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SHORT COMMUNICATION

Insights into the development of a juvenile harpy eagle's hunting skills

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ABSTRACT

The post-fledging period is of paramount importance for raptors, since this is when a juvenile develops its hunting skills and gains the abilities required in adulthood and independence through dispersal. Little is known however, about this stage in the lives of raptors such as harpy eagles, *Harpia harpyja*. Between March 2016 and July 2017, we recorded three predation attempts on groups of primates by a wild juvenile harpy eagle in southwestern Brazilian Amazonia, including the first predation of an adult squirrel monkey, *Saimiri ustus*. These sequential records give insights into the gradual development of hunting skills during the post-fledging period, similar to what has been reported for other birds of prey. We hypothesize that a link between developing flight skills, decreasing parental food provisioning and increasingly successful captures triggers adulthood and independence in harpy eagles.

KEYWORDS: hunting behavior, juvenile raptor, predator-prey interaction, foraging, *Harpia harpyja*

Considerações sobre o desenvolvimento da habilidade de caça de um gavião-real juvenil

RESUMO

O período pós-emplumagem é de suma importância para os rapinantes, pois é quando um jovem desenvolve a habilidade de caça necessária na idade adulta e a independência por meio da dispersão. Entretanto, pouco se sabe sobre esse estágio na vida de rapinantes como o gavião-real, *Harpia harpyja*. Entre março 2016 e julho 2017, três tentativas de predação sobre grupos de primatas por um gavião-real juvenil foram registradas no sudoeste da Amazônia brasileira, incluindo a primeira predação de um macaco-de-cheiro adulto, *Saimiri ustus*. Estes registros sequenciais indicam um desenvolvimento gradual da habilidade de caça ao longo do período de pós-emplumagem, de forma similar ao relatado para outros rapinantes. Hipotetizamos que a associação entre o desenvolvimento da habilidade de voo, diminuição do provisionamento pelos pais e aumento da taxa de capturas bem-sucedidas promove a maturidade e independência no gavião-real.

PALAVRAS-CHAVE: comportamento de caça, rapinantes juvenis, interações predador-presa, forrageio, *Harpia harpyja*

The post-fledging period, between the first flights and recruitment, is of paramount importance for raptors because it is when juveniles develop their hunting skills and acquire the skills required in adulthood and the independence necessary to disperse (Penteriani and Delgado 2009). Despite its importance (Varland and Klaas 1991; McCann and Kemp 1994; Kitowski 2004, 2009), the development of hunting skills during the post-fledging is still poorly known for many species of raptors.

The harpy eagle, *Harpia harpyja* is the largest and most powerful Neotropical raptor, hunting from small birds to sloths (Miranda 2018). Items eaten by harpy eagles are known from inspection of nest remains and monitoring of prey brought to nests (Rettig 1978; Aguiar-Silva *et al.* 2014; Miranda 2018). Direct observations of predation attempts have allowed to identify new prey species of harpy eagles, and to obtain information on behavioral interactions between raptors and their prey (e.g., Barnett *et al.* 2011; Lenz and dos Reis 2011). The available knowledge about sequential predation events involving juveniles is limited to a study focusing on captive-bred individuals (Touchton *et al.* 2002). Here, we provide data on the development of hunting skills in a wild juvenile harpy eagle.

We observed an active nest built at a height of 20 m into a 30-m *Ficus* tree (366 cm DBH) located in a pasture, 15 m away from the edge of a 383-ha forest fragment at Fazenda Coqueiral (11°38'27.0"S, 61°39'08.9"W; 260 m above sea

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level), in Rolim de Moura, Rondônia State, Brazil. The climate is tropical humid (Koppën AW) with mean temperature of 27 °C, and annual precipitation of 1600 - 2400 mm (rainy season: October - May) (SEDAM 2012). The vegetation is Amazonian open ombrophilous forest. Observations were carried out from March 2016 to July 2017. The nest was monitored during the breeding period once a week, up to the 40th week. Subsequent visits occurred biweekly, resulting in a total of 47 observation sessions, and 108 monitoring hours (mean = 2 h 30 min per session).

The study subject was born between April 9th and 16th, 2016. The chick began wing exercising at around the 12th week (first record on July 7th, 2016). The first fledge took place at around the 22nd week (first record on September 10th, 2016) and the juvenile was perfectly capable of flying around two weeks later. Seven provisioning events were recorded (last record in the 55th week, on April 29th, 2017), all of which took place in the nest. Three predation attempts, all of them involving primates, were recorded.

At 1700 h on March 12th, 2017 the juvenile was perched 18 m high in a standing-dead tree (ca. 20 m) in the pasture, about 200 m from the nest, and 30 m from the forest fragment edge. It was staring at an unidentified primate group at least 50 m away within the forest. After observing the monkeys for approximately 10-15 min, it took flight towards the group. The dense forest canopy prevented further direct observation, but from the sudden, short (<10 seconds) loud screams emitted by several individuals and the branch agitation it was possible to infer that at least one predation attempt had occurred there. The harpy eagle landed with empty claws on a 25 m high perch in a tree ~80 m away from the departure point.

