With three species, *Coniophanes* is the genus with the highest species diversity in the study area of the ongoing nocturnal snake surveys being conducted by several authors in the Chetumal area of southern Quintana Roo, Mexico. The species treated in the following article, i.e., *C. imperialis, C. meridanus*, and *C. schmidti*, are among the most commonly encountered snakes in this study. The road-killed specimens are collected and later dissected to generate data on the diet and reproduction of the species. Pictured here is an adult female *C. imperialis* (ECO-CH-H 3994) found between Bacalar and Reforma, Quintana Roo, Mexico. The diet of this small terrestrial snake consists mostly of lizards, lizard eggs, small anurans, and insects. © J. Rogelio Cedeño-Vázquez

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The Chetumal Snake Census: generating biological data from road-killed snakes. Part 4. *Coniophanes imperialis*, *C. meridanus*, and *C. schmidti*

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Abstract: We present data and observations on the snake species *Coniophanes imperialis*, *C. meridanus*, and *C. schmidti* collected during bimonthly surveys along a 39 km road transect near the city of Chetumal, Quintana Roo, Mexico, from February of 2010 to August of 2017. For these species, we present data on their external morphology, seasonality, spatial distribution, reproduction, and diet.

Key Words: Diet, Dipsadidae, Mexico, monitoring, population dynamics, Quintana Roo, reproduction, road-kills, snake survey

Resumen: Presentamos datos y observaciones sobre las especies de serpientes *Coniophanes imperialis*, *C. meridanus* y *C. schmidti* registradas durante muestreos realizados cada 15 días desde febrero de 2010 hasta agosto de 2017, a lo largo de un transecto de carretera de 39 km cercano a la ciudad de Chetumal, Quintana Roo, México. De cada una de estas especies presentamos datos sobre morfología externa, estacionalidad, distribución espacial, reproducción y dieta.

Palabras Claves: Dieta, Dipsadidae, Mexico, mortalidad por atropello, muestreo y monitoreo de serpientes, dinámica poblacional, Quintana Roo, reproducción

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INTRODUCTION

In previous articles (Köhler et al., 2016a, b, c), we introduced our long-term snake survey study based on snakes found along a 39 km road transect in southern Quintana Roo, Mexico. Here we report the data for three species of snail-eating snakes of the genus *Coniophanes*, generated from road-killed specimens and supplemented by observations of living individuals found on the road during our nocturnal surveys. From 13 February 2010 to 19 August 2017, we recorded 19 specimens of *C. imperialis*, 14 of *C. meridanus*, and 15 of *C. schmidti* (see Appendix 1 for list of specimens examined). For measurements, we use the abbreviations SVL (snout–vent length) and TL (tail length).

SPECIES ACCOUNTS

Coniophanes imperialis (Baird and Girard, 1859)

Material: We collected 18 specimens of *Coniophanes imperialis* (Fig. 1), of which we identified 11 as males, five as females, and two of undetermined sex. Additionally, we recorded one live individual, an adult male, found crossing the road.

External morphology: See Table 1 for variation in selected morphometric and scalation characters.

Fig. 1. *Coniophanes imperialis* (ECO-CH-H 3994) in life. © J. Rogelio Cedeño-Vázquez

Table 1. Selected measurements, proportions, and scale characters of *Coniophanes imperialis*, *C. meridanus*, and *C. schmidti.* Range is followed by mean value and standard deviation in parentheses. See text for abbreviations.

Character		***C. imperialis*** ♂ **13** ♀ **9**	***C. meridanus*** ♂ **12** ♀ **2**	***C. schmidti*** ♂ **10** ♀ **7**
SVL (mm)	Males	162–292 (255.0 ± 37.20)	186–220 (203.0 ± 11.70)	135–372 (308.0 ± 67.10)
	Females	246–380 (315.0 ± 45.00)	211-213 (212.0 ± 1.41)	174–485 (350.0 ± 102.39)
TL / SVL	Males	0.506–0.683 (0.550 ± 0.075)	0.573–0.604 (0.588 ± 0.022)	0.417–0.487 (0.457 ± 0.023)
	Females	0.391–0.460 (0.431 ± 0.036)	—	0.332–0.430 (0.396 ± 0.044)
Ventrals	Males	120–126 (122.6 ± 1.89)	119–125 (121.9 ± 2.13)	154–163 (157.1 ± 2.69)
	Females	122–133 (129.2 ± 3.19)	132–134 (133.0 ± 1.41)	162–166 (164.0 ± 1.79)
Subcaudals	Males	78–82 (80.6 ± 1.67)	83–87 (85.0 ± 2.83)	85–101 (94.1 ± 4.95)
	Females	65–77 (71.0 ± 8.49)	—	78–91 (86.0 ± 7.00)
Number of dorsal scales rows at midbody		19 (19.0 ± 0.00)	17 (17.0 ± 0.00)	23–25 (24.8 ± 0.63)
Number of dorsal scales rows anterior to vent		15–17 (15.8 ± 1.0)	15 (15.0 ± 0.0)	19 (19.0 ± 0.0)
Cloacal scute		divided	divided	divided
Number of loreal scales		1 (1.0 ± 0.0)	1 (1.0 ± 0.0)	1 (1.0 ± 0.0)
Number of preocular scales		1–2 (1.2 ± 0.38)	1–2 (1.3 ± 0.49)	1–2 (1.8 ± 0.42)
Number of postocular scales		2 (2.0 ± 0.0)	2 (2.0 ± 0.0)	2 (2.0 ± 0.0)
Number of anterior temporals		1 (1.0 ± 0.0)	1 (1.0 ± 0.0)	1 (1.0 ± 0.0)
Number of posterior temporals		2 (2.0 ± 0.0)	2 (2.0 ± 0.0)	2 (2.0 ± 0.0)
Number of supralabials		8 (8.0 ± 0.00)	8 (8.0 ± 0.00)	8–9 (8.2 ± 0.42)
Number of infralabials		8–9 (8.8 ± 0.44)	8–9 (8.7 ± 0.50)	8–9 (8.9 ± 0.32)

Diet: Several specimens of *C. imperialis* (i.e., ECO-CH-H 3102, 3657, 3682, 3700) contained undigested parts of arthropods.

