NESTING BEHAVIOR OF THE GRASSLAND YELLOW-FINCH (*SICALIS LUTEOLA*) IN SOUTHEASTERN BRAZIL

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Resumo. – Comportamento de nidificação do tipio (*Sicalis luteola*) no sudeste do Brasil. – O tipio (*Sicalis luteola*) é uma ave comum que ocorre em campos abertos e capinzais da América do Sul e Central. Aqui nós apresentamos a primeira descrição detalhada do comportamento de nidificação desta espécie no sudeste do Brasil, baseando-se no estudo de 20 ninhos ativos. A estação reprodutiva diferiu entre dois anos analisados, tendo variado de outubro a janeiro na estação de 2009/2010 e de dezembro a março na estação de 2010/2011. Os ninhos foram tigelas fundas e volumosas feitas de folhas e talos de grama, construídos entre as moitas mais densas e altas (60–90 cm) de capim. Os ovos foram brancos a levemente azulados com manchas e pintas marrons (intensas ou pálidas), mais concentradas no pólo maior, eventualmente formando uma coroa. Eles mediram 17.0 mm de comprimento, 12.7 mm de largura e pesaram 1.4 g (mediana). O tamanho das ninhadas foi de quatro ovos. Apenas as fêmeas participaram da construção dos ninhos, incubação e alimentação dos filhotes. Os períodos de incubação e permanência dos filhotes nos ninhos foram ambos de 12.0 dias. A porcentagem média de sucesso dos ninhos, estimada através de um modelo nulo de taxa diária de sobrevivência constante, foi de 47% (95% IC, 21–70%). Comparações com dados da literatura do canário-da-terra (*S. flaveola*) da mesma região de estudo, mostraram que o período de permanência dos filhotes nos ninhos foi bastante menor em *S. luteola*, corroborando a premissa de que a taxa de desenvolvimento dos ninhegos é menor em espécies que nidificam em cavidades.

Abstract. – The Grassland Yellow-Finch (*Sicalis luteola*) is a common species that occurs in open fields and grasslands from South and Central America. Here we present the first description of its nesting behavior in southeastern Brazil, based on 20 active nests. Breeding season phenology varied between years, with breeding activities occurring from October to January in 2009/2010 season, and from December to March in 2010/2011 season. Nests were bulky and deep cups made of dry grass leaves and stems, built in the middle of dense and tall (about 60–90 cm) grass tussocks. Eggs were white to slightly blue, with pale to intense light and dark brown spots and blotches that were concentrated at the larger end, sometimes forming a crown. They measured 17.0 mm in length, 12.7 mm in width, and weighed 1.4 g (median). Clutch size was four eggs. Only females constructed the nests, incubated, and provisioned the nestlings. Incubation and nestling periods were both 12.0 days, respectively. Estimated overall nesting success was 47% (95% CI, 21–70%), using a null model of constant daily survival rate. Comparisons with literature data on the secondary hole-nester Saffron Finch (*S. flaveola*) from the same study region, has shown that nestling period of *S. luteola* was shorter, supporting the premise that young developmental periods are longer in cavity nesting species. *Accepted 15 August 2012.*

Key words*:* Grassland Yellow-Finch, *Sicalis luteola,* Brazil, breeding behavior, parental care, reproductive biology.

INTRODUCTION

The genus *Sicalis* comprises a diverse group of predominantly yellow finches, widely distributed in South America, with the Grassland Yellow-Finch (*S. luteola*) occurring also in Central America (Ridgely & Tudor 1994, Silveira & Méndez 1999). They inhabit open areas and feed on the ground, often forming large flocks (Ridgely & Tudor 1994).

The Grassland Yellow-Finch can be locally common in open fields and tall grasslands, where breeding males perform typical display flights with fluttering wings (Ridgely & Tudor 1994, Sick 1997). Like most yellow finches, the breeding biology of *S. luteola* is poorly documented (but see Palmerio & Massoni 2009, Gressler & Marini 2011). Nests and eggs are known from rough descriptions provided by Euler (1900) and Ihering (1900), and from a picture presented by De La Peña (2006). Mason (1985) reported clutch size, egg dimensions, and nestling characteristics based on three nests found in Buenos Aires, Argentina, as well as the incubation period obtained from a single nest. Here we present the first description of the nesting behavior of *S. luteola*. Our goal was to provide information on phenology and duration of the breeding season, clutch size, length of incubation and nestling periods, nesting success, and parental care for a population in São Paulo State, southeastern Brazil.

