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SHORT NOTES

Facultative nesting in *Rhinella spinulosa* (Anura: Bufonidae): strategy to avoid dehydration of offspring

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The diversity of reproductive modes in amphibians is greater than that observed in other groups of vertebrates. Reproductive strategies of anurans are likewise varied and related to the characteristics of the environment as well as to the presence of vegetation and variation in the water depth, among others (DUELLMAN & TRUEB, 1986). LAVILLA & ROUGES (1992) described eighteen reproductive modes for Argentinean amphibians, but nest building was not included. The construction of nests (or breeding-stalls) has been described for different species of Hylidae such as *Hypsiboas pardalis*, *Hypsiboas faber*, *Hypsiboas boans*, *Hypsiboas wavrini* and *Hypsiboas rosenbergi* (LUTZ, 1960; DUELLMAN, 1970; CRUMP, 1974; KLUGE, 1981; MARTINS & MOREIRA, 1991; HADDAD & HOLD, 1997).

The toad *Rhinella spinulosa* (WIEGMANN, 1834) inhabits the cordilleran and pre-cordilleran regions of Argentina, Chile, Bolivia and Peru (FROST, 2011). In Argentina, *R. spinulosa* is reported from Catamarca, Jujuy, La Rioja, Mendoza, Salta, San Juan and Tucuman, in the 900-4,000 masl altitudinal range (CEI, 1980). This species usually deposits egg chains at the bottom of water bodies (SINSCH, 1988; 1990), where the embryonic development and hatching occurs (LAVILLA & ROUGES, 1992). Here, we report and describe for the first time the construction of breeding-stalls for a population of *R. spinulosa* inhabiting desert environments of San Juan Province, Argentina.

The study area is located 70km west of San Juan city, in "Sierra de la Dehesa" (31.3497 W; 68.8333 S; Datum: WGS84, elevation: 1,560m). The environment is characterized by numerous shallow streams (water depth: 2- 12cm). Stream vegetation is dominated by *Cortadera rudiscula* and *Baccharis salicifolia.* Marginal vegetation is typical of the xeric environments with low cover. The region belongs to the Monte Phytogeographic Province, characterised by an arid climate with a mean annual temperature of 17.3ºC, a maximum mean annual temperature of 25.7ºC, a minimum mean annual temperature of 10.4ºC and a mean annual rainfall of 89mm, concentrated mainly in summer (CABRERA, 1976). According to the Köppen Climate Classification System, Monte desert belongs to the BWw climate zone, which represents a desert with summer precipitation (POBLETE & MINETTI, 1999).

We visited the study area for three consecutive days in August 2006 in order to characterize nests of *R. spinulosa*. The current selection was based on accessibility and the number of nests that could be easily found in this place. Also, the distance between streams was at least five kilometres, which made daily measurements of water levels of the streams possible. We measured water depth of the stream flow every three hours (eight times a day) using a digital calliper (Essex; ±0.1mm). A total of fifteen nests were studied, and we measured the following variables using the digital calliper: wall height, water depth in the centre of the nest, water depth outside the nest. We recorded water temperature inside the nest and under the egg mass, and outside the nest with two digital thermometers (Barnant model 600-1040, USA; ±0.1ºC). Nest surface was calculated as $A=\pi*r^2$ (where: A=area; $\pi=3.14$; r=radius). Furthermore, nest position (under shade or sun-exposed) and position of the egg chain within the nest (centre or side) were also registered. All measurements of the nest were taken between 1400 to 1800 hours. All variables are expressed as mean ± standard error. We conducted Sign tests to compare measurements of water temperature and water depth between inside and outside of nests; the generalized linear model (GLM) was used to test differences in the water depth of a stream during the day. We used the R statistical software (R DEVELOPMENT CORE TEAM, 2008) for data analysis.

Stream water depth showed significant changes during the day [GLM: water deep ~ hours, family = Gamma (log)], a minimum depth record at 1 400 ($p<0.001$), 1 700 ($p<0.001$) and 2 000 ($p<0.001$) hours (Fig. 1; Table 1). Water depth variation within mountain streams in the xeric environment is insufficiently studied. We had

