The bee left the nostril and began to hover again near the hawk's head (Figure 1d), but had no opportunity to land because the bird took wing. The interaction lasted *ca*. 1 min.

Another encounter between a larger (*ca*. 10 mm) stingless bee, apparently *Trigona* sp., and an adult Roadside Hawk also began with the bee hovering in front of the bird's head (Figure 2a). Upon noticing the bee, the hawk first lowered its head and then hid most of its bill between the wing coverts (Figure 2b). This behaviour apparently discouraged the bee, which retreated from the proximity of the bird. The interaction lasted *ca*. 1 min.

One encounter between an unidentified, small (*ca*. 5 mm) Meliponina bee and a juvenile Burrowing Owl began with the bee approaching the bird and hovering in front of its head. The bird noticed the bee at once, lowered its head and watched the insect closely (Figure 2c). Then the apparently disturbed owl bill-snapped 2-3 times towards the bee, which retreated (Figure 2d). The interaction lasted *ca*. 30-40 sec.

DISCUSSION

From the three encounters of raptors with stingless bees recorded here, only one adult Roadside Hawk appeared to tolerate, or perhaps even allow, the bee to enter its nostrils and scrap mucus there. Alternatively, instead of letting the bee to enter its nostrils, the hawk could simply be undisturbed with the bee's presence. Since the bird remained in plain view and did not show signs of disturbance due to the observer and two other people standing by, distraction seems an unlikely cause for the hawk's absence of aversive behaviour towards the bee. Whatever the cause, the bee successfully obtained the resource it was seeking and reduced the mucus in the hawk's nostrils. Reduction of secretion in nostrils improve breathing in captive raptors and is viewed as an instance of facultative mutualism between birds of prey and stingless bees (Lobato *et al*. 2007). These authors report on seven species of hawks, including *R. magnirostris*, and two owl species whose nostrils are visited by Meliponina bees to collect mucus as a source of proteins and minerals (Lobato *et al*. 2007). Based on claims of indigenous people in Northern Brazil, Santos & Antonini (2008) mention that a stingless bee species visits the beak and nostrils of captive Harpy Eagle (*Harpia harpyja*) to collect food there. To obtain nutrients or nest material, stingless bees collect the most unusual sources, including carrion, faeces, urine, blood, human sweat, and ashes (Roubik 1982, 1992, Santos & Antonini 2008, IS pers. obs.). Thus, collecting mucus should not come as a surprise for the versatile Meliponina, even if to obtain this material the bees must enter the nostrils of raptors.

The apparent avoidance behaviour displayed by one adult Roadside Hawk (lowering the head and hiding most of the bill) might be related to the larger size of the bee. Although the bee's size would allow it to enter the bird's nostrils, even if partially, its presence there may well be a nuisance to the hawk. Since the hawk was not preening its plumage before or after the bee arrival, its head lowering and hiding the bill was unrelated to this comfort behaviour (Marks *et al*. 1999). The response of the juvenile Burrowing Owl differs from that of the hawk basically by the bird's bill-snapping towards the hovering bee. Similarly, the young owl was not preening its plumage before or after the bee arrival. Bill-snapping (or bill-clapping) is a common response of owls to individual disturbance (Gehlbach 2009), and may partly explain the young bird's reaction towards the bee. Avoidance behaviour seems a novelty in the relationship between raptors and stingless bees (Lobato *et al*. 2007).

In conclusion, it seems that raptors let or let not stingless bees in. The outcome may depend on various circumstances, including the predisposition (or tolerance) of the bird, the bee size relative to the bird, and the apparent disturbance caused by the bee to the bird. The role stingless bees play in the lives of some bird species remains little known, and this relationship ought to be studied both in the field and in captivity (Lobato *et al.* 2007). I suspect that the association of birds and stingless bees is not restricted to raptors, and other bird groups may be involved. Natural history-oriented studies may disclose additional bird species whose nostrils are visited by stingless bees. To detect a tiny bee entering the nostrils of a bird in the field is admittedly a difficult task, but ornithologists and apidologists alike may help to unravel this captivating relationship between birds and bees.

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ARTICLE

Population trends and conservation of the Mangrove Rail

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ABSTRACT: The Mangrove Rail occupies only mangrove areas in South America. Though present in one of the most endangered forests in the world, there is little data available on the Mangrove Rail. In this paper, I present local population trends and the latest population density estimates for the Mangrove Rail in an urban mangrove area based on two years of fieldwork conducted on the Island of Santa Catarina, southern Brazil. I have also revised the global conservation status of the Mangrove Rail based on literature and specimen records. Surveys were conducted monthly at 10 stations along a 4 km-transect. The maximum number of individuals detected was 17 (2012). Total density was around 2 rails/ha, although a significant increase in population occurred when the surveyed area developed from 8.7 ha to 43 ha. A strong relationship between the presence of rails records and mangrove extension was observed and already expected. Altogether, the Mangrove Rail occurs in an extent of 19,615 km² and an area of 12,455 km² in South America, strictly associated with mangrove forests under severe pressure by deforestation, therefore qualifying as Vulnerable at a global level according to IUCN criteria. The results presented herein reinforce the importance of preserved wetlands for the conservation of the Mangrove Rail as well as of mangrove restoration initiatives since even areas of human intervention can be a good alternative to future adaptive management strategies and the conservation of this endangered species.

KEY-WORDS: Density, occupancy, Clapper Rail, *Rallus longirostris*, mangrove, South America.

INTRODUCTION

The Mangrove Rail (*Rallus longirostris*) was recently split from the closely related rails *R. crepitans*, *R. elegans*, *R. obsoletus* and *R. caribaeus*, and its distribution is now recognized as occurring on the eastern and western coasts of South America (Maley & Brumfield 2013). The Mangrove Rail ranges from the latitudes 13°N in the northern coast of Venezuela to latitudes 3°S in Peru and 28°S in southern Brazil, with seven currently recognized subspecies (Rosário 1996, Taylor 1996, Sick 1997, Ridgely *et al.* 2005, Maley & Brumfield 2013). Unlike other *Rallus*, the Mangrove Rail is restricted to mangrove areas, and not found in salt marshes as their closely related species in Central and North America (Eddleman & ConWay 1998, Maley & Brumfield 2013).

The Brazilian coastline stretching from Pará to Santa Catarina holds available habitat with documented records of the Mangrove Rail (Rosário 1996, Lees *et al.* 2014). However, there are no studies available on the species' population trends, current distribution, threats, and other aspects. This overall lack of knowledge also applies to French Guyana, Suriname, Guyana, Trinidad and Tobago, Venezuela, Colombia, Ecuador, and Peru, where the species is also found (Taylor 1996, Sick 1997, Ridgely *et al.* 2005, Sigrist 2009, Maley & Brumfield 2013).

The state of Santa Catarina in Brazil is the only geopolitical unit to regard the Mangrove Rail as a Vulnerable species due to its dependence on mangrove areas (CONSEMA 2011). In contrast, lists of endangered species throughout South America have not included this species or any of its subspecies in the endangered categories. However, it is well known that mangrove areas are at great risk, due to anthropogenic pressure by landfills, settlements, shrimp farming, predatory fishing, dumping of waste, and other threats (Lugo & Snedaker 1974, Cintrón & Schaeffer-Novelli 1992, Valiela *et al.* 2001, MMA 2003, Vieira *et al.* 2011, 2012). Herein, this paper presents population trends and density estimates for *Rallus longirostris* in an urban mangrove area on the Island of Santa Catarina, southern Brazil, in addition to revising the species' conservation status at a global level based on distributional records according to the IUCN criteria (IUCN 2011, 2012).

MATERIAL AND METHODS

Study area

South America holds 26% of the mangrove forests in the world, with most part of these forests occurring along the Brazilian coastline (Valiela *et al.* 2001, Magris & Barreto 2010, Giri *et al.* 2011, Maley & Brumfield 2013). Mangrove areas in South America with known occurrence of the Mangrove Rail range from latitudes 13°N in the northern coast of Venezuela to latitudes 3°S in Peru and 28°S in southern Brazil, including the coastline of Brazil, French Guyana, Suriname, Guyana, Trinidad and Tobago, Venezuela, Colombia, Ecuador, and Peru (Valiela *et al.* 2001, Magris & Barreto 2010, Giri *et al.* 2011, Maley & Brumfield 2013).

Near the extreme southern limit of the Mangrove Rail distribution, the Island of Santa Catarina has seven main mangrove patches distributed along two main bays (*pers. obs.*). Located in the southern bay, the Mangrove of Pirajubaé is protected by the Marine Extracting Reserve (RESEX) of Pirajubaé, and had spread northern along the *Saco dos Limões* Bay (27°36'S and 48°32'W; 27°38'S and 48°32'W; Figure 1). Mangrove colonization along this bay is related to landfill establishment. Mangroves either naturally colonized the landfill or were planted between 1997 and 1998 to ensure that the area would not silt (Macedo 2003). This landfill was established for the construction of the Southern Expressway in 1995 (Trindade 2000), and had 43 ha of mangroves, as well as a salty lagoon, directly influenced by urban area from 2009 onwards (Figure 1).

Surveys

Population trends were based on data collected in September 1994 (ENGEVIX 1994), as well as from April 2000 to April 2001, and December 2002 to December 2003 (Rosário 2004). Additionally, a two-year long fieldwork was conducted between October 2009 and September 2010, and October 2011 and September 2012. These surveys were conducted monthly at 10 stations (within a 100 m radius) separated from each other by at least 300 m along a single 4 km-transect (an adaptation of Hinojosa-Huerta *et al.* 2008), with a total sampling effort of 214 hours. Playback was not used due to continuous frequency of natural callings. Yearly abundance indexes were calculated by dividing the number of Mangrove Rail contacts per the number of point-counts carried out each year (Hinojosa-Huerta *et al.* 2008). A robust regression from the average number of individuals per month against year (1994 to 2012) was used to estimate population trends. The Spearman correlation coefficient (rs) measured the relationship between available mangrove area and the average number of individuals detected per year. Population density was estimated for each year and based on the extent of mangrove area obtained from aerial photographs (PMF 2014) and measured by Google Earth Pro 4.2 (Google 2009). Population density was estimated using the Distance Sampling 6.0 software (Thomas *et al.* 2010). Estimates were stratified and based on Conventional Distance Sampling. A negative exponential rate model for the detection function was fixed against the records using a cosine function and assuming certainty of detection and measurements (Thomas *et al.* 2010). The

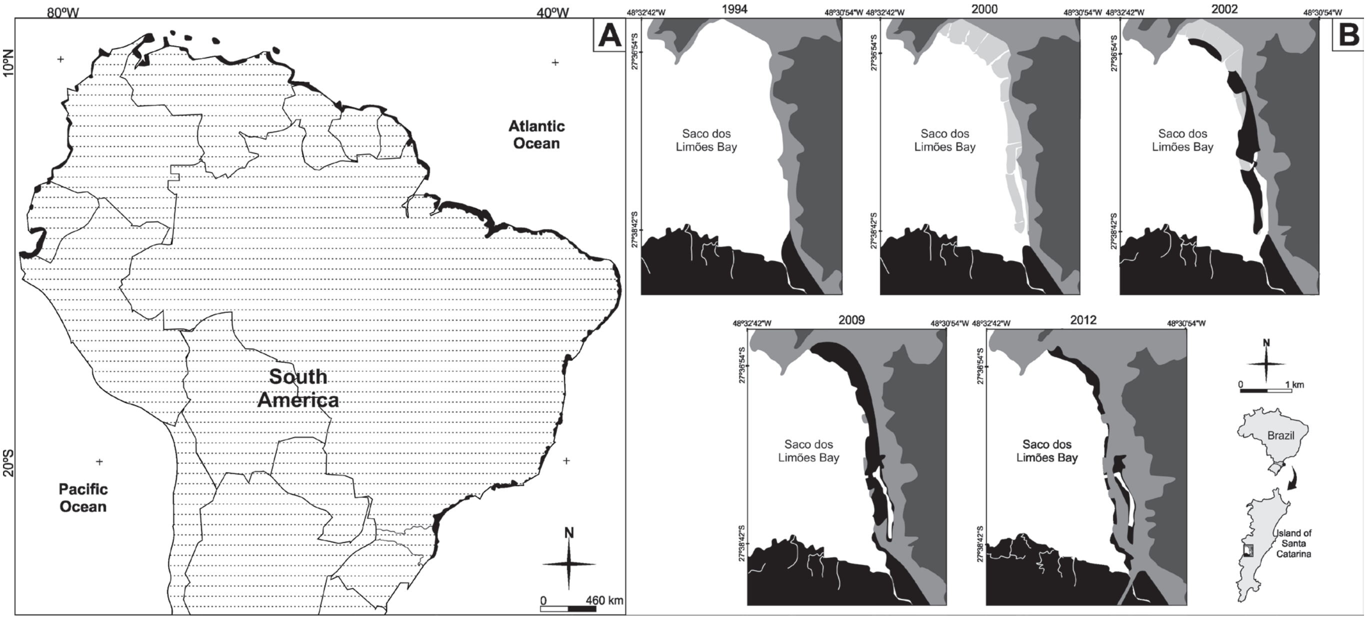

FIGURE 1. A) Distribution of mangrove forests in South America; and **B)** local landscape changes occurring between 1994 and 2012 along the Southern Expressway on the Island of Santa Catarina, southern Brazil. **Legend:** mainland (dotted), water (white), mangroves (black), landfill (light grey), urban area (middle grey), and Atlantic forest (dark grey). Maps based on Giri *et al.* (2011) and PMF (2014).

raw minimum and maximum numbers of rails observed per year were also considered.

Conservation

The Mangrove Rail global conservation status was revised according to IUCN criteria and categories (see IUCN 2011, 2012 for more details and definition of concepts). Range and population sizes, habitat threats and specificity, and population trends data presented herein as well as obtained from the literature, were contrasted against IUCN criteria and categories.

Global and national extents of occurrence for the Mangrove Rail were indirectly estimated based on mangrove forest cover in South America (based on Valiela *et al.* 2001, Cumana *et al.* 2010, Magris & Barreto 2010, and Giri *et al.* 2011) due to the species' strict association with mangroves (Holliman 1978, Taylor 1996, Sick 1997, Ridgely *et al.* 2005, Maley & Brumfield 2013) and known absence from salt marshes at latitudes higher than 28°S in southern Brazil (Rosário 1996, Sick 1997, Ridgely *et al.* 2005). Literature, web, and museum records (Figure 2) were used to confirm the Mangrove Rail area of occurrence within the estimated mangrove forest distribution. Since two major gaps of Mangrove Rail records were identified (between Bragança in Brazil and Cayenne in French Guyana, and between Guajiras in Colombia and Cojimíes in Ecuador), they were subtracted from the mangrove forest area cover in South America to obtain the species' area of occurrence. Area measurements were obtained from literature (Bacon 1993, Valiela *et al.* 2001, FAO 2005, Cumana *et al.* 2010, Magris & Barreto 2010, Giri *et al.* 2011, Anthony & Gratiot 2012) and confirmed or corrected with Google Earth Pro 4.2 (Google 2009).

