

DISTRIBUTION, HABITAT, SIZE, AND COLOR PATTERN OF  
*CNEMIDOPHORUS LEMNISCATUS* (SAURIA: TEIIDAE) ON CAYO COCHINO  
PEQUEÑO, HONDURAS

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**ABSTRACT**—Cayo Cochino Pequeño is a 0.64-km<sup>2</sup> Caribbean island in the Cayos Cochinos archipelago, Department of Islas de la Bahía, Honduras. One published report noted the presence of the rainbow whiptail (*Cnemidophorus lemniscatus*) on Cayo Cochino Pequeño, but nothing is known about the biology of this insular population. During a part of the dry season in July and August 2004, we used drift fences, pitfall traps, and separate observational transects to elucidate the distribution and habitat use of *C. lemniscatus* on the island. The only population of this species was located in a narrow coastal zone (width to 60 m and length to 450 m) on the southern half of the eastern windward side of the island. We analyzed the percentage of the canopy cover and the percentage of 4 ground coverage types along 2 transects 200 m long in this area to understand the basis of the suitability of the habitat for *C. lemniscatus*. Descriptively, the area harboring this species on Cayo Cochino Pequeño consisted of the remnants of a coconut palm grove with low-lying herbaceous vegetation and grasses, in which a mosaic of small, open areas of sandy soil and coral fragments, with or without accumulations of debris, were the foci of lizard activities. Also observed in this habitat were 2 individuals of the brown racer (*Dryadophis melanolomus*), an actively foraging snake and likely predator on *C. lemniscatus*. Data obtained on rainbow whiptails captured in pitfall traps and subsequently released were used to determine the size and color patterns of hatchlings and adult males and females.

**RESUMEN**—Cayo Cochino Pequeño es una isla caribeña de 0.64 km<sup>2</sup> localizada en el archipiélago de Cayos Cochinos, Departamento de Islas de la Bahía, Honduras. Una publicación señaló la presencia de la lagartija (*Cnemidophorus lemniscatus*) en Cayo Cochino Pequeño, pero no se sabe nada sobre la biología de esta población isleña. Durante parte de la estación seca en julio y en agosto del 2004, utilizamos cercas de zanja y trampas de hoyo y transectos de observación para explicar la distribución y utilización del hábitat de *C. lemniscatus* en la isla. La única población de esta especie fue localizada en una zona costera angosta (ancho 60 m y largo 450 m) en la mitad sur del lado este de la isla expuesta al viento. Analizamos el porcentaje de cubierta del dosel y el porcentaje de cuatro tipos de suelos a lo largo de dos transectos de 200 m de largo en esta área para entender las bases de condiciones adecuadas del hábitat para *C. lemniscatus*. Descriptivamente, el área que alberga a esta especie en Cayo Cochino Pequeño consistió de los remanentes de una plantación de palmas de coco con vegetación herbácea baja y pastos, en la cual un mosaico de áreas pequeñas, abiertas de suelo arenoso y fragmentos de coral, con o sin acumulaciones de materia orgánica, fueron el foco de la actividad de las lagartijas. En este hábitat también observamos dos individuos de la culebra (*Dryadophis melanolomus*), una serpiente que forrajea activamente y que probablemente es un depredador de *C. lemniscatus*. Datos obtenidos de lagartijas capturadas en las trampas de hoyo y liberadas posteriormente fueron utilizados para determinar el tamaño y patrón de coloración de crías y de adultos de machos y de hembras.

