# THREATS FACING ENDEMIC HERPETOFAUNA IN THE CLOUD FOREST RESERVES OF ECUADOR

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ECUADOR is a small equatorial country (283,520 sq. km) on the western coast of South America. Colombia is to the north and Peru to the south. Its diverse natural history, striking scenery, and fascinating anthropology continually inspire questions about its geographical and ecological make-up. Ecuador is one of the world's 'mega-diverse' countries, having more plant species as a country than the whole of Europe (Rachoweiki, 1997). It is a link in an arc of distinctive biodiversity stretching from the Eastern Andean base of Venezuela right through to Bolivia. There are four geographical regions; coastal lowlands, Andean highlands (Sierra), Amazonia (El Oriente), and the famous Galapagos archipelago, where animals exhibit no apparent fear of man (Jackson, 1993).

The coastal region is a mix of cliff headland, large estuarine rivers, grove forests, meandering rivers, and flat valleys. The Andean highland mountains stretch north to south of the country and have an eastern and western ridge (9900-13,200 ft / 3-4000 m) with a dip separating them (altiplano 6600-9900 ft / 2-3000 m) that stretches 10-20 km wide. This parallel mountain chain boasts gigantic snow covered volcanoes, paramó, and cloud forest environments. The Amazonian region equates to nearly 50% of Ecuador's territory and has four major rivers flowing in a southeasterly direction to one of the main tributaries of Peru and Brazil.

Ecuador's climate is typical of many tropical regions and is split into wet and dry seasons depending on geography. The Galapagos and coastal climate are affected by oceanic currents from the warm equatorial Pacific. They are hot and rainy between January and April, overcast during July / August and are generally cooler from May - December. El Oriente is wettest during April - June and drier from August-December, although rain in the region is often irregular. The highlands and paramó are dry from June-September and after a short dry spell during December becomes progressively wetter, with most rain falling in April. Rain does not fall daily during the wet season. Day time temperatures are around 20-22°C (68-72° F) for the highlands and they have a year round low of 7-8° C, 45-48°F, based on data from Quito (Rachoweiki, 1997). Despite this apparent trend all regions can be unpredictable in their weather patterns.

## DESCRIPTION OF STUDY AREAS

Cashca Tortoras is located in the Bolivar province and is named after the native Cashca Tree (Cunoniaceae). The Bolivar province is home to a large agricultural fraternity despite having an elevation of just 200 m at its lowest point. Cashca Tortoras consists of approximately 10 ha of Tropical Montane Cloud Forest (Holdridge, 1967) of which 2 ha is owned by the Universidad De Bolivar. Cashca Totoras research station is located at the top of a basin of forest (1° 43' 03.7" S, 078° 58' 40.8" W: 3100 mamsl) and was built in 1994. The forest has a northern ridge and stream gullies that percolate south joining a central stream in a herringbone fashion. The stream gullies trickle water at a depth of barely a few inches and are usually less than 1 m wide, the main stream being approximately 2 m at its widest point and rarely more than 1 ft deep. The slopes are very steep and clouds roll beneath the research station into the valley basin. Rainfall in this valley can occur both above and below the station. The forest vegetation has a mixture of shrubs (local names in italics)

from the Araceae (Camacho), Asteraceae, Ericaceae (Mortiño; edible berries, well used by locals), Graminae, Gunneraceae, Moraceae, Pipperaceae, and *Polylepis* (Cascarilla paper bark trees). The Araceae leaves are broad with a waxy appearance. They stand anything from 15-30 cm and frogs use them for 'sit and wait' ambush or vocalising posts. Several tropical orchid species can also be found. Cashca Totoras boasts some incredible fauna — parakeets, tarantulas, large beetles, stunningly diverse Lepidoptera and phasmids (stick insects) are just a few to mention. Several secretive ground -dwelling mammals that were not identified also patrol the area. General conditions at Cashca Totoras are 10-17°C (50-63°F), elevation 9070-11340 ft, and 1000-1500 mm annual rainfall.

