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QUANTITATIVE DESCRIPTION OF NESTS AND EGGS OF THE ISTHMIAN WREN *CANTORCHILUS ELUTUS* AND CABANIS'S WREN *C. MODESTUS*

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Abstract · Information on the nests (for reproduction and dormitory) and eggs of Cabanis's Wren *Cantorchilus modestus* and Isthmian Wren *C. elutus* is incomplete and limited to old records. Here, I describe quantitatively the reproductive nests and eggs of both species, and dormitory nests of Cabanis's Wren. Reproductive nests of both species were similar in size and structure: globular, with a lateral circular entrance, nests sometimes have an entrance tail and are a very dense structure made of dry vegetation fibers. However, Cabanis's Wren dormitory nests were highly variable in their form (e.g., closed globular, low cup, and platform), with a weak structure of dry vegetation fibers that allowed an easy view of the interior from outside. The eggs were plain white, similar to those of other species within this genus.

Resumen · Descripción cuantitativa de los nidos y huevos del Soterrey Ístmico *Cantorchilus elutus* y el Soterrey de Cabanis *C. modestus*
La información sobre nidos (de reproducción y dormitorios) y huevos del Soterrei de Cabanis *Cantorchilus modestus* y el Soterrey Ístmico *C. elutus* se reduce y limita a información antigua. Aquí, describo cuantitativamente los nidos reproductivos y huevos de las dos especies y los nidos dormitorios solo del Soterrey de Cabanis. Los nidos reproductivos de ambas especies fueron similares en tamaño y estructura: globulares cerrados, con una entrada lateral circular, con y sin cola de entrada, y con una estructura hecha de fibras vegetales secas muy densamente tejidas. Sin embargo, los nidos dormitorio del Soterrey de Cabanis tuvieron formas muy variables (p. ej., globulares cerrados, copa baja y plataforma), y débiles en la estructura de fibras vegetales secas, lo que permitían ver el interior fácilmente desde el exterior. Los huevos fueron blanco puro y similares a los de otras especies del mismo género.

Key words: *Dormitory nest · nest materials · nestling period · reproductive nest · Troglodytidae*

INTRODUCTION

Until recently, the Plain Wren *Cantorchilus modestus* was considered a single species with a range extending from southern Mexico to southern Panama and from sea level to 2000 m (Saucier et al. 2015). However, genetic, morphometric, and plumage differences revealed that the Plain Wren formed a species complex consisting of at least three species: Cabanis's Wren *C. modestus*, Isthmian Wren *C. elutus*, and Canebrake Wren *C. zeledoni* (Saucier et al. 2015, Chesser et al. 2016). All three species are small, secretive, and furtive insectivores (12.5–14 cm in length, 17.9–19.7 g in weight) that defend territories year-round in thickets, dense grasslands, secondary forest edges, plantations (e.g., coffee or sugar cane), and riverside forests (Stiles & Skutch 1989, Marshall-Ball & Salter 2003, Kroodsma & Brewer 2005). Cabanis's and Isthmian wrens show similar plumage color, which makes it difficult to separate them using field observations, although the Isthmian Wren has a larger tarsus and beak than Cabanis's Wren (Saucier et al. 2015). The Canebrake Wren has grayer plumage and is larger, which can be used as field marks to separate it from the other two species (Kroodsma & Brewer 2005, Saucier et al. 2015).

The breeding biology of the three species is apparently well known, in part because they are common and widely distributed, resulting in several publications on the nesting and parental care (e.g., Skutch 1940, 1960; Blake 1956, Wetmore et al. 1984, Winnett-Murray 1986, Marshall-Ball & Salter 2003). For example, previous descriptions of the breeding nests of Isthmian and Cabanis's wrens (Skutch 1940, 1960; Blake 1956) noted the general form of the nests (i.e., retort-shape, ellipsoidal, or globular) and external materials. This previous study, however, lacked a quantitative description of the nests (but see Blake 1956 for external measurements of a single Isthmian nest), despite multiple nests being examined (range: 6–11; Skutch 1960, Wetmore et al. 1984). Additionally, some authors have combined information from both species in the descriptions of breeding nests (e.g., Skutch 1940, 1960), making it difficult to determine how distinct nests are for each species.

