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Short Communication

Notes on the reproduction and thermal biology of *Porthidium ophryomegas* (Serpentes: Viperidae)

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Palabras clave: Honduras, Sabanagrande, Tamagás negro, termorregulación, viviparidad.

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To maintain a preferred body temperature, ectothermic vertebrates have unique anatomical and physiological characteristics, in addition to environmental requirements (Raske *et al.* 2012). For example, in live-bearing reptiles, the impact of the thermal environment on embryos can be buffered by the thermoregulatory behavior of the gravid female; however, the optimal temperatures for various physiological functions can vary widely (Dawson 1975, Beuchat 1988, Garrick 2008). In addition, the body and environmental temperatures differ, and this difference may affect the behavior of the snakes, as well as their physiology and ecological functionality (Arnold and Bennett 1984, Huey and Kingsolver 1989, Schiereck 1989).

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The Slender Hognose Viper, *Porthidium ophryomegas* (Bocourt, 1868), occurs at low and moderate elevations on the Pacific slope of Central America, from southwestern Guatemala to west-central Costa Rica, and on the Atlantic slope in the interior valleys of Guatemala, as well as in several Honduran coastal localities. Throughout much of Honduras, this species occurs mostly in disjunct populations in open habitats (McCranie 2011). McCranie (2011) reported that *P. ophryomegas* occurs in Lowland Dry Forests, Lowland Arid Forests, Premontane Moist Forests, Premontane Dry Forest, and peripherally in Lowlands Moist Forests in Honduras.

Although sexual dichromatic variation has been reported for this species in Guatemala (Lawson 1997) and Costa Rica (Solórzano *et al.* 1988), based on examination of alcohol-preserved specimens, McCranie (2011) stated that sexual dichromatic variation does not seem to occur in *Porthidium ophryomegas* of Gracias a Dios in northeastern Honduras. Little information is available on the ecology and behavior of this species in the wild or in captivity; for example, fluctuations in the body temperature of gravid females has not been studied. Here we describe body temperatures of a gravid female maintained in captivity, and provide some data on habitat, reproductive biology, and sizes of newborn *P. ophryomegas.*

A male and a female *Porthidium ophryomegas* were rescued from two private properties located in Sabanagrande, Departament of Francisco Morazán, central Honduras. The female was found on 08 April 2017 at Los Nanzales (13°42'12'' N, 87°14'17'' W, WGS84 datum; 425 m a.s.l.), and the male on 14 April 2017 at Los Portillos (13°43'49'' N, 87°14'32'' W, WGS84 datum; 404 m a.s.l.). The day that the snakes were captured, they were taken to the Colección Privada y Centro de Rescate de Fauna Silvestre El Ocotal. The center is authorized and registered by the wildlife department of the ICF (Instituto Nacional de Conservación y Desarrollo Forestal, Áreas Protegidas y Vida Silvestre) under resolution GG-MP-066-2001. We collected external morphometric data according to McCranie (2011). The male [snout–vent length (SVL) = 54.6 cm, tail length (TL) = 7.1 cm, total length (ToL) = 61.7 cm] was smaller than the female (SVL = 62.2 cm, LT = 7.6 cm; ToL = 69.8 cm), and when they arrived at El Ocotal, the female was not gravid. The snakes were encountered in a crop field of *Zea mays* (Poaceae) within a Tropical Dry Forest based on the life zones of Holdridge (1987) composed of pines (*Pinus oocarpa* and *P. maximinoi*) and oaks (*Quercus oleoides*). In Honduras, *P. ophryomegas* occurs at elevations between sea level and 1400 m a.s.l., and the distribution of the species includes the department of Francisco Morazán (McCranie 2011). The Sabanagrande localities are new for this species; however, it has been recorded from cornfields in the department of Santa Bárbara in western Honduras (Espinal *et al*. 2014).

