

SHORT COMMUNICATION

The first evidence of viviparity in the lizard *Liolaemus reichei* (Squamata: Liolaemidae)

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Studying the reproductive biology of an organism is fundamental to understanding its life history and adaptations to different environments (Packard *et al.* 1977). In the case of reptiles, given their condition as ectothermic vertebrates, reproduction and embryo gestation of species that inhabit temperature-challenged environments face diverse physiological defiances (Shine 2004). The evolution of viviparity (live breeding) from oviparity (egg-laying) may be an adaptive response to extreme climates, allowing females to regulate the embryo temperature and thus keep it under stable conditions in contrast to the comparatively higher thermal variation to which eggs are exposed in the environment (Shine 2005, Fernández *et al.* 2017).

Lizards in the genus *Liolaemus* Wiegmann, 1834 inhabit the southern cone of South America and are highly diverse, with almost 300 species (Uetz *et al.* 2025). They occur in a variety of

habitats, from hot areas on the Atlantic coast of Brazil, and hot deserts in Peru and Chile to the cold regions in Argentine Patagonia and the highlands (~ 5000 m a.s.l.) of the Central Andes of Peru and Bolivia (Abdala and Quinteros 2014, Abdala *et al.* 2020, Cerdeña *et al.* 2021). Data for this genus support the hypothesis that viviparity evolves in cold climates because this reproductive mode is primarily observed in high altitudes and latitudes (Pincheira-Donoso *et al.* 2013, Esquerré *et al.* 2019). However, viviparity has also been observed in species that inhabit hot deserts (Abdala *et al.* 2021b) with extreme climatic conditions, such as high daily temperature oscillations and low precipitation (Weischet 1975, Valdivia-Silva *et al.* 2012). Under these conditions, viviparity would not only protect embryos against significant thermal variation but also against water stress (Shine and Thompson 2006). This situation may be the case for the species of the *Liolaemus reichei* clade (*sensu* Abdala *et al.* 2020, Valladares *et al.* 2021) that inhabit the desert zones of southern Peru and northern Chile. Viviparity has been reported

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for seven of the 12 species in this clade: *L. anqapuka* Huamani-Valderrama, Quiróz, Gutiérrez, Aguilar-Kirigin, Chaparro, and Abdala, 2020 (Huamani-Valderrama and Quiróz 2021), *L. audituvelatus* Núñez and Yáñez, 1983 (Valladares-Faúndez and Briones 2012), *L. balagueri* Villegas Paredes, Huamani-Valderrama, Luque-Fernández, Gutiérrez, Quiróz, and Abdala, 2020 (Huamani-Valderrama and Gutiérrez 2021), *L. chiribaya* Aguilar-Puntriano, Ramírez, Castillo, Mendoza, Vargas, and Sites, 2019 (Quiroz and Huamani-Valderrama, 2021), *L. insolitus* Cei and Péfaur, 1982 (Abdala *et al.* 2021a), *L. nazca* Aguilar-Puntriano, Ramírez, Castillo, Mendoza, Vargas, and Sites, 2019 (Aguilar-Puntriano *et al.* 2019), and *L. torresi* Núñez, Navarro, Garín, Pincheira-Donoso, and Meriggio, 2003 (Núñez *et al.* 2003). The prevalence of viviparity in this clade suggests that this reproductive mode may be an ancestral character and that the other species of the clade may also be viviparous. Of the five species for which reproductive mode is unknown, one is *Liolaemus reichei* Werner, 1907 (Valladares-Faúndez and Abdala 2021, but see Donoso-Barros 1966), considered a junior synonym of *L. stolzmanni* Steindachner, 1891 and revalidated a few years ago as a full species (Langstroth 2011, Valladares-Faúndez *et al.* 2018, Troncoso-Palacios and Escobar 2020). This species, listed as endangered by the IUCN, is small, with a maximum snout–vent length (SVL) of 50.82 mm, has non-evident sexual dichromatism, and precloacal pores are present only in males (Valladares and Abdala 2021). It inhabits absolute desert, occupying terrestrial biotopes with sandy and stony substrates (Valladares-Faúndez and Abdala 2021). In the present study, we report field observations that reveal viviparity in this species.