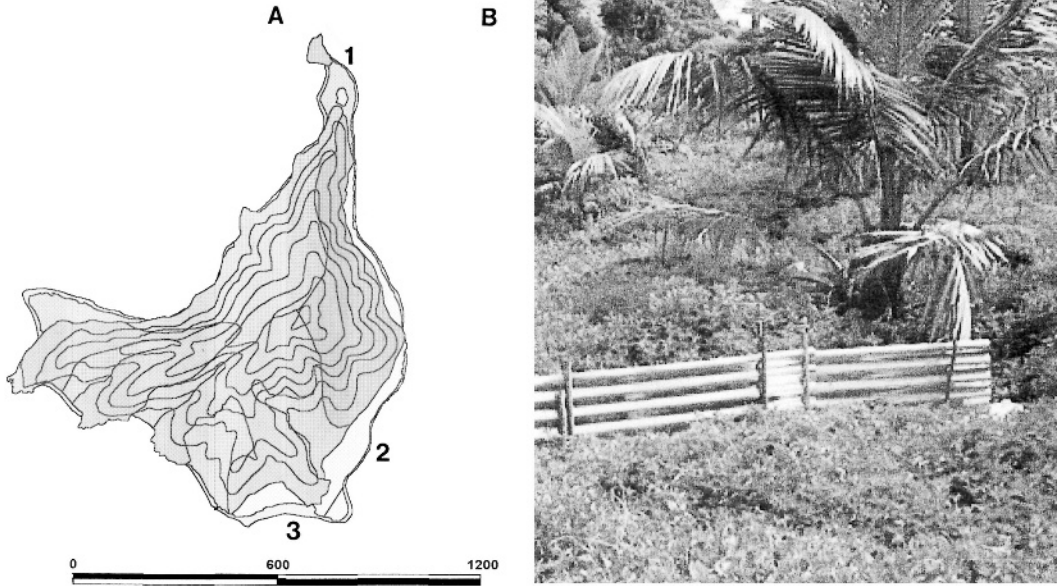


FIG. 1—A) Contour map of Cayo Cochino Pequeño, Honduras (scale in meters), showing the previously reported locality for the rainbow whiptail, *Cnemidophorus lemniscatus* (1), study area discussed in this paper (2), and location of the research station (3). B) Photograph (looking northeastward) taken in 2004 on Cayo Cochino Pequeño, showing part of the windward coastal zone inhabited by *C. lemniscatus* (2 on outline map), with a drift fence and pitfall trap used to capture lizards.

The rainbow whiptail lizard, *Cnemidophorus lemniscatus*, is widely distributed in northern South America, Central America, on numerous islands in the Caribbean Sea, and in the vicinity of Miami, Florida, where it has been introduced (Peters and Donoso-Barros, 1970; Serena, 1984; Cole and Dessauer, 1993; Markezich et al., 1997; Conant and Collins, 1998). Documentation of this species in the herpetofauna of Cayo Cochino Pequeño (=Cayo Menor; Fig. 1A), the second largest of the 2 small islands and 13 keys in the Cayos Cochinos archipelago, Department of Islas de la Bahía, Honduras, was based on observations of lizards and one voucher specimen deposited in the University of Kansas Museum of Natural History (KU 220101) collected in 1988 near Bonkes Nose Point at the northern tip of the island (Wilson and Cruz Díaz, 1993). Eleven individuals of the species also were

reported from Cayo Cochino Pequeño by J. Ferrari (unpubl. report) in a herpetofaunal survey of the Cayos Cochinos archipelago in 2002. This privately owned continental island, which lies about 14.8 km from the coast of Honduras, is variously estimated to have a surface area of only 0.64 to 0.71 km<sup>2</sup>. It is 1.1 km wide and has a steep elevational gradient (to 141 m) to a ridge that runs the 1.5-km north-south length of the island (Wilson and Cruz Díaz, 1993; McCranie et al., 2005). There are 5 major habitat formations on the island: hill forest, rocky promontory, mangrove, coconut palm, and sea wind scrub (Wilson and Cruz Díaz, 1993), although the coconut palm trees have undergone a massive die off due to Lethal Yellowing disease (McCranie et al., 2005). Currently, human presence on this small but topographically complex and well-vegetated island is repre-

sented by the important conservation activities of the research station of the Honduras Coral Reef Foundation, and the carefully monitored activities associated with research (e.g., this study) and ecotourism. However, Cayo Cochino Pequeño lies in the Caribbean hurricane zone and, therefore, the fauna and flora are impacted by periodic, severe, natural perturbations, exemplified by category-5 Hurricane Mitch. According to the U. S. Department of the Interior (U. S. Geological Survey Open File Report 01-133), this storm passed over the Cayos Cochinos on 27–28 October 1998 with 130-mph winds (then at category-4) and caused severe damage to buildings, onshore habitats, and coral reefs.

We here report the results of a recent study of *C. lemniscatus* on Cayo Cochino Pequeño. The ecological objectives of the study were to assess the distribution and habitat use of the rainbow whiptail, also known locally on the island as shake-paw (see McCranie et al., 2005). We also present preliminary data on body size and color pattern variation in the Cayo Cochino Pequeño population of *C. lemniscatus* compared to samples of specimens from Isla de Roatán and mainland Honduras.

