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Source: The Wilson Journal of Ornithology, 124(4):737-742. 2012.

Published By: The Wilson Ornithological Society

DOI: <http://dx.doi.org/10.1676/1559-4491-124.4.737>

URL: <http://www.bioone.org/doi/full/10.1676/1559-4491-124.4.737>

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NESTING OF THE THORN-TAILED RAYADITO (*APHRASTURA SPINICAUDA*) IN A PINE PLANTATION IN SOUTHCENTRAL CHILE

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ABSTRACT.—We installed nest boxes for Thorn-tailed Rayaditos (*Aphrastura spinicauda*) and monitored their use in a Monterrey pine (*Pinus radiata*) plantation in the Maule Region, southcentral Chile. Thirty-four breeding pairs built nests in boxes, of which 75% began laying eggs. Nest establishment began in early September and construction lasted 12.8 ± 4.9 days ($n = 23$). Rayaditos used mainly pine needles, together with mosses, epiphytes, herbs, and animal hair in their nests. Clutch size ranged from two to four eggs (mode = 3) that were incubated for 15.8 ± 1.2 days. Brood size negatively affected mass of nestlings, but was positively related to mass of the parents. Adults had higher body mass and built larger nests than those reported previously for the species on Chiloé Island, where broods are larger and the incubation period is shorter. The provision of artificial cavities allowed Thorn-tailed Rayaditos to nest in the pine plantation. Nest boxes combined with other management tools, such as maintaining snags and understory enhancement, may be important factors in mitigation of negative effects of pine plantations on secondary cavity-nesting birds. Received 18 February 2012. Accepted 7 June 2012.

The Furnariidae consists of a large variety of species that have colonized a wide diversity of habitats from tropical rainforests to savannas and deserts (Fjeldså et al. 2005). They are mostly insectivorous, socially monogamous, and territorial. Their plumage is typically brown or grayish-brown, and males and females are morphologically similar (Zyskowski and Prum 1999, Mezquida 2001, Remsen 2003, Rubio and de Pinho 2008).

The Thorn-tailed Rayadito (*Aphrastura spinicauda*) is an endemic member of Furnariidae from South American temperate rainforests (Grigera 1982). It does not exhibit sexual dimorphism and has high parental care of eggs and chicks (Moreno et al. 2007, van Dongen et al. 2009). It is territorial during the breeding season (Ippi et al. 2011), but joins mixed-species flocks during the non-breeding season where it is the dominant species (Vuilleumier 1967, Ippi and Trejo 2003).

Plantations of exotic Monterrey pine (*Pinus radiata*) have replaced the original native vegetation in southcentral Chile, affecting wildlife diversity by homogenizing the landscape (Muñoz-Pedreros et al. 1996, Vergara and Simonetti 2003). The Thorn-tailed Rayadito is considered sensitive to habitat fragmentation and patch vegetation characteristics (Vergara and Simonetti

2004, Vergara and Marquet 2007), but also frequently visits the pine matrix to forage (Estades 1999, Estades and Temple 1999). Rayaditos use small and isolated remnants of native forest during the breeding season, where there are available tree cavities, a limiting resource for nesting (Tomasevic and Estades 2004, 2006; Cornelius et al. 2008).

Pine plantations represent usable foraging habitat for Thorn-tailed Rayaditos and may also enhance connectivity between remnant native vegetation patches (Estades and Temple 1999; Estades 2001b, c; 2006). However, the scarcity of cavities in industrial forests severely restricts breeding use by the species (Estades 2001b). Thus, use of nest boxes has the potential to become a habitat improvement tool to allow Thorn-tailed Rayaditos to nest in pine plantations.

Information about Rayadito breeding biology in pine plantations is scant, despite its usefulness to assess conservation status as well as species responses to environmental disturbances in natural and managed habitats (Vasquez and Simonetti 1999). Our objectives were to: (1) examine if Rayaditos can breed in exotic pine plantations if they have access to nesting cavities, and (2) describe their breeding biology in pine plantations for comparison with previously published data from a native forest on Chiloé Island, Chile (Moreno et al. 2005).

