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BREEDING BEHAVIOR OF A PAIR OF RUFOUS-TAILED HAWKS (*BUTEO VENTRALIS*) IN SOUTHERN CHILE

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The Rufous-tailed Hawk (*Buteo ventralis*) is an endemic species of the temperate beech forests of Chile and Argentina (35°–55°S; Vuilleumier 1985) that occurs in low densities (Jaksic and Jiménez 1986) and has a strong dependence on the forest for hunting and breeding (Figueroa et al. 2000, Rivas-Fuenzalida et al. 2011). Their reproduction and nest sites have recently been studied in temperate forests of southern Chile; nest sites there were primarily in old-growth or second-growth native forest or in pine plantations surrounded by mature native forest, and the nests were located not far from human activity or disturbance (Rivas-Fuenzalida et al. 2011). Reproduction in these sites occurs between September and March and phenology varies depending on latitudinal/altitudinal location (Rivas-Fuenzalida et al. 2011). However, to the best of our knowledge, the breeding behavior of Rufous-tailed Hawks has not been systematically studied in detail (Clark 1986, del Hoyo et al. 1994, Ferguson-Lees and Christie 2001, Trejo et al. 2006, Rivas-Fuenzalida et al. 2011).

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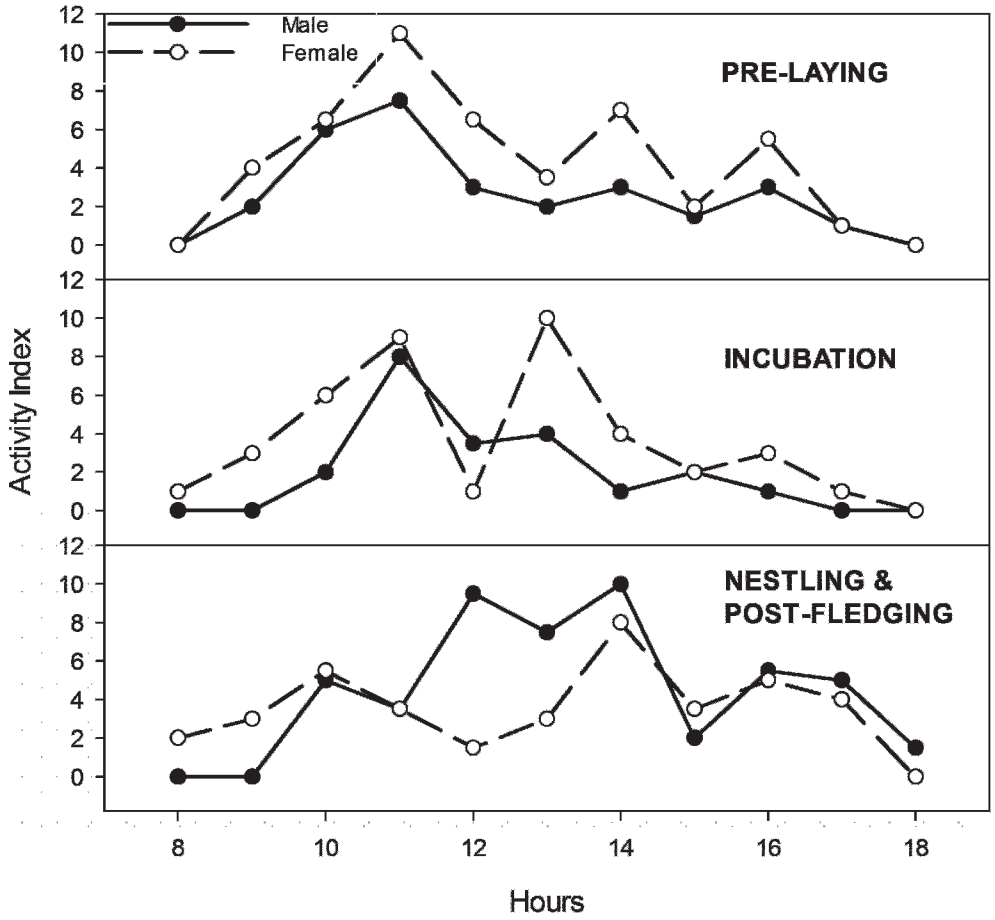

Figure 1. Daily activity index (number of different activities performed; see text) as a function of time of day for a pair of Rufous-tailed Hawks at the nesting site during the pre-incubation, incubation, and post-incubation periods in southern Chile.

At one Rufous-tailed Hawk nest found by JEJ in 1995 close to the city of Temuco in southern Chile, Figueroa et al. (2000) described the diet and hunting behavior of the Rufous-tailed Hawk. Here, we describe the breeding behavior of a pair of Rufous-tailed Hawks nesting in the same suburban forest during the breeding seasons of 2008–09 and 2009–10.

