PROJECT ANURAN PHASE IV:
Preliminary Report

An ecological research project concerned with the assessment and monitoring of anuran populations in the region around Las Cuevas, Chiquibul Forest Reserve, Belize

Phase IV: Preliminary Report

By

Iain Hawthorne, Malamo Korbetis, Jenny Diack, Loïc Lhopitallier, Antoine Lecocq and Norberto Coc

October 2003

Project Anuran
University of Edinburgh
Darwin Building
Kings Buildings
Mayfield Road
EH9 3JU
Edinburgh, Scotland
Email: projectanuran@hotmail.com
Website: www.projectanuran.org

Summary

The international scientific community is continuously being alarmed by successive reports observing amphibian population decline in abundance and diversity. The phenomenon appeared almost two hundred years ago, but it is only now that scientists have taken action towards resolving it. This includes monitoring amphibian populations, investigating causes of their decline, research into their ecology, prioritising species conservation, evaluating methods of conservation and, finally, protecting some of the endangered species. However, there seems to still be a long way to go in successfully conserving amphibian populations.

Amphibians have great significance in both ecological and human environments, their decline, therefore, being a distressing factor for the balance of ecosystems. Moreover, due to their permeable skin and their bi-phasic lifestyle they can be excellent bio-indicators.

The aim of Project Anuran Phase IV is to carry out a comprehensive monitoring program, continuing the efforts of the last three Phases. The methods used were taken from the standard protocol of Phase I: vocalising species nocturnal surveys plus day and night transects for non-vocalising species. Our first statistical results indicate a general decline in vocalising species diversity compared to previous phases (see discussion). However, the prevalent explanation given to our observation is the dry conditions at the Las Cuevas location this summer.

This long-term undergraduate study fulfilled all the aims, mentioned in the protocol, October 2002. We feel that Project Anuran has made a considerable contribution towards producing the needed data for comprehensive monitoring programs, as well as being an excellent experience for its members.

Contents

1. Introduction

1.1 Global Amphibian Decline

Over the past two centuries, extensive human disturbance of the natural environment by urbanisation and pollution, leading to global climate change has –not surprisingly- led to a rapid worldwide decline in amphibian populations and biodiversity. Amphibian populations have been unchanged since the era of dinosaurs (Barinaga, 1990); underlining the importance of the current decline.

Looking back through the history of this alarming phenomenon, we find ourselves in the late 18th century American continent, where anecdotal reports of the phenomenon were written (Burry 1999). However, only after two centuries, herpetological reports have attracted the attention of the scientific and conservationist's community, as a more dramatic reduction in anuran populations has been observed. Alarming is the fact that Chapin, 2000, characterised this change as the sixth major extinction event in the history of life.

The First World Herpetology Conference, Canterbury, England, 1989 was the first movement towards dealing with the absence of scientific interest up to that time (Barinaga 1990). The event led to the formation of the DAPTF (Declining Amphibian Population Force Task) in 1991, supported by the Species Survival Commission (SSC) of the World Conservation Union (IUCN); essentially, the starting point of the past decade's effort to increase our knowledge on amphibians. DAPFT also organises advanced training in declining amphibian populations research in Central America supported by Research and Analysis Network for Neotropical Amphibians (RANA) and the IRCEB team studying Host-Pathogen Biology and the Global Decline of Amphibians[1]. Moreover, input towards this goal has been put in by researchers; monitoring efforts are being set up worldwide to keep track of the pace of the decline (Eterovick PC, 2003, Linzey DW 2003, Murphy JF et al 2003, Young BE, 2001, Campbell, A 1998). However, declines in vertebrate populations are still increasing in recent years (Blaustein 1994) and it has been observed that research on amphibians has been rather scarce compared with that on other vertebrates (Venturino et al 2003).

We, members of Anuran Project, feel that a better understanding of the declining phenomenon, its diagnostic characteristics and the best way of resolving the problem, is needed. This introduction provides some background information on:

a) Why are anurans ecologically important?
b) Evidence for the decline of amphibian populations
c) Possible factors responsible for the amphibian decline
d) The role of Project Anuran?

Amphibians have both ecological and human value in the environment. They constitute the highest fraction of vertebrate biomass (Beebee 1996), help maintain arthropod abundance and are a the main prey for many higher predators.(Guyer 1990). It is obvious that a change in amphibian population, can result in a great upset in the ecosystem energetics and carbon flow (Pearman 1997). The problem becomes enlarged in Neotropical forests, such as Belize, which host the highest anuran biodiversity (Lee 1996). Amphibians have physiological constraints and relatively low mobility, thus decreasing the possibilities of their successful recolonisation after natural local extinction (Blaustein 1994). As recent studies suggest, anurans occupy different positions on the trophic chain, not necessarily being able to be functionally variable (Chalcraft 2003). The two latter recent observations emphasise the importance of carefully organised conservation efforts.

Moreover, amphibians are excellent bioidicators of environmental change due to their susceptibility to chemicals during their freshwater cycles (Venturino et al 2003) and their highly permeable skin (Duellman & Trueb 1994). Some anurans are also herbivores during

[1] www.open.ac.uk/daptf/index.htm

their larval stages and carnivores as adults, thus providing information to scientists about changes in both the plant and animal kingdom.

Anuran declines are mainly reported from areas that were thought to be untouched from humans. Areas in which serious declines have been observed include the Atlantic forests, Brazil (Heyer et al. 1988), North West USA (Drost & Fellers 1996, Murphy JF et al 2003. Bulger JB et al 2003), Montane forests, Australia (Laurance et al 1996), Monteverde cloud forest of Costa Rica (Lips 1998, 1999), above 500m remote highlands in Central America and above 1000m in the Andes (Young BE et al 2001). Few examples of scientifically credible decines or threatened species include the Golden toad (Bufo periglenes) and Harlequin frog (Atelopus varius) (Pounds & Crump 1994), the Cascades frog (Rana cascade) (Fellers & Drost 1993), the Yellow and Red-legged tree frogs (Rana muscosa and Rana aurora) (Davidson C et at 2001, Bulger JB et al 2003) and the Black toad (Bufo exsul) (Murphy JF et al 2003).

It is difficult to estimate amphibian declines from a global perspective from individual research studies. The most recent reports that have attempted to draw wide conclusions are Alford &Richards (1999), Houlahan et al (2000) and Young BE et al (2001). The first, collected data over the period 1951-1997 and found amphibian populations decreased more than their model predicted. However, there was no evidence that the agents of decline were becoming more prevalent over time. Houlahan et al used data from 936 populations to assess variations in amphibian population trends on a global scale. Unfortunately, their results indicate relatively rapid declines from the late 1950s to the late 1960s, but a reduced rate of decline was observed to the present. There has been a debate between the two groups of scientists, which has appeared in Nature, 2 August, 2001. Alford at al argue that by emphasising the global mean, Houlahan et al have masked spatial and temporal variation in amphibian population trends (Houlahan et al –reply 2001). This is a problem emphasised by many herpetologists and can only be minimised if a long time series of monitoring data is provided. Finally, Young et al initiated an effort in Latin America, where they convened workshops with 88 Latin American herpetologists and conservationists. Studies in that area of the world indicate that at least 13 countries have experienced declines, affecting 30 genera and 9 families of amphibians (Young BE et al 2001).

There are numerous candidates for the cause of the amphibian decline phenomenon: habitat modification, increase in ultraviolet radiation, acidification and toxins, predation, disease climate and weather.

Habitat modification is the main factor held responsible for the observed loss of amphibian biodiversity and abundance. This includes deforestation, land drainage, introductions of exotic species to habitats and spread of contaminants. The ozone depletion results in increased UV-B radiation and, as the most recent studies suggest, (Davidson C et al 2003, Hatch AC et al 2003) that there is a positive correlation between increasing UV-B radiation and decreasing larval mass, as well as increasing rate of species decline. Evidence for the existence of such an effect though is still being investigated. Pollutants from industries and agricultural depositions have the exceptional ability to travel vast distances and have long persistence. This results in the widely observed phenomenon of increased acidity in rain, which enhances embryo and larval mortality (Alford & Richards 1999). As the most recent study on agrichemicals suggests, they are also a factor contributing towards amphibian declines, but little is known about which of them pose the greatest threat (Rohr JR et al 2003).

1.2 Role of Project Anuran, Phase IV

Project Anuran is an undergraduate research study which has completed its 4th year of study this summer, 2003. The project aims to undertake a comprehensive monitoring program of the anuran community in the neotropical area of Las Cuevas, Chiquibul National Park, Belize. Hopefully, Phase V will continue the monitoring process in summer 2004, so that 5 years of studies are completed, thus, making our results more statistically analysable. Belize, having vast protected areas, retaining some 75% of its natural vegetation (Harcourt 1996) and having a large percentage of its amphibian population remaining mysterious (Meyer & Foster

1996), is an excellent spot to collect our data. We feel that our contribution to the tackling of the global amphibian declining phenomenon, consists of the fact that we are in a place to offer a certain amount of time, personnel, resources and enthusiasm towards a scientifically useful monitoring program. Throughout our 7 week stay in Las Cuevas Research Station we followed the Phase I standard protocols of methodology, carrying out nocturnal vocalisation surveys, visual encounter surveys(day and night transects), quadrat surveys, weather monitoring and vegetation surveys around each of the ponds; and continually assessing these. Moreover, for the first time this year we managed to overcome the problem of covering all the rainy season, by training long-term research volunteers at the LCRS to carry out night surveys throughout their 6 month stay.

Most importantly, Project Anuran cooperates with MAYAMON (Maya Forest Anuran Monitoring Program), co-ordinated by the DAFT. The resulting species abundances will be fed into this program that covers the entire Selva Maya region (Belize, South Mexico and Peten, Guatemala), creating a regional picture of anuran species distribution and abundance.

2. Aims and Objectives

2.1 Research Aim :

To contribute to the understanding of the ecology and conservation of amphibian populations via intensive assessment of the status of species at the neo-tropical site of Las Cuevas (N16°44' W88°59').

2.2 Research Objectives :

1) To continue monitoring of ten sites previously assessed during 2000-2002 using tested profitable survey methods
2) To concentrate effort to compare alternative monitoring methods for assessing the diversity and population status of leaf litter anurans at sites identified as being suitable / known habitat type.
3) To conduct survey work to compare the diversity and population status of ground dwelling amphibian fauna at four sites in the Las Cuevas area, in order to assess the congruence of amphibian diversity with the presence/absence of four key umbrella species.

2.3 Further Objective

To continue efforts to establish firm links with a collaborative student group from the University of Belize and other local support.

3. Methodology and Approach

3.1 Site Description:

Our work is conducted in the vicinity of Las Cuevas Forest Research Station (N16^{0}44' W88^{0}59'), Belize. The station is maintained as a joint initiatitive between the Natural history Museum (London) and the Forestry Department of Belize, and is situated in the Chequibul Forest Reserve, North of the main Maya Mountains divide. It stands at roughly 500 m a.s.l. with an annual rainfall of between 1500 and 2000 mm, with vegetation consisting of mostly lowland subtropical moist forest (Hartshorn *et al.* 1984). Since the collapse of the Mayan civilisation c. AD 750-1000 there have been no permanent inhabitants of the region around Las Cuevas. However, the forest has experienced repeated subsequent disturbances, both natural and human (e.g. logging for mahogany, chicle extraction, fire, and periodic hurricanes)

3.2 Methodology

In order for our data to be useful for collaborative analysis, of changes in species diversity or population status, with previous years projects we were obliged to follow a well established standard protocol. The design of the protocol is such, that it allows wide applicability with respect to other, similar Mesoamerican survey work. Our methodological approach falls under two directions; that for vocalising species (Field Study 1), and that for non-vocalising species (Field Study 2).

3.3 Field study 1: Monitoring and assessment of vocalising species:

Most anuran species, especially in the tropics congregate *en masse* around breeding sites (Duellman & Trueb 1994; Beebee 1996), Making the monitoring of vocalising choruses often the most effective technique by which to assess a population (Alford & Richards 1999).

Ten breeding pond sites were chosen and consolidated during Phases I, II, and III. These represent a number of different sub-habitats of the forest surrounding Las Cuevas, which different compositions of Anuran favour. Surveys of these breeding ponds ran from 1900 hours to 0200 hours when possible and until at least 2300 hours otherwise. The varying times of surveys were the result of security concerns in the area. On this occasion only eight ponds were consistently monitored due to as considerable extension of the dry season in the area this year. Puzzle Pond and Cockspur pond remained dry for the duration of our study, while Guava, Elegans, Warrie and Marshy all fluctuated between having no water and very little, comparatively to previous years. Each pond was surveyed over at least 5 repeats in concordance with data from Phase II and III. Single repeats were carried out at dry ponds to investigate the presence of any anuran species. Measurements taken on arrival at each pond include; depth of pond (deepest part), collection of water sample for pH measurement and a summery weather report. Following this, half hourly recordings of species abundance and calling activity were made. Measures of abundance follow the MAYAMON protocol (Meyer 1999), which uses measures of vocalisation categories to assess the abundance of each species present for the first fifteen minutes of every hour (Table 1.)

In an attempt to assess the calling activity of the species present a measure of call intensity was devised during Phase I, which has proved to be an invaluable addition to the protocol in Phases I, II, III, and IV. This was done by measuring the frequency of calls of an average individual of each species for the first fifteen minutes of every hour. One call is taken as each noticeably distinct vocalisation per individual (Table 1).

Vocalisation Category (VC)	VC definition	Vocalisation Intensity (VI)	VI definition
1	1-5 individuals	A	1 or <1 calls per 15 minutes
2	6-20 individuals	B	2-14 calls per 15 minutes
3	21-50 individuals	C	5-10 calls per minute
4	>50 individuals	D	2-5 calls per minute
		E	6-10 calls per minute
		F	11-20 calls per minute
		G	21-40 calls per minute
		H	>40 calls per minute

Table 1: Vocalisation categories and intensities

In addition to these half hourly recordings the air and water temperature were recorded, allowing maximum and minimum temperatures for the entire night to be noted. Also recorded was the volume of rainfall, the duration and number of rainfall events (the former being done with transportable rain-gauges).

We identified individual species vocalisations through using reference recordings produced by J. Meyer and J.C Lee. In addition to this there were other recordings made available from previous Phases of the project, representing the majority of different species to be found specifically around Las Cuevas. Visual identification was aided by the use of the practical field guide compiled by Project Anuran (Phases I and II) with reference to texts; Meyer & Foster (1996), Lee (1996), Campbell (1998). This guide was excellent for confirming vocalisations with visualisations.

In addition to the standard protocol outlined above, all anecdotal recordings of these species were noted. The emphasis here was placed on species type, location, and time of day. Relevant natural history notes were also recorded. To try and relate the different species of Anurans found at the different ponds, to their natural history and distributions a floral diversity assessment of the ponds was made during Phase I. Phase III re-assessed this to identify any local changes. This year we chose to re-map the ponds using general vegetation types, noting any particular species of interest (These maps shall be included in the final report, due in September 04). We were unable to carry out a full floral diversity assessment due to the inherent difficulties with identification.

3.4 Field Study 2: Non-vocalising and leaf litter species:

The monitoring of leaf litter and stream dwelling frogs is subject to a variety of methods the effectiveness of which can vary greatly between geographic locations, amphibian species assemblages and local habitat conditions (Pearman *et al.* 1995). Phases I and II established six permanent transect lines as the most suitable method for the area. Of these six transect lines only five were used this year. This decision was made due to the fact that the San Pastor Trail Transect was being heavily disturbed by other people on a regular basis.

