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Original Article

Monitoring the feeding and parental care behavior of a pair of free-living owls (*Tyto furcata*) in the nest during the reproductive period in Rio de Janeiro, Brazil

Monitoramento do comportamento alimentar e cuidado parental de um casal de corujas de vida livre (*Tyto furcata*) no ninho durante o período reprodutivo no Rio de Janeiro, Brasil

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Abstract

The American Barn Owl (*Tyto furcata*) lives in urban, periurban and wild environments and feeds mainly on small rodents, meaning it has great importance in the biological control of pests. The aim of this work was to describe the reproductive, parental and eating habits of a pair of American barn owls naturally living outside a residence in the urban area of the municipality of Campos dos Goytacazes, Rio de Janeiro state, Brazil. A wood box was installed on an outside wall of the home, monitored by a video camera. A spreadsheet was created to keep track of the observations recorded. The female laid four eggs, and after an incubation period of 30-32 days all the eggs hatched, but only two chicks survived after cannibalism among the chicks. Initially, the male provided the food to the chicks and the female remained in the nest caring for the brood. After approximately a month, the female also began to leave the nest and return with prey, which was offered to the chicks, with the male also continuing this behavior. The chicks left the nest in September, 2017. The data obtained show the existence of cooperation and division of tasks between male and female owls during the reproductive period.

Keywords: raptors, behavior, reproduction.

Resumo

A coruja-das-torres americana (*Tyto furcata*) vive em ambientes urbanos e se alimenta principalmente de pequenos roedores, sendo de grande importância no controle biológico de pragas. O objetivo deste trabalho foi descrever os hábitos alimentares, parentais e reprodutivos de um casal de corujas-das-torres americanas, naturalmente vivendo fora de uma residência na zona urbana do município de Campos dos Goytacazes, estado do Rio de Janeiro, Brasil. Uma caixa de madeira foi instalada em uma parede externa da casa, monitorada por uma câmera de vídeo. Uma planilha foi criada para manter o controle das observações registradas. A fêmea pôs quatro ovos, e após período de incubação de 30-32 dias todos os ovos eclodiram, mas apenas dois filhotes sobreviveram após o canibalismo entre os filhotes. Inicialmente, o macho fornecia a comida aos filhotes e a fêmea permanecia no ninho cuidando da ninhada. Depois de cerca de um mês, a fêmea também começou a sair do ninho e voltar com a presa, que era oferecida aos filhotes, com o macho também continuando com esse comportamento. Os filhotes deixaram o ninho em setembro de 2017. Os dados obtidos mostram a existência de cooperação e divisão de tarefas entre corujas machos e fêmeas durante o período reprodutivo.

Palavras-chave: rapinante, cooperação, reprodução.

1. Introduction

Despite the great diversity, order Strigiformes has only two families, the largest of which is Strigidae. Other than the American barn owl (*Tyto furcata*), which belongs to the Tytonidae family, all other owl species in Brazil belong to the Strigidae family, the main ones being the burrowing owl (*Athene cunicularia*), great horned owl (*Bubo virginianus*) and black-banded owl (*Strix huhula*) (Menq, 2013).

Tyto furcata (American barn owl) lives in urban environments and is considered an essential predator for biological control of pests that pose a risk to public

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health (Lekunze et al., 2001; Magrini and Facure, 2008). The species diet consists mainly of small rodents and insects (Roda, 2006), thus helping to reduce the population of rodents and insects that are potentially harmful to human health. Therefore, studying the behavior and diet of those birds in the urban setting is of ecological and public health interest, and what they eat precisely reflects the variation in population and composition of the local fauna (Love et al., 2000).

In species in which male and female care for the brood, taking into account the behavior of both of them is important to the reproductive success (Burtka and Grindstaff, 2015).

Isaac et al. (2008) recommend carrying out ecological studies related to the breeding of owls in less natural environments to ensure their conservation, as they would help to understand the reason for the use of urban areas. The same authors consider that the use of nest boxes allocated according to the birds' georeferencing helps to guarantee their reproduction (Isaac et al., 2008). Urban habitats can be chosen by individuals with a behavioral phenotype characterized by less fear of proximity to humans, as seen in the burrowing owl (Cavalli et al., 2018).