METHODS

Study area. We conducted our study in an approximately 50 ha artificial pastureland that has been abandoned for five years. The predominant vegetation was the exotic grass *Brachiaria* sp., with scattered native bushes (mainly *Baccharis dracunculifolia*, Asteraceae) in early regenerating stage. The area is located in Sorocaba city, São Paulo state, southeastern Brazil (23°34'41"S, 47°31'48"W). The climate is tropical with two well-marked seasons: a humid, hot season from October through March (average rainfall = 919 mm, temperatures range from 15.7 to 32.4 °C) and a dry, cold season from April through September (average rainfall = 294 mm, temperature range from 11.4 to 30.6 °C).

Field procedures. We conducted systematic nest searches from August to April during two breeding seasons: 2009/2010, and 2010/2011. We searched for nests at least three times per week by covering all of the sites where males were defending territories. Irregular visits were also performed in 2008. Nests were located by following adults in their territories when they were carrying nest material or feeding young, and were checked every 1–3 days. We used metal calipers accurate to ± 0.01 mm to measure nests and eggs, and a spring scale accurate to ± 0.1 g to weigh eggs. Clutch sizes were determined from nests in which we could follow egg-laying from the first to the last egg. The incubation period was the first day of incubation to the day before hatching, and nestling period was considered from the hatching day to the day before fledging. Observations were performed daily during the laying stage to detect if females could begin incubation before or after the set of eggs was complete. We also checked if eggs were warm to detect the beginning of incubation. We have assumed that the latter eggs to be laid were also the latter to hatch. We did not touch or handled young to avoid shortening the nestling period (Skutch 1945). Clutch initiation dates were obtained from nests found in the construction stage (i.e., we observed the first egg in the nests), and by back-dating for nests for which hatching or fledging dates were known, based on mean incubation and nestling periods.

We estimated the frequency at which adults brought materials to build nests, the

proportion of time females spent incubating the eggs, as well as the frequency of provisioning visits during the nestling period from 1-hr focal observation sessions every 1–3 days using 8 x 40 binoculars. These observations were made early in the morning (06:00–09:00 h).

We assumed predation to have occurred when eggs or nestlings younger than fledging age (with poorly developed feathers) disappeared from a nest or when eggs or young were found partially eaten near nests. Abandonment was considered when adults were not seen near the nests, and eggs were cold for more than two days (Pletschet & Kelly 1990).

Statistical analysis. Descriptive statistics were presented as median, range, and interquartile range (IQR), and were performed using the software BioEstat 2.0 (Ayres *et al.* 2000). Since data from the same nest may not be statistically independent, the median of egg measurements, time gaps between nest material depositions, time spent incubating/h, number and duration of incubation recesses, and number of times females provisioned nestlings, were obtained within nests and then calculated again among the different nests.

We used the maximum likelihood method implemented in Program MARK, Version 6.1 (White & Burnham 1999, Dinsmore *et al.* 2002) to estimate nest success of 2009/2010, and 2010/2011 breeding seasons pooled together. Then, we have assumed that year dependent factors were not a source of variance in the survival. We calculated daily survival rate (DSR) using the null model of constant DSR, S(.), which is similar to that of Mayfield (1961). The cumulative probability of overall nest success was estimated by raising DSR to the power corresponding to the mean duration of the nesting cycle obtained in our study (incubation + nestling periods). We evaluated a set of three Program MARK can-

didate DSR models that used continuously varying covariates: (a) S(nest age) (number of days since incubation onset date), (b) S(date) (date within the breeding season), and (c) their combinations, S(date + nest age). These models were compared to the null model of constant DSR using Akaike's information criterion for small samples (AIC_c). The model with the lowest AIC_c value was considered the best fit of the data, but models with $\Delta AIC_c \leq 2$ were also considered as presenting substantial support for explaining the data (Burnham & Anderson 1998). Akaike weight (w_i) was used to measure the relative support for each candidate model. We used logit-link function to convert all DSR values to an interval between 0 and 1. Egg-laying stage was not considered in our DSR analyses due to the reduced number of nests found during this stage.