Reproduction: The dissection of 12 specimens of *Coniophanes imperialis* (7 males, 5 females) yielded data on reproduction (see Fig. 2). The relative testis size (ratio of testis length × width/SVL) in the seven males was 0.094–0.382 (0.237 ± 0.010). We found the largest relative testis size (0.382) in a specimen collected in January, and the one with the smallest value (0.094) in a specimen preserved in April. The relative ovary size (ratio of ovary length × width/SVL) in three females was 0.020–0.229 (0.133 ± 0.088). We detected the largest relative ovary size (0.229) in a female collected in April. The number of vitellogenic follicles per side ranges from 2 to 6 (3.63 ± 1.33). The follicle length was 1.82–9.74 (4.61 ± 2.33), and the follicle width 1.22–3.33 (2.12 ± 0.60). We counted the highest number of follicles (6) in a female collected in May, and the lowest number (2) in females preserved in April and October. A female of *C. imperialis* (SVL = 342 mm; ECO-CH-H 3979) collected on 4 March 2017 outside of our road transect, but in same the general area (San Felipe Primero, Quintana Roo, Mexico; 19.812778N, -88.832778W; WGS 84; elev. 33 m), contained 5 oviducal eggs (3 on the right side, 2 on the left; length = 10.8–12.3 mm; width 3.7–4.1 mm; Fig. 2D).

Seasonality: See Figure 3 for the temporal distribution of the 19 individuals of *Coniophanes imperialis* encountered on our road transect from 13 February 2010 to 19 August 2017. No seasonal trend was evident, except for a high peak in April.

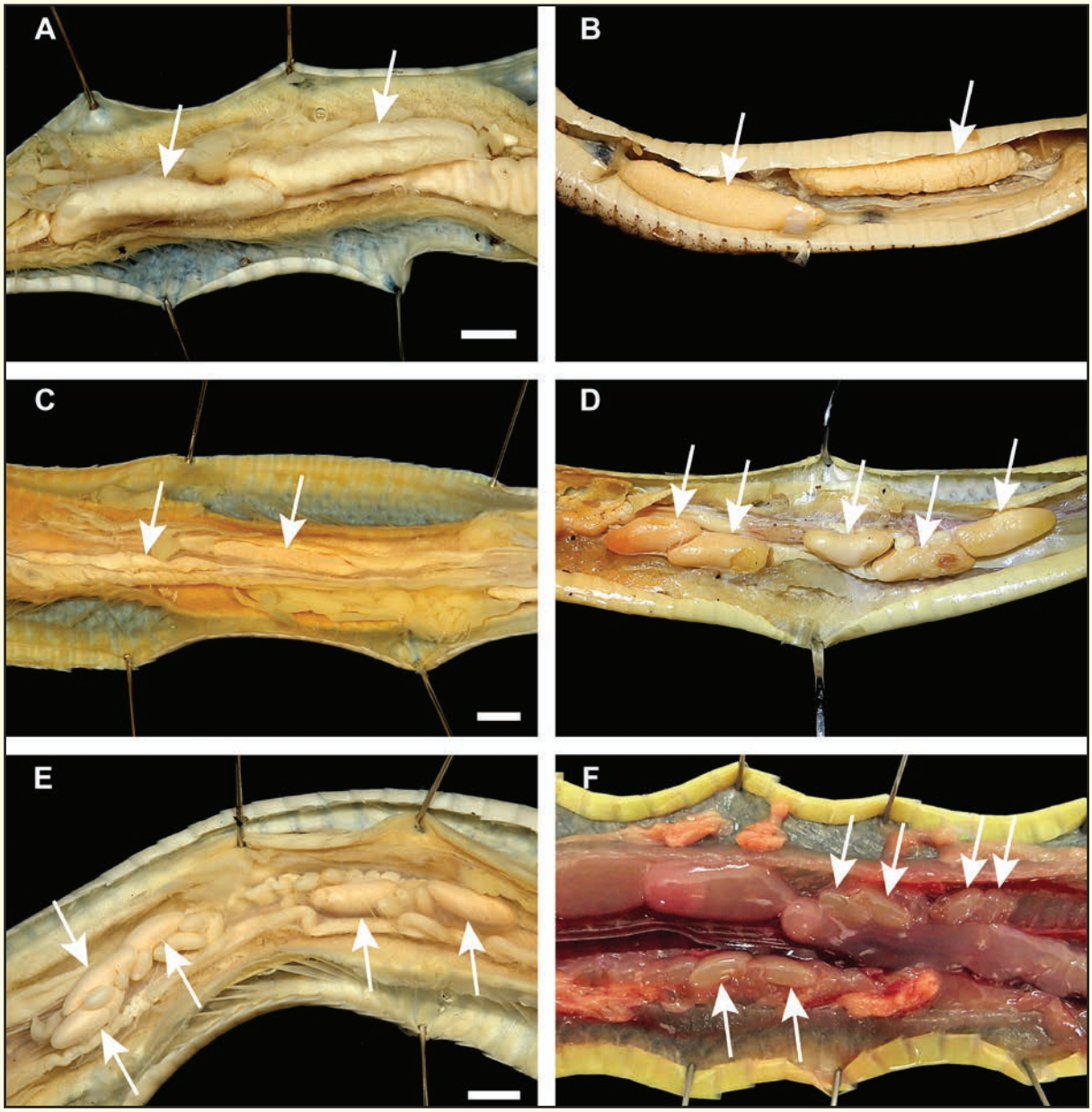

Fig. 2. Specimens of *Coniophanes imperialis* dissected to study their gonads. (A) ECO-CH-H 3682 (male); (B) ECO-CH-H 3102 (male); (C) ECO-CH-H 3403 (female); (D) ECO-CH-H 3979 (female); (E) SMF 100529 (female); and (F) SMF 102613 (female). The testes, follicles, and eggs, respectively, are indicated by arrows. Scale bars equal 5 mm. © Gunther Köhler (A–E), and Nidia Gabriela Blanco-Campos (F)

Distribution in the transect: We recorded this species throughout the 39 km road transect (Fig. 4). We found 15.7% of the specimens near cropland, 1.5% near residential areas, 13.6% in areas surrounded by vegetation-free open habitat, 22.6% near wetlands, 4.6% in areas surrounded by vegetation-covered open habitat, 23.5% adjacent to tree plantations, 13.5% in areas surrounded by open, sandy habitat, and 5.0% adjacent to natural forest.

