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COMPOSITION, MICROHABITAT AND CONSERVATION OF THE ANURANS COMMUNITY IN LOWER BASIN TEMASCATIO RIVER, GUANAJUATO

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Abstract: We carried out this study in the lower basin of the Temascatio River, Guanajuato, Mexico, in a seasonal tropical environment. We identified ecological aspects of the microhabitat use and composition of nine species of anurans found in three types of vegetation, in both the dry and rainy seasons. We characterized five types of habitats (saxicolous, arboreal, terrestrial, aquatic and riparian). The tropical deciduous forest and subtropical scrubland had higher species representation than oak forest. A significant change was observed, both by species and season, and in the use of microhabitats between the rainy and dry seasons. Niche overlap was related to the habits of the species; that is, the arboreal–terrestrial species (*Dryophytes eximius*, *Anaxyrus compactilis*, *A. punctatus*, *D. arenicolor* and *Hipopachus variolosus*) and the aquatic species (*Lithobates neovolcanicus* and *L. megapoda*) presented the highest overlap values. The principal component analysis showed that the thermal factor and vegetation explain the structure of the anuran community, but not microhabitat use. This work provides information on the ecology of the anurans inhabiting in the LBTR and emits an alert signal for conservation of the species at site, since the EVS (Enviroment Vulnerability Score) showed that *A. punctatus*, *Spea multiplicata*, *H. variolosus* and *L. megapoda* presented values of high vulnerability. Finally, when concluding that natural vegetation determines the presence and structure of the anuran community, local governments must prioritize the protection of this ecosystem.
Keywords: Amphibians, ecology, niche, vegetation, Mexico.

INTRODUCTION

Anurans are a cosmopolitan group with a wide distribution in a range of environments and latitudinal gradients. These organisms also exhibit a great variation in morphology and reproductive cycles (García and Cabrera-Reyes, 2008; Urbina-Cardona, 2008; Vitt and Caldwell, 2014). Therefore, they have been regarded as important study models for testing ecological hypotheses at local and regional scales (Cruz-Elizalde *et al.*, 2016; Johnson *et al.*, 2017). Given their physiological characteristics and moisture requirements, most of these species are limited to wet environments and seasons where food, optimum environmental conditions, and mating partners are available (Santos *et al.*, 2008; Martínez-Baños *et al.*, 2011; Leyte-Manrique *et al.*, 2018; Luria-Manzano *et al.*, 2019). Consequently, an understanding of ecological aspects that influence the distribution of anurans is important when it comes to their conservation, especially when species are found in seasonal habitats that drastically affect their characteristics such as abundance, sex proportion, and age classes (Conte and Machado, 2005; Cortés-Suárez, 2014; Vitt and Caldwell, 2014; Nieva-Cocilio *et al.*, 2020).

Amphibians in general have been experiencing changes in their distributions driven by anthropogenic activities in their natural habitats. Endemic species can be the most affected, to the point of local extinction (Urbina-Cardona, 2008; Cruz-Elizalde *et al.*, 2016; Leyte-Manrique *et al.*, 2019). Therefore, the objective of this work was to find and understand microhabitat use, spatial distribution, and structure of the community of anurans inhabiting ecosystems that experience drastic seasonal and landscape changes due to activities such as grazing and deforestation such as the changes found in the region known as Lower Basin River Temascatio (LBRT) in Guanajuato, Mexico, where studies of this kind are practically nonexistent. We understand that microhabitat use in different types of vegetation significantly determines not only species composition but also the structure of the community. Information that includes both microhabitat and habitat use is expected to help with the design of effective conservation strategies for species or populations that could be threatened in the LBTR and the state of Guanajuato.

MATERIAL AND METHODS

STUDY AREA

The Lower Basin Temascaio River (LBTR) is located in the northwestern portion of the municipality Irapuato, Guanajuato, Mexico (20.81 N, 101.15 W; **Figure 1**). This area is bordered to the north by Natural Protected Area upper basin of the Temascatio, which is located in the municipality of Salamanca (Cadena-Rico *et al.* 2020). The study area includes an elevation range of 1876 to 2208 m, with shallow and rocky soils. The climate is semi-warm with a total annual precipitation that ranges between 400 and 900 mm, and a mean annual temperature of 19.2 °C (9.4-29.7 °C; García, 2004). The major vegetation components are deciduous tropical forest, subtropical scrub, and oak forest (Rzedowski, 2006; Zamudio-Ruíz, 2012).

