2011

Distribution of tadpoles (Hyla arenicolor) in the pools associated with the Rio Salado, Puebla, Mexico

G. A. Woolrich-Pina

J. A. Lemos-Espinal

Geoffrey R. Smith

R. Montoya-Ayala

Luis Oliver-López

Distribution of Tadpoles (*Hyla arenicolor*) in the Pools Associated with the Río Salado, Puebla, Mexico

One of the goals of studying the ecology of anurans is to understand why it's distributed in some sites and not in others. It has been documented that factors such as pH, temperature, photoperiod, dissolved oxygen, and salinity, among others, are involved in the distribution of tadpoles (Welch and MacMahon, 2005; Girish and Krishnamurthy, 2009; Woolrich-Piña et al., 2010).

The Río Salado is characterized by a high level of salinity present in the low basin (1.0-6.0 ppt) due to the erosion of carbonated sediment from the medium and high basin as well as for the production of salt (Woolrich-Piña, 2010). This might influence the distribution of the anurans that inhabit the different pools associated with the river. *Hyla arenicolor* is one of four species of anurans that are distributed along the Río Salado, in the Valle de Zapotitlán Salinas, Puebla, México. Here we report which are the factors that influence the distribution of *H. arenicolor* (tadpoles) in the Río Salado.

Materials and Methods.

The study was realized in San Juan Raya, municipality of Zapotitlán Salinas Valley (18° 18' N, 97° 37' W and 1730 m elevation), in Puebla, Mexico. Mean annual temperature and precipitation are 21°C and 400 mm, respectively. Plant species include some cacti (*Nebouxbamia tetetzo*, *Cephalocereus* spp.), mesquite trees (*Prosopis laevigata*), and pata de elefante trees (*Beucarnea gracilis*), principally (Rzedowski 2006).

We conducted surveys along a 1 km segment of the Río Salado monthly from March to June 2010 to characterize conditions in the river and determine the distribution of tadpoles of *H. arenicolor*. The conditions characterized were: length, width and depth (cm), salinity (ppt), and dissolved oxygen (mg/L^{-1}) of each pond. Salinity, and dissolved oxygen were measured using a YSI Model 85 Handheld DO/ conductivity meter.

We used a multivariate analysis of variance (MANOVA) to compare the physical and chemical parameters between pools with and without tadpoles among months. A significant MANOVA was followed by unifactorial nested ANOVAS to examine each variable in detail.

Results.

MANOVA found significant differences in the pools with and without tadpoles (Wilks' $\lambda = 0.008$, $F_{28,132} = 25.13$, $P < 0.01$). Tadpoles were found in pools deeper ($F_{1,52} = 23.8$, $P < 0.01$), wider ($F_{1,52} = 5.73$, $P < 0.01$), longer ($F_{1,52} = 5.68$, $P < 0.01$), with higher dissolved oxygen (DO) levels ($F_{1,52} = 40.3$, $P < 0.01$) and lower salinity ($F_{1,52} = 348.7$, $P < 0.01$) than pools without tadpoles (see table 1).

Discussion.

Hylid tadpoles were observed in pools with low salinity. This has been observed in other anuran species, because it generally does not frequent environments with high salt concentrations (Davenport and Huat, 1997; Smith et al., 2007; Wells 2007). However, it has been observed that salinity did not affect the distribution of *Buergeria japonica* tadpoles, the abundance of *Rhinella marina* increased with salinity, and *Fejervarya cancrivora* tolerates it in very high concentrations (Gordon et al., 1961; Haramura, 2007; Ríos-López, 2008).

We also found tadpoles in pools with higher DO levels. This is consistent with other species (e.g. *Incillius* [*Ollotis*] *occidentalis*, *Rana pipiens* and *Anaxyrus terrestris*; Noland and Ultsch, 1981; Woolrich-Piña et al., 2010). Dissolved oxygen can be related to species richness and predation on tadpoles (Ultsch et al., 1999; Peltzer and Lajmanovich, 2004).

Tadpoles were distributed in longer, wider and deeper pools. A pool with a greater volume has a lower probability of dessication, increasing the time for larval development. Premature pool drying is often a major cause of mortality for the larvae of many species (Beebee, 1996).

Due to the importance of water chemistry in the distribution of *H. arenicolor* tadpoles, it is important to consider the potential effect of salt factories on water quality in the river. Salt factories ("salineras") divert water from the Río Salado to harvest the salt by evaporation. Thus it is possible that the salineras may impact the habitat of native fauna, including *H. arenicolor*.

Table 1. Mean values and interval of the chemicals and physicals parameters present in the ponds.

Pond	O mg/L-1	Salinity ppt	Length (m)	Width (m)	Depth (m)
With tadpoles	4.7 ± 0.4	(1.2 –2.8)	4.1 ± 0.7	(0.8 – 5.9)	6.4 ± 1.6
	(1.3 – 15)	1.1 ± 0.6	(0.43 – 3.2)	0.26 ± 0.05	(0.25 – 1)
Without tadpoles	2.3 ± 0.7	(3.3 – 6.5)	0.9 ± 0.08	(0.2 – 0.9)	3.2 ± 0.9
	(0.8 – 4.7)	2.5 ± 0.6	(0.84 – 6.4)	0.55 ± 0.08	(0.08 – 0.42)

Acknowledgments.