Isthmian and Cabanis's Wrens also build dormitory nests (Skutch 1960, Winnett-Murray 1986). Although this nest type is common, descriptions are limited and focus only on the flimsy structure and globular form (Skutch 1940, 1960; Winnett-Murray 1986). To date, eggs have only been described for the Isthmian Wren in Costa Rica and Panama (Blake 1956, Skutch 1960, Wetmore 1984) and not for the other two species.

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In this study, I provide a quantitative description of the structure of breeding nests and eggs of Cabanis's and Isthmian wrens, and the structure of dormitory nests for Cabanis's Wren. This information will help to conduct comparative analyses in the future at higher taxonomic levels about how nest or egg dimension vary between species, or to understand how climatic changes and urban development affect species breeding biology and nest building (Xiao et al. 2017, Jagiello et al. 2019).

METHODS

Nests and eggs of both species were opportunistically collected from 10 localities in Costa Rica between 1985 and 2019 (Table 1). All study nests were deposited at the Museo de Zoología, Universidad de Costa Rica (MZUCR), or Museo Nacional de Costa Rica (MNCR). For the nests that I collected, I identified the species by observing the adults building it or departing from the nest. From the nests deposited in both museum collections and collected by other investigators, I used the information reported in the nest label and database.

For each nest, I measured (1) two perpendicular nest entrance diameters (horizontal and vertical), (2) nest depth from the entrance to the back wall, (3) nest height at the entrance from the bottom to the roof, (4) external height, (5) external length, and (6) tail length (Figure 1). I also describe the types of materials used to build each nest. I describe nest structure using Simon & Pacheco (2005) nomenclature for the standardization of nest descriptions. Additionally, I measured the length and width of each egg and recorded the shell color. I took measurements using an analog caliper (Spi ± 0.1 mm).

RESULTS

In total, I analyzed three breeding nests of Isthmian Wren and 17 nests of Cabanis's Wren (five breeding and 12 dormitories), and two eggs for each species.

Cabanis's Wren nest. Five reproductive nests were found in the montane forest between April and November (Table 1). Nests were located at 0.5 to 2.2 m height between branches of a coffee plant (*Coffea arabica*), the leaves and the main trunk of a *Dracaena* sp. (Dracaenaceae) or between the main trunks of a lime tree (*Citrus* sp., Rutaceae). One nest was found on the ground, below a group of dense plants. The habitats where nests were found varied, including the edge of secondary forest, botanical gardens, and coffee plantations. The five nests were built with dry fibers, mostly grasses, but also included feathers (down, contour, and wing/tail), bamboo leaves, roots, mosses, pine needles (*Pinus* sp., Pinaceae), fungal rhizomorphs (*Marasmius* sp.), and twigs (Figure 2). Additionally, the nests from Buena Vista and Bajo La Paz had plastic fibers as part of the nest materials including a piece of a plastic bag and long fibers of a plastic sac (Figure 3). Nests showed a closed globular/base or closed retort/base form with an entrance tail (Figure 2) and small variation in the nest measurements (mean ± SD): entrance length of 53.5 ± 8.4 mm, entrance height of 48.7 ± 4.7 mm, nest depth of 84.3 ± 29.2 mm, nest height of 53.2 ± 17.1 mm, nest external height of 91.9 ± 16.1 mm, nest external length of 132.5 ± 38.6 mm, and a tail length of 170 ± 71 mm (Table 1).

All dormitory nests were found between May and November, except one (from Calle Hernandez), and were found in the same population (Lankester Botanical Garden; Table 1). Dormitory nests were found within *Dracaena* sp. (Dracaenaceae) leaves and main trunks, at 1.0 to 1.5 m height. The Calle Hernandez dormitory nest, however, was located at a height of 3 m on an earth wall inside tall grass, next to a road. Dormitory nests showed variable structures: platform, low cup/base, close long/base, or close globular (Figure 4). Three nests lacked entrance tails (Figure 4). Additionally, one of the dormitory nests included a black fiber from a plastic sac (Figure 3). Reproductive nests were built with a large number of fibers and were more densely woven, reducing or completely preventing the internal egg chamber from being seen from the outside. Meanwhile, dormitory nests were built with thin and flimsy walls, allowing the internal chamber of the nest to be visible from the outside. All reproductive nests and only some dormitory nests contained roofs (Figures 2 & 4).