FIELD WORK

From February 2017 to March 2018, a total of 12 monthly samplings were carried out, covering both rainy (May-September) and dry (October-April) seasons, in three vegetation components: 1-deciduous tropical forest (DTF), 2-subtropical scrub (STS), 3-oak forest (OF), with the goal of identifying changes in the amphibian communities (Leyte-Manrique *et al.*, 2018). Previous to sampling, ten transects of 300 × 10 m were established in each vegetation type with two replicates each, 100 m apart (Vite-Silva *et al.*, 2010). Observation of individuals took place from 09:00 to 12:00 and 17:00 to 24:00. The organisms were searched for in pools of water, on stream banks, on rocks, trunks, and branches of shrubs (Scrocchi and Kretzschmar, 1996). Body temperature data (T °CC) were taken, and in parallel the microhabitat temperature (T °CMH), and environmental temperature (T °CA) using a Mitutoyo digital thermometer with a reading range of 10 to 120 °C. The specimens were identified at the species level using specialized guides (Vázquez-Díaz and Quintero-Díaz, 2005). After capture and identification, each individual was released at the site where it had been collected. Field collection for this study was conducted under scientific collection permit SGPA/DGVS/06622/13 issued by the Dirección General de Vida Silvestre of the Secretaría de Medio Ambiente y Recursos Naturales (SEMARNAT).

MICROHABITAT CHARACTERIZATION

The microhabitats (MH) were classified based on species behavior; 1-saxicolous, 2-terrestrial, 3-arboreal, 4-riparian, and 5-aquatic (Martín-Regalado *et al.*, 2016; Roth-Monzón *et al.*, 2018). The structures of the habitat and microhabitat were characterized based on physical features (rocks, plants, logs, water bodies, etc.), and ambient conditions (temperature, moisture, etc.) found within a one-meter circumference taking the position of the organism as the center (Vrcibradic and Rocha, 1995). The resulting data from these variables were used for a principal component analysis (PCA).

DATA ANALYSIS

We used species abundance data to calculate abundance ranges (Whittaker's curve) by both vegetation type and season to graphically describe anuran species composition (Magurran, 2004). We also used a Kruskall-Wallis test to compare microhabitat use between species (Balzarini *et al.*, 2015). The results from this section were processed with InfoStat version 2.1, considering mean values ± s.e. (standard error), and a significance value of $P = 0.05$. Additionally, analyses of niche overlap between species were obtained with Pianka's (1973; Krebs, 1999) overlap index O_{jk}

$$Ojk = \sum_{i}^{n} p_{ij}\, p_{ik} / \sqrt{(\sum_{i}^{n} p_{ij}^{2} \sum_{i}^{n} p_{ik}^{2})}$$

Where p represents the use of resource i (microhabitat) by species j and k, and n is the total number of resources. This index yields values between 0 (no overlap) and 1 (complete overlap). The analysis was done using the program Ecological Methodology, version 2.

Lastly, we applied a principal component analysis to determine which variables best explain the variation in the relationship between the structure of the anuran community and its physical environment or habitats (Leyte-Manrique *et al*., 2018). For the analysis, eleven variables were used, grouped into two categories (which served as the basis for assigning the resulting factors): 1-thermal, such as body temperature (T °CC), microhabitat temperature (T °CMH), and environmental temperature (T °CA Microhabitat(MH),T°CC(bodytemperature), T °CA); and 2-microhabitat structure, such as microhabitat (MH used by the species), VEGT = vegetation type, vegetation coverage (VC), rock coverage (RC), bare soil coverage (BSC), and water portion (W), distance to nearest microhabitat (DNMH), which is the distance from the microhabitat site where lizards were first observed to the nearest different microhabitat, and nearest microhabitat (MHN). All of these variables were measured within a one-meter circumference of the microhabitat (Vrcibradic and Rocha 1995). The variables were measured with a standard measuring tape (Vanhooydonck *et al*., 2000). The averaged data were adjusted and normalized by taking the log with the intention of looking for collinearity between variables, since the data of the variables were of different scalar magnitudes (Balzarini *et al*., 2015). The analysis was carried out using the statistical program InfoStat version 2.1. A dual graphic representation (biplot) was also drawn to represent the principal plane and the variables correlated with each other.

CONSERVATION STATUS OF ANURANS IN LBTR

The conservation status of the species that make up the community of anurans in the Lower Basin Temascatio River was determined, based on two traditional indicators such as NOM-059-SEMARNAT (2010), and the IUCN (2021) red list. Which were compared with the values of the Environmental Vulnerability Score (EVS) proposed by Wilson y colaboradores (2013). Which considers the vulnerability of the species on three scales: Low (B, 3-9), Medium (M, 10-13) and High (A, 14-19), and which usually provides current information on the state of conservation and vulnerability of species, at a local and regional scale. The result of the index value assigned to each species is the sum of three aspects: 1- geographical distribution, 2- extension of the ecological distribution (types of vegetation in which the species are found), and 3- reproductive modes.