RESULTS

We analyzed 20 active nests during three breeding seasons, 2008/2009 (N = 2), 2009/2010 (N = 7), and 2010/2011 (N = 11). Nests were bulky and deep cups made of dry grass leaves and stems (*Brachiaria* sp.). A number of longer grass stems are bent around nest walls with one or both extremities pointing out the border, forming a structure of interlaced stems around the nest borders (Fig. 1). Incubatory chamber was lined with rootlets, finer grass stems, and rhizomorphs of horsehair fungus (*Marasmius* sp.). Nests were always built in the middle of dense and tall (about 60–90 cm) grass tussocks, 12–32 cm above ground [22.5 (13.2), N = 11], and were laterally supported by grass stems that, however, were not attached to nest walls. Nest measurements were: outside diameter 8.6 (1.2) cm (range = 6.9–10.1), inside diameter 5.4 (0.4) cm (4.5–5.7), outside height 7.1 (1.4) cm (5.7–8.4), and inside height 4.4 (0.4) cm (3.5–5.1) (N = 11). In 6 h of focal observations in six different nests, only females participated in

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FIG. 1. Nest and eggs of Grassland Yellow-Finch (*Sicalis luteola*) (photograph: Mercival R. Francisco).

nest construction, bringing nest materials 31.0 (15.5) times/h (range = 13–54). Time gaps between nest material depositions ranged from 0.37 to 12.8 min [1.2 (0.3), N = 196 observations]. Nests found at the beginning of construction took one to four days to completion (N = 4).

The earliest clutch initiation dates (laying of the first egg) varied between years, being 23 October 2009 and 22 December 2010 (Fig. 2). The latest clutch initiation occurred on 14 February 2011, and the latest nesting activity (last young observed in a nest) was on 02 March 2011. In both seasons, laying periods spanned three months (Fig. 2). Eggs were always laid on consecutive days, and incubation started on the third day after onset of laying (N = 7 nests). Eggs were white to slightly blue, with pale to intense light and dark brown spots and blotches that were con-centrated at the larger end, sometimes forming a crown (Fig. 1). They measured 15.4–18.0 mm in length [17.0 (0.7)], 12.5–13.2 mm in width [12.7 (0.3)], and weighed 1.2–1.5 g [1.4 (0.1)] (N = 6 nests). Clutch sizes were four eggs (N = 7 nests). In 30 h of focal observa-tions in seven different nests, only females incubated. They spent from 20.7 to 60 min incubating the eggs per h [48.2 (14.7)], and left the nests 0–2 times/h [1.0 (0.0)]. Incuba-tion recesses were 5.5–32.4 min long [15.2 (10.8), N = 11]. Incubation periods were 11 (N = 3 eggs), 12 (N = 22 eggs), or 13 days (N = 3 eggs) [12.0 (0.0) days, N = 28 eggs from eight different nests]. Within-clutch variation in incubation periods (one day) was observed in four of eight nests. Hatching was synchronous in four of nine nests, occurring in two consecutive days in the five others.
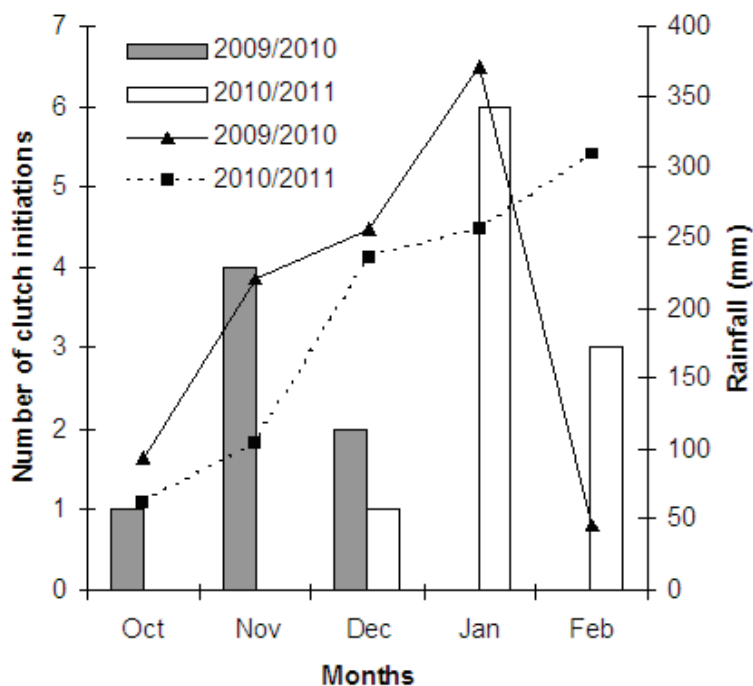
FIG. 2. Numbers of clutch initiations of Grassland Yellow-Finch (*Sicalis luteola*) (bars), and rainfall (lines) throughout two breeding seasons (2009/2010 and 2010/2011) at Sorocaba, southeast Brazil.

