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FIRST DESCRIPTION OF THE REPRODUCTIVE BIOLOGY OF THE GREY-BELLIED HAWK (*ACCIPITER POLIOGASTER*)

ANDREA LARISSA BOESING,^{1,2} WILLIAN MENQ,¹ AND LUIZ DOS ANJOS¹

ABSTRACT.—We observed an active nest of the Grey-bellied Hawk (*Accipiter poliogaster*) in the mixed rainforest of southern Brazil during the 2011 breeding season. The nest was a platform built in the branches of the upper part of a Paraná pine (*Araucaria angustifolia*). The clutch size was two eggs, but only a single nestling survived and left the nest, ~49 days post-hatching. The fledgling was fed by adults at the nest for at least 90 days post-hatching. Only the adult female incubated the eggs and brooded the nestlings. Both female and male provided nest defense, the former up to 50 m from the nest and the latter at 50 to 200 m. Only the male hunted and only the female fed the nestlings. The identified prey brought to the nest by the male included eight birds and one young armadillo. Five voice types were identified: one alarm call, three food-related calls (performed by adults), and one food-begging call (performed by the fledgling). The type of habitat where the nest occurred suggested this poorly known species can possibly survive in disturbed areas. It seems to be naturally rare and its shy behavior contributes to its low detection. Received 14 February 2012. Accepted 12 July 2012.

The Grey-bellied Hawk (*Accipiter poliogaster*) is a poorly known species occurring over a large area in South America. This species inhabits lowland tropical forest, humid secondary growth and other dense woodland, and also riverine strips, apparently almost entirely below 500 m and is perhaps migratory (Ferguson-Lees and Christie 2001). It is distributed from northern Colombia, the extreme west and south of Venezuela and lowland Guyana and Surinam southwards through east Ecuador, northeastern Peru and the Amazon, and east Brazil, from south to north and east of Bolivia, east Paraguay, and the extreme northeast of Argentina (Ferguson-Lees and Christie 2001). It is a rare species and is poorly known throughout its range (Thiollay 1994), and is also poorly represented in museum collections (Lanzer et al. 2009). It is treated as Near-Threatened by Collar et al. (1994), but the species was recently categorized as a species of Least Concern by BirdLife International (2012).

Information on the nest and reproductive biology of the Grey-bellied Hawk has not been described (Bierregaard 1994, Márquez et al. 2005), and the vocal repertoire and diet of this species are unknown. There are several short articles discussing the possibility of a Grey-bellied Hawk nest in Ecuador. This nest was described by Vries and Melo (2001) as belonging to a Slaty-backed Forest Falcon (*Micrastur mirandollei*), a species with a similar adult

plumage as the Grey-bellied Hawk. Thorstrom (2002) questioned this designation, because some of the nesting habits reported by the authors differ markedly from those of the genus *Micrastur*, suggesting the nest described was misidentified as belonging to a forest falcon, and instead possibly belonged to either a Bicolored Hawk (*Accipiter bicolor*) or Grey-bellied Hawk.

We made observations on the reproductive biology and behavior of the Grey-bellied Hawk based on an active nest found in mixed rainforest in southern Brazil. We provide the first descriptions of the nest, egg, nestling, and fledgling, as well as information on the diet and vocal repertoire of this poorly known species.

METHODS

Study Site.—The nest was in a disturbed area within mixed rainforest in Santa Catarina State, southern Brazil at 800 m elevation. This forest area, ~500 ha in size, has a heavily degraded understory because it is used for livestock. In particular, the area around the nest (~ 200 m radius) had a poor understory. Paraná pine (*Araucaria angustifolia*) represented ~50–60% of the tree species in this disturbed forest; the density of this conifer in mixed rainforest is ~40% of the individual trees (Oliveira and Rotta 1982) and it is the dominant tree species of this forest type (Maak 1981, Oliveira and Rotta 1982). Other tree species in the study area included *Ocotea porosa*, *Ilex paraguariensis*, *Cedrea fissilis*, *Lithraea molleoides*, and *Ocotea odorifera*.