RESULTS

A total of 262 individuals were recorded. These anurans belong to nine species, six genera, and five families (**Figure 2**). The most abundant species were *Dryophytes eximius*, (n = 132), *Lithobates neovolcanicus* (n = 56), and *D. arenicolor* (n = 37), and the least abundant was *Spea multiplicata* (n = 1). *Dryophytes eximius* was the most abundant species in OF, and *Lithobates neovolcanicus* in STS. *Anaxyrus* *punctatus*, *D. eximius*, *D. arenicolor*, *L. neovolcanicus*, *L. megapoda*, *and I. occidentalis* were the species best represented in DTF. The highest abundance by vegetation type was in OF with 149 individuals (57 %), followed by DTF with 61 individuals (23 %), and STS with 52 individuals (20 %). Abundance rank curves showed that *D. eximius* exhibited the highest abundance in both wet and dry seasons, while *I. occidentalis* had lower abundance during the dry season, and *Spea multiplicata* and *L. megapoda* in the rainy season (**Figure 3**).

Five types of microhabitats utilized by the anuran community were identified. Of these, the saxicolous microhabitat had the highest percentage (43 %), followed by aquatic (21 %), terrestrial (18 %), arboreal (15 %), and riparian (4 %) (**Table 1**). The anurans used five types of microhabitat in tropical forest and oak forest, using saxicolous most frequently. They used four microhabitat types in subtropical shrub (saxicolous, riparian, aquatic, and terrestrial), the aquatic microhabitat being the most frequently used. A Kruskall-Wallis test showed significant differences in microhabitat use among vegetation types ($H_{5,257}$ = 5.23, $P<0.05$), and there were differences with respect to the equal variances test (F = 19.04, $P<$ 0.05). Differences were also observed with respect to anurans presence in the different vegetation types and seasonality (**Figure 4**; $F_{2,257}$ = 5.32, $P<0.05$).

The highest niche overlap in the same vegetation type and microhabitat was between *Anaxyrus compactilis* and *Dryophytes eximius* (O_{jk} = 0.894) using rocks, followed by *A. punctatus* and *D. arenicolor* (0.702) using open space, *A. punctatus* and *D. eximius* (0.855) using rocks, *D. arenicolor* and *H. variolosus* (0.831) using open space, and *D. arenicolor* and *S. multiplicata* (0.813) using both rocks and open space. By season, the highest niche overlap value occurred between *Lithobates neovolcanicus* and *L. megapoda* (0.975) in the dry season using aquatic microhabitats, while *A. punctatus* and *H. variolosus* showed the highest overlap (0.957) using rocks (**Figure 4**).

The PCA showed that PC1 accumulated the most variation (35 %), and PC2 explained 23 % of the variation, with both components together explaining 58 % of the variation (**Table 2**). The graphic representation of the principal plane with the species and the correlation of the variables suggested five groups (thermal, vegetation, water, rocks, and microhabitat proximity), where the thermal group and vegetation contained the highest number of correlated variables, and each factor was formed by the similarity of species (internal circumferences, **Figure 5**). These are embedded in the variables that are positively correlated. The species affinity to environmental factors was heterogeneous. The thermal factor associates *L. neovolcanicus*, *A. punctatus*, and *D. arenicolor*, and the factors rocks and water associated *S. multiplicata* and *A. compactilis*; and *H. variolosus* and *L. megapoda*, respectively. The factors vegetation and proximity to microhabitats related to *D. eximus* and *Incilius occidentalis*.

Of the nine species that make up the anuran community, five are endemic to the country (56%). On the IUCN Red List (2020), the conservation status of *Lithobates megapoda* it's found as vulnerable and into the NOM-059-SEMARNAT (2010); *L. neovolcanicus* is in the threatened category, and *L. megapoda* as subject to special protection. On the other hand, using the EVS of Wilson et al. (2013) two species were considered low risk (*Anaxyrus punctatus*, *Dryophytes arenicolor*), three in medium (*Incilius occidentalis*, *D. eximius* and *L. neovolcanicus*) and four in high risk (*A. compactilis*, *Hipopachus variolosus*, *L. megapoda* and *Spea multiplicata*; **Table 3**).

DISCUSSION

Seasonal habitats have a strong effect on the population dynamics of anuran species and therefore on abundance values (Luja *et al*., 2016, Leyte-Manrique *et al*., 2018, Duarte-Ballesteros *et al*., 2021). This was observed in this study, where more species were recorded during the rainy season, but more abundance during the dry season. The pattern observed during the dry months is different from that in other studies, where more abundance was observed during the wet season (Conte and Machado, 2005; Huckembeck *et al*., 2012; Leyte-Manrique *et al*., 2018; Roth-Monzón *et al*., 2018). This pattern could be related to the reproductive strategies displayed by the different species. *Dryophytes eximius* and *Lithobates neovolcanicus* are the most representative taxa of the dry season, primarily due to the presence of hatchlings and juveniles (Duellman and Trueb, 1994, Duellman, 1995; Cadena-Rico *et al*., 2020). The species least represented during the rain season was *Spea multiplicata*, which was observed only once, at the beginning of the rains (June). However, the presence of this species is likely due to significant disturbance of the subtropical shrub, driven by cattle raising in the area. Species such as *D. eximius*, *D. arenicolor*, *L. megapoda*, and *L. neovolcanicus* were found in the three vegetation types, and in both seasons. These results suggest that these species are able to withstand seasonal environmental changes (García and Cabrera-Reyes, 2008, Roth-Monzón *et al*., 2018).

