FIRST RECORDS OF REPRODUCTIVE CHARACTERISTICS FOR THE PATAGONIAN LIZARD, *LIOLAEMUS XANTHOVIRIDIS* (IGUANIA: LIOLAEMIDAE)

PRIMEROS REGISTROS DE CARACTERÍSTICAS REPRODUCTIVAS DE LA LAGARTIJA PATAGÓNICA, *LIONALEMUS XANTHOVIRIDIS* (IGUANIA: LIOLAEMIDAE)

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Resumen.— *Liolaemus* presenta es de las mayores radiaciones de lagartijas con más de 289 especies descritas. Se sabe poco sobre las características reproductivas y la historia natural de la mayoría de estas especies. Dentro del grupo *L. fitzingerii*, encontramos la especie *L. xanthoviridis*, la cual se distribuye en un área alrededor de la meseta de Montemayor en la costa atlántica oriental de la provincia de Chubut, Argentina. Aquí, presentamos los primeros datos sobre algunos rasgos reproductivos de esta especie. *L. xanthoviridis* es una especie ovípara, que presentó una reproducción estacional (primavera - verano) y el tamaño de la camada se asoció positivamente con el tamaño de la hembra, en promedio el tamaño de puesta fue de ocho huevos.

Palabras claves.— Lagartija de Rawson, Patagonia, cópula, tamaño de puesta.

Abstract.— *Liolaemus* is one of the largest radiations of lizards with more than 289 species described. Little is known about the reproductive characteristics and natural history of the majority of these species. Within the *L. fitzingerii* group, we find *L. xanthoviridis* is distributed in an area around the Montemayor Plateau in the eastern Atlantic coast of Chubut Province, Argentina. We present the first data on some reproductive traits of this species. *Liolaemus xanthoviridis* is an oviparous species, that presented a seasonal reproduction (spring - summer) and the clutch size was positively associated with female size, in average the clutch size was eight eggs.

Key words.— Rawson's lizard, Patagonia, mating, clutch size.

Liolaemus is one of the largest radiation of neotropical lizards with more than 289 species described (Uetz, 2021) along a variety of habitats found mainly along Andean and Patagonian aridlands. Reproductive characteristics and natural history are known only for a relatively small number of species, and in some clades, information is only anecdotical, following observations included in the original description or some general mentions in publications focused in other topics. Within the *L. fitzingerii* group (*sensu* Avila et al., 2006; partially equivalent to "*fitzingerii* clade" to Abdala, 2007) no contributions have been made on almost any aspect of its ecology, biology or natural history. This lizard clade occurs along Patagonian and southern Monte habitats between Colorado and Santa Cruz river basins, along Neuquén, Río Negro, Chubut and Santa Cruz provinces, Argentina (Avila et al., 2006; Abdala, 2007), and include two species complex: *fitzingerii* and *melanops* (Avila et al., 2006). Within the *fitzingerii* complex five species have been described: *L. fitzingerii*, *L. xanthoviridis*, *L. chehuachekenk*, *L. shehuen and L. camarones*, but despite their size and commonness, only anecdotical data about the natural history of the species have been published.

Liolaemus xanthoviridis, Cei & Scolaro 1980, is distributed in an area of approximately 50 x 200 km located around the Montemayor Plateau (Rawson, Gaiman and Florentino Ameghino Departaments) in the eastern Atlantic coast of Chubut Province, Argentina. This species lives mainly around clusters of spiny trees or bushes on a substrate of loose or sandy soils. They are sexually dimorphic in size with males larger and more robust than females (mean snout vent length ± standard deviation = 82.34 ± 7.75 mm vs. 78.39 ± 6.48 mm; Escudero, 2016). In both

Figura 1. Cópula entre hembra 11 y macho 17 (mostacilla amarilla y naranja en la base de la cola) de *Liolaemus xanthoviridis*, en Bahía Isla Escondida, Chubut, Argentina.

Figure 1. Mating between female 11 and male 17 (yellow and orange beads in the tail base) of *Liolaemus xanthoviridis*, in Bahía Isla Escondida, Chubut, Argentina .

sexes, individuals show a noticeable polymorphism in the dorsal coloration (yellow-green to orange) and in the distribution of the ventral melanism (Escudero, 2016; Escudero et al., 2016). While there is some knowledge of their biology and ecology in its original description by Cei & Scolaro (1980) and recently by Escudero et al. (2016; 2017; 2020), there is no information about its reproductive biology. We present here the first data on some reproductive traits of *L. xanthoviridis*, registered under natural and laboratory condition, obtained within the framework of an ecological study of the species.