Andean Paramó and puna are areas above tree-line that superficially resemble an alpine tundra, but are unique because of the extreme temperature fluctuations. This habitat is characterised by high winds, large amounts of precipitation, and increased UV light levels. Due to these environmental extremes, the flora has evolved specific morphological features such as short stature, thick stems, and persistent leaf bases. Paramó flora includes spongy lichens, hardy wildflowers, dense thickets, and clumps of tussock grass. Among its various animal inhabitants are Marsupial Frogs, endangered condors, Pumas, Andean Spectacled Bears, Pudu Deer, ducks, falcons, and Paramó Hummingbirds. Over 1400 Ha of paramó habitat surrounding Cashca Tortoras is protected by national legislation. Many of the amphibians found in this habitat are extreme opportunists and can breed in the smallest pools. Temperatures range from 3-6°C (37-43°F), annual rainfall from 500-1500 mm. Elevations range from 12960-14250 ft.

Rio Azuela is located north east of Quito toward Cayambe, close to the borders of the Napo and Sucumbios provinces. The areas of forest surveyed at Rio Azuela follow the banks of the Rio Grada River, which is located in a deep valley, making the terrain steep. Two trails were surveyed. The first was a flat ridge walk that followed a southerly winding stream that eventually looped back on itself. It joined a larger stream that would eventually connect with the main tributary. The site trails extended at their furthest to San Rafael falls. They proceed upstream to a small area of local accommodation and cross the stream many times. The stream was fast flowing, 2 m at its widest point, and pools were no more than 60 cm deep. One trail was further north of our accommodation in a small roadside patch of forest and had a pool. This area was dense and its trails needed to be re-cut before surveying. The forest vegetation of Rio Azuela mirrored that of Cashca Totoras, although understorey shrub layers were more dense. Orchids, melastomes, bromeliads, and bryophytes are present illustrating the site's floral diversity. Rio Azuela was warmer than Cashca Totoras due to a drop in elevation (18-22°C / 64-72°F, 5640 ft). It was also notably more humid (1500-2000 mm annual precipitation) and is classified as Cloud Forest (Holdridge, 1967).

## SPECIES DESCRIPTIONS

The following papers and guides were used for classification and identification: Coloma (1995), Duellman & Hillis (1987), Lynch & Duellman (1997), Miyata (1982). The survey results and morphometric data collected in the field are excluded from this report as it is to be collated with further surveys for relative distribution analysis and publication by PUCE. Key: CT = Cashca Totoras / RA = Rio Azuela / (p) = paramó.

### AMPHIBIA

ANURA: Hylidae

*Gastrotheca pseustes*, San Lucas Marsupial Frog (Duellman & Hillis, 1987), CT (p). — Adults of this species were not found. The individuals we encountered were a mixture of young and developing tadpoles. *Gastrotheca pseustes* tadpoles are easily identified by their large black bodies. The developing individuals were in stage 43-44 (Gosner, 1960; also see Duellman & Trueb, 1986), having fully developed front and rear limbs and well formed jaws and tongue. Those that were in stage 41 (without emerging front limbs) still had larval mouthparts. The developing tadpoles had

blotched tan coloured markings and a dark band through the eyes. Each dorsal blotch had a gold ribbed edge. They exhibited a golden underside, blunt snout, and block-shaped head. This species is known to be susceptible to Chitrid fungus (Berger, et. al, 1999).

*Osteocephalus verruciger*, Slender-legged Treefrog (Werner, 1901), RA. — The single specimen caught was an adult male with a SVL of 5.0 cm. A medium-sized treefrog with a warty dark brown/green body and head. It has an orange-brown groin and has a creamy blotched underside and throat. It has bulging eyes, wide nostrils, and a large tympanum. Its large hind limbs are dark green and the feet are a blend of pink and orange with pronounced toe-pads, indicating its arboreal habits.