Field Observations.—We made observations continually (4 days/week) between 16 September and 27 November 2011 with occasional observations

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until mid January 2012. Observations were usually made by the same observer (ALB) and were *ad libitum* with all activities in the nest observed and noted. Thus, we achieved continuous observation for 6 hrs/day. Observations were primarily from 0600 (sunrise) until 1200 hrs, and at a lower frequency from 1300 to 1900 hrs. The activities recorded included: parental care and incubation, nestling/fledgling development, hunting sessions, provisioning sessions, and agonistic interactions. We built a camouflaged blind 40 m from the nest from which to make observations and not disturb the birds. Occasional observations were made until 15 January 2012 for 1–2 hrs/day in the nest area. We used Zeiss 8 × 42 binoculars, and a Canon PowerShot SX20 camera to describe and document observations, and a digital recorder Panasonic RR-US 470 to record calls and Raven Pro 1.4 (Bioacoustics Research Program 2011) to produce the spectrograms. Vegetation nomenclature follows Missouri Botanical Gardens (2011) and bird nomenclature follows Gill and Donsker (2012).

RESULTS

Nest Location and Description.—The Grey-bellied Hawk pair was first known to be in the area on 14 September 2011. However, the pair and a juvenile had been observed in the same area at the end of September, 1 year earlier. The nest was located because of the aggressive behavior of the female in response to human presence as she perched high and made an attacking dive in the direction of the observer's position.

The nest was found on 16 September 2011 during incubation. The platform-type nest was constructed 18 m above ground level in the branches of the canopy of a young Paraná Pine, close to the top of the tree, and was surrounded by dense foliage. The nest was ~50 cm in height and ~80 cm in diameter, and was built with twigs and sticks that ranged from 0.5 to 5 cm in diameter (Fig. 1A, B). The inside of the nest was accessed on 26 Sep 2011 and we observed an egg and a newly hatched nestling (Fig. 1A). The egg had a rounded oval shape, and was spotted brown on a white background. The newly hatched-nestlings were overall beige in color and nestling development was followed for ~40 days (Table 1).

Incubation and Nestling Development.—The female incubated the eggs the entire day and, during the period of observations, remained on the nest 96% of the time. She left the nest only for short periods (12 ± 9.74 min, $n = 14$) during

incubation and brooding, only when taking food from the male or attacking potential predators and intruders. The male remained close (10–20 m) to the nest at all times when the female was off the nest.

Only one nestling survived and, at the end of the sixth week (5 Nov 2011; ~ 42 days), we found the remains of the oldest nestling on the ground, 30 m from the nest. The surviving nestling left the nest at the end of the seventh week (~ 49 days) when its first flight was observed. The fledgling had a black cap and malar streaks, rufous cheeks, neck and breast, and a white throat and middle-breast with the pattern of black streaks complete on the underparts in the eighth week (~ 55 days; Fig. 1D). The fledgling stayed close to the nest from the eighth until the twelfth week, venturing up to 300 m from it.

Nest Defense.—Both the female and male defended the nest, but while the former defended up to a radius of ~50 m, the latter seemed to defend a zone from ~50 to 200 m. The female was observed chasing a Grey-headed Kite (*Lepidodon cayanensis*) and a Southern Crested Caracara (*Caracara plancus*). Her aggression was strongest towards the Grey-headed Kite with three observed body contacts. She grabbed the kite with her claws on his back on one occasion, and flew in the direction of the conifer canopy and continued to do so until ~50 m from the nest.

The aggressiveness of the female against raptors or humans continued throughout the nesting period, from incubation until fledgling. She continued to demonstrate this behavior after the fledgling left the nest until the tenth week post-hatching when aggressive behavior began to decrease. She no longer performed this behavior in the twelfth week and it was difficult to find her or the fledgling in the nesting area.