**METHODS—Taxonomic Considerations**—To partially resolve paraphyly in *Cnemidophorus*, Reeder et al. (2002) resurrected the generic name *Aspidoscelis* for whiptail lizards in North and Central America formerly allocated among 5 species groups of *Cnemidophorus* (presently the *A. cozumela*, *A. deppoi*, *A. sexlineata*, *A. tessellata*, and *A. tigris* groups). These authors retained all other whiptail lizards, *C. lemniscatus* and other taxa in Central and South America placed with it in the same species group by Burt (1931) and subsequent authors, in *Cnemidophorus*, which remains paraphyletic pending further revision. Presently, the whiptail lizard population on Cayo Cochino Pequeño is one of many taxonomically poorly known insular and mainland groups in the Caribbean Sea and Central and South America that are provisionally assigned to *C. lemniscatus lemniscatus*. In particular, studies are needed to evaluate the applicability of the name *C. lemniscatus ruatanus*, type locality Isla de Roatán, to all or some populations of whiptail lizards in Central America.

**Collection of Lizards**—The first 4 authors conducted the field investigation of *C. lemniscatus* during part of the dry season in July and August 2004 coincidental with their participation in a project to assess the population status of the snake *Boa constrictor* (boa) on Cayo Cochino Pequeño. They obtained distributional, ecological, morphological, and color data for rainbow whiptails through captures of live lizards by using drift fence arrays constructed on the island by the research group. Each array consisted of the linearly arranged components of the fence (Fig. 1B) of approximately 7 m in length; this barrier resulted in the movement of

many lizards and snakes along the fence to a buried pitfall trap at each end consisting of an 18-L bucket. All of the fences were placed on the southern end of the island near the research station to accommodate ease of checking them each day over a period of 7 weeks (Fig. 1A). Other lizards captured in the pitfall traps included juveniles of *Ctenosaura melanosterna* (spinytail iguana), a population allocated to this species by Buckley and Axtell (1997), and *Basiliscus vittatus* (brown basilisk).

**Habitat Assessment along Transects**—In addition to the pitfall traps, 12 observational transects of 200 m in length were positioned on the island to traverse one or more areas in each of the 5 major habitat types described by Wilson and Cruz Díaz (1993). Numbers pertaining to distances between reference points on Cayo Cochino Pequeño were estimated based on satellite images of the island. Habitat characteristics were studied on each transect to compare areas of the island where *C. lemniscatus* was present and where it was absent. Each transect was walked once a week for 6 weeks at different times of day to account for diel variation in the activity of rainbow whiptails and other reptiles. For this study, effort was concentrated on 3 of the 12 transects; one of these was situated on the extreme northern part of the island on the narrow isthmus south of Bonkes Nose Point promontory, where *C. lemniscatus* had been reported by Wilson and Cruz Díaz (1993), and 2 were located in the area on the southern half of the eastern, windward side of the island, where this lizard species occurred in 2004. These 3 transects were used to determine the percentage of canopy cover and the percentage of 4 ground-cover types (rock/bare ground, leaf litter, vegetation, or logs) for 21 quadrats of 1 m<sup>2</sup> spaced every 10 m starting at 0 m. We also observed *C. lemniscatus* by incidental encounter during the study.

**Body Size and Color Pattern**—We compared body size and color pattern variation in captured and subsequently released individuals of *C. lemniscatus* on Cayo Cochino Pequeño with data for samples of preserved specimens in the KU collection from Isla de Roatán and mainland Honduras. Data obtained by examination of 7 of 10 individuals of the species captured in pitfall traps in 2004 on Cayo Cochino Pequeño included sex (based on the presence of a pointed scale [i.e., an anal spur] on each side of the preanal scales in males and absence of these scales in females), snout vent length (SVL), tail length (TL), head length (HL), head width (HW), hind leg length (HLL), fore leg length (FLL), mass (M), and color pattern (number of complete dorsal stripes at midbody, and dorsal and ventral coloration). We were not permitted to retain voucher specimens of individuals of *C. lemniscatus* captured in 2004; thus, color pattern notes obtained for live adult lizards were compared with color photographs of a mature adult male and female. We also used color photographs of individuals of *C. lemniscatus* included in Gutsche (2005) from Isla de Utila, McCranie et al. (2005) from Islas de Utila and Roatán, and the personal files of CEM from Panama.

