December 2003

A survey of the herpetofauna of the San Luis valley, Costa Rica, in three microhabitats

John Benjamin

A Survey of the Herpetofauna of the San Luis Valley, Costa Rica, in Three Microhabitats

John Benjamin

Department of EPO Biology, University of Colorado-Boulder

ABSTRACT

I surveyed reptile and amphibian diversity in three types of microhabitats in the San Luis valley, Puntarenas, Costa Rica, an area whose herpetofauna has not yet been thoroughly inventoried. I sampled species richness and abundance using nine line transects of 150 m in length around the Ecolodge and Biological Station San Luis, located all 1150 m in elevation. Three transects were in riparian habitat, three were in forest habitat, and three were in pasture habitat. I found 14 species within the transect areas, and a total of 23 species in San Luis including specimens that were encountered outside the transects. Some of these species *(Bolitoglossa robusta, Sphenomporhus cherriei* and *Leptodiera annulata)* were notable since they are not listed as being common in the Tropical Premontane Moist Forest life zone. No statistically significant difference in diversity was found between the habitats when their H' values were compared with a t-test, which was likely due to the small sample size and limited time frame of the study. However, H', S, and Smarg were all found to increase from pasture to riparian to forest microhabitat, revealing a general trend of highest diversity in the forest and lowest diversity in the pasture. Species composition similarity was found to be relatively high between the forest and rivers, moderate between the rivers and pasture, and low between the forest and pasture.

RESUMEN

Examiné la diversidad del reptiles y anfibios en tres tipos de microhabitats en el valle del San Luis, Puntarenas, Costa Rica, un área en que la herpetofauna todavía no ha estado examinado en detalle. Muestreé la riqueza y abundancia de las especies usando nueve transectos de línea alrededor del Ecolodge San Luis, localizado a 1150 m de elevación. Tres transectos estaban en hábitat riparian, tres estaban en hábitat del bosque, y tres estaban en hábitat del pasto. Encontré 14 especies dentro de las áreas de los transectos, y un total de 23 especies en San Luis incluyendo los especímenes que fueron encontrados fuera de los transectos. Algunas de estas especies *(Bolitoglossa robusta, Sphenomorphus cherriei* y *Leptodiera annulata)* eran notables porque no se enumeran como siendo comunes en la zona del bosque premontaña húmeda. No se encontró una diferencia estadística significativa en diversidad entre los habitantes cuando sus números de H' fueron comparados con una t-prueba, que era probablemente debido al tamaño pequeño de la muestra y al tiempo limitado del estudio. Sin embargo, H', S, y S_{marg} fueron encontrados para aumentar de pasto a riparian al bosque, revelando una tendencia general de la diversidad más alta en el bosque y de la diversidad más baja en el pasto. La semejanza de la composición de especies fue encontrada para ser relativamente alta entre el bosque y los ríos, mas bajo entre los ríos y el pasto, y el más bajo entre el bosque y el pasto.

INTRODUCTION

Amphibians and reptiles play many pivotal roles in biological communities. They are an integral component of food webs in many ecosystems, serving as key prey items for a variety of creatures. Additionally, they are themselves important predators, feeding on and controlling the populations of many small organisms, especially arthropods. Some herps, particularly snakes, have a high degree of dietary specialization, while others have much more generalist diets (Spiller and Schoener l994). Due to their important ecological niches, analyzing the herpetofauna in a community can yield significant information about the overall biodiversity of an area (Pounds 2000).

Changes in reptiles and amphibian populations can be indications of large-scale changes in an ecosystem. Amphibians are especially susceptible to environmental changes due to their permeable skin. Amphibian populations worldwide have declined drastically since in the 1980's without any definitive cause, although possibilities causes include UV radiation, habitat destruction, pollution, pathogens, and even researcher disturbance (Lips 1998). Monteverde, Puntarenas, Costa Rica has experienced a decline in many amphibian species, including the famous Golden Toad *(Bufo periglenes),* which has entirely disappeared. Certain reptiles have declined there as well, including species of ancles and frog-eating snakes (Pounds 2000). A study by Pounds et al. (1999) proposed that the population declines of herps in Monteverde may be linked to increased dryness caused by global warming.