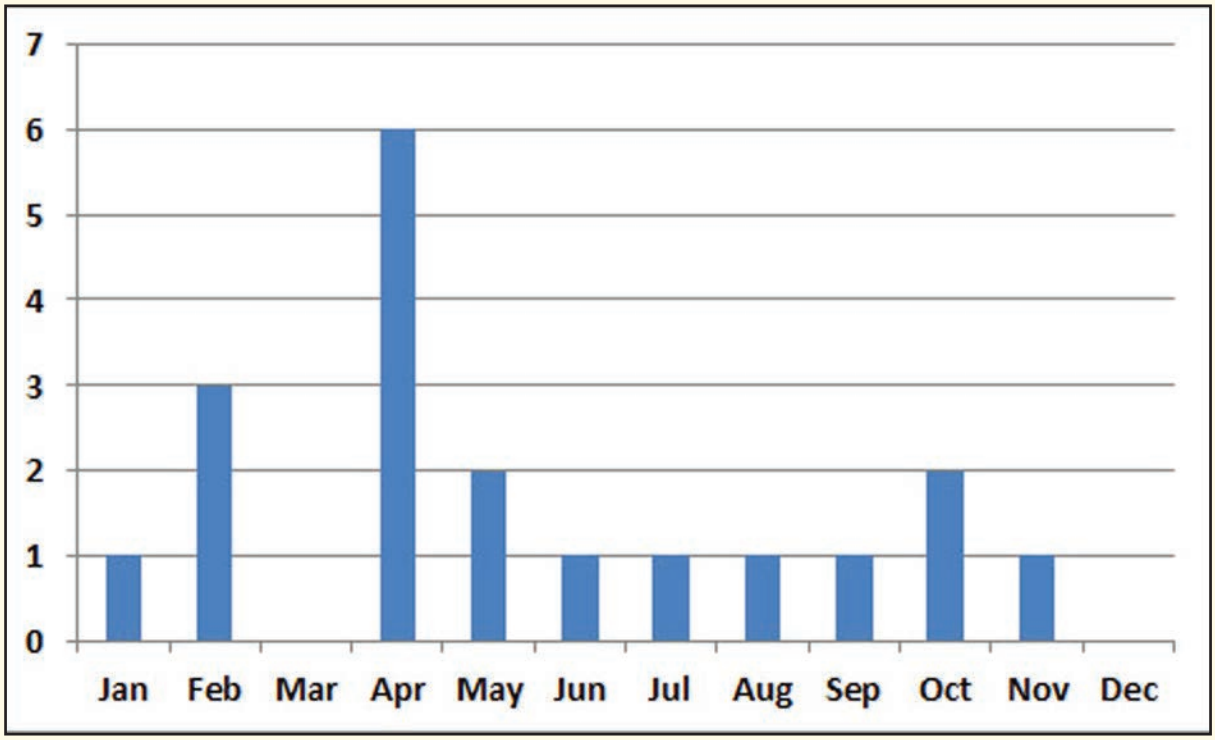

Fig. 3. Diagram showing the frequency distribution of collected specimens of *Coniophanes imperialis* during the course of the year.

Coniophanes meridanus Schmidt and Andrews, 1936

Material: We collected 14 specimens of *Coniophanes meridanus* (Fig 5), of which we identified 12 as males and two as females.

External morphology: See Table 1 for variation in selected morphometric and scalation characters.

Diet: None of the specimens of *Coniophanes meridanus* contained identifiable gastrointestinal contents.

Reproduction: The dissection of five male specimens of *Coniophanes meridanus* yielded data on reproduction. The relative testis size (ratio of testis length × width/SVL) in the five males was 0.026–0.076 (0.052 ± 0.022). We found the largest relative testis size (0.076) in a specimen collected in May, and the one with the smallest value (0.026) in a specimen preserved in April. One female (SMF 102614; SVL = 22.5 cm) collected dead on the road on 14 January 2017 at 2206 h at the village of Calderitas, contained 3 oviducal eggs with a length of 10.8–12.9 and a width of 2.6–2.9.

Seasonality: See Figure 6 for the temporal distribution of the 14 individuals of *Coniophanes meridanus* encountered on our road transect from 13 February 2010 to 19 August 2017. Except for one specimen found in January, we encountered this species only during the spring and summer (March through August), with a peak in June.

Distribution in the transect: We recorded this species throughout the 39 km road transect (Fig. 7). We found 30.1% of the specimens in areas surrounded by vegetation-free open habitat, 58.1% adjacent to tree plantations, and 11.8% adjacent to natural forest.