**RESULTS—Habitat Characteristics and Use**—In 2004, we were unable to confirm the presence

of *C. lemniscatus* on the narrow isthmus leading to Bonkes Nose Point promontory at the northern tip of Cayo Cochino Pequeño (Fig. 1A-1). This was the site of the original discovery of the lizard on the island in 1988 (Wilson and Cruz Díaz, 1993) as documented by their collection of voucher specimen KU 220101 and observations of additional lizards. Analysis of the observational transect on the isthmus indicated that canopy cover was  $30.2 \pm 4.9\%$  (mean  $\pm$  SD) above any 1 m<sup>2</sup> examined and that dominant groundcovers were rock/bare ground ( $37.6 \pm 8.0\%$ ) and leaf litter ( $36.2 \pm 6.0\%$ ); logs and vegetation were less abundant ( $18.6 \pm 4.2\%$  and  $7.6 \pm 3.6\%$ , respectively). These data suggested that the placement of this transect was in an area of the isthmus where shading by the moderately thick canopy and a resulting reduced amount of low-lying vegetation were apparent limiting factors for *C. lemniscatus*.

In 2004, we located *C. lemniscatus* in only one area of Cayo Cochino Pequeño, a band of habitat of about 60 m at its widest point and 450 m in length (about 25,000 m<sup>2</sup> and amounting to about 3.5% of the surface area of the island) on the southern half of its eastern, windward coast (Fig. 1A-2). We estimated this area to be separated from the first recorded locality for *C. lemniscatus* on the island (Wilson and Cruz Díaz, 1993) by a 950-m straight-line distance through apparently unsuitable habitat for the lizard. We confirmed that *C. lemniscatus* is an index animal for a coastal habitat type of limited distribution on Cayo Cochino Pequeño that is based on a unique combination of topography, substrate, geographic position, and climate (Fig. 1A-2). The area inhabited by *C. lemniscatus* had adequately recovered from the scouring by Hurricane Mitch in late October 1998 and was characterized by wave-borne and wind-dispersed sandy soil and coral fragments that supported some grasses and thick, low-lying, herbaceous vegetation (e.g., beach morning glory, *Ipomoea pes-caprae*) and scattered palm trees. Here, this type of vegetation began within 1 m of the high tide line and extended 20 to 60 m westward, where it met palm forest edge; within 60 to 80 m of the ocean, the hill forest began and elevation increased dramatically to the north-south ridge. An additional indication of the uniqueness of the area near sea level inhabited by *C. lemniscatus* was its sharp delineation in satellite images and photographs.

In addition to incidental encounters, we observed 8 individuals of *C. lemniscatus* along two 200-m transects (each walked once per week) in the coastal habitat (Fig. 1A-2). The results of the habitat analysis of these 2 observational transects indicated that there was less than 1% canopy cover above the average 1 m<sup>2</sup> quadrat examined and that ground vegetation ( $59.4 \pm 6.6\%$ ; mean  $\pm$  SD) was the dominant cover type, bare ground ( $21.9 \pm 5.2\%$ ) was abundant, and log and leaf litter ( $8.6 \pm 1.9\%$  and  $2.1 \pm 0.4\%$ , respectively) were less important. However, lizards did use leaf litter and debris in the absence of ground vegetation at the edge of the palm forest (Fig. 2B). In addition, we captured 10 individuals of *C. lemniscatus* in 2 pitfall arrays located in the coastal habitat (Fig. 1B); however, no individuals were captured or observed in or near any of the other pitfall arrays located in different habitat types.

We also captured individuals of the brown racer, *Dryadophis melanolomus*, an actively foraging diurnal colubrid snake that largely subsists on lizards, while sampling in the coastal habitats inhabited by *C. lemniscatus*. Based on the relative paucity of other lizard species observed in these habitats, we suspect that these snakes were foraging for *C. lemniscatus*, and this snake is likely its primary predator on Cayo Cochino Pequeño.