In order to monitor changes in herpetofauna populations in a particular area and investigate possible causes of decline, as well as gain an understanding of overall biological community structure, it is first essential to obtain basic data on the diversity and abundance of herp species there. The San Luis valley, which is located directly below the Monteverde Cloud Forest Reserve, is still relatively unstudied in regards to herpetofauna diversity, with many species as yet unrecorded (Hayes et al. 1989). In this study I surveyed the herp species of San Luis in three microhabitats: riparian, forest, and pasture. I hypothesized that the forest and river habitats would exhibit a significantly higher diversity than the pasture, since pastureland is a simplified habitat with fewer resources and spaces to inhabit.

This study contributes to a larger one that also reports data on San Luis herp species sampled in Spring 2003 during the dry season (Balsavich 2003). The goal is to combine data from both wet and dry season surveys in order to obtain a more thorough inventory of the herp diversity of San Luis, which can then be compared with the diversities of other locations and habitats.

METHODS AND MATERIALS

To survey the herp species of San Luis, I used the method of transect sampling, which is an effective means of studying species numbers and relative abundances within a habitat (Jaeger 1994). I surveyed nine line transects of 150 m surrounding the Ecolodge and Biological Station San Luis, located between 1100 m and 1200 m in elevation, between October 20 and November 14, 2003, during the end of the wet season and the beginning of the transition season (Clark 2000). Three transects were along forest trails, three were along rivers, and three were through pasture. I sampled each transect a total of ten times: five times in the morning between 7:00 AM and 11:00 AM and five times at night between 6:00 PM and 10:00 PM. I rotated the order in which I sampled the transects to ensure that each one was sampled at different times during the four hour period to avoid biases in herp activity based on time of day (Jaeger 1994). On each transect, I searched within

approximately three meters on both sides over the course of about twenty to thirty minutes (night transects tended to take longer, especially in the forests). Whenever a specimen was encountered, I recorded the species, time and location. I generally attempted to catch the animal to ensure proper identification. During the night transects, I used a flashlight.

After gathering all data, I ran a Shannon-Wiener index to determine the diversity (H'), and additionally calculated evenness (E) and S_{marg} diversity for each of the three habitat types. The H' values were compared using a modified t-test. I also calculated the similarities in species composition between the habitats using the Sorenson quantitative index (Magurran 1988).

I additionally recorded herp species that were encountered outside of the transect areas during the course of the study to add to the total list of species observed in San Luis.

RESULTS

14 species of reptiles and amphibians were found during the transect surveys. A total of 23 species from 3 orders and 13 families were observed in San Luis during the course of the study, including species that were encountered outside of the transect area (Table 1). Table 2 compares the relative abundances of species, species richness (S), and the total number of encountered individuals (N) within each habitat type. Table 3 presents the Shannon-Wiener diversity (H'), evenness (E), and Margalef diversity (S_{marg}) values of each habitat. No significant difference in diversity was found comparing the H' values with a modified t-test. Table 4 compares the species composition similarity between habitats using the Sorenson quantitative index.

DISCUSSION

I originally hypothesized that the pasture diversity would be significantly lower than the river or forest diversity. In the end, no statistically significant difference in habitat diversity was found between the H' values, and E was similar for all habitats, although Smarg value for the forest (2.18) was somewhat larger than that of the pasture (1.44). More interestingly, it could be considered biologically significant that values for S, H', and Smarg were all highest in the forest and lowest in the pasture, with the riparian habitat in the middle. This reveals a general trend that diversity is highest in forest microhabitats, followed by riparian areas and then pasture, which roughly corresponds with my original hypothesis. Overall, my results seem to point to higher diversity in the forest and riparian microhabitats than the pasture (with higher S and especially N values), which would make sense biologically since the natural forest and river habitats are more complex than the simplified and disturbed pasture habitat. I believe that a more extensive study would verify this statistically.