METHODS

Habitat. Between January 2008 and March 2010, we monitored a pair of light-morph Rufous-tailed Hawks that nested in the bottom of a 280-m-long densely-vegetated ravine on Cerro Ñielol Natural Monument (CÑNM), located in the urban margin of Temuco (38°43′S, 72°35′W) in southern Chile. CÑNM is a forest fragment of 114 ha that has a rugged topography with elevations between 115 to 322 m and slopes ranging from 15° to 30°. Most of CÑNM (76%) is covered by temperate forest, dominated by associations of boldo-roble (*Peumus boldus-Nothofagus obliqua*), peumo-boldo (*Cryptocarya alba-Peumus boldus*), and olivillo (*Aextoxicon punctatum*; Hauenstein et al. 1988). The forest is dense, with uneven-aged trees making up a dense canopy 25–45 m tall with numerous openings. Less represented (24%) are the open shrublands dominated by maqui (*Aristotelia chilensis*), retamilla (*Teline monsppesulana*), blackberry (*Rubus ulmifolius*), and colonial bentgrass (*Agrostis capillaris*; Hauenstein et al. 1988). The southern and southeastern boundaries of the CÑNM are bordered by the city of Temuco, and extensive Monterey pine (*Pinus radiata*) and eucalyptus (*Eucalyptus globulus*) plantations of various ages border the north and northeast. The northwestern boundary of CÑNM borders a mixture of grasslands with patches of shrubs and second-growth forest, which is the dominant landscape in the region (Luebert and Pliscoff 2006).

Observations of Adults, Nests, and Nestlings. The female hawk could be easily distinguished from the male

by her larger size (Ferguson-Lees and Christie 2001). Additional plumage markings in the male, such as the presence of a rufous ventral band–which was absent on the female–also allowed us to identify the birds when not together, both when they were flying and when perched at a distance of up to ca. 400 m. Although the adult birds were not banded, other color marks (i.e., on the legs) enable us to confirm that the same pair of adults used the nest during both years.

During the breeding seasons of 2008–09 and 2009–10, we made direct observations using 10 × 40 binoculars and a 20–60 × 80 scope from a vantage point 230 m from the nest. A few observations were made from around 1.5 km from the nest. Between March to July 2009 (the nonbreeding season), we also visited the site to determine the seasonal presence/absence of the Rufous-tailed Hawks in the area. We conducted observations once a week from as early as 0700 H to as late as 1930 H.

For both adults, we recorded their behaviors, the time, duration, and frequency of each behavior, and related notes, if any. The adult behaviors in the vicinity of the nest were classified as: perching-resting, preening, adding nest material/repairing nest, flying, incubating, feeding self, and feeding nestlings or fledglings. We derived a proxy for an ''activity index'' that represents changes in behaviors by averaging the counts of all the different behaviors performed hourly by the adults in the vicinity of the nest. Descriptions of behaviors associated with the reproductive periods (1) pre-laying, (2) incubation, and (3) nestling and post-fledgling, followed Newton (1979). Because we could not see the cup of the nest, the estimated incubation time was not accurate; we inferred the starting and ending of the incubation from the behavior of the female. Given the limited sample size, we did not use inferential statistics, but rather described the behaviors.

RESULTS

We observed an average of 7.0 ± 2.3 (SD) hr per d (n = 63 d), for a total of 440 hr of observation (142 hr in 2008–09 and 298 hr in 2009–10). The total comprised 119.6 hr during the pre-laying period (i.e., from courtship until egg-laying), 80.7 hr during incubation, 208.9 hr during the nestling and post-fledgling periods, and 31.2 hr during the nonbreeding season.

We first observed territory occupancy by the pair in late July in 2008 and in mid-July in 2009, when the male Rufous-tailed Hawk was observed perching nearby the nest, for 1.3 hr and 8.1 hr, respectively. From their arrival at the site in July until late September, male and female repaired and rebuilt the nest structure. On six occasions, we observed the male displaying by soaring upward, followed by the female. On one of these occasions, the female presented her talons to the male, flipping upside-down onto her back when soaring in circles and in a figure-eight pattern (Preston and Beane 2009). The latter was the only observation at 1 km from the nest. Two courtship flights ended in copulations (see below). During the pre-laying period, the male defended the territory by perching visibly on conspicuous, tall trees (>40 m) located at the top of the ravine (n = 19), by making soaring upward flights (n = 54), by stooping (n = 6), and by making undulating display flights (n = 2); all of these behaviors other than perching were generally accompanied by vocalizations (*kee-ahrr*; Fjeldsa and Krabbe 1990, Jaramillo 2003). Undulating flights were performed on 20 September 2009 and 20 December 2009, in response to a Bicolored Hawk (*Accipiter bicolor chilensis*) and a dark-morph Rufous-tailed Hawk, respectively, which flew in the vicinity of the nest.