At hatching, nestlings had yellowish red skin and were covered with light gray down. They presented yellow bills, white swollen flanges, and bright red mouth lining (see also Mason 1985). In 25 h of observation at eight nests, only females provisioned nestlings, 1.0 (1.0) time/h (range = 0–4 feeding events/h). Nestling periods of 17 young from five different nests were 11 (N = 3), 12 (N = 12), or 13 days (N = 2) [12.0 (0.0)]. Fledging was synchronous (N = 5 nests) and young departed from nests with well-developed feathers and flying well. Nests were never reused.

Of 17 nests for which fate was known, eight successfully fledged young (47.0%), one was abandoned in the incubation stage (5.9%), six were predated during the nestling stage (35.3%), and in two nests young fell down after heavy storms (11.7%). Three of

42 eggs that were not predated or abandoned were infertile (7.1%), each in a different nest.

The average nest exposure period was 24 days (12 days of incubation and 12 days of nestling stage). Estimated nest daily survival rate using the null model of constant DSR was 0.97, with a 95% confidence interval (CI) of 0.94–0.98. Estimated overall nesting success was 47% (95% CI, 21–70%) (244 nest days and eight nest failures in 16 different nests). Two models of DSR received substantial support ($\Delta AIC_c \leq 2$). The best-fit model was S(nest age), being 1.1 AICc units better than the second best model, S(date + nest age). These models together accounted for 96% of the data variation (w_i values = 0.61 and 0.35), and the null model of constant DSR received little support ($\Delta AIC_c = 6.6$, and $w_i = 0.02$). The S(nest age) model indicated a

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negative correlation between DSR and nest age ($\beta = -0.192$, CI = -0.327 to -0.057), and the S(date + nest age) model indicted DSR was negatively correlated with both date ($\beta = -0.013$, CI = -0.039 to 0.014) and nest age ($\beta = -0.185$, CI = -0.323 to -0.047).

DISCUSSION

Broad surveys of breeding season lengths of central-south Brazilian birds have shown that most species start breeding at the end of the dry season (August/September) (Piratelli *et al.* 2000, Marini & Durães 2001). During the two breeding seasons in which we searched systematically for nests, *S. luteola* presented a delayed pattern, beginning breeding activities in October and in December. This pattern is similar to that found for other granivorous passerines that occur in the study region, such as the seedeaters (Double-collared Seedeater *Sporophila caerulescens*, Lined Seedeater *S. lineola*, and White-bellied Seedeater *S. leucoptera*), which do not start breeding before the coming of the heavier rains (Francisco 2006, 2009; Oliveira *et al.* 2010). Our data also suggest that breeding phenology can vary greatly between years, which could be related to rainfall, since breeding initiation was retarded in the drier year (see also Duca & Marini 2011). Further analyses are needed before a clear pattern can be established.

Sick (1997) has mentioned that nesting territories of *S. luteola* are aggregated. Indeed, in November 2009 we found three active nests (in incubation and nestling stages) distant two to 17 m from each. On the other hand, many other nests we observed were isolated, suggesting that territorial clustering in this species may reflect habitat heterogeneity in terms of adequate vegetation for nest construction and/or food, rather than being a reproductive strategy (see Dias *et al.* 2009).