This research work aimed to observe and describe the social, reproductive, and feeding behavior of a wild pair of *Tyto furcata* during the reproductive period in an urban region of the municipality of Campos dos Goytacazes (Rio de Janeiro state). The observations described the copulation, egg laying, incubation, hatching, and feeding of the parents and the chicks, by analyzing the frequency, duration, and temporal duration of behavior.

2. Material and Methods

The study was approved by the Committee on Ethical Use of Animals of Norte Fluminense Darcy Ribeiro State University (UENF) under protocol no. 366.

2.1. Birds and study area

This observational study involved a pair of American barn owls (*Tyto furcata*) found naturally living outside a house located in an urban area of the municipality of Campos dos Goytacazes in the state of Rio de Janeiro, Brazil (geographic coordinates -21.7778040; -41.3309670). Before starting the study, the pair of birds had lived near the residence for seven days, resting during the day and leaving at night to hunt.

At the seventh day that the owls were resting on the spot, on December 10, 2016, after the birds had left to hunt, at around 8:00 p.m., a wood box with front opening and perch, measuring 52 (L) X 31.5 (W) X 37 (H) cm, was installed five meters from the ground on a metal support attached to the house. At the same time, an analog infrared CFTV security camera was installed on a wall opposite the opening of the nesting box (3.6 mm, 750 lines, Al-mdir 720d Dome Alive®). After installation of the box and camera, the owl couple rapidly accommodated themselves to the artificial nesting place. The birds' recorded images were observed from the day nesting box was placed until September 9, 2017, for a total of 273 days.

The video images of the inside of the box and its periphery captured by the camera were saved and analyzed using the Luxvision® software (Figure 1). The images contained information on the date and time of recording, in files with an average period of seven to 10 days.

The phenotypic characteristics classified the birds. The male had a smaller stature, with a lighter color, white chest, and ventral plumage without spots. The female was larger, with light brown plumage, and the presence of spots on the breast.

2.2. Method of observation and variables analyzed

The behavior observation method adopted was focal animal sampling with a continuous recording (Castro, 2010). Based on previous observations, we prepared a spreadsheet to tally the data from the images recorded. This enabled analysis of the main behaviors, by making daily notations about the dates, frequency and main habits of the birds.

In particular, data were registered on the start of egg laying, the number of eggs laid in the observation period, the interval between eggs, the duration of incubation and the survival rate of the chicks, after which the birds were monitored throughout the development of the chicks until September 9, 2017 when the surviving fledglings left the nest and did not return.

Behavioral variables during the incubation period were also considered, such as daily frequency of turning the eggs in the nest and frequency of feeding the female by the male, as well as number and duration of mating during the entire observation period. Finally, after hatching, data were collected on the parental behavior, consisting of the frequency the parents moved the chicks close to themselves, the frequency they brought food, and the total time dedicated to feeding the chicks.

2.3. Analysis of the data

The data were analyzed by calculation of qualitative and quantitative descriptive statistics, as is usual for an observational study of focal animals with continuous observation.

Figure 1. Couple of *Tyto furcata* image captured by the security camera positioned opposite from the nest. Campos dos Goytacazes, RJ.

3. Results

Copulation behavior in the nest was observed from December 10, 2016 to June 9, 2017, a total of 181 days, with average frequency of six copulations per day and average duration of 9.1 seconds each copulation.

In the moments prior to the copulation, the female used to lie down in the nest and then the male climbed to the dorsal part of the female for mating. Most of the time the male brought prey and delivered to the female before copulation.

The first egg was laid on May 1, 2017 (Figure 2), after that the female laid three more eggs. The incubation period was approximately 31 days (Table 1).

During the incubation period, the female turned the eggs in the nest an average of 114 times a day. The movement consisted of bringing each egg near her and positioning the eggs beneath her body using her beak and/or legs (Figure 3A).

The eggs started to hatch on June 2, 2017 and out of the four chicks, only two survived (Figure 3B). The two larger chicks killed and ate the smaller ones in the nest (Table 1). During this period, the male did not interact with the eggs; he only brought food to the female (Figure 3C) and mated with her.

Figure 2. The first egg of the couple of *Tyto furcata*. Campos dos Goytacazes, RJ.

Table 1. Dates and time of events concerning the laying and hatching of eggs and cannibalism among the *Tyto furcata* chicks in Campos dos Goytacazes, RJ, Brazil.

