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Oviductal egg development in the curly-tailed lizard *Leiocephalus carinatus aquarius*

Desarrollo de los huevos oviductales en el lagarto Leiocephalus carinatus aquarius

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INTRODUCTION

Leiocephalus carinatus (saw-scaled curly-tailed lizard, Fig.1) has thirteen currently recognized subspecies that occur throughout Cuban Archipelago, Cayman Islands, Swan Islands, Bahama Islands and introduced in Florida (Schwartz and Henderson 1991, Powell *et al*. 2016). It's a diurnal species that inhabits xerophilic vegetation, mogote complex, coastal and subcoastal microphyllous forest, semidesert thorny crubwoodland, associated with urban habitats (nearby to the coastal zones and rocky ground in the beach) and abandoned walls and concrete blocks (Henderson and Powell 2009).

Reproduction periods for *L. carinatus* are continuous and increasing in some months (Rodríguez Schettino, 1999). Sexual maturity in males reach between 78.6-81.2 mm SVL and females 70.2-73.0 mm SVL (Meshaka *et al*. 2004, 2006). Eggs dimensions and deposition were previously reported for some subspecies (Petzold, 1962; Petzold *et al*., 1970; Rodríguez Schettino, 1999), and only for two subspecies (*L. c. armouri*, *L. c. carinatus*) has been reported data related with ovarian follicles and oviductal eggs to determine the ovarian cycle and clutch characteristics (Meshaka *et al*., 2006; Oliva Martín 2012). Here we report a synchronized development of oviductal eggs in the curly-tailed lizard *Leiocephalus carinatus aquarius*.

METHODS

Study area and data collection

Field work was conducted in July 2009, I visit two localities where the species is very abundant around the coastal area between Santiago de Cuba (Juraguá: 19.936806 N, 75.670189 W) and Guantánamo (Tortuguilla: 19.975833 N, 74.938856 W) province, south-eastern Cuba. Lizards were captured by noose, checking their sex and only adult's females were transported to the Zoology Lab. (Biology Department, University of Oriente, Cuba). Specimens collected (Fig. 2A) were sacrificed inside the hermetic glass chambers under a chloroform atmosphere and preserved in 70% ethanol. An abdominal dissection was performance to extract the reproductive system and count the number of oviductal eggs (OE). Female snout-vent length (SVL) were measure with a digital vernier caliper (0.02 mm), also, oviductal

Figure 1: Adult female of *Leiocephalus carinatus aquarius* perching in a rock "diente de perro" in Juraguá, Santiago de Cuba province, Cuba.

Figura 1. *Hembra adulta de* Leiocephalus carinatus aquarius *perchando en una roca cársica en Juraguá, provincia Santiago de Cuba, Cuba.*

(Fig.2B) and shelled eggs (Fig.2C) were measured and weighed with a digital balance (Ohaus SP-123®, ± 0.003g).

RESULTS AND DISCUSSION

A total of 14 females (Juraguá: 8 and Tortuguilla: 6) were captured, measure and sacrificed under laboratory conditions. Females snout-vent length and oviductal eggs number were similar between localities (Fig. 3), Juraguá (SVL=120.6 ± 8.87 mm, OE: 6.83 ± 1.69) and Tortuguilla (SVL=123 ± 7.19 mm, OE: 6.34 ± 1.64). Only two females from Tortuguilla locality was observed without shelled eggs, the first female (SVL=124.8 mm) hold 4 ovarian follicles with ±6.4 mm in size. However, the second female (SVL=120.3 mm) had enlarged oviducts, suggesting recent deposition of eggs.

Was found a total of 95 eggs (62 oviductal and 33 shelled), dimensions for oviductal eggs were similar between localities Juraguá (Diameter: 13.6 ± 2.22 mm, Weight: 1.05 ± 0.47 g.; n=36) and Tortuguilla (Diameter: 13.4 ± 2.00 mm, Weight: 1.04 ± 0.44 g.; n=26). Shelled eggs also show a similar pattern between locality Juraguá (Length: 20.7 ± 2.87 mm, Width: 11.9 ± 2.12 mm; n=20) and Tortuguilla (Length: 22.2 ± 1.94 mm, Width: 12.9 ± 1.40 mm; n=13).