The anurans of the Lower Basin Temascatio River primarily used rocky microhabitats, followed by aquatic microhabitats. These results are similar to those reported by Roth-Monzón *et al*. (2018) in oak forest and xerophytic shrub. It is likely that individuals preferred this saxicolous habitat because it provides protection against predation, and rocks help to ensure homeostasis during both night and day (Cruz-Elizalde *et al*., 2016; Hernández-Salinas *et al*., 2018). In this study, we observed individuals of *D. eximius* using arboreal and rocky microhabitats, with adults observed in shrubs and juveniles on rocks during the dry season. *Anaxyrus compactilis*, *A. punctatus*, *I. occidentalis*, and *S. multiplicata* mostly used saxicolous microhabitats. The latter observation was also reported by Vitt and Caldwell (2014), and Leyte-Manrique *et al*. (2018), who listed these microhabitats for these species in tropical and seasonal environments. Additionally, Leyte-Manrique (2018) suggested that the use of this microhabitat is likely a behavioral–physiological response to environmental factors such as ambient temperature and humidity, as opposed to preference for a particular vegetation type. Species such as *L. megapoda* and *L. neovolcanicus* displayed an obvious preference for the aquatic habitat, with populations being abundant in ponds and puddles, although they also showed some ability to use other seasonal microhabitats as other species of the genus do (Leivas *et al*. 2012a, b). The selection of a substrate or microhabitat is driven by the species' own attributes; ecological, physiological, behavioral, and morphological (Cortés-Gómez *et al*., 2013; Cortés-Suárez, 2014; Muñoz-Guerrero *et al*., 2007; Luja *et al*., 2016; Dos Santos and Conte, 2016), which may explain the high overlap between *A. punctatus* and *H. variolosus*, since both species display saxicolous–fossorial habits and similar anatomical features.

When comparing different species using a PCA, the model of the anuran community structure (diversity, abundance, interactions, habitat use, among others) showed that species such as *A. punctatus*, *D. arenicolor*, and *L. neovolcanicus* show higher dependence on temperature, similar to that observed in other anuran communities (Cortés-Gómez *et al.*, 2013; Álvarez-Grzybowska *et al.*, 2020). This suggests that aspects such as dispersal capability are essential for dealing with temperature changes (Leyte-Manrique *et al.*, 2018; Álvarez-Grzybowska *et al.*, 2020). There are studies that show how anuran activity is affected by temperature, especially in aspects such reproduction and during the initial stages of development (Leivas *et al.*, 2012a). However, from another perspective, this leads to a possible risk for the anurans community in the face of climate change (Corn, 2005; McCallum, 2010; Shoo *et al.*, 2011; Vasconcelos *et al.*, 2018; Medina *et al.*, 2020). Of particular note is the relationship of *L. neovolcanicus* with *L. megapoda*; of *D. arenicolor* with *D. eximius*; and *A. compactilis* with *A. punctatus*, which reveals the plasticity of these species to adapt to these environments. These results also reflect the way two species interact without competing for resources in the same niche, as has been observed in other anuran communities where syntopic species use similar microhabitats, partitioning the resources and thereby avoiding intense competition (Stuart *et al.*, 2008; Duré *et al.*, 2009; Blanco-Torres and Bonilla-Gómez, 2010). A strong contribution to the model of the factor "closeness to microhabitats" was also observed, in which *Incilius occidentalis* responds to any microhabitat that is nearby, which possibly indicates that this species is the least specialized for any microhabitat and varies according to its natural history in various ecosystems (Ramírez-Bautista *et al.*, 2014).