Date	Time	Event
05/01/2017	7 am	First egg laying
05/03/2017	10:03 am	Second egg laying
05/05/2017	03:53 pm	Third egg laying
05/08/2017	10:43 pm	Fourth egg laying
06/02/2017	05:29 pm	First chick birth
06/02/2017	05:51 pm	Second chick birth
06/05/2017	05:38 pm	Third chick birth
06/07/2017	03:04 am	Fourth chick birth
06/17/2017	07:54 pm	Cannibalism of one of the chicks
06/21/2017	09:21 pm	Cannibalism of one of the chicks

Figure 3. Observation of the *Tyto furcata* family in the nest. (A) Female sitting on eggs in the artificial nest; (B) 25-day-old chicks; (C) Adult owl bringing food to the chicks; (D) Chicks feeding alone in the nest. Campos dos Goytacazes, RJ.

With respect to the chicks' feeding behavior, initially they swallowed the food offered as a whole. Later, the female dilacerated the prey in front of the chicks and offered small pieces to them, an apparent way of teaching the chicks how to feed themselves.

As the chicks grew, the female taught them how to dilacerate the prey. This consisted of holding part of a prey animal in her beak and offering the other part to the chicks, who then grabbed that part in their beaks and pulled it out. This behavior occurred repeatedly until complete dilaceration of the prey. Finally, the chicks were able to feed themselves (Figure 3D) and the main behaviors were fighting between them for food, alternating with dilaceration of the food or swallowing it whole.

Figure 4 shows the daily interaction of the parents with the chicks in the first eight weeks of life. This behavior consisted of the adult moving the chicks near themselves using their beaks. There was greater interaction of the female with the chicks than the male, with averages of four and two contacts per day, respectively, during the chicks' first two months of life.

There was a gradual decline in the number of daily contacts by the female, starting with 10 contacts in the first week to only two in the eighth week. In the first two weeks of life, the female did not leave the nest, and sometimes did not allow the male to come near the chicks, which can explain the high interaction in this period. However, there was a considerable decrease in the interaction starting in the third week, when the female started leaving the nest to hunt.

During these two months, the female was responsible for cleaning the chicks, teaching them to consume food, and avoiding falling from the nest. In turn, the few interactions of the male with the chicks consisted of pushing them to the rear of the box and delivering food.

Overall, the observations of the interaction of the mother with the chicks (Figure 4) and the mother bringing food to them (Figure 5) revealed that during the first four weeks of life of the chicks there was greater care by the female, but this care declined drastically as of the fifth week, when the female started to leave the nest to hunt, and in the third month there was no more interaction to care for the brood other than to provide food. In turn, the male was the main provider of food during the first month, both to the chicks and female, while during the second month, the provision of food was divided equally between the male and female (Figure 5).

As shown in Figure 6, referring to the behavior of bringing food to the nest, it was possible to note that the parents steadily brought less food to the chicks as the days passed, forcing them to leave the nest to hunt for themselves, as observed in August. During September, no provision of food by the parents was observed, so the young owls were responsible for their own feeding.

Figure 6 shows the average frequency per day that the male and female brought food to the nest between May and September. In May, during egg laying and incubation, only the male brought food; in June, the chicks hatched and food was provided almost exclusively by the male, with the female leaving the nest very infrequently; in July, the female left the nest more often to hunt and the chicks also started leaving the nest occasionally to hunt; in August, the reduction of parental feeding care was more drastic; and in September the chicks left the nest definitively. So, the chicks were cared for by the parents for approximately three months.

Another variable observed was the average time dedicated to feeding the brood during the months. In

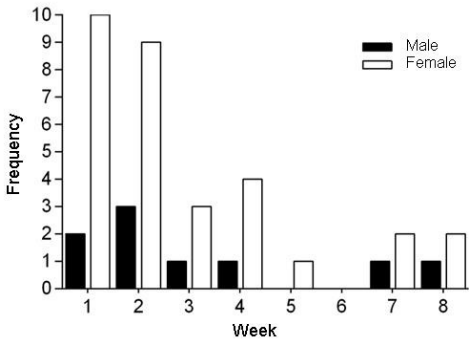

Figure 4. Frequency that the *Tyto furcata* parents bring the chicks near themselves (July and August, 2017). Campos dos Goytacazes, RJ.