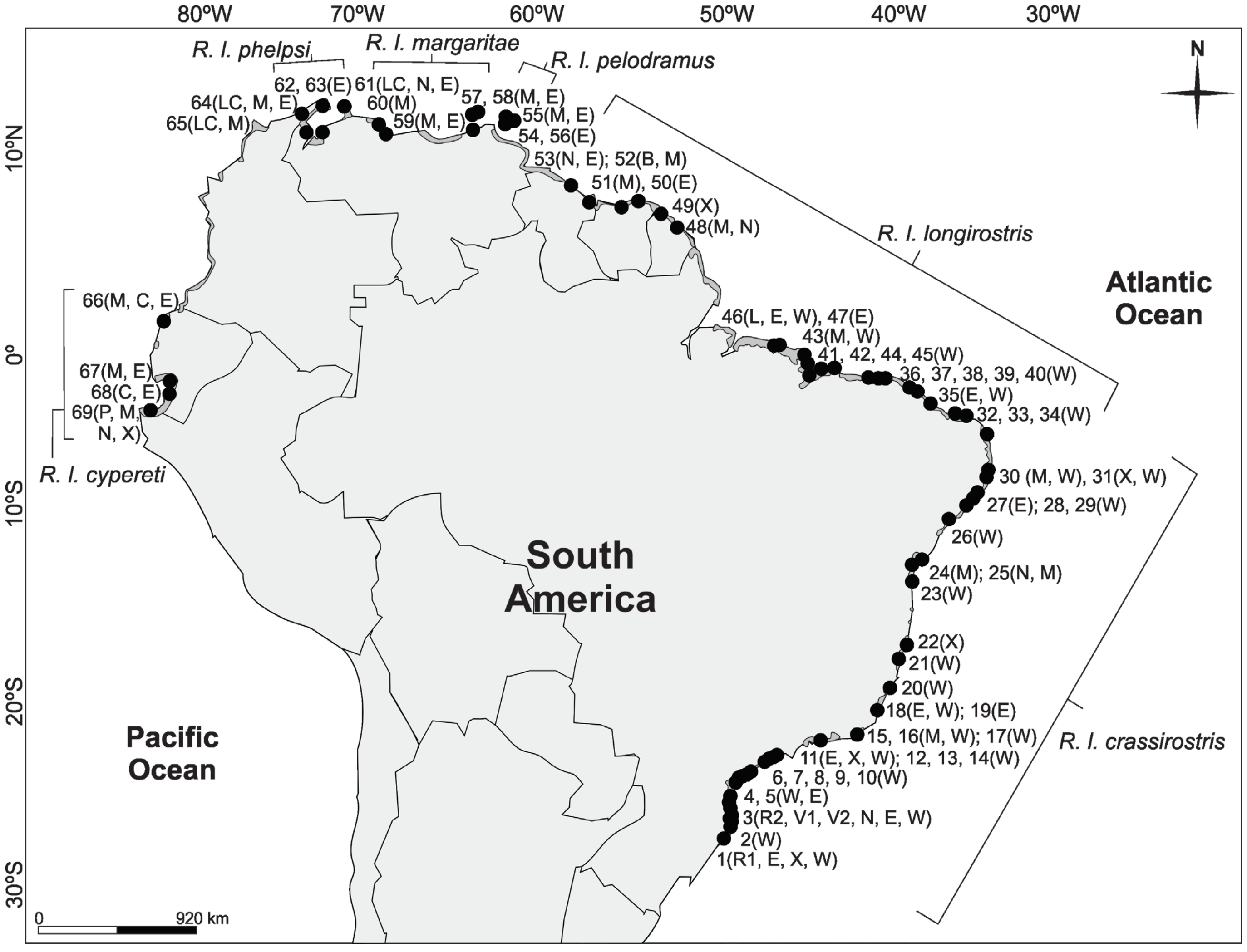

FIGURE 2. Occurrence of the Mangrove Rail (*Rallus longirostris*) and its subspecies in South America based on Maley & Brumfield (2013) and data compiled herein. Localities: 1 = Laguna (SC), Brazil; 2 = Palhoça (SC), Brazil; 3 = Florianópolis (SC), Brazil; 4 = Joinville (SC), Brazil; 5 = São Francisco do Sul (SC), Brazil; 6 = Morretes (PR), Brazil; 7 = Guaratuba (PR), Brazil; 8 = Guaraqueçaba (PR), Brazil; 9 = Antonina (PR), Brazil; 10 = Santos (SP), Brazil; 11 = Peruíbe (SP), Brazil; 12 = Itanhaém (SP), Brazil; 13 = Ilha Comprida (SP), Brazil; 14 = Cananeia (SP), Brazil; 15 = Iguapé (SP), Brazil; 16 = Rio de Janeiro (RJ), Brazil; 17 = Campo dos Goytacazes (RJ), Brazil; 18 = Cabo Frio (RJ), Brazil; 19 = Arraial do Cabo (RJ), Brazil; 20 = Vitória (ES), Brazil; 21 = Caravelas (BA), Brazil; 22 = Canavieiras (BA), Brazil; 23 = Ituberá (BA), Brazil; 24 = Jaguaripe (BA), Brazil; 25 = Salvador (BA), Brazil; 26 = Entre Rios (BA), Brazil; 27 = Santa Luzia do Itanhy (SE), Brazil; 28 = Aracaju (SE), Brazil; 29 = Pacatuba (SE), Brazil; 30

= Recife (PE), Brazil; 31 = Sirinhaém (PE), Brazil; 32 = Natal (RN), Brazil; 33 = Macau (RN), Brazil; 34 = Grossos (RN), Brazil; 35 = Icapuí (CE), Brazil; 36 = Aquiraz (CE), Brazil; 37 = Caucaia (CE), Brazil; 38 = Paracuru (CE), Brazil; 39 = Jijoca de Jericoacoara (CE), Brazil; 40 = Camocim (CE), Brazil; 41 = São José de Ribamar (MA), Brazil; 42 = Raposa (MA), Brazil; 43 = São Luís (MA), Brazil; 44 = Alcântara (MA), Brazil; 45 = Apicum-Açu (MA), Brazil; 46 = Bragança (PA), Brazil; 47 = Ajuruteua (PA), Brazil; 48 = Cayenne (Cayenne), French Guyana; 49 = Awala-Yalimapo (Awala-Yalimapo), French Guyana; 50 = Warappa Creek (Commewijne), Suriname; 51 = Diana Creek (Paramaribo), Suriname; 52 = Berbice River (East Berbice-Corentyne), Guyana; 53 = Georgetown (Demerara-Mahaica), Guyana; 54 = Nariva (Saint Andrew), Trinidad and Tobago; 55 = Caroni (Caroni), Trinidad and Tobago; 56 = Oropouche (Princes Town), Trinidad and Tobago; 57 = Puerto Cruz (Anzoátegui), Venezuela; 58 = Boca del Río (Nueva Esparta), Venezuela; 59 = Cumaná (Sucre), Venezuela; 60 = Puerto Cabello (Carabobo), Venezuela; 61 = Morrocoy (Falcón), Venezuela; 62 = Pueblo Nuevo (Falcón), Venezuela; 63 = Sabaneta de Palmas (Zulia), Venezuela; 64 = Maracaibo (Zulia), Venezuela; 65 = Uribia (La Guajira), Colombia; 66 = Cojimíes (Manabi), Ecuador; 67 = Guayaquil (Guayas), Ecuador; 68 = Churute (Guayas), Ecuador; 69 = Tumbes (Tumbes), Peru. Sources: B = Braun *et al.* (2000); C = Coopmans *et al.* (2004); E = www.eBird.org; L = Lees *et al.* (2014); LC = Lira & Casler (1979); M = museum voucher on www.ornisnet.org; N = voucher in the Natural History Museum at Tring; P = Parker *et al.* (1995); R1 = Rosário (1996); R2 = Rosário (2004); V1 = Vieira *et al.* (2014); V2 = Vieira (this study); W = www.wikiaves.com.br; X = www.xeno-canto.org.

RESULTS

Population trends

The minimum number of detections was 1 individual recorded during 2009, and the maximum number was 17 recorded during 2012 (Table 1). In mangroves planted between 1997 and 1998, the first records of Mangrove Rail did not occur until 2002 (Table 1). Mangrove Rail colonization of the whole mangrove area along the Southern Expressway took 10 years, from the first to the latest records (Table 1). The density of Mangrove Rails as an established population at the study area was 2 individuals per hectare (Table 1). As expected, the Spearman coefficient showed a very strong correlation between mangrove area development and Mangrove Rail population sizes ($rs = 1$; $p = 0.016$). A regression clearly indicated significant population increase ($y = 0.5736x – 0.9014$, $r^2 = 0.86$, $t = 44.57$, $p = 0.02$) through time.

TABLE 1. Number of Mangrove rails detected in the urban mangrove area along the Southern Expressway, Island of Santa Catarina, southern Brazil between 1994 and 2012.

	Density (rails/ha)	Average number of rails	Minimum number of rails	Maximum number of rails	Mangrove area (ha)
1994	0	0	0	0	0
2000 - 2001	0	0	0	0	0
2002 - 2003	2.1	1.5	0	4	8.7
2009 - 2010	1.4	3.2	1	8	27.1
2011 - 2012	2.0	7.2	3	17	43.5

Population size and colonizing time were probably influenced by mangrove immaturity until 2002 (Figure 3), when the first Mangrove rails were observed around the salty lagoon, the nearest formation to the Mangrove of Pirajubaé (Figure 3; Rosário 2004). From 2009 to 2010, densities were similar throughout the studied area (Figure 3). However, greater densities occurred where mangroves were more developed after 2011 (Figure 3).

Global Conservation

Literature records and vouchers of Mangrove Rail indicated occurrence at 69 localities throughout South America (Figure 2). Most of them (n = 46) were situated in Brazil (Figure 2). All records were taken in mangrove ecosystems. No Mangrove Rail records came from areas of salt marshes. Most mangrove forests with confirmed records are described as having formations of *Spartina* spp., which is often used by the Mangrove Rail to build nests and protect itself from predators (*pers. obs.*). The overall distribution of records confirmed the initial expectation of the Mangrove Rail being restricted to the extent of 19,615 km² of mangrove forests in South America (Table 2). However, the Mangrove Rail apparently does not occur continuously throughout South American mangroves (Figure 2), since two major distributional gaps were found: 1) between Bragança, Pará (Brazil) and Cayenne (French Guyana); and 2) between Guajiras (Colombia) and Cojimíes (Ecuador). Therefore, the estimated extent of occurrence for the Mangrove Rail drops to 12,455 km² when these gaps are discounted from the total mangrove forest cover of South America (Table 2).

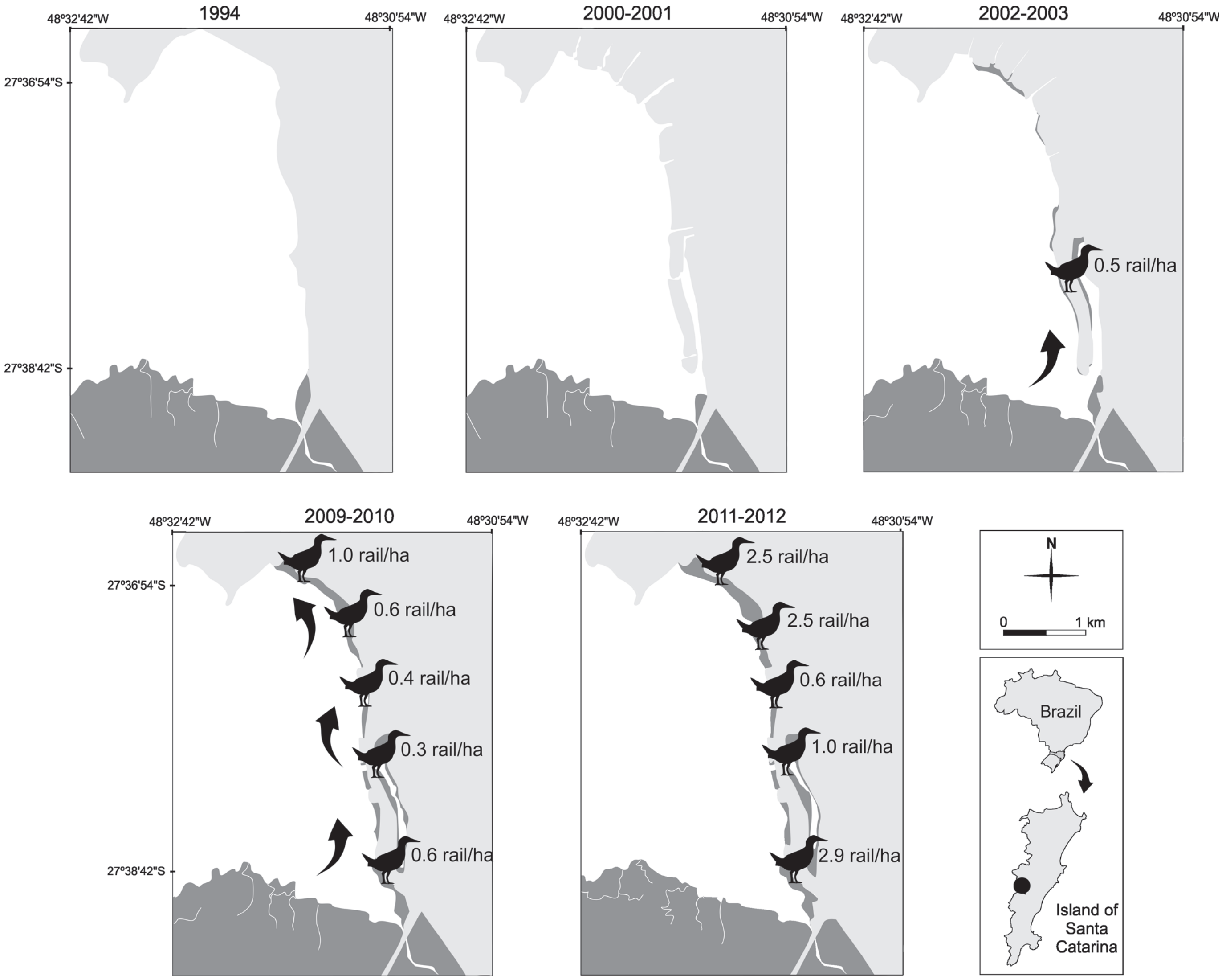

FIGURE 3. Density per hectare, probable direction of colonization (black arrows) and distribution of Mangrove rails between 1994 and 2012 along the Southern Expressway, Island of Santa Catarina, Brazil.

TABLE 2. Area of mangrove forests estimated in South America based on literature records and validated with Google Earth Pro 4.2 (Google 2009).

Country	**Mangrove area (km²)**	**Reference**
Brazil	11,114	Magris & Barreto (2010)
Colombia	3,580	Valiela *et al.* (2001)
Ecuador	1,620	Valiela *et al.* (2001)
Venezuela	1,380	Cumana *et al.* (2010)
Suriname	900	Correction of FAO (2005) who estimated 981.21 km² in 2002.
French Guiana	760	Valiela *et al.* (2001)
Guyana	160	Anthony & Gratiot (2012)
Peru	51	Valiela *et al.* (2001)
Trinidad and Tobago	50	Correction of Bacon (1993) who estimated 70 km² in 1992.
TOTAL IN SOUTH AMERICA	19,615	

Records of Mangrove rails in Peru, Ecuador and Trinidad and Tobago were inside or nearby the protected areas of the National Sanctuary Manglares de Tumbes (Parker *et al.* 1995), Ecological Reserve of Manglares de Churute (Coopmans *et al.* 2004), and Caroni Swamp National Park (voucher MVZ Egg8005 on ORNIS), respectively. In Venezuela, the Morrocoy and the Laguna de la Restinga national parks preserve mangroves areas, and both have records of Mangrove rails (Figure 2). Guyana has Coppename Nature Preserve and Wia-wia Nature Preserve protecting mangroves, but available Mangrove Rail records were outside these areas in Georgetown and Berbice (Figure 2). Records of Mangrove rails in Colombia come from Guajiras, on the border with Venezuela, and outside the six national parks (Sanquianga, Tairona, Ensenada de Utría, MacBean Lagoon, Isla Salamanca, and Uramba Bahía Málaga) that protect mangroves throughout the Colombian coastline (MADS 2015).