Although the species present varied adaptations to the environment, specifically to particular microhabitats in their ecological distribution, differentiation and plant heterogeneity are decisive in the selection of microhabitats by making them more varied, thus avoiding overlap between species (Urbina-Cardona, 2008; Luria-Manzo *et al.*, 2019; Nieva-Cocilio *et al.*, 2020). However, this did not occur in the present study, given the high overlap that occurred in several species, which shows that factors such as temperature also influence the selection of microhabitat and the distribution and association between species. This study is the first to address ecological aspects of the anuran community in the Lower Basin Temascatio River. Therefore, these results are important for an understanding of these communities from seasonal tropical environments in the state of Guanajuato. The local distribution pattern of the anuran community in the LBTR was found to be strongly influenced by vegetation type, availability of habitats, and adaptation to environmental factors and seasonal changes between the rainy and dry seasons. This is reflected in the composition and abundance of the species present at the site. Five of the nine species registered in this study are endemic to the country: *Lhitobates neovolcanicus* and *L. megapoda* (Ranidae); *Dryophytes eximius* and *D. arenicolor* (Hylidae); *Anaxyrus compactilis* (Bufonidae). These proportions are mostly in agreement with those of Johnson *et al.* (2017), who also mention that the largest number of endemic anurans in Mexico are found in families Hylidae, Craugastoridae, Eleutherodactylidae and Ranidae. Regarding the conservation status, the IUCN (2021) Red List has a higher percentage of species in some category of threat with respect to NOM-059-SEMARNAT (2010). According to the EVS values obtained for the anuran community of the LBTR, seven of the nine species are found at a high to medium level, and only two are low. (*A. puntactus* and *D. arenicolor*), and in the case of the *A. compactilis* it's reported in a category of least concern (LC) in the IUCN Red List and without information in NOM-059-SEMARNAT (2010). The implementation of the EVS as a support to determine the state of conservation of the species, allows to have data at a more local level of the situation of the species in a specific area, this would compensate for the lack of updates and/or information that is available for many species in the NOM-059-SEMARNAT (2010) and in the IUCN. Additionally, these results enable species to be identified that could face higher risks in the Lower Basin Temascatio River; therefore, we plan to continue to monitor these populations and design conservation strategies for species such *as S. multiplicata* and *H. variolosus*, which showed very limited distribution at the study site. By knowing the close relationship of the anuran community with the natural vegetation of the area, local governments must now address the protection of this existing ecosystem. The results of this work, being the first to deal with ecological aspects for the anuran community in the region of the LBTR, provide valuable information for understanding the composition and structure of the anuran communities in seasonal tropical environments from the state of Guanajuato. Additionally, the results of this study allow the identification of species at risk within the LBTR, as well as establishing strategies for their preservation.

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TABLES

Species	Microhabitat				
	Saxicolous	Aquatic	Terrestrial	Arboreal	Riparian
Anaxyrus compactilis (Wiegmann, 1833)	1	0	1	0	0
A. punctatus (Baird & Girard, 1852)	15	0	8	0	0
Incilius occidentalis (Camerano, 1879)	1	0	2	0	0
Dryophytes arenicolor (Cope, 1866)	18	1	19	0	0
D. eximius (Baird, 1854)	70	5	15	39	4
Hypopachus variolosus (Cope, 1866)	1	0	1	0	0
Lithobates megapoda (Taylor, 1942)	0	2	0	0	1
L. neovolcanicus (Hillis & Frost, 1985)	6	46	0	0	5
Spea multiplicata (Cope, 186)	0	0	1	0	0
IND / %	112/43	54/21	47/18	39/15	10/4

IND = Individual number. % Percentage of organisms in each microhabitat.

Table 1. Species abundance and occurrence in microhabitats.

Variables	CP 1	CP 2	
MH	0.86	0.11	
T°CC	0.64	-0.52	
T°CA	0.41	-0.48	
T°C MH	0.45	-0.44	
VEGT	0.94	-0.01	
CV	0.71	0.32	
CR	-0.59	-0.71	
BSC	0.28	-0.59	
W%	-0.17	0.17	
DNMH	-0.05	0.86	
MHN	0.69	0.34	
Component	Autovalue	%	Acumulate
PC1	3.84	0.35	0.35
PC2	2.54	0.23	0.58

Table 2. Analysis of principal components with the factors that define the structure of the anuran community in the LBTR.

Specie	**NOM-059**	**IUCN**	**EVS**	**ENDM**
Anaxyrus compactilis	NC	LC	H (14)	E
Anaxyrus punctatus	NC	LC	L (5)	NE
Incilius occidentalis	NC	LC	M (11)	NE
Dryophytes arenicolor	NC	LC	L (7)	E
Dryophytes eximius	NC	LC	M (10)	E
Hypopachus variolosus	NC	LC	H (14)	NE
Lithobates megapoda	Pr	VU	H (14)	E
Lithobates neovolcanicus	A	NT	M (13)	E
Spea multiplicata	NC	NE	H (15)	NE

Table 3. Conservation status anurans in the stuy area. 1-NOM-059-ECOL-2010: A = Threatened, Pr = Special Protection, and Nc = Not evaluated; IUCN (2017): LC = Least Concern, NT = Near Threatened, VU = Vulnerable, EN = Endangered, CR = Critically Endangered, NE = Not Evaluated, and DD = Data Deficient; EVS (Wilson et al., 2013): L = Low, M = Medium, and H = High vulnerability. Endemicity (ENDM): No endemic (NE) and endemic (E) to Mexico.

