



# Maximum Clutch Size in the Cuban Pale-necked Galliwasp, *Diploglossus delasagra* (Squamata: Anguidae), with Comments on Behavior and Natural History

Tomás M. Rodríguez-Cabrera<sup>1</sup> and Yoan Oliver Cárdenas<sup>2</sup>

<sup>1</sup>Instituto de Ecología y Sistemática, La Habana 11900, Cuba, and Sociedad Cubana de Zoología, Cuba (tomasmichel.rodriguez@gmail.com [corresponding author])

<sup>2</sup>Calle Fidelidad, Guaracabulla, Placetas, Villa Clara 52800, Cuba (yoanoliverc@gmail.com)

Galliwasp in the genus *Diploglossus* (Anguidae) comprise 17 species, five of which occur in the West Indies (Henderson and Powell 2009; Uetz et al. 2021), including three Cuban endemics (Cuban Pale-necked Galliwasp, *D. delasagra*; Cuban Small-eared Galliwasp, *D. garridoii*; and Cuban Spotted Galliwasp, *D. nigropunctatus*) (Thomas and Hedges 1998). Very little is known about their natural history

and, in particular, the reproductive biology of these lizards, although a variety of reproductive modes, including both egg-laying and live-bearing species, have been reported in the family (Greer 1967; Greene et al. 2006).

In regard to the Cuban species of *Diploglossus*, clutch sizes of five and six eggs have been reported in *D. delasagra* (Barbour and Ramsden 1919; S.B. Hedges in Henderson



**Fig. 1.** A gravid female Cuban Pale-necked Galliwasp (*Diploglossus delasagra*) freshly captured near Guaracabulla, Placetas Municipality, Villa Clara Province, Cuba. Notice the fully-developed eggs visible through the skin. Photograph by Y. Oliver Cárdenas.



**Fig. 2.** A female Cuban Pale-necked Galliwasp (*Diploglossus delasagra*) in a glass terrarium after two eggs had been laid (top) and a shallow depression with seven eggs two days after oviposition (dry leaves and the lizard were momentarily removed to take the photograph) (bottom); one egg, apparently infertile, had been eaten the previous night. Photographs by Y. Oliver Cárdenas (top) and T.M. Rodríguez-Cabrera (bottom).

and Powell 2009; Parada Isada et al. 2010). Greer (1967) also reported one female *D. delasagra* containing two oviductal shelled eggs with small whitish embryos. Female *D. nigropunctatus* are known to lay as many as four eggs (P.J. Darlington in Barbour and Shreve 1937). Thomas and Hedges (1998) noted that the female holotype of *D. garri-doi* contained four shelled eggs. Martínez Reyes and Moreno García (2003) mentioned clutches of as many as nine eggs in Cuban species of *Diploglossus*.

In regard to parental care in Cuban species of *Diploglossus*, Barbour and Ramsden (1919) reported a “male” *Diploglossus* “under a stone near Belona, not far from Guantánamo” (which could have been either *D. delasagra* or *D. nigropunctatus*; Rodríguez Schettino et al. 2013) “lying over five eggs and when disturbed made no effort to escape...” However, Shine (1988) questioned the assumption that a male would be guarding a clutch of eggs. P.J. Darlington (in Barbour and Shreve 1937) mentioned that the female holotype of *D. nigropunctatus* was found “curled around and among four eggs under a chunk of rotten wood,” and was told by children who showed him the nest “that the lizard had been there for several days.” Parada Isada et al. (2010) documented egg/nest guarding by a captive female *D. delasagra*. Herein we report a maximum clutch size in *D. delasagra*, corroborate egg/nest-guarding behavior in this species in captivity, and comment on diet and activity period.

We maintained a female *D. delasagra* in a small (35 x 25 x 15 cm) glass aquarium kept at room temperature with a 3-cm-deep substrate of sandy soil and dry leaves. We monitored environmental variables with a Hobo® Data Logger. Air temperature and relative humidity within the terrarium during the incubation period was 29.2–31.9 °C and 77–86%, respectively. We provided Mealworm Beetle larvae (*Tenebrio molitor*) and Tropical House Crickets (*Gryllodes sigillatus*) weekly during the incubation period. Beginning on the third day after oviposition, we measured the eggs to the nearest 0.05 mm with a caliper. All means are presented ± one standard deviation (SD). Datum for all coordinates is WGS 84.