Isthmian Wren nest. Two reproductive nests were found in lowland forests and one in a montane forest between February and July (Table 1). Nests were located at 0.3 to 1.5 m height be-

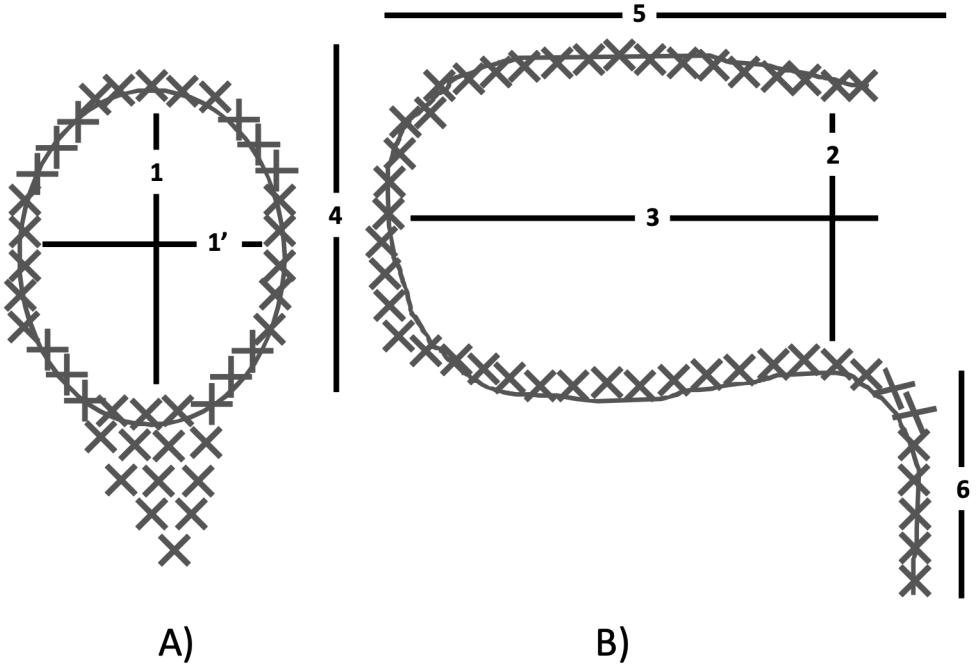

Figure 1. Diagram of the breeding nest with six measurements. A) Nest entrance with two perpendicular diameters: length (1') and height (1). B) Lateral view of the nest: nest depth from the entrance to the back wall (2), nest height at the entrance from the bottom to the roof (3), external height (4), external length (5), and tail length (6).

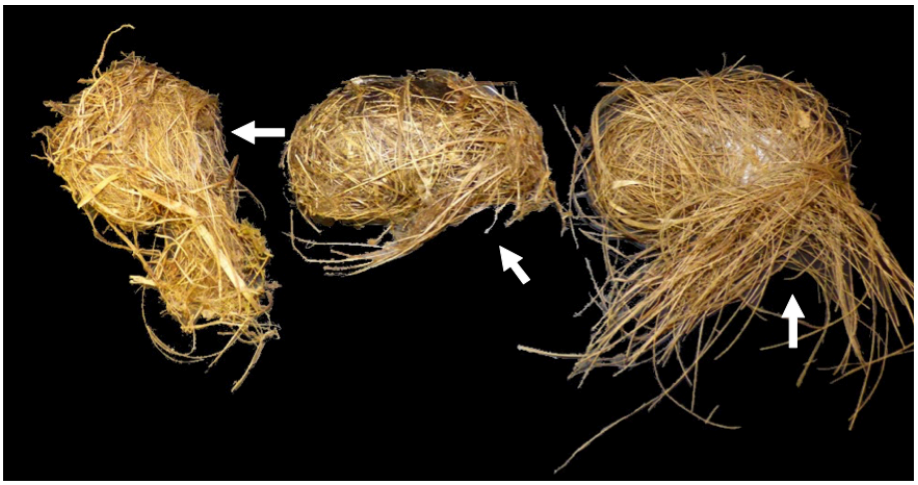

Figure 2. Three reproductive Cabanis's Wren nests. White arrows indicate nest entrance.