Brazil has dozens of protected areas covered with mangrove forests with different sizes (ICMBIO 2011). Nevertheless, these protected areas may or may not allow human activities ranging from sustainable use to industrial parks (ICMBIO 2011). According to Magris & Barreto (2010) and ICMBIO (2011), Brazil has six large protected mangrove forest areas (Biological Reserve of Lago do Piratuba and Environmental Protection Areas of Reentrâncias Maranhenses, Archipelago of Marajó, Baixada Maranhense, Delta do Parnaíba, and Guaraqueçaba), which combined preserve a total of 4,280 km² of mangrove forests, with most of them allowing only sustainable use of natural resources. Of these six protected areas, three (Reentrâncias Maranhenses, Delta do Parnaíba, and Guaraqueçaba) have confirmed records of the Mangrove Rail (Figure 2). Other smaller protected mangrove areas also preserve the extremes of the Brazilian area of occurrence of the Mangrove Rail. Extreme confirmed records (Figure 2) were at or nearby the Marine Reserves of Tracuateua, Caetetaperaçu, Arai-Peroba, and Gurupi-Piria in the state of Pará, and at Ecological Station of Carijós, Marine Extractive Reserve of Pirajubaé, Serra do Tabuleiro State Park, and Environmental Protection Area of Baleia Franca in the state of Santa Catarina (Figure 2).

DISCUSSION

Total density of *Rallus longirostris crassirostris* from the first and latest observations in the Island of Santa Catarina was around 2 rails/ha, even when both available habitat and the average number of Mangrove Rails increased. Other studies found similar densities for the former *Rallus longirostris* complex. Anderson & Ohmart (1985) found the density interval from 1.5 to 2.8 rail/ha in Arizona, USA. Hinojosa-Huerta *et al.* (2008) estimated it at 1.03 rails/ha, but the most conservative abundance estimate recorded 4,698 individuals in 5,800 ha at Ciénega de Santa Clara (México). In turn, Liu *et al.* (2012) modeled densities ranging from 0.20 to 0.34 rails/ha in 13,254 ha at San Pablo Bay, San Francisco Bay, and Suisun Bay (USA). They also estimated 1,167 Clapper Rails at San Pablo Bay, San Francisco Bay, and Suisun Bay between 2009 and 2011 (Liu *et al.* 2012).

Local population in this study increased due to dispersal, whereas spatial density remained stable after colonization of the whole sampled area. For populations already established in a certain territory, Overton *et al.* (2014) found subspecies *Rallus obsoletus obsoletus* declining in California, though *Rallus obsoletus levipes* had a stable population in the same state (Powell 2006). Such variety of results in population trends is related to specific interactions with habitats and resources, as well as due to differences in the prediction power of models and measures used. The positive relationship between presence of rails and habitat availability was already expected, because Mangrove rails are found specifically in mangrove areas, and their presence mostly depends on availability of grass, mainly *Spartina* spp., and intertidal invertebrates, mainly *Uca* spp. (*pers. obs.*). Foin & Brenchley-Jackson (1991) suggested that restoring wetlands could help improving rail populations, and the Mangrove Rail showed good capability for colonizing mangrove habitats in southern Brazil.

If the density of individuals found in southern Brazil could be extrapolated for the whole species' range, the Mangrove Rail global population would be in good numbers in South America, probably having more than 100,000 individuals. Nonetheless, mangrove forests in South America are not properly preserved in most of its distribution, and special management measures are justified. Though the loss of habitat is apparently not considerable in most extensive mangrove forests in north and northeastern Brazil, all other countries in South America and even southeastern and southern Brazil face the impacts of mangrove deforestation and contamination (Lugo & Snedaker 1974, Cintrón & Schaeffer-Novelli 1992, Valiela *et al.* 2001, MMA 2003, Anthony & Gratiot 2012, Vieira *et al.* 2011, 2012). The absence of records of Mangrove Rail in Colombia may be related to geographic constraints such as the Andes (*pers. obs.*). In Brazil, the abscence of records in extensive mangrove forests mainly in the state of Amapá is mirrored by a similar gap found between northern South American populations of *Aramides mangle* (Marcondes *et al.* 2014). Whether this gap for *A. mangle* and *R. longirostris* represent true absence or sampling artifact remains to be determined by future surveys (Marcondes *et al.* 2014).

Nevertheless this gap may be also related to ecological constrains such as low salinity levels near the mouth of the Amazon River, which may affect the habitat used by these rails (Alexander Lees 2015 *pers. comm.*).

The IUCN criteria for establishing the conservation status of a species demands investigating its degree of isolation and dispersion capacity, extent of occurrence, area of occurrence, presence in protected areas, and main threats. As local results obtained for the Island of Santa Catarina show, dispersion to new areas depends on connectivity between developed mangrove forests. Connectivity between neighboring populations also depends on mangrove extents.

The presence of Mangrove Rails in protected areas is a positive sign to its conservation, but it is important to remember that the presence in a protected area itself does not guarantee the species conservation. Management must be effective and connectivity between mangroves must exist to allow meta-population flux. Mangroves are the most endangered forest formation in the world (Valiela *et al.* 2001), and anthropogenic pressures have a devastating result in South America (Cintrón & Schaeffer-Novelli 1992, Valiela *et al.* 2001, Anthony & Gratiot 2012), reflected by the existence of less than 20,000 km² of mangrove forests in the whole continent.

Loss of habitat due to landfills, industrial activities, shrimp farms and settlements is the greatest problem Mangrove Rail populations face. These activities not only promote the loss of habitat but also contaminate the environment with dangerous and cumulative chemicals (Lugo & Snedaker 1974, Cintrón & Schaeffer-Novelli 1992, Valiela *et al.* 2001). Guyana, Suriname, and French Guyana have a fast replacement of mangrove forests for settlements (Anthony & Gratiot 2012), while Brazil loses almost 1,000 km² of mangrove forests per year (Valiela *et al.* 2001) as a result of illegal settlements, landfills, shrimp farming, and harbors even inside restricted protected areas (*pers. obs.*). Even though not tested yet in South America, the Mangrove Rail population may also be affected by heavy metals and dumping of waste as *Rallus crepitans* in North America (Novak *et al.* 2006). In a local context of isolated populations, constant use of playback by birdwatchers can affect breeding success and territory establishment, as proven to occur with other territorial birds (Mennill *et al.* 2002, Ward & Scholossberg 2004). However, ethical conduct, proper guiding and monitoring can easily regulate this activity.

Mostly because of deforestation of mangrove forests, the conservation status of the Mangrove Rail must be reviewed at all levels. The Mangrove Rail current global conservation status according to the IUCN is Least Concern. However, considering IUCN criterion VU-B1ab(i,ii,iii), the Mangrove Rail should be classified as Vulnerable at the global level. When applied to national levels, the Vulnerable status would also be supported for the Brazilian populations. In Colombia, the species (represented by *R. l. phelpsi*) should be considered as Endangered according to criterion EN-D since the local population size is most estimated as fewer than 250 mature individuals (Figure 2; Lira & Casler 1979, Pantaleón-Lizarazu & Rodríguez-Gacha 2002). Rates of mangrove deforestation in Suriname, French Guyana, Guyana, and Venezuela and national extents of occurrence calculated for these countries support the criterion EN-B1ab(i,ii,iii) for Mangrove Rail local populations, also indicating an Endangered status. Criteria EN-B2ab(i,ii,iii) and CR-B1ab(i,ii,iii), respectively, support classifying Ecuadorian and Peruvian populations (*R. l. cypereti*) as Endangered and Critically Endangered. The Trinidad and Tobago population (*R. l. pelodramus*) would also be classified as Critically Endangered according to criterion CR-B1ab(i,ii,iii).

As demonstrated by the Mangrove Rail, the conservation status of other species strictly associated with mangrove forests in South America need to be revised. Results obtained by this study show that habitat restoration can contribute to the recovery of mangrove-associated species even in areas of intensive human intervention (e.g. urban areas), which can be an alternative to future adaptive management of endangered species.

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ARTICLE

Wing feather mites (Acari: Astigmata) on some Passeriformes (Aves) from state of Paraná, Brazil

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ABSTRACT: Feather mites are the most abundant arthropods found on birds, however, few studies have investigated their ecological associations with their hosts in Brazil. Here, we present a checklist of feather mites on 11 bird species from forest patches of Paraná State, Brazil. We recovered 16 species of feather mites belonging to two astigmatan families, namely Proctophyllodidae and Trouessartiidae. No visible external injuries were observed in the birds which could be related to the presence of these mites on their feathers. We report for first time five feather mite species from Paraná State. The present checklist expands the geographical range for five mite species, with one recorded for the first time in Brazil. Moreover, we have collected two potential new species of the genera *Amerodectes* and *Trouessartia* and recorded new bird hosts for three mite species.

KEY-WORDS: Astigmata, bird-mite interactions, checklist, Proctophyllodidae, Trouessartiidae.

INTRODUCTION

Feather mites (Astigmata: Analgoidea and Pterolichoidea) are the most diverse and abundant arthropods associated with birds (Gaud & Atyeo 1996, Proctor 2003). Although usually regarded as ectoparasites, most feather mites living on the plumage apparently do not cause visible damage to their hosts. According to Proctor & Owens (2000), feather mites feed on uropygial oil, but occasionally can ingest pollen, fungal spores and other particles attached to the feathers, and some species also feed on skin scales.

About 2,400 feather mite species are presently recognized, but the extant number of these animals may potentially reach 18,000 according to some estimates (Gaud & Atyeo 1996; Mironov 2003). In recent years, there have been increasing efforts aimed at investigating and describing feather mites and their distribution in Brazil. Most notable among these studies are works containing redescriptions or descriptions of new taxa (Hernandes & Valim 2005, 2006, 2014, Valim & Hernandes 2006, 2008, Hernandes 2012, 2013, 2014a, b, Mironov & Hernandes 2014) and checklists of feather mites of Cerrado (Rojas 1998, Kanegae *et al.* 2008) and the Atlantic Rain Forest (Carvalho & Serra-Freire 2001, Lyra-Neves *et al.* 2003). Valim *et al.* (2011) summarized and reviewed the literature on feather mites described/registered from Brazilian birds. According to those authors, 185 nominal species of feather mites belonging to 21 families were reported in Brazil on 15 bird orders. Among the species, only mites from the families Proctophyllodidae, Crypturoptidae and Pterolichidae had more than 10 species reported on Brazilian birds and the most species were recorded on the order Passeriformes (Valim *et al.* 2011).

The Neotropical region presents the greatest avifaunal diversity (García-Moreno *et al.* 2007) and consequently has a great potential to harbor a high richness of feather mite taxa. At the same time most bird species of this region have their mite fauna still unknown. In this paper, we report feather mite species found on some birds from several patches of Atlantic forest in Paraná State, Brazil.

METHODS

The bird communities were sampled at seven patches of the Atlantic forest in the municipalities of Fênix and São Pedro do Ivaí, Paraná State, Brazil (Figure 1) from July 2002 until June 2003, and from March 2006 until December 2006. The sampling was developed with ten mist nets set in line configuration in each forest patch, and totaling 300 m^2 of capture area. All bird specimens captured had their wings visually analyzed in the field and the most infested remige feather was removed and stored in individual vials containing 70% ethanol. The birds were banded and released after examination (Cemave Permit Number 1234). Bird scientific names follow CBRO (2014).

Mites were cleared in 30% lactic acid for 12-24 hours at 50 degrees Celsius and mounted in Hoyer's medium (Krantz & Walter 2009). Identifications were based on the keys to supraspecific taxa presented by Gaud & Atyeo (1996) and following the recent literature on specific taxa (e.g. Valim & Hernandes 2010, Hernandes 2014a, Hernandes & Valim 2014).

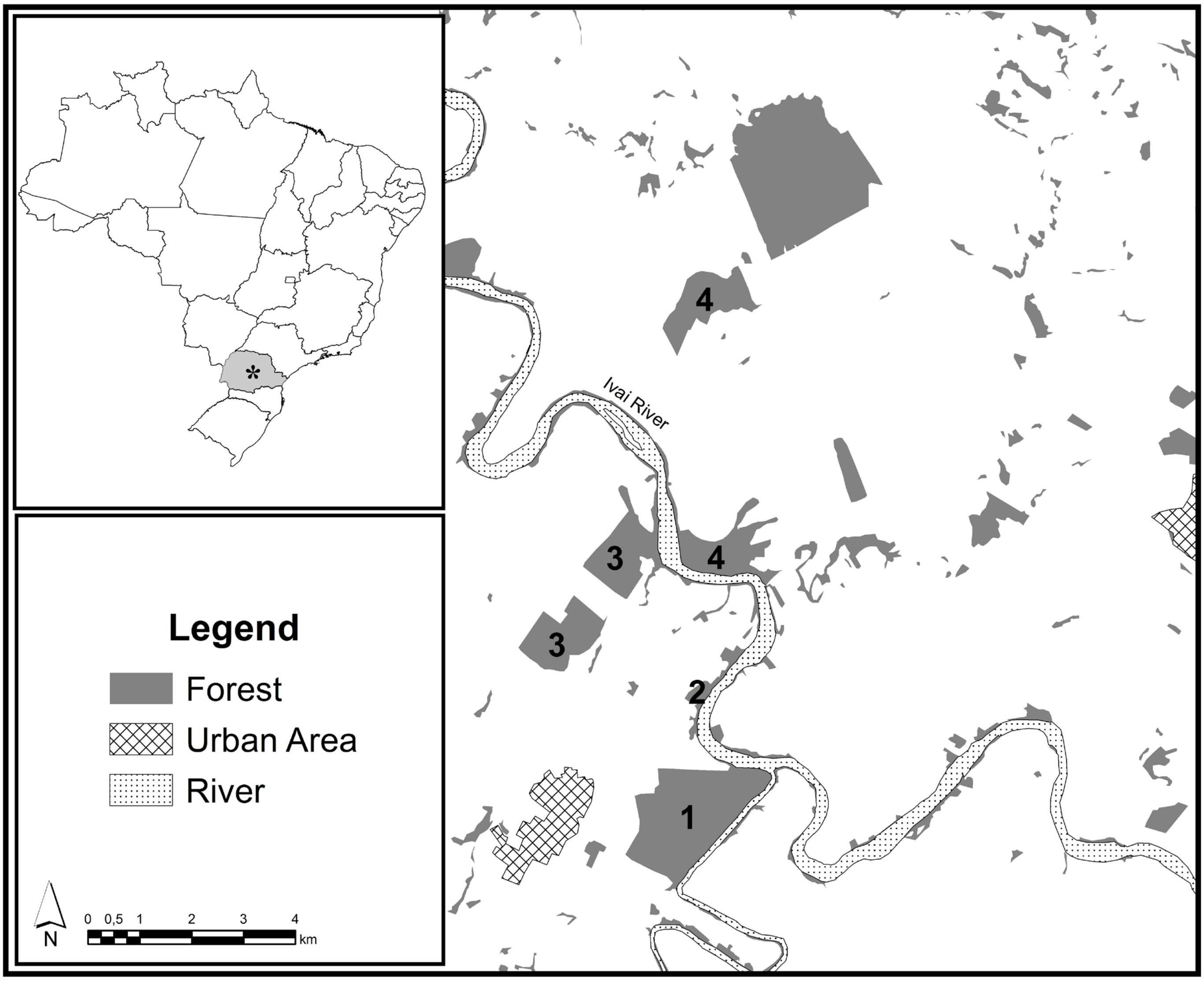

FIGURE 1. Sampling sites at several municipalities in the State of Paraná. Fênix: (1) Vila Rica Espírito Santo State Park (23S 54' 48"/51W 57' 07"); (2) Guajuvira Farm (23S 53' 44"/51W 57' 09"); (3) Cagibi Farm (23S 52' 41"/51W 58' 18"). São Pedro do Ivaí: (4) Santa Vitória Farm (23S 52' 17"/51W 56' 59").