The snakes were housed in a terrarium that was 51 cm high × 76 cm wide × 71 cm long, and contained sand, rocks, and small logs to simulate their natural habitat. The animals were maintained under a 12L/12D photoperiod (Lawson 1997). One 100W reflector bulb was placed 45 cm above the substrate to provide heat (Carretero 2012). The snakes were fed with white mice (*Mus musculus*) every seven days. Fresh water was provided every three days in a 500mL dish that was inserted in the sand. Approximately 1 yr later, we observed the male courting the female on three occasions. As described by Lawson (1997), the male pushed the posterior part of the female's head while attempting to hold her, particularly along her sides.

We adopted the methods of Hare *et al.* (2007) and Carretero (2012) to register body temperatures of the snakes with a thermometer laser (FLUKE 62 MAX with ±1.5°C of reading precision). We pointed the laser at the center of the midbody of the snake, in line with the body axis, at a distance of approximately 25 cm (based on the specifications of the thermometer, this distance measures an area of infrared to 1 cm^2). The temperature reading was stabilized at 10–15 s. We collected the body temperatures at 08:00 h and 17:00 h from May–July 2018 for a period of 35 days before and after parturition (excluding data from 25 June 2018 from statistical analysis). The terrarium temperature was recorded with a standard thermometer that was placed in the left corner inside of terrarium when the body temperatures of the snakes were taken.

Considering the normality of the measurements, we analyzed and compared the mean prepartum and postpartum temperatures of the female with a two-way analysis of variance (ANOVA). One-way ANOVAS were performed to calculate the mean external morphometric measurements of the neonates and were compared to those of Lawson (1997). We used the statistical software R 3.4.2 (R Core Team 2015) for all the analyses.

Our results are based on the analysis of 426 temperature measurements comprising female (71 prepartum temperatures and 71 postpartum temperatures) and male body temperatures, and the terrarium temperatures. The prepartum temperature (29.10–32.30°C) of the female was lower (ANOVA $t_{1,69} = -12.43$, $p < 0.05$) than the postpartum temperature (31.00–35.20°C) (Figure 1), which is consistent with the results of Sanders and Jacob (1981) and Gao *et al*. (2010), who reported that gravid viviparous snakes may have lower body temperatures than non-gravid females.

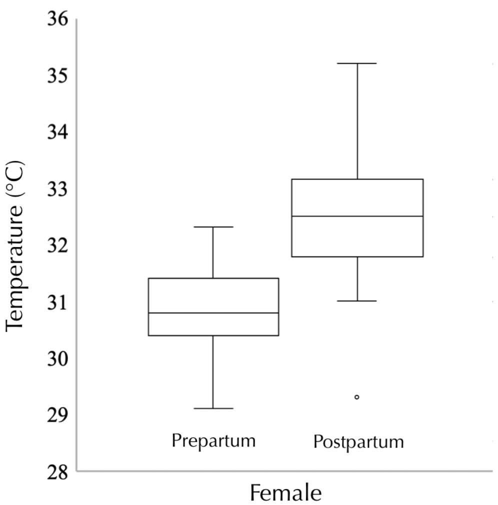

Figure 1. Box plots of the mean prepartum (30.80°C) and postpartum (32.50°C) temperatures of female *Porthidium ophryomegas.*

Birthing (see https://www.dropbox.com/s/7cm7ojuscvxkf9l/birthday.mov?dl=0) occurred on 25 June 2018 from 22:49 h (first newborn) to 23:49 h (last newborn), during which time the temperature of the female was 32.20–32.40ºC; the temperature of the male was 31.70–33.10ºC, and the temperature of the terrarium was 31.30–32.80°C. In total, 14 snakes were born, and at birth all had the same temperature as the female. See Table 1 for comparison of the measurements and body mass of the newborns.

The newborn *Porthidium ophryomegas* did not accept mice until the third week; we did not observe any cannibalism. We offered them Yellow-headed Geckos (*Gonatodes albogularis*), which were not accepted. Juvenile *Porthidium nasutum* have been reported to feed on earthworms, frogs, lizards of the genus *Anolis*, mice, as well as members of their own species (*Álvarez* del Toro 1973, Picado 1976, Porras *et al*. 1981).

