

Reproduction of the Bromeliad Arboreal Alligator Lizard, *Abronia taeniata* (Squamata: Anguidae), in a temperate environment of central Mexico

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Manuscript received: 27 May 2019

Accepted: 25 August 2019 by EDGAR LEHR

Abstract. We analysed size (snout–vent length, SVL), body mass, reproductive cycles, and reproductive characteristics (litter size) of a population of the viviparous lizard *Abronia taeniata* in the central part of the Sierra Madre Oriental in Mexico. Sizes and weights were similar between sexes. The males reach sexual maturity (SVL = 74.6 mm) at a smaller size than females (SVL = 81.7 mm). In males, testicular volumes varied with the month; it was small during November, and began to increase in volume in December, continued to increase in January, February, and March, to a plateau from April to August, peaking in September and October, and decreasing in November. The increase in testicular volume is correlated with precipitation, but not with temperature or photoperiod. In females, early vitellogenic follicles were found in August and September, and embryonic development occurred from November to June, with a period of high embryonic development from January to June, i.e., during the birthing period. Mean monthly gonad volume was positively correlated with precipitation, but not with temperature or photoperiod. Mean litter size was 6.4 ± 0.31 , which was not correlated with female SVL, but was correlated with female body mass. Mean SVL of neonates was 54.0 ± 3.7 mm. *Abronia taeniata* showed the typical reproductive pattern of viviparous species inhabiting temperate environments at high altitudes, with asynchronous gonad activity between males and females, but with a longer period of reproductive activity in both sexes with respect to other viviparous species from high altitudes and related species. This study is the first to describe the reproductive cycle of *Abronia taeniata*, as well as the reproductive characteristics of minimum size at sexual maturity and litter size. Studies that analyse aspects of diet, sexual dimorphism, behaviour, and demography are necessary to increase our knowledge of this endemic species, in order to design informed strategies for the maintenance and conservation of its populations.

Key words. Anguidae, litter size, reproductive cycle, viviparous lizard.

Introduction

The reproductive aspects, such as reproductive cycles, litter/clutch size, embryonic development, and birthing period of many lizard species have been summarized in the pioneering study by TINKLE et al. (1970). Later, these reproductive characteristics were called life history traits, and they have since been considered adaptations to the environments in which populations of species occur (TINKLE 1969a, b). Based on these and other studies, general reviews of life history patterns of lizard species were conducted, primarily considering single populations of the species examined (FITCH 1970, TINKLE et al. 1970). These studies

identified six general patterns, including (1) age and snout–vent length (SVL) at sexual maturity, which varies among lizard species, (2) most lizard species reach sexual maturity at one year of age or less; these are smaller in SVL and have smaller clutch/litter sizes than species with delayed maturity, (3) lizards producing multiple clutches in one reproductive season tend to have smaller SVLs and smaller clutches per event, distributing their reproductive effort over time and space as a survival strategy, (4) numbers of clutches per season vary geographically in lizard species with multiple clutches, which is a response to different environmental conditions; for example quantity and quality of food resources, (5) live-bearing lizards produce only one litter per

reproductive period, and (6) female SVL and clutch/litter are positively correlated in most oviparous and viviparous species, except in species with fixed clutch size (FITCH 1970, TINKLE et al. 1970, VITT 1986, RAMÍREZ-BAUTISTA & VITT 1997, RAMÍREZ-SANDOVAL et al. 2006). Subsequently, these general patterns have been complemented in other studies on reproduction with data from oviparous (MANRIQUEZ-MORÁN et al. 2013, VALENCIA-LIMÓN et al. 2014, RAMÍREZ-BAUTISTA et al. 2016) and viviparous species (GUILLETTE & CASAS-ANDREU 1980, GUILLETTE & BEARCE 1986, MARTÍNEZ-MÉNDEZ & MÉNDEZ-DE LA CRUZ 2007, RAMÍREZ-BAUTISTA et al. 2008a, b, 2016).

Reproductive patterns for many lizard species found after the studies by TINKLE et al. (1970) and FITCH (1970) are important for adding to our knowledge about the natural history of this group of vertebrates (BALLINGER 1979, BALLINGER et al. 1996, GUILLETTE & CASAS-ANDREU 1980, FERIA-ORTÍZ et al. 2001, RAMÍREZ-BAUTISTA et al. 2012, 2015, 2016, 2017). These findings have included, for example, synchronous reproduction between males and females of *Sceloporus grammicus* WIEGMANN, 1828 (RAMÍREZ-BAUTISTA et al. 2012, LOZANO et al. 2014, 2015), variation in sexual size dimorphism (SSD) within and between populations of single oviparous species (RAMÍREZ-BAUTISTA et al. 2015, 2016), variation in life history evolution between populations of a single species (DU et al. 2005, WANG et al. 2011, HORVÁTHOVÁ et al. 2013, PÉREZ-MENDOZA et al. 2014, RAMÍREZ-BAUTISTA et al. 2017), growth rate (ANDREWS & NICHOLS 1990, HERNÁNDEZ-SALINAS et al. 2019), and phylogenetic and environmental effects (DUNHAM & MILES 1985, RAMÍREZ-BAUTISTA et al. 2017).