We also observed the male attacking potential predators (Grey-headed Kite and Southern Crested Caracara) on two occasions at a distance between 50 and 200 m of the nest. Other raptors were observed close to the nest but appeared to be tolerated within the defended area. These included Yellow-headed Caracara (*Milvago chimachima*), Roadside Hawk (*Buteo magnirostris*), Plumbeous Kite (*Ictinia plumbea*), and Swallow-tailed Kite (*Elanoides forficatus*). These species were probably tolerated in the nest area because they were usually observed flying above the canopy. A Roadside Hawk approached the nest closely on one occasion and perched on a branch at a



FIG. 1. The nest of the Grey-bellied Hawk in the upper part of a Paraná pine in the mixed rainforest of southern Brazil. (A) Inner nest: the newly hatched nestling (on the right) and an egg (on the left) on 26 September 2011; (B) the nest and female Grey-bellied Hawk; (C) nestlings 6 weeks post-hatching (2 Nov 2011); (D) fledgling 9 weeks post-hatching (23 Nov 2011).

distance of 20 m before the female chased it away. A juvenile Yellow-headed Caracara in another situation ventured close to the nest and was frightened away by skimming of the female.

Hunting and Food Provisioning.—The male's role during both incubation and post-hatching periods was mainly providing food for both female and nestlings/fledgling. The male brought prey to the female during the incubation period to feed upon on the nest. The male continued to bring food to the female during the nestling period, which she used to feed herself and also tore it into pieces before delivering it to the nestlings (up to the sixth week; ~42 days). The nestlings began to feed themselves at ~20 days, but female assistance, by tearing the prey into pieces, was usually observed. The male left the food in the nest for the chicks to start feeding themselves after ~42 days. It was at this point that the first sign of competition between the nestlings appeared, normally occurring when the

male left the prey in the nest. The faster nestling would take the prey using its claws and feed itself, not allowing the other chick to feed. The other chick would remain attentive and, if its sibling was distracted, would steal the prey.

The prey was delivered by the male to the female within a radius of ~50 m of the nest (during the incubation/nesting periods), or was left on the nest (during the fledging period). The hunts, undertaken only by the male, more frequently occurred in the early morning and before sunset (Fig. 2). Twelve of 22 occasions when we observed the male bringing food were early in the morning (0600–0900 hrs) and seven were in the later afternoon (1600–1900 hrs). Prey were brought outside of these times (at ~1400 hrs) on just three occasions. It was possible to make a general identification of nine of the prey items: eight were small birds, probably Columbidae, and one was a mammal, probably a young armadillo. The female dropped the carcass of a

TABLE 1. Means (\pm SD) of measurements of activities obtained while two nestlings of the Grey-bellied Hawk were present in the nest in southern Brazil. Means were obtained from each continuous observation session (corresponding to 6 hrs).

Post-hatching	Nestling development	Female's time in the nest brooding (min)	Female's time perched in the Paraná pine nest tree (min)	Number of prey brought to the nest/period ($n = 22$)	Time feeding the nestlings by female (min)
~5 days	Overall beige in coloration	355.5 \pm 3.09	16 \pm 14.5	0.66 \pm 0.81	20 \pm 10.5
~12 days	Nestlings became whitish with both bill and eyes clearly black, and legs yellow	163.7 \pm 137.5	12.3 \pm 16.7	0.50 \pm 0.70	30.5 \pm 3.33
~20 days	The flight feathers became grayish		141 \pm 69.7	0.60 \pm 0.58	46.7 \pm 1.90
~25 days	The upper parts of the wings became predominantly black, the first black streaks appeared on their flanks and the first black band also appeared in the tail; the first flecking on the wings was observed		174 \pm 111	1 \pm 0.00	38 \pm 16.3
~35 days	The top of the head became black with increased streaking in the flanks		129 \pm 86.9	1.25 \pm 0.96	28 \pm 10.7
~40 days	The pattern of black streaks on the underparts was almost complete, and the cheeks, neck, and sides of the breast begin to turn rufous (Fig. 1C)		04 \pm 05.3	1.25 \pm 0.00	13 \pm 04.5

Ruddy Ground Dove (*Columbina talpacoti*) on one occasion during one of her aggressive attacks in response to human presence during the incubation period.

Time spent by the female in the nest decreased as the nestlings matured (Table 1), although she usually remained next to the nest perched on a branch (5–30 m distant). The time spent feeding the nestlings appeared similar throughout their development (Table 1). We did not observe the male directly feeding the young; his function was as a hunter. He rarely visited the nest, and then only for a few minutes, usually in the absence of the female.