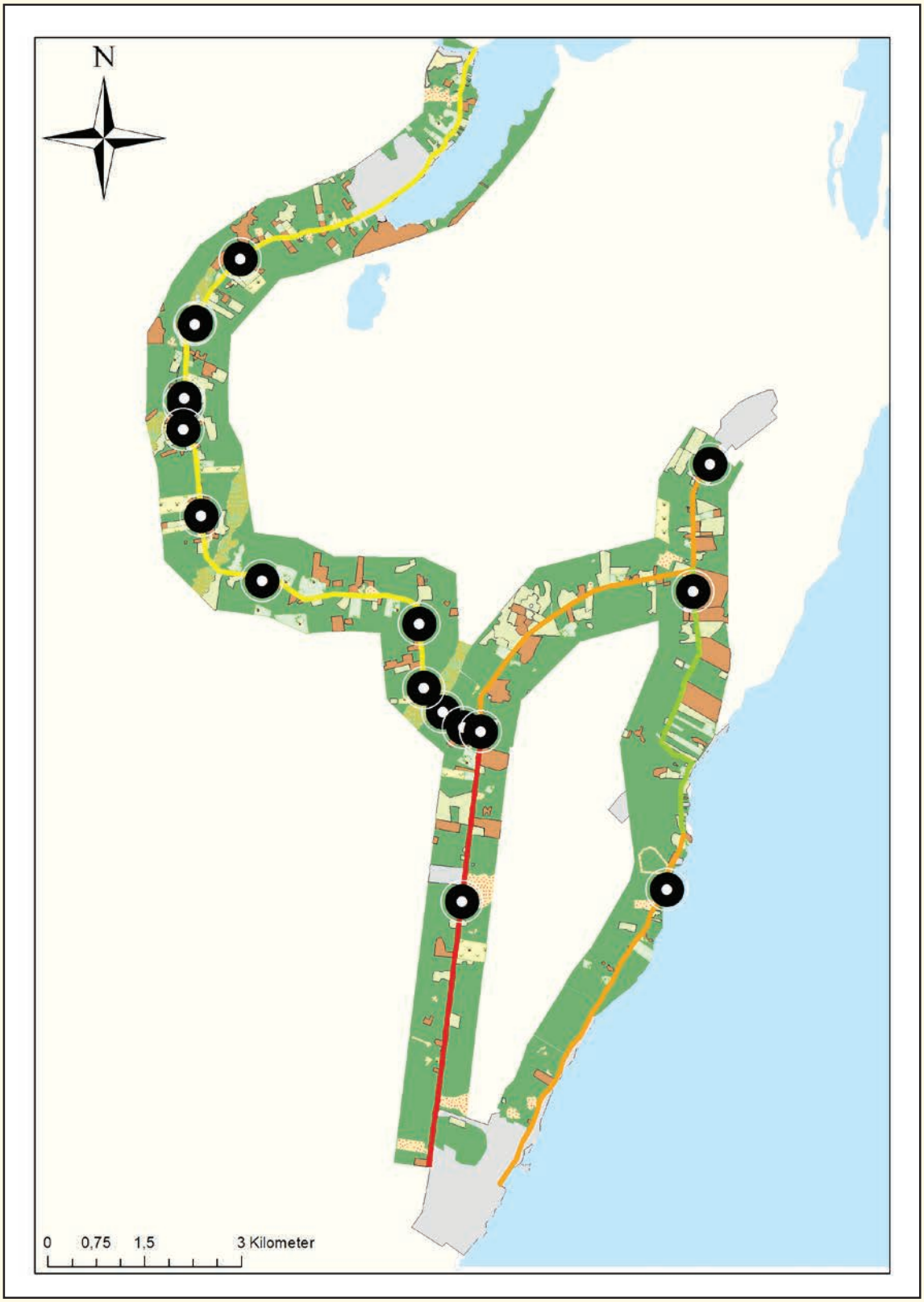

Fig. 4. Spatial distribution of the collected specimens (black dots with white centers) of *Coniophanes imperialis* along the transect.

Fig. 5. *Coniophanes meridanus* (from Chetumal, Quintana Roo, Mexico) in life. © Pierre Charruau and J. Rogelio Cedeño-Vázquez

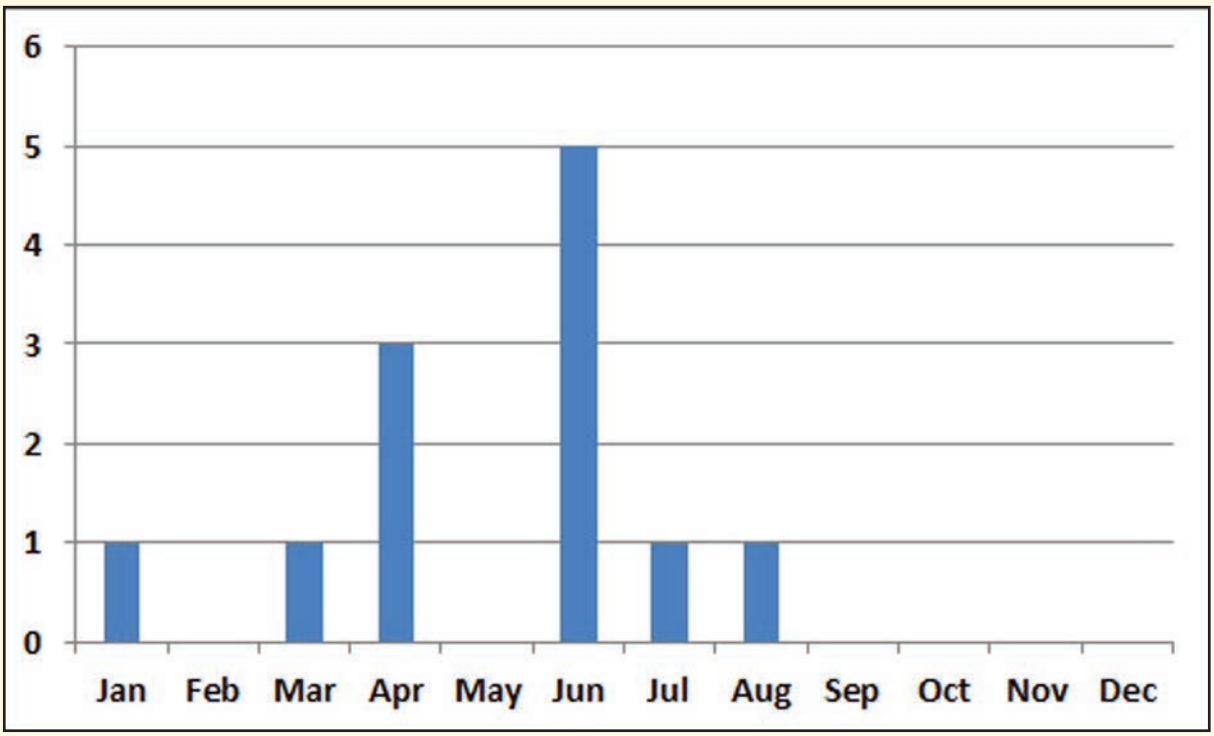

Fig. 6. Diagram showing the frequency distribution of collected specimens of *Coniophanes meridanus* during the course of the year.