METHODS

Study Area.—The study was conducted during austral spring 2009 in the Coastal Range of the Maule Region, Constitución Province, southcentral Chile ($35^{\circ} 29' S$, $72^{\circ} 21' W$) (Fig. 1). The

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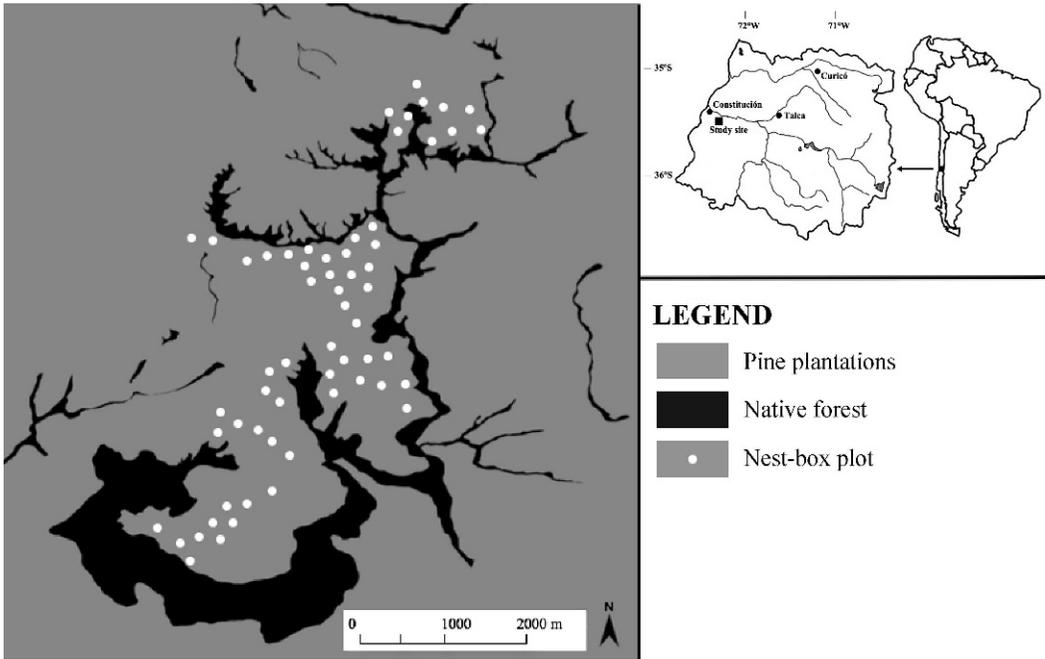


FIG. 1. Study area and location of sample plots ($n = 60$) in southcentral Chile. Fragmented remnants of native *Nothofagus* forest (black) are embedded in a matrix of exotic Monterey pine (*Pinus radiata*) plantations (gray).

area was originally a deciduous forest of *Nothofagus glauca* (Hualo), which began being exploited in the early 19th century (San Martín and Donoso 1996). The Maule Region now contains one of the largest concentrations of *P. radiata* plantations in the country, covering 76% of the Coastal Range. Native forest remains in small isolated fragments surrounded by exotic Monterey pine plantations. The climate is warm temperate with an oceanic influence. The average minimum temperature is 5.9 °C during winter (Jul) and the mean maximum temperature is 22.7 °C during summer (Jan). Mean annual rainfall is 881 mm (Estades and Temple 1999).

We worked in plantations that were 18 years of age where we placed 180 nest boxes in 60 sample plots (3 boxes/plot; Fig. 1). The minimum distance between neighboring sample plots was 183 m. Sample plots were considered independent, as the activity of Rayadito breeding pairs is usually restricted to a radius of 30 m from the nest (van Dongen et al. 2009). Distance from the plots to native forest ranged from 23 to 520 m (mean = 210 m).

Nest boxes were attached to tree trunks between 2.5 and 4 m above the ground and all three boxes in a single sample plot were given different orientations. Boxes were made of wood

and had a height of 25 cm, width of 16 cm, and an entrance hole of 3 cm in diameter (Moreno et al. 2005, 2007).

Nest Monitoring.—We checked nest boxes weekly from the last week of August, recording any sign of nesting activity, including use of twigs and/or feathers to build the nest. We increased frequency of monitoring once we observed activity in the box to detect laying dates (date of first egg) and hatching dates (date of first hatchling in the nest). The latter frequency depended on advancement of the nest building stage, from three times per week to daily when the nest was nearly completed. We weighed and measured eggs on the day they were laid. Length and width were measured to the nearest 0.1 mm with a digital caliper. Egg volume was obtained using Hoyt's (1979) formula: $\text{Volume} = 0.51 (\text{Length} \times \text{Width}^2)$.