Transect lines were stratified around areas presumed to be of both high diversity (creeks and rivers), and areas noted to be ecologically distinct in terms of forest habitat. Each line was cut to be 500m in length and 2m in width. Transect lines were surveyed by two people (selected at random), who walked slowly down the line searching the leaf litter and branches up to eye level on one half of the transect. In order to standardise the search effort a time restraint of one hour was placed on each transect survey, producing an average search speed of 0.5 km per hour. All individuals sited were noted with respect to species, number, location (nearest 50m), time and any relevant behavioural observations. A minimum of 5 repeats were conducted per transect, for both day and night, with searches being spaced as evenly across the study period as possible. The latter point was only really an issue for the Monkey Tail transect approximately 8km away from the research station, where safety was an issue due to the likelihood of flash floods, made even more pronounced by the dry weather conditions this year. Identification of specimens for transect lines followed the relevant guides; Lee (1996), Meyer & Foster (1996), Campbell (1998), and Lee (2000)

3.5 Weather Monitoring:

Daily recordings were made at 0900 of rainfall volume and duration for the previous 24 hours, maximum and minimum temperature, relative humidity and cloud cover. These were taken using standard equipment from the weather station at the Las Cuevas site (we are awaiting the arrival of the LCRS weather data). In addition to this three more rain gauges were encorporated into the weather monitoring. These were placed at the Aguada (4 km East LCRS), Millionario (5 km West LCRS) and another at LCRS, creating a cross-sectional map of rainfall. Data collected from these will hopefully allow consideration of the spatial variability in rainfall patterns within the study area.

4. Results

4.1 Species accounts:

Family	Species	Common name
Rhinophrynidae	*Rhinophrynus dorsalis*	Mexican Burrowing Toad
Leptodactylidae	*Eleutherodactylus chac*	Chac's Rainfrog
	Eleutherodactylus laticeps	Broadhead Rainfrog
	Eleutherodactylus rhodopis	Lowland Rainfrog
Hylidae	*Agalychnis callidryas*	Red-eyed Treefrog
	Agalychnis moreletii	Morelet's Treefrog
	Hyla ebraccata	Hourglass Treefrog
	Hyla loquax	Loquacious or Mahogany Treefrog
	Hyla microcephala	Small-headed or Yellow Treefrog
	Hyla picta	Painted Treefrog
	Smilisca baudinii	Mexican Treefrog
	Smilisca cyanostica	Blue-spotted Treefrog
Centrolenidae	*Hyalinobatrachium fleischmanni*	Fleischman's Glassfrog
Bufonidae	*Bufo campbelli*	Campbell's Forest Toad
	Bufo marinus	Cane or Marine Toad
	Bufo valliceps	Gulf Coast Toad
Ranidae	*Rana berlandieri*	Leopard Frog
	Rana juliani	Maya Mountain or Julian's Frog
	Rana vaillanti	Vaillant's Frog

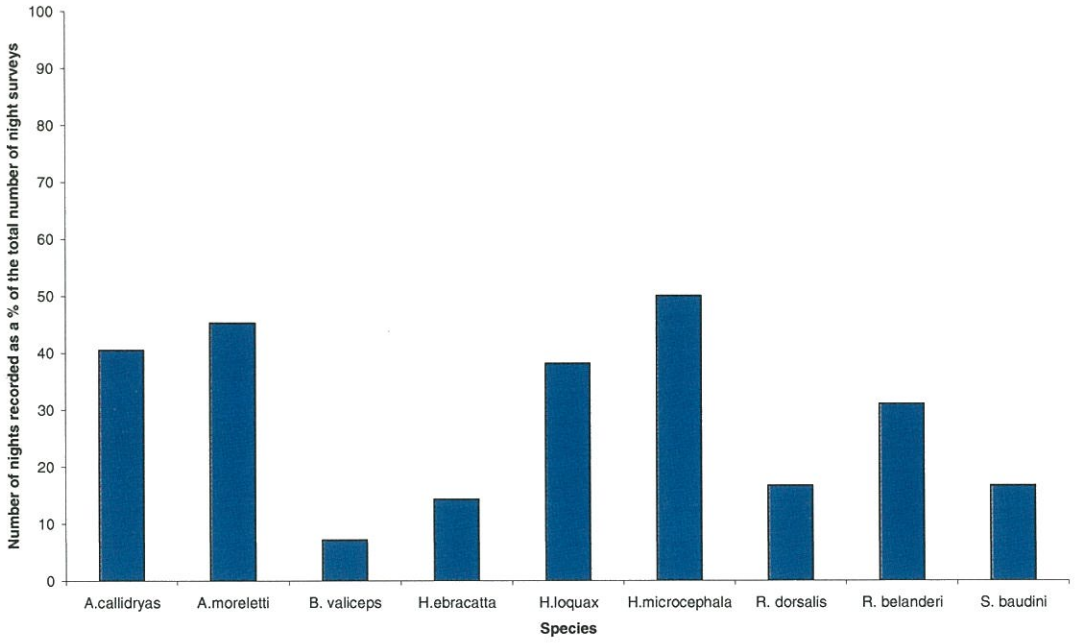
Table 2: Classifications and common names of anuran species found around LCRS (2003)

Table 2 above illustrates the classification and common names of the species of anurans found at Las Cuevas Research Station (LCRS) during Phase IV of Project Anuran. A total of 19 different species were found. During phases I, II, and III, there were 20, 21, and 18 species found respectively. Phase II encountered *Eleutherodactylus sabrinus* and *Gastrophyne elegans* which were absent from Phase IV findings, while Phase III was void of any *Hyalinobatrachium fleischmanni* sightings. This consistant high level of species richness helps confirm the site to be one of the most diverse throughout Belize, with respect to amphibian fauna (Miller & Miller, 1995). The last section of this report is an update of the Project Anuran field guide, incorporating descriptive details of every anuran species encountered during this years field research. We have also chosen to use as many new photographs as possible.

4.2 Vocalising species:

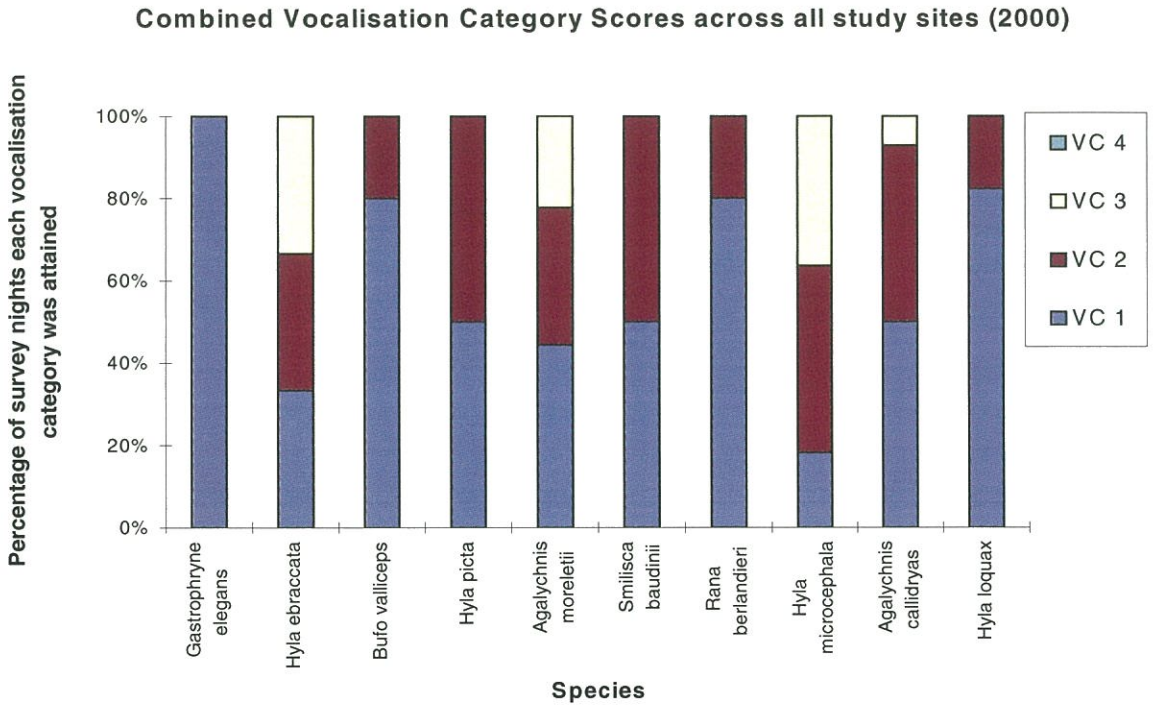
A total of 45 survey nights were carried out during the study, with five or more repeats at all of the ponds containing water. Of these repeats the five most representative from each pond have been selected for analysis (the others were excluded due to either early mistakes in identification of vocalisations, time shortages i.e. requested to return to LCRS, or poor time spacing). This amounts to a total of 280 hours of acceptable data.

Graph 1 below illustrates the relative abundance of vocalising anurans found at LCRS. With respect to last years results there are three species missing from the vocalisation records. These species are *Gastrophryne elegans, Hyla picta*, and *Smilisca cyanostica.*

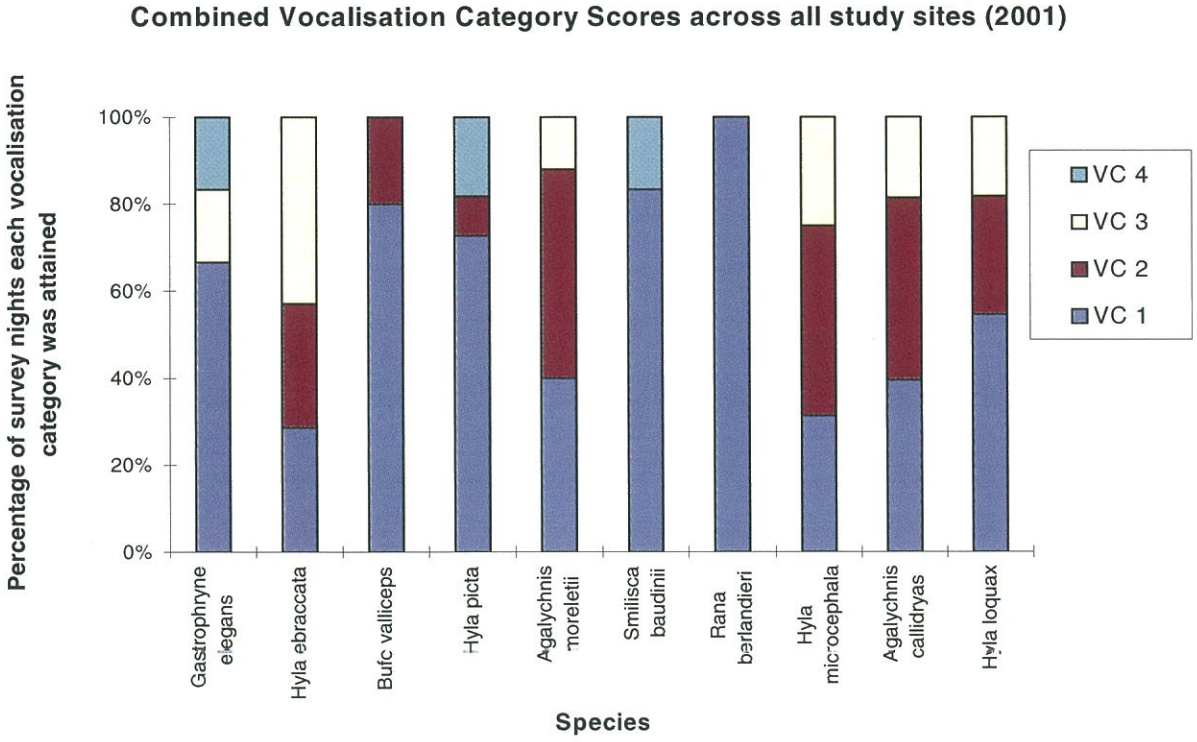


Graph 1: Relative abundance of vocalising anurans around LCRS

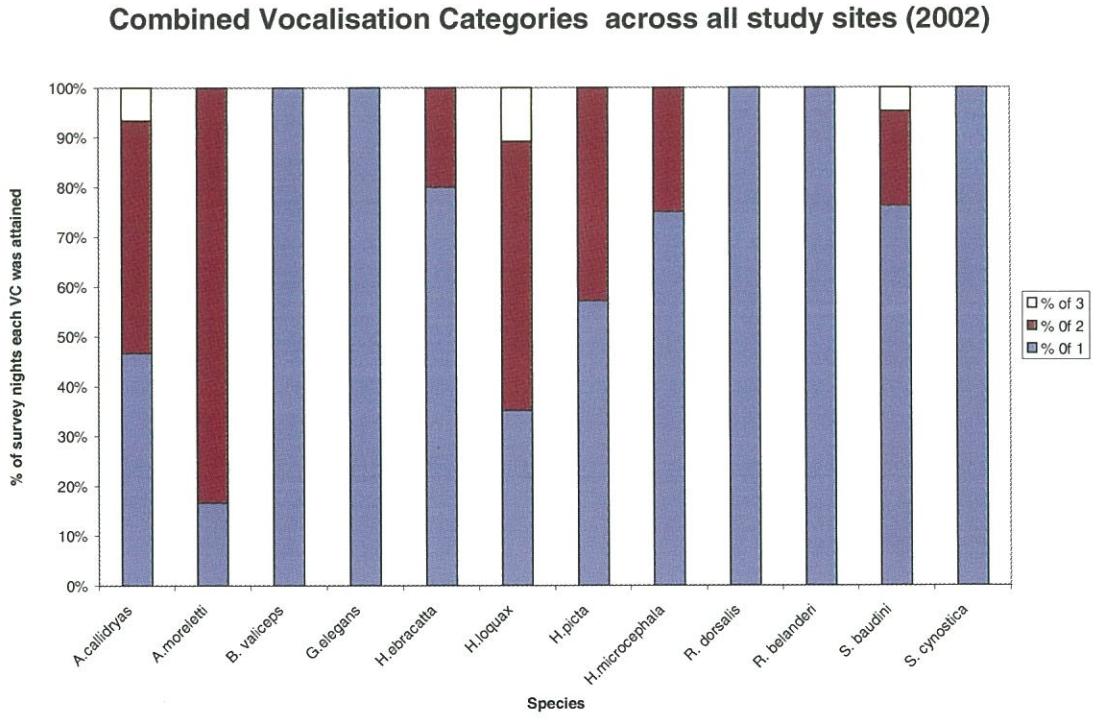
Graph 2 illustrates the proportion of survey nights in which a species was heard at each vocalisation category (VC) in the year 2000. It allows comparisons in reproductive activity to be made across species. The reproductive activity of some species is characterised by short periods of intense calling activities, where as other species exhibit a more constant calling pattern.