At noon on 25 June 2016, we collected a gravid female *D. delasagra* (SVL = 105 mm) (Fig. 1) crawling on leaf litter in secondary gallery forest along the Oropesa, a tributary of the Río Sagua la Chica, 5 km NW of Guaracabulla, Placetas Municipality, Villa Clara Province, Cuba (22.28789, -79.77864; elev. 150 m asl). Nearby vegetation was secondary grassland and disturbed “cuabal” (dry evergreen thorny thicket on serpentine-derived soil). During the first day in captivity, the lizard defecated the chitinous remains of two beetle larvae (Elateridae). At noon on 7 July (12 days after collection), it excavated a shallow nest about 130 mm diameter and started to lay eggs. Eight eggs had been laid by about 0600 h the next day, with intervals of about two hours between eggs (Fig. 2). One presumably infertile egg with a collapsed shell and no visible signs of an embryo was eaten

**Table 1.** Measurements of seven eggs laid by a female Cuban Pale-necked Galliwasp (*Diploglossus delasagra*) during the incubation period. All measurements are in millimeters. Dashes represent spoiled and/or eaten eggs.

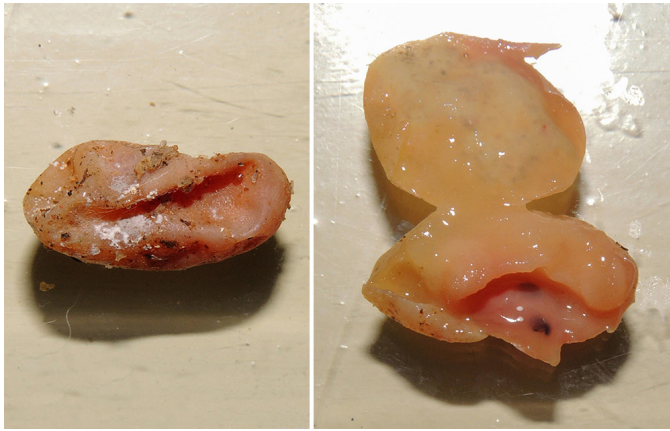
	Date		
	10 July	22 July	31 July
1	13.8 x 9.0	13.7 x 9.6	—
2	14.8 x 8.9	15.1 x 9.8	14.8 x 10.2
3	14.5 x 8.4	—	—
4	14.2 x 9.6	14.4 x 10.4	14.6 x 10.7
5	13.5 x 9.4	13.9 x 10.2	13.8 x 10.4
6	14.0 x 8.0	14.2 x 10.2	13.6 x 10.3
7	13.2 x 8.8	—	—

by the female during the night of 9 July. Mean egg size was  $14.0 \pm 0.56$  mm (613.2–14.8 mm) x  $8.9 \pm 0.55$  mm (8.0–9.6 mm) (Table 1). On 10 July, a second egg was eaten. On 13 July, the shell of a third egg had collapsed and a close examination revealed a dead embryo (Fig. 3). Developing embryos and blood vessels were clearly visible in the remaining five eggs (Fig. 4). Eggs increased slightly in size during the following weeks, particularly in width; some eggs became shorter and more rounded (Fig. 5; Table 1). A fourth egg, presumably spoiled, was eaten by the female on 28 July (21 days after oviposition).