Variations in reproductive cycles between oviparous (VITT 1986, BENABIB 1994, MANRIQUEZ-MORÁN et al. 2013, VALENCIA-LIMÓN et al. 2014, RAMÍREZ-BAUTISTA & VITT 1997) and viviparous species (GUILLETTE & BEARCE 1986, FERIA-ORTÍZ et al. 2001, RAMÍREZ-BAUTISTA & PAVÓN 2009) have been well documented. In most oviparous species from tropical and temperate environments, males and females are synchronized in their reproductive activity, even though they may have seasonal or unseasonal reproduction, whereas viviparous species from temperate environments (high latitudes) and high altitudes (mountains) appear to be seasonal by default (RAMÍREZ-BAUTISTA et al. 2014, 2017). In some populations of the viviparous lizard *S. grammicus* in central Mexico, however, two patterns have been found (RAMÍREZ-BAUTISTA et al. 2012, LOZANO et al. 2014, 2015). Populations from high altitudes (mountains) show a typical autumnal reproductive mode, in which males become reproductively active before females. While courtship and copulation obviously necessitates that males and females are responsive to these at the same time, the female will fertilize her eggs only later, keeping the sperm viable (in pouches called spermatic storage tubules) until she has mature ovules (GUILLETTE 1981, GUILLETTE & CASAS-ANDREU 1980). Examples of this pattern are the species *S. grammicus* (ORTEGA & BARBAULT 1984, GUILLETTE & BEARCE 1986, JIMÉNEZ-CRUZ et al. 2005, HERNÁNDEZ-SALINAS et al. 2010, LOZANO 2013), *S. formo-*

sus WIEGMANN, 1834 (GUILLETTE & SULLIVAN 1985, RAMÍREZ-BAUTISTA & PAVÓN 2009), *S. torquatus* WIEGMANN, 1828 (FERIA-ORTÍZ et al. 2001), *S. mucronatus* COPE, 1885 (MÉNDEZ-DE LA CRUZ et al. 1988), *S. jarrovii* COPE, 1875 (RAMÍREZ-BAUTISTA et al. 2002), and *S. minor* COPE, 1885 (RAMÍREZ-BAUTISTA et al. 2008a). On the other hand, populations of *S. grammicus* from low altitudes (Mexican Plateau) show an atypical reproduction mode (RAMÍREZ-BAUTISTA et al. 2012). This pattern is characterized by females and males remaining reproductively active for long periods, almost all year round, and thus in synchrony (HERNÁNDEZ-SALINAS et al. 2010, RAMÍREZ-BAUTISTA et al. 2012, LOZANO et al. 2014, 2015).

Abronia taeniata (WIEGMANN, 1828) is a viviparous, arboreal lizard that inhabits temperate environments in cloud forests of Mexico, Guatemala, El Salvador, and Honduras (CAMPBELL & FROST 1993, PETERSON & NIETO-MONTES DE OCA 1996, ARIANO-SÁNCHEZ & TORRES-ALMAZÁN 2010, CLAUSE et al. 2018). This species belongs to the family Anguidae within which the genus *Abronia* at present comprises 25 species, of which 17 occur in Mexico (MORENO-LARA 2019). Little is known about the natural history of *A. taeniata* (CLAUSE et al. 2018) save for some notes about its reproduction (MARTIN 1955, SOLANO-ZAVALETA et al. 2007). With this species inhabiting temperate environments at high altitude (mountains), we would expect that it follows a reproductive patterns similar to those of other viviparous high-altitude species (GUILLETTE & CASAS-ANDREU 1980, RAMÍREZ-BAUTISTA et al. 1995). Based on this assumption, we herein present data on reproduction of a population of *A. taeniata* from the cloud forests of central Mexico. We address the following questions: (1) Are sexually mature males and females of comparable size? (2) Are the reproductive cycles of males and females similar? (3) What is the litter size of females? (4) Is peak reproductive activity associated with environmental factors (temperature, precipitation, photoperiod)? (5) Is there a correlation between litter size and body size of females?

Materials and methods

Study area

This study was carried out in the locality of La Selva in the municipality of Huayacocotla ($20^{\circ}31' N$, $98^{\circ}29' W$; datum WGS84), Veracruz, Mexico, at an altitude of 2000 m a.s.l. (INEGI 2009). The vegetation type here is oak forest (RZEDOWSKI 2006). The climate is humid temperate, the mean annual temperature is $13.9^{\circ}C$; with rains occurring during most of the year, and mean annual precipitation is 1380 mm (Fig. 1; GARCÍA 1988).