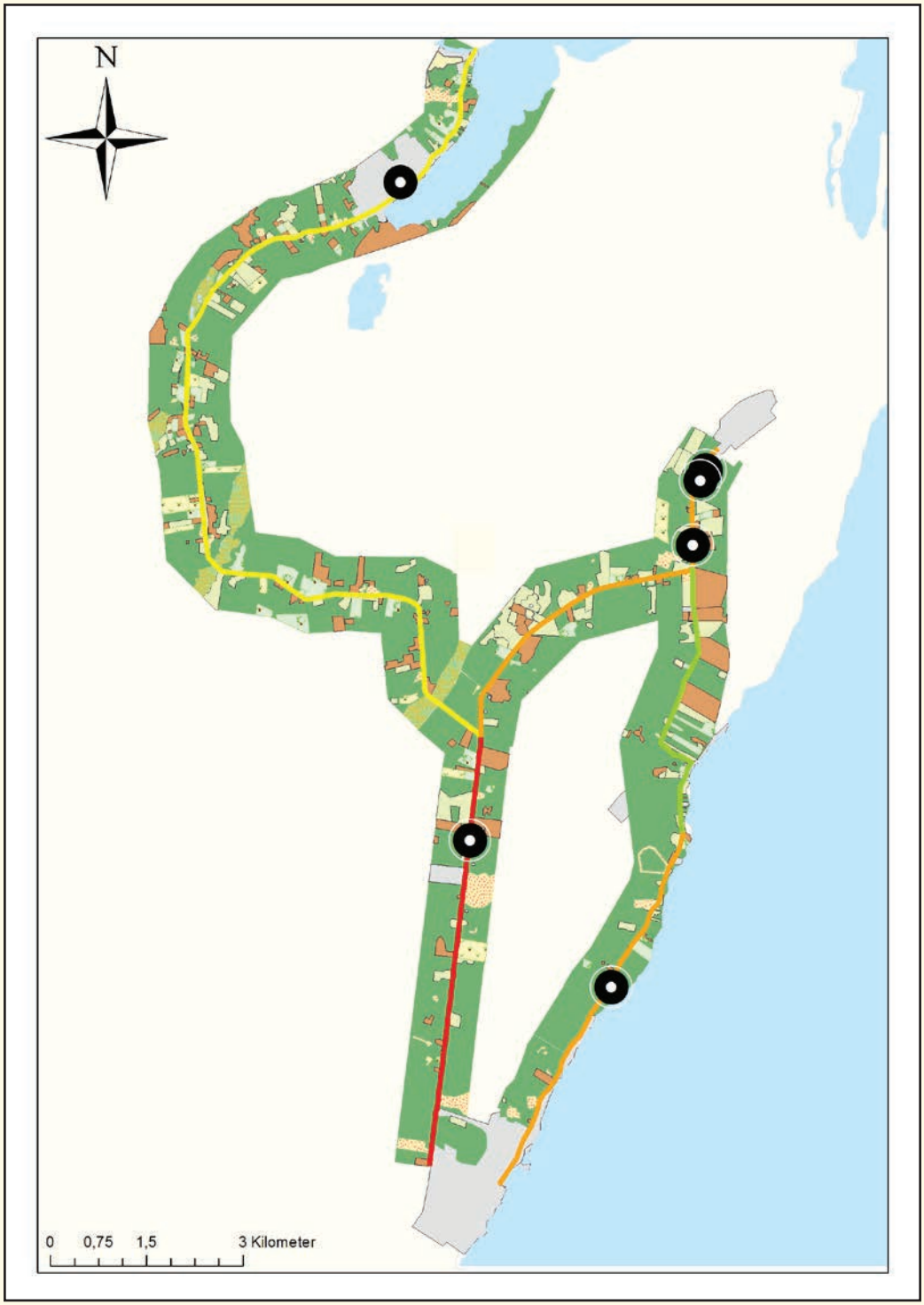

Fig. 7. Spatial distribution of collected specimens (black dots with white centers) of *Coniophanes meridanus* along the transect.

Coniophanes schmidti Bailey, 1937

Material: We collected 15 specimens of *Coniophanes schmidti* (Fig. 8), of which we identified nine as males, and six as females.

Fig. 8. *Coniophanes schmidti* (from Calakmul, Campeche, Mexico) in life. © J. Rogelio Cedeño-Vázquez

External morphology: See Table 1 for variation in selected morphometric and scalation characters.

Diet: One of the preserved specimens of *Coniophanes schmidti* (SMF 100527) contained undigested parts of arthropods. We identified the remains of a *Coleonyx elegans* in the gastrointestinal tract of one specimen (ECO-CH-H 3496). And, a juvenile specimen (ECO-CH-H 3982; SVL = 115 mm) contained an egg in its stomach (Fig. 9A, B).

Reproduction: The dissection of five specimens of *Coniophanes schmidti* (2 males, 3 females) yielded data on reproduction. The relative testis size (ratio of testis length × width/SVL) in the 2 males was 0.030 (collected in November) and 0.147 (January). The female specimen ECO-CH-H 3120 contained 2 vitellogenic follicles per side, with a follicle size of 3.12 × 1.96 mm (right side) and a follicle size of 4.91 × 2.56 mm (left side). The second female specimen (SMF 100530) contained 3 vitellogenic follicles on the right side, with a follicle size of 3.95 × 1.24 mm. One female (SMF 102612; SVL = 420 mm), collected on 14 January 2017, contained 3 oviducal eggs (length 22.8–23.1 mm; width 5.1–5.9 mm; Fig. 9C).

Seasonality: See Figure 10 for the temporal distribution of the 15 individuals of *Coniophanes schmidti* encountered on our road transect from 13 February 2010 to 19 August 2017. No seasonal trend was evident.

Distribution in the transect: We recorded this species throughout the 39 km road transect (Fig. 11). We found 14.7% of the specimens in areas surrounded by vegetation-free open habitat, 31.1% near wetlands, 18.9% in areas surrounded by vegetation-covered open habitat, 32.3% adjacent to tree plantations, and 3.0% adjacent to natural forest.