This study was supported by the projects: PAPIIT IN 221707, and PAPCA 2008-2009; PAPCA 2009-2010.

Literature Cited.

Beebee T. J.
1996. Ecology and conservation of amphibians. Chapman & Hall Press. UK. 214 pp.

Davenport J., and K. K. Huat.
1997. Salinity tolerance and preference in the frog *Rana rugulosa* (Wiegmann). Herpetological Journal 7: 114-115.

Girish K., and S. V. B. Krishnamurthy.
2009. Distribution of tadpoles of largewrinkled frog *Nyctibatrachus major* in central Western Ghats: influence of habitat variables. Acta Herpetologica 4 (2): 153-160.

Gordon M. S., K. Schmidt-Nielsen, and H. M. Kelly.
1961. Osmotic regulation in the crab-eating frog (*Rana cancrivora*). Journal of Experimental Biology 38: 659-678.

Haramura T.

2007. Microhabitat selection by tadpoles of *Buergeria japonica* inhabiting the coastal area. Journal of Ethology 25: 3-7.

Noland R., and G. R. Ultsch.

1981. The roles of temperature and dissolved oxygen in microhabitat selection by the tadpoles of a frog (*Rana pipiens*) and a toad (*Bufo terrestris*). Copeia 1981: 645-652.

Peltzer P.M., and R. C. Lajmanovich.

2004. Anuran tadpole assemblages in riparian areas of the Middle Paraná River, Argentina. Biodiversity and Conservation 13: 1833-1842.

Rios-Lopez N.

2008. Effects of increased salinity on tadpoles of two anurans from a Caribbean coastal wetland in relation to their natural abundance. Amphibia-Reptilia 29: 7-18.

Rzedowski J.

2006. Vegetación de México. 1ª edición digital. CONABIO. D. F. México. 504 pp.

Smith M. J., E. S. G Schreiber, M. P. Scroggie, M. Kohout, K. Ough, J. Potts, R. Lennie, D. Turnbull, C. Jin, and T. Clancy.

2007. Associations between anuran tadpoles and salinity in a landscape mosaic of wetlands impacted by secondary salinisation. Freshwater Biology 52: 75-84.

Ultsch G. R., D. F. Bradford, and J. Freda.

1999. Physiology: Coping with the Environment. In R.W. McDiarmid and R. Altig (eds). Tadpoles: The Biology of Anuran Larvae. Univ. Chicago Press, Chicago, Illinois. USA. pp. 189-214.

Welch N. E., and J. A. Macmahon.

2005. Identifying habitat variables important to the rare Columbia spotted frog in Utah (USA): an information-theoretic approach. Conservation Biology 19:473-481.

Wells K. D.

2007. The ecology and behavior of amphibians. University of Chicago Press. Chicago, Illionois. USA. 1148 pp.

Woolrich-Piña G. A.

2010 . Caracterización hidrológica del Valle de Zapotitlán Salinas (Puebla) y su influencia en la distribución de los anfibios: aspectos geográficos, ecológicos y de conservación. Tesis doctoral. Facultad de Filosofía y Letras, UNAM. 138 pp.

Woolrich-Piña G. A., G. R. Smith, L. Oliver-López, M. Barbosa Morales, and J. A. Lemos-Espinal.

2010. Distribution of tadpoles of *Ollotis occidentalis* (Amphibia: Anura: Bufonidae) along the Río Salado, Puebla, Mexico. Acta Herpetologica 5 (2): 151-160.

Guillermo A. Woolrich-Piña[1,2,5], Julio A. Lemos-Espinal[1], Geoffrey R. Smith[3], Raymundo Montoya-Ayala[4] and Luis Oliver-López[1]

[1]Laboratorio de Ecología, Unidad de Biología, Tecnología y Prototipos, FES Iztacala UNAM, Av. De los Barrios # 1 Col. Los Reyes Iztacala, Tlalnepantla, Estado de México, México. C. P. 54090de Herpetología, Vivario, FES Iztacala UNAM, Av. De los Barrios # 1 Col. Los Reyes Iztacala, Tlalnepantla, Estado de México, México. C. P. 54090.

[2] Laboratorio de Geobiología y Paleontología, ESIA Ticomán "Ciencias de la Tierra" IPN. Av. Ticomán # 600, Col. San José Ticomán, Del. Gustavo A. Madero, México D. F. C. P. 07340.

[3] Department of Biology, Denison University, Granville, Ohio 43023 USA.

[4] Laboratorio de Cómputo, Unidad de Biología, Tecnología y Prototipos, FES Iztacala UNAM, Av. De los Barrios # 1 Col. Los Reyes Iztacala, Tlalnepantla, Estado de México, México. C. P. 54090de Herpetología, Vivario, FES Iztacala UNAM, Av. De los Barrios # 1 Col. Los Reyes Iztacala, Tlalnepantla, Estado de México, México. C. P. 54090.

[5] Author for Correspondence: woolrichg@unam.mx

Received: 14 July 2011
Accepted: 23 August 2011