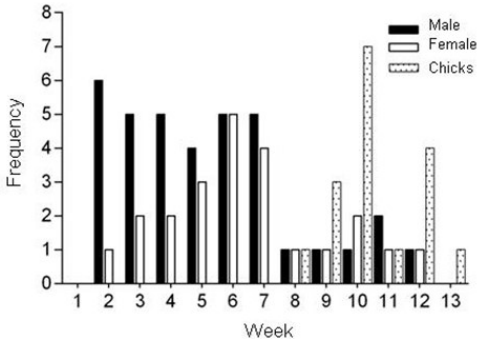

Figure 5. Day frequency that the *Tyto furcata* family brought food to the nest. Campos dos Goytacazes, RJ.

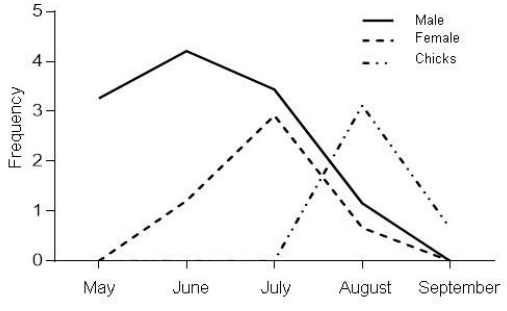

Figure 6. Day frequency that the *Tyto furcata* family brought food to the nest, from laying the eggs until the chicks left the nest. Campos dos Goytacazes, RJ.

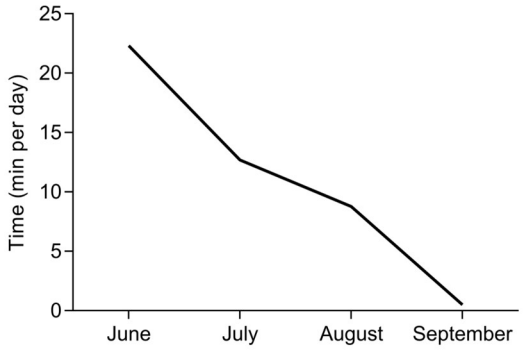

Figure 7. The average time per day (minutes) dedicated per *Tyto furcata* adults to teaching the feeding behavior for the brood, from the birth until left the nest. Campos dos Goytacazes, RJ.

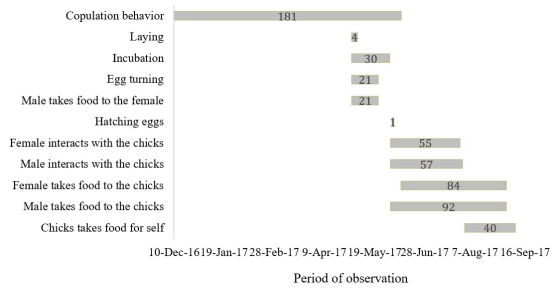

Figure 8. Activities schedule of a *Tyto furcata* family registered within a urban nest box in Campos dos Goytacazes. Each bar shows the total number of days of the activity.

June, when the chicks were learning to dilacerate and swallow the food brought, this period was the longest, as shown in Figure 7.

A final noteworthy behavior observed was cannibalism among the chicks, where the two larger ones killed and ate the smaller ones in the nest. This occurred when the female brought a rat to feed the chicks and was holding it high in the air in her beak, a behavior that had been observed previously when a larger chick repeatedly pecked the head of a smaller one until dilacerating it. The same behavior occurred with the second of the smaller chicks, a few days after the first act of cannibalism. Both events occurred during the night. This cannibalism apparently occurred due to the dispute for food among the chicks.

Figure 8 shows a chronological view of activities registered during the 272 days of observations in the nest box.

4. Discussion

Especially for those species with biparental care, different factors such as how male and female divide the reproductive tasks interfere in the reproductive success. But when they agree on how to divide their tasks in a dynamic interaction, based on how much compatibility, coordination and competence they have to help one another and divide such reproductive tasks, then one may say they have a partnership (Ihle et al. 2015).