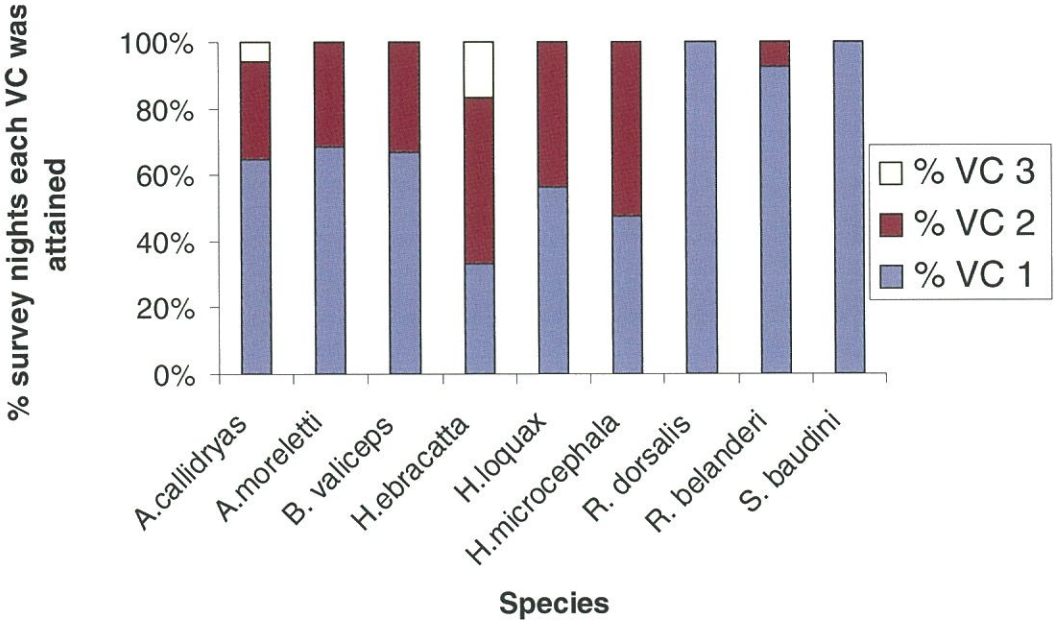
Graph 2: Combined vocalisation categories across all study sites (2000)



Graph 3: Combined vocalisation categories across all study sites (2001)



Graph 4: Combined vocalisation categories across all study sites (2002)



Graph 5: Combined vocalisation categories across all study sites (2003)

Graph 5 represents this years combined vocalisation categories across all the study sights and at first glance is visibly different from graph 4.

4.3 Non-vocalising species:

During Phase IV, 50 transect lines were surveyed, adding a further 50 hours (50:50, day:night) of acceptable data to this years project. Transect lines have proved the most profitable survey method in the assessment of ground dwelling anurans, hence a continued emphasis has been placed on this research method. Table 3 below highlights the findings from our permanent transect surveys.

Transect	No. of Transect Days/Nights	*B. campbelli*	*B. marinus*	*B. valliceps*	*E. rhodopsis*	*E. laticeps*	*H. fleishmanni*	*R. juliani*	*R. vaillanti*	Transect Success (individuals / transects)
Creek	10	0	0	0	0	0	1	2	3	0.6
Saffron Trail	10	0	0	0	0	1	0	1	0	0.2
Fifty Ha Plot	10	0	0	0	1	1	0	0	0	0.2
Nature Trail	10	0	0	1	1	0	0	0	0	0.2
Monkey Tail	10	2	1	0	0	0	0	6	1	1
Total	50	2	1	1	2	2	1	9	4	0.44

Table 3: Visual encounters of Anurans on five different, permanent transect lines.

Data which is not presented here shows that the majority of Anuran visualisations occurred during our night surveys (approximately 82%)

4.4 Weather:

The weather during our stay was unusually dry this year. From conversation with staff at the research station it was ascertained that the heavy rains expected to begin in June had never arrived. It is uncertain yet if the weather was an anomaly this year or if perhaps the loss of foliage (large albedo and transpiration change) from the neighbouring area, the Pine Ridge could be a cause. These landscape alterations will create changes in the land surface interactions and therefore perhaps the climate in surrounding areas. This is pure speculation at present, and indeed may be insignificant as the area of Pine Ridge regularly undergoes loss of vegetation resulting from fires. Undoubtably with relation to Project Anuran is that, the outcome of this dry weather was an evident lack of leaf litter and soil moisture, except after small rainfall events. More importantly it resulted in all of our ponds having particularly low, variable water levels and some (Puzzle and Cockspur pond) remaining dry for the duration.

5. Discussion

5.1 Vocalising species

The results from Phase IV graph 1 may at first glance suggest that there is a loss of diversity in anuran species numbers around LCRS. If we consider the transect and anecdotal observations as listed in table 1, we see that this is not the case. Reasons for this loss of diversity in the recorded anuran vocalisations is probably due to extended dry season this year making breeding conditions unfavourable for many species. We have yet to receive the weather data from LCRS which will strengthen this point. Both *Hyla picta* and *Gastrophryne elegans* are explosive breeders, congregating *en masse* around ponds to breed after the onset of heavy rains. There absence indicates a flaw in the sampling methodology for studying such species. *G. elegans* was never encountered this year, while *H. picta* was observed during daylight hours (16/07/03) after a heavy rainfall event the night before. Due to the anecdotal sightings of *H. picta* the absence of, and under-representation throughout the project of similar species suggests our study does not give a fair representation of their numbers and prevailance around LCRS. *Smilisca cyanosticta* another vocalising species encountered vocalising in the previous year was absent from this years counts. There was an anecdotal recording, where it was observed approximately 6 km down the Monkey Tail path (31/07/03), it has been observed in a similar manner in Phase I and II. The variability in the presence of *S. cyanosticta* in the vocalisation surveys, its known natural history and the anecdotal sightings, suggest that our study sites perhaps do not suitably cover its preferred habitat. It has been seen vocalising along water filled vehicle tracks in the Chiquibul National Park (Meyer, J. R. & Foster, C. F. 1996). From this years project that is not surprising as often it would seem there was a great diversity of anurans capitalising on these semi-permanent water pools. It is hypothesised that these pools retain water well due to high compaction of the soil underneath them, resulting from the weight of the vehicles passing over them.

The results from Phase IV as displayed on graph 5 further highlight the existence of variation in reproductive behaviour across species. Those species missing have already been mentioned so we will go on to discuss the values of those recorded. Our *Agalychnis callidryas* vocalisation categories (VCs) are similar to last year, involving categories 1, 2, and 3. VC 3 was only found in the latter species mentioned and *Hyla ebracatta* , during Phase IV. This represents the worst year for recording VCs 3 and 4. It is suspected that these results are probably connected to dry environmental conditions not favouring breeding. The results with respect to *H. ebracatta* contest a suggested decline in numbers made in Phase III, where only VC 2 was counted across all the survey nights. This was not backed up by this years data collection and highlights one of the difficulties involved in assessing anuran populations through our methodology. The problem being that our methodology incorporates breeding sites and therefore represents breeding patterns more strongly.

One decline that does seem to be consistent with reference to VCs can be found with *Agalychnis moreletti* scores. In Phase I and II it had VCs of 3 (<20% of the time) and in Phase III its highest score was VC 2 (>80% of the time), this year the VC seems to be reduced again to VC 2, less than 40% of the time. This of course could again just be a result reflecting the dry weather during this year, or it may be something more. For this reason it is suggested that more information should definitely be gathered on the species in the area.

The results for *Rhinophrynus dorsalis* are worth mentioning briefly in this report because of the nature of the species. *R. dorsalis* can burrow to great depths (reported at 4m by Carol Farneti Foster) avoiding desiccation and predation, and only emerging after the onset of prolonged heavy rains (Meyer & Foster, 1996). For this reason the fact that we recorded this species at all this year is unusual. Its VC category as can be seen on graph 5 never exceeded 1, from our anecdotal records we observed that there was never more than one individual and

that they were sometimes calling from the depths of the forest in the middle of the day. Reasons for this shall be investigated in more detail in the main report.

5.2 Non-vocalising and leaf-litter species

Unfortunately due to the popularity of LCRS with other researchers one of the transect lines (San Pastor Transect Line) had to be excluded due to the excessive number of pedestrian traffic using the area. Many of the other transect lines, in particular the Nature Trail, also suffered from anthropogenic disturbances. The occurrence of such disturbances may upset species visualisations as anuran species may selectively avoid such an area. For this reason this years group also conducted a series of quadrat surveys, between Millionario and Monkey Tail River. This was done using random placement of a 4*4 quadrat off of the main track, between the two aforementioned points and off of the permanent transect lines. This constituted an extra 50 hours of daylight survey work. The validity of this survey to our project is unknown at present and therefore its results are not included in our preliminary report.

Having been involved in the collection of this data and considering the numbers seen in table 2 it becomes apparent, either a)How well these species hide in their respective habitats, or b) Just how low in numbers they are. Generally it is believed that the Leptodactylidae family thrive in suitable environments, there low representation in the transect survey may indicate the absence of suitable environmental conditions. There were no highly unusual discoveries this year, although the visual encounters of *Bufo marinus* and *Hyalinobatrachium fleischmanni* were particularly welcome. This is not just because they represent two very interesting species of frogs, (*B. marinus* is the largest known anuran growing up to1780 mm in length, while *H. fleischmanni* has a transparent ventral surface), but also because of their absence from last years encounters. *Bufo marinus*'s presence at the Monkey Tail Transect is perhaps indicative of the low levels of rainfall causing drying of surrounding streams and ponds. Typically *B. marinus* will avoid large rivers during the wet season due to their strong current. On the occasion it was seen at Monkey Tail River the volume of water in the river was exceedingly low. The deepest point along the transect was just 1 m and there were many still ponds effectively cut off from the main flow of the river. The presence of *H. fleischmanni* at the Creek Transect is understandable from what we know of its natural history, which is mainly that it enjoys clear streams to breed around.

6. **Conclusions**

The findings from Phase IV are limited at present until a more detailed analysis of results has been carried out. We did find that there are certain limitations to using Field study 1 methods to completely account for all anuran species around Las Cuevas and that an extended dry season results in a large decline in breeding activity of the frogs, which could potentially lead to a decline in future numbers. For this reason the continuation of the project into its fifth year is vitally important.

Species accounts

The following pages contain information on the species found during Phase IV of Project Anuran, in addition there is also information on a few species present in previous years that were not recorded during Phase IV. Each of the species is described in turn, by way of taxonomic characteristics, natural history, distribution, and finally a brief note on its local status around Las Cuevas. The taxonomic descriptions are taken almost entirely from the available guides; Lee (1996), Meyer & Foster (1996), Campbell (1998), and Lee (2000). Additional information especially concerning the Leptodactylidae was taken from the recent monograph by Campbell & Savage (2000), and personal communication with Julian Lee, Jack Meyer, and Peter Stafford. This page is only meant as an introduction for prospective visitors to the anurans inhabiting the area around Las Cuevas. It by no means acts as a substitute for the excellent guides referenced above. For the interested visitor, we recommend purchasing Meyer & Foster (1996) as a very reasonably priced guide to the anurans of Belize. If more information is desired then Lee (2000) offers the best coverage in a transportable format, which also serves to cover reptile species.

The brief reference to the local status for each species is taken from observations of Project Anuran Phase I - IV members. There shall be a more detailed consideration of many of these species in the full text of the main report (Results and Discussion).

Family	Species	Common name
Rhinophrynidae	*Rhinophrynus dorsalis*	Mexican Burrowing Toad *
Leptodactylidae	*Eleutherodactylus chac*	Chac's Rainfrog *
	Eleutherodactylus laticeps	Broadhead Rainfrog *
	Eleutherodactylus sabrinus	Sanderson's Rainfrog
	Eleutherodactylus sandersoni	Long legged stream-frog
	Eleutherodactylus rhodopis	Lowland Rainfrog *
Hylidae	*Agalychnis callidryas*	Red-eyed Treefrog *
	Agalychnis moreletii	Morelet's Treefrog *
	Hyla ebraccata	Hourglass Treefrog *
	Hyla loquax	Loquacious or Mahogany Treefrog *
	Hyla microcephala	Small-headed or Yellow Treefrog *
	Hyla picta	Painted Treefrog *
	Scinax staufferi	Stauffer's Treefrog
	Smilisca baudinii	Mexican Treefrog *
	Smilisca cyanostica	Blue-spotted Treefrog *
Microhylidae	*Gastrophryne elegans*	Elegant Narrowmouth Frog
Centrolenidae	*Hyalinobatrachium fleischmanni*	Fleischman's Glassfrog *
Bufonidae	*Bufo campbelli*	Campbell's Forest Toad *
	Bufo marinus	Cane or Marine Toad *
	Bufo valliceps	Gulf Coast Toad *
Ranidae	*Rana berlandieri*	Leopard Frog *
	Rana juliani	Maya Mountain or Julian's Frog *
	Rana vaillanti	Vaillant's Frog *

(those marked with '*' were recorded during Phase IV)

Unavoidably many of the taxonomic descriptions require reference to morphological terms and amphibian characteristics. For the less informed reader we have included a glossary of these terms which is taken largely from Campbell (1998) and Lee (1996).

Biosystematic glossary (from Campbell 1998 & Lee 1996)

Adpress : To press closely to the body
Aguada : A shallow surface depression that may be a permanent pond of water or may become mostly dry during the dry season.
Amplexus : The sexual embrace of anurans
Auricular : Pertaining to the ear
Axillary : Pertaining to the armpit. During axillary amplexus male anurans grasp females just behind the forelimbs
Canthal : Referring to the area between the supraocular and the rostral, where the dorsum of the snout turns downward on the side
Casque : A process or structure suggestive of a helmet. Frogs of the genus *Triprion* are frequently called casque-headed tree frogs.
Co-ossified : *adj* The condition in which the integument is fused to the underlying bones. The skin of the dorsal surface of *Triprion petasatus,* for example is co-ossified with certain cranial bones
Cranial crest : Any of the raised, bony ridges on the top or the side of the head in many toads (Bufonidae)
Crepuscular : Active under conditions of dim illumination, such as dawn and dusk
Denticulate : With reference to amphibian skin, having a rough sandpapery feel and covered in numerous small, sharp, keratinous projections. Examples of anurans having keratinous skin are certain bufonids and ranids.
Dermal : Relating to the skin, or superficial bones that lie in or just beneath the skin.
Disc : The flat, plate-like expansion on the tips of digits. Characteristic of many anurans - most hylids.
Distal : Part of the body that is farther removed from the centre of the body than some other part.
Dorsolateral : A position that is intermediate between dorsal and lateral. For example the eyes of the tadpoles of many species are dorsolateral in position.
Dorsolateral ridge/fold : The glandular ridge extending from behind the eye down the dorso-lateral surface of the body of some frogs - mainly ranids.
Dorsum : The upper surface of the animal or part of the animal
Face mask : Present when the side of the head below the canthus through the eye to the tympanum is conspicuously darkened and sharply delimited from more dorsal coloration. A face mask is present in many leptodactylid and some ranid frogs.
Fossorial : Adapted to digging or living below the ground - eg *Rhinophrynus dorsalis*
Frontoparietal : A dermal roofing bone in the skull of anurans formed by fusion of the frontal and parietal bones
Glandular ridge : A narrow, elevated ridge of glandular skin, usually on the dorsal surface of the body as seen in some species of frog
Granular : Possessing granules, for example the skin of *E.rugulosus* species
Gular : Of or pertaining to the ventral surface of the throat or neck
Inner metatarsal tubercle : A large tubercle on the sole of the hind foot at the base of the first digit. There can be inner and outer metatarsal tubercles
Inner tarsal tubercle : A tubercle on the inner, or medial side of the tarsus in certain species of frogs
Inner tarsal fold : A distinct ridge or fold that extending along the inner tarsus in many frogs.
Interorbital : Of or pertaining to the area of the dorsal surface of the head between the eyes
Labial : Of, or pertaining to the lips
Labial shelf : A bony, shelf like projection along the upper lip of some anurans
Lateral : Pertaining to a position away from the midline of the body.
Lichenose : Resembling lichens, such as certain colour patterns with irregular and diffuse blotches or mottling
Maxillary : One of the principle bones of the upper jaw in amphibians and reptiles - usually bears teeth
Medial (Median) : Pertaining to a position toward the midline of the body
Mesic : Characterised by a moderate to great amount of moisture.
Metachrosis : The ability to change colour.
Metatarsus : The sole of the foot; specifically the portion of the foot supported by the metatarsal bones and extending from the heel to the base of the digits
Middorsal : The portion of the dorsal surface of the body that lies along the midline
Monontypic : Consisting of a single species or taxon.
Montane : Relating to a mountain or mountainous region.
Mottled : Marked with many spots or blotches that often run together.