RESULTS AND DISCUSSION

We sampled 11 bird species belonging to nine families (Table 1). Among those, *Pipra fasciicauda* Hellmayr, 1906 was the most abundant followed by *Turdus leucomelas* Vieillot, 1818*, Automolus leucophthalmus* (Wied-Neuwied, 1821) and *Leptopogon amaurocephalus* Tschudi, 1846. Other bird species with few individuals sampled were *Turdus albicollis* Vieillot, 1818, *Capsiempis flaveola* (Lichtenstein, 1823), *Basileuterus culicivorus* (Deppe, 1830), *Habia rubica* (Vieillot, 1817), *Lanio melanops* (Vieillot, 1818), *Tachyphonus coronatus* (Vieillot, 1822), and *Dysithamnus mentalis* (Temminck, 1823) (Table 1).

In 2002, 209 birds were captured, with 34 of them harboring feather mites, whereas in 2006 we captured 139 birds with 57 of them harboring feather mites (Table 2).

We collected feather mites of 16 species and two families (Table 1). All recovered species of the family Trouessartiidae belong the genus *Trouessartia*, whereas the family Proctophyllodidae was represented by mites of five genera: *Amerodectes*, *Atrichophyllodes*, *Lamellodectes*, *Proctophyllodes*, and *Tyrannidectes*. Undetermined species

TABLE 1. Feather mites sampled on bird species during this study at several localities in the State of Paraná, Brazil.

bird family	**bird species**	**mite species**	**locality***
Pipridae	*Pipra fascicauda*	*Nycteridocaulus* sp. 1	Fênix/1 and 3
Turdidae	*Turdus leucomelas*	*Amerodectes turdinus*	Fênix/1
	“	*Trouessartia serrana*	Fênix/2
	“	*Tyrannidectes fissuratus*	Fênix/1
	Turdus albicollis	*Amerodectes turdinus*	Fênix/3
	“	*Proctophyllodes weigoldi*	Fênix/3
Furnariidae	*Automolus leucophtalmus*	*Lamellodectes ocelatus*	Fênix/1 and 3
Tyrannidae	*Leptopogon amaurocephalus*	*Nycteridocaulus* aff. *tyranni*	Fênix/2
	Capsiemps flaveola	*Nycteridocaulus* aff. *tyranni*	São Pedro do Ivaí/4
Parulidae	*Basileuterus culicivorus*	*Amerodectes* sp. 1	Fênix/2
	“	*Trouessartia basileuteri*	Fênix/2
	“	*Nycteridocaulus* sp. 2	São Pedro do Ivaí/4
Thraupidae	*Habia rubica*	*Proctophyllodes habiae*	São Pedro do Ivaí/4
	“	*Trouessartia* sp. 1	São Pedro do Ivaí/4
	“	*Nycteridocaulus* sp. 3	Fênix/1
	Lanio melanops	*Trouessartia* sp. 2	Fênix/2
	Tachyphonus coronatus	*Amerodectes* sp. 2	São Pedro do Ivaí/4
Thamnophilidae	*Dysithamnus mentalis*	*Atrichophyllodes mentalis*	Fênix/2

*(1) Vila Rica Espírito Santo State Park; (2) Guajuvira Farm; (3) Cagibi Farm; (4) Santa Vitória Farm (see figure 1 for details).

TABLE 2. Total number of individuals of each bird species and number of birds infested by mites captured during this study at several localities in the State of Paraná, Brazil.

Birds species	**SAMPLED**		**INFESTED**	
	2002	**2006**	**2002**	**2006**
Pipra fascicauda	109	83	9	33
Turdus leucomelas	44	7	11	2
Turdus albicollis	11	3	4	1
Automolus leucophtalmus	16	8	1	4
Leptopogon amaurocephalus	14	9	4	1
Capsiemps flaveola	0	1	0	1
Basileuterus culicivorus	9	3	4	3
Habia rubica	0	13	0	7
Lanio melanops	3	5	0	2
Tachyphonus coronatus	1	1	1	0
Dysithamnus mentalis	2	6	0	3
TOTAL	209	139	34	57

of the genus *Nycteridocaulus* were recorded on three hosts. *Amerodectes turdinus* (Berla, 1959) and *Nycteridocaulus* aff. *tyranni* were recorded on two hosts whereas the remaining mite species were each collected only on one host species (Table 1): *Amerodectes* sp. 1, *Amerodectes* sp. 2, *Atrichophyllodes mentalis* Hernandes, Valim & Mironov, 2007, *Lamellodectes ocelatus* (Berla, 1960), *Proctophyllodes weigoldi* Vitzthum, 1922, *P. habiae* Atyeo & Braasch, 1966, *Trouessartia basileuteri* Hernandes, 2014, *Trouessartia serrana* Berla, 1959, *Trouessartia* sp 1., *Trouessartia* sp. 2. and *Tyrannidectes fissuratus* (Hernandes & Valim, 2005) (Table 1).

The *Trouessartia* species were collected on the dorsal surface of primary, secondary and tertiary remiges, whereas proctophyllodid mites were sampled on the ventral surface of remiges. This surface preference of wing feathers was already observed by previous authors (Santana 1976, Mironov & González-Acuña 2013, Hernandes 2014a).

We recorded five wing mite species sampled for the first time in the State of Paraná, namely, *A. turdinus*, *T.*

serrana, *L. ocelatus*, *T. basileuteri* and *P. habiae*. Moreover, the species *P. habiae,* found on *Habia rubica,* is a new record for Brazil. Previous authors recorded this mite species on *H. rubica* in Honduras and Mexico (Atyeo & Braasch 1966).

In the present paper we also recorded new hosts for three mites; *A. turdinus* and *T. serrana* on feathers of *Turdus leucomelas* and *P. weigoldi* on *Turdus albicollis*. *Amerodectes turdinus* has been previously reported on *Turdus rufiventris* Vieillot, 1818 and *Turdus albicollis* (Turdidae), whereas *T. serrana* was known only from *T. albicollis* (Valim *et al.* 2011), both collected on birds from Rio de Janeiro State, Brazil. *Proctophyllodes welgoldi* has been previously observed on *Turdus obscurus* Gmelin, 1789 from Malaysia and on *Turdus rufiventris* and *Turdus amaurochalinus* Cabanis, 1850 from Brazil (Amaral *et al.* 2012, Atyeo & Braasch 1966).

We sampled at least two potential new species of mites from the genera *Amerodectes*, on *Capsiemps flaveola*, and *Trouessartia* on *Habia rubica*. Both species need future taxonomic evaluation and description.

Here, we expanded the geographical range for five mite species and recorded one of them for the first time in Brazil. Moreover, we recorded a new host species for three feather mites. These results contribute to reduce the lack in knowledge about the biodiversity of these poorly known micro-arthropods inhabiting bird feathers.

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ARTICLE

Geographic variation in plumage coloration of Turquoise Tanager *Tangara mexicana* (Linnaeus, 1766)

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ABSTRACT: The Turquoise Tanager *Tangara mexicana* is largely distributed in northern South America, and has been considered a polytypic species comprising four or five subspecies. Our study on plumage coloration of 175 specimens, from localities covering the entire species' range, revealed the existence of two variable characters: color of underparts and color of lesser upper-wing coverts. Seven morphotypes were found that combine the different states presented by these two characters. Two morphotypes were very distinct, representing two of the most easily diagnosable subspecies (*T. m. mexicana*, having yellowish white underparts and a contrasting turquoise green humeral patch; and *T. m. boliviana*, having bright yellow underparts and the blue of lesser upper-wing coverts similar to that of the sides of head, throat, breast and rump). The other morphotypes (including those representing subspecies *T. m. media*, *T. m. vieilloti* and *T. m. lateralis*) are shared by birds with character states that are intermediate between those found in *T. m. mexicana* and *T. m. boliviana*, thus representing a polymorphic population ranging widely across central Amazonia, from northern Venezuela and Trinidad to the south of the lower Amazon. This large area may be considered as a hybrid zone of considerable phenotypic instability, more evident especially in the region between the lower Rio Madeira and east of the Tocantins in the Belém area. Based on the General Lineage Species Concept two species could be recognized based on plumage: *T. mexicana*, restricted to the Guyana center of endemism, and *T. boliviana*, which is widely distributed in western Amazonia and the eastern foothills of the Andes, an area corresponding to the centers of endemism Napo and Inambari. The taxonomic validity of *T. lateralis* is once more challenged.

KEY-WORDS: Amazonia, biodiversity, centers of endemism, hybrid zones, subspecies, taxonomy.

INTRODUCTION

Comprising about fifty species, *Tangara* is one of the richest genera of birds and one of the most representative of Neotropical birds (Peters 1970, Sibley 1996, Clements 2007, SACC 2015, Hilty 2011, Barker *et al.* 2013). Sedano & Burns (2010) produced a large phylogeny of tanagers based on mitochondrial genes, which lumps many morphologically distinctive groups into a few genera. Among the surprising results of this study is that *Thraupis* was found to be embedded in *Tangara.* The Turquoise Tanager is found in forest borders, varzea, second growth, plantations and gardens from southeastern Colombia and Ecuador to Guyanas, northern Brazil, Peru and northern Bolivia (Isler & Isler 1987, Ridgely & Tudor 1989). Five subspecies of the Turquoise Tanager *Tangara mexicana* (Linnaeus, 1766) have been proposed (Hellmayr 1936, Isler & Isler 1987, Hilty 2011). After the larger and paler White-bellied Tanager *Tangara brasiliensis* (Linnaeus, 1766) from southeastern Brazil had been treated as a separate species by Hellmayr (1936), it was considered a subspecies of *T. mexicana* (Zimmer 1943, Pinto 1944), but now it has been accepted as a valid and independent species again (Piacentini *et al.* 2015). *Tangara brasiliensis* shows a high level of genetic divergence (Burns & Naoki 2004), allopatric distribution (with no apparent gene flow) and consistent phenotypic differences (Isler & Isler 1987, Ridgely & Tudor 1989, Sick 1997), making it fully diagnosable from *T. mexicana*. However, *T. brasiliensis* is still considered a subspecies of *T. mexicana* by some authors (Clements 2007, Hilty 2011, SACC 2015). According to Hellmayr (1936), *T. m. mexicana* is known from the north of the lower Amazon (Guyanas and Brazil); *T. m. boliviana* (Bonaparte, 1851) is widely distributed in southeastern Colombia and Ecuador, Peru, northern Bolivia and Brazil from the Solimões to the lower Madeira; *T. m. vieilloti* (Sclater, 1857) is endemic to Trinidad, and *T. m. media* (Berlepsch & Hartert, 1902) is found in Venezuela and extreme northern Brazil. *Tangara m. lateralis* Todd, 1922, from southern Amazon (Todd 1922), was considered indistinct from *T. m. boliviana* by Hellmayr (1936) and treated as a hybrid between *T. m. mexicana* and *T. m.*

boliviana by Isler & Isler (1987). However, Griscom & Greenway (1941), Pinto (1944) and Gyldenstolpe (1945) recognized the validity of *T. m. lateralis*.

According to several authors (Hellmayr 1936, Zimmer 1943, Gyldenstolpe 1945) subspecies of *T. mexicana* are distinguished by the tone of blue on the sides of head, throat, breast and rump, and by the color of underparts (belly, thighs and under-tail coverts) and lesser upper-wing coverts. While the underparts are yellowish white in the nominate form (*T. m. mexicana*) and bright yellow in *T. m. boliviana*, the other three nominal taxa *T. m. vieilloti*, *T. m. media* and *T. m. lateralis* are transitional forms showing intermediate shades of yellow on the underparts between those found in *T. m. mexicana* and *T. m. boliviana*. Birds from Trinidad (*T. m. vieilloti*) are usually distinguished from those in Venezuela (*T. m. media*) by the darker blue plumage and brighter yellow underparts, although some birds from Venezuela were very similar to *T. m. vieilloti* specimens (Hellmayr 1936). *Tangara m. boliviana* is diagnosed primarily by the bright yellow underparts and the blue of lesser upper-wing coverts similar to that of the sides of head, throat, breast and rump. While this phenotype predominates in western Amazonia, several specimens (especially towards the lower Amazon) have paler blue lesser upper-wing coverts (Hellmayr 1936, Zimmer 1943).

Understanding the geographic differentiation of plumage in *T. mexicana* has been considered a challenge by some authors (Hellmayr 1936, Zimmer 1943, Hilty 2011). Therefore, we present here a review of the complex pattern of geographical differentiation in plumage coloration of the Turquoise Tanager throughout its entire distribution and discuss taxonomic implications and interpretations that emerged from the obtained data.

METHODS

We examined 101 specimens of *T. mexicana* housed at the Museu Nacional do Rio de Janeiro (MNRJ), Museu Paraense Emílio Goeldi (MPEG), and Museu de Zoologia da Universidade de São Paulo (MZUSP) (Appendix I). Additionally, we examined photographs of 74 specimens pertaining to the ornithological collections of the American Museum of Natural History (AMNH), Academy of Natural Sciences of Philadelphia (ANSP), Carnegie Museum of Natural History (CMNH), Collección Ornitológica Phelps (COP), Field Museum of Natural History (FMNH), Muséum National d'Histoire Naturelle (MNHN), and Yale Peabody Museum (YPM) (Appendix II). Photographs examined include those of the type specimens of *Tangara mexicana boliviana* [formerly *Callospiza boliviana*] (MNHN 7897), *Tangara mexicana media* [formerly *Calliste mexicana media*] (AMNH 513316) and *Tangara boliviana lateralis* (CMNH 78031). To obtain comparable color measurements, the photos were taken in a standardized fashion with the specimens photographed with the use of flashes in similar conditions. The color descriptions in the photos were taken by looking them in the same computer screen. Only adult birds were included in this study. Both sexes were included in the analysis because sexual dimorphism in plumage is not recognized in *Tangara mexicana* (Isler & Isler 1987, Hilty 2011).

We based our analyses on the following plumage color characters traditionally employed to diagnose taxa in *T. mexicana*: 1) the tone of blue on the sides of head, throat, breast and rump; 2) the color of underparts; and 3) the color of lesser upper-wing coverts. We used Smithe (1975, 1981) to determine the colors corresponding to different character states. These were referred to as italicized names (with corresponding numbers in the first citation). The color description of each specimen was made with no regard to its possible subspecies allocation or collection locality. Geographic coordinates of collecting localities of the specimens analyzed were obtained from Paynter (1982), Paynter Jr. & Traylor Jr. (1991) and Vanzolini (1992).