In studies by Hadad et al. (2015), in Israel, a rare case of polygamy was observed in this species with a laying of 19 eggs, which is beyond the average reported in this region of five to 11 eggs per pair of laying, with an average of 3.6 hatchlings. Similarly, Taylor (1994) reports that, for that species, one or two breeds are produced in a year, consisting on 2-16 eggs each (mean: 5-6). This reality is close to that reported in our study, where we observed postures of four eggs, with four hatchlings, two surviving. In the same study the authors report that the male provided food in the initial incubation period, while the female did not hunt, which corroborates the data observed in the current research work (Taylor, 1994).

Barn owls are considered to have the highest copulation rate among owls, copulating hundreds of times in the reproductive period, averaging one to two copulations per night. Mating is often preceded by mutual duets, when the male approaches, the female simply lowers her body to a horizontal position in a gesture of solicitation, and the pairs mate. During mating, the male balances slightly on the female's back. To maintain balance, the male can extend the wings slightly and gently hold the feathers at the nape of the female. Sometimes the male brings prey before copulation as present (Lynch, 2007), in line with current research. In this work, we observed an average of 9.1 seconds of copulation. Pais (2014) observed copulation of two 2.5-second burrowing owl couples, which differ from our studies, even when dealing with different but free-living species. Nores and Gutiérrez (1986) report couple copulation from *Tyto alba*, Argentina, lasting approximately 50 seconds, which is quite different from what was reported in our study.

Bunn et al. (1981), reported in their studies cannibalism among owls, even if it occurs infrequently, but when there is little amount of food available the older siblings eat the younger ones, allowing survival to periods of scarcity, corroborating with our observations, because the older brothers' cannibalism occurred with younger ones, at a time when parents were unable to feed the entire litter evenly. The same authors report that cannibalism of parents with chicks has never been documented, as cited in this work.

Since interactions between partners and with chicks are usual, stable and always repeated, compatible partners are able to coordinate their parental tasks, thus having a more efficient cooperation overall (Spoon et al., 2006). The data obtained showed the existence of cooperation and division of tasks between the male and female *Tyto furcata* owls during the reproductive period, with most of the parental care provided by the female. The male was the main food provider, both during incubation of the eggs and the start of life of the chicks, as reported by Datta (2019), concerning that same species, who observed this cooperation between male and female. During the incubation, the male feeds the female and both take care of the young. The male is responsible for hunting and the female for providing the food, brought by the male, to the young. In the same way, Roulin (1999) describes that the male feeds the female since before the laying of eggs and

continues until the chicks reach 2 weeks of life, when the female starts hunting, but with half the preys hunted.

It was observed the act of cannibalism performed by the two older chicks, which fed on the younger chicks in the nest. Allen et al. (2020) emphasizes that cannibalism in raptors usually involves nestlings, and it is a means of increasing survival by improving nutrition and reducing competition for food (e.g., killing a sibling in a nest also reduces immediate competition for food brought by parents). The same authors describes that this behavior in raptors is prevalent and usually occurs during the nesting period, when they are energetically stressed, and the parents are providing food for young, according to the reports of this research. Allen et al. (2020) performed a systematic literature review and meta-analysis of the scientific literature, gathering together 29 articles regarding 25 raptors species, and they could not find any quotes regarding cannibalism among those animals in South America. Sheffield (1994) described cannibalism is frequent in many broods of raptor species, but among barn owls, such reporting is less frequent. When there is abundant food, the chicks share the food with their siblings, but in periods of scarcity, the chicks kill and consume their own siblings so that there is a greater likelihood of the species perpetuating. According to Baudvin (1978), cannibalism is common among the crude-of-tores for the reduction of litters in some periods of the year. This act does not affect the physical conditions of adults, which indicates that tower owls prioritize reproductive success throughout their lives over individual success.

In the current work, owls remained in the nest during day time, and they left at night time to hunt. During the laying, hatching and the first month of feeding of chicks, the female own remained in the nest box most of the time.

In a study that used GPS devices in barn owls aiming to describe behavioral modes and habitat type, the researchers found that, during the day, owls roost almost exclusively in buildings, while pastures, meadows and forest edges were preferred as nocturnal perching sites. Over the 915 daylight roosting events identified, 468 were in the nest box or in the nest box building, 441 in another building and 6 were in forested areas, showing a clear pattern of habitat selection and avoidance (Séchaud et al., 2021). Those data indicate that placing nesting boxes in urban environments could help preserving that species. It was possible to describe the birth and mortality rate, breeding season and parental behavior of this *T. furcate* family.

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