Significant differences in species composition similarity were found when the habitats were compared using the Sorenson quantitative index. The forest and riparian habitats had a relatively high species similarity (2.7), with river-pasture similarity being lower (1.4) and forest-pasture similarity being the lowest (0.7). This reveals that disturbed pasture habitats contain a significantly different species composition than the natural forest and riparian habitats. Considering the lower S and N found in the pasture, this supports the conclusion that pasture microhabitats contain lower species diversity

comprised of a few species that can do well under the disturbed conditions.

It should be noted that certain species were found in very high relative abundances, which had a significant impact on N values. In the river microhabitats, 54 individuals were found of the anole *Norops oxylophus*, which lives exclusively in riparian areas (Savage 2002), accounting for 70% of the 77 total individuals and cause N to be very high for the riparian habitat. This was the single most abundant species found in the study. The second most abundant species found was the frog *Eleutherodactylus ridens*, with 26 specimens found in the forest microhabitats accounting for 67% of the 39 total individuals.

One unexpected bias that likely affected my results arose from the fact that one of the rivers where a transect was located is seasonal and dried up half-way through the study. This resulted in a decrease in the number of individuals encountered for this transect, and may have had an influence overall riparian diversity. It also accounts for the presence *of Norops humilis*, a ground-dwelling anole, in the river habitat, as it was only encountered in the dry river bed.

Several species encountered were notable for their presence in the San Luis valley. The salamander *Bolitoglossa robusta* was the most surprising find, since Savage (2002) does not list it as occurring in the Premontane Moist Forest life zone. *Leptodiera annulata* and *Sphenomorphus cherriei*, two species that were found in the dry season study (Balsavich 2003), are listed as only occurring marginally in Premontane Moist Forest (Savage 2002). The fact that these species were both encountered again during my study indicates they may have a consistent presence in San Luis.

Future herpetofauna surveys in San Luis should involve more people searching earlier in the wet season over a longer period of time to add to the inventory of species and to obtain more extensive data on differences in diversity between different microhabitats. Nevertheless, this study will hopefully contribute to our knowledge of the herpetofauna in this area and lay the groundwork for more research in the future.

ACKNOWLEDGEMENTS

I would first like to thank Karen and Alan Masters for being such inspiring and supportive instructors, and for always sharing their knowledge and wisdom with patience and good humor. I would also like to thank Andre's Vaughan for his help, expert advice and herpetological enthusiasm, and for giving me the opportunity to participate in this study. Thanks as well to Andrew Rodstrom, Matt Gasner and Carmen Rojas for their continuous help and support. I additionally wish to thank the Arce Leiton family of San Luis for generously housing and feeding me during my homestay, Nathan Dappen for his herping assistance, and the Ecolodge and Biological Station San Luis. Finally, I'd like to thank all the friends I've made in Costa Rica for helping to make this such an incredible experience.

LITERATURE CITED

Balsavich, L. 2003. The Herpetofauna Surrounding Ecolodge San Luis and Biological Station: An Inventory and Analysis. Am. Colleges of the Midwest, Spring Program.

Clark, K. L., R. O. Lawton and P. R. Butler. 2000. The Physical Environment. Pp. 15-38. *in* N. M. Nadkarni and N. T. Wheelwright (eds.), Monteverde. Oxford University Press, New York.

Hayes, M. P., J. A. Pounds and W. W. Timmerman. 1989. An Annotated List and Guide To the Amphibians and reptiles of Monteverde, Costa Rica. Society for the Study Of Reptiles and Amphibians, Oxford, OH.

Jaeger, R. G. 1994. Standard Techniques for Inventory and Monitoring. Pp. 103-107. *In* W. R. Heyer, et al. (eds.), Measuring and Monitoring Biological Diversity: Standard Methods for Amphibians. Smithsonian Institution, Washington.

Lips, K. R. 1998. Decline of a Tropical Montane Amphibian Fauna. Conservation Biology 12: 106-117.

Magurran, A. E. 1988. Ecological Diversity and Its Measurements. Princeton University Press, Princeton, NJ.

Pounds, J. A. 2000. Amphibians and Reptiles. Pp. 149-177. *In* N. M. Nadkarni and N. T. Wheelwright (eds.), Monteverde. Oxford University Press, New York.