**Body Size**—Size data for 7 of 10 individuals of *C. lemniscatus* captured in pitfall traps on Cayo Cochino Pequeño are compared for M, SVL, TL, HL, HW, HLL, and FLL in Table 1. There were 3 juveniles, the smallest of which had a SVL of 26 mm (TL = 58 mm, M = 0.9 g) and was considered to represent the size of the species at hatching. It was smaller than any of the 25 specimens from Honduras (KU 101328–101351, 200584) and 5 from Isla de Roatán (KU 192621–192622, 203160–203162) available to us for comparison, and smaller than Gutsche (2005) reported for hatchlings of *C. lemniscatus* (SVL range of 28 to 30 mm) from incubated wild-harvested eggs obtained on Isla de Utila in 2001. One captured adult female with a SVL of 67 mm (TL = 136 mm, M = 5.5 g) and another photographed individual (Fig. 2B) of similar size from Cayo Cochino Pequeño were only slightly smaller than the 3 largest females (SVL = 69 to 70 mm) in the KU Honduran sample. The 2 largest males captured on the island had SVL of 72 mm (TL = 166 mm, M = 8.3 g) and 74 mm



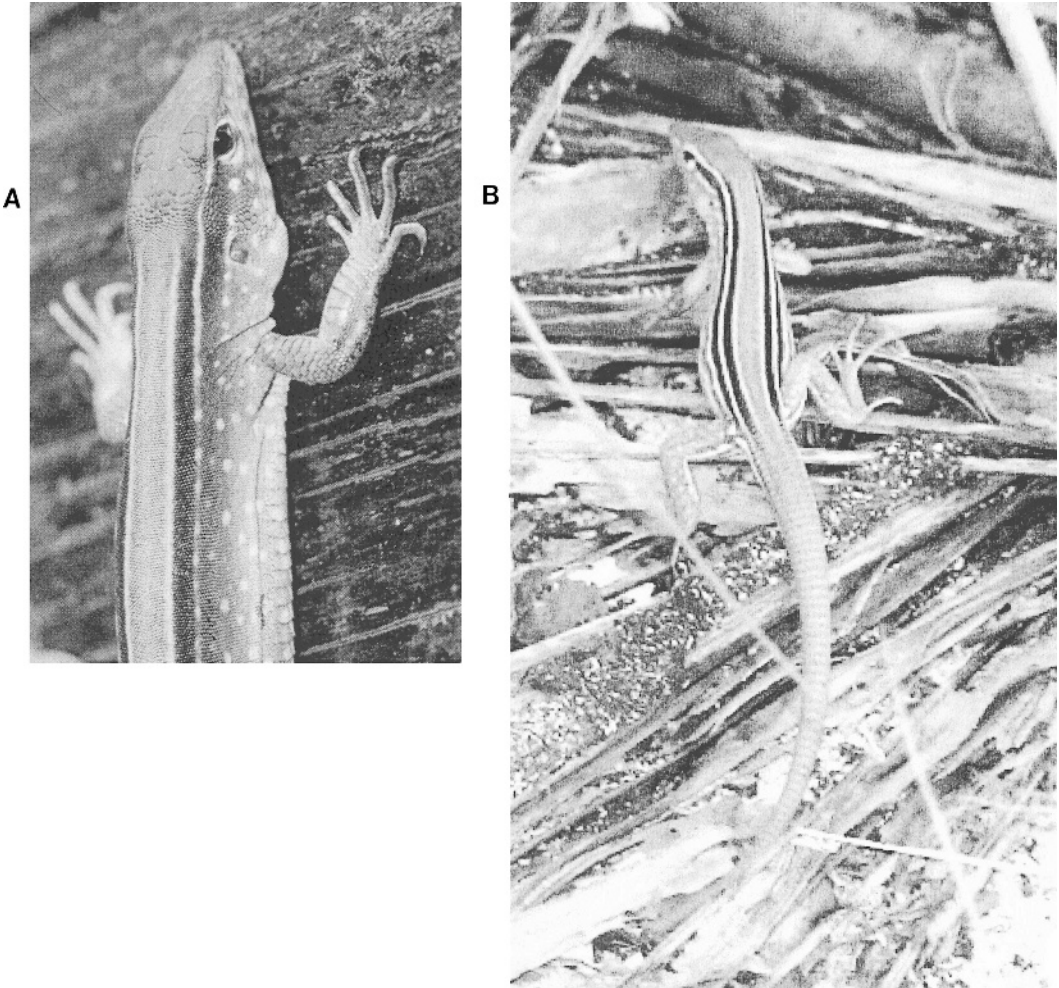


FIG. 2—A) Captured and released adult male of *Cnemidophorus lemniscatus* on Cayo Cochino Pequeño, Honduras, showing complete metamorphosis of color pattern. B) Sexually dimorphic female (photographed on the island at a different scale), showing relatively little modification of the juvenile pattern of the species.