A *L. xanthoviridis* population located in Isla Escondida Bay was studied for five years. The study site was located in an area of coastal dunes between the gravel shore and a temporary river, approximately 50 km south of Rawson city (Chubut, Argentina). The study of reproductive characteristics was conducted during two activity seasons (October 2013 to mid-March 2014 and October 2014 to mid-March 2015) using capture-mark-recapture sampling system. In the study area a grid of 100 x 100 m was demarcated and every time an individual was captured (using a forked stick) we recorded its sex, snout-vent length (SVL, with a Mitutoyo® caliper to the nearest 0.01 mm) and mass (with a Pesola® scale to the nearest 0.1 gr). Each lizard was marked individually with beads (see Fig.1) and toe clipping, which was processed quickly (< 5 min) at the capture site, and released immediately. All the results reported in this study were obtained from live specimens, by observing their behaviors in the field, by the successive marking and recapturing of the animals and by observations in laboratory. The gravid females were assessed by ventral palpation to detect enlarged ovarian follicles or

Tabla 1. Medidas morfométricas de las hembras preñadas y de la puesta de *Liolaemus xanthoviridis* de Bahía isla Escondida, Chubut, Argentina.

Table 1. Morphometric measurements of gravid females and the clutches of *Liolaemus xanthoviridis* from Bahia Isla Escondida, Chubut Argentina.

	Mean ± SD	Min.	Max.	n
Female SVL (mm)	80.42 ± 5.60	71.00	89.00	12
Female body mass (g)	17.56 ± 3.86	11.00	23.50	12
Female body mass post oviposition (g)	10.90 ± 2.55	7.00	15.00	12
Clutch size	8.00 ± 1.70	5.00	11.00	12
Egg volume (mm3)	799.92 ± 1.68	349.78	1113.25	12
Egg length (mm)	15.92 ± 1.89	12.21	18.40	12
Egg width (mm)	9.66 ± 1.01	7.40	10.75	12

oviductal eggs (Rúa & Galán, 2003), and the period of oviposition was estimated through observations in laboratory and field observations of females with lateral skin folds in successive recaptures, which is indicative of a recent egg-laying event (Rúa & Galán, 2003).

In addition, gravid females were collected in areas near the study grid, which were transported to the laboratory and housed in individual terrariums, measuring 120 × 40 × 40 cm. Lizards were maintained on a photoperiod 10Light: 14Darkness (similar to the conditions of their natural environment) and heat was supplied with an infrared lamp of 150 Watt. Lizards were fed with live insects (*Tenebrio molitor* larvae) and fruits of "yaoyín" (*Lycium chilense*); water was supplied *ad libitum*. The terrarium substrate was sand, similar to their natural environment, creating a suitable environment for laying eggs. Snout-vent length and body mass were recorded for each female and with these data the body condition was calculated like scaled mass index method, proposed by Peig and Green (2009, 2010), which standardizes body mass at a fixed value of a linear body measurement based on the scaling relationship between mass and length, applying the following equation: $\widehat{M}i = \mathrm{Mi}[\mathrm{L0/Li}]^{\mathrm{bSMA}}$, where Mi and Li are the body mass and linear body measurement of individual i, respectively; L0 is the arithmetic mean of a linear body measurement of the species studied; bSMA is the scaling exponent estimated by standardized major axis regression between M on L. Ventral palpation on each female was performed periodically in order to detect the presence of eggs in oviducts. Immediately after laying, each female was weighted. Number of eggs as well as their lengths and widths were also recorded. Egg volume was estimated as $V = 4/3\pi\, a2b$, where a =½ width and b =½ length. Egg characteristics were in all cases determined within 8 hr of laying. We perform Simple Linear Regressions to analyze the relationship between the clutch size with the SVL, mass and body condition of the female. Similarly, the relationship between egg volume and SVL, mass and condition of the female was analyzed. The analyses were carried out in the software R 4.1.1.