Data collection

During 2002 and 2003, the area of La Selva was heavily deforested, and the Secretaría del Medio Ambiente y Recursos Naturales (SEMARNAT) requested support to rescue

several species of animals, among which was *A. taeniata*; these rescues were made during a one-year period (2002–2003). The forest was explored each month to find the arboreal lizards. Most of the lizards were found dead due to the effects of deforestation, but a small number of survivors were collected. The morphological characteristics recorded were SVL (mm) and body mass (g). In addition, age class was recorded (neonates, juveniles, and adults). Lizards were humanely sacrificed with an intracardiac overdose of pentobarbital (0.1 ml) and subsequently fixed with 10% formalin (CASAS-ANDREU et al. 1991). The specimens were deposited at the Bioterio General, Facultad de Estudios Superiores Iztacala, Universidad Nacional Autónoma de México (Appendix). Fieldwork was conducted in accordance with the Institutional Animal Care and Use Committee's Guidebook (OLAW 2002), and Mexican laws CT-CERN-001-91 (DOF 1991) and NOM-PA-CRN-001/93 (DOF 1993). Specimens were collected under scientific permit SGPA/DGVS/3969 issued by SEMARNAT.

Reproductive analysis

A sample of 186 adult lizards, 109 males and 77 females, of *A. taeniata* were examined in this study (Appendix). For all individuals, we measured snout–vent length (SVL; \pm 0.1 mm) and body mass (to the nearest 0.01 g). A sample of 11 neonates was used to measure SVL at birth. Reproductively active males and females were used to describe annual reproductive cycles. For reproductive characteristics, such as SVL at sexual maturity, litter size, and egg/embryo volume, we used the methods defined by DUFRAURE & HU-

BERT (1961) and LOZANO et al. (2014, 2015). The smallest female containing enlarged vitellogenic follicles (in ovary) or embryos (in uterus) were used to estimate the minimum SVL at sexual maturity (LOZANO et al. 2014, RAMÍREZ-BAUTISTA et al. 2017). Males were considered sexually mature if they contained enlarged testes and highly convoluted epididymides, which are typically associated with sperm production (LOZANO et al. 2015). Snout–vent lengths, lengths and widths of testes in males, lengths and widths of left and right non-vitellogenic follicles (NVF, previtellogenic follicles), numbers of vitellogenic follicles (VF in ovary) were recorded, and ovulated eggs (or embryos in oviduct/uterus) in females were removed and measured. All measurements were made to the nearest 0.1 mm with digital callipers. In addition, the numbers of NVF and VF (in ovary) or embryos in each oviduct were recorded (RAMÍREZ-BAUTISTA et al. 2002, RAMÍREZ-BAUTISTA & PAVÓN 2009).

The lengths and widths of the gonads were used to obtain testicular and follicular volume (V), which was calculated using the formula of an ellipsoid: $V = \frac{4}{3}\pi a^2 b$, where a is one-half of the shortest diameter and b is one-half of the longest diameter (SELBY 1965, RAMÍREZ-BAUTISTA & VITT 1997). Testicular and follicular volumes were used as indicators of reproductive activity of males and females (RAMÍREZ-BAUTISTA et al. 2002, RAMÍREZ-PINILLA et al. 2009, HERNÁNDEZ-SALINAS et al. 2010, BUSTOS-ZAGAL et al. 2011).

Litter size was determined by counting the embryos in the oviduct of adult females during the reproductive season (RAMÍREZ-BAUTISTA & PAVÓN 2009, HERNÁNDEZ-SALINAS et al. 2010). We fitted a linear regression to test for relationships between litter size and SVL and body mass of females

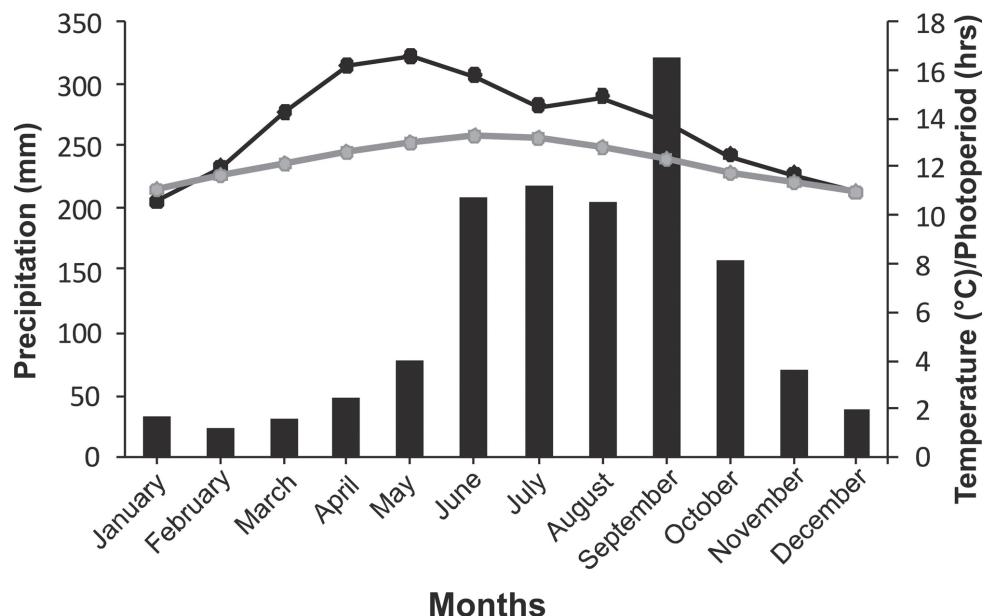


Figure 1. Annual variation in mean monthly temperature (black line), photoperiod (grey line), and precipitation (black bars) at La Selva, Huayacocotla, Veracruz, Mexico.