Leptodactylidae

*Eleutherodactylus marmoratus*, Marbled Robber Frog (Boulenger, 1900), RA. — This frog has a marbled upper body with no dorso-lateral folds. It has a rounded snout, red/pink throat, white spotted underside, small back legs and, large mushroom shaped toe-pads. The specimen we caught had a SVL of 3.0 cm.

*Eleutherodactylus peruvianus*, Peru Robber Frog (Melin, 1941), RA. — This tan brown robber frog has prominent dorso-lateral folds, mushroom shaped toepads and striped eyes that have two black spots behind them. Its underside is yellow, the groin red, and its dorsum brown. This frog was common at Rio Azuela.

*Eleutherodactylus phoxocephalus*, Cotopaxi Robber Frog (Lynch, 1979), CT. — This medium sized frog had golden yellow spots on the lateral region, a cream belly, and light brown back. It has a small, sharp snout and mushroom shaped toe-pads. Markings of *E. phoxocephalus* are highly variable. Most of the specimens had tan coloured chevron arrangements on the back. The species has a large, lemon yellow vocal sac.

*Eleutherodactylus prolatus*, Hidden Robber Frog (Lynch & Duellman, 1980), RA. — The dorsal surface of this frog has only a few warts. It has a large tympanum, long head and an 'H' shaped occipital mark. The underside is cream and there are brown streaky patterns on its cream throat.

*Eleutherodactylus pyrrhomerus*, Lynch's Pilalo Robber Frog (Lynch, 1976), CT. — Males have a yellow spot/area on the groin and females a red spot. Both sexes have long toes. *Eleutherodactylus pyrrhomerus* is a very common species at Cashca Totoras and can be found close to streams, under logs, and nestled in moss. Juvenile males were also observed. They have a mottled grey throat with a light yellow belly. The lower portion of the throat was pinkish and they had mottled brown backs. Juveniles have a central zip-type line on the underside, a key feature in their identification.

*Eleutherodactylus quaquaversus*, Rio Coca Robber Frog (Lynch, 1974), RA. — Adult females of this species had the appearance of a short, plump frog with mushroom-shaped toe pads. They had a non-uniform, mottled, eggshell-coloured back with a few tiny black dots. They were easily distinguished by two dark brown chevrons on each thigh. *Eleutherodactylus quaquaversus* has a short snub snout and eyes that are beige with a creamy pink horizontal pupil. Juveniles had a striking bright orange bar between the eyes and a greenish groin. *Eleutherodactylus quaquaversus* may be identified by the presence of elbow, heel, and eyelid tubercles.

*Eleutherodactylus simonbolivari*, Simon's Robber Frog (Wiens & Coloma, 1992), CT. — This small brown frog is endemic to Cashca Totoras and has a dusky red orange colour on its palms. Its groin flash markings are conspicuous and consist of a black patch with a single white or orange spot. *Eleutherodactylus simonbolivari* has a deep red throat and white speck on its legs. It has a rounded snout, round pupil and golden iris. A key feature of this species is its enormous vocal sac. Several males were observed calling and each had vocal sacs almost as large as the frog itself. Its call is comprised of two high pitched 'chinks' spaced by a two second interval.

*Eleutherodactylus truebae*, (Lynch & Duellman, 1997), CT. — Adult *E. truebae* have three distinctive stripes on each hind thigh and dorso-

lateral folds. Two white stripes run dorso-laterally from the snout, over the eye ridges toward the groin. They have lemon yellow throats and a white spotted stomach. Juveniles do not have the dorso-lateral striping, but have a dark brown dorsum, and a small light brown cap on the tip of the snout. Both adults and juveniles have a dark eye stripe that distinguishes juveniles of this species from other eleutherodactylines at Cashca Totoras.

REPTILIA

SERPENTES: Colubridae.

*Leptodeira annulata*, RA. — Only juveniles were encountered. They had a white rostral stripe, white collar, and bead-like eyes. The head was noticeably wider than the wiry body. The dark saddle markings on its body were white lined and several white bands were present on the neck. The saddles were interspersed with grey and white bands. SVL approximately 10-15 cm.