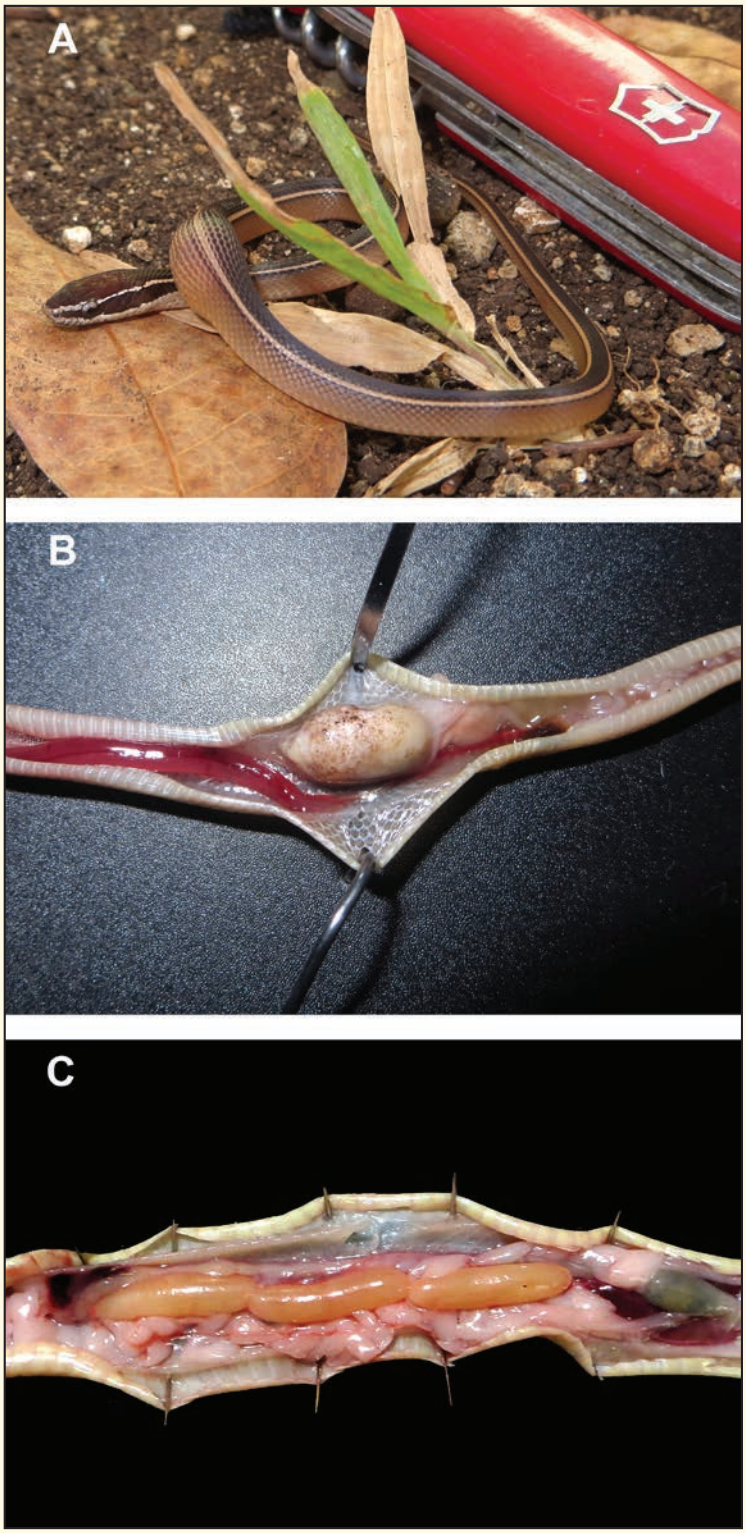

Fig. 9. *Coniophanes schmidti* dissected to study their intestinal contents and gonads. (A, B) ECO-CH-H 3982 (SVL = 115 mm) with an egg in its stomach; and (C) SMF 102612 with three oviducal eggs.

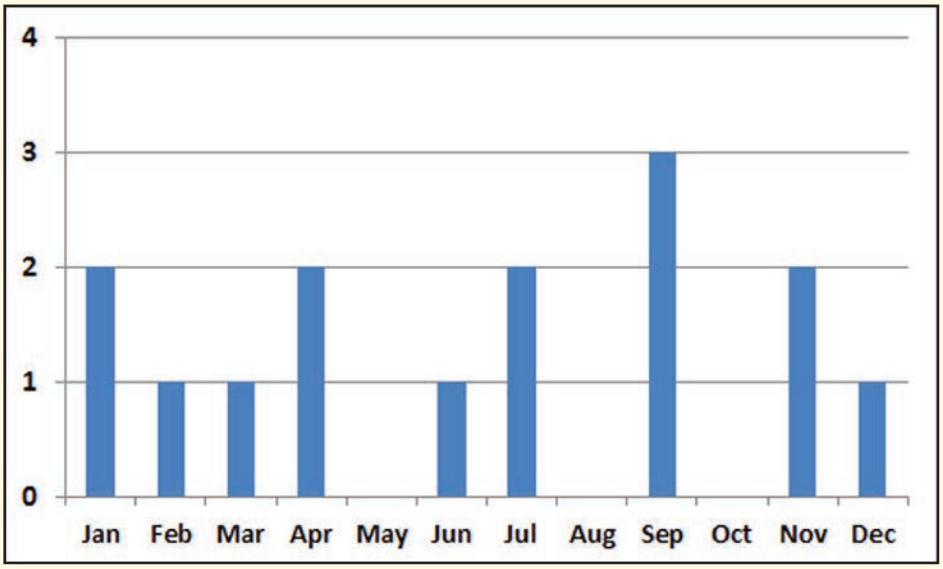

Fig. 10. Diagram showing the frequency distribution of collected specimens of *Coniophanes schmidti* during the course of the year.

DISCUSSION

We depict the annual number of collected specimens of the three species of *Coniophanes* in Fig. 12. We could not detect a clear trend of their seasonal occurrence during this seven-year period. On average, one to three individuals of each species were collected annually. Regarding the distribution of these three species within the transect, we collected the majority adjacent to tree plantations and near wetlands.