We captured adults with traps in the nest box when nestlings were 13 days of age and banded them with a combination of three plastic colored bands under the authority of Servicio Agrícola y Ganadero of Chile. Adult mass was recorded with a spring balance to the nearest 0.1 g. We measured tarsus and head-bill length to the nearest 0.1 mm with a digital caliper, and wing length and the two

central rectrices with a millimeter ruler. We recorded mass, tarsus, head-bill, and wing length for the young, using the same technique as for adults. We took measurements of all eggs, nestlings, and adults. Averages were calculated for each nest.

The time required for nest construction was the period between the first record of nest material inside the nest box and the laying date of the first egg. The incubation period was assumed to be the time between the last egg laid and hatching. Fifteen nests were removed, after the young had fledged, for a composition analysis.

Statistical Analysis.—Data are expressed as mean \pm standard deviation (SD). All nests are considered statistically independent because no two simultaneously active nests were in the same plot. We used Pearson correlation analysis for comparisons among nests. The criterion for statistical significance was $\alpha \leq 0.05$. We used generalized linear models (GLM) with binomial response variables (occurrence of nest building, laying, and the presence of at least one successful fledgling) to evaluate the effect of distance to native forest on nest-site selection. Morphological measurements between adult and juveniles were compared using a paired *t*-test. The main results of our study and the previously published data for Chiloé Island were compared using a two-sample Welch's *t*-test. All statistical analyses were performed with R (R Development Core Team 2008).

RESULTS

Thirty-four breeding pairs built nests in the boxes, and 25 (74%) began laying eggs. We estimated a nest construction time of 12.8 ± 4.9 days ($n = 23$). Some pairs continued carrying building material to the nest during egg laying and the beginning of incubation. Nest composition was mainly pine needles and small twigs of trees and shrubs. The center of the nest contained feathers, mosses, epiphytes, herbs, and animal hair. Dry nest weight (41.6 ± 14 g; range = 12.2–69.8 g, $n = 15$) was not related to laying date ($r = -0.1$, $P = 0.58$, $n = 15$) or clutch size ($r = 0.27$, $P = 0.33$, $n = 15$).

Nest construction began between 3 September and 23 November (median = 4 Oct, $n = 28$). Laying occurred between 17 September and 18 November with a median laying date of 15 October ($n = 24$). Hatching of the first clutch occurred between 12 October and 8 December

(median = 4 Nov, $n = 22$). Clutch size ranged from two to four eggs (3.3 ± 0.7 , $n = 22$) with modal size of three eggs. Brood size at hatching ranged from one to four nestlings (2.9 ± 0.8 , $n = 19$) with a mode of three nestlings per nest.

Laying occurred on alternate days with eggs measuring 18.6 ± 0.53 mm in length and 14.5 ± 0.2 mm in width ($n = 16$). Mean egg volume was $2,010 \pm 92$ mm³ ($n = 16$) and mean mass was 2.02 ± 0.14 g ($n = 18$). There was no association between mean egg volume and clutch size ($r = -0.2$, $P = 0.44$, $n = 16$) or laying date ($r = 0.06$, $P = 0.8$, $n = 16$). Incubation lasted between 14 and 18 days (15.8 ± 1.2 , $n = 20$) with a modal time of 16 days. Fledging occurred at 21 days. There was no significant association between laying date and incubation period ($r = 0.01$, $P = 0.96$, $n = 20$).

The lengths of 13-day old nestlings' tarsus, wing, central rectrix, and total body were 6%, 48%, 75%, and 45% smaller than adults, respectively. However, adult body mass was 11% lower than of nestlings at day 13 (Table 1). Brood size negatively affected the mass of chicks ($r = -0.74$, $P = 0.03$, $n = 8$), and there was a positive correlation between adult mass and mean mass of nestlings ($r = 0.52$, $P = 0.03$, $n = 16$). There was no association between laying date and adult mass ($r = -0.03$, $P = 0.9$, $n = 18$) or between laying date and nestling mass ($r = 0.3$, $P = 0.2$, $n = 18$).

Eleven of 25 active nests (44%) were depredated before eggs hatched, and five (36%, 5/14) were depredated during the nestling stage. The total reproductive failure rate was 64%. Six pairs with depredated nests laid a second clutch; three were depredated during the egg stage and two during the nestling stage. Three successful pairs re-nested but these nests were not monitored. Considering all nests that hatched young ($n = 19$), $89 \pm 16\%$ eggs hatched and $72 \pm 44\%$ chicks left the nest.