As part of monthly monitoring to study *L. reichei* in a desert area (Figure 1) located 70 km southeast of Iquique (20°49'16" S, 69°57'09" W) in the Tarapacá Region of northern Chile, on 16 January 2024 at 13:20 h we captured an adult pregnant female under a rock. Its reproductive

state was determined based on the bulging of her abdomen (Figure 2). Her SVL was 48.91 mm, and her tail length (TL) was 32.93 mm, both measured with a Proster® electronic caliper (± 0.01 mm). The female's weight was 4.3 g, recorded with a MH Pocket digital scale® (± 0.1 g). Following the monitoring protocol, the female was georeferenced using the phone App Locus map® version 4.28.3, marked with non-toxic paint, and photographed with a Canon EOS 90D® camera before it was released at the site of capture.

Two months later, on 11 March 2024 at 14:37 h, this female was recaptured under a rock, approximately 100 m from the previous site. It was recognized by a characteristic malformation in the tail revealed when photographs were inspected. Before starting the routine measurements, we noticed a neonate head protruding from the female's cloaca. The lizard was placed back under the rock to allow expulsion of the neonate. After one hour, we returned to find no change in the neonate position. Close examination confirmed that this individual was dead (Figure 3). The female was left under the rock, allowing expulsion of the stillborn. The next day, 12 March, at 10:50, the female was found under a different rock located 30 m from where it was found the day before. Because the stillborn was not yet expelled, we assisted the female in its expulsion, thus preventing her death. The posterior part of the female's body was placed in a container with warm water (~35°C) to promote dilatation of the cloacal region. Together with a controlled massage of the abdominal region and the application of petroleum jelly with a cotton swab in the cloacal area, the stillborn was finally expelled, a procedure that lasted approximately two minutes. The female and the stillborn were weighed separately; these values were 2.5 and 0.5 g, respectively. The SVL of the stillborn was 31.03 mm, and its TL was 26.68 mm. The stillborn lizard was collected for future research. Further analysis of the female reproductive condition was not performed (e.g., palpations,



Figure 1. The desert environment in the Tarapacá region inhabited by *Liolaemus reichei*.



Figure 2. Pregnant female of *Liolaemus reichei*.



Figure 3. Cloacal area of the pregnant female of *Liolaemus reichei* with an emerging neonate (stillborn).

ultrasounds) to minimize the intervention. After that, the female was released and ran actively to hide under the same rock where she had been found earlier. Two months later, on 12 May at 13:55 h, this female was recaptured under a rock located approximately 130 m from the last capture. It actively attempted to bite and escape while handled. At this time, her weight was 2.6

g. Finally, on 7 February 2025 at 15:15 h, the female was recaptured approximately 60 m from the last capture point and weighed 3.3 g.

These observations confirmed viviparity in *L. reichei*, which is consistent with the occurrence of this reproductive mode in other species of the *L. reichei* clade. However, our observations contradict the proposition that the species is

oviparous (Donoso-Barros 1966). This discrepancy may be rooted, as Núñez *et al.* (2003) indicated, because Donoso-Barros (1966) observed oviductal eggs at an early stage of pregnancy. Our observations suggest that births in *L. reichei* occur in Austral summer, partially coincident with the parturition of *L. audituvelatus* recorded in late spring (Valladares and Briones 2012). Nevertheless, data from the ongoing monitoring revealed the presence of small individuals (< 35 mm) between October and May, suggesting that the species may have an extended breeding season. Finally, it should be noted that the neonate emerged head-first, as has been observed in other species of *Liolaemus* (Halloy and Halloy 1997, Cabrera and Monguillot 2007, Minoli *et al.* 2010, Valladares-Faúndez and Briones 2012).