(RAMÍREZ-BAUTISTA & PAVÓN 2009). Additionally, linear regressions were used to test for a relationship between gonad activity and environmental variables (temperature, precipitation and photoperiod). Means are presented ± 1 SE, unless otherwise indicated. All statistical analyses were performed with Statistica 7.0 (StatSoft, Inc. Tulsa, OK).

Results

Body size at sexual maturity

Males of *A. taeniata* reached sexual maturity at a smaller SVL (74.6 mm) than females (81.7 mm). Males (SVL = 96.10 mm, n = 109) and females (SVL = 98.42 mm, n = 77; Mann-Whitney, U = 3689, P = 0.161) were of similar SVL; a similar pattern was found in body mass, with males and females having similar weights (16.3 g in both sexes; Mann-Whitney, U = 4184, P = 0.974, Table 1).

Male reproductive cycle

There was a significant relationship between \log_{10} SVL and \log_{10} gonad volume ($r^2 = 0.53$, $F_{1,107} = 118.3$, $P < 0.001$). Therefore, we used the residuals of the regressions to describe the testicular cycle independent of male size (Fig. 2A). An ANOVA on residuals of the regressions revealed significant effects of month on testes volume ($F_{11,97} = 2.66$, $P = 0.005$). Testicular volume varied by month; it was small during November, and began to increase in December, followed by further increases in January, February, March, with a plateau from April to August, but the peak was in September and October, decreasing in November (Fig. 2A). The increase in testicular volume was correlated with mean monthly precipitation ($r = 0.78$, $P = 0.003$), but not with temperature ($r = 0.26$, $P = 0.407$) or photoperiod ($r = 0.28$, $P = 0.376$).

Female reproductive cycle

There was no significant relationship between \log_{10} SVL of sexually mature females and \log_{10} gonad volume ($r^2 = 0.002$, $F_{1,75} = 0.17$, $P = 0.682$). Therefore, the female reproductive cycle is better represented by using log volume of the gonads (Fig. 2B). An ANOVA revealed a significant effect of month on log gonad volume ($F_{10,66} = 5.22$, $P < 0.001$). Results showed early vitellogenetic follicles in August and September, and embryonic development occurred from November to June (Fig. 2B). In January and February, all females (100%, 8 and 11 respectively) contained embryos, while in March 6/9 (66.7%), April 5/8 (62.5%), May 5/10 (50%), and June 6/6 (100%) had embryos. The high period of embryonic development is from January to June, i.e., during the birthing period. Mean monthly gonad volume is positively correlated with precipitation ($r = 0.64$, $P = 0.02$), but not with temperature ($r = 0.24$, $P = 0.454$) or photoperiod ($r = 0.34$, $P = 0.276$).

Table 1. Mean values ± 1 SE, and range in parentheses of snout-vent lengths and body masses of adult females and males of *Abronia taeniata* from La Selva, Huayacocotla, Veracruz, Mexico. Comparisons were made with Mann-Whitney U-test, P-value.

Characteristics	Males (n = 109)	Females (n = 77)	U	P
SVL (mm)	96.1 \pm 0.83 (74.64–113.99)	98.42 \pm 0.70 (81.74–109.87)	3689	0.161
Mass (g)	16.39 \pm 0.46 (6–27.90)	16.37 \pm 0.40 (9.10–24.92)	4184	0.974

Litter size

Mean litter size was 6.4 ± 0.31 (3–11, n = 16). Litter size was not related to female SVL ($r^2 = 0.009$, $P = 0.526$; Fig. 3A); however, litter size was correlated with female body mass