Plumage color character states obtained for each specimen were mapped separately to assess the degree and kind of geografic variation associated with each character. Subsequently, all character states variations were mapped together to assess overall trends of geographic variation. We gave special attention to the identification of localities that had one or more specimens with intermediate plumage characters because they could indicate the existence of hybrid zones. Localities with evidence of intermediate character states were classified as representing hybrid zones.

RESULTS

Variation of character states

We found no significant individual variation in the color of head, throat, breast and rump, which was *Ultramarine Blue* (Color 170A) in all specimens analyzed (including those examined through photographs).

Four states were recognized for the color of underparts, namely *Pale Horn* (Color 92), *Cream* (Color 54), *Straw Yellow* (Color 56) and *Spectrum Yellow* (Color 55) (Figure 1), while the color of wing coverts presented three states, namely *Ultramarine Blue* (Color 170A), *Sky Blue* (Color 168C) and *Turquoise Green* (Color 64) (Figure 2). *Ultramarine Blue* wing coverts always occurred together with *Spectrum Yellow* or *Straw Yellow* underparts, while *Turquoise Green* wing coverts were accompanied by *Pale Horn*, *Cream* and *Straw Yellow* underparts.

FIGURE 1. Color character states of underparts in *Tangara mexicana*. Colors from left to right: *Pale Horn* (MPEG 22995), *Cream* (MPEG 21553), *Straw Yellow* (MPEG 43353), and *Spectrum Yellow* (MPEG 23003).

FIGURE 2. Color character states of lesser upper-wing coverts in *Tangara mexicana*. From left to right: *Ultramarine Blue* (AMNH 513329), *Sky Blue* (AMNH 278331) and *Turquoise-Green* (AMNH 513315).

Geographic distribution of character states

Specimens with *Pale Horn* underparts were recorded exclusively from the north of the lower Amazon (Guyanas and adjacent parts of Brazil). Specimens with *Cream* underparts were recorded from the upper Rio Branco to the Rio Orinoco in Venezuela. Several birds with *Straw Yellow* underparts were from the southern bank of middle and lower Amazon (lower Rio Madeira, Rio Tapajós, Rio Xingu and Rio Tocantins) but also from the upper Rio Negro, northern Guyana and all specimens from Trinidad. Specimens with *Spectrum Yellow* underparts were widely distributed across western Amazonian Brazil, southern Colombia, eastern Peru and northern Bolivia (Figure 3).

Ultramarine Blue wing coverts were predominant in the upper Amazon, with some specimens occurring on the southern bank of middle and lower Amazon. Birds with *Turquoise Green* humeral patches were restricted to the north of the lower Amazon, Guyanas, upper Rio Branco, Venezuela and Trinidad. Specimens with *Sky Blue* humeral patches were found mainly in the southern bank of the lower and middle Amazon, but also in the upper Rio Negro (Figure 4).

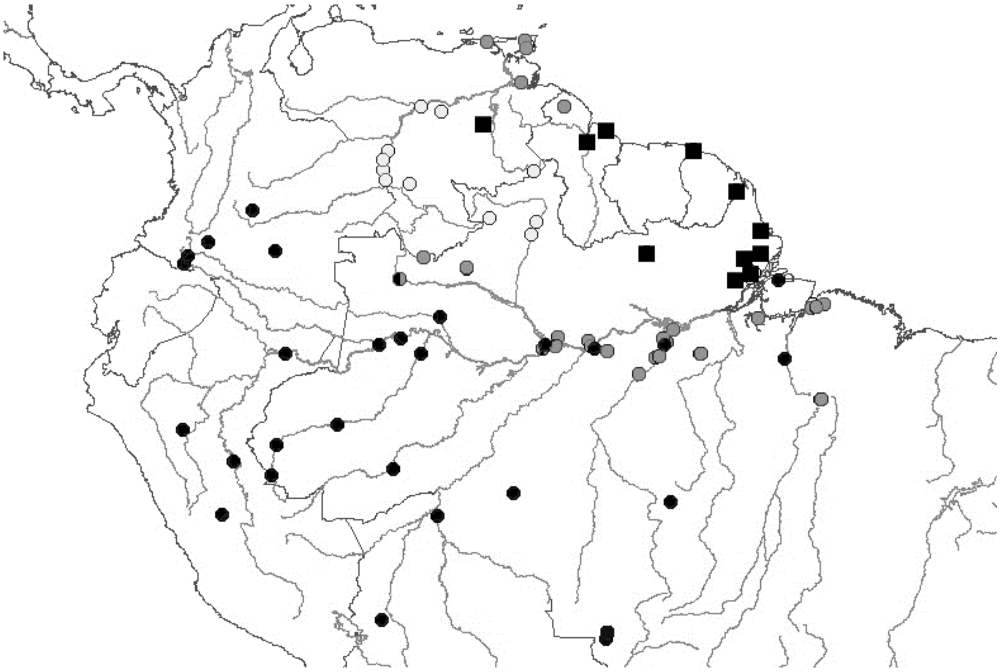

FIGURE 3. Geographic distribution of underparts color character states in *Tangara mexicana* (black circles – *Spectrum Yellow*, gray circles – *Straw Yellow*, light gray circles – *Cream*, black squares – *Pale Horn*).

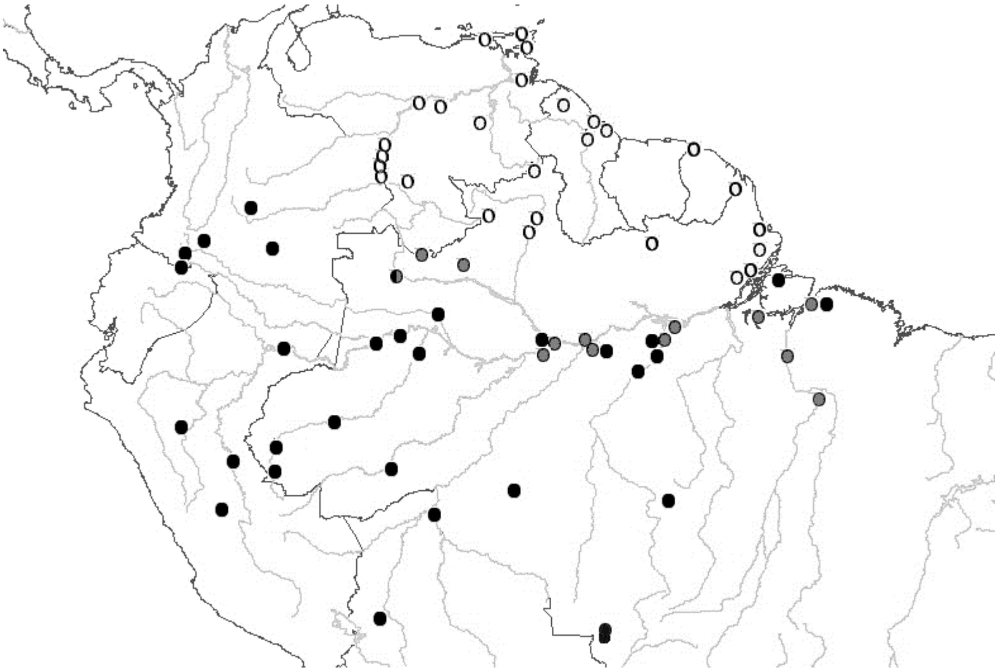

FIGURE 4. Geographic distribution of lesser upper-wing coverts color character states in *Tangara mexicana* (black circles – *Ultramarine Blue*, gray circles – *Sky Blue*, white circles – *Turquoise-Green*).

Morphotypes and their geographic distribution

We found seven morphotypes that combine the different character states (Figure 5). Five of these morphotypes correspond to described taxa that have been considered subspecies of *T. mexicana*.

Morphotype 1 is characterized by having the head, throat, breast, rump and lesser upper-wing coverts *Ultramarine Blue* and *Spectrum Yellow* underparts (Figure 5). Specimens of this morphotype were found from the eastern foothills of the Andes (Colombia, Peru and Bolivia), to lower Rio Negro and southern bank of the lower Amazon (from the middle Rio Tocantins to the Marajó island). This morphotype was very poorly represented in the lower Amazon (Figure 6). It includes the holotype of *Callospiza boliviana*.

Morphotype 2 differs from morphotype 1 only by the underparts, which are *Straw Yellow* (Figure 5). It was found on the southern bank of the middle and lower Amazon, between the right bank of the lower Rio Madeira and the region of Belém (Figure 6). It includes the holotype of *Tangara boliviana lateralis*.

Morphotype 3 is similar to morphotype 1 with respect to the color of underparts, but it has *Sky Blue* humeral patch (Figure 5). The distribution of morphotype 3 coincides with that of morphotype 2, ranging from the left bank of the Rio Madeira to the lower Rio Tocantins (Figure 6).

Morphotype 4 is characterized by the combination of a *Sky Blue* humeral patch and *Straw Yellow* underparts (Figure 5). It occurs from Belém to Manaus, and in upper Rio Negro (Figure 6).

Morphotype 5 is characterized by having *Straw Yellow* underparts and *Turquoise Green* humeral patches (Figure 5). It was found in lower Rio Orinoco (Venezuela), northern Guyana and Trinidad (Figure 6). The holotype of *Calliste vieilloti*, from Trinidad, was not examined, but supposedly would belong to this morphotype.

Morphotype 6 has *Cream* underparts and *Turquoise Green* humeral patches (Figure 5). It is widely distributed in central Venezuela and upper Rio Branco in Brazil (Figure 6). It includes the holotype of *Calliste mexicana media*.

Morphotype 7 differs from all other morphotypes by having *Pale Horn* underparts and *Turquoise Green* humeral patches (Figure 5). Specimens of this morphotype were from the Guyanas and north of the lower Amazon (Figure 6). It corresponds to the nominate *T. m. mexicana*.

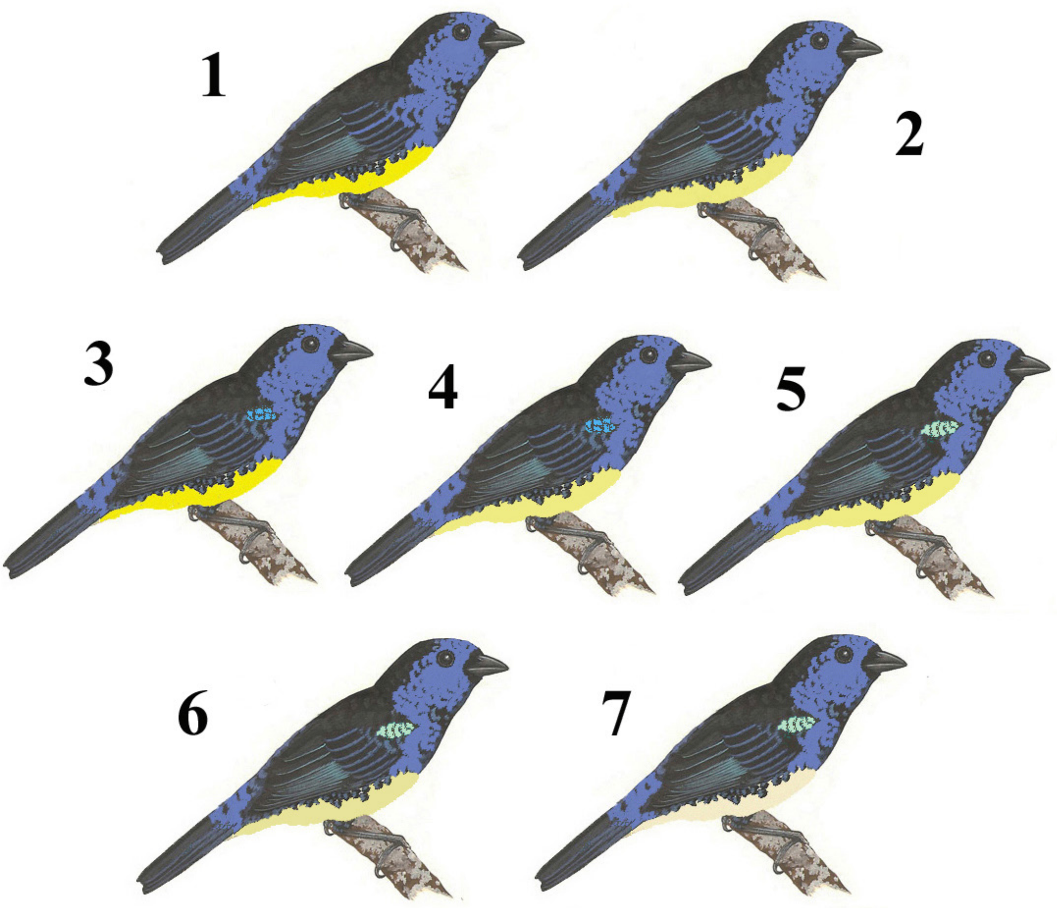

FIGURE 5. Morphotypes of *Tangara mexicana* based on the combined coloration of underparts and lesser upper-wing coverts (drawing: Raphael Dutra). See text for details.

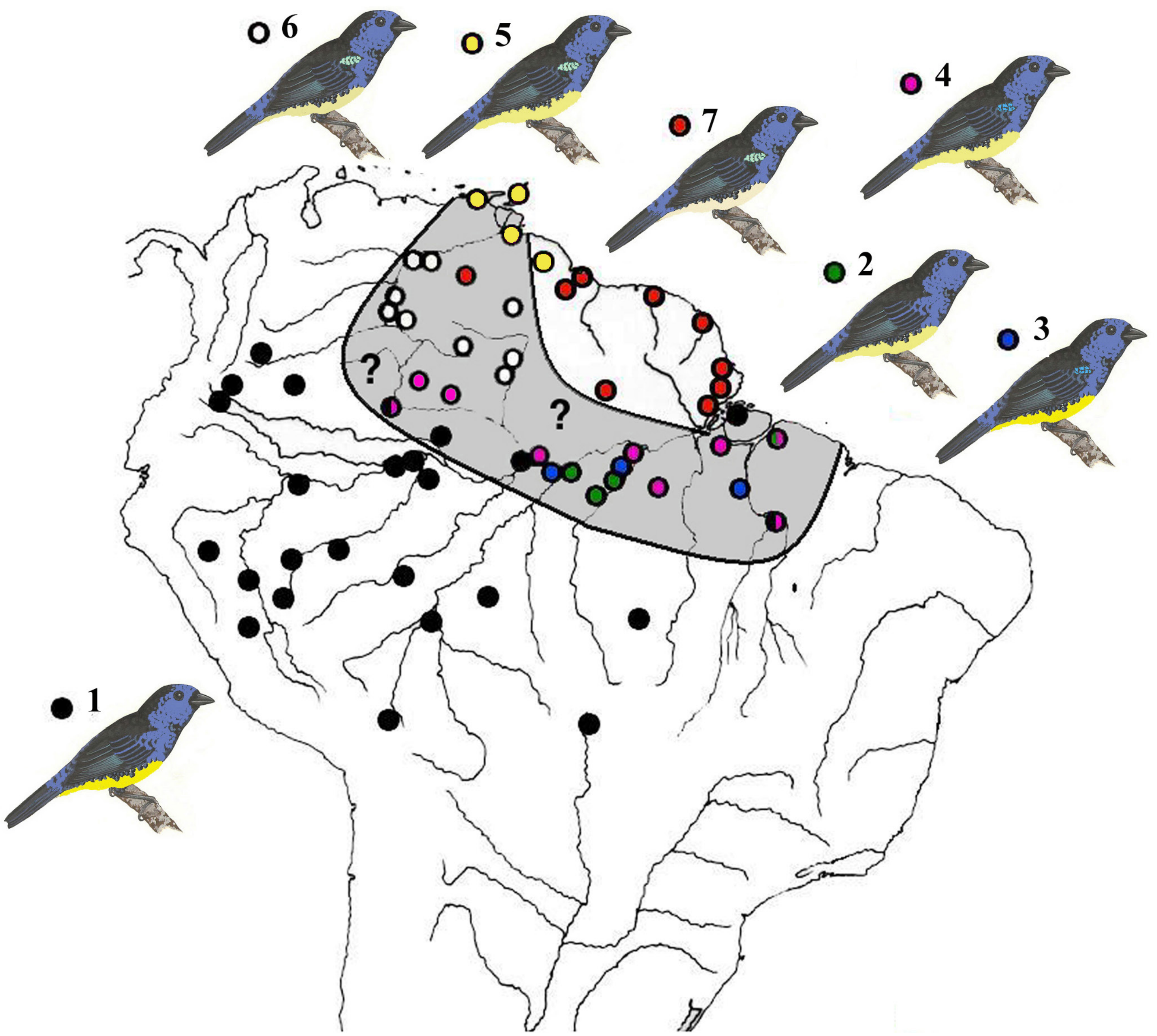

FIGURE 6. Geographic distribution of morphotypes of *Tangara mexicana* recognized in this study, showing a possible hybrid zone highlighted in gray.