Several studies have reported on birds breeding life history adaptations to open versus cavity nests, i.e., clutch sizes have been argued to be larger in non-excavating cavity-nesting birds (Lack 1948, Slagsvold 1982, Martin 1993), and incubation and nestling periods are longer in hole nesters (Lack 1948, Brooke & Birkhead 1991, Martin & Li 1992). However, these premises are based mostly on comparisons between species belonging to different genera or families (Nilsson 1986, Brooke & Birkhead 1991, Martin & Li 1992), so that the results can be confounded by phylogenetic effect (Martin 1993). For instance, to test the prediction that clutch sizes are larger in non-excavating hole-nesters due to their uncertainty in obtaining a nesting hole (nest site limitation hypothesis), Martin (1993) counteracted the phylogenetic influence through analyzing cavity-nesting families in which some species varied in their propensity to excavate, depending on the availability of soft wood. Yet, direct intrageneric comparisons between open versus cavity-nesting species are unavailable. In this context, the representatives of the genus *Sicalis* are well suited for comparisons. While some representatives of the genus build deep cup nests in bushes and/or grass tussoks (i.e., Stripe-tailed Yellow-finch *S. citrina*, and *S. luteola*), others are secondary cavity nesters, such as Saffron Finches (*S. flaveola*), and Bright-rumped Yellow Finches (*S. uropygialis*) (Roe & Rees 1979, Marcondes-Machado 2002, Vasconcelos *et al.* 2007). *S. luteola* and *S. flaveola* are common species in our study region and often occur in the same areas. Marcondes-Machado (2002) provided breeding information for a population of *S. flaveola* also from São Paulo state, which permitted nestling periods to be compared without geographic influence. In nine nests of *S. flaveola* analyzed by this author nestling periods varied from 15–23 days (3–12 days longer than that of *S. luteola*). Average nestling periods of *S. flaveola* from Buenos Aires province, Argentina, were 14.2 days (Palmerio & Massoni 2009), being still larger

then that we have found for *S. luteola*, and average nestling period of the open-cup nester *S. citrina* from central Brazil was 12.8 days (Gressler & Marini 2011), supporting the premise that young developmental periods are longer in cavity nesting species. Incubation periods lasted 11–13 days in *S. flaveola* and 10–13 days in *S. citrina*, while clutch sizes varied from three to five eggs in *S. flaveola*, and were three eggs for *S. citrina* (Marcondes-Machado 2002, Gressler & Marini 2011). Although clutches of five eggs have never been reported for *S. luteola* and *S. citrina*, statistical comparisons could not be performed due to small sample sizes, precluding any conclusion about these parameters to the moment.

Indeed, clutch size of *S. luteola* is remarkably large for a Neotropical passerine. In a survey provided by Skutch (1985) on 217 species of passerines from the humid Neotropics, the predominant number of eggs was two while three were less frequent, and larger sets were rare and usually limited to hole-nesting species. Except for *S. flaveola* and *S. citrina* (Marcondes-Machado 2002, Palmerio & Massoni 2009, 2011; Gressler & Marini 2011), detailed reproductive information on other species of *Sicalis* is unavailable, and it is not clear if large clutch size is a particularity of this genus. Future phylogenetic reconstructions of *Sicalis* could elucidate which of the two breeding strategies (open- or hole-nesting) is ancestral within the group, and if each strategy has evolved only once or independently in different occasions (see Winkler & Sheldon 1993). It could indicate, for instance, if large clutch sizes in *S. luteola* could be resulted from phylogenetic influence of a hole-nesting ancestor.

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REFERENCES

Ayres, M., M. Ayres Jr., D. L. Ayres, & A. S. Santos. 2000. BioEstat 2.0: aplicações estatísticas nas áreas das ciências biológicas e médicas. Sociedade Civil Mamirauá/MCT-CNPq, Brazil.

Brooke, M., & T. Birkhead. 1991. The Cambridge encyclopedia of ornithology. Cambridge Univ. Press, Cambridge, UK.

De La Peña, M. R. 2006. Guía de fotos de nidos, huevos y pichones de aves argentinas. Editorial LOLA, Buenos Aires, Argentina.

Dias, R. I., M. Kuhlmann, L. R. Lourenço, & R. H. Macedo. 2009. Territorial clustering in the Blue-Black Grassquit: reproductive strategy in response to habitat and food requirements. Condor 111: 706–714.

Disnmore, S. J., G. C. White, & F. L. Knopf. 2002. Advanced techniques for modeling avian nest survival. Ecology 83: 3476–3488.

Duca, C., & M. A. Marini. 2011. Variation in breeding of the Shrike-like Tanager in central Brazil. Wilson J. Ornithol. 123: 259–265.

Euler, C. 1900. Descrição de ninhos e ovos das aves do Brasil. Rev. Mus. Paulista 4: 9–148.