Nape : The dorsal part of the neck.
Nuptial excrescences : A thick, roughened pad on the skin of sexually active male anurans, usually on the thumb, synonymous with nuptial pad
Occipital : Of or pertaining to the posterior portion of the skull
Ocular : Of or pertaining to the eye
Oviparous : Producing eggs that hatch outside of the maternal body.
Oviposition : The act of laying eggs
Palmar : The ventral surface of the forefoot; the palm of the hand.
Palpebral membrane : The transparent eyelid of anurans. It may be clear, as in most species of *Hyla* or reticulate as in *Agalychnis callidryas*
Parotoid gland : A large glandular area lying behind the eye on the side of the neck. This gland is present in *Bufo* and the Tungara frog (*Physalaemus pustulosus*).
Parietal : The region or scales located on the back of the head posterior to the frontal and supraocular region.
Parthenogenesis : A kind of reproduction that involves the deveopment of offspring (all female) without fertilisation bya male parent.
Phragmosis : The act of plugging the entrance to a hole or burrow by using a body part. This body part is usually adapted for this use and is bony or has spines. *Triprion petasatus* (casque-headed treefrog) is thought to block the entrance to tree holes by using the bony casque on the top of its head.
Pollex : The first finger or innermost digit on the hand; the thumb is a pollex.
Postocular : The region or scales lying behind the eye.
Postorbital : Behind the eye.
Prefrontal : The region or scales on top of the snout behind the internasals and in front of the
Preocular : The region bordering the anterior margin of the eye.
Premaxillary bone : One of a pair of dermal bones at the anterior end of the skull in amphibians and reptiles
Prenasal bone : An unpaired dermal bone lying anterior to the premaxillary bones in *Triprion petastus*
Prepollex : A small skeletal element on the inner side of digit 1 (the pollex) of the hand of some anurans
Proximal : Pertaining to a part of the body that is closer to the centre of the body than is some other part
Pustulate : Bearing pustules - eg the skin of *Physalaemus pustulosus*
Reticulate : With respect to the colour pattern, having the appearance of a net or mesh
Rostral : Of or pertaining to the snout, anterior
Rostrum : The snout
Rugose : Covered with wrinkles or tubercles
Seat patch : In anurans a triangular area of skin surrounding the vent, generally darker coloured than the surrounding skin
Shank : A lower section of the hind leg of a frog or lizard
Sinistral : Relating to the left side
Splenial : One of the dermal bones of the lower jaw in some vertebrates
Squamosal : A cranial bone located on posterior part of the side of the head
Striated : Marked with many minute parallel grooves or channels
Subarticular : Located below the joint between two of the bony phalanges
Subgular : Of or pertaining to the area below the gular region, when inflated the vocal sacs of males are often subgular in position
Supernumerary tubercle : IN anurans a tubercle on the hand or foot that does not lie immediately below a point of articulation between the phalanges
Supralabial : Of or pertaining to the region immediately above the upper margin of the jaw
Supraocular : The region of the top of the head
Suprascapular : Part of the dorsum lying above the scapula; the shoulder region
SVL : Abbreviation for Snout Vent Length - measurement from the anterior surface of the snout to the posterior edge of the vent
Tarsal fold : A fold of skin running along the tarsus
Tarsus : The segment of the hind limb lying just distal to the tibia and fibula, and the metatarsus
Temporal : The region lying behind the postoculars, above the supralabials or mouth and below the parietal region
Truncate : Blunt or square at the end

Tubercle : A small discrete bump or knob on the skin. Most anurans have a distinctive, large inner metatarsal tubercle on the inner side of the hind foot; in the case of *Rhinophrynus dorsalis* there are two of these tubercles
Tuberculate : Bearing tubercles
Tympanum : The eardrum
Vent : The posterior cloacal aperture
Venter : The undersurface of an animal
Ventral : Pertaining to the undersurface of an animal
Ventral disc : A portion of the abdomen that is demarked by a circular fold of skin, the presence or absence of which is of taxonomic importance - *Leptodactylus labialis* for example has a ventral disc
Ventrolateral : A position intermediate between ventral and lateral.
Vestigial : A small and degenerate bodily part that remains from one more fully developed in an eariler state of the individual or evolutionary time
Vocal sac : A ventral outpocketing of the aural cavity in male anurans, that serves to amplify vibrations of the vocal cords
Vocal slit : In male anurans, on e of a pair of slit like valves in the floor of the mouth though which air passes between the buccal cavity and the vocal sac(s)
Wart : A rounded, elevated bump on the skin of certain anurans, espeacially those of the family Bufonidae. Warts are larger than pustules, although some authors do not distinguish between the two.

Species *Rhinophrynus dorsalis*

(Dumeril and Bibron, 1841)

Family Rhinophrynidae

Common names Mexican Burrowing Frog / Middle American Burrowing Toad

1) Distinguishing features

Size (SVL) Males 65 – 75mm, females 70 – 80mm

Dorsum is blackish or dark grey, usually with reddish orange markings. These markings may well be yellowish in some individuals. Middorsal stripe and mottling on the dorsolateral and upper lateral surface of the flanks is usually present. The venter is uniformally grey or blue-grey. Dorsal skin is smooth, but with a few minute, scattered tubercles. **It is a globular anuran with an especially fat body, a small tapered head and tiny eyes, and the tip of the snout is flattened and appears calloused**. Digits lack discs, and the toes are about three quarters webbed. The hind foot has only four digits and there is no tarsal fold, instead, along the inner tarsal surface are two large whitish, spadelike tubercles used for digging.

2) Distribution

Found at lower elevations throughout Belize where soil conditions allow this fossorial species to burrow. Seems primarily to inhabit open or disturbed situations in the wetter parts of its range, and elsewhere restricted to seasonal forests with a noticeable dry season.

3) Natural history

These frogs are accomplished burrowers, and only appear above ground after the heaviest rains of the year. Breeding occurs during the rainy season only. They aggregate around temporary ponds and aguadas that the heavy rains fill. Males greatly inflate their bodies when calling, and eggs are laid singly and sink to the bottom where they later coalesce to form large clutches. Tadpoles school, and many thousands of tadpoles may metamorphose into froglets and leave the water at the same time, and head for the nearest muddy banks or other cover where they burrow into the ground.

4) Remarks

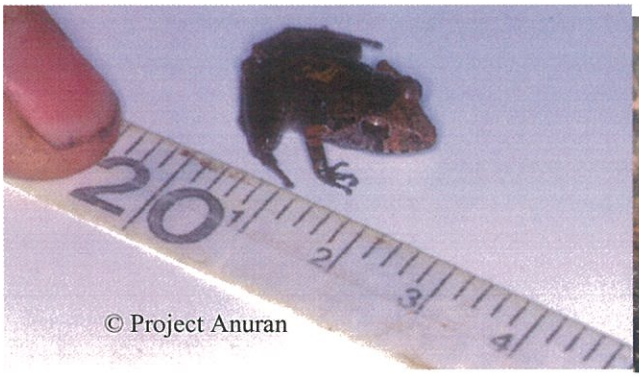
This species is perhaps the most ridiculous looking animal one is likely to ever see, an excellent example of the marvels of the natural world.

5) Where did we find it near Las Cuevas?

This strange little frog was recorded on a number of occasions. As observed in previous years it only emerged during and immediately after rainfall events. Five minutes of heavy rain was enough to stimulate its emergence from the soil. It is extremely shy, and difficult to catch on film due to the speed with which it burrows into the ground. They were only ever present in numbers <10 although in previous years they have been recorded as being present in numbers approaching a 1000, in particular when they aggregated in temporary ponds which formed in the clearing outside the station. Other aggregations could also be heard calling from within the forest from all directions. This year they were heard around Guava, Aguada, Coral, Warrie, Elegans and Puzzel.

Species *Eleutherodactylus chac*

Family Leptodactylidae
Common names Chac's Rainfrog or Maya Rainfrog



1) Description

Smallest of the Belizean rainfrog species, max svl 40mm (adult male 20-27mm, female 31-39mm). Closely related to *E.laticeps,* and *E.rhodopis*. Colour : variable – tan, yellow tan, brown, reddish brown, grey-brown dorsum – weakly granular and most specimens have several enlarged often paired dorsal tubercles. Thin pale mid-dorsal line often present. **Side of face usually black or dark brown, the dark coloration continues as a line/stripe behind the eye, across the ear until a point about halfway down the flank. The iris can be described as red / or reddish bronze above and brown below (compare to *E.laticeps* copper coloured above + brown below).** Venter is immaculate white, cream or grey. **A dark seat patch surrounds the vent (distinguishing from *E.laticeps*). Alternating light and dark bands on the upper surfaces of the limbs (compare to *S.leprus*). Toes have basal vestigial webbing and an inner tarsal fold (absent in *E.rhodopis*).** Intra-specific variation can result in some individuals lacking a dark face and most dorsal markings

2) Distribution

Found through central to southern Belize. Individuals sited in wet broadleaf forests of the Maya Mountains. Known only 100 – 1000m on the windward slopes – found in Stan Creek, Toledo and probably Cayo districts.

3) Natural History

Moderately common on the forest floor and both nocturnally and diurnally active. Inhabits the leaf litter, often seen hopping in a zig-zag course across the forest floor. Males are not known to vocalise. Can be found in surprisingly high numbers in optimal conditions, otherwise rarely encountered. Does not tolerate drying conditions, restricted to undisturbed forests. Breeding – eggs deposited in moist ground and hatch directly into small frogs, no definite breeding season (known). Chac is the Maya rain god. **Vocalisation is a series of 4 – 9 soft, short, 'ducklike' quacks.**

4) Where did we find it near Las Cuevas?

During Phase IV we recorded this species once when it was heard vocalising off the Saffron trail transect. Leaf litter species such as this are rarely observed in the vicinity of Las Cuevas, possibly due to a number of factors; the unsuitable habitat (few streams owing to the limestone bedrock), the fact that this species is highly cryptic and therefore difficult to spot and the particularly dry conditions of this summer's wet season making the leaf litter was extremely dry. In such conditions it is likely that *E.chac* would dig itself deeper into the leaf litter making it even more difficult to find. Only two confirmed sightings were made during Phase I at Las Cuevas, once on the steep hill close to the bird watch tower, and once close to the Monkey Tail river. Another sighting was made on the banks of the Chiquibul river near to the Natural Arch rock formation.

Species *Eleutherodactylus laticeps*
(Dumeril 1853)

Family Leptodactylidae
Common names Broadhead rainfrog or broad-headed leaf-litter frog

1) Distinguishing features
Size (SVL) : Male 31 – 47mm, female 55 – 80mm (**notably larger than** *E.chac*)
Dorsum colour variable, usually medium to dark brown with a variety of lighter markings – possible mid-dorsal light stripe. **Legs are banded light and dark brown – about four dark transverse bars (comparable to *E.chac*).** **A dark facemask is present** with the sides of the face below the canthus, eye and tympanum being dark. **No dark seat patch is present in comparison to *E.chac*.** The venter is cream with some brown mottling on the throat. **The upper iris is copper or yellow coloured in life (red in *E.chac*).** Toes bear only vestigial webbing. It has a granular / finely tuberculate dorsal surface, with well-developed dorsolateral glandular ridges and occasionally a thin mid-dorsal glandular ridge. Inner tarsal fold is strongly developed and extends one half to two thirds from the inner metatarsal tubercle to the heel (comparable to *E.chac*)

2) Distribution
Low and moderate elevations of Atlantic versant from Mexico though the Mayan mountains to northern Honduras. Altitudinal range 600 – 3000ft. Records in Belize from Cayo and Toledo districts.

3) Natural History
A relatively uncommon (in comparison to *E.chac*) inhabitant of lowland and premontane Evergreen Broadleaf and Subtropical Evergreen Forest. Found on forest floor in leaf litter or near forest aguadas. Found during night and day depending on local conditions. No known vocalisation. Direct development of eggs in leaf litter comparable to rest of genus. Suggested breeding in wet season. **Closely related to *E. chac* with which it is sympatric in some places.**

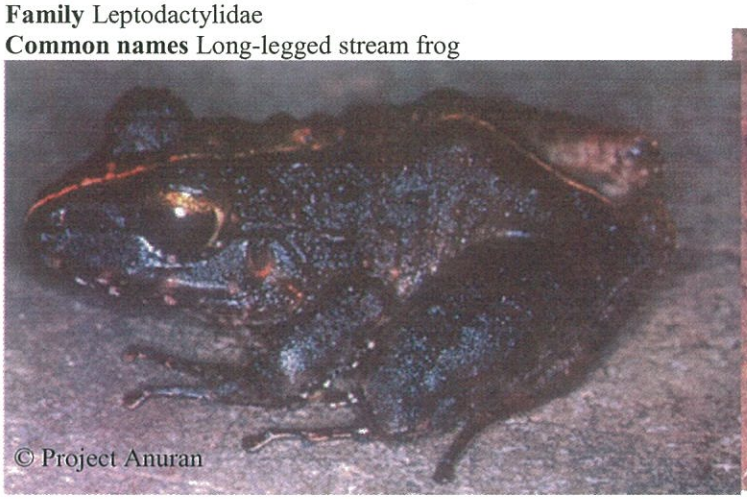
4) Where did we find it around Las Cuevas?
This year we found three individuals, two on the Saffron transect; one during the day and one at night, and one on the 50-hectare plot transect. As is normal for leaf litter species, the number of individuals observed was low, however the unusually dry conditions possibly made the species even less abundant. In previous years it has been found at night both close to water (Monkey Tail river) and in dense undergrowth near to the station. Twice it has been found near clumps of bright pinkish eggs, which were suggested could have been its own. Also found around Rio Frio River in the Mountain Pine Ridge area, where one individual was observed in early afternoon sheltering in a tree bole. A note of caution is relevant here to those intent on searching for these cryptic leaf litter species, as one of the few *E.laticeps* individuals cited was within 5 m of a *Bothrops asper* (Fer-de Lance) the deadly pit viper, a common predator of frogs (Lee 1996).

Species *Eleutherodactylus sabrinus*

(Campbell & Savage 2000)

Family Leptodactylidae

Common names Long-legged stream frog



1) Distinguishing features

This is a medium sized frog in its genus – adult males roughly 30-41mm, adult females 60-75mm (SVL). Dorsum is pale to dark brown with dark brown or black mottling and often a pale and thin mid-dorsal line or broad stripe. An interorbital bar is present, its posterior border usually black, and there are dark markings along the lips and three to four dark transverse limb bars, although these markings are highly variable. The posterior surface of the thighs is dark brown with large, pale spots. The whitish venter is suffused with brown pigment and the throat is mottled in males and females. Iris is gold above and dark brown below. The dorsum is finely granular with large tubercles on the flanks. Digits are well developed and moderately expanded and toes have a moderate **degree of webbing – less than ¼ (c.f. *E.sandersoni*)**. The inner tarsal fold is strongly developed and extends about half way from the inner metatarsal tubercle to the heel. **Adult males have vocal slits but no nuptial excrescences.**

2) Distribution

Occurs in the Atlantic foothills of northern Central America including the Maya Mountains of Belize from near sea level to about 600m.

3) Natural History

This frog is almost always encountered near streams running though pristine tropical wet and subtropical wet and moist forests **(sympatric with *E.sandersoni*)**. Eggs undergo direct development and the nests are found well camouflaged in dirt near to stream banks. For distinction from the commonly confused *E.sandersoni* see the separate entry for this species.