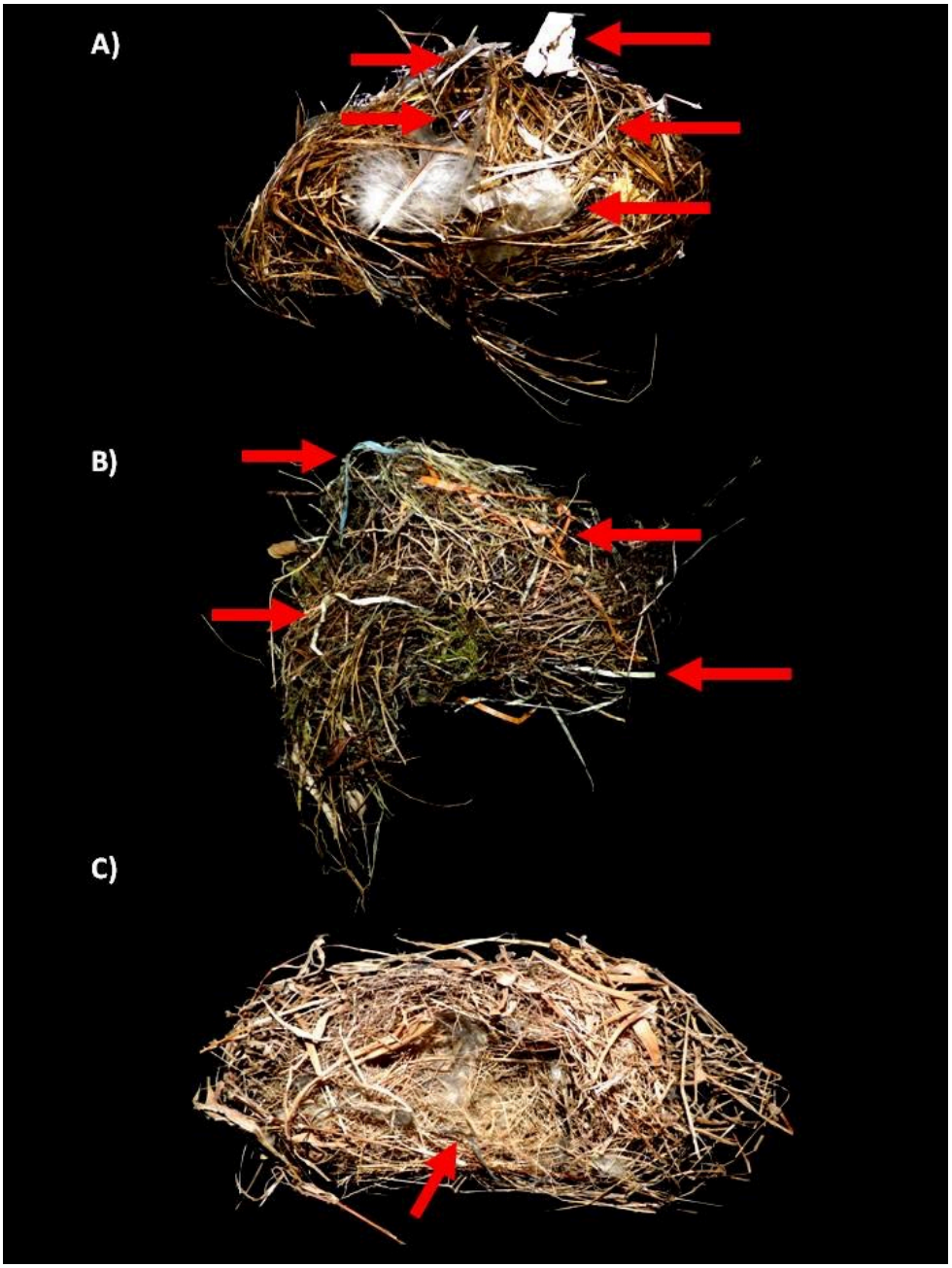

Figure 3. Two reproductive (A & B) and one dormitory (C) Cabanis's Wren nests with plastic materials (bag pieces and fibers) are indicated with red arrows.