LACERTILIA: Hoplocercidae.

*Enyalioides cofanorum*, Duellman's Dwarf Iguana (Duellman, 1973), RA. — A medium-sized lizard (10-12 cm SVL/10-15 cm TL) with a pointed snout, rounded triangular head, and scaly-ridged eyelids. It has prominent eyebrow ridges and its small dewlap has a dark spot on the base. The dark green background skin colour is covered with granular green spots yet the belly is a simple light green. It has a yellow spot behind the ear and a short spiky crest on its head that stretches down its back, almost in line with its venter; this was not continuous with the tail and had simple dark banding. *Enyalioides cofanorum*'s claw-like toes (front - ca. 2 cm, rear - ca. 4 cm) advertised its agile climbing ability and made capture difficult. This species is a little erratic when handled, persistently gaping its mouth displaying its pink mouth. It occasionally bluffed a bite.

Teiidae: Gymnophthalmidae (Microteiids).

*Proctoporus cashcaensis*, Kizirians Lightbulb Lizard (Kizirian & Cucoma, 1991), CT. — A small, black-bodied lizard with white throat specks and orange/white marks on the underside of its tail base. It has a pointed snout, granular dorsal scales, large belly plates, high eyebrow scales, and a pink mouth lining. The specimen encountered had a complete tail and was approximately 4.5 cm SVL (5.0 cm TL). It was found unintentionally, outside of survey time during a leaf litter examination. Interestingly, five tiny eggs (identified as possibly belonging to *P. cashcaensis*) were found close by during a second leaf litter examination. They were small, dull white, and rotund in shape. This species bites frequently when handled.

*Enyalioides cofanorum*. Rio Azuela. Photograph by Tim Aplin and Todd Lewis.

## DISCUSSION

Ecuador is the world's third leading country in amphibian diversity (415 species) and about half of its species are endemic. Declines of several species of anurans have already occurred in the Equadorean Andes (Coloma, 1995; Stebbins & Cohen, 1995). Species that are known to have declined are listed in the Appendix, although this may change and such decline patterns could eventually become extinctions. The exact magnitude of these declines is unknown and concern is now great. Unusually, there are very few scientific publications that specifically address the problem for Equador, despite the fact that the number of possibly affected species is comparable to those of countries like Costa Rica or Panama where amphibian declines have

received considerable attention and publicity (Pounds & Crump, 1994; Lips, 1998; Lips, 1999; Ron & Merino, 2000). Investigations on this theme are currently being undertaken by staff and students of the Pontificia Universidad Catolica del Equador. *Colostethus* have been missing from both areas mentioned in this report, where in such ideal, fast flowing aquatic habitats they have previously been abundant. During our visit we failed to find any *Colostethus* species and it is feared that chitrid fungus could be to blame. Chytridiomycosis has been responsible for deaths in *Gastrotheca pseustes*, *Telmatobius niger*, and *Atelopus bomolochos* in Equador and can cause fast and high levels of mortality in anuran populations (Berger, et al. 1998). Funded by the DAPTF, researchers Santiago Ron, Luis Coloma, Andrés Merino, and Juan Guayasamín of Pontificia are acting swiftly to try to establish the geographic and taxonomic range of Chytridiomycosis. The need for research has become so critical that a network has been set up to facilitate exchange of information, and to motivate institutional cooperation about the decline problem. The 'Jambato' network, as it is known, takes its name from the popular name of the bufonid *Atelopus ignescens*, a once common inhabitant of the high Andes which is now extinct (Vázquez & Romo, 2000).

Chitrid fungus is not the only threat. Agriculture has had an alarming toll on Ecuador's natural habitats. The rise in farming is largely fuelled by population increases and short-term trade gain efforts. Ecuador's major industries include bananas, shrimp, fish, coffee, textiles