We compared the results of our study with those obtained by Moreno et al. (2005) for a population of Thorn-tailed Rayaditos breeding in a native forest at Chiloé Island, Chile (Table 2). Egg morphology and breeding success did not differ between populations. However, adults were heavier and took longer to build a heavier nest in the pine plantation near Constitución. They also laid fewer eggs that were incubated over a longer period of time, and had fewer chicks per nest than documented for the Chiloé population.

TABLE 1. Morphological traits (mean \pm SD) of nestling (day 13) and adult Thorn-tailed Rayaditos (*Aphrastura spinicauda*) in a *Pinus radiata* plantation in southcentral Chile ($n = 14$).

Morphological measurements	Nestlings (13 days)	Adults	t	P
Tarsus length (mm)	20.8 \pm 0.7	22.1 \pm 0.6	6.5	<0.001
Head-Bill length (mm)	26.4 \pm 0.9	30.6 \pm 0.7	13.2	<0.001
Wing length (mm)	30 \pm 5.1	58 \pm 2	23.3	<0.001
Total length of central rectrix (mm)	20 \pm 11	83 \pm 6	17.1	<0.001
Body length (mm)	69 \pm 8	135 \pm 7	26.3	<0.001
Mass (g)	13.1 \pm 1.3	11.6 \pm 0.3	-4.9	<0.001

Distance to native forest did not influence nest-site selection ($Z = -1.1$, $P = 0.27$, $n = 60$), as this factor did not affect any of the other variables studied, considering all sites or those that had nesting activity (laying of eggs: $Z = -0.89$, $P = 0.38$, $n = 60$, $Z = -0.96$, $P = 0.34$, $n = 34$; and production of at least one fledging: $Z = -0.88$, $P = 0.38$, $n = 60$, $Z = -0.28$, $P = 0.78$, $n = 34$). There were no significant associations between distance to native forest and egg mass ($r = 0.3$, $P = 0.2$, $n = 22$), chick mass ($r = 0.2$, $P = 0.3$, $n = 16$), adult mass ($r = -0.1$, $P = 0.6$, $n = 16$), or clutch size ($r = 0.2$, $P = 0.2$, $n = 22$).

DISCUSSION

Several studies have shown that provision of artificial cavities during the reproductive period may increase the abundance of cavity-nesting birds as well as their frequency of use of pine plantations (e.g., Muñoz-Pedrerros et al. 1996, Bull 2003, Maicas and Haeger 2004). We observed Thorn-tailed Rayadito using Monterrey pine plantations for breeding if nest boxes were present.

Pine plantations may differ from native forests, in addition to scarcity of cavities, in other breeding habitat aspects for Thorn-tailed Rayaditos. However, evidence of food abundance for small insectivores suggests pine plantations in southcentral Chile provide levels of foraging resources similar to native forests (Estades and Escobar 2005). Thus, the observed difference in clutch sizes may be more consistent with the hypothesis proposed by Lack (1968), which predicts that at higher latitudes (Chiloé $\sim 41^\circ$ S and Constitución $\sim 35^\circ$ S), clutch size increases, presumably because of longer day length, which provides more time for parents to feed nestlings and reduces the possibility of re-nesting (Dunn and MacInnes 1987, Shamel and Tracy 1987, Young 1994, Piersma 1996). A recent study of House Wren (*Troglodytes aedon chilensis*) on Chiloé Island, also suggests that clutch size increases with latitude in the Southern Hemisphere (Ippi et al. 2012).

Estades (2001b) argued that pine plantations might offer a safe place to nest for cavity-nesting birds such as the Thorn-tailed Rayadito, because

TABLE 2. Breeding biology traits of two populations of Thorn-tailed Rayaditos, one breeding in the *Nothofagus* rainforest of Chiloé Island (southern Chile; data from Moreno et al. 2005) and the other in a *Pinus radiata* plantation near Constitución city in the Maule Region (southcentral Chile; present study). Values are mean \pm SD (n).