TABLE 1—Data for 7 live individuals of *Cnemidophorus lemniscatus* removed from pitfall traps and released on Cayo Cochino Pequeño, Honduras, in 2004. M = mass; SVL = snout vent length; TL = tail length; HL = head length; HW = head width; HLL = hind leg length; FLL = fore leg length.

Sex	Capture date	M	SVL	TL	HL	HW	HLL	FLL
Female	7 July 2004	0.8	35	79	10.0	5.1	25.0	14.0
Male	12 July 2004	8.3	72	166	20.2	10.7	50.0	26.0
Female	12 July 2004	5.5	67	136	15.9	8.8	43.0	24.0
Female	18 July 2004	0.9	26	58	9.7	5.0	17.0	11.0
Male	15 August 2004	7.0	66	160	21.0	9.4	45.5	25.8
Male	18 August 2004	10.3	74	175	20.0	9.8	50.8	27.0
Female	22 August 2004	3.5	45	113	16.0	7.7	28.9	14.0

(TL = 175 mm, M = 10.3 g) compared with the 3 largest males with SVL of 81 to 86 mm in the KU sample from Honduras. The largest female (67 mm SVL) and 2 largest males (SVL = 72 and 74 mm) of *C. lemniscatus* captured in 2004 were sexually mature based on their body sizes and characteristic sexually dimorphic adult color patterns (Fig. 2A, B).

**Color Pattern**—Juveniles of *C. lemniscatus* (SVL = 26 to 45 mm; Table 1) on Cayo Cochino Pequeño were characterized by 9 white, cream, or pale yellow-tan dorsal stripes separated by intervening brown to black fields, except near the ventral scales, where the color was light brown. On each side of the body (ventral to dorsal), there were ventrolateral (=lower lateral), lateral, dorsolateral, and paravertebral primary stripes. Also present on each lizard was a moderately distinct to diffuse vertebral stripe (=middorsal line) that was set within a vertebral band of similar color located between the paravertebral stripes (Fig. 2B). The dorsal surfaces of the hind legs of juveniles were brown-black with moderately distinct spots (Fig. 2B).

Ontogenesis of color pattern in adult females (Fig. 2B) on Cayo Cochino Pequeño was less extensive than in adult males (Fig. 2A). The mature female depicted in Fig. 2B had 9 stripes at midbody, though the vertebral stripe was barely visible in the vertebral band. In this individual, the ventrolateral and lateral stripes were in the process of fragmenting into spots anteriorly. The mature male with a completely metamorphosed color pattern depicted in Fig. 2A is illustrative of the basis of the common name of this species, the rainbow whiptail. At capture, it retained evidence of only 3 stripes at midbody; they included the pair of white paravertebrals and the single subtle gray-brown middorsal set in a vertebral band of similar color. Remnants of the white dorsolateral stripes extended from above the orbits to the level of the forelimbs, where they were replaced by a series of elongate spots, first white and then yellow posteriorly. The lateral and ventrolateral stripes were not present, having been completely replaced by spots. The color scheme on the sides of the body and head in the animal (dorsal to ventral) included a black-brown longitudinal band ventral to each paravertebral stripe, a green zone, a yellow zone, and a gray zone, the last 3 with distinct oval spots throughout. The sides of the head and lateral aspects of the body anterior

to the limbs were light blue with white spots. Colors of other areas of the body were: dorsal surface of the head adobe; hind legs brown with distinct white spots; tail light brown at its base and becoming gray posteriorly; ventral surface of the head blue with white spots; and other parts of venter a mixture of ivory, pale blue, and pale green with lighter spots on both sides of the abdomen.

Males of *C. lemniscatus* from Cayo Cochino Pequeño differed from those from mainland Honduras in the KU sample and those in photographs on various internet sites in having a lesser intensity of green or blue coloration on the dorsal and lateral surfaces of the head and on the fore legs. More particularly, none of the adult males from Cayo Cochino Pequeño examined had the intensity of blue coloration on the lateral surfaces of the head as shown by the male from Isla de Utila depicted by Gutsche (2005).