FIGURES

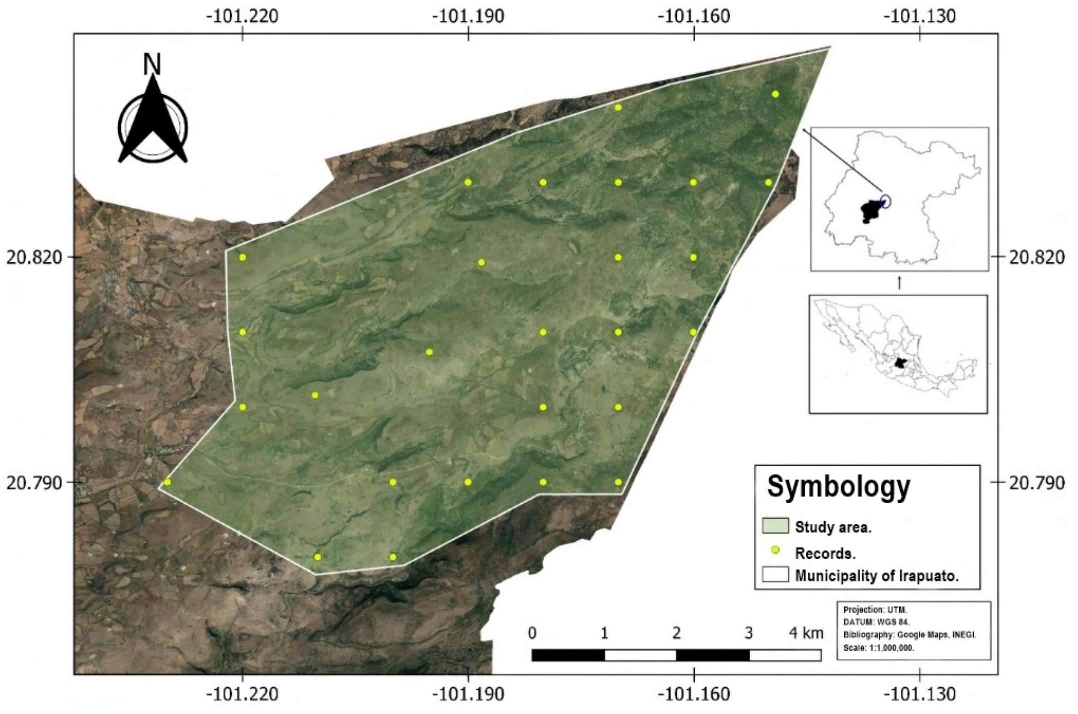

Figure 1. Study area in the Lower Basin Temascatio River, Irapuato, Guanajuato.