Breeding season can vary between *Leiocephalus* species across the Greater Antilles islands. Some species (i.e. *L. lunatus*, *L. macropus*, *L. raviceps*) start the reproduction process early during the first months of the year and has been observed with their ovarian follicles elongated. Moreover, the most common periods among species (i.e. *L. barahonensis*, *L. carinatus*, *L. cubensis*, *L. lunatus*, *L. macropus*, *L. personatus*, *L. psammodromus*, *L. schreibersii*, *L. semilineatus*, *L. stictigaster*) occurs between March-August, and only

Figure 2: (A) Female collected in Tortuguilla, Guantánamo province (B) Oviductal eggs under development. (C) Shelled eggs with maximum development ready for been oviposited.

Figura 2: *(A) Hembra recolectada en Tortuguilla, provincia Guantánamo; (B) Huevo oviductal en desarrollo; (C) Huevo con cascara en máximo desarrollo, listo para ser ovipositado.*

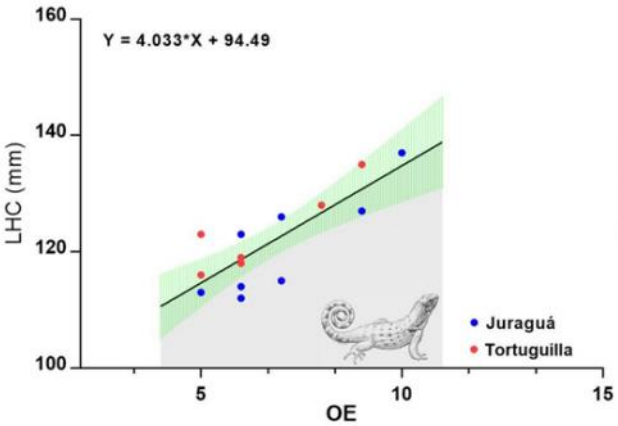

Figure 3: Relationship among LHC and number of oviductal eggs (OE) in adult female of *Leiocephalus carinatus aquarius* on south-eastern Cuba.

Figura 3: *Relación entre la LHC y el número de huevos oviductales (OE) en hembras adultas de* Leiocephalus carinatus aquarius *en el sudeste de Cuba.*

L. inaguae, *L. stictigaster*, *L. psammodromus* has been observed with extended reproductive activity (*reviewed in* Henderson and Powell 2009).

Our results are similar to those obtained in other *L. carinatus* populations (see Rodríguez Schettino, 1999; Henderson and Powell 2009). Gravid females of *L. c. carinatus* was observed between May-July with two reproductive peak on the same season, one starting on April and the second one at the end of September (Rodríguez Schettino 1999, Oliva Martín 2012). Shell eggs founded in gravid females of *L. c. aquarius* can potentially predict that were ready to be laid. Also, Schwartz (1959) reported for *L. c. labrossytus* a hatching period for mid-July, being the same period covered in our research for *L. c. aquarius* populations.

Clutch size varies between *Leiocephalus* species (Table 1), with maximum eggs deposition observed in *L. carinatus* which could explain a possible reproductive strategy (multiple clutches) which has facilitated his wide distribution.

Previous data related with ovarian cycle or ovarian follicles size has been reported only for five *Leiocephalus* species (*reviewed in* Henderson and Powell, 2009). The ovarian cycle (e.g. vitellogenesis process) in *L. c. armouri* (Meshaka *et al*., 2006) began in March with the first females producing shelled eggs two months later. Also, shelled eggs continued through August and egg deposition could extend into early September. The size distribution of ovarian follicles observed in one *L. c. aquarius* female (Tortuguilla locality) was lower than the other previous report for *L. c. armouri* (6.8–8.5 mm, Meshaka *et al*., *op.cit.*) but still in accordance with the seasonal increase in ovarian follicle size. Moreover, ovarian follicles size has been analyzed for three Cuban species (i.e. *L. cubensis*, *L. macropus*, *L. strictigaster*). Martinez Reyes (1994) reported for *L. cubensis* a developing ovules size between 3–7.6 mm, 1–4 ovarian follicles and ovulation start when follicles reach up to 11.5–13.5 mm in length. Also, Rodríguez Schettino (1999) observed in *L. macropus* ovarian follicles between 3.1–10.2 mm long. Martinez Reyes *et al*. (1990) observed for *L. strictigaster* 1–4 (±1.8) developing ovules per female with length mean ovules 1.1 mm (0.1–2.2 mm) in inactive females and 1.4 mm (0.2–2.7 mm) in active females. Oviductal eggs mean was 1.3 (egg per female) for the same *L. strictigaster* populations and eggs length was 13.9 mm (11.6–17.0 mm). Smith and Nickel (2002) observed in a *L. strictigaster* two yolked follicles and Nelson *et al*. (2001) reported a mean yolked ovarian follicle length 3.4 ± 2.57 mm for *L. semilineatus*.