This research was conducted with the approval of the Dirección de Fauna y Flora Silvestre de la Provincia de Chubut (collecting permits #37/2012 [Exp.-02304/12]-MP and #17/2015 [Exp. 0425/15]-MDTySP, issued by Law XI (#10), Dec. Regl. 868/90 y Disp. #48/08, DFyFS-SSRN-MIAyG]). Animal care procedures follow the guidelines approved by COSELABI-CENPAT and CONICET under the Argentinean National Law #14346. To our knowledge, our study followed the advices presented in the document ASIH-HL-SSAR (Beaupre, 2004).

During the first activity season (austral spring), the first copulation was recorded in the field on October 18, 2013, at 15:24 and lasted three minutes. During copulation the male held the female by hugging her side and biting her neck (Fig. 1), after the copulation the male released the female and she left. We were unable to record pre-mating behavior.

Between October and December 2013, a total of 23 females were captured in the study grid. Eight females showed no signs of being gravid and 15 appeared to be gravid. Of these 15 females, 11 showed signs of oviposition (lateral folds) and a sharp weight loss was recorded between mid to late December 2013, the remaining four gravid females were not recaptured in successive samplings to confirm the oviposition. On the other hand, in areas near the study grid, in November 2013, five females were captured, marked by toe clipping, and transported to the laboratory where they were kept in individual terrariums. All females laid their eggs between the 11th and 15th of November, the smallest female measuring 77mm SVL.

Between January to March 2014, another 21 females were captured in the study grid, but none showed signs to be gravid. At the same time, six females were caught (in areas near the grid), marked and transported to the laboratory where they were kept in individual terrariums; none showed signs to be gravid or egg laying. By mid-January first newborns of the season were observed in the field.

In the second season of activity, between October and December 2014, we captured 31 females in the study grid, of which 24 were pregnant, as eggs were evident. Moreover, in October 2014, 10 females were caught (in areas near the grid), marked and transported to the laboratory where they were kept in individual terrariums. Seven females laid their eggs between the 7 and 25 de November 2014, the smallest female measuring 71mm SVL. The remaining females did not lay eggs. Between January to March 2015, 26 females were captured (in the study grid) but none showed signs to be gravid.

Table 1 summarizes morphometric measurements of gravid females (kept in the laboratory) and their clutches. A significant and positive relationship between clutch size, SVL and mass of the female was found, but not with the condition of the female (F-statistic(clutch size, SVL): 6.20, p-value= 0.03, DF= 10, R^2= 0.32; F-statistic(clutch size, mass)= 11.10, p-value> 0.01, DF= 10, R^2= 0.48 and F-statistic(clutch size, condition of the female)= 1.95, p-value= 0.19, DF= 10, R^2= 0.08 respectively). We found no relationship between the volume of the eggs and the same variables (F-statistic(volume of the eggs, SVL)= 0.02, p-value= 0.89, DF= 10, R^2= 0.00; F-statistic(volume of the eggs, mass)= 0.375, p-value= 0.55, DF= 10, R^2= 0.00 and F-statistic(volume of the eggs, condition of the female)= 2.26, p-value= 0.16, DF=: 10, R^2= 0.10 respectively).

From these data we can infer that the period of activity of *Liolaemus xanthoviridis* could be divided into two, depending on the reproductive cycle. Between October and December, mating and oviposition occur, while between January and March, the emergence of the first newborns mark the moment when hatching occurs. This type of seasonal reproduction (Spring-Summer) has been reported for other oviparous species of *Liolaemus* at low altitude environments such as *L. kuhlmani* (Ortiz & Zunino, 1976), *L. nigromaculatus, L. zapallarensis* (Ortiz, 1981), *L. wiegmannii* (Ramírez-Pinilla, 1991), *L. koslowskyi* (Martori & Aun, 2010), *L. multimaculatus* (Kacoliris et al., 2012), and *L. occipitalis* (Verrastro & Rauber, 2013).

Interestingly, this species has the largest clutch size recorded for the gender in Argentina; probably related to the fact that this is one of the largest species of *Liolaemus*, given that we found a positive relationship between clutch size, SVL and mass of the female, this positive correlation has been reported for others *Liolaemus* lizards (Martori & Aun, 1997; Pincheira-Donoso & Tregenza, 2011; Ramírez-Pinilla 1994; Rocha, 1992; Troncoso-Palacios & Labra, 2017). Although detailed studies are needed to elucidate the reproductive cycle of this species, the data generated from this study allow us to establish the first bases on the subject.

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