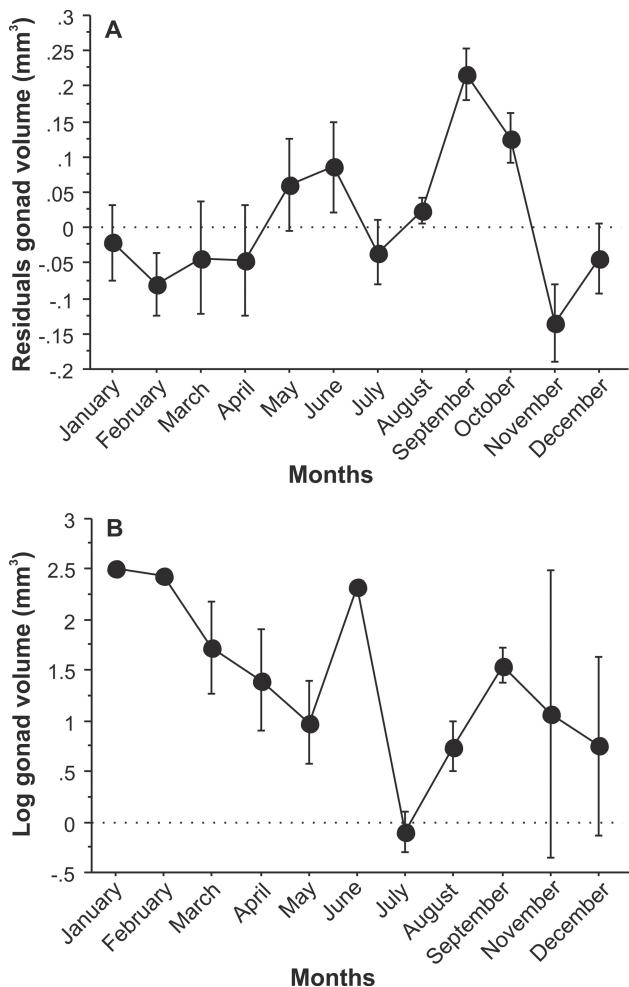


Figure 2. Monthly variation in residual volume of gonads of males (A), and log volume of females (B) of *Abronia taeniata* from La Selva, Huayacocotla, Veracruz, Mexico. Means reported with ± 1 SE.

($r^2 = 0.167$, $P = 0.007$; Fig. 3B). Gravid females were seen from January to June, i.e., during the birthing period. Mean SVL of neonates at birth was 54.0 ± 3.7 mm (34.8–69.8 mm, $n = 11$).

Discussion

Within species of the family Anguidae, very few studies have been carried out on natural history; for example,