Our observation related with shelled eggs dimensions between *L. c. aquarius* localities on southeastern Cuba suggest that both populations have

Table 1. Clutch size in *Leiocephalus* species from Greater Antilles islands. Species are listed in order to the clutch size. *L. c.* = *Leiocephalus carinatus*.

Tabla 1. *Tamaño de puesta en especies de* Leiocephalus *de las Antillas Mayores. Las especies aparecen en orden del tamaño de puesta. L.c.* = Leiocephalus carinatus.

Species	Location	Clutch size	Reference
L. altavelensis	Hispaniola	1	Henderson and Powell (2009)
L. c. labrossytus	Cuba	1	Schwartz (1959)
L. inaguae	Bahama Islands, Great Inagua Island	1	Henderson and Powell (2009)
L. lunatus	Hispaniola	± 1.60	Gifford and Powell (2007)
L. semilineatus	Hispaniola	± 1.78	Gifford and Powell (2007)
L. raviceps	Cuba	1-2	Smith and Nickel (2002)
L. stictigaster	Cuba	1-2	Smith and Nickel (2002)
L. psammodromus	Turks and Caicos Islands	1-3	Smith and Iverson (1993)
L. cubensis	Cuba	1-4	Martínez Reyes (1994), Rodríguez Schettino (1999)
L. personatus	Hispaniola	2	Gifford and Powell (2007)
L. barahonensis	Hispaniola	± 2.06	Gifford and Powell (2007)
L. schreibersii	Hispaniola	± 2.47	Gifford and Powell (2007)
L. macropus	Cuba	2-3	Henderson and Powell (2009), Alfonso *et al.* (2012)
L. carinatus	Cuba, Cayman Islands, Swan Islands, Bahamas	2-9	Henderson and Powell (2009)
L. melanochlorus	Hispaniola	4	Henderson and Powell (2009)
L. c. aquarius	Cuba	5-10	This study

similar conditions during the reproductive season. Meshaka *et al*. (2006) reported for *L. c. armouri* (southern Florida) a shelled eggs average of 3.9 mm, and oviductal eggs (shelled) of 19.1 × 10.8 mm. Also, Schwartz (1959) reported a leathery shelled egg for *L. c. labrossytus* (25.1 × 11.5 mm) and Rodríguez Schettino (1999) observed an oviductal egg (25.1 × 11.5 mm) in *L. c. carinatus*. For other Cuban species (*L. macropus*), Martínez Reyes in Rodríguez Schettino (1999) reported an average of oviductal eggs between 12.0–20.3 mm. Nevertheless, Nelson et al. (2001) reported for one Hispaniolan species (*L. semilineatus*) a mean length of 11.0 mm. Development eggs rate and dimensions between *Leiocephalus* species from Greater Antilles islands has been previously reported (Henderson and Powell, 2009 and references therein). Eggs dimensions can range between *Leiocephalus* species, but previously data (Henderson and Powell, op. cit.) suggest an average of 12.89 – 24.2 mm (length) and 7.0 – 14.2 mm (width).

Our results for oviductal egg development in the curly-tailed lizard *L. c. aquarius* for south-eastern Cuba suggest that multiple clutch production could contributed to a successful colonization after the breeding season. Also, single large clutch of large eggs and probably subsequent rapid growth of young to maturity can avoid predation rates that focused on juveniles on these coastal areas.

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