The nest was used in both years by the same hawks. The nest platform was placed in the top of a 27.8-m tall olivillo tree (*A. punctatum*), 112 cm in DBH, in an even-aged native forest stand with a dense bamboo (*Chusquea quila*) understory. The transport of material to the nest started at the end of July (59 d before laying) and continued until 7 d after incubation started in November. The female brought material to the nest more frequently (n = 13) than the male (n = 3). In three additional cases, we could not identify the sex of the hawk. Of the 19 occasions when we observed material brought to the nest, six preceded and three occurred after copulations. The materials delivered consisted of dead (n = 10) and live (n = 5) 0.5-m to 1-m-long branches of roble (*Nothofagus obliqua*; n = 15), *A. punctatum* (n = 2), and lichens (*Usnea* sp.; n = 2).

Daily activity patterns (i.e., the number of different behaviors exhibited) of males and females differed markedly among reproductive periods. During the pre-laying period, the activity index peaked at 1100–1200 H, with two smaller peaks in the afternoon; the female had a higher activity index than the male. During incubation, the activity index of the male peaked at 1100 H, whereas the female's activity index had two peaks, at 1100 H and at 1300 H. During the post-fledgling period the male was somewhat more active than during the incubation, with a peak in the activity index at 1200–1400 H, and a smaller peak at 1600–1700 H. In contrast, the activity index of the female was low at 1200 H and high at 1400 H (Fig. 1).

We observed nine copulations, six with the male atop the female and three reverse copulations with the female atop the male. Normal mounts occurred between 42 and 7 d before laying started (19.3 ± 12.5 d), whereas reverse mounts occurred 56 to 14 d (37.3 ± 21.4 d) before laying (V. Raimilla unpubl. data). Mounts lasted between 4 and 7 sec and occurred on *N. obliqua* trees (>40 m tall) within 300 m of the nest, at the top of the ravine where the nest was located.

Incubation started on 28 September 2008 and 4 October 2009, was performed exclusively by the female, and lasted 33 to 34 d, into the beginning of November. During incubation, the male visited the vicinity of the nest only for brief periods (1.6 ± 0.9 min; n = 9), perhaps attracted by the vocalizations of the female, who called with increasing intensity. We saw the female leave the nest only twice during incubation to pick up a prey item (unidentified rodent) left by the male within 300 m of the nest; the prey was consumed at the delivery site by the female, who then returned to the nest to resume incubation.

During the first week of November in both years, we observed nestlings in the nest, three in 2008–09 and one in 2009–10. All four young fledged. During the first four weeks after hatching, the nestlings remained in the nest, resting and begging for food with vocalizations.

Starting on day 35 after hatching in 2008–09 and on day 42 in 2009–10, nestlings were in the nest only 38% of the time (standing, resting, or lying down), spending the remainder of their time exploring the nest tree and flapping their wings. On day 49, nestlings started flying in the area surrounding the nest, further reducing the time spent in the nest to 25%. Until then, nestlings fed exclusively in the nest. Between day 56 and day 91, the nestlings fledged. They perched nearby, practiced short flights following the adults, and attempted to hunt. Feeding happened further away from the nest, with little assistance from the adults in plucking and dismembering prey.

During the nestling phase, we recorded 14 prey deliveries, eight by the female, five by the male, and one by a bird whose sex we did not identify. Identified prey delivered were birds ($n = 4$), small rodents ($n = 4$), and one juvenile European hare (*Lepus europaeus*). On three occasions, we saw the male taking old prey remains and releasing them up to 200 m from the nest. The female made more visits to the nest than the male did (23 vs. 17), although the durations of their visits were similar (male: 2.7 ± 2.1 min and female: 2.2 ± 1.7 min). Conversely, the male perched conspicuously more often and longer ($n = 29$; 1.6 ± 2.2 hr) near the nest than did the female ($n = 13$; 0.4 ± 0.4 hr). The juveniles and adults left the area around the nest during the third week of March in 2008–09 and during the second week of February in 2009–10.

On 14 January 2009, we observed two visits of Red-backed Hawks (*Buteo polyosoma*) exploring the nest area. Additionally, between November and December 2009, we observed three aggressive interactions between Red-backed and Rufous-tailed Hawks. These interactions occurred in foraging and resting areas ca. 1 km away from the nest. The attacks involved short-distance (<10 m) persecutions by Red-backed Hawks upon Rufous-tailed Hawks, ending in stoops by the latter on the former and circular, upward soaring with vocalizations and attempted talon-grasping by both species ($n = 3$). Rufous-tailed Hawks generally were not seen in CÑNM outside of the breeding period, except that one male was observed on 5 July 2010 perching on trees ca. 1 km from the nest.