	Chiloé Island	Constitución	df	t	P
Nest construction (days)	6.1 \pm 4.8 (15)	12.8 \pm 4.9 (23)	30.5	-4.17	<0.001
Incubation period (days)	12.8 \pm 1.9 (16)	15.8 \pm 1.2 (20)	24.2	-5.49	<0.001
Clutch size	4.1 \pm 0.8 (30)	3.3 \pm 0.7 (22)	48.4	3.83	<0.001
Brood size	4.2 \pm 0.7 (22)	2.9 \pm 0.8 (19)	36.1	5.49	<0.001
Adult mass (g)	10.8 \pm 0.8 (41)	11.6 \pm 0.3 (14)	52.4	-5.38	<0.001
Nest dry weight (g)	33.7 \pm 5.1 (12)	41.6 \pm 14 (15)	18.4	-2.02	0.05
Egg volume (cm ³)	2010 \pm 200 (57)	2010 \pm 92 (16)	55.2	0	0.99
Hatching success (%) ^a	95.2 \pm 10.2 (26)	89 \pm 16 (19)	28.5	1.48	0.15
Breeding success (%) ^b	76.7 \pm 31 (26)	72 \pm 44 (19)	30.5	0.4	0.69

^a % eggs hatched for all nests.

^b % young fledged for all eggs that hatched.

both the structural simplicity and the low density of breeding birds would limit nest predators present in these artificial forests. However, we observed that predation and breeding success rates were similar to those in native forest. Potential Rayadito nest predators in pine plantations include mice, opossums (*Thylamys elegans*) (Estades 2001b), and the long-tailed snake (*Phylodrias chamissonis*) (Escobar and Vukasovic 2003).

We did not find any effect of distance to native forest on the use rate of nest boxes or on nesting success. Rayaditos breeding in native forest patches usually move several hundred meters into the adjacent pine plantations during the non-breeding season (Estades 2001b, 2006). Thus, it is likely birds were able to detect the presence of nest boxes throughout the entire range of distances in our study.

Use of an artificial habitat for nesting reflects some level of behavioral plasticity by the Thorn-tailed Rayadito. Examples of the latter are use of pine needles as one of the main materials for nest construction, and consumption of pine seeds by this insectivorous species (Estades 2001a).

Our results support the use of nest boxes to offset the scarcity of cavities in a landscape dominated by plantations of fast growing pine, thus allowing nesting by cavity-dependent birds (Munoz-Pedrerros et al. 1996, White and Seginac 2000, Bull 2003, Maicas and Haeger 2004, Woodley et al. 2006, Cockle et al. 2008). Use of artificial nest boxes, together with other management tools such as maintenance of snags and enhancement of the understory (Tomasevic and Estades 2008), may be important methods to mitigate the negative effects of pine plantations on forest birds in Chile.

ACKNOWLEDGMENTS

This study was funded through grants to R. A. Vásquez (FONDECYT 1090794, PFB-23-CONICYT), and grant P05-002 Millenium Scientific Initiative of the Ministry of Economy, Advancement and Tourism of Chile. C. E. Estades thanks FONDECYT for grant 1080463. Mininco kindly granted access to the study area and provided cartographic information. The School of Forest Science and Nature Conservation of the University of Chile contributed with lodging. C. S. Quilodrán acknowledges support from an IEB scholarship. R. F. Zúñiga, C. I. Venegas, and D. I. Medina helped set up the nest boxes, and F. M. Maureira, N. D. Von Kunowsky, M. A. Chávez, and C. A. Pernollet helped with fieldwork. We thank Kristof Zyskowski, an anonymous reviewer, and C. E. Braun for valuable comments and suggestions on an earlier version of this paper.