Vocalizations.—The male, upon arriving in the nest area with prey, emitted a call composed of single notes (Fig. 3A) to alert the female which responded with a similar call, also composed of single notes, but which were longer than the male calls (Fig. 3B). Thus, both would be found in the mid-level of the forest in the air emitting distinctive, high-pitched calls (Fig. 3C); the female would then fly 50–100 m from the nest with the prey and continue calling (varying between 3 and 11 times/min). The female was observed on some occasions emitting this call when perched on a branch next to the nest in the

absence of the male, possibly seeking delivery of food.

We identified two other Grey-bellied Hawk vocalizations during the reproduction period: an alarm call performed by adults and a food-begging call performed by the fledgling. The alarm call was relatively long (almost 3 sec), composed of seven to eight melodic notes repeated in a rapid rhythm, and was given by the adults in response to intruders or potential predators (Fig. 3D). The food-begging call of the fledgling was given when receiving or seeking food (Fig. 3E). The food-begging call had variations based on the proximity of food; motivation seemed higher when the male was arriving and calling in the nest area and, alternatively, motivation was lower when the fledgling was seeking food.

Appearance of Adults.—The female had a pure white breast and neck with two dark stripes on the neck. Her back was dark gray, as were also the cheeks, having an almost black appearance. This coloration extended until the top of the head creating a 'helmet' effect. The area around the eyes up almost to the bill was yellow. The male was ~30–40% smaller than the female. He also had a white breast and neck, but his back and

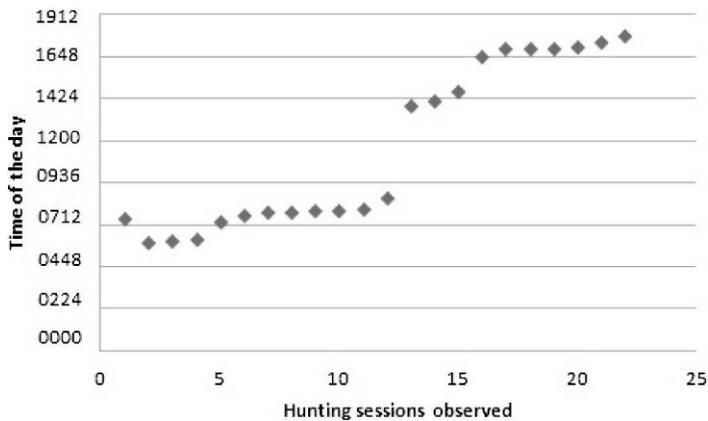


FIG. 2. Time of day the male Grey-bellied Hawk hunted to feed the female and young during the nesting period in the mixed rainforest of southern Brazil.

cheeks were light gray with only the wings and the top of the head being dark gray. Both male and female had three dark bands on the tail.

DISCUSSION

This is the first description not only of the nest but also of some aspects of the reproductive behavior of the Grey-bellied Hawk that were previously unknown. The Grey-bellied Hawk has been considered by many as an 'aberrant' *Accipiter* with obscure relationships with the rest of the genus (S. H. Seipke, pers. comm.). Our observations of its breeding biology and ecology revealed it may be closer to other neotropical *Accipiters* than has been generally assumed. Knowledge of this hawk is so sparse that, until a few years ago, the juvenile, which has a plumage similar to the Ornate Hawk-Eagle (*Spizaetus ornatus*), was considered to be another species (*A. pectoralis*).

Sexual dimorphism between the male and female was apparent with the latter being noticeably larger (~ 40%). We believe the surviving fledgling was also a female as on the last occasion the male was observed to leave prey in the nest (late Dec), the juvenile was taller than the adult male. The juvenile (~ 40 days post-fledging) also had the dark bands that occur on the neck of the female. Schulenberg et al. (2007) described an important morphological feature distinguishing male from female Grey-bellied Hawks: cheek coloration. We observed the female had darker gray and the male lighter gray cheeks and agree with Schulenberg et al. (2007).

However, one important feature is that the female had a 'helmet' linked with the rest of the plumage of the back and head, forming a uniform dark gray plumage. The male clearly had a light gray 'helmet' with the top of the head being dark gray.