Lawson (1997) reported that a captive female *Porthidium ophryomegas* from Guatemala gave birth to 19 live neonates in April. Solórzano (2004) indicated that female snakes in Costa Rica give birth to at least 15 newborn from May–August. McCranie (2011) collected three gravid females from northeastern Honduras in July, but herein we report for the first time the number of neonates and the month in which they were born (June), as well as the first documented records of body temperatures for *P. ophryomegas* during the reproductive season. The Honduran neonates are larger than those reported by Lawson (1997) from Guatemala. The link, if any, between variation in offspring size and offspring fitness in other viviparous snakes with regard to the thermoregulatory behavior of gravid females is unknown (Gao *et al*. 2010).

The body temperatures of gravid *Porthidium ophryomegas* are lower than postpartum temperatures. However, individual body temperatures of thermoregulating reptiles may vary between day and night and seasonally, as well as being affected by snake behavior (Webb and Shine 1998, Seebacher and Franklin 2005).

One reason that temperatures may differ in females is that the higher body temperature of gravid females allows the embryos to adapt more easily to the ambient external temperature. Gao *et al*. (2010) suggested that the thermoregulatory behavior of gravid snakes may be associated with the thermal optimality that they will provide to the embryos. For example, prolonged gestation periods at low body temperatures increases

Table 1. Snout–vent length (SVL), tail length (TL), total length (ToL), body mass and observations of the 14 neonates of *Porthidium ophryomegas* born on 25 June 2018 compared with the data of Lawson (1997). The measurements of this study were taken 2 days and Lawson's data were taken 1 day after birth.

Individuals	SVL (mm)		TL (mm)		ToL (mm)		Body mass (g)	
	Lawson (1997)	This study	Lawson (1997)	This study	Lawson (1997)	This study	Lawson (1997)	This study
1	15.0	23.2	2.4	4.1	17.4	27.3	3.15	5.0
2	15.7	21.5	2.4	3.0	18.1	24.5	4.14	5.0
3	16.8	22.6	2.2	3.2	19.0	25.8	4.31	5.5
4	16.0	22.4	2.1	3.5	18.1	25.9	3.33	5.5
5	16.7	20.5	2.2	2.6	18.9	23.1	3.89	4.5
6	15.3	21.8	2.3	2.6	17.6	24.4	3.4	5.0
7	16.4	21.4	2.0	2.8	18.4	24.2	4.22	5.0
8	16.5	21.9	2.2	2.8	18.7	24.7	4.01	6.0
9	17.1	22.4	2.2	3.2	19.3	25.6	4.43	5.5
10	16.5	23.9	2.5	3.8	19.0	27.7	3.94	5.0
11	15.5	22.6	2.2	3.0	17.7	25.6	3.34	5.5
12	17.4	21.6	2.3	2.9	19.7	24.5	4.45	5.0
13	16.0	21.6	2.3	3.1	18.3	24.7	3.79	5.5
14	16.4	22.0	2.2	2.9	18.6	24.9	3.85	5.0
15	17.2	-	2.4	-	19.6	-	4.36	-
Mean ± SD	**16.3 ± 0.71**	**22.1 ± 0.84**	**2.26 ± 0.13**	**3.11 ± 0.43**	**18.6 ± 0.70**	**25.21 ± 1.22**	**3.91 ± 0.43**	**5.21 ± 0.38**

reproductive costs. Furthermore, females of viviparous snakes may change their thermal preference when they are gravid (Li *et al*. 2009, Gao *et al*. 2010), and they may increase the thermoregulatory behavior for the efficiency of the embryogenesis to provide an optimum thermal environment to the embryos (Sanders and Jacob 1981, Brown and Weatherhead 2000). We recommend continued monitoring of the temperature of gravid female Slender Hognose Vipers during a longer time span and in different seasons, both in captivity and in nature, to confirm that nongravid females have lower temperatures.

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