DISCUSSION

Our analyses revealed the existence of at least two main areas of plumage color character state stability in the Turquoise Tanager (corresponding to morphotypes 1 and 7), separated by a smaller geographic area where intermediate phenotypes are present, sometimes even at the same locality (corresponding to morphotypes 2-6) (Figures 5 and 6). Two alternative interpretations of this overall pattern are: 1) morphotypes 1 and 7 represent evolutionary independent lineages / taxa that intergrade along a wide northwestern-southeastern trend hybrid zone across Central Amazonia; or 2) morphotypes 1 and 7 are extremes of a cline, with a corresponding wide intergradation zone in Central Amazonia. Below, we discuss these two alternatives with respect to the plumage color data but stress that distinguishing between them is difficult, and could be more easily accomplished by a phylogeographic study. Therefore, our data can be viewed as evidence supporting alternative scenarios of Turquoise Tanager diversification to be tested by future genetic studies.

Based on the General Lineage Species Concept (de Queiroz 1998), in which the only necessary property of a species is existence as a separately evolving metapopulation lineage (de Queiroz 2005), we propose that morphotypes 1 and 2 of *T. mexicana* found in this study would deserve the status of separate species. These two morphotypes have been traditionally recognized as the most distinct subspecies of the Turquoise Tanager (Zimmer 1943).

One of these (*T. m. mexicana*) occurs on the Guiana shield, being diagnosed by having *Pale Horn* underparts and a contrasting *Turquoise-Green* humeral patch, while the other (*T. m. boliviana*) is found from the base of the

Andes (below 500 m, following Hilty & Brown 1986) to the southern bank of the middle and lower Amazon, being diagnosed by having *Spectrum Yellow* underparts and the wing coverts indistinguishable from the blue of the rest of the plumage.

According to Hellmayr (1936) and Zimmer (1943), however, the challenge for understanding the complex pattern of geographical differentiation in *T. mexicana* is in the regions of the middle Amazon and southern bank of the lower Amazon. In this area we have found a significant individual variation in the color of underparts, with birds at times showing them *Spectrum Yellow* and *Straw Yellow* in the same locality. In the northern Amazon (upper Negro, Branco and Orinoco rivers) and Trinidad, although individual variation in the tone of yellow is less evident, some specimens are clearly distinct from others with respect to this character, as stated by Hellmayr (1936). The apparent phenotypic stability of the birds from Trinidad could result from the founder effect due to ca. 11,000 years of isolation from the continent (Snow 1985). However, some birds from the coast of Venezuela are barely distinct from those of Trinidad.

The color of lesser upper-wing coverts is another important variable character among populations of *T. mexicana*. While specimens from the Guyanas and north of the lower Amazon, upper Rio Branco, Venezuela and Trinidad have the wing coverts forming a bright *Turquoise-Green* humeral patch, birds from the southern bank of the middle and lower Amazon and upper Rio Negro have a *Sky Blue* or *Ultramarine Blue* humeral patch. All specimens from western Amazonia have dark blue (*Ultramarine Blue*) wing coverts. There is a trend to the occurrence of a lighter blue humeral patch in birds of the lower Amazon, as stated by Hellmayr (1936) and Zimmer (1943). However, birds with dark blue wing coverts also occur in the southern bank of the lower Amazon, and are indistinguishable from specimens from the upper Amazon, which reveals the instability of this character in the lower Amazon.

Our analysis of geographical variation in plumage characters, thus, revealed the existence of at least two major and up to four nuclear areas (with phenotypic stability) in *T. mexicana*. One of these coincides with the Guyana Center of Endemism (Cracraft 1985), including birds corresponding to morphotype 7 or *T. m. mexicana*. Another nuclear area is located in western Amazonia, encompassing the Napo and Inambari centers of endemism (Cracraft 1985), and including birds corresponding to morphotype 1 or *T. m. boliviana*. According to Zimmer (1943), these two forms have evolved separately when "an arm of the sea occupied the Amazon valley", *T. m. mexicana* in the Guiana shield and *T. m. boliviana* in western Amazonia. Two additional smaller areas of apparent phenotypic stability occur between those two, one in central Venezuela and upper Rio Branco in Brazil, including birds corresponding to morphotype 6 or *T. m. media*, with *Cream* underparts and a *Turquoise-Green* humeral patch, and the other in Trinidad and northern Venezuela, including birds corresponding to morphotype 5 or *T. m. vieilloti*, with *Straw Yellow* underparts and a *Turquoise-Green* humeral patch. However, the diagnose of these two morphotypes may be subtle in practice, so that both could alternatively be regarded as part of a larger polymorphic population ranging widely across central Amazonia, from northern Venezuela and Trinidad to the south of the lower Amazon (lower Rio Madeira to Belém). This includes forms described as *T. m. vieilloti*, *T. m. media* and *T. m. lateralis*, consisting of birds with character states that are intermediate between those found in *T. m. mexicana* and *T. m. boliviana*. As pointed out by Price (2008), subspecies rank has been often mistakenly assigned considering populations with different levels of character intergradation between distinct species. However, more studies on birds of Venezuela and Trinidad are needed to improve understanding of the taxonomic status of *T.m. media* and *T.m. vieilloti*.

The existence of a rather large area of polymorphism linking areas of phenotypic stability seems to preclude interpretation of morphotypes 1 and 7 as extremes of a clinal pattern of variation in the Turquoise Tanager. This whole range occupied by intermediate birds could be better considered as a hybrid zone because of the considerable phenotypic instability detected (distinct phenotypes coexisting in the same regions), which is more evident especially in the region between the lower Madeira River east across the Tocantins River in the Belém area. A relatively narrow hybrid zone along the Amazon valley has also been found between two purported phylogenetic species (*Icterus chrysocephalus* and *Icterus cayanensis*)(D'Horta *et al.* 2008). As advocated by Hellmayr (1936), who nevertheless recognized the taxonomic validity of *T. m. media* and *T. m. vieilloti*, this phenotypic instability does not allow a diagnosis of *T. m. lateralis*, described by Todd (1922) from the region of the Rio Tapajos and recognized by Gyldenstolpe (1945). Zimmer (1943), in turn, also preferred to consider populations from the lower Amazon as an unstable and intermediate *T. m. mexicana*/*T. m. boliviana* population, in which the recognition of a taxon is rather questionable.

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APPENDIX I.

Material examined (Specimens from each locality in parenthesis).

TRINIDAD. Trinidad (MZUSP 3706); VENEZUELA. *Monagas:* Maturin (MZUSP 2476); COLÔMBIA. Bogotá (MNRJ 6808); BRAZIL. ***Roraima***: Alto Mucajaí (MPEG 21553; MZUSP 56239); Caracaraí (MPEG 56485); ***Amapá***: Serra do Navio (MNRJ 29248); Fazenda Prosperidade, Rio Maracá, Mazagão (MPEG 22990; MPEG 22995); Rio Vila Nova, Macapá (MPEG 22991); Estrada do Curiaú km 01, Ilha Curuçá, Macapá (MPEG 28873); Igarapé Ariramba, afluente direito do Rio Tartarugal, Acampamento 4, Amapá (MPEG 28874); Rio Maruanum, Macapá (MPEG 28388); Fazenda Nova Califórnia, Rio Araguari (MPEG 22994); Fazenda Itauqueira, Tartarugalzinho (MPEG 53651; MPEG 53652); Oiapoque (MPEG 22996); ***Acre***: Cruzeiro do Sul, Rio Juruá (MPEG 22997; MPEG 22998); Vila Taumaturgo, Seringal Oriente, Rio Juruá (MPEG 23000; MPEG 23001); ***Amazonas***: São Gabriel da Cachoeira (MZUSP 16979); Acajutuba, Rio Negro (MPEG 12106); Maraã, margem esquerda do Rio Japurá, Maguari (MPEG 42934; MPEG 43352; MPEG 43353); Caitaú, margem direita do Rio Solimões, Uará (MPEG 50197; MPEG 50198); Santa Cruz, Rio Eirú, Juruá (MZUSP 18498; MZUSP 18504); Santo Antônio do Içá (MZUSP 69910); Bom Lugar, Rio Purus (MPEG 3499); Rio Jutaí (MZUSP 69909); Manacapuru (MNRJ 6816; MZUSP 16977; MZUSP 16978); Reserva Ducke, Manaus (MPEG 30079; MPEG 30370; MPEG 30371); Itacoatiara (MNRJ 32790; MNRJ 32791; MZUSP 17798; MZUSP 18499; MZUSP 18500; MZUSP 18501; MZUSP 18502; MZUSP 18505; MZUSP 18506); Igarapé Anibá (MZUSP 18496; MZUSP 18508); Rio Maraú (MZUSP 62116); Lago Baptista (MPEG 18493; MZUSP 17797; MZUSP 18494; MZUSP 18495; MZUSP 18497); ***Pará***: Rio Paru (MNRJ 27369; MNRJ 27370; MNRJ 27371); Ilha de Marajó, cerca de 4km ao sul de Chaves (MPEG 58095); Santa Bárbara, Benevides (MPEG 22190); Portel, Rio Anapu (MPEG 23012; MPEG 23014); Val-de-Cans (MPEG 23672); Utinga, Belém (MZUSP 36041; MZUSP 36098; MZUSP 36100; MZUSP 36101); Providência, Belém (MPEG 5543; MPEG 7741); Vila do Outeiro, Ilha de Caratateua, Belém (MPEG 29883; MPEG 29884); Murutucu (MZUSP 36099); Igarapé Pucuruzinho, BR-422, km 67, Tucuruí/Novo Repartimento (MPEG 35346; MPEG 47957); Santarém (MZUSP 3359; MZUSP 3360); Fordlândia, Rio Tapajós (MZUSP 47352; MZUSP 47353); Aramanaí, Rio Tapajós (MZUSP 32773); Sumaúma, Rio Tapajós (MZUSP 47354); Villa Braga, Rio Tapajós (MNRJ 6815; MPEG 13126); Boim, Rio Tapajós (MPEG 8581); Alcobaça, Rio Tocantins (MPEG 5373); ***Tocantins***: Araguatins (MPEG 20682; MZUSP 53054; MZUSP 65820; MZUSP 66095; MZUSP 66096); ***Rondônia***: Guajará-Mirim, Rio Mamoré (MPEG 23002; MPEG 23003; MPEG 23005; MPEG 23006; MPEG 23008; MPEG 23010); Cachoeira Nazaré, margem oeste do Rio Jiparaná (MPEG 40290); ***Mato Grosso***: Salto de Sepotuba (MNRJ 6809); Salto do Rio Jauru (MNRJ 6810); Fazenda São José, Rio Peixoto de Azevedo (MPEG 33846); PERU. ***Ucayali***: Pucallpa (MZUSP 68248).

APPENDIX II.

Specimens examined through color photographs (Specimens from each locality in parenthesis).

TRINIDAD. Santa Cruz (YPM 26422); Brasso, Caroni (YPM 26427); Caroni Swamp, Caroni (YPM 26428); VENEZUELA. *Delta Amacuro* (COP 48307); *Sucre* (COP 56715; COP 56715; COP 56715; COP 56715; COP 56715; COP 56715; COP 56715) *Amazonas* (COP 21207; COP 21208; COP 21209; COP 21391; COP 22153; COP 22154; COP 22155; COP 38788; COP 69709; COP 69710; COP 69711; COP 69712); *Bolívar* (COP 16591; COP 16592; COP 17977; COP 17978; COP 17979; COP 26062; COP 26063; COP 26064; COP 26065; COP 45212); GUYANA. Georgetown (FMNH 32389; FMNH 32390); *North West District*: Koriabo (FMNH 190651; YPM 26429); *Demerara-Berbice*: Rio Essequibo, Rockstone (FMNH 108649); *Potaro-Siparuni*: Rio Essequibo, Iwokrama Reserve (ANSP 189019); Rio Abary (ANSP 189015; ANSP 189016; ANSP 189018); *Mahaica-Berbice*: Onverwagt (ANSP 189020); FRENCH GUYANA. *Mana*: Mana (YPM 31203; YPM 31204; YPM 31205); COLOMBIA. *Vichada*: Maipures (AMNH 513316) [type specimen of *T. m. media*]; *Meta*: Serrania de Macarena, Rio Guapaya (FMNH 249262; FMNH 249263); *Caquetá*: Morelia (ANSP 152949); *Putumayo*: Guascayaco (FMNH 282349); Mocoa (FMNH 282350); Santo Antonio Guamez (FMNH 287583); Umbria (ANSP 160131); Rio San Miguel (ANSP 165547); Rio Rumyiaco (ANSP 165546);; BRAZIL. *Amazonas*: Padauari (COP 35056; COP 35057; COP 35059; COP 35060; COP 35061); Manacapuru, Solimões (ANSP 67172; ANSP 67173); *Pará*: Castanhal (ANSP 80760; ANSP 80761); Apacy, Rio Tapajós (CMNH 78031)[type specimen of *T. m. lateralis*]; Pinhy, Rio Tapajós (ANSP 108373); PERU. *Napo*: Apayucu (ANSP 83750); *San Martin*: San Martin (ANSP 116134); Yurinaqui (ANSP 176557); BOLÍVIA. *Huanay*: Rio Mapiri (ANSP 119228; ANSP 119229; ANSP 119230); *Santa Cruz*: Guarayos (MNHN 7897)[type specimen of *T. m. boliviana*].

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ARTICLE

New record of the brown pelican *Pelecanus occidentalis* in continental waters of the Brazilian Eastern Amazon

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ABSTRACT: A brown pelican (*Pelecanus occidentalis*) individual was recorded and photographed in the urban area of Santarém, northern Brazil. The bird perched on the roof of a fish market (2°25'S, 54°43'W) located on the Tapajos River bank in Santarém urban area, and stayed in the region for at least 45 days. This is the third record and the first photographic record of the brown pelican for inland Brazil.

KEY-WORDS: Amazon; Brazil; sea bird; Western Pará.