Table 1. Measurements (in mm) of reproductive (Rep) and dormitory (Dor) nests of Cabanis's and Isthmian Wren, with locality of collection. For an explanation of the measurements, see Methods and Figure 1. * El Radio and Lankester are from Cartago province; UCR is from San Jose province; Buena Vista is from Heredia province; and Las Alturas, Rincón de Osa, and Ciudad Neilly are from Puntarenas province, Costa Rica. Letters with numbers refer to museum catalogs (MNCR: Museo Nacional de Costa Rica and MZUCR: Museo de Zoología, Universidad de Costa Rica). Empty cells are missing data because the structure was incomplete or absent (e.g., nest roof or nest tail at entrance).

	Type	Locality*	Date	Coordinates	Altitude (m)	Entrance length	Entrance height	Nest depth	Nest height	External height	External length	Tail length
Cabanis's Wren												
MNCR101	Rep	El Radio	3 Jul 1985	09°51' N, 83°53' W	1400	65.5	50.9	48.5	55.0	110	85.0	230
MZUCR170	Rep	Buena Vista	27 Jul 2012	10°03' N, 84°06' W	1500	43.1	54.2	79.5	81.5	83.7	145.0	
MZUCR402	Rep	UCR	16 Apr 2015	09°56' N, 84°03' W	1200	57.3	47.8	80.0	41.4	75.1	150.0	150
MZUCR426	Rep	Lankester	13 Nov 2015	09°50' N, 83°53' W	1366	50.5	49.1	83.5	49.1	82.5	102.1	79
MZUCR	Rep	Bajo La Paz	31 Aug 2019	10°09' N, 84°32' W	1130	51.0	41.5	130.0	38.8	108.2	180.5	222
MZUCR423	Dor	Lankester	05 May 2015	09°50' N, 83°53' W	1366	45.7		146.0		64.3	150.0	120
MZUCR439	Dor	Lankester	05 May 2015	09°50' N, 83°53' W	1366	64.5		116.6		128.4	116.6	128
MZUCR438	Dor	Lankester	05 May 2015	09°50' N, 83°53' W	1366	48.5		65.2	36.4	62.2	66.0	192
MZUCR428	Dor	Lankester	13 Nov 2015	09°50' N, 83°53' W	1366	49.2	48.0	66.0	48.0	80.1	97.4	108
MZUCR424	Dor	Lankester	13 Nov 2015	09°50' N, 83°53' W	1366	53.0	47.0	46.9	53.0	109.1	133.6	
MZUCR429	Dor	Lankester	13 Nov 2015	09°50' N, 83°53' W	1366	42.3		64.4	51.4	84.9	114.8	
MZUCR427	Dor	Lankester	13 Nov 2015	09°50' N, 83°53' W	1366	77.7		44.7	77.7	91.4	44.7	
MZUCR516	Dor	Lankester	09 May 2017	09°50' N, 83°53' W	1366	50.4		56.1	47.0	54.4	79.3	130
MZUCR542	Dor	Calle Hernandez	14 May 2015	10°01' N, 84°04' W	1520	56.6	51.0	92.2	51.0	94.5	210.0	
MZUCR	Dor	Lankester	6 Sep 2019	09°50' N, 83°53' W	1366	50.5	41.5	110.6	52.4	72.4	130.5	
MZUCR	Dor	Lankester	6 Sep 2019	09°50' N, 83°53' W	1366	36.4	44.7	75.3	44.7	86.5	98.5	130
MZUCR	Dor	Lankester	6 Sep 2019	09°50' N, 83°53' W	1366	40.0	27.6	83.0	50.2	80.4	90.9	160
Ithsmian Wren												
MZUCR287	Rep	Las Alturas	01 Jul 2014	08°57' N, 82°50' W	1550	39.0	55.0	70.0	53.0	106.9	170.0	
MZUCR513	Rep	Rincon de Osa	02 Feb 2017	08°41' N, 83°30' W	52	42.0	46.0	58.8	60.0	125.7	125.0	150
MZUCR	Rep	Ciudad Neilly	02 Jun 2017	08°38' N, 82°56' W	43	48.3	56.2	82.0	70.3	74.4	144.1	17