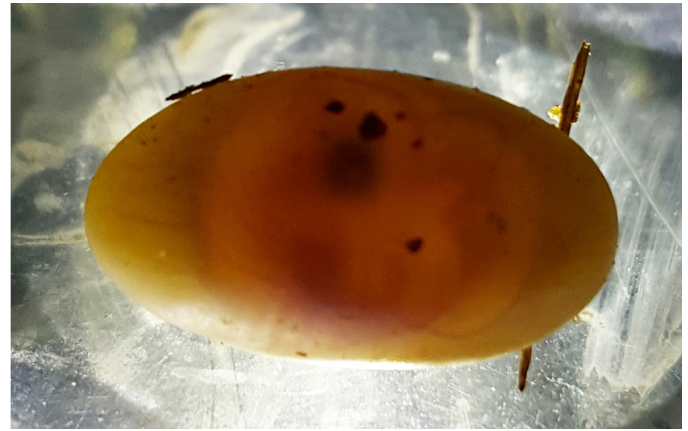
From the onset of oviposition, the female curled her body around the clutch and moved frequently through the eggs (Figs. 2 & 6), sometimes rotating the eggs with her snout (Fig. 6C). Although we regularly offered food, she consistently refused to eat. We never saw her leaving the clutch. Four eggs remained viable (blood vessels and embryos visible through the shell) for at least three weeks after oviposition (Fig. 5), but the embryos died of unknown causes before we could determine the full incubation period. On 15 August (38 days after oviposition), the female died of unknown causes (Fig. 7).

Martínez Reyes and Moreno García (2003) listed a maximum clutch size of nine eggs for Cuban species of *Diploglossus* but did not specify the species. Therefore, the clutch of eight eggs reported herein represents the maximum known clutch size for *D. delasagra*. Sizes of the eggs coincided with those (14.3 x 4.1 mm) recorded by Parada Isada et al. (2010) but were smaller than those listed in Barbour and Ramsden (1919) (17 x 9 mm). Also, our observations are the first evidence that the proportions of eggs of *D. delasagra* change during incubation.

The fact that the eggs contained well-developed embryos when they were laid suggests that *D. delasagra* retains eggs prior to oviposition (Greer 1967; Blackburn 1994). “Pattern 1” of Blackburn (1994) coincides with previous observations of the Puerto Rican Galliwasp (*D. pleii*), which led Greer



**Fig. 3.** An egg of a Cuban Pale-necked Galliwasp (*Diploglossus delasagra*) with a collapsed shell about a week after oviposition (left) and dissected to show the dead embryo (right). Photographs by T.M. Rodríguez-Cabrera.



**Fig. 4.** An egg of a Cuban Pale-necked Galliwasp (*Diploglossus delasagra*) soon after oviposition; note the developing embryo and blood vessels. Photograph by Y. Oliver Cárdenas.

(1967) to suspect the occurrence of both oviparous and viviparous reproductive modes in the species. Schmidt (1928) reported two female *D. pleii* containing, respectively, one and three “well-advanced embryos.” However, Greer (1967) had found 2–4 yolky oviductal eggs in four female *D. pleii*, each with thin transparent membranes and very small whitish embryos. However, the hypothesis of bimodal reproduction in *D. pleii* has not been conclusively tested since live birth has not been documented in this species. Several West Indian species in the genus *Celestus* and some continental anguids are known to be viviparous; however, to the best of our knowledge, this reproductive mode has not been demonstrated in any species of *Diploglossus* (Greene et al. 2006; Henderson and Powell 2009).

Gravid female *Diploglossus* have been found repeatedly in June (Barbour and Ramsden 1919; Thomas and Hedges 1998; Parada Isada et al. 2010; this paper), probably coinciding with the onset of the rainy season in Cuba.

Our observations also are consistent with previous reports regarding the existence of some degree of parental care, in this case egg/nest-guarding, in *D. delasagra* (Barbour and Ramsden 1919; P.J. Darlington in Barbour and Shreve 1937; Parada Isada et al. 2010). The female described above never reacted aggressively when disturbed and limited activity to the immediate vicinity of her eggs. Parada Isada et al. (2010) also noted that the female they described never displayed any aggressive behavior and remained indifferent to stimuli such as a camera flash and handling of the container and substrate. Savage (2002) noted similar observations of a female O’Shaughnessy’s Galliwasp (*D. bilobatus*) in Costa Rica. However, a female Rainbow Galliwasp (*D. monotropis*) attending a clutch in captivity assumed an open-mouthed threatening posture when disturbed (Solórzano 2001). Guarding behavior in *D. delasagra* and probably at least some other congeners (Greene et al. 2006) seems to be limited to protecting the eggs from predation by arthropods or small ver-