The reproductive behavior of the Grey-bellied Hawk seems not to differ from that of other *Accipiter* species. The nest of the Grey-bellied Hawk was in the upper parts of a tall tree, as is true for most of its neotropical counterparts (e.g., Bicolored Hawk, Thorstrom and Quixchán 2000; Rufous-thighed Hawk [*A. erythronemius*], Seipke and Cabanne 2008; White-breasted Hawk [*A. chionogaster*], Jenner 2010). The Rufous-thighed Hawk has similarly been observed to build its nest close to the top of Paraná pine (Seipke and Cabanne 2008). Platt (1976) reported Sharp-shinned Hawks (*A. striatus*) also have a preference for nesting in conifers.

Paraná pine is the preferred nesting tree of the Rufous-thighed Hawk according to Seipke and Cabanne (2008). These authors suggest many factors could contribute to this choice and, of these factors, one seems more important and applicable to the Grey-bellied Hawk. These trees, other than the nest tree, usually have variable amounts of sticks in the upper branches, forming platform-like structures that could serve to confuse potential predators (Seipke and Cabanne 2008). This is consistent with our field observations because potential predators flying above the canopy were tolerated in the nest area by the Grey-bellied Hawk, in contrast to those flying through it. The Paraná pine presents nearly

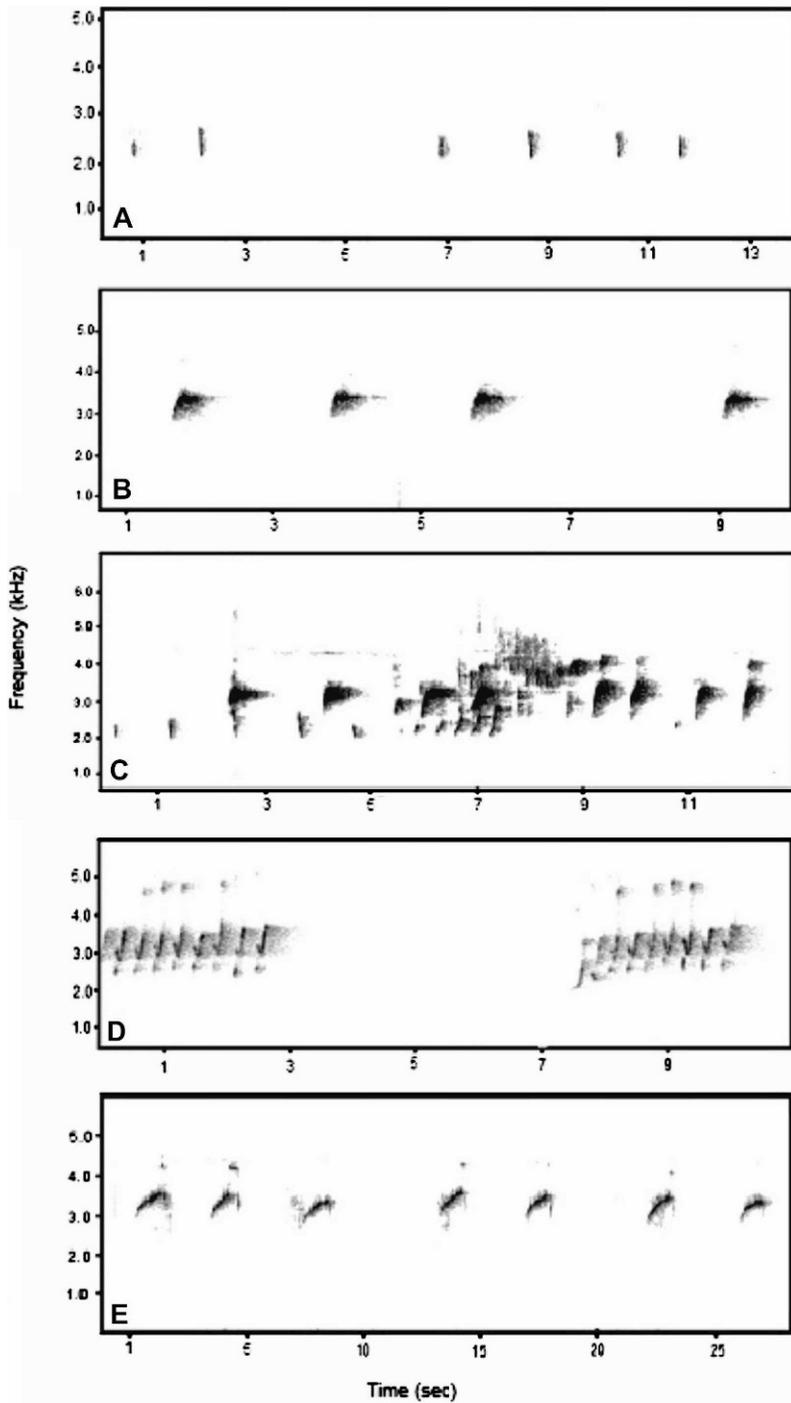


FIG. 3. Adult and fledgling vocalizations of the Grey-bellied Hawk during the nesting period in the mixed rainforest of southern Brazil: (A) male food-related call; (B) female food-related call; (C) interaction call; (D) alarm call; (E) food-begging call performed by the fledgling before feeding.

horizontal branches radiating from the trunk at the same height, providing a stable foundation for nests (Seipke and Cabanne 2008).

The Grey-bellied Hawk nest seems no different from those of other neotropical *Accipiter* (e.g., Bicolored Hawk, Bierregaard 1994; Rufous-thighed Hawk, Seipke and Cabanne 2008). Clutch size is variable among species of *Accipiter*; the Bicolored Hawk varied between one and four eggs, while the Sharp-shinned Hawk has 2–3 in the Caribbean, 3–5 in Mexico, and 4–5 in North America (Ferguson-Lees and Christie 2001). Nestlings of the Grey-bellied Hawk appear to remain longer in the nest (~ 49 days) than nestlings of Bicolored Hawks (~ 35 days, Thorstrom and Quixchán 2000).

Thiollay (1994) reported fledglings are dependent on food brought by adults for at least several days after leaving the nest. The fledgling Grey-bellied Hawk left the nest and continued to receive prey from the male for at least 60 days, and possibly longer. Bicolored Hawk fledglings similarly remain close to the nest and are dependent on their parents for nearly 2 months or more (Ferguson-Lees and Christie 2001).