4) Remarks

The *Eleuterodactylus rugulosus* group has recently undergone an extensive taxonomic revision (see Campbell & Savage 2000), and *E.sabrinus* was one of ten new species to be described. The name sabrinus is taken from the Latin *sabrina* which means river-nymph.

5) Where did we find near Las Cuevas?

We did not observe this species during Phase IV and this species, like all leaf litter species was rarely observed during Project Anuran Phase I. One individual was found near to the banks of the Monkey Tail branch of the Raspaculo River, and four individuals were found along the banks of the Rio Frio river in the Mountain Pine Ridge area (broadleaf gallery forest). Note during Phase II a number of individuals were seen on the newly created transect lines running along the creek side and the river bank of Monkey Tail – see Phase II reports.

Species *Eleutherodactylus sandersoni*

(Schmidt 1941)

Family : Leptodactylidae

Common names : Sanderson's Streamfrog / River Rainfrog

1) Distinguishing features

Size : Possibly the largest member of its genus in Belize, adult male 35-50mm, adult female 70-85mm (SVL). Dorsum is brown, gray-brown to olive with irregular dark markings often with **distinct orange or rust spots in the interorbital region or on the back, although a uniform dorsal colour is not unknown**. In keeping with species of the rugulosus group the skin is moderately tuberculate, often with large tubercles on the flanks and eyelids. **No mid-dorsal stripe is present in any known species**. Dark markings/bands are present along the lips often with a black interorbital bar. Dark head and limb markings are variable. The posterior thighs are dark brown or gray-brown with a mottled cream pattern. The belly is white or purplish and the throat is heavily mottled with brown or grey brown. **The iris is gold to copper with fine, dark reticulations but no division as in *E.sabrinus***. Tympanum is distinct (roughly 2/3rd eye diameter in males and 2/5th in females). Compared to other members of the genus the toes bear **characteristically significant webbing** – roughly one quarter to one third, and the tips of toe and fingers are reasonably expanded to form discs. Strongly developed inner tarsal fold which extends half-way to two-thirds the distance from the inner metatarsal tubercle to the heel. **Vocal slits are absent on the males, but a whitish nuptial pads are present on the pollex of adult males** (cf: *E.rugulosus*).

2) Distribution

Known only in the Caribbean slopes of the Maya Mountains of Belize and the Caribbean foothills of Guatemala – sea level to 700m.

3) Natural History

Occurs in the tropical wet forest and subtropical wet and moist forest seemingly restricted to certain streambeds. It appears to be strictly nocturnal being found on the face of ledges and behind water falling over frogs. Very little is known of its biology but the eggs appear to undergo direct development during the wet season not dissimilar to other members of the genus.

4) Remarks

This species is closely related to other members of the *E.rugulosus* group including *E.sabrinus,* and *E.rugulosus*. Following Campbell & Savage (2000) these three species are recognised as distinct. In the vicinity of Las Cuevas it is most likely to be confused with *E.sabrinus*, from which it is most easily distinguished by the extent of webbing on hind feet of *E.sandersoni*, significantly different length of hind limbs (*E.sabrinus* being greater), presence of vocal slits in adult male *E.sabrinus*, and the presence of nuptial pads in adult male *E.sandersoni*.

5) Where did we find near Las Cuevas?

This species was not recorded during Phase IV. It is not definite that this species has been observed at all in the vicinity of Las Cuevas. A group of juvenile *Eleutherodactylus* spp. were found on the bank of the Monkey Tail river in Phase III, which were suspected to be most similar to *E.sandersoni* (see above photograph).

Species *Eleutherodactylus rhodopis*

(Cope 1806)

Family Leptodactylidae

Common names Lowland rainfrog / Common leaf-litter frog

1) Distinguishing features

Size (SVL) : Male 19 –21mm, (Comparable to *E.chac*), female 27 –32mm

Dorsum colour; tan, yellowish tan or pale brown, usually with dark brown irregular markings. The venter is cream, or yellowish. Dorsolateral glandular ridges and usually a mid-dorsal glandular ridge. Two pairs of suprascapula glandula ridges extending from the posterior edge of each eye to the midback region. Dorsum is relatively smooth with few scattered small tubercles, whereas flanks are covered with numerous large, round tubercles. **Differs from *E.chac* in absence of inner tarsal fold**. Inner tarsal tubercle present between inner metatarsal tubercle and heel. Dark interorbital bar may be present. **Side of head below eye and canthus is dark with the marking extending behind eye, across top of ear to point of insertion of the forearm**. A dark seat patch is present. **Have a bronze iris in life (red in *E.chac*).**

2) Distribution

Low and moderate elevations of the Atlantic versant. From sea level to about 1700m. Definitely known in Belize from Orange Walk District – only member of genus known from north of the Belize river.

3) Natural History

Apparently restricted to areas of ample leaf litter. Appears to be resident of Semi-Evergreen Seasonal Forest, occasionally in Tropical dry forest. **Only observed once in Belize, fifty years ago**. Possibly restricted to areas containing permanent water or aguadas. Eggs undergo direct development in leaf litter. Males are not known to vocalise.

4) Where did we find near Las Cuevas?

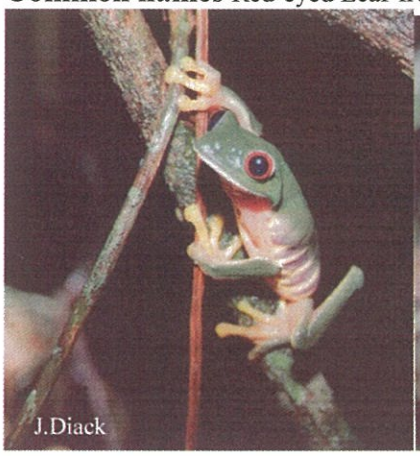
This year, Phase IV, we had one confirmed sighting of this species on the Nature Trail transect, and one possible sighting on the 50 hectare plot transect. It has rarely been seen in previous years with four individuals being sighted in Phase II, (2001), and none in Phase II, (2000). 2001 was noted as being the first confirmed recording of this species for 50 years. In 2001 all the individuals were found after 1900 hours in areas of dense forest local to the research station. Two were found on transect lines, and two from anecdotal sightings – see Phase II reports.

Species *Agalychnis callidryas*

(Cope 1862)

Family Hylidae

Common names Red-eyed Leaf-frog/Red-eyed Treefrog



1) Distinguishing features

Size (SVL) Adult males 50-55mm, adult females 65-70mm

As the name suggests this frog is characterised by having a **bright red iris**. The eyelid is reticulated with gold. The dorsum surfaces of the head, body, forearm, hind limbs, fourth fingers and fifth toes are green, often with white spots. The **flanks are bluish with 3-8 vertical cream bars,** the venter is cream. The **anterior and posterior surfaces of the thighs and the hands and the feet are mostly orange.** The skin of the dorsum is smooth in texture. The frogs have long slender limbs and tend to walk rather than leap. Digits bear moderately large disks and fingers are one-half and toes about two-thirds webbed. A poorly defined tarsal fold is present. Along with A. moreletti it is the only frog in the Petan to have a vertical pupil. Vocal slits are present and the vocal sac is not greatly distensible.

2) National distribution

This frog occurs country wide at elevations between sea level and about 600m.

3) Natural History

This frog is common in wet forest habitats (Semi-Evergreen Seasonal & Evergreen Broadleaf but perhaps Sub-tropical Evergreen), especially in the wet season around pools, aguadas, slow-moving streams and water-filled ditches. They are nocturnal and search for insects through the vegetation with slow graceful movements. **Calling generally begins about dusk and the call of the male is a single or double 'chuck' or 'cluck'**. Males will call from vegetation surrounding ponds between 1-5m in height. Calling individuals can congregate into a chorus of over a few hundred individuals. Eggs found around pools on overhanging vegetation and are greenish at one pole and cream at the other. Following hatching the tadpoles fall into the water with the development taking roughly 2 months. The breeding season is extended and lasts over the wet season.

4) Where did we find it around Las Cuevas?

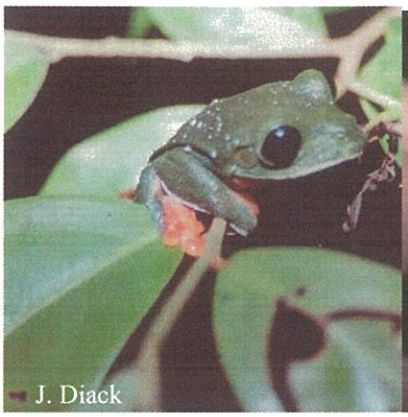
This common species was found around closed canopy, permanent and temporary ponds. It was more common than its sister species A. moreletti, and found at similar locations. It was recorded at all ponds other than Millionario and Cockspur. The former having an open canopy and the latter being dry for the duration of our study period. *Callidryas* eggs were found on a number of occasions but unfortunately most were doomed to fail due to the lack of rain. A main predator of *Callidryas* eggs was the cat-eyed tree snake, *Leptodeira frenata*, who was observed eating eggs on a number of occasions. This species of frog has been common in previous studies.

Species *Agalychnis moreletii*

(Dumeril 1853)

Family Hylidae

Common names Morelet's Leaf-frog / Morelet's Tree-frog



1) Distinguishing features

Size (SVL) Adult males 60-65mm, adult females 75-80mm

The dorsal surfaces of head, body forearm and hind limbs are green as for *A.callidryas* – white spots may also be present on the dorsal surface. Again **similar to *A.callidryas* the flanks, anterior and posterior surfaces of the thighs, inner surfaces of shanks and forearms, upper arms and three first fingers and first four toes are orange**. White stripes are present on the outer edges of the forearm and tarsus. The venter is cream or yellow. In marked comparison to *A.callidryas* there are **no barred blue markings on the flanks and the iris is deep purple/black rather than bright red**. The eyelid remains reticulated with gold. The skin of the dorsum is smooth in texture. As in other members of the genus the legs are long and slender and this species tends to walk rather than leap. Digits bear well-expanded discs and the webbing on the hands and feet is about ¾. The tarsal fold is usually well developed and extends the length of the tarsus. Vocal slits are present and the vocal sac is not greatly distensible.

2) National distribution

In Belize it is known only from 1500-2000ft in the Mayan Mountains. It may occur higher if breeding sites are available. Suggested to be more common than presently thought in understudied areas of the Mayan Mountains.

3) Natural History

This species appears to replace *A.callidryas* at higher elevations in Belize and appears to be restricted to Evergreen Broadleaf Forest and Subtropical Evergreen Forest. It is an uncommon species and probably inhabits epiphytes, and branches of trees and has been found in Cayo and Toledo districts of Belize. **The breeding call is a *'wor-or-op'* repeated every one to several minutes**. Eggs are similar to those of *A.callidryas* in being green at one pole and cream at the other and are usually laid on vegetation overhanging permanent or temporary pools. **The egg mass is usually twice the amount of *A.callidryas.*** There is an extended breeding season from May to August

4) Where did we find it around Las Cuevas?

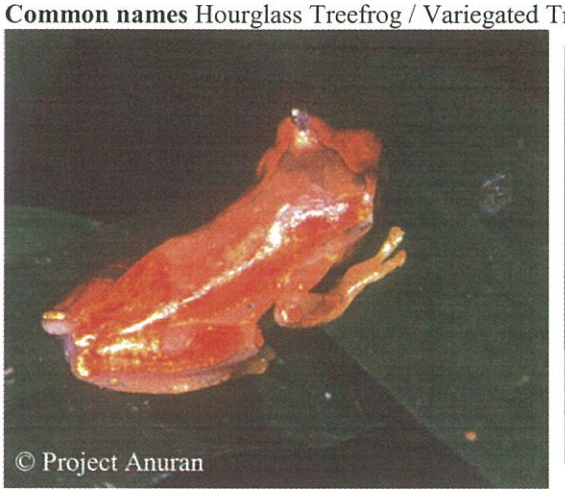
Morelet's treefrog was common at closed canopy ephemeral pools in the forest around Las Cuevas. This year it was recorded at Aguada, Coral, Warrie and Elegans, and, less often, at Marshy and Guava. It was usually found in the presence of its more common sister species, *Agalychnis callidryas*. Due to unusually dry weather it was not present in large numbers this year. However after short spells of rain large choruses were recorded.

Species *Hyla ebraccata*

(Cope, 1874)

Family Hylidae

Common names Hourglass Treefrog / Variegated Treefrog



1) Distinguishing features

Size (SVL) Males 24 – 27mm, females 30 – 34mm

Dorsum is yellow or yellowish tan, and maybe uniformly covered, although almost all have brown dorsal markings. These are highly variable in shape, but often take the form of an hourglass. The side of the head is mostly brown, with **distinct cream upper labial stripe** which usually is expanded to a pale spot below the eye. Thighs uniformly pale orange or yellow, the upper arm, flanks, hands and feet pale yellow. Venter is cream and iris is reddish bronze. The snout is truncate in profile. An extensive axillary membrane extends almost to the elbow, the discs on the digits are relatively large, and the toes about three quarters webbed, fingers about one half webbed. **Patternless individuals distinguished from *H. loquax* by the orange-red colouration of the webbing and posterior thighs in the latter species**. A thin tarsal fold extends the length of the tarsus.

2) Distribution

Sea-level to 600m. Appears to be restricted to the Semi-evergreen Seasonal Forest and possibly the drier portions of the Evergreen Broadleaf Forest formations.

3) Natural history

Nocturnal, arboreal frogs. Presumably spending most of non-breeding time up in forest trees, possibly in bromeliads. During rainy season call from low emergent vegetation at the edge of a pond, from dusk throughout most of the night. Eggs laid in clumps comtaining 24 – 76 eggs in a single layer on the upper surfaces of leaves above water. **Call is a high-pitched squark or creeek, repeated at frequent intervals – easily confused with *H.microcephala* to the untrained ear.**

4) Remarks

Although common in the north and central Belize, has yet to be found in the wetter south. Future studies needed.

5) Where did we find it near Las Cuevas?