tween branches of a *Citrus* sp. bush, fern leaves, and barbwire at the edge of a gravel road, and branches of a small bush located inside tall grasses. The habitats where nests were found varied, including cattle land, the edge of secondary forest, and the side of the road. The three nests were built mostly of dry fibers and grasses (i.e., introduced grass species as *Cynodon plectostachyus*), bamboo leaves, lichens, dicotyledonous leaves, palm fibers, rhizomorphs, mosses, feathers, *Heliconia* sp. leaves, and dry Juncaceae steams (Figure 5). The nest from Rincon de Osa contained a synthetic polyester fiber (Fig. 5). The three nests also showed a closed retort/base form with and without an entrance tail (Figure 5) and small variation in the nest measurements: entrance length of 43.1 ± 4.7 mm, entrance height of 52.4 ± 5.6 mm, nest depth of 70.3 ± 11.6 mm, nest height of 61.1 ± 8.7 mm, nest external height of 102.3 ± 26.0 mm, nest external length of 146.4 ± 22.6 mm, and a tail length of 84 ± 94 mm (Table 1).

Eggs. Both species laid two white eggs. Two Isthmian Wren eggs from the nest collected at Rincon de Osa showed a mean size of 19.5x14.2 mm (Table 2). I measured two Cabanis's Wren eggs from the nest collected at El Radio. However, as both eggs were broken, I was only able to measure their width and showed a mean size of 15.8 mm (Table 2).

DISCUSSION

This is the first quantitative description of the nests of Cabanis's and Isthmian Wrens, although the nest structure was previously described when both were considered a single species (Skutch 1940, 1960; Blake 1956, Wetmore et al. 1984, Winnett-Murray 1986, Stiles & Skutch 1989). Both species build closed globular/base or closed retort/base nest forms, similar to the descriptions in the literature where the authors mentioned a retort-shaped, globular, or elongated structure, and rounded ball for both species (Skutch 1940, Blake 1956, Wetmore et al. 1984, Winnett-Murray 1986, Stiles & Skutch 1989). Contrary to previous descriptions, both species (Cabanis's 4 of 5 and Isthmian 2 of 3) may add a tail at the entrance (Table 1). In general, the nest structures of both species are similar to those of Canebrake Wren nests (the third species of the species complex), which also construct globular nests with a side entrance (Marshall-Ball & Slater 2003).

The quantitative measurements for both species nests were variable, as has also been reported for Canebrake Wren nests (Marshall-Ball & Slater 2003). Within the complex, there is a decrease in the external size of the nests, from the largest species, Canebrake (Marshall-Ball & Slater 2003), to the small-

Figure 4. Five dormitory nests of Cabanis's Wren, showing the difference in structure among them. White arrows pointing nest entrance or roosting camera (bottom left nest).

est, Cabanis's (Table 1). However, the internal size for Cabanis's and Isthmian Wrens (no information available for Canebrake) varied in the opposite direction, with a larger internal size for Cabanis's Wren (Table 1).

As reported previously for the three species, dry vegetation fibers were the main nest building materials, including the introduced giant star grass *Cynodon plectostachyus*, which is among the most common materials for the external structure (Skutch 1940, Blake 1956, Stiles & Skutch 1989, Marshall-Ball & Slater 2003, Kroodsma & Brewer 2005). Additionally, four nests (one of Isthmian and three of Cabanis's) included synthetic materials (i.e., polyester and plastic). Although present in small quantities, such materials have been found more often in the nests of species that inhabit urban and suburban areas (Wang et al. 2009, Antczak et al. 2010, Surgey et al. 2012, Gutiérrez-Vannucchi & Sandoval 2021), likely because of their abundance and properties (e.g., flexibility and porousness), which make them a good resource for nest construction (Hilton et al. 2004, Gladalski et al. 2016). However, the effect of these materials on the breeding success of these wrens is unknown, as is the case in most species where artificial materials have been reported to be used for nest building (Batisteli et al. 2019a, 2019b). However, the use of artificial materials may increase the detection by visual predators or affects the thermoregulatory properties of nests, potentially reducing breeding success (Gedeon et al. 2010, Rodewald & Kearns 2011, Batisteli et al. 2019b; Corrales-Moya et al. 2021, 2023).