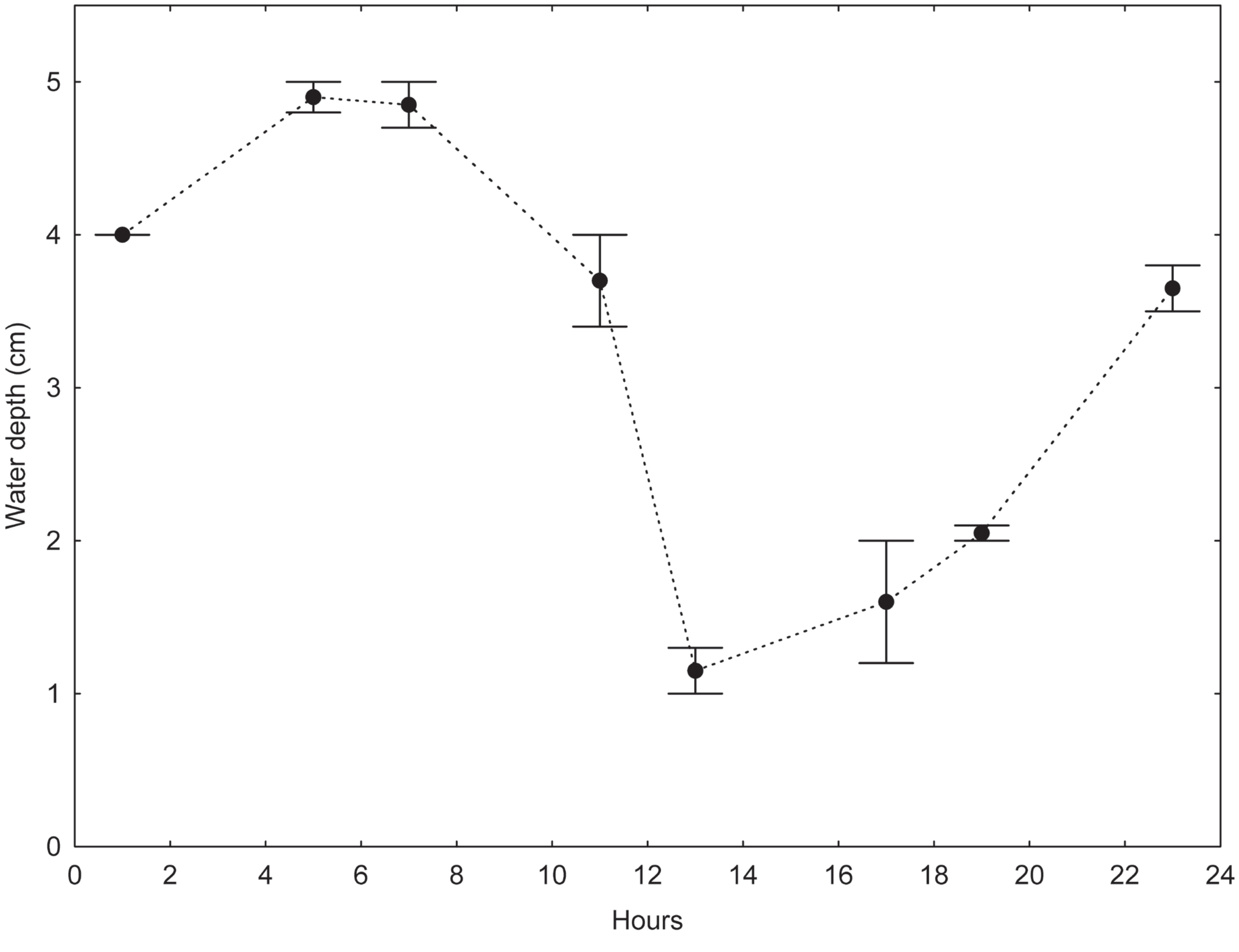

Fig. 1. – Variation of water depth of the studied streams. The level of the water was measured every three hours during two days.

TABLE 1

Results from generalized linear models testing effects of hours and stream water depth in Sierra de la Dehesa, San Juan, Argentina.

	ESTIMATE	STD. ERROR	T-VALUE	*p*	WATER LEVEL (CM)
Intercept	1.58924	0.09232	17.215	0.001	
1100 h	0.27193	0.11918	-2.282	0.05	3.73±0.18
1400 h	-1.52470	0.11918	-12.793	0.001	1.07±0.12
1700 h	-1.14028	0.11918	-9.568	0.001	1.57±0.23
2000 h	-0.81605	0.11918	-6.847	0.001	2.17±0.12
2300 h	-0.26304	0.11918	-2.207	0.05	3.77±0.15
0200 h	-0.19464	0.11918	-1.633	>0.05	4.03±0.03
0500 h	0.01351	0.11918	0.113	>0.05	4.97±0.09

observed this circadian variation of water depth in other streams of Monte desert, where marked reductions of the water level coincided with the hours of maximum insolation.

The nests of *R. spinulosa* were circular, pot-shaped, built on sandy soils, and had a mean surface area of 762.36±168cm^2 and a mean diameter of 30.1±8.5cm. The wall that surrounded the clutch was 3.5±1.2cm high. Mean water temperature in the centre of the nest was 20±1.2ºC, while the external water temperature was 18.3±1.5ºC. We did not detect significant differences between water temperature inside and outside of the nests (Sign test: Z=1.22, P=0.22). Mean depth in the centre of nests was 3.5±0.63cm and 1±0.5cm outside of them. Depth differences were statistically significant (Sign test: Z=2.04, P<0.004). All the nests were found sun-exposed with egg chains laid in the centre of the nests, where the water is deeper (Fig. 2).