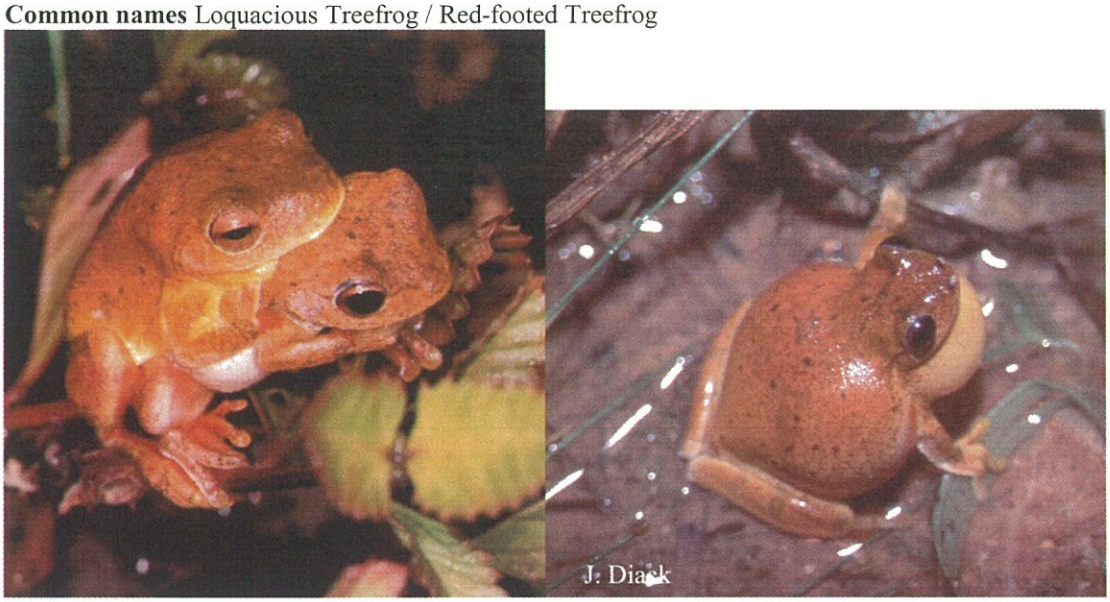
This year this species was observed on seven separate occasions, mainly during night surveys at Marshy pond but also at Guava and Aguada. Their appearance was closely linked to rainfall events. At Aguada they could be found on the vegetation surrounding the pond but also on adjacent vegetation using puddles that had formed in tyre tracks as temporary pools. During Phase III it was rarely observed and only at one site, Marshy pond, though it was present in reasonable abundance (often more than 50 males calling). This site was distinct from all others in being an open vegetation formation area but still surrounded by closed canopy forest. The site is further characterised by dense reeds and marshy ground. This year it was often heard calling synchronously with *H.microcephala and H.picta.*

Species *Hyla loquax*

(Gaige and Stuart, 1934)

Family Hylidae

Common names Loquacious Treefrog / Red-footed Treefrog



1) Distinguishing features

Size (SVL) 36 – 43mm, males usually larger than females

Dorsum is yellowish, reddish brown, brownish or greyish, often with dark flecks**, and the limbs lack transverse bars characteristic of many frogs**. Venter is cream or yellowish**. The hidden surfaces including the axilla, groin, anterior and posterior surfaces of the thighs, and the inner surfaces of the tarsi are bright orange-red, as is the webbing of the fingers and toes**. Iris is reddish tan. Snout is broadly rounded in dorsal profile and the dorsal skin is minutely corrugated. Forelimbs moderately long and robust with extensive axillary membrane reaching the elbow. Digits have well-developed discs, fingers are two thirds webbed, and toes nearly fully webbed. Weak tarsal fold extends from the inner metatarsal tubercle for about a third of the distance of the tarsus.

2) Distribution

Near sea level to 300m. Found during rainy season in and temporary and permanent pools in the forests and savannahs. Occurrence in the savannah limited to pools with 'islands' of broadleaf forest nearby.

3) Natural history

During dry season have been found in epiphytes found high in trees. One of the last frogs to appear at the beginning of the rainy season – needs about a dozen soakings before induced to breed. Males call from low vegetation, often far out in the deeper parts of the ponds or aguadas. Eggs deposited in clumps, up to 250 eggs, attached to submerged vegetation. Breeding normally restricted to deeper bodies of water. **Call is series of notes that have been likened to the honking of a goose**.

4) Where did we find it near Las Cuevas?

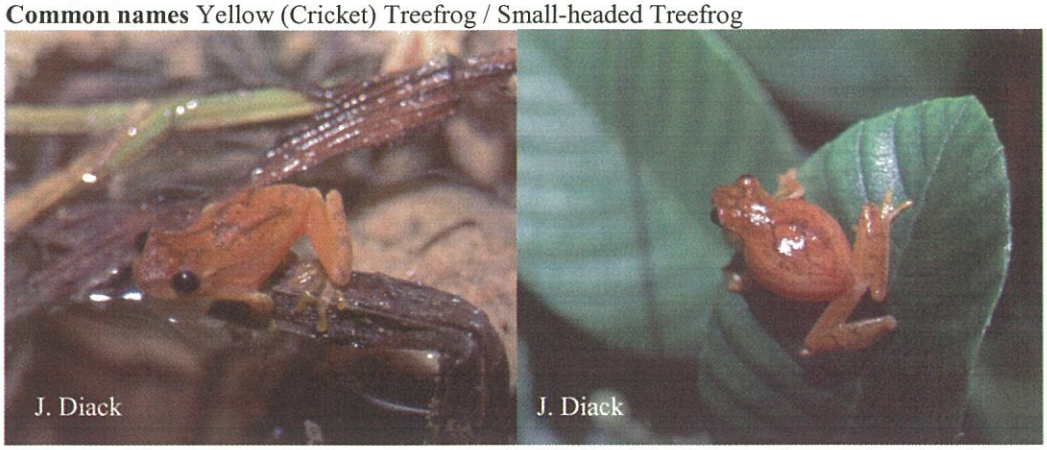
This species was common this year as in previous years. Unlike many species it continued to be present even after quite long periods of drought. Found at both open and closed canopy ponds. Most often at Millionario, also common at Guava, was observed at Tapir and Marshy but less often. In previous years it has been common at all studied breeding sites. - both open canopy temporary and permanent ponds. In past studies it has been noted that it was found to be present in a wide range of weather conditions, a consequence of which is that it was often heard calling in the absence of other frog species, this corresponds to our observations this year. Although having a distinctive call, it is often quite quiet against the background of a larger multi-species chorus. Once heard it is usually quite easy to visualise, being one of the larger species of the family Hylidae.

Species *Hyla microcephala*

(Cope, 1886)

Family Hylidae

Common names Yellow (Cricket) Treefrog / Small-headed Treefrog



1) Distinguishing features

Size (SVL) Adult males up to 25mm, females up to 30mm

Dorsum is yellowish or tan broken by irregular dark spots, and reticulations with X or H shaped markings. A dark interorbital marking is usual as are narrow, **lateral dark lines (pale bordered above) extending from above the eyes to the sacral region**. Thighs uniformly yellow and the shanks have dark transverse markings. The venter is mostly whitish. The iris is bronze. Snout somewhat pointed in dorsal profile, and the skin on the dorsum is smooth. Forelimbs are short and moderately robust and an abbreviated axillary membrane is present. Fingers about one third webbed, the toes about three quarters. A poorly defined tarsal fold extends the length of the tarsus.

2) Distribution

Sea level to 750m (at least 333m in Belize). Known from most vegetation formations, except for the Subtropical Evergreen Forest and Elfin Forest. Appears most abundant in open or disturbed areas, shying away from the deep forest.

3) Natural history

Nocturnal and largely arboreal. Breeding coincides with much of the rainy season, but may also take advantage of heavy rains at other times. Males call from low emergent bushes and grass in ponds. Often breeds in large choruses with thousands of individuals calling. Eggs deposited in small clumps on vegetation just beneath the water surface. Generally encountered around standing water, ranging from temporary ditches and pools to permanent lagoons. **Call is a cricket like sound *"shreek, shreek, shreek"* repeated at frequent intervals.**

4) Where did we find it near Las Cuevas?

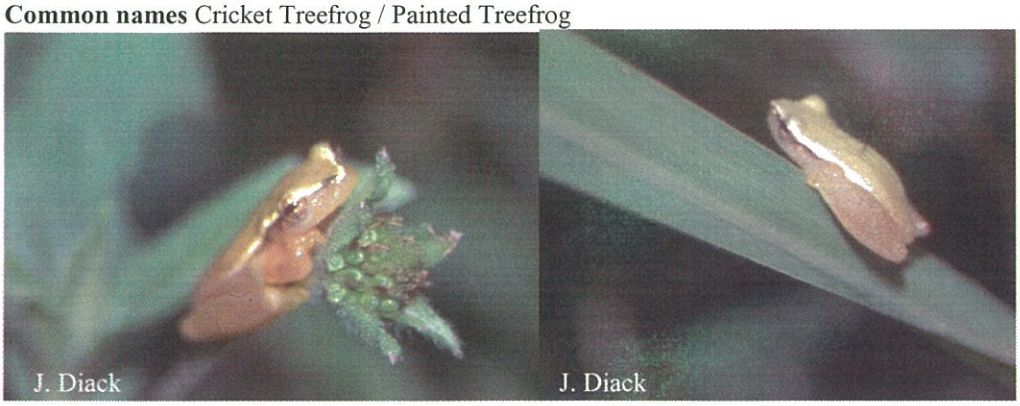
We found this species very commonly around both closed and open canopy ponds. As in previous years it was usually present in large numbers calling from low branches, or vegetation in the pond such as reeds. This species is capable of producing an incredibly loud and resonant call despite its deceivingly small stature.

Species *Hyla picta*

(Gunther, 1901)

Family Hylidae

Common names Cricket Treefrog / Painted Treefrog



1) Distinguishing features

Size (SVL) Adult males 18 – 21mm, females 20 – 23mm. **Smallest of the Belizean treefrogs.** Dorsal colour is cream to medium olive-brown with small dark flecks. **Most conspicuous feature is dorsolateral white stripe extending from the nostril posteriorly to the groin region, often accompanied by a dark stripe below – only Belizean frog to consistently exhibit this light stripe.** Venter is mostly whitish except for yellow vocal sac in breeding males. Forearm relatively short and slender and a distinct axillary membrane is present. The discs on digits are relatively small, fingers are one third webbed, and toes about three quarters webbed. Poorly defined tarsal fold is present distally on the tarsus.

2) Distribution

Near sea level to about 600m (upper limits unknown). Known from the Evergreen Broadleaf, Semi-evergreen Seasonal Forest, Mountain Pine Ridge, Karst Hills Forest, Savannah vegetation and the Coastal Lagoons and Marshes and Interior Wetlands formations. Probably countrywide in Belize.

3) Natural history

In the dry season found in bromeliads and banana plants. Breeds at the beginning of the rainy season in temporary bodies of water, usually in open areas. Males call from blades of tall grass or shrubs that are emergent in the water. Eggs are deposited on vegetation in or just above the water**. Call is shrill, insect like buzz, sometimes likened to a cricket. *H. picta* often breeds in association with *H. microcephala* and *Scinax staufferi*, but its vocalization is much weaker than theirs and its presence can thus be overlooked.**

4) Where did we find it around Las Cuevas?

Hyla picta was only observed once during Phase IV, during the day at Marshy pond. A number of individuals were present. This highlights their explosive breeding behaviour. It had been triggered by heavy rainfall the night before. Due to the low rainfall this wet season, *Hyla picta* was not observed at any other time. The fact that this species appear to be explosive breeders makes them difficult to survey using conventional survey methods. In previous years they were found fairly commonly at open canopy permanent and temporary ponds, normally together with *H. microcephala* and *H. loquax,* calling from low branches, shrubs and grasses around ponds. Observations made in previous years include the fact that their calling involves short choruses of frogs all starting together, and all seeming to finish together rather mysteriously at exactly the same point, followed by breaks in varying lengths. Also, despite their capability to produce quite a racket, it was often difficult to pick them out from a chorus (especially to estimate abundance) and to the untrained ear further confusion could be produced by the cacophony of surrounding crickets and circadas.

Species *Scinax staufferi*

(Cope, 1865)

Family Hylidae
Common names Stauffer's (Longnosed) Treefrog

1) Distinguishing features

Size (SVL) Adult males 21 – 25mm, females 23 – 27mm

General colouration is tan or olive-tan with dark brown markings. **Dark line from the nostril to the eye and a dark interorbital spot that may be triangular in some individuals**. Dark longitudinal dorsolateral stripes tend to be broken, but dark lateral stripes are often continuous, extending from behind the eye across the top of the tympanum to the inguinal region. The belly is whitish. Usually two or three dark transverse bars on the shanks and often there is some green around the eye. The iris is bronze with brown flecks. **Pronounced snout that overhangs the lower jaw giving frog an elongated appearance**. Skin on the dorsum is smooth, relatively long and slender forelimbs, and there is an abbreviated axillary membrane. Webbing is vestigial on hands, and toes are about two thirds webbed. Tarsal fold is absent.

2) Distribution

Up to 1,300m, but widespread at lower elevations. Known from all vegetation formations except the Subtropical Evergreen Forest and Elfin Forest formations. Appears to be absent from deep forest in those heavily vegetated formations and is a common inhabitant of the savannas, open forest and disturbed situations.

3) Natural history

Prefers subhumid and xeric habitats. Breeds following onset of rainy season and the first heavy rains. **Males congregate at temporary bodies of water in pastures, on savannas, and at roadside ditches- often in association with *H. microcephala* and *H. picta*** - where they call from low in the emergent vegetation or on the ground at the edge of the water. During the dry season may be found in bromeliads, rolling heliconia and banana leaves. Quite a common frog. **Breeding call of males is about half a dozen high pitched cheeps followed by a trill of about the same tone. There may be two to thirty or more consecutive notes.**

4) Where did we find them near Las Cuevas?

This year this species was not recorded. This may have been due to the sporadic nature of the rains, this wet season. In Phase III they were not found at all in the area of undisturbed broadleaf forest around Las Cuevas. They were found in abundance (greater than 100 males) at a large temporary breeding site in the main clearing of the Douglas Da' Silva forest station in the Mountain Pine Ridge area. This habitat is dominated by Caribbean pine (*Pinus carribea*) although the pond site was less than 500 m from an area of broadleaf gallery forest which parallels the Rio Frio river. A number of individuals were also noted in the savanna vegetation around the Tropical Education Centre on the main road between Belmopan and Belize city.

Species *Smilisca baudinii*

(Dumeril and Bibron, 1841)

Family Hylidae
Common names Mexican Treefrog / Baudin's Treefrog

1) Distinguishing features

Size (SVL) Males 55 – 65mm, females 70 – 85mm – **one of the largest treefrogs along with *P. venulosa*, may be distinguished from this by its smoother skin and lack of sticky glandular secretions**. Dorsum colour is variable, tan, brownish, or pale green and may be uniformly coloured, but usually there are large irregular dorsal splotches that may be dark brown or olive-green. **Capable of considerable metachrosis – may be completely different colour from night before when observed the next morning**. A dark canthal stripe is present and a whitish, ash grey, or lime green spot usually occurs between the lower posterior of the eye and the margin of the upper lip. Dark transverse limb bars are present. The venter is mostly white. The iris is gold above and brown below.

2) Distribution

The most abundant and ubiquitous frog on the Yucatan Peninsula. Known from all vegetation formations in Belize except the Subtropical Evergreen Forest and Elfin Forest formations.

3) Natural history

Frequently encountered in disturbed situations. During dry season stay in the forest in bromeliads, loose tree bark and other hiding places. Breeding extends most of the way through the rainy season, and one can almost always hear **their distinctive wonk-wonk-wonk calls** from shrubs, small trees and the edges of temporary bodies of water. Any quiet temporary water body seems to suffice for breeding. Eggs form film on the top of water.

4) Remarks

One of the most common anurans in Belize, and likely to be encountered in populated areas including Belize City.

5) Where did we find it near Las Cuevas?

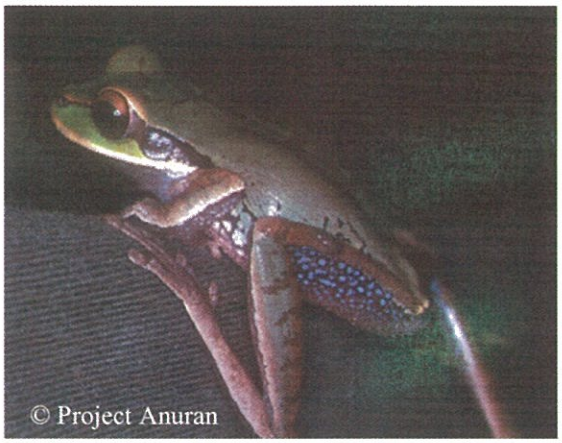
This species was far less abundant than previous years. In Phase III it was most commonly found following heavy rain when it is was extremely abundant, especially in newly formed open pools (e.g. in front of the research station) and tyre tracks. This year we recorded it at four of our study sites, Guava, Millionario, Coral and Marshy. Due to low rainfall they were not present in large numbers. It is probable that they may have been present in higher numbers at these sites after sustained rainfall events. It is thought that its explosive breeding strategy makes it difficult to achieve a representative picture of the status of this species using conventional survey methods.