Both wren species studied here lay plain (immaculate) white eggs according to my observations and published data (Blake 1956, Skutch 1969, Stiles & Skutch 1989). Such characteristic is shared, at least, with three other species of the genus *Cantorchilus* (*C. zeledoni, C. superciliaris,* and *C. thoracicus;* Marshall-Ball & Slater 2003, Kroodsma & Brewer 2005). Furthermore, the size of Isthmian Wren eggs inspected was similar in width to that reported in the literature but smaller in length (Table 2). For Cabanis's Wren, the width of the eggs was similar to that of Isthmian eggs (Table 2). The clutch size for the Isthmian Wren is, on average, two eggs, and rarely three (Blake 1956, Skutch 1960, Wetmore et al. 1984). For Cabanis's Wren, at least in Monteverde, Costa Rica, Winnett-Murray (1986) claims an average of three eggs (n = 6 nests), although my observation of a single nest was of two eggs. According to my data

Figure 5. Three reproductive Isthmian Wren nests. White arrows indicate the nest entrance. The red arrow indicates a polyester fiber used in the nest collected in Rincón de Osa, Costa Rica.

and published information, in Costa Rica, the breeding season of Cabanis's Wren occurs at least from January to November (Skutch 1940, Stiles & Skutch 1989, Kroodsma & Brewer 2005), while that of Isthmian Wren is, apparently, from January to July. In both, the breeding season seems protracted, but more studies are required to determine the phenology and to detect breeding peaks.

Although several wren species of *Cantorchilus, Henicorhina, Campylorhynchus, Cyphorhinus*, and *Thryophilus* genera build or use dormitory nests (Skutch 1940, Stiles & Skutch 1989, Kroodsma & Brewer 2005), quantitative descriptions of these structures are scarce, even for studies that analyze the abundance of dormitory nest and their use and correlation with breeding success (Winnett-Murray 1986, Robinson et al. 2000, Marshall-Ball & Slater 2003, Gill & Stutchbury 2005). Dormitory nests, compared with reproductive nests within the same species, tend to be smaller and have a flimsy structure (Skutch 1960, 1961; Table 1). Additionally, dormitory nests have thin walls that are scarcely connected, which in some cases lack walls or roofs to complete a closed globular structure, as is the case for the six dormitory nests of Cabanis's Wren found in Lankester (Table 1). Cabanis's dormitory nests were also more structurally variable than reproductive nests; for example, in length external measurements, but similar in entrance diameter (Table 1). Although dormitory nests of Isthmian Wrens appear to be common, Skutch (1960) provided a single quantitative description of its internal measurements (63.5 mm in diameter and a length varying between 89 and152 mm), which is within the range of measurements of Cabanis's Wren dormitory nests reported in this study (Table 1).

Dormitory nest-building behavior has been explained as an energy-saving adaptation at night (Merola-Zwartjes 1998), to protect against predators or inclement weather (Skutch 1961), as a signal of male parental ability (Gill & Stutchbury 2005), or to reduce nest predation (Robinson et al. 2000). For Cabanis's and Isthmian Wrens, the causes of such behavior remain unknown; however, Skutch (1960) furthered the idea that flimsy walls of their nests allow for an easy escape when a predator approaches. However, I cannot rule out any other hypotheses, so further studies are required to test them.

In conclusion, my data showed that both wren species built similar reproductive nests and have eggs similar to those of closely related species. Nest size was associated with bird size, and smaller species built the smaller nests. The function of dormitory nest in both species remains unknown, and studies that analyze its function are highly encouraged, especially if we want to have a better understanding of the breeding biology of these species. Therefore, I recommend a quantitative study of the dormitory nest for Isthmian Wren and its comparisons with other species in the genus, as the first step in the investigation of dormitory nest functions.

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