The second attempt occurred at 1630 h on April 1st, 2017. The juvenile was on a 25 m high perch and about 150 m away from the nest. There was a small group of 3-4 adult black-faced black spider monkeys (*Ateles chamek*) feeding in a tree close to the fragment edge which the juvenile stared at for about 6 min. The nest tree was approached to search for remains and the juvenile fled to a ~20 m high perch in a tree about 50 m from the nest. From there, it stared alternately at the spider monkeys and the researchers for another 5 min before flying towards the monkeys. Within 4 m from the monkeys, the raptor abruptly changed its direction and flew away. Immediately afterwards, the spider monkeys slowly and silently left the area.

A successful predation attempt occurred at 1730 h on July 1st, 2017. The juvenile flew from the forest and over the pasture matrix near the fragment edge carrying an adult bare-eared squirrel monkey (*Saimiri ustus*). It perched ~5 m high in an approximately 10 m high *Cecropia* tree. Then, the juvenile flew for about 50 m landing on two relatively low perches (ca. 8-10 m high) close to the forest edge, where it stayed for a few minutes before moving out of sight. This event lasted ~26 min.

Unsuccessful predation is relatively common even among experienced adult harpy eagles (Boinski *et al.* 2003; de Luna *et al.* 2010; Lenz and dos Reis 2011). A possible cause for the unsuccessful outcome during the first attempt was the last-minute vocalization by monkeys during the attack. This kind of startle vocalization can be interpreted as a key instantaneous anti-predator response that creates a moment of hesitation at the very last moment, thus interfering with attack completion (Sargent 1990; Lenz and dos Reis 2011).

The second attempt was one of the first documented interactions between harpy eagles and *Ateles chamek*. A similar behavior was described when a large unidentified eagle tried to attack an equatorial saki (*Pithecia aequatorialis*; de Luna *et al.* 2010). Even adult raptors make several flights before a successful attack (Boinski *et al.* 2003; de Luna *et al.* 2010; Lenz and dos Reis 2011), probably due to visual and anatomical constraints in birds of prey that limit fine-adjustments during flights (Land 1999; Shifferman and Eilam 2004). Juvenile raptors may also feel confident to attack adult spider monkeys when they are far away, but quit as they get closer. Harpy eagles usually attack prey averaging 2.6 kg in central Amazonia (Aguiar-Silva *et al.* 2014), but adult spider monkeys can reach up to 9.8 kg (Peres 1994). Therefore, this failure can also be attributed to the junenile's lack of experience. Spider monkeys apparently do not show observable responses to raptors and other flying pseudo-predators (van Roosmalen 1985; Mourthé and Barnett 2014). In fact, there are only a few reported cases of spider monkey predation by eagles (Julliot 1994; Miranda 2018). Although it appeared that spider monkeys did not react here, they did immediately retreat from the tree in a manner that corresponds to a known anti-predatory response (Matsuda and Izawa 2008; Mourthé 2011).

In the third attempt, it was not possible to ascertain that the juvenile captured the monkey by itself as juvenile raptors are frequently provisioned by their parents, but there is evidence in favour of the former. Firstly, the prey was practically intact, with the exception of injuries on the head and where the claws had penetrated the body (Figure 1); secondly, the last recorded parental provisioning was on April 29th, 2017; and thirdly, the parents had not been observed near the nest since May 13th, 2017, strongly indicating that the juvenile hunted the monkey by itself.

The deadly wound to the front of the captured squirrel monkey's head is similar to those reported by Martins *et al.* (2005) and de Luna *et al.* (2010). A necropsy report suggested that cerebral wounds were the cause of death of a bearded saki (*Chiropotes utahicki*) attacked by a harpy eagle in eastern Amazonia (Martins *et al.* 2005). This fatal injury may be important if the prey does not die at the first strike, thus avoiding counterattacks that may result in damage to the raptor (Martins *et al.* 2005). In extreme situations,

Figure 1. Juvenile harpy eagle preying upon a recently captured adult *Saimiri ustus* in a forest fragment in southwestern Brazilian Amazonia. Credit: Thiago Cavalcante. This figure is in color in the electronic version.

failed attacks can be fatal to large raptors (Jones *et al.* 2006). Therefore, it is important to kill the prey as fast as possible after it has been caught.

Capturing primates is not an easy task for an immature harpy eagle due to their anti-predatory behaviors (Ferrari 2009; de Luna *et al.* 2010; Barnett *et al.* 2011; Mourthé and Barnett 2014). Squirrel monkeys exhibit a wide anti-predatory repertoire, including vigilance, alarm-calls, changes in group size and habitat use, and the formation of mixed-species groups (Terborgh 1983; Boinski *et al.* 2003). Despite all of these complex anti-predatory strategies, our study subject was able to hunt a monkey before reaching the dispersion age (Muñiz-López *et al.* 2012). The juvenile was seen for the last time approximately six months (January 13th, 2018) after its first assumed successful attack. It possibly dispersed since there were no further sightings on further 15 visits to the nest.

Our study indicates a gradual development of hunting skills by a post-fledging harpy eagle. Various raptors have similar chronological patterns (Shrubb 1982; Sherrod 1983; Johnson 1986; Konrad and Gilmer 1986). Hunting skills and confidence seem to increase with time and increasing experience as soon as flight skills are developed and the rates of parental provisioning decrease. Our observations raise the question of what triggers the dispersal of juvenile harpy eagles, since hunting ability, at least in this case, seems to have developed before dispersal. Thus the hypothesis of adulthood and independence in harpy eagles and other raptors being triggered by concomitant development of flight skills, decreasing rates of provisioning, and increasing rates of successful predation (e.g., McCann and Kemp 1994) remains to be tested.

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