Species *Smilisca cyanosticta*

(Smith, 1953)

Family Hylidae

Common names Blue-spotted Treefrog



1) Distinguishing features

Size (SVL) Males 50 – 56mm, females 60 – 70mm

Dorsal colour may be leaf green, pale green, tan or gold depending on time of day and temperature. Dark brown or green dorsal markings are present, including markings on the occipital and interorbital regions. The thigh or shank has three or four dark brown or green transverse bands. The margin of the upper lip is creamy white, a dark brown canthal stripe extending from the nostril to the eye and a dark brown postocular mark from the eye to the axillary region, including the tympanum. A gold or bronze stripe runs from the snout above the dark canthal stripe across the lateral edge of the eyelid and above the dark postocular markings onto the flank. **The flanks and anterior and posterior surfaces of the thighs are dark brown to reddish brown with many small pale blue spots**. The webbing is brown, the venter creamy white and the iris copper coloured. The snout is broadly rounded in dorsal profile, the forelimbs relatively long and robust, and the dorsal skin smooth. Digital discs are relatively small, the fingers about one third webbed and the toes about three quarters webbed, and a thin, well-developed tarsal fold extends the length of the tarsus.

2) Distribution

150 to 750m elevations. Known in the Evergreen Broadleaf Forest and Subtropical Evergreen Forest formations, but actual distribution in Belize poorly documented.

3) Natural history

Reproduction dependant on rains and maybe active throughout most of year during wet periods. Eggs have been found in temporary ponds, in water filled depressions in logs, forks of tree trunks and in springs and quiet stream pools, deposited as thin surface film. Appears to occur high in forest, probably inhabiting arboreal bromeliads and trees at low to medium heights. **Call is one or two short notes, "wonk, wonk".**

4) Where did we find this near Las Cuevas?

During Phase IV, we only observed this species once after heavy rainfall. It was found in puddles on the main road leading to Monkey Tail River. Five individuals were recorded. Reasons for the seemingly low abundance of this species are likely to be related to low rainfall levels. Temporary puddles did form after heavy rainfalls but rainfall events were sporadic and it is likely that sustained periods of rain are required to stimulate reproductive behaviour in this species. In Phase II and III it was rarely observed around Las Cuevas.

Species *Gastrophryne elegans*

(Boulenger, 1882)

Family Microhylidae

Common names Elegant Narrow mouthed Frog / Toad

1) Distinguishing features

Size (SVL) 22 – 25mm, females larger than males

Dorsum is brown or brownish-grey, sides of head and flanks being a darker colour. Usually an inguinal spot. Ventral colour is irregular white blotches seperated by narrow dark reticulum. Iris is medium brown. **Small and fat with small triangular head. Transverse fold of skin across top of the head immediately behind eyes – characteristic shared with *H. variolosus*, but *G. elegans* only has inner metatarsal tubercle as opposed to inner and outer metatarsal tubercles in *H. variolosus*.** Dorsal skin is smooth and thick, limbs short and robust and tips of toes very slightly dilated, toes scarcely have a trace of webbing.

2) Distribution

Countrywide at low elevation (up to about 900m). Specimens have been known from Evergreen Broadleaf Forest, Semi-evergreen Seasonal Forest and Savannah. Small, wet depressions in forest and in open areas surrounding agaudas.

3) Natural history

Fossorial – hiding under logs, rocks and other debris, or digging into soil. Call from within bunches of grass or beneath thick vegetation. Diet is small insects. Probably breed after heavy rains – eggs laid on surface of water to hatch in a few days**. Call is high pitched and prolonged, almost like the buzzing of an insect – *baaaaaaaaa*.**

4) Remarks

Not commonly encountered in Central America and only reported 4 times in Belize

5) Where did we find near Las Cuevas?

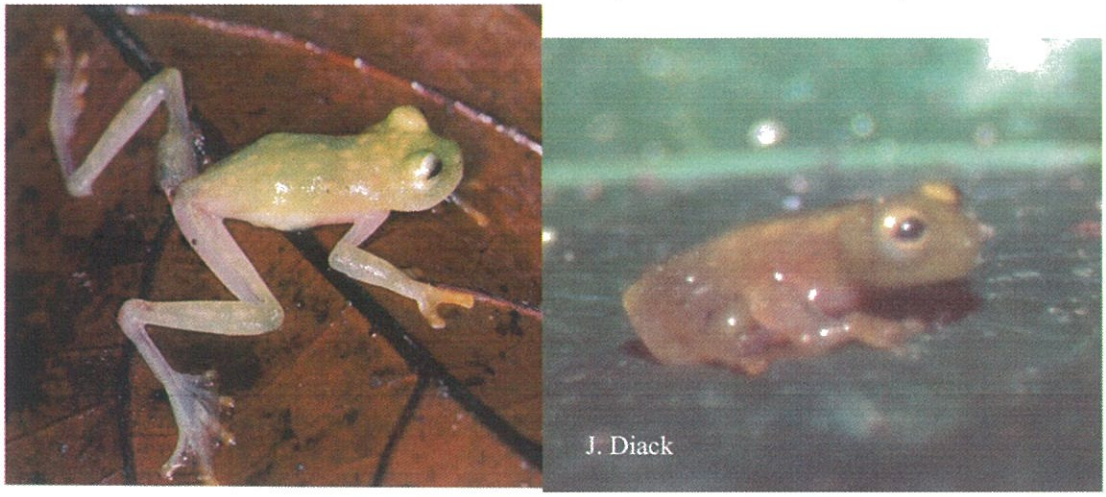
This species was not observed during Phase IV. A herpetologist staying at Las Cuevas recorded individuals after a sustained rainfall event two weeks before we arrived at the station, but they were not observed during our stay. Previously a relatively large population (>100) was estimated from subsequent captures in a pitfall trap established in wet ground off the main road towards the Monkey Tail River. During Phase III, a number of individuals were also seen to be calling outside the station during an intense storm in the late wet season and two confirmed sightings were made along the river bank of the Rio Frio gallery forest in the Mountain Pine Ridge area. They were also heard calling near to closed canopy ponds, often amongst choruses of *H.microcephala* and *H.picta*. Often heard in the early hours of the morning after the majority of other species had retired. Note that during Phase II after a period of intense drought an estimated 5000 of this species were seen at Puzzle Pond and also lesser numbers at various other sites during the week following this freak event. That night represented the most fantastic demonstration of the explosive nature of this and other (R.dorsalis, S.baudinii, B.valliceps) species.

Species *Hyalinobatrachium fleischmanni*

(Boettger 1893)

Family Centrolenidae

Common names Northern Glassfrog / Mexican Glassfrog / Fleischmann's Glassfrog



1) Distinguishing features

Size (SVL) 22-25mm (males slightly smaller)

Dorsum is smooth in texture and a pale, lime green with many tiny scattered dark melanophores and small yellow spots. Top of digits and discs are yellow. **Name derives from the characteristic transparent venter, through which some organs can be seen – especially the heart**. The iris is gold. **The snout is exceptionally short in dorsal profile**. Digits have well developed discs that are moderately expanded to form discs. Fingers are about ½ webbed (toes ¾). Tarsal fold is absent. Vocal slits are present and the vocal sac is moderately distensible. Tadpoles are mostly transparent with tiny uniformly serrated beaks.

2) Distribution

Occurs widely in the wet forests of Central America up to 1,600m. Known in Belize in Cayo, Belize and Toledo and Stann Creek districts.

3) Natural History

Found in Evergreen Broadleaf and Subtropical Evergreen Forest formations. In Mountain Pine Ridge they are confined to broadleaf forests that border streams though the pine forests. Occurring near free-flowing, clear streams (especially during breeding)– quite common if habitat is suitable, although this is limited in the Yucatan peninsula. Possibly also inhabit epiphytes in more humid situations. Almost exclusively nocturnal in activity. Most males vocalise from undersides of vegetation overhanging water. **The call is a high pitched *peep* of about 0.1 seconds repeated every 6-16 seconds – this is usually heard from a chorus of males**. Males are highly territorial – an intruder elicits a series of more mew like *peeps* and even physical grappling can ensue. **Eggs are deposited on the underside of leaves (ie heliconias)** and are guarded by the male (between 18-30 in one brood). Eggs hatch and tadpole fall into streams below. Growth and development of tadpoles is slow with metamorphosis possibly taking up to a year.

4) Where did we see it around Las Cuevas ?

In Phase IV, we found one individual on the Creek transect during the day, (see above right). A number were also recorded vocalising during night transects at the Monkey Tail River. None found during Phase I. However, one individual was found during Phase II – seen by the side of a fast flowing creek which joins the Monkey Tail River whilst on a day transect. This species would not normally be seen during the day, but in this case the individual (see above left) has what appears to be a parasite on its back leg, which could have notably altered its behaviour. The fact that the creek site was only added to the Project Anuran monitoring protocol during Phase II explains why its presence was not recorded during Phase I, as it is known to call from by the side of fast flowing water (Lee 1996).

Species *Bufo campbelli*

(Mendelson 1994)

Family Bufonidae

Common names Campbell's forest toad / Rainforest toad

1) Distinguishing features

Size (SVL) males reach about 70mm, females about 90mm (compare with *B. marinus*)

Large females – dorsum is mostly brown with a bluish brown, dark brown or cream vertebral stripe, often with small, irregular, blackish dorsal blotches. Adult males paler dorsal colouration – pale greenish yellow with reddish tubercles. Sides greyish brown with dorsolateral tubercles and some intervening orange skin. Lateral and edge of mouth tubercles whitish. Limbs brown with black-bordered greyish bars. Highest portion of cranial crests black. **Tips of digits are orange** and iris is bronze with black reticulations. Distinct cranial crests (canthal, preocular, supraorbital, postocular, supratympanic, parietal). **Parotoid gland medium in size – less than half the side of the head and triangular, tapering to a point posteriorly and extending no further than the level if the insertion of the forearm (compare with** *B. marinus*). Lateral series of tubercles extends from posterior edge of parotoid gland to inguinal region. Limbs short and stout. Distinguishing features from *B. valliceps* – **relatively small tympanum (less than half diameter of eye), preorbital and pretympanic crests absent or weakly developed, relatively long tibia and feet (more than 43% SVL), and orange tips to digits**. Relatively smooth skin – dorsum with a few scattered tubercles dorsolaterally, snout acutely rounded in lateral view and pointed in dorsal view. Pale, conical tubercles along inner tarsus.

2) Distribution

Near sea level to 1,000m elevation. Near streams in humid rainforest. Restricted to primary forest (compare to *B. valliceps*). Currently known in Evergreen Broadleaf Forest and Subtropical Evergreen Forest.

3) Natural History

Probably primarily nocturnal, but may be encountered in day on darkened forest floor. Breed in small mountain streams – restricted to wet season. **Call is very soft trill.**

4) Where did we find it at Las Cuevas?

This year all specimens were found on or around the path near the Monkey Tail branch of Raspaculo River. We found four individuals in total, one of which was an adult. These are far scarcer than the juveniles with only 2 confirmed sightings in Phase II, and no adults being observed in Phase III. Note – during Phase II considerable number more individuals were seen in the same area, the majority of which were juveniles.

Species *Bufo marinus*

(Linnaeus 1758)

Family Bufonidae

Common names Giant toad / Marine toad / Cane toad

1) Distinguishing features

Size (SVL) 200mm plus – **largest toad in Belize**. Females reach larger sizes than males. Males reddish brown with spiny tubercles covering dorsum. Females medium brown to pale gray-brown, darker brown mottling (similar to juveniles), large rounded tubercles. Prominent cranial crests (canthal, supraorbital, postocular and supratympanic). **Huge, enlarged parotoid glands (distinguishable from all other toads)** – occupy area larger than side of head and extending posteriorly to a level well beyond insertion of forearm - coloured similar to dorsum or sometimes reddish brown. Snout pointed in dorsal view. Skin on dorsum rugose – numerous large tubercles. Limbs moderately short and stout. Males have keratinized patch on thumb.

2) Distribution

Common at lower elevations throughout Belize. Primarily found in open habitats such as savannas and secondary forests; it is uncommon in or completely absent from closed-canopy forests. Seldom found far from water. Has become a human commensal over much of its range, and it is now very abundant in and around human habitations. Throughout the Yucatan Peninsula these toads congregate beneath streetlights and feed on the insects attracted to the lights. They are often seen on roads at night, especially following rains, and can easily be mistaken for small boulders.

3) Natural History

Nocturnal – tropical dry, moist and wet forest and subtropical dry and moist forest. **Eats almost anything that moves and can be swallowed !**. Usually extremely abundant wherever it occurs – well protected by toxic secretions from its parotoid glands – it is not a good idea to handle this species. Year round breeder, especially around permanent water where eggs laid in stings – breeding peak coincides with beginning of rainy season. Loud, rolling trill like call, very distinctive.

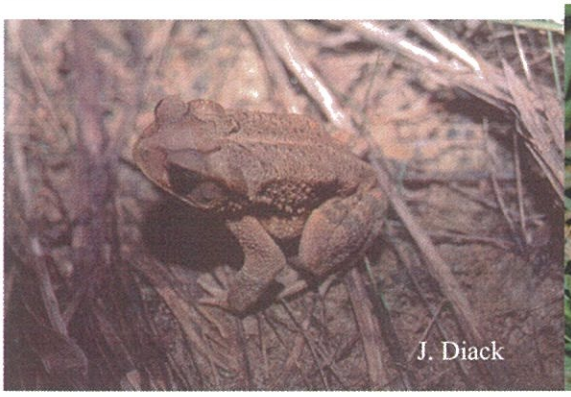
4) Where did we find it near Las Cuevas?

We only found one individual this year on the Monkey Tail transect at night. This corresponds to previous years when it was rarely found or heard in the undisturbed forest around Las Cuevas, although a number of solitary individuals were found near to the Monkey Tail River whilst searching at night. In Phase III it was noted that the increase in abundance near to habitation (around the town of San Ignacio) was marked and individuals were found hiding in the kitchens of bars and cafes. Note: during Phase II a number of individuals were seen on the newly established riverbed transect during nocturnal surveys.

Species *Bufo valliceps*
(Wiegmann 1833)

Family Bufonidae

Common names Gulf coast toad



1) Distinguishing features

Size (SVL) Males; 60-70mm, females; 80-90mm (similar to *B. campbelli)*

Dorsal colour highly variable – orangish, tan, reddish brown, brown, pale grey. Females usually darker than males. Some have pale dorsolateral band – contrasts with darker flanks. Venter is cream, some have few to many black spots, some have black blotch on chest. Iris is coppery red. Distinct cranial crests (canthal, preocular, supraocular, postocular, suprtympanic, parietal). Parotoid gland moderate in size, same shape and space as *B. campbelli*. Distinguishing features from *B. campbelli*; **large tympanum (> half the diameter of the eye), preorbital and pretympanic crests relatively well developed. Relatively short tibia and feet (<43% SVL). Skin rough and warty, snout shorter and blunter both in dorsal and lateral view**. Series of pale conical tubercles along inner tarsus.

2) Distribution

One of widest ranging amphibians. Sea level to 1,200m elevation. Inhabit savannas, agricultural and urban lands and undisturbed forest. Seems to be found more commonly in disturbed and less humid environs in comparison with *B. campbelli*.

3) Natural history

Breed throughout year – large choruses at ponds, lakes etc, and in any temporary waters (explosive breeding). Mostly nocturnal. Strictly terrestrial, blending in with dead leaves on forest floor, or hiding under rocks, logs and other debris when not active. **Call is short trill, repeated frequently, large choruses can be quite deafening – somewhat akin to a pneumatic drill !**

4) Where did we find them near Las Cuevas?