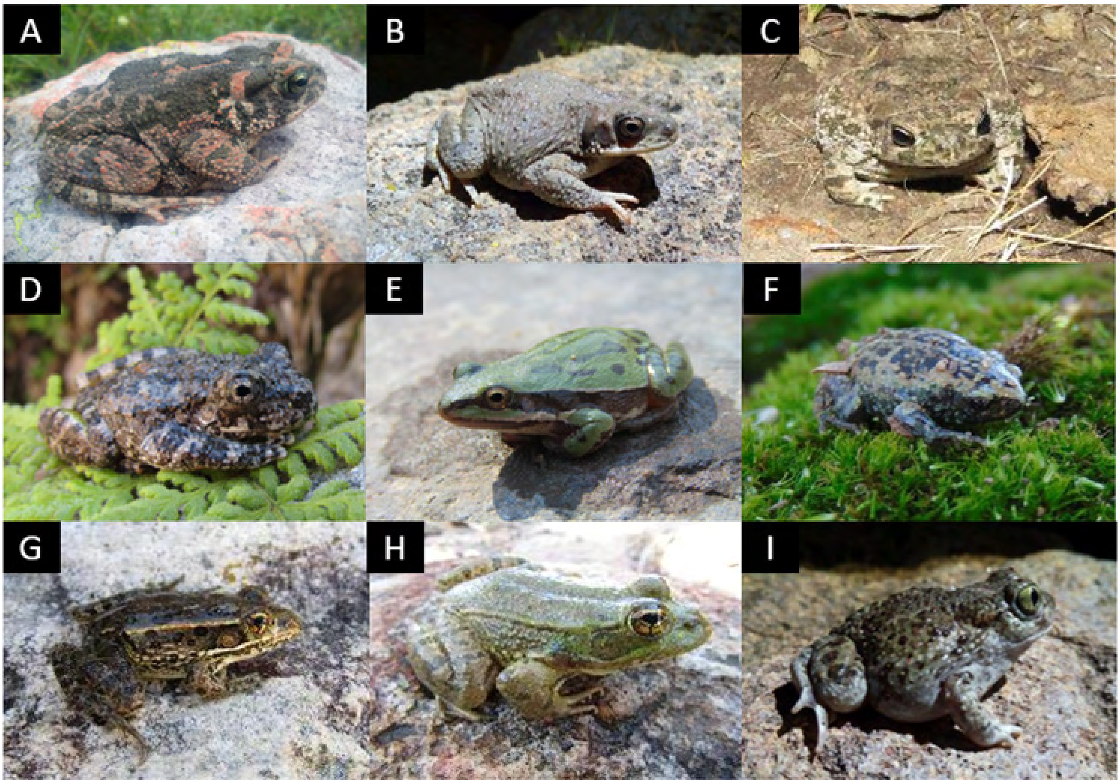

Figure 2. Anurofauna in the LBTR. A = *Incilius occidentalis*, B =*Anaxyrus punctatus*, C = *Anaxyrus compactilis*, D = *Dryhophytes arenicolor*, E = *D. eximius*, F = *Hipopachus variolosus*, G = *Lhitobates neovolcanicus*, H = *L. megapoda* e I = *Spea multiplicata*.

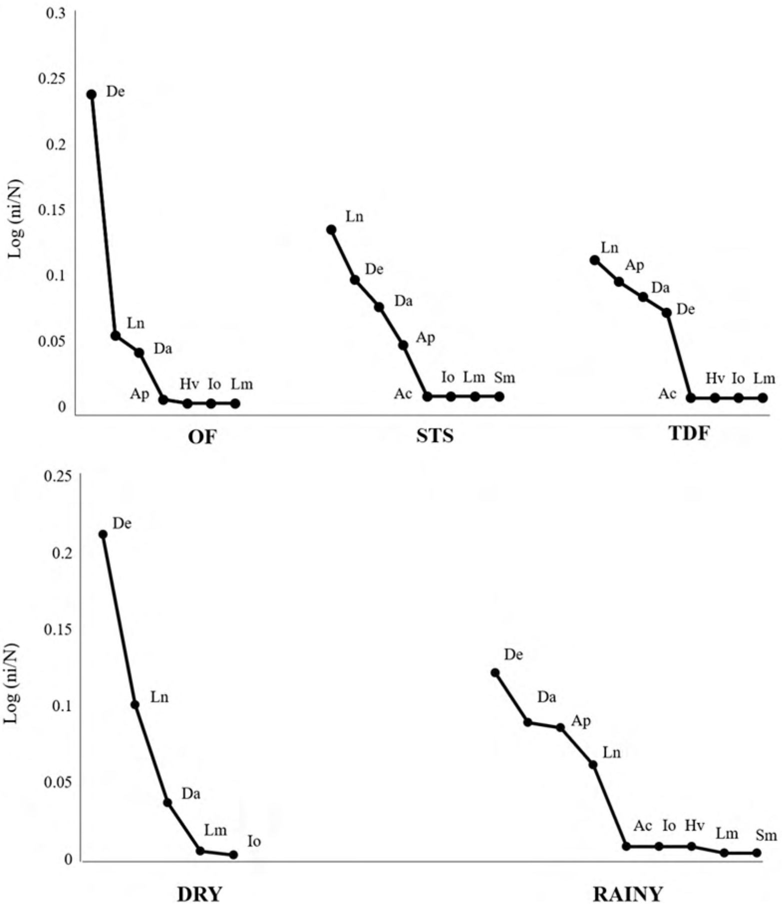

Figure 3. Species composition in each type of vegetation. The letters represent the species as follows: De = *Dryophytes eximius*, Ln = *Lithobates neovolcanicus*, Da = *Dryophytes arenicolor*, Lm = L. *megapoda*, Io = *Incilius occidentalis*, Ap = *Anaxyrus punctatus*, Hv = *Hypopachus variolosus*, Ac = *Anaxyrus compactilis*, and Sm = *Spea multiplicata*. Vegetation: TDF = tropical deciduous forest, STS = subtropical scrub, and OF = oak forest.