Whereas *C. schmidti* can be readily identified based on its distinctive dorsal coloration pattern, differentiating the other two species of the genus treated in this article was not nearly as straightforward. In order to test which morphological character can be used to distinguish between these two species, so we could assign our specimens correctly to either species, we generated DNA barcode (16S) sequences (G. Köhler, unpublished). Apparently, the number of dorsal scale rows at midbody can be used to reliably identify the two species, as 19 rows are present in *C. imperialis* and 17 in *C. meridanus*. Also, in our male specimens, the number of subcaudals was higher in *C. meridanus* (83–87) than in *C. imperialis* (78–82). The coloration of the head and body in both species, however, shows much overlap.

Coniophanes imperialis has been reported to feed on lizards, lizard eggs, blindsnakes, small anurans, and insects (Lee, 1996; Campbell, 1998; McCranie, 2011, and references therein). Individuals with oviducal eggs have been reported for the months of April and May (McCranie, 2011, and references therein). Little or no information is available on the reproductive biology of *C. meridanus*. To our knowledge, the data on reproduction we present in this article are the first for this species (see also Lee, 1996). *Coniophanes schmidti* has been noted to feed on lizards and frogs and to lay 4–5 eggs during the rainy season (Campbell, 1998). We also found a lizard egg (probably of *Norops sagrei*, which is abundant in the urban area of Chetumal, where the snake specimen was found) and the remains of arthropods in the gastrointestinal tract of one individual, which indicates that these also might constitute part of this species' diet.

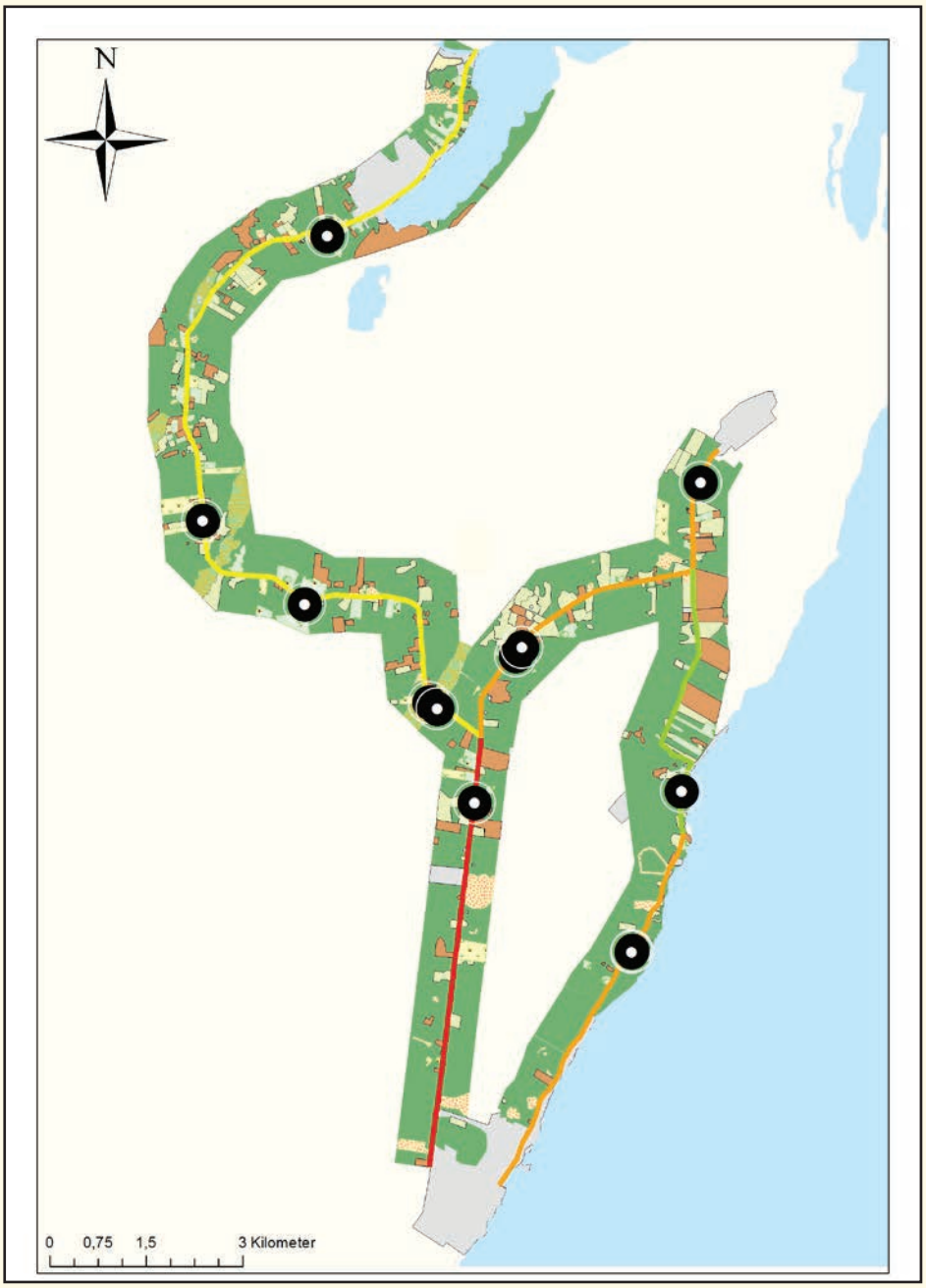

Fig. 11. Spatial distribution of collected specimens (black dots with white centers) of *Coniophanes schmidti* along the transect.