LITERATURE CITED

- BULL, E. L. 2003. Use of nest boxes by Vaux's Swifts. *Journal of Field Ornithology* 74:394–400.
- COCKLE, K., K. MARTIN, AND K. WIEBE. 2008. Availability of cavities for nesting birds in the Atlantic Forest, Argentina. *Ornitología Neotropical* 19:269–278.
- CORNELIUS, C., K. COCKLE, N. POLITI, I. BERKUNSKY, L. SANDOVAL, V. OJEDA, L. RIVERA, M. HUNTER, AND K. MARTIN. 2008. Cavity-nesting birds in neotropical forests: cavities as a potentially limiting resource. *Ornitología Neotropical* 19:253–268.
- DUNN, E. H. AND C. MACINNES. 1987. Geographical variation in clutch size and body size of Canada Geese. *Journal of Field Ornithology* 58:355–371.
- ESCOBAR, M. A. H. AND M. A. VUKASOVIC. 2003. Depredación de *Philodryas chamissonis* (Serpentes: Colubridae) sobre polluelos de *Aphrastura [Aphrastura] spinicauda* (Passeriformes: Furnariidae): una culebra arborícola? *Noticiario Mensual Museo Nacional de Historia Natural (Chile)* 352:18–20.
- ESTADES, C. F. 1999. Nidificación de aves en un rodal maduro de *Pinus radiata*. *Boletín Chileno de Ornitología* 6:35–38.
- ESTADES, C. F. 2001a. Consumo de semillas de Pino (*Pinus radiata*) por rayaditos (*Aphrastura spinicauda*). *Boletín Chileno de Ornitología* 8:30–31.
- ESTADES, C. F. 2001b. Forest bird in landscape mosaic: theory and empirical evidence. Thesis. University of Wisconsin, Madison, USA.
- ESTADES, C. F. 2001c. The effect of breeding-habitat patch size on bird population density. *Landscape Ecology* 16:161–173.
- ESTADES, C. F. 2006. Comunidades de aves en un mosaico de bosques naturales y artificiales. Pages 69–81 in *Biodiversidad en ambientes fragmentados de Chile: patrones y procesos a diferentes escalas* (A. A. Grez, J. A. Simonetti, and R. O. Bustamante, Editors). Editorial Universitaria, Santiago, Chile.
- ESTADES, C. F. AND M. A. H. ESCOBAR. 2005. Los ecosistemas de las plantaciones de pino de la Cordillera de la Costa. Pages 600–616 in *Biodiversidad, Historia y Ecología de los bosques de la Cordillera de la Costa de Chile* (J. J. Armesto, C. Smith-Ramírez, and C. Valdovinos, Editors). Editorial Universitaria, Santiago, Chile.
- ESTADES, C. F. AND S. A. TEMPLE. 1999. Deciduous-forest bird communities in a fragmented landscape dominated by exotic pine plantations. *Ecological Applications* 9:573–585.
- FJELDSÅ, J., M. IRESTEDT, AND P. ERICSON. 2005. Molecular data reveal some major adaptational shifts in the early evolution of most diverse avian family, the Furnariidae. *Journal of Ornithology* 146:1–13.
- GRIGERA, D. E. 1982. Ecología alimentaria de algunas Passeriformes insectívoras frecuentes en los alrededores de San Carlos de Bariloche. *Ecología Argentina* 7:67–84.
- HOYT, D. F. 1979. Practical methods of estimating volume and fresh weight of bird eggs. *Auk* 96:73–77.
- IPPI, S. AND A. TREJO. 2003. Dinámica y estructura de bandadas mixtas de aves en un bosque de Lengua