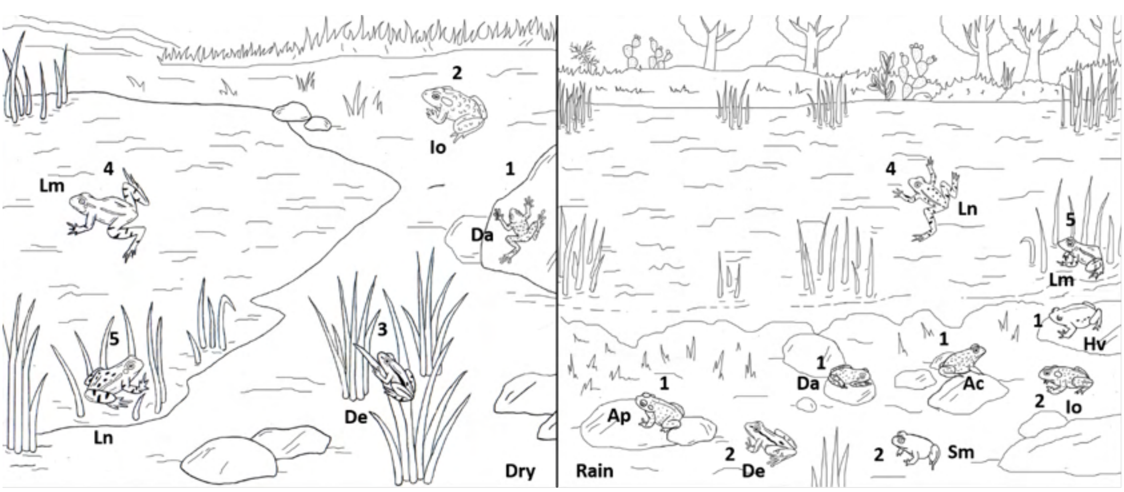

Figure 4. Habits representation of the anuran community in the LBTR for the dry and rainy seasons. Microhabitats: 1 = saxicolous, 2 = terrestrial, 3 = arboreal, 4 = riparian, and 5 = aquatic. De = *Dryophytes eximius*, Ln = *Lithobates neovolcanicus*, Da = *Dryophytes arenicolor*, Lm = L. *megapoda*, Io = *Incilius occidentalis*, Ap = *Anaxyrus punctatus*, Hv = *Hypopachus variolosus*, Ac = *Anaxyrus compactilis*, and Sm = *Spea multiplicata*.

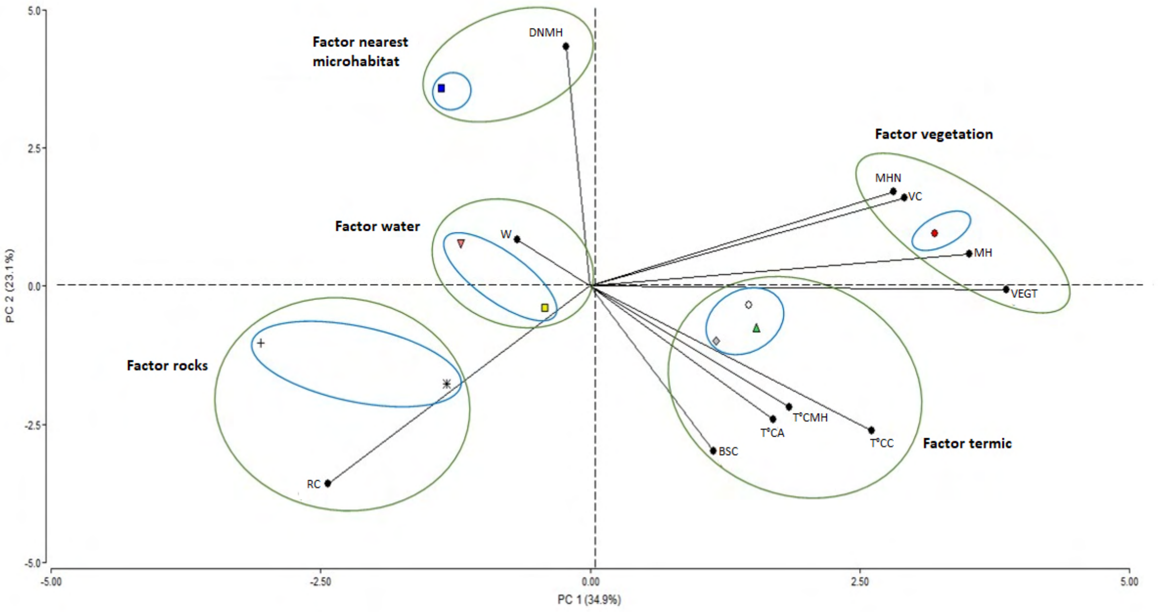

Figure 5. Principal component analysis (PCA) that represents the structure of the anuran community in the Lower Basin Temascatio River. Δ (green fill) = *Anaxyrus punctatus*, ⁎ = *A. compactilis*, ◊ (gray fill) = *Dryophytes arenicolor*, o (red fill) = *D. eximius*, ☐ (yellow fill) = *Hypopachus variolosus*, ☐ (blue fill) = *Incilius occidentalis*, ∇ (red fill) = *Lithobates megapoda*, o = *L. neovolcanicus*, + = *Spea multiplicata*. For the meaning of the abbreviations of the variables, see text. The inner circles group related species, and the outer circles group positively correlated variables.