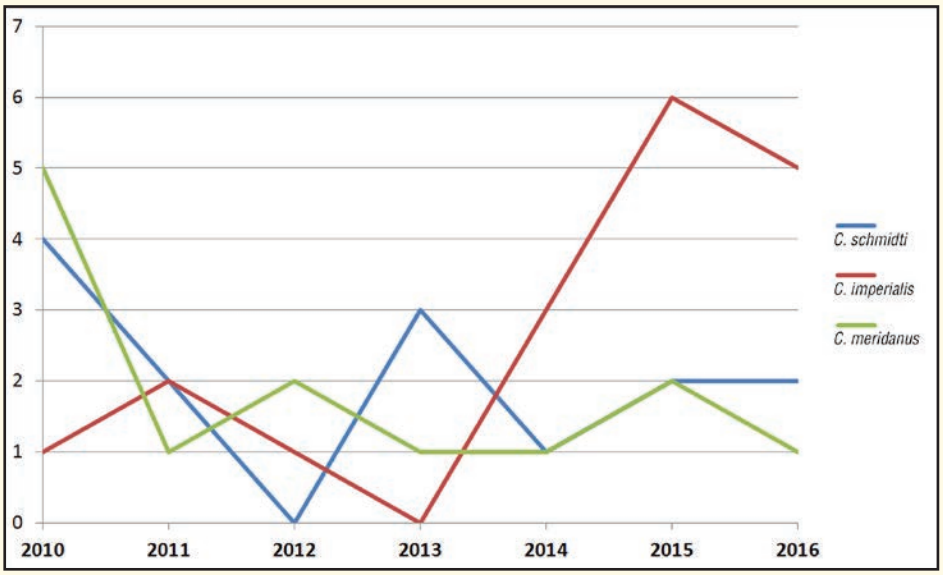

Fig. 12. The annual number of collected specimens of the three species treated in this paper. *Coniophanes imperialis* (red graph); *C. meridanus* (green graph); and *C. schmidti* (blue graph).

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Appendix 1. Specimens examined.

Coniophanes imperialis.—**MEXICO:** QUINTANA ROO: between Laguna Guerrero and turn to Calderitas: ECO-CH-H 2921, 3101–02, 3385, 3433, 3503, 3600, 3702, 4038, SMF 99578, 100522, 100528, 100942; between Luis Echeverría and turn to Laguna Guerrero: ECO-CH-H 3595, 3683; between Luis Echeverría and Ruínas de Oxtankah: SMF 100529; village of Laguna Guerrero: ECO-CH-H 3657, 3700; and on road from Bacalar to Reforma: SMF 102613.

Coniophanes meridanus.—**MEXICO:** QUINTANA ROO: between Calderitas and turn to Laguna Guerrero: ECO-CH-H 3103, SMF 100524; between Laguna Guerrero and turn to Calderitas: ECO-CH-H 2923, SMF 100523; between Luis Echeverría and Ruínas de Oxtankah: ECO-CH-H 3455, 3505; between Luis Echeverría and turn to Calderitas: ECO-CH-H 3704; between Luis Echeverría and turn to Laguna Guerrero: ECO-CH-H 2922, 3117, 3383, SMF 100525; coastal road between Calderitas and Ruínas de Oxtankah: ECO-CH-H 2948, SMF 100520; and village of Laguna Guerrero: SMF 102614.

Coniophanes schmidti.—**MEXICO:** QUINTANA ROO: between Calderitas and Ruínas de Oxtankah: ECO-CH-H 3741, 4025; between Calderitas and turn to Laguna Guerrero: ECO-CH-H 3496, 3662; between Laguna Guerrero and turn to Calderitas: ECO-CH-H 3119–20, SMF 100526–27, 100530; between Luis Echeverría and Ruínas de Oxtankah: SMF 100533; between Luis Echeverría and turn to Laguna Guerrero: ECO-CH-H 2931, 3244, SMF 100531; coastal road between Calderitas and Ruínas de Oxtankah: ECO-CH-H 2930, SMF 100532; and on road from Bacalar to Reforma: SMF 102612.

Gunther Köhler received a degree in Veterinary Medicine (Staatsexamen) at the University Gießen, Germany, in 1993, and a Doctoral degree at Goethe University Frankfurt am Main, Germany, in 1995; since that time, he has been the Curator of Herpetology at the Senckenberg Research Institute, Frankfurt am Main, Germany. His research focuses on the Neotropical herpetofauna, primarily that of Central America and Mexico. To date, Gunther has authored or co-authored 27 books and 214 research papers on amphibians and reptiles.

José Rogelio Cedeño-Vázquez completed his Licenciatura in biology at the Universidad Michoacana de San Nicolás de Hidalgo, Morelia, Michoacán, Mexico in 1995, and received his Master's and Doctoral degrees at El Colegio de la Frontera Sur (ECOSUR) in 2002 and 2008, respectively. From 1996 to 2000 he collaborated in several research projects in the Yucatan Peninsula. He was a researcher and instructor in the school of Biology at the Instituto Tecnológico de Chetumal, Quintana Roo, Mexico from 2008 to 2012, and since 2013 has been a faculty member in the Departamento de Sistemática y Ecología Acuática at ECOSUR Unidad Chetumal; he also is the Curator of Herpetology at the Museo de Zoología of ECOSUR. Rogelio is interested in the systematics, ecology, conservation, and management of amphibians and reptiles from the Yucatan Peninsula, and to date has co-authored a book, several book chapters, research notes, and scientific and popular articles. He is a member of the Sistema Nacional de Investigadores (National System of Researchers), of Mexican herpetological associations, and of the IUCN/ SSC-Amphibian and Crocodile Specialist Group.

Akary Myat Tun graduated with a B.Sc. in Biology and currently is working on her M.Sc. studying the snakes of Myanmar under the guidance of Gunther Köhler at the Senckenberg Research Institute, Frankfurt am Main, Germany. Akary is particularly interested in biodiversity, evolution and systematics.

Pablo M. Beutelspacher-García is an independent researcher. Although Pablo did not pursue a professional career, he is a born naturalist with huge empirical knowledge on the herpetofauna of the Yucatan Peninsula. Pablo's curiosity and passion for reptiles (especially snakes) arose in childhood, when he began making detailed observations on their behavior in order to distinguish between facts and myths. He has collaborated with researchers from El Colegio de la Frontera Sur, Chetumal, Quintana Roo, Mexico, in several research projects involving biodiversity inventories in Campeche, Quintana Roo, and Yucatán, Mexico, and also has co-authored technical reports, and several distribution and natural history notes on amphibians and reptiles.