Francisco, M. R. 2006. Breeding biology of the Double-collared Seedeater (*Sporophila caerulescens*). Wilson J. Ornithol. 118: 85–90.

Francisco, M. R. 2009. First description of nests and eggs of the White-bellied Seedeater, *Sporophila leucoptera*. Wilson J. Ornithol. 121: 628–630.

Gressler, D. T., & M. A. Marini. 2011. Breeding biology of the Stripe-tailed Yellow-finch (*Sicalis citrina*) in central Brazilian Cerrado. Ornitol. Neotrop. 22: 319–327.

Ihering, H. von. 1900. Catálogo crítico-comparativo dos ninhos e ovos das aves do Brasil. Rev. Mus. Paulista 4: 191–300.

Lack, D. 1948. The significance of clutch size. Part III. Some interspecific comparisons. Ibis 90: 25–45.

Marcondes-Machado, L. O. 2002. O canário-da-terra (*Sicalis flaveola*): comportamento reprodutivo, social e repovoamento. Santa Edwiges Artes Gráficas, Tietê, São Paulo, Brasil.

Marini, M. A., & R. Durães. 2001. Annual patterns of molt and reproductive activity of passerines in south-central Brazil. Condor 103: 767–775.

Mason, P. 1985. The nesting biology of some passerines of Buenos Aires, Argentina. Neotrop. Ornithol. 36: 954–972.

Martin, T. E. 1993. Evolutionary determinants of clutch size in cavity-nesting birds: nest predation or limited breeding opportunities? Am. Nat. 142: 937–946.

Martin, T. E., & P. Li. 1992. Life history traits of open- versus cavity-nesting birds. Ecology 73: 579–592.

Mayfield, H. 1961. Nesting success calculated from exposure. Wilson Bull. 73: 255–261.

Nilsson, S. G. 1986. Evolution of hole-nesting in birds: on balancing selection pressures. Auk 103: 432–435.

Oliveira, L. S., L. M. S. Sousa, P. V. Davanço, & M. R. Francisco. 2010. Breeding behaviour of the Lined Seedeater (*Sporophila lineola*) in southeastern Brazil. Ornitol. Neotrop. 21: 251–261.

Palmerio, A. G., & V. Massoni. 2009. Reproductive biology of female Saffron Finches does not differ by the plumage of the mate. Condor 111: 715–721.

Palmerio, A. G., & V. Massoni. 2011. Parental care does not vary with age-dependent plumage in male Saffron Finches *Sicalis flaveola*. Ibis 153: 421–424.

Piratelli, A. J., M. A. C. Siqueira, & L. O. Marcondes-Machado. 2000. Reprodução e muda de penas em aves de sub-bosque na região leste de Mato Grosso do Sul. Ararajuba 8: 9–107.

Pletschet, S. M., & J. F. Kelly. 1990. Breeding biology and nest success of Palila. Condor 92: 1012–1021.

Ridgely, R. S., & G. Tudor. 1994. The birds of South America. Volume 2. Univ. of Texas Press, Austin, Texas, USA.

Roe, N. A. & W. E. Rees. 1979. Notes on the Puna avifauna of Azángaro province, Department of Puno, southern Peru. Auk 96: 475–482.

Sick, H. 1997. Ornitologia Brasileira. Editora Nova Fronteira, Rio de Janeiro, Brasil.

Silveira, L. F., & A. C. Méndez. 1999. Caracterização das formas brasileiras do gênero *Sicalis* (Passeriformes, Emberizidae). Atual. Ornitol. 90: 6–8.

Skutch, A. F. 1985. Clutch size, nesting success, and predation on nests of Neotropical birds, reviewed. Ornithol. Monogr. 36: 575–594.

Vasconcelos, M. F., V. T. Lombardi, & S. D. Neto. 2007. Nota sobre o canário-rasteiro (*Sicalis citrina*) nas serras de Minas Gerais, Brasil. Atual. Ornitol. 140: 6–7.

White, G. C., & K. P. Burnham. 1999. Program MARK: survival estimation from populations of marked animals. Bird Study 46: 120–138.

Winkler, D. W., & F. H. Sheldon. 1993. Evolution of nest construction in swallows (Hirundinidae): a molecular phylogenetic perspective. Proc. Natl. Acad. Sci. U. S. A. 90: 5705–5707.