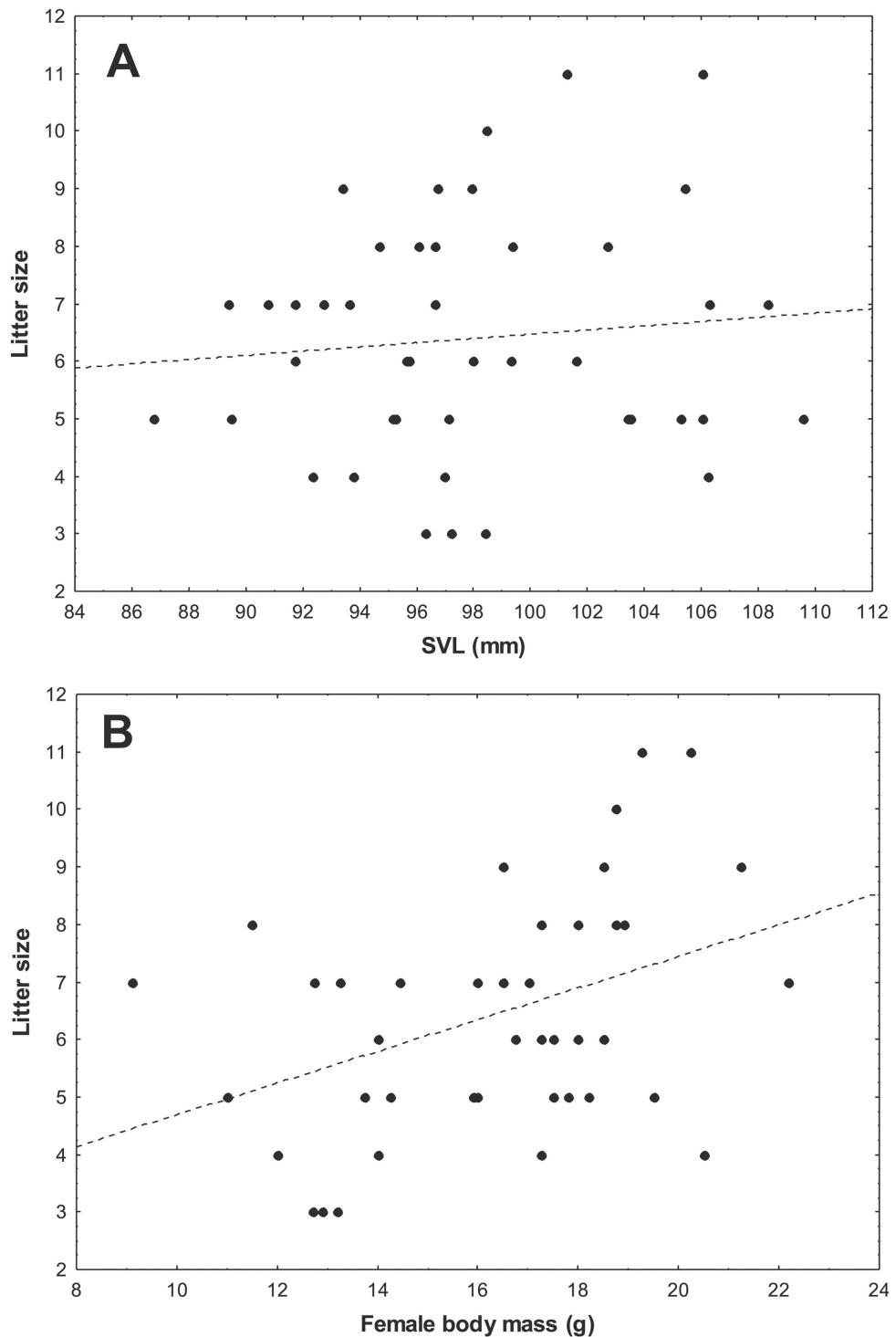


Figure 3. Relationship between litter size and snout–vent length (A), and litter size and body mass (B) of females of *Abronia taeniata* from La Selva, Huayacocotla, Veracruz, Mexico.

on *Elgaria coerulea* (WIEGMANN, 1828) (STEWART 1979, 1985), *Barisia imbricata* (WIEGMANN, 1828) (GUILLETTE & SMITH 1982, GUILLETTE & CASAS-ANDREU 1987), *Mesaspis monticola* (COPE, 1978) (VIAL & STEWART 1985), and still fewer in species of the genus *Abronia* GRAY, 1838 (CAMPBELL & FROST 1993, PETERSON & NIETO-MONTES DE OCA 1996, LEMOS-ESPINAL et al. 2001, VILLAMAR-DUQUE 2001, CLAUSE et al. 2018). The few studies that exist on the genus include descriptions of new species (GOOD & SCHWENK 1985, CAMPBELL et al. 1998). CAMPBELL & FROST (1993) provided general data on the reproduction of several species of the genus. GONZÁLEZ-PORTER et al. (2015) carried out a study on reproduction (litter size) and sexual dimorphism of *A. graminea* (COPE, 1864) in captivity, but nothing is known on this subject in *A. taeniata* beyond general notes (CAMPBELL & FROST 1993) and a more specific note by SOLANO-ZAVALETA et al. (2007). In the latter, the birth of seven young from a single female (SVL = 88 mm, body mass 22.62 g) in April 2006 was reported (mean SVL = 31.43 mm ± 1.09; 30–32.5 mm, n = 7; mean body mass = 0.44 g ± 0.07; 0.35–0.55 g, n = 7).

Body size at sexual maturity

Both males and females were similar in SVL and body mass (Table 1), meaning that in these characteristics, this population of *A. taeniata* does not exhibit sexual size dimorphism. This pattern has also been observed in both congeneric species (*A. graminea*; GONZÁLEZ-PORTER et al. 2015), and other species of the family Anguidae such as *B. imbricata* (GUILLETTE & CASAS-ANDREU 1987, DASHEVSKY et al. 2013). The pattern of no sexual size dimorphism has been tested in the Anguidae (Cox et al. 2007) and may have to do with the males of these species not being territorial, and probably monogamous; that is, males do not fight with other males for access to females, as has been noted in other viviparous lizards of the genus *Sceloporus* (*S. torquatus*, FERIA ORTÍZ et al. 2001; *S. minor*, RAMÍREZ-BAUTISTA et al. 2008a; or *S. grammicus*, JIMÉNEZ-CRUZ et al. 2005). However, in anguids, sexual size dimorphism can be seen in other morphological characteristics such as the head (*B. imbricata*, DASHEVSKY et al. 2013; *A. graminea*, GONZÁLEZ-PORTER et al. 2015).

Reproductive cycles

Abronia taeniata has a reproductive cycle in which males and females exhibit asynchronous gonad activity. Reproductive activity of males begins with testicular recrudescence in early spring (April), with maximum activity during the autumn months (September–October; Fig. 2A); while the reproductive activity of females begins in August and September with vitellogenesis, continues with ovulation in November, and embryonic development from November to June. This is a typical reproductive pattern among viviparous species that inhabit temperate environ-

ments at high altitudes (GUILLETTE & CASAS-ANDREU 1980, 1987, GUILLETTE & BEARCE 1986), with some examples being *S. formosus* (GUILLETTE & SULLIVAN 1985, RAMÍREZ-BAUTISTA & PAVÓN 2009), *B. imbricata* (GUILLETTE & CASAS-ANDREU 1987), *Plestiodon copei* (TAYLOR, 1933) (RAMÍREZ-BAUTISTA et al. 1995), and *P. lynxe* (WIEGMANN, 1834) (RAMÍREZ-BAUTISTA et al. 1998). However, differences were found in the durations of reproductive activity periods between males and females of *A. taeniata*, which were longer compared to other viviparous species from high altitudes, and related species, such as *B. imbricata* (GUILLETTE & CASAS-ANDREU 1987). *Abronia taeniata* follows a pattern similar to those of species from tropical environments; for example, *M. monticola* (VIAL & STEWART 1985).

Reproductive activity of both male and females of *A. taeniata* was correlated only with precipitation. This is surprising insofar as it is generally accepted that photoperiod and temperature are the most important environmental factors for the timing of reproductive activity in viviparous species from temperate environments at high altitudes (DUVAL et al. 1982, MARION 1982, RAMÍREZ-BAUTISTA et al. 2002, JIMÉNEZ-CRUZ et al. 2005). For example, reproductive activity of males is more related to temperature than precipitation or photoperiod in species such as *S. undulatus* (BOSC & DAUDIN, 1801) (MARION 1982), *S. grammicus* (JIMÉNEZ-CRUZ et al. 2005), *S. formosus* (RAMÍREZ-BAUTISTA & PAVÓN 2009), *S. minor* (RAMÍREZ-BAUTISTA et al. 2008a), and *P. lynxe* (RAMÍREZ-BAUTISTA et al. 1998). Likewise, reproductive activity of the female can be related to other environmental factors, such as precipitation and/or photoperiod rather than temperature, as has been documented for viviparous species from high altitudes, such as *S. jarrovii* (RAMÍREZ-BAUTISTA et al. 2002), *S. grammicus* (JIMÉNEZ-CRUZ et al. 2005), *S. minor*, RAMÍREZ-BAUTISTA et al. 2008a), *S. formosus* (RAMÍREZ-BAUTISTA & PAVÓN 2009), and *B. imbricata* (GUILLETTE & CASAS-ANDREU 1987). These data suggest that each species and sex respond in different ways to environmental factors during their reproductive activity (FITCH 1970, 1982, MARION 1982). In this study, however, gonad activity of males and females was correlated with precipitation, as has been noted in other viviparous lizard species (BALLINGER 1977). This pattern could also be related to the abundance and quality of food (insects) during the rainy season (BALLINGER 1977), as it is important for spermatogenesis, vitellogenesis, and embryonic development (GUILLETTE & CASAS-ANDREU 1987). Taking into account that in cloud forest environments, precipitation occurs throughout the year, but is highest from April through October (Fig. 1), this environmental condition indicates that food resources are available throughout the year and thus enables males and females to have a longer reproductive period. It could be the reason why young are born from January to June, as in some tropical viviparous species (*Lepidophyma pajapanensis* WERLER, 1957, MÉNDEZ-DE LA CRUZ et al. 1999; *L. sylvaticum* TAYLOR, 1939, RAMÍREZ-BAUTISTA et al. 2008b; *S. formosus*, RAMÍREZ-BAUTISTA & PAVÓN 2009)

and temperate viviparous species (*B. imbricata*, GUILLETTE & CASAS-ANDREU 1987).

Litter size

Mean litter size of *A. taeniata* was found to be 6.4 (3–11, n = 16), which is larger than sizes documented for other species of the genus; for example, *A. graminea*, *A. fimbriata* (COPE, 1885), and *A. lythrochila* SMITH & ALVAREZ DEL TORO, 1963 (3–5 young; WERLER 1951, CAMPBELL & FROST 1993, GONZÁLEZ-PORTER et al. 2015), *A. taeniata* (4; MARTIN 1955), *A. oaxacae* (GÜNTHER, 1885) (1 young; SMITH & WILLIAMS 1963), and *A. smithi* CAMPBELL & FROST, 1993 (3–4). The offspring of these species were born between April and December, which suggests an extended reproductive activity of the females of the species of genus *Abronia*, facilitated by the environmental conditions and ready availability of food in the rainy season (BALLINGER 1977).

No correlation between litter size and female SVL was observed in *A. taeniata*; although it may be noted that such a pattern is uncommon (GUILLETTE & CASAS-ANDREU 1987). Viviparous lizard species from temperate mountain environments more commonly present a correlation between litter size and female SVL (e.g., *S. grammicus*, GUILLETTE & CASAS-ANDREU 1980, JIMÉNEZ-CRUZ et al. 2005, HERNÁNDEZ-SALINAS et al. 2010; *S. minor*, RAMÍREZ-BAUTISTA et al. 2008a; *S. formosus*, RAMÍREZ-BAUTISTA & PAVÓN 2009), or have no such relationship (*B. imbricata*, GUILLETTE & CASAS-ANDREU 1987; *P. lynxe*, RAMÍREZ-BAUTISTA et al. 1998; *S. grammicus*, RAMÍREZ-BAUTISTA et al. 2012; *L. sylvaticum*, RAMÍREZ-BAUTISTA et al. 2008b). This latter pattern implies that female body size does not strongly influence the development of follicles, but other factors could be involved; for example, the size and shape of the abdomen or pelvic girdle, as in oviparous species (*Anolis carolinensis* VOIGT, 1832; MICHAUD & ECHTER-NACHT 1995). Another possible explanation for this pattern is that there is an inverse relationship between the size of the neonate and female body size (e.g., *B. imbricata*, GUILLETTE & CASAS-ANDREU 1987; *G. coeruleus*, STEWART 1979); however, it was not tested in *A. taeniata*. Females of *A. taeniata* that inhabit this kind of environment (cloud forest), probably with a high predation pressure, could be using food resources (energy) for either producing larger neonates or larger litter sizes in response to high environmental pressures (bet-hedging hypothesis; PINCHEIRA-DONOSO & HUNT 2015). This hypothesis might be supported by variation in litter size among species of the genus *Abronia* (CAMPBELL & FROST 1993), and also for the SVL of neonates at birth, which in this study was larger (34.9 mm) than for other species (*A. graminea*, 32 mm, GONZÁLEZ-PORTER et al. 2015; *A. fimbriata*, 33 mm, CAMPBELL & FROST 1993). These variations in neonate SVL at birth in the genus *Abronia* imply that each species, and probably population, responds according to the environment they inhabit, which is known as phenotypic plasticity (STEARNS 1992, ROFF 1992).

Conclusion

Prior to the present paper, nothing used to be known about the reproductive cycles of males and females of *A. taeniata*. Our study demonstrates that the reproductive cycles of males and females do not follow a pattern based upon spring or summer months (FITCH 1970) as is found in other viviparous species from temperate environments (GUILLETTE & CASAS-ANDREU 1980). For example, other temperate viviparous species exhibit an autumn reproductive activity pattern, somewhat similar to males and females of *A. taeniata* (*S. grammicus*, GUILLETTE & CASAS-ANDREU 1980, HERNÁNDEZ-SALINAS et al. 2010; *S. formosus*, GUILLETTE & SULLIVAN 1985, RAMÍREZ-BAUTISTA & PAVÓN 2009; *S. mucronatus*, MÉNDEZ DE LA CRUZ & VILLAGRÁN-SANTA CRUZ 1983; *P. lynxe*, RAMÍREZ-BAUTISTA et al. 1998; *L. sylvaticum*, RAMÍREZ-BAUTISTA et al. 2008b). In addition, SVL at sexual maturity in males and females is similar to those of *B. imbricata*, but litter size in *A. taeniata* is smaller. No information is available, however, about some reproductive characteristics (SVL at sexual maturity, litter size, reproductive cycles) in other populations of *A. taeniata* or congeneric species that could be compared to our data. We assume that precipitation and food availability are the main environmental factors that influence the reproductive characteristics of males and females of *A. taeniata* in this studied population. Much remains to be learned about reproductive characteristics and cycles of several distinct evolutionary lineages identified within *Abronia* (CAMPBELL & FROST 1993).

Acknowledgements

We thank the Programa para el Desarrollo Profesional Docente (PRODEP) at Universidad Autónoma del Estado de Hidalgo and the Project JM001 of CONABIO. We thank the various anonymous reviewers for greatly improving our manuscript. We thank MARGARET SCHROEDER for her revising the language of our manuscript. The scientific collection permit SGPA/DGVS/3969 was issued by SEMARNAT.

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Appendix

Specimens of *Abronia taeniata* collected for use in this study, and deposited in the Biotero General, Facultad de Estudios Superiores Iztacala, Universidad Nacional Autónoma de México.

La Selva, Huayacocotla, Veracruz, Mexico.

Adult females (n = 77): VIDT-AT-81, 96, 97, 98, 116, 117, 118 (January), 101, 103, 106, 114, 131, 136, 137, 138, 139, 140, 141 (February), 145, 147, 150, 156, 159, 160, 166, 167, 168 (March), 169, 171, 173, 174, E04, E05, E06, E49 (April), E07, E11, E40, E41, E42, E43, E47, E52, E54, E56 (May), E45, E12-1, E12-2, E12-3, E45-1, E45-2 (June), E31, E37, P3, P5-1, P5-2, P6 (July), E53, 44, E19, E29, E55, P2 (August), E22, 52, E28, E51, E61, P1, P4-1, P4-2 (September), 60, 63 (November), 70, 72, 74 (December).

Adult males (n = 109): VIDT-AT-82, 83, 95, 99, 107, 119, 120, 121, 122, 123 (January), 100, 102, 104, 105, 115, 124, 125, 126, 128, 129, 130, 132, 133, 135, 142, 143 (February), 162, 146, 152, 153, 154, 161, 170, E58 (March), 151, 155, 157, 163, 164, 165, 172, 179, E65 (April), 180, 181, 182, 183, 184, 186, 188, 191, E59, E60, E62, E66 (May), 189, 27, 190, 192, E16, E44, E57, E64 (June), 40, 36, 42, E14, E25, E35, E48, E50, E67 (July), E39, 45, E15, E26, E30, E36, E63 (August), 49, 52-1, E18, E20, E27, E34, E68 (September), E24, 56, E17, E23, E32, E33, E38 (October), E10, 64, 65, 69, 71, E02, E03, E46 (November), 76, 67, 73, 78, 79, E01, E13, E21 (December).

Neonates (n = 11): VIDT-AT-147, 176, 178, 185, 187, 57, 61, 68, 75, 77, 80.