This year this species was present in far lower numbers than previous years and was only recorded on three occasions at Millionario, an open canopy pond. A few individuals were observed hopping around the station but none were vocalising on such occasions. Two more individuals were observed out with night surveys at ponds; one on the path to Monkey Tail River and another on the Nature Trail transect, both at night. In Phase III, alongside *Smilisca baudinii* the Mexican tree frog, this was one of the most abundant species in the area around Las Cuevas. It was especially common after periods of heavy rain, when it could be heard calling in choruses of many hundred, often alongside *S.baudinii* and the *Rhinophrynus dorsalis* the Mexican burrowing toad. Again, like other explosive breeders it is undoubtedly misrepresented by traditional survey techniques especially in years of low rainfall as has just been seen.

Species *Rana berlandieri*

(Baird 1854)

Family Ranidae

Common names Rio Grande Leopard Frog

1) Distinguishing features

Size (SVL) Adult males 75-85mm, adult females 115-120mm

Th dorsum is smooth and usually brown or olive brown with **characteristic, irregular dark blotches**. Well-formed dorso-lateral ridges are present and are tan or yellow in colour. There is a dark canthal stripe and a white labial stripe may extend from beneath the eye to the angle of the jaw. **The ear is large and pale to medium brown, extending from the dorsolateral fold of the supralabial stripe**. The lower flanks are pale brown to whitish and marked with small, dark spots. There are often dark markings on the lower jaw and distinctive dark bars present on the thighs and shank. The throat and chest are usually dark whilst the belly is whitish/cream. **There is extensive webbing between the toes and the digits are not expanded to form discs**. Adult males have a pair of vocal slits and lateral vocal sacs.

2) Distribution

Widespread, usually at lower elevations – its distribution in the Mayan mountains is poorly known.

3) Natural History

This is a common species known from nearly all freshwater vegetation formations in Belize except Subtropical Evergreen Forest and Elfin Forest formations (probably due to lack of information). Individuals are almost always encountered at night near water – usually temporary or permanent ponds, marshes or slow-moving streams. Daylight sightings have been recorded but are not common. Known to disperse quite widely following the first heavy rains of the summer season. **Their call can be described as a series of low pitched chuckles or trills.** Eggs are laid in still water to await development. They have terrestrial lifestyles and feed primarily on invertebrates but can sometimes achieve sufficient size to take small vertebrates.

4) Where did we find it near Las Cuevas?

This species was recorded on a number of occasions, seemingly preferring open canopy permanent pools such as Millionario and Marshy, also recorded at Aguada, Coral and Guava. It was usually to be found near vegetation at the edge of the pond. Highly mobile and alert, if disturbed jumped into water and swam away. Unlike previous years it was not recorded at Tapir. Tapir had unusually low numbers of all species this year and further investigations into possible reasons shall be discussed in the main report. In previous years *Rana berlandieri* was present in greater numbers and at more sites, the difference in numbers was probably due to the delay in the wet season.

Species *Rana juliani*

(Hillis & de Sa 1988)

Family Ranidae

Common names Julian's Frog / Maya Mountains Frog

1) Distinguishing features

Size (SVL) Males reach about 70mm, females up to 100mm

The dorsum between the dorso-lateral folds is medium brown, often with scattered dark blotches. The sides of the body beneath the well developed dorso-lateral folds are uniformly dark brown and the venter is cream. The frog possesses a cream supralabial (upper lip) stripe and **a distinct black face mask**. The ear is pale brown and of similar diameter to the eye. The skin of the dorsal surfaces is denticulate (common amongst ranids), and the sides of the body (below the dorso-lateral folds) are covered with raised striations. Webbing between the toes is extensive if not complete and the toes are not expanded to form discs. **As is typical in many stream dwelling species vocal slits and sacs are absent in males.**

2) Distribution

This species is considered to be an endemic of the Mayan Mountains of Belize, known from Mountain Pine Ridge and Little Quartz Ridge of Toledo district and also reported in mountains of the Cayo district. Elevations between 1000 and 3000ft.

3) Natural History

Occurs commonly in streams of Mountain Pine Ridge and also known from Subtropical Evergreen formations. There appears to a be a clear ecological restriction to the riparian habitats around mountain streams. No vocalisations are known are there are unlikely to be any owing to the absence of vocal slits or sacs. Eggs are presumed to be laid in streams and it is likely that breeding takes place in the rainy season.

4) Where did we find around Las Cuevas?

This year this species was found most commonly during night transects in Monkey Tail River, usually on the banks. A few were also found during night transects at the Creek site. In previous years it has been observed in the Mountain Pine Ridge area on the banks near fast flowing water – particularly around the Rio Frio river, where it seemed to be quite common. It is the smallest of the three Ranid species known from Belize, but still retains the speed and agility of its close relatives, making it notoriously difficult to catch. – Note from Phase II, this species was also found in relatively high abundance along a creek leading into Monkey Tail River, but very rarely by the river itself.

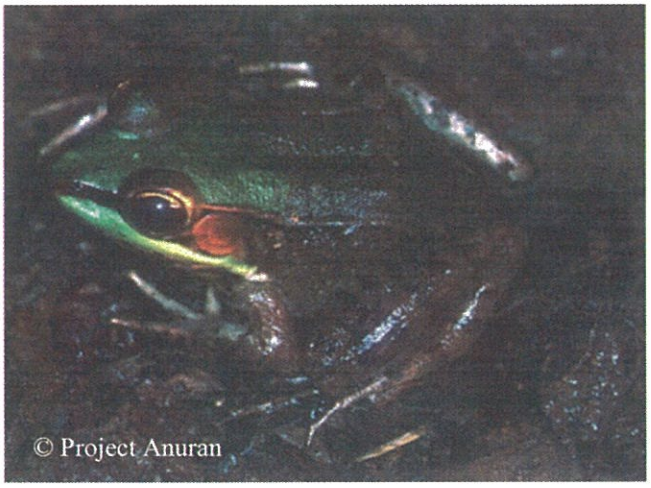
5) A new species ?

During Project Anuran Phase I, an individual was caught which closely resembled *Rana juliani*, but which also differed in several key features. Although the specimen possessed the bold markings on the posterior thigh and the distinct supr-labrial stripe characteristic of *R.juliani*, its tympanum was relatively tiny – about $1/3^{rd}$ the diameter of the eye. Another species *R.maculata* is noted to occur in the Peten region of Guatemala, which serves to match this description although there are no known records from Belize. Professor Julian Lee, the herpetologist after whom *R.juliani* takes its name, suggests that it may be an unusual morph of either *R.juliani* or *R.vaillante*, which is particularly likely with respect to its juvenile condition. Project Anuran Phase II is returning to survey the MPR area with the express purpose of searching for more individuals portraying these unusual characteristics.

Species *Rana vaillanti*

(Brocchi 1877)

Family Ranidae
Common names Valliant's Frog / Forest Frog / Rainforest Frog



1) Distinguishing features

Size (SVL) Adult males 67-94mm, adult females 76-125mm

This is the largest frog known to Belize and second only to *Bufo marinus* in size amongst the anuran order. The dorsum colour between the dorso-lateral ridges is brownish/bronze and the **dorsal surface of the head and anterior portions of the body are often bright green, especially in males.** The ear is tan and often with irregular black markings. The supralabial stripe is absent or only present posterior to the eye, **and there is no black facemask – comp. To *R.juliani*.** Below the dorso-lateral folds the sides of the body are brown with darker spots or blotches, and the limbs usually have indistinct dark bars. The venter is cream or yellow coloured. The skin of the dorsal surfaces is smooth to finely denticualte. The webbing between the toes is extensive and expansion of the digits is minimal. Vocal sacs and slits are present in the males.

2) Distribution

Mesoamerica wide distribution from sea level to about 2000ft.

3) Natural History

As the common name suggests this species is often associated with forested areas where it is never found far from streams or forest pools. It is a common species known from most vegetation formations in Belize where it usually inhabits sluggish lowland streams, lakes and temporary ponds. It is active all year around permanent bodies of water but reproductive activity is mainly during the wet season. Eggs are deposited in forest pools or in still sections of streams where tadpoles undergo development for several months. It is primarily nocturnal but has been observed resting near pools during the day. **The call is a series of five or six grunts each lasting about 0.2s separated by an interval of 2-11s.**

4) Where did we find it near Las Cuevas?

This species was recorded on three occasions. Once during a night transect in Monkey Tail River and twice in the Creek transect. It was rarely seen in Phase III, with one individual (the above photograph) being seen on the banks of the Monkey Tail river and two more unconfirmed sightings by the Rio Frio river in the MPR region (broadleaf gallery forest). Note from Phase II – this species was seen in high abundance during the new transect line established in 2001 which runs along the river bank itself and was monitoring after 2100 hours.

7. Future Outputs

- The aim of this report was to highlight some of our initial findings, making general comparisons with previous years and illustrate some of the challenges we faced in collecting this years data. A final report of all our results and a more in depth study will be submitted by September 2004. Within the final report we hope to investigate the potential effects of drought years on the overall balance of Anuran diversity in the area.
- The team will also be giving talks to various groups e.g Edinburgh University Exp-ed society, about this years project.
- The arrangement of a final phase of Project Anuran, to collect the fifth year of data is presently underway.

8. Acknowledgments

Project Anuran Phase IV would like to warmly thank:
The Royal Geographical Society, The Scottish Royal Geographical Society, The Weir Fund for Field Studies, Eurocarriers S.A.. James Rennie Bequest, The Barnson Bequest, Derek Scott, Chris Minty, Peter Stafford and Peter Furley and all of the staff at the NHM.

Last, but, of course, not least we'd like to thank Heather for all her support and hard work she did throughout the year! We also received an immense amount of help Norberto Coc (LCRS staff member) as a field assistant for the majority of our stay. Also helping us for a short time (5/07-20/07) was Jose Guavera.
We also want to thank everyone at the LCRS: Chapal and Celia Bol, Isidro and Judie, Bo, Norry, Venicia, Matthew and Enrique.
Their help and guidance is greatly appreciated

9. References

Alford, R.A. & Richards, S.J. (1999) Global amphibian declines: a problem in applied ecology. *Annual Review of Ecology Systematics,* **30**, 133-165.

Barinaga, M. (1990), Where are all the froggies gone?, *Science*, **247**, 1033-1034.

Blaustein A.P., Wake D.B, Sousa W.P., (Mar 1994) Amphibian Declines- Judging stability, persistence and susceptibility of populations to local and global extinctions, *Conservation Biology* **8** (1), 60-71.

Beebee, T.J.C (1996) Ecology and Concervation of Amphibians. Chapman and Hall

Burry, R.B. (1999), A historical perspective and critique of the declining amphibian crisis, *Wildlife Society Bulletin*, **27**, 1064-1068.

Bulger JB, Scott NJ, Seymour RB (Mar 2003), Terrestrial activity and conservation of adult California red-legged frogs Rana aurora draytonii in coastal forests and grasslands, *Biological Conservation* **110** (1), 85-95.

Campbell, J.A. (1998) Amphiibians and reptiles of Northern Guatamala, the Yucatan and Belize. University of Oklahoma, Norman, OK.

Chalcraft DR and Resetarits WJ, (2003), Predator identity and ecological impacts: Functional redundancy or functional diversity?, *Ecology*, 84 (9), 2407-2418.

Chapin F.S *et al.*, (2000) Consequences of changing biodiversity, *Nature,* **405,** 234-242.

Davidson, C., Schaffer, H.B. & Jennings, M.R. (2001) Declines of the California red-legged frog: Climate, UV-B, habitat, and pesticides hypotheses. *Ecological Applications*, **11**, 464-479.

Duellman, W.E. & Trueb, L. (1994) Biology of Amphibians. John Hopkins University Press.

Drosr C.A. & Fellers G.M. (1996), Collapse of a regional frof fauna in the Yosemiute area of the California Sierra Nevada, USA, *Conservation Biology* **10**, 414-425.

Eterovick PC 2003) Distribution of anuran species among montane streams in south-eastern Brazil, *Journal of Tropical Ecology* 19, 219-228 Part 3.

Fellers, G.M. & Drost, C.A. (1993) Disappearance of the cascades frog (*Rana cascade*), at the southern end of its range, California, USA. *Biological Conservation*, **65**, 177-181.

Harcourt, C. (1996) The conservation Atlas of Tropical Forests of the Americas. IUCN.

Hartshorn, G. *et al* (1984) *Country Environmental Profile of Belize:* A Field Study. Robert Nicolait & Associates USAID San Jose.

Hatch AC, Blaustein AR, (Aug 2003), Combined effects of UV-B radiation and nitrate fertilizer on larval amphibians, *Ecological Applications*, **13** (4), 1083-1093.

Heyer W.R., Rand A.S., da Cruz C.A.G.& Paixoto O.L. (1988), Decimation, extinctions and colonisations of frog populations in South-east Brazil and their evolutionary implications, *Biotropica*, **20**, 230-235.

Houlahan JE, *et al.* (2001), Quantitative evidence for global amphibian population declines *Nature* **404** (6779), 752-755

Houlahan J.E., (2001) Nature, 412 (6846) 500-500

Guyer C. (1990) The herpetofauna of La Selva, Costa Rica, *Four Neotropical Rainforests,* 371-385, Yale University Press.

Laurance W.F., Mc Donald K.R. & Speare R. (1996) Epidemic disease and the catastraophic decline of Australian rain forest frogs, *Conservation Biology* **10** 406-413.

Lee, J.C. (1996) *The amphibians and reptiles of the Yucatan Peninsula.* Cornell University Press, Ithaca, London.

Lee, J.C. (1996) *A field guide to the reptiles of the Maya World.* Cornell University Press, Ithaca, London.

Linzey DW, *et al.* (Jun 2003), Role of environmental pollutants on immune functions, parasitic infections and limb malformations in marine toads and whistling frogs from Bermuda, *International Journal of Environmental Health Research*, 13 (2), 125-148

Lips, K.R. (1998) Decline of a tropical montane amphibian fauna. *Conservation Biology*, **12**,106-117.

Lips, K.R. (1999) Mass mortality and population declines of anurans at an upland site in western
Panama. *Conservation Biology*, **13**, 117-125.

Meyer J.R. & Foster, C.F. (1996) *A Guide to Frogs and Toads of Belize.* Krieger, Florida.

Meyer, J.R. (1999b) MAYAMON-Maya Forest Anuran Monitoring Project – General information for participants. Unpublished.

Miller, B. & Miller, C. (1995) National protected areas management plan – zoological report : Faunal and site analysis. Unpublished report.

Murphy JF, Simandle ET, Becker DE (Mar 2003), Population status and conservation of the black toad, Bufo exsul, *Southwestern Naturalist*, **48** (1) 54-60.

Pearman P.B. (1997), Correlates of amphibian diversity in an altered landscape of Amazonian Equador, *Conservation Biology*, **11**, 1211-1225.

Pearman, P.B., Velasco, M. & Lopez, A. (1995) Tropical amphibian monitoring: A comparison of methods for detecting inter-site variation in species composition. *Herpetologica* **51**, 325-335.

Pounds, J.A. & Crump, M.L. (1994) Amphibian declines and climate disturbance : The case of the Golden Toad and the Harlequin Frog. *Conservation Biology*, **8**, 72 – 85.

Rohr JR, *et al.* (Oct 2003), Lethal and sublethal effects of atrazine, carbaryl, endosulfan, and octylphenol on the streamside salamander (Ambystoma barbouri), *Environmental Toxicology and Chemistry*, **22** (10) 2385-2392.

Venturino A, *et al.* (May 2003), Biomarkers of effect in toads and frogs, *BIOMARKERS* **8** (3-4), 167-186.

Young B *et al.*(Oct 2001), Population declines and priorities for amphibian conservation in Latin America *Conservation Biology* **15** (5), 1213-1223.