Pounds, J. A., M. P. Fogden and J. H. Campell. 1999. Biological response to climate Change on a tropical mountain. Nature 398: 102-106.

Savage, J. M. 2002. The Amphibians and Reptiles of Costa Rica. The University of Chicago Press, Chicago and London.

Spiller, D. A. and T. W. Schoener. 1994. Effects of Top and Intermediate Predators in a Terrestrial Food Web. Ecology 75(1): 182-196.

Table 1: Complete list of species found in San Luis
(*) indicates species found outside the transects

Class Amphibia
- **Order Caudata**
  - **Family Plethodontidae**
    - *Bolitoglossa robusta*
- **Order Anura**
  - **Family Leptodactylidae**
    - *Eleutherodactylus ridens*
    - *Eleutherodactylus bransfordii*
  - **Family Hylidae**
    - *Smilisca sordida*
  - **Family Ranidae**
    - *Rana forreri **
  - **Family Bufonidae**
    - *Bufo marinus **

Class Reptilia
- **Order Squamata**
  - **Family Polycrotidae**
    - *Norops oxylophus*
    - *Norops humilis*
    - *Norops intermedius*
    - *Norops cupreus*
    - *Norops capito*
    - *Norops woodi*
    - *Norops biporcatus*
  - **Family Corytophanidae**
    - *Basiliscus basiliscus*
  - **Family Scincidae**
    - *Sphenomorphus cherriei **
  - **Family Teidae**
    - *Ameiva undulata**
  - **Family Phrynosomatidae**
    - *Sceloporus malachiticus**
  - **Family Viperidae**
    - *Bothriechis schlegelii*
  - **Family Colubridae**
    - *Leptodiera annulata*
    - *Lampropeltis triangulum**
    - *Oxybelis fulgidus**
    - *Imantodes cenchua**
  - **Family Elapidae**
    - *Micrurus nigrocinctus**

Table 2.Species richness and abundance results of transect surveys

	Forest	River	Pasture
Norops oxylophus	0	54	0
Norops woodi	1	3	1
Norops humilis	3	3	0
Norops intermedius	1	0	5
Norops biporcatus	0	0	5
Norops capito	2	0	0
Norops cupreus	3	1	0
Basiliscus Bsiliscus	0	2	0
Bothriechis achlegelii	1	0	0
Leptodiera annulata	0	1	0
Elutherodactylus ridens	26	8	1
Eleutherodactylus bransfordii	1	0	0
Smilisca sordida	0	5	0
Bolitoglossa robusta	1	0	0
Species richness(s)	**9**	**8**	**4**
TOTAL number of species(N)	**39**	**77**	**8**

Table 3. H, E and Smarg values for transects of each microhabitat

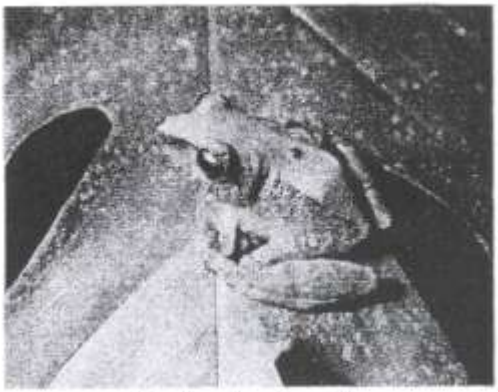
	Forest	River	Pasture
H'	1.29	1.12	1.07
E	0.58	0.54	0.77
S_{marg}	2.18	1.68	1.44

Table 4. species composition similarity between microhabitats using Sorenson quantitative index