The role of the male as hunter and the female as feeder (Thiollay 1994) was observed for the Grey-bellied Hawks we studied, similar to the majority of *Accipiter* species. We did not observe the female Grey-bellied Hawk bringing food for nestlings while they were growing, as has been described generally for *Accipiter* (Thiollay 1994). It seems the Grey-bellied Hawk is a bird-hunter, as suggested by Bierregaard (1994) and by association with its neotropical congeners (e.g., Bicolored Hawk, Thorstrom and Quixchán 2000; Chilean Hawk [*A. chilensis*], Rojas et al. 2004; White-breasted Hawk, Jenner 2010). Our observations (8 of 9 prey were birds) and the time of the day the male Grey-bellied Hawk hunts, coincided with higher activity of birds.

This was the second year the Grey-bellied Hawk pair was known to have used the same location to raise their young, and it is possible the same nest was used, because the female defended the same nest area in the presence of humans in the previous year. We suspect this might be the third year the site was used by this pair, because in mid-September 2010, in addition to the pair of Grey-bellied Hawks, we also observed one juvenile in the nest area. Many Accipitridae species re-use old nests, to which they add new material (Thiollay 1994). Gundlach's Hawk (*A.*

gundlachi), a species endemic to Cuba, appears to use the same nest for at least 3 years or more (Bierregaard 1994). Whether or not a nest-site is changed from 1 year to another is strongly related to breeding success in the previous year (Thiollay 1994).

Our observations do not enable us to resolve if the nest found by Vries and Melo (2001) belonged to the Slaty-backed Forest Falcon or Grey-bellied Hawk, as suggested by Thorstrom (2002). Morphological features reported by Vries and Melo (2001) are general and a more precise description is needed to reach a conclusion on species identity; however, some ecological features reported by those authors are not consistent with our observations for the Grey-bellied Hawk.

Our field observations confirm the secretive behavior attributed to the Grey-bellied Hawk (Santos et al. 2009). This secretive behavior would explain the rarity of records and why it is easily overlooked. It became difficult to find the adult pair or the fledgling in the nest area soon after the fledgling had left the nest, and we were barely able to detect the calls of the fledgling seeking food. This species seems to be naturally rare and its shy behavior contributes to its' low detection.

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