- (*Nothofagus pumilio*) del noroeste de la Patagonia Argentina. *Ornitología Neotropical* 14:353–362.
- IPPI, S., R. A. VASQUEZ, W. F. D. VAN DONGEN, AND I. LAZZONI. 2011. Geographical variation in the vocalizations of the subsocial Thorn-tailed Rayadito *Aphrastura spinicauda*. *Ibis* 153:789–805.
- IPPI, S., R. A. VASQUEZ, J. MORENO, S. MERINO, AND C. P. VILLAVICENCIO. 2012. Breeding biology of the Southern House Wren (*Troglodytes aedon chilensis*) on Chiloé Island, southern Chile. *Wilson Journal of Ornithology* 124:531–537.
- LACK, D. 1968. Ecological adaptations for breeding in birds. Methuen, London, United Kingdom.
- MAICAS, R. AND J. F. HAEGER. 2004. Pine plantations as a breeding habitat for a hole-nesting bird species Crested Tit (*Parus cristatus*) in southern Spain. *Forest Ecology and Management* 195:267–278.
- MEZQUIDA, E. T. 2001. La reproducción de algunas especies de Dendrocolaptidae y Furnariidae en el desierto del Monte Central, Argentina. *Hornero* 16: 23–30.
- MORENO, J., S. MERINO, R. A. VASQUEZ, AND J. J. ARMESTO. 2005. Breeding biology of the Thorn-tailed Rayadito (Furnariidae) in south-temperate rainforests of Chile. *Condor* 107:69–77.
- MORENO, J., S. MERINO, E. LOBATO, M. A. RODRIGUEZ-GIRONES, AND R. A. VASQUEZ. 2007. Sexual dimorphism and parental roles in the Thorn-tailed Rayadito (Furnariidae). *Condor* 109:312–320.
- MUÑOZ-PEDREROS, A., A. GANTZ, AND M. SAAVEDRA. 1996. Nest boxes in *Pinus radiata* woodlands in southern Chile: a tool to mitigate negative environmental impacts? *Revista Chilena De Historia Natural* 69:393–400.
- PIERSMA, T. 1996. Energetic constraints on the non-breeding distribution of coastal shorebirds. *International Wader Studies* 8:122–135.
- R DEVELOPMENT CORE TEAM. 2008. R: a language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria.
- REMSEN, J. V. 2003. Family Furnariidae (Ovenbirds). Pages 162–357 in *Handbook of the birds of the world*. Volume 8. Broadbills to tapaculos (J. del Hoyo, A. Elliott, and D. Christie, Editors). Lynx Edicions, Barcelona, Spain.
- RUBIO, T. C. AND J. B. DE PINHO. 2008. Biología reproductiva de *Synallaxis albilora* (Aves: Furnariidae) no Pantanal de Poconé, Mato Grosso. *Papéis Avulsos de Zoologia* 48:181–197.
- SAN MARTÍN, J. AND C. DONOSO. 1996. Estructura florística e impacto an trópico en el bosque maulino de Chile. Pages 153–168 in *Ecología de los bosques nativos de Chile* (J. J. Armesto, C. Villagrán, and M. T. K. Arroyo, Editors). Editorial Universitaria, Santiago, Chile.
- SHAMEL, D. AND D. M. TRACY. 1987. Latitudinal trends in breeding Red Phalaropes. *Journal of Field Ornithology* 58:126–134.
- TOMASEVIC, J. A. AND C. F. ESTADES. 2004. Oferta de cavidades para aves de bosque en relación a parámetros dendrométricos en Hualo (*Nothofagus glauca*) y Coihue (*Nothofagus dombeyi*). *Boletín Chileno de Ornitología* 10:26–29.
- TOMASEVIC, J. A. AND C. F. ESTADES. 2006. Stand attributes and the abundance of secondary cavity-nesting birds in southern beech (*Nothofagus*) forests in south-central Chile. *Ornitología Neotropical* 17:1–14.
- TOMASEVIC, J. A. AND C. F. ESTADES. 2008. Effects of the structure of pine plantations on their “softness” as barriers for ground-dwelling forest birds in south-central Chile. *Forest Ecology and Management* 255:810–816.
- VAN DONGEN, W. F. D., I. LAZZONI, AND R. A. VASQUEZ. 2009. Behavioral experiments in a wild passerine cause short-term reductions in parental provisioning and nestling mass. *Revista Chilena de Historia Natural* 82:223–231.
- VASQUEZ, R. A. AND J. A. SIMONETTI. 1999. Life history traits and sensitivity to landscape change: the case of birds and mammals of Mediterranean Chile. *Revista Chilena de Historia Natural* 72:517–525.
- VERGARA, P. M. AND P. A. MARQUET. 2007. On the seasonal effect of landscape structure on a bird species: the Thorn-tailed Rayadito in a relict forest in northern Chile. *Landscape Ecology* 22:1059–1071.
- VERGARA, P. M. AND J. A. SIMONETTI. 2003. Forest fragmentation and nest predation in central Chile. *Acta Oecologica* 24:285–288.
- VERGARA, P. M. AND J. A. SIMONETTI. 2004. Avian responses to fragmentation of the Maulino in central Chile. *Oryx* 38:383–388.
- VUILLEUMIER, F. 1967. Mixed species flocks in Patagonian forest, with remarks on interspecies flock formation. *Condor* 69:400–404.
- WHITE, D. H. AND J. T. SEGNAK. 2000. Nest box use and productivity of Great Crested Flycatchers in prescribed-burned longleaf pine forests. *Journal of Field Ornithology* 71:147–152.
- WOODLEY, S. J., G. JOHNSON, B. FREEDMAN, AND D. A. KIRK. 2006. Effects of timber harvesting and plantation development on cavity-nesting birds in New Brunswick. *Canadian Field-Naturalist* 120:298–306.
- YOUNG, B. E. 1994. Geographic and seasonal patterns of clutch-size variation in House Wrens. *Auk* 111:545–555.
- ZYSKOWSKI, K. AND R. O. PRUM. 1999. Phylogenetic analysis of nest architecture of neotropical ovenbirds (Furnariidae). *Auk* 116:891–911.