INTRODUCTION

The brown pelican (*Pelecanus occidentalis*) is a marine bird with broad distribution in the Americas, mainly on the coast. It occurs in the U.S., Central America, Caribbean, Galapagos, and northern South America (Enticott & Tipling 1997). Sometimes, this species goes further south and reaches northern and southeastern Brazil, and sporadically Tierra del Fuego, the southernmost extreme of South America (Sick 1997, Elliott *et al.* 2014).

In Brazil, the Brazilian Ornithological Records Committee (CBRO 2014) classifies *P. occidentalis* as an occasional visitor from the Northern Hemisphere, and Sick (1997) considers the species an occasional visitor from the northern region of Brazil. Some records of this species have already been made in Brazil.

There are five documented records of *P. occidentalis* for the Brazilian coast. The first was made by Mitchell (1957 *apud* Sick 1997), who recorded a brown pelican in the Rio de Janeiro. The second record was made by Sick (1997), who reported the occurrence of a white pelican in Guanabara Bay, state of Rio de Janeiro, in 1960. However, the author was not sure whether the observed individual was an albino *P. occidentalis* or a *P. erythrorhynchos*, which could probably escaped from captivity. The third record was made by Teixeira *et al.* (1993), who saw an individual brown pelican in Todos os Santos Bay, state of Bahia, in 1982. In 2005, Patrial and collaborators recorded an individual *P. occidentalis* flying over Ipióca Beach, Maceió, state of Alagoas (Patrial *et al.* 2011). This individual was photographed (Patrial 2010, WA88534). Patrial *et al.* (2011) also reported an individual pelican of the subspecies *P. occidentalis thagus*, which was photographed in 2008 flying over the sea, close to the city of Santos, state of São Paulo. These authors identified the pelican as *P. thagus*, but other researchers identified it as *P. o. thagus*, a subspecies of *P. occidentalis* (CBRO 2014, Elliott *et al.* 2014). Following the nomenclature used by these authors, this would be the fifth record of *P. occidentalis* in the Brazilian coast.

In continental Brazil, there are only two records of *P. occidentalis*, both for the northern region. The first record was made in the middle Tapajós River, in the city of Itaituba, state of Pará. In this locality, one individual was collected and deposited in the Emílio Goeldi Museum in Belém by Emilie Snethlage (MPEG 00433, Snethlage 1914). A second record was made in the Uraricoera River, state of Roraima (Pinto 1978, Sick 1997). Unfortunately, there is no precise indication of the observation site for this latter record. We present here the first photographic record of *P. occidentalis* for continental Brazil. The record was made in Eastern Amazon, in the city of Santarém, Pará, Northern Brazil.

METHODS

The brown pelican was observed and photographed in the urban area of Santarém (2°25'S, 54°43'W), on the right margin of the Tapajós River, in its confluence with the Amazonas River. We made periodical checking of the permanence of the bird in the area and observations on its behavior for 38 days.

RESULTS

On 22 November 2013, E.V.L and D.A.A.S recorded a *P. occidentalis* individual perched on the roof of a local fish market (Figure 1). Based on its color we believe it was a juvenile or sub-adult. According to reports by local fishermen, the bird was observed for the first time at the site one week before our record. From November 22 on, we made periodic visits to document the presence of the bird at the site. The last observation was made on 28 December 2013, which totals at least 45 days of presence of the pelican at the observation site.

We observed that, during its permanence in the region, the pelican spent most of its time perched on the fish market roof together with great egrets (*Ardea alba*) and black vultures (*Coragyps atratus*), which are common at the site (Figure 2). These birds consumed small fish and fish viscera discharged in the Tapajos River by fishermen and people of the fish market. In some occasions, the pelican was observed perched on boats and actively foraging in the Tapajós River, diving from the air or from the water, as its typical hunting strategy. The pelican was also observed swimming and foraging with cormorants (*Phalacrocorax brasilianus*). In addition, it frequently made circular flights in the surroundings using air currents, together with black vultures.

FIGURE 1. A juvenile *Pelecanus occidentalis*, perched on the roof of a fish market in Santarém, Pará, 22 November 2013.

FIGURE 2. The *P. occidentalis* individual (red circle) perched on the roof of a fish market, together with individuals of *Ardea alba* and *Coragyps atratus.*

DISCUSSION

Pelecanus occidentalis is a typical marine bird (Elliott *et al.* 2014), and hence its occurrence in continental waters very far from the sea would be unexpected. Some marine birds, such as species of the families Sternidae and Rynchopidae, also occur in continental waters (Sick 1997), but some species of the families Laridae and Pelecanidae are seldom seen inland. Santarém is located at approximately 600 km from the closest coast at the Marajó Island. This *P. occidentalis* individual probably followed the channel of the Amazonas River and arrived at Santarém, in a supposedly erratic movement. This could also explain other inland records of this species (Snethlage 1914, Pinto 1978). As the bird we recorded was a juvenile (and probably naive) individual, this hypothesis is even more plausible. Another possibility is that this individual arrived at Santarém perched on one of the large ships that frequently arrive at Santarém harbor. We can also speculate if large-scale climatic phenomena, such as the El Niño, can sometimes affect the movements of marine birds in a way not fully understood as yet, and their migratory movements might be irregular. However, this latter suggestion is difficult to demonstrate.

Regardless of why and how this typical marine bird reached far inland, it is important to record the presence and the period of permanence of bird species at sites where their occurrence is unexpected or occasional. This kind of information is important to plan for bird conservation. It is also important to stress that *P. occidentalis* is not on the recent list of bird species recorded in the past 135 years in Santarém (Lees *et al.* 2013), and this is the first record of the brown pelican for the Santarém city. We believe that some species considered atypical in this region perhaps are not so uncommon, but rather poorly documented, due to the lack of bird watchers able to identify them. However, with the help of online photo archives such as the websites www.wikiaves.com.br, www.xeno-canto.org, and http://ibc.lynxeds.com, and a greater exchange of information among scientists, unexpected occurrences such as the one reported here became more common. A record of the kelp gull (*Larus dominicanus*) also in the Tapajós River on Santarém city, on 2 June 2013 (Cruz 2013) is another example of the usefulness of these new tools of bird documentation in Brazil.

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SHORT-COMMUNICATION

First documented record of the Sapphire Quail-Dove *Geotrygon saphirina* Bonaparte, 1855, in Brazil, an overlooked specimen from the Klages expedition to Amazonia

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ABSTRACT: We report the long overlooked first record of Sapphire Quail-Dove *Geotrygon saphirina* in Brazil, a male specimen collected at São Paulo de Olivença, Amazonas state, in March 1923, by Samuel M. Klages. This is the first and only documented record for the country, pre-dating a sight record from Benjamin Constant, in extreme western Brazil, in April 1966.

KEY-WORDS: Columbidae, *Geotrygon saphirina*, Samuel Klages.

Between the publication of Peters (1937) and the mid-1990s, the Sapphire Quail-Dove *Geotrygon saphirina* Bonaparte, 1855, and the Indigo-crowned (Purple) Quail-Dove *G. purpurata* (Salvin, 1878) were generally retained as a single species (*e.g.* Baptista *et al.* 1997), but since the early 2000s their allopatric distributions, different morphology (Gibbs *et al.* 2001, Ridgely & Greenfield 2001) and, most recently, vocalizations (Donegan & Salaman 2012) have been used to re-promote *purpurata* to specific status, a position since favoured by most taxonomic committees and checklists (*e.g.* del Hoyo & Collar 2014, Remsen *et al.* 2015), though not by Dickinson & Remsen (2013). Whereas *G. purpurata* is confined to a comparatively small and highly deforested range west of the Andes, in western Colombia and north-west Ecuador, and is treated as Endangered by BirdLife International (2015), *G. saphirina* is considerably more widespread, being found throughout a considerable portion of upper Amazonia, from eastern Ecuador and probably extreme southeast Colombia, south to southeast Peru, where it is represented by another, weakly marked, subspecies in the Marcapata Valley, *G. s. rothschildi* (Stolzmann, 1926), as well as west into westernmost Brazil (Gibbs *et al.* 2001). Nevertheless, the presence of *G. saphirina* in the last-named country has hitherto uniquely rested on an undocumented claim by Willis (1987), who reported observing a single individual on the forest floor, attracted by an imitation of its voice, in the environs of Benjamin Constant (04°22'58"S, 70°1'51"W), Amazonas state, on 17 April 1966. To our knowledge there have been no subsequent records in Brazilian territory and the species is currently maintained on the secondary list of Brazilian birds (CBRO 2014) for which material documentation is lacking.

In May 2015, during a search for online specimen data pertaining to *G. saphirina sensu lato*, via VertNet (http://portal.vertnet.org/), GMK's attention was drawn to a specimen held in the Carnegie Museum of Natural History (CMNH), Pittsburgh, USA, pertaining to *G. s. saphirina* (Figure 1). Subsequent correspondence with the Collection Manager at CMNH, Stephen Rogers, revealed that CMNH 95975, a male Sapphire Quail-Dove was collected at São Paulo de Olivença (*c.* 03°27'N, 68°48'W), Amazonas state, western Brazil, on 22 March 1923, by the American collector, Samuel M. Klages. No other details are presented on the label (Figure 1). São Paulo de Olivença lies on the right (south) bank of the Solimões (Amazon), c. 200 km downstream of Benjamin Constant, and Klages collected specimens within the environs of this settlement on at least 5, 8, 21 and 28 February, 3, 7, 10, 19 and 22 March, and 5-7, 9-10, 12-13, 17 and 20 April 1923 (Todd 1925a, b, 1927, 1931, 1937), although it is not known more precisely where Klages collected during his time there.

It is only known that prior to working São Paulo de Olivença, Klages had collected for several months on the Rio Purus. By June 1923, he was collecting at Tonantins, on the left bank of the Solimões, *c.* 150 km downriver of São Paulo de Olivença (Paynter & Traylor 1991). Klages, who died in comparative penury in 1957, was one of the most extraordinary collectors of South American birds in the first third of the 20th century, with the bulk of his material being sent to Tring (subsequently purchased by the American Museum of Natural History, New York), Munich and CMNH, where it was extensively studied and published upon by Count Berlepsch, E. Hartert, C. E. Hellmayr, G. K. Cherrie, but above all by W. E. C. Todd, who described many new taxa based on Klages' material. Klages obtained the largest collection of Neotropical birds housed at CMNH (Parkes 1995). Departing the USA in 1891 (at the age of 26), he collected in Venezuela between 1898 and 1902, as well as in 1909-10, in Trinidad & Tobago in 1912-13, French Guiana in 1917-18, and in Brazilian Amazonia between 1918 and 1927 (Phelps 1945, Beolens & Watkins 2003, Paynter & Traylor 1991). The list of 2744 specimens (deposited at seven museums) collected by Klages at São Paulo de Olivença (accessible via VertNet) includes no biogeographically questionable species, thus we have no reason to suspect that the specimen of *G. saphirina* was obtained elsewhere and erroneously listed for this locality. In addition to the *G. saphirina*, Klages collected other rare or poorly-known taxa around São Paulo de Olivença including Red-billed Ground Cuckoo *Neomorphus pucheranii* (*n* = 2 specimens), Orange-fronted Plushcrown *Metopothrix aurantiaca* (*n* = 8), Striated Antthrush *Chamaeza nobilis* (*n* = 4) and Purple-throated Cotinga *Porphyrolaema porphyrolaema* (*n* = 1), as well as rarely-recorded boreal migrants such as Grey-cheeked Thrush *Catharus minimus* (*n* = 2) and Bobolink *Dolichonyx oryzivorus* (*n* = 5), but all of these could be anticipated at this locality.

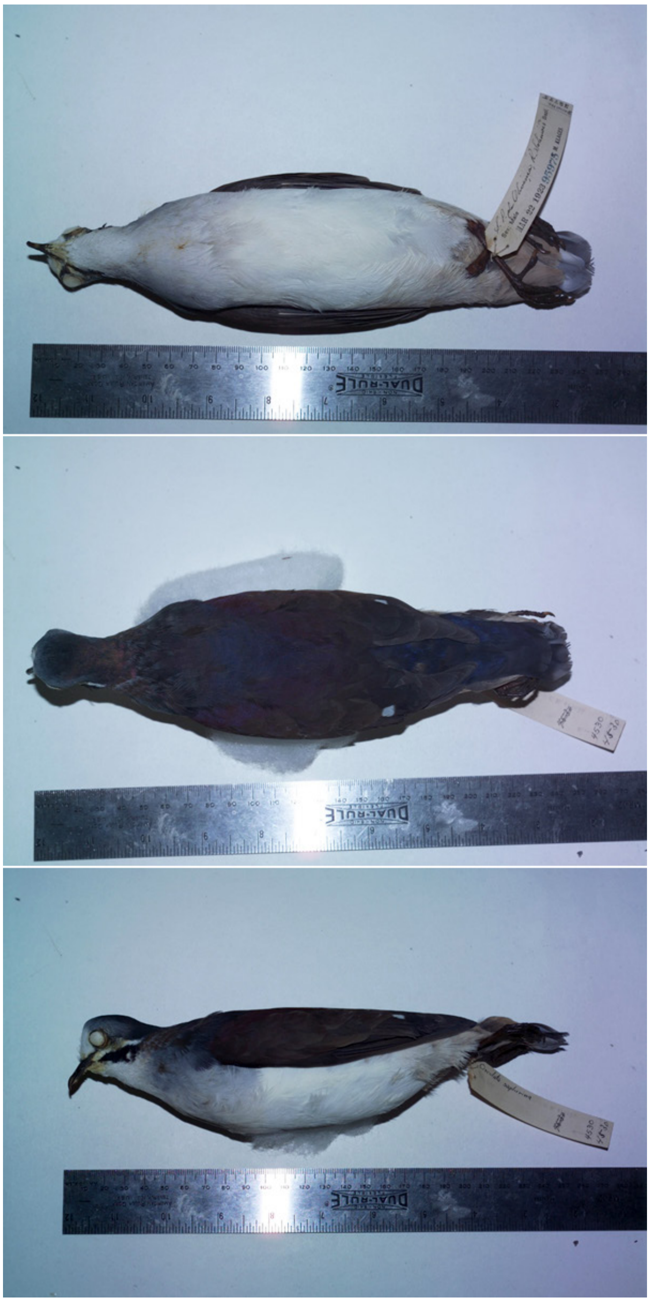

FIGURE 1. Ventral, dorsal and lateral views of a male specimen of the Sapphire Quail-Dove *Geotrygon saphirina* collected at São Paulo de Olivença, Amazonas, March 1923, by Samuel M. Klages, held at the Carnegie Museum of Natural History (CMNH 95975), Pittsburgh, USA (© Stephen P. Rogers, Carnegie Museum of Natural History).

Klages' record of *G. saphirina*, belatedly recognized for its full significance here, pre-dates that of Willis by 43 years and becomes the first and only documented record for Brazilian territory, although the species might be expected to occur at other localities in westernmost Brazil, especially south of the Solimões and along the frontier with Peru. Intra-tropical movements are well documented in Ruddy Quail-Dove *G. montana* (Stouffer & Bierregaard 1997) and have been hypothesised for Violaceous Quail-Dove *G. violacea* (Lees *et al.* 2013), so the possibility that *G. saphirina* is only an occasional visitor to the western Brazilian Amazon, rather than a low-density resident, exists. That the species has not been found at the comparatively well-inventoried Palmari Lodge, on the lower Rio Javarí southwest of Tabatinga, or by recent collecting expeditions to the same general region by the Museu Goeldi, but that both Brazilian reports stem from the same season (late March-mid April) lends highly circumstantial weight to this hypothesis.