**Fig. 5.** Four eggs of a Cuban Pale-necked Galliwasp (*Diploglossus delasagra*) on 31 July 2016 (24 days after oviposition). Notice the more rounded shape. Photograph by T.M. Rodríguez-Cabrera.

tebrates, but apparently does not include deterrence of larger predators. Arachnids such as vinegaroons (Thelyphonida) are known to prey on lizard eggs in Cuba (Armas et al. 2009). Marques and Sazima (2003) reported a female and four young Banded Galliwasp (*D. fasciatus*) together on a newly fallen tree in Brazil, suggesting the possibility of post-hatching parental care at least in that species.

The female *D. delasagra* consumed several presumably infertile eggs during the incubation period. Greene et al. (2006) reported hygienic removal of spoiled eggs in continental anguids. Post-parturient hygienic activities such as egg consumption have been treated as an ecological advantage of parental care, as it likely reduces the possibilities of predator detection and microbial contamination, and hence enhances survivorship of descendants (Greene et al. 2006). Also, egg consumption might help the female to recover some of the energy invested during reproduction (e.g., Polis 1981).

The two elaterid larvae defecated by the female is the first evidence of the diet of *D. delasagra* or any other Cuban congener in nature. An examination of stomach contents of another individual collected later at the same locality as the female above revealed another elaterid larva (YOC, pers. obs.), suggesting that these insect larvae might be frequent prey for this species in this area. Martínez Reyes and Moreno



**Fig. 6.** A female Cuban Pale-necked Galliwasp (*Diploglossus delasagra*) curled around her clutch of eggs at various times during the incubation period. Photographs by T.M. Rodríguez-Cabrera.



**Fig. 7.** A female Cuban Pale-necked Galliwasp (*Diploglossus delasagra*) shortly after death. Photographs by T.M. Rodríguez-Cabrera.

García (2003) noted that Cuban species of *Diploglossus* feed on insects and other invertebrates of the soil macrofauna, but offered no details. The Puerto Rican Galliwasp (*D. pleii*) is known to consume a variety of arthropods (insects, centipedes, millipedes) and mollusks (slugs) (Thomas and Gaa Kessler 1996). Parada Isada et al. (2010) offered spiders, ants, termites, and small mollusks to a captive female *D. delasagra* attending an egg clutch, but observed no feeding behavior. Apparently, feeding is incompatible with parental care in most situations, but in prey-rich environments in captivity some female anguils have been observed to continue eating during clutch attendance (Greene et al. 2006).

Our observations in the wild contradict Martínez Reyes and Moreno García (2003) and Parada Isada et al. (2010), who indicated that *D. delasagra* is nocturnally active. When first found, the female studied herein was active at noon. Also, around noon on 24 July 2006, the senior author observed another large adult, presumably of this species (it was not collected), actively crawling on leaf litter in a patch of semi-deciduous forest between Manguito and Rejondón, Báguanos Municipality, Holguín Province (20.74625, -76.06386; elev.

230 m asl). Other Cuban Galliwasp have been observed active by day near la Gran Piedra, Santiago de Cuba Province, some of them even crossing roads (R. Teruel, pers. comm., 19.x.2021).

The Cuban Pale-necked Galliwasp is widely distributed at elevations from sea level to 1,214 m (Rodríguez Schettino et al. 2010, 2013). However, due to the secretive habits of this elusive lizard, data on its biology and natural history are scarce (Henderson and Powell 2009; Parada Isada et al. 2010). Because long-term ecological studies involving lizards of the genus *Diploglossus* are almost impossible due to the difficulty of encountering an adequate number of individuals, the most reasonable way to compile baseline natural-history information seems to be by examining in detail every individual encountered until the accumulated data allow generalizations to be made.

#### Acknowledgements

We thank Javier Torres for his review of an early draft of the manuscript. We also thank Rolando Teruel for sharing unpublished data and Carlos A. Mancina for providing the Hobo® Data Logger.

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