	River	forest
Pasture	1.41	0.72
Forest	2.67	

Appendix 1: Photographs of select herps of San Luis

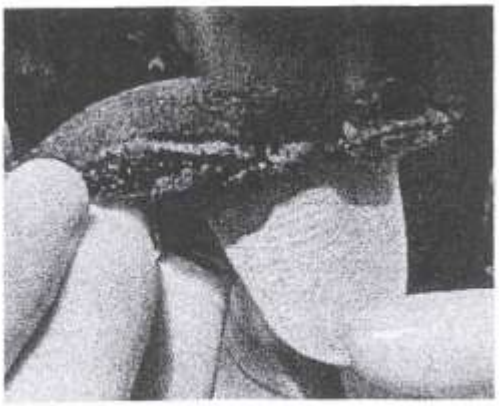
Bolitoglossa robusta
Ring-tailed salamander



Eleutherodactylus ridens
Pygmy rain frog

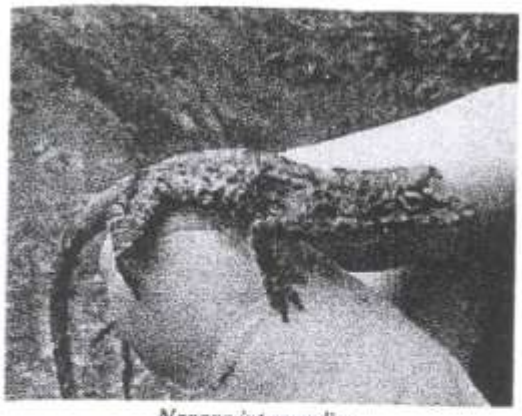
Eleutherodactylus bransfordii
Bransford's litter frog

Smilisca sordida
Drab tree frog

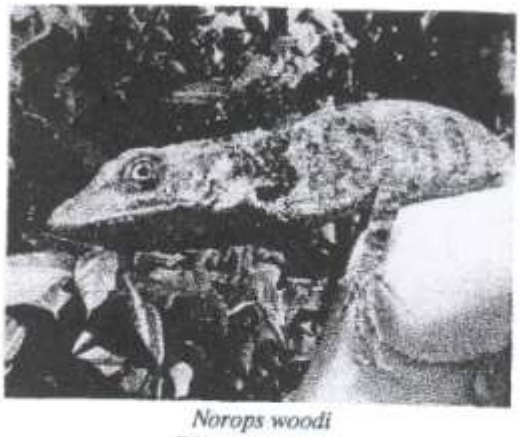


Norops oxylophus
Stream anole

Norops humilis
Ground anole



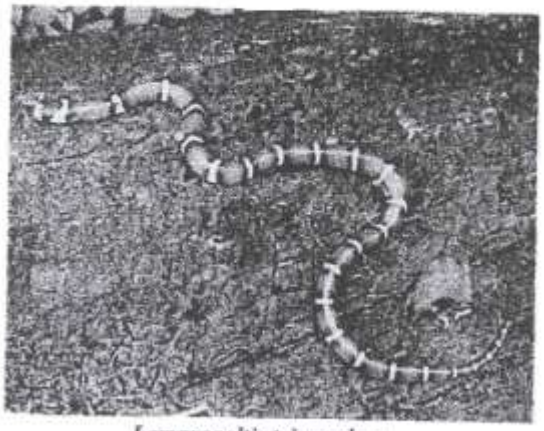
Norops intermedius
Green lichen anole



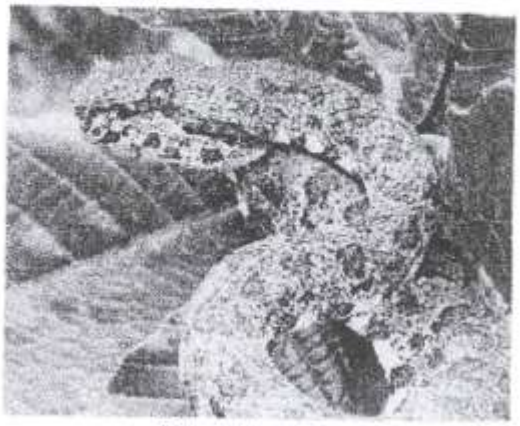
Norops woodi
Blue-eyed anole

Sphenomorphus cherriei
Litter skink

Leptodiera annulata
Cat-eyed snake



Lampropeltis triangulum
Tropical king snake



Bothriechis schlegelii
Eyelash viper