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Revista Brasileira de Ornitologia, 23(3), 357-359
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SHORT-COMMUNICATION

New records of *Sporophila nigrorufa* (D'Orbigny & Lafresnaye, 1837) in Brazilian Cerrado and Pantanal

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ABSTRACT: The Black-and-tawny Seedeater, *Sporophila nigrorufa*, is an endangered species and one of the rarest seedeaters found in Brazil's Pantanal and Cerrado. Although its distribution range encompasses Bolivia and Brazil, few sites harbor this species in both countries. In Brazilian territory, this species was recorded at only three sites. Here, we report on two new documented observations from Mato Grosso do Sul State, in the Pantanal and easternmost Brazilian Cerrado.

KEY-WORDS: Conservation, native grasslands, range extension, seedeater, Thraupidae.

From the 32 *Sporophila* Brazilian species, 17 are found in the Pantanal and Cerrado domains (Sigrist 2009, Nunes 2011, CBRO 2014). These Thraupidae are usually associated with natural grasslands where they feed and breed. These habitats are threatened by conversion to agriculture or conversion of natural vegetation into exotic pasture. As a consequence of these landscape alterations, nearly 50% of *Sporophila* species inhabiting these environments are, to some degree, threatened (Nunes 2010, ICMBIO 2014).

One of the least known *Sporophila* species is the Black-and-tawny Seedeater, *Sporophila nigrorufa* (D'Orbigny & Lafresnaye 1837), categorized as Vulnerable (ICMBIO 2014, IUCN 2014). The earliest records of this species date back to the 19th century when it was found in western Mato Grosso State and eastern Bolivian cerrados (Pelzeln 1868-1871). Its current distribution comprises eight localities in Bolivia and three in Brazil (Willis & Oniki 1990, Silveira & D´Horta 2002, Birdlife International 2014). In 2008, Güller (2008) published the first record to Argentina from the Parque Nacional Lihué Calel, La Pampa Province, rejected by Kirwan & Areta (2014) who considered it a Cooper Seedeater (*Sporophila bouvreuil*). Cestari (2006) presented the first record to Brazilian Pantanal, in the Nhecolândia subregion, but without any documentation. Here we present two new documented records for Mato Grosso do Sul State, in the Pantanal and easternmost Brazilian Cerrado.

Both records occurred in Mato Grosso do Sul State and the digital vouchers were first published in the WikiAves website (Figure1; Melo 2014, Severo-Neto 2014). A male in eclipse plumage (Figure 2A) was observed in the morning of 4 April 2014 in a pasture area with lagoons and marshes at Terenos (20°30'46"S, 54°48'34"W). The individual was foraging in a mixed flock of seedeaters, including *S. palustris, S. cinnamomea* and *S. pileata*. The species were recorded in a field with dominance of both native (*Andropogon* sp.) and exotic grasses (*Urochloa* sp.).

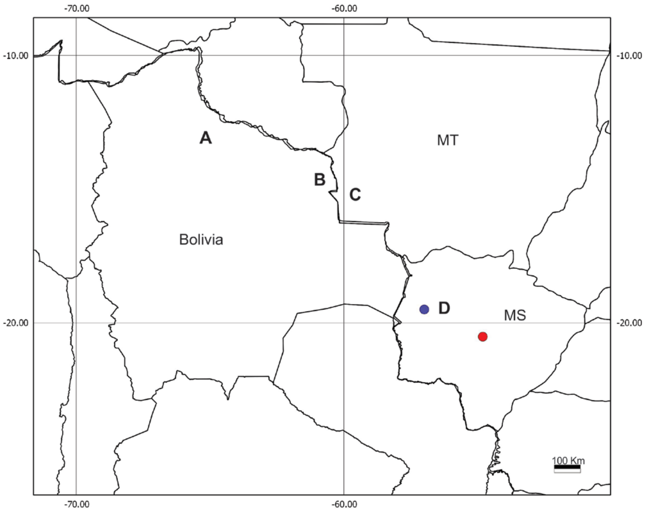

FIGURE 1. Records of *Sporophila nigrorufa* (Acronym of Brazilian states: MS-Mato Grosso do Sul; MT-Mato Grosso). Letters represent previous modern records (A - Herrera & Maillard 2007, B – Davis 1993, C – Silveira & D´Horta 2002, D - Cestari 2006) whereas colored circles represent the new records to Mato Grosso do Sul State (blue= Corumbá / red=Terenos).

A male with prenuptial plumage was photographed (Figure 2 B) in the morning of 4 November 2014 at São Bento Farm, Abobral Pantanal subregion, Corumbá (19°29'49"S, 56°59'32"W). As previously recorded in Terenos, at this site both native and exotic grasses were present, and we recorded adults and juveniles of *Sporophila collaris* nearby.

FIGURE 2. Digital vouchers of *Sporophila nigrorufa* recorded in Mato Grosso do Sul State. (A) Male in eclipse plumage recorded in Terenos (A.L. Melo). (B) Male with partial prenuptial plumage recorded in Corumbá (F. L. Souza).

The record from Terenos extends the distribution range of *Sporophila nigrorufa* about 800 km in a straight line to the site with the highest density of *S. nigrorufa* in Brazil, Vila Bela da Santíssima Trindade city and 185 km from the nearest known record, made by Cestari (2006). It is noteworthy that this last record occurred during November, typically the end of the dry season in the Pantanal wetlands and the onset of rainfall. This record adds evidence to the previous undocumented record for the same period in the area and confirms the species to the Pantanal, reallocating it to the primary list (Tubelis & Tomas 2003, Cestari 2006, Nunes 2011).

Although this manuscript helped to elucidate the record of *S. nigrorufa* from the Pantanal and expanded its present range, more efforts, such as avian inventories in grasslands areas, banding and capture/recapture proceedings, are needed to clarify the *Sporophila nigrorufa* migratory movements in South America.

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September 2015

Obituary: André de Mendonça-Lima (1973-2015)

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On August 18th 2015, the Brazilian society of Ornithology lost one of its most beloved and competent members: André de Mendonça-Lima. André (Dedé) was born in Porto Alegre, on August 13th 1973. Since the age of 20 he attended the laboratory of Ornithology at the "Museu de Ciências e Tecnologia da PUCRS", under the guidance of ornithologist Carla Suertegaray Fontana, where he was the first PUCRS student to do an internship at the newly founded Laboratory. From an early age, he demonstrated excellent skills in bird identification out in the field, having a special interest in small and inconspicuous species, which did not go unnoticed to his "sharp-eye". In Rio Grande do Sul, he collaborated on more than 30 field trips to study birds at the PUCRS Center for Research and Conservation of Nature – "CPCN Pró-Mata in São Francisco de Paula" also surveying birds in Porto Alegre – at the Country Club, in the "Morro do Osso" Park and throughout the city. Between 1999 and 2001, he was one of the young researchers who assisted in the study of the bird community of Porto Alegre, the object of Carla S. Fontana's PhD.

His graduate work was completed at the Universidade Federal do Rio Grande do Sul-UFRGS, where he obtained a masters and PhD in ecology, working at the laboratory of Populations and Communities Ecology, coordinated by Prof. Sandra Maria Hartz, his supervisor. During his master's degree, between 2000 and 2001, he was motivated to understand the co-occurrence of syntopic species, concentrating his studies on the behavioral aspects of birds in the Parulidae family. A by-product of this study, published with Graziele Volpato, was a proposal for a standardized nomenclature for bird's foraging maneuvers in the Portuguese language, which is still widely used and made him nationally known on the ornithological stage. Later, during his doctorate, conducted between 2008 and 2011, he focused on silvicultural systems, motivated by the need to understand how the commercial areas of pine modify the diversity and behavior of birds in Araucaria forest (Floresta Ombrófila Mista) areas, as well as the diversity of tree species that are able to colonize these areas.


André de Mendonça-Lima
(from http://lattes.cnpq.br/0119549503872549)

During his PhD studies he advised, along with Prof. Sandra, the undergraduate student Gisele Patel and master's student Lucilene Jacoboski. André was always a dedicated and responsible student, loved by all the members of the classes in which he participated, admired for his wide knowledge of bird biology and for his great ability to identify the songs of different species. Throughout his academic career, mainly conducted in UFRGS, he never failed to assist colleagues at the PUCRS Ornithology laboratory supervised by Prof. Carla, aiding undergraduate and graduate students, collaborating on relevant academic discussions and, mainly, on the analysis of ecological data.

In May 2012, Dedé joined the Board of biologists of the Museu de Ciências Naturais da Fundação Zoobotânica do Rio Grande do Sul (FZBRS) under emergency procurement. In the FZB Ornithology Section, he guided undergraduate research fellows, served as subject editor of the journal Iheringia Zoology Series and participated in research projects, conservation, and the fostering of biodiversity projects. One of his last contributions related to the revision of the checklist of the endangered fauna in Rio Grande do Sul, coordinated by FZB. This required registering all the bird species in a database system and being responsible for the evaluation of 147 out of the total 666 species being evaluated. He also reviewed nearly all of the non-endangered species and, as everything he did, was extremely effective in this task. In December 2013 after being diagnosed with a brain tumor, he took a sick leave but did not terminate his contract with FZB. His last field research for the institution was for the PELD and RS-biodiversity programs at "APA do Ibirapuitã" and around the Lagoa do Peixe, in November and December of 2013.

Throughout his short but intense career at PUCRS, UFRGS and FZBRS, Dedé taught people that surrounded him not only about birds, but also about how the coexistence between colleagues in the lab and in the field could be both a fun and serious experience. He leaves behind many friends in Rio Grande do Sul and countless pupils as well as 12 published scientific articles focusing on ornithology. Without doubt a great colleague and the first ornithologist to depart from the second "Beltinho generation", that is, those inspired from the legacy of the Gaucho Ornithologist William Belton. As an exceptional father to Marina and a great husband to Cristiane he will be missed.

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ERRATUM

In the paper "Lightning predator: the Ferruginous Pygmy Owl snatches flower-visiting hummingbirds in southwestern Brazil" by Ivan Sazima [Revista Brasileira de Ornitologia 23(1): 12-14.], one of the preyed hummingbirds is the Glittering-bellied Emerald (*Chlorostilbon lucidus*), not the White-tailed Goldenthroat (*Polytmus guainumbi*) as stated in the paper. Ivan Sazima thanks to Wagner Nogueira for pointing out the mistaken identification.

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Each Table should be on a separate page, numbered in Arabic numerals, with its own legend. The legend should be part of the table, and occupy the space made by inserting an extra line at the beginning of the table, in which the cells are merged. Figure legends, occupying one or more pages following the tables, should be numbered successively, also in Arabic numerals. Figures will follow, one to each page, and clearly numbered in agreement with the legends.

As necessary, subsections may be identified and labeled as such. All pages should be numbered in the upper, right hand corner.

The following *abbreviations* should be used: h (hour), min (minute), s (second), km (kilometer), m (meter), cm (centimeter), mm (millimeter), ha (hectare), kg (kilogram), g (gram), mg (miligram), all of them in lowercase (not capitals) and with no "periods" ("."). Use the following *statistical notations:* P, n, t, r, F, G, U, $\chi 2$, df (degrees of freedom), ns (non significant), CV (coefficient of variation), SD (standard deviation), SE (standard error). With the exception of temperature and percentage symbols (e.g., 15°C, 45%), leave a space between the number and the unit or symbol (e.g., n = 12, P < 0.05, 25 min). Latin words or expressions should be written in italics (e.g., *et al., in vitro, in vivo, sensu).* Numbers one to nine should be written out unless a measurement (e.g., four birds, 6 mm, 2 min); from 10 onwards use numbers.

Author *citations* in the text must follow the pattern: (Pinto 1964) or Pinto (1964); two publications of the same author must be cited as (Sick 1985, 1993) or (Ribeiro 1920a, b); several authors must be presented in chronological order: (Pinto 1938, Aguirre 1976b); for two-author publications both authors must be cited: (Ihering & Ihering 1907), but for more than two authors, only the first one should be cited: (Schubart *et al.* 1965); authors' names cited together are linked by "&". Unpublished information by third parties must be credited to the source by citing the initials and the last name of the informer followed by the appropriate abbreviation of the form of communication: (H. Sick *pers. comm.)* or V. Loskot (*in litt.);* unpublished observations by the authors can be indicated by the abbreviation: (*pers. obs.);* when only one of the authors deserves credit for the unpublished observation or another aspect cited or pointed out in the text, this must be indicated by the name initials: "... in 1989 A. S. returned to the area...". *Unpublished manuscripts* (e.g., technical reports, undergraduate monographs) and *meeting abstracts* should be cited only exceptionally in cases they are absolutely essential and no alternative sources exist. The *reference* list must include all and only the cited publications (titles written in full, not abbreviated), in alphabetical order by the authors' last name:

Articles

Fargione, J.; Hill, J.; Tilman, D.; Polasky, S. & Hawthornez, P. 2008. Land clearing and the biofuel carbon debt. *Science,* 319: 1235-1238.
Santos, M. P. D. & Vasconcelos, M. F. 2007. Range extension for Kaempfer's Woodpecker *Celeus obrieni* in Brazil, with the first male specimen. *Bulletin of the British Ornithologists' Club,* 127: 249-252.
Worthington, A. H. 1989. Adaptations for avian frugivory: assimilation efficiency and gut transit time of *Manacus vitellinus* and *Pipra mentalis. Oecologia,* 80: 381-389.

Books and Monographs

Sick, H. 1985. *Ornitologia brasileira, uma introdução,* v. 1. Brasília: Editora Universidade de Brasília.

Book Chapters

Remsen, J. V. & Robinson, S. K. 1990. A classification scheme for foraging behavior of birds in terrestrial habitats, p. 144-160. In: Morrison, M. L.; Ralph, C. J.; Verner, J. & Jehl Jr., J. R. (eds.). Avian foraging: theory, methodology, and applications. Lawrence: Cooper Ornithological Society (Studies in Avian Biology 13).

Theses and Dissertations

Novaes, F. C. 1970. *Estudo ecológico das aves em uma área de vegetação secundária no Baixo Amazonas, Estado do Pará.* Ph.D. dissertation. Rio Claro: Faculdade de Filosofia, Ciências e Letras de Rio Claro.

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Dornas, T. 2009a. [XC95575, *Celeus obrieni*]. www.xeno-canto.org/95575 (access on 25 February 2012).
Dornas, T. 2009b. [XC95576, *Celeus obrieni*]. www.xeno-canto.org/95576 (access on 25 February 2012).
Pinheiro, R. T. 2009. [WA589090, *Celeus obrieni* Short, 1973]. www.wikiaves.com/589090 (access on 05 March 2012).

Footnotes will not be accepted.

Illustrations and *tables.* The illustrations (photographs, drawings, graphics and maps), which will be called figures, must be numbered with Arabic numerals in the order in which they are cited and will be inserted into the text. Upon manuscript acceptance, high quality image files (extensions JPG, TIF, PSD, CDR, AI, EPS, WMF or XLS; minimum resolution of 300 DPI) of the original figures will be requested. Tables and figures will receive independent numbering and must appear at the end of the text, as well as all legends to the figures that must be presented on separate sheets. In the text, mentioning figures and tables must follow the pattern: "(Figure 2)" or "... in figure 2." Table headings must provide a complete title, and be self-explanatory, without needing to refer to the text. All figure legends must be grouped in numerical order on a separate sheet from the figures.

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