DISCUSSION

Although our study is not the first on the reproduction of the Rufous-tailed Hawk (Rivas-Fuenzalida et al. 2011), it constitutes the most detailed description of breeding behavior at a nest site. We found that the nestling period was longer in the Rufous-tailed Hawk than in other *Buteo* species (49 vs. 43.3 d; Newton 1979), perhaps as a result of its relatively larger size (male: 1031–1175 g and female: 1195–1410 g; Jaksic et al. 2002) or latitudinal location. However, when comparing the breeding behavior of this hawk with that of its close relative, the Red-tailed Hawk (*Buteo jamaicensis*; Vuilleumier 1985, Riesing et al. 2003), we found that the duration of the nestling period (49 vs. 42–46 d) and incubation were similar (Hardy 1939, Fitch et al. 1946, Luttich et al. 1971, Preston and Beane 2009). Difficulties in acquiring enough food from elusive and small prey items may result in a prolonged nestling period in Rufous-tailed Hawks.

We observed a clear separation of behavioral roles between male and female during the different phases of the breeding cycle, which agreed with that described for other hawks (Newton 1979, Krüger 2005). In *Buteo* species, the male generally defends the nest, hunts, and provisions the female when incubating (Widen 1984, Krüger 2005), and the female typically performs most or all of the incubation, brooding, and feeding of nestlings (Newton 1979). In our study, although the male Rufous-tailed Hawk seemed to be solely responsible for territory defense before and after egg-laying, he delivered fewer prey to the nest than did the female. It is possible that prey were captured by the male and transferred to the female out of our sight, as occurs in other *Buteo* species.

The diet of Rufous-tailed Hawks during the breeding season at CÑNM was similar to that previously described for the area, consisting of similar proportions of small birds and mammals (Figueroa et al. 2000). The removal of carcasses and prey remains from the nest has been described for other raptors and may function as a sanitation behavior that might improve the health of the nestlings (Dwyer and Bednarz 2011). A similar role has been ascribed to the greenery brought by raptors to nests, in that plant secondary compounds may keep ectoparasites away from the nest (Wimberger 1984).

The observed later departure of the hawks from the nesting area during the first year may have been a response to larger clutch size (3 vs. 1), lower prey availability (Newton 1979) or both. The number of chicks fledged during the first year of the study corresponded to the maximum reported (Housse 1945).

According to Rivas-Fuenzalida et al. (2011), based on 42 nest territories located between 37°46′–39°32′S, nest-building for this species started in July (late austral winter) and the nestling and post-fledgling period occurred during late October-early November (mid-austral spring), dates similar to what we documented in our study area. However, these dates differed from previously published anecdotal information (Housse 1945, Behn 1947, Trejo et al. 2006). The dates of the beginning of the egg-laying and incubation periods were consistent with previously reported information for the Rufous-tailed Hawk (Housse 1945, Fjeldsa and Krabbe 1990, Rivas-Fuenzalida et al. 2011).

Although we did not always detect the Rufous-tailed Hawks during the nonbreeding season in CÑNM, the observation of one adult in July in the area could indicate that the hawks were secretive or inactive or that their nonbreeding home ranges were larger (Rivas-Fuenzalida et al. 2011).

As a caveat, we note that our study was based on observations at a single nest. We recommend additional studies on the breeding behavior and habitat requirements of this little-studied hawk, especially considering the rapid frag-

mentation and disappearance of the temperate forests in southern Chile that may negatively affect this species.

COMPORTAMIENTO REPRODUCTIVO DE UNA PAREJA DE *BUTEO VENTRALIS* EN EL SUR DE CHILE

RESUMEN.—*Buteo ventralis* es una rapaz endémica y virtualmente desconocida de los bosques templados de *Nothofagus* de Chile y Argentina. Estudiamos el comportamiento reproductivo de una pareja en el mismo nido durante dos temporadas reproductivas consecutivas (2008–09 y 2009–10) en el Monumento Natural Cerro Ñielol, cerca de Temuco en el sur de Chile, de julio del 2008 a marzo del 2010. La pareja construyó y arregló un nido en un árbol alto de *Aextoxicon punctatum* en el fondo de una quebrada densamente vegetada. El macho defendió activamente el territorio. La hembra incubó exclusivamente los huevos durante 33–34 días, comenzando a principios de octubre. La pareja produjo tres y un pichones, en 2008–09 y 2009–10 respectivamente, los cuales dejaron el nido a los 49–56 días de edad y dejaron de visitar el nido a los 91 días de edad. La pareja y los juveniles permanecieron en el área del nido hasta finales de marzo. El comportamiento reproductivo de *B. ventralis* fue similar al de otros *Buteo*, especialmente al de su pariente más cercano, *B. jamaicensis* en América del Norte.

[Traducción del equipo editorial]

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