**DISCUSSION**—In South and Central America and on islands, *C. lemniscatus* and its derivatives (sensu Cole and Dessauer, 1993; Markezich et al., 1997; Walker and Rhoads, 2003) inhabit 4 basic types of habitats: coastal scrub; beach strand; savannah; and sparsely vegetated urban-suburban enclaves (Echternacht, 1968; Serena, 1984; Markezich et al., 1997; Vitt et al., 1997; Gutsche, 2005; McCranie et al., 2005). The essential attributes shared by all of these are the availability of unshaded areas with open spaces and loose or sandy soil. Our habitat data for *C. lemniscatus* on Cayo Cochino Pequeño fall within this pattern: the species occurs in a wind-swept coastal zone with dense low-lying vegetation interspersed with enough open spaces and exposed ground for basking, foraging, burrowing, mating, and predator avoidance. The remnant coconut palm and coastal formation inhabited by *C. lemniscatus* on Cayo Cochino Pequeño is ecologically similar to beach strands occupied by the species on Isla de Utila (Gutsche, 2005; pers. comm.), but geographically closest to areas reported for the lizard in the coastal zone at La Ceiba and Trujillo (Echternacht, 1968; Meyer and Wilson, 1973; Wilson and McCranie, 2004). On Cayo Cochino Pequeño, the maximum interior penetration of *C. lemniscatus* was only about 60 m from the high tide line compared to its usual penetration to little more than 200 m from the high tide line on the much larger Isla de Utila (Gutsche, pers. comm.). The

well-known ability of this lizard to use various disturbed habitats associated with human settlements (Vitt et al., 1997) led us to surmise that it would be found around the research station on the southern edge of Cayo Cochino Pequeño not far from the study area (Fig. 1A-3). However, the species was not observed around the station in 2004, apparently due to the absence of low-lying vegetation from the seashore throughout the area (Fig. 1A-3). The absence of *C. lemniscatus* on Cayo Cochino Grande, the largest island in the archipelago (Wilson and Cruz Díaz, 1993; J. Ferrari, unpubl. report), separated from Cayo Cochino Pequeño by about 1.5 km, could be based on either zoogeographical (e.g., dispersal failure) or ecological (e.g., lack of suitable habitat) factors. However, it seems likely that ecological factors underlie the absence of the rainbow whiptail on Cayo Cochino Grande, which has less flat terrain (3.3%) than Cayo Cochino Pequeño (7.7%) (see McCranie et al., 2005).

In a recent evaluation of the conservation status of the amphibians and reptiles of Honduras, Wilson and McCranie (2004) scored *C. lemniscatus* as follows: geographic range, 1 (=widespread in and outside of Honduras); ecological distribution, 8 (=occurs in one formation); and human persecution, 3 (=generally ignored by humans) for an overall environmental vulnerability score of 12 (=medium vulnerability on scale of 4 to 19). The implication of this ranking for *C. lemniscatus* was that, although local populations could be either damaged or severely reduced by habitat change or destruction, the possibility of its extirpation from the fauna of mainland Honduras and Caribbean islands as large as Roatán and Utila (north and west of Cayos Cochinos) is remote. On Cayo Cochino Pequeño in 2004, we confirmed the presence this lizard in only one small area within the parts of the island that are flat (Fig. 1A-1, 2); however, it has persisted there in spite of recent ecological damage to the island by Hurricane Mitch in late October 1998. Nevertheless, we suspect that *C. lemniscatus* remains susceptible to island-wide extinction due to hurricanes, assuming that the population on the southeastern coastal area occupies the only type of habitat available to the species; if it is found elsewhere on the island, such sites would be expected to be in narrow coastal zones. This population, and that reported by Wilson and

Cruz Díaz (1993) at the northern tip of the island that we did not locate in 2004, were found on either the windward side or narrowest part of the island, such that a hurricane could easily over-wash the entire habitat used by the rainbow whiptail. Although the presently known population of *C. lemniscatus* on Cayo Cochino Pequeño also seems to be highly vulnerable to human activities, it is to be hoped that this report further stimulates interest in the conservation of this lizard species on the island.

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APPENDIX 1—*Comparative Material Examined*—  
Honduras: Atlantida: 1 km W of La Ceiba (KU 101328–101340,  $n = 13$ ); 2 km SE of La Ceiba (KU 101341,  $n = 1$ ); 1 to 3 km W of Trujillo (KU 101342–101348,  $n = 7$ ); Trujillo (KU 101349–50,  $n = 2$ ); about 12 km SSE of La Ceiba (KU 101351,  $n = 1$ ); along Rio Viejo (KU 200584,  $n = 1$ ). Islas de la Bahía: Isla de Roatán: Oak Ridge (KU 192621–192622,  $n = 2$ ); Sandy Bay (KU 203160–203162,  $n = 3$ ). Additional records for the Bay Islands are listed in Wilson and Hahn (1973).