There are two hypotheses on the benefits of nest-building. The first one is based on the isolation of eggs and embryos to protect them from potential predators, including cannibalism from conspecific tadpoles (CRUMP, 1974; KLUGE, 1981). However, *R. spinulosa* is the only anuran species inhabiting these streams and predatory fish are absent. *R. arenarum,* like *R. spinulosa,* begins reproduction at the end of winter, by middle August (SANABRIA et al., 2005) when temperatures are low (about 12.7°C). It is likely that it minimizes the predation of eggs and tadpoles this way, because invertebrate predators are not active at the end of the winter (HEYER et al., 1975). The second hypothesis suggests that environmental temperature within the breeding-stall is higher than in the surroundings, which implies accelerated embryonic growth (LAMOTTE & LESCURE, 1997). All the clutches of *R. spinulosa* in this study were located at sun-exposed sites. In desert environments, the high radiation during daylight (WARNER, 2004) provides enough energy for the fast development of embryos and tadpoles. Female *R. arenarum* selectively lay eggs on open sites (SANABRIA et al., 2007), behaviour that promotes the early development of embryos, which behave in this sense as black bodies, enhancing radiation absorption (SAVAGE, 1975; SEALE, 1982). Although clutches of *R. spinulosa* are in the sun, the differences in the temperature between inside and outside the nest were not significant in our study. We therefore propose the hypothesis that adults of *R. spinulosa* build nests to avoid stream

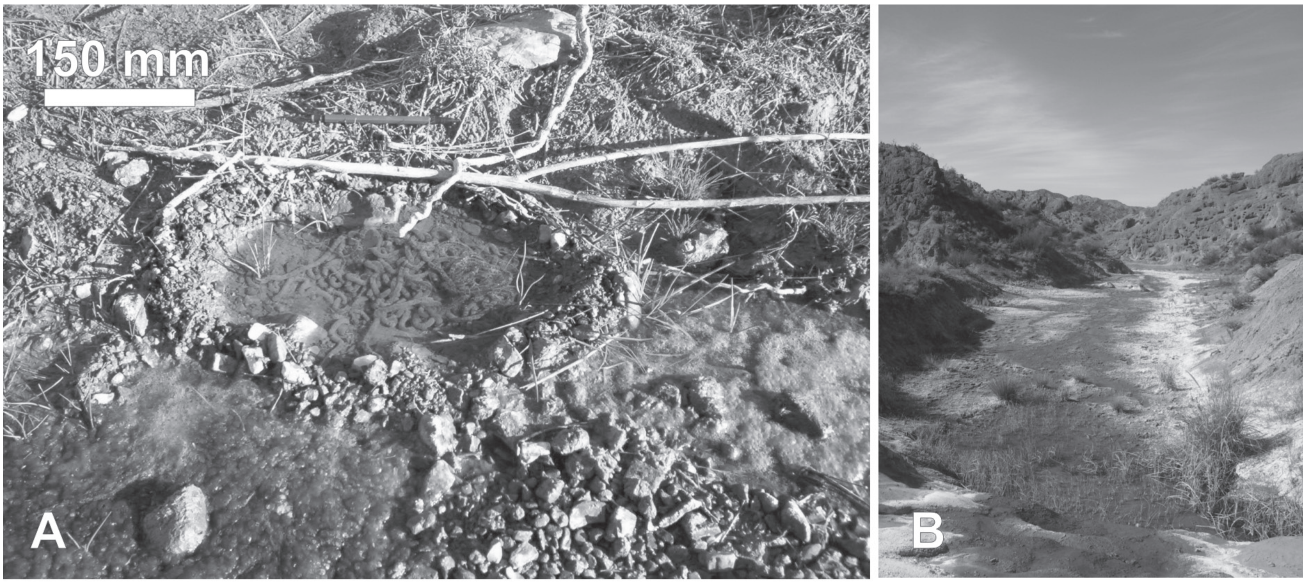

Fig. 2. – (A): The nest of *Rhinella spinulosa.* Eggs are deposited in the centre of the nest. Water level outside the nest water is lower than inside. (B): Typical environment where adults of *R. spinulosa* build the facultative-nest.

water fluctuations throughout the day, assuring in that way the survival of their offspring by avoiding dehydration of eggs and tadpoles. During hours of maximum insolation (1400-2000) streams show a minimum water depth. This effect is seen in a narrowing of the stream and the consequent decrease of water around the nest. Sanabria and collaborators (2005) observed in *R. arenarum* that the repeated decrease of water depth in natural environments caused the death of eggs and tadpoles. The facultative nest-building may be an adaptation of *R. spinulosa* for ensuring the successful raising of offspring in different habitats and in different seasons. This facultative behaviour would allow this species to conserve energy by not constructing nests in environments and periods where the water level is more stable.

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