Valladares-Faúndez and Briones (2012) indicated that in *L. audituvelatus*, parturition lasted 63 min, with birth intervals between the three offspring of 14 and 49 min. In other viviparous species of *Liolaemus*, the reported duration of parturition ranged between 38 and 100 min, with variable birth intervals between seven and 60 min, for litter sizes of two to seven individuals (Halloy and Halloy 1997, Ibagüengoytia *et al.* 2002, Cabrera and Monguillot 2007, Kozykariski *et al.* 2008, Minoli *et al.* 2010, Fernández *et al.* 2015). In this context, our decision to wait 60 min for the end of the neonate expulsion was appropriate. On the other hand, considering that the pregnant female weighed 4.3 g in January 2024, but after the (induced) parturition weighed 2.5 g, and that the stillborn mass was 0.5 g, we postulate that the female had previously given birth to one or two neonates. This litter size is in line with litter sizes reported for other species of the *L. reichei* clade: *L. audituvelatus* ($N = 3$; Valladares-Faúndez and Briones 2012), *L. insolitus* ($N = 3$; Abdala *et al.* 2021a), *L. nazca* ($N = 2$; Aguilar-Puntriano *et al.* 2019) and *L. torresi* ($N = 2$; Núñez *et al.* 2003). Since no other newborns were observed in the vicinity, presumably, the birth of the other neonates would have occurred

several hours or days before our observation. In *L. audituvelatus* and *L. kingii* Bell, 1843 newborns initially remain after birth in the vicinity of the female (Ibagüengoytia *et al.* 2002, Valladares-Faúndez and Briones 2012).

Dystocia is an abnormal, slow, or difficult parturition, which is a reproductive disorder commonly reported in different species of reptiles in captivity. Egg retention is the most common cause in snakes, turtles, and lizards, such as iguanas and geckos (DeNardo *et al.* 2000, Lock 2000, Sykes 2010). Dystocia is classified as obstructive and non-obstructive, and its causes are multifactorial. Obstructive dystocias are associated with anatomical abnormalities (fetal or maternal) that constrain the passage of eggs or young through the oviduct, uterus, or cloaca but also can be associated with external factors related to the reproductive system that compress the passage of eggs or young through the birth canal (e.g., neoplasia, narrow pelvis, fecal bolus, renomegaly). Non-obstructive dystocias are the most common cases reported in captivity and are caused by inappropriate environmental conditions for parturition or egg laying, such as lack of nesting sites, inadequate environmental conditions (e.g., temperature, humidity, substrate, photoperiods), poor physical condition of females, inadequate diet, or early birth (DeNardo *et al.* 2000, Lock 2000, DeNardo 2006, Sykes 2010). The causes of most dystocias remain unresolved (DeNardo *et al.* 2000). In the case of *L. reichei*, it was not possible to determine the type of dystocia. However, because the stillborn had a similar size as the neonates of *L. torresi* reported by Núñez *et al.* (2003), a species of the *L. reichei* clade with a similar size as *L. reichei* (M. Weymann, pers. obs.), we ruled out the possibility that the neonate was premature. Other factors may have determined the neonate's death. Our observation may have resulted from non-obstructive dystocia due to extreme climatic conditions and low food availability where *L. reichei* lives (Donoso-Barros 1966). These conditions may have negatively affected the female at the time of parturition. Nevertheless, other observations indicate that the

female was not moribund or lacking energy. It was able to move between shelters (~ 30 m) while still carrying the stillborn, was shedding during the parturition period (Figure 3), and after the assisted parturition, ran actively. In addition, during each handling, it struggled to escape. The female was recaptured two and 11 months later and had gained weight from 2.5 to 2.6 g to 3.3 g, respectively. Therefore, the factors involved in this dystocia are unclear.

Observations of dystocia in reptiles in the wild are rare (DeNardo *et al.* 2000). Our study of *L. reichei* not only revealed the reproductive mode of this species but also is the first case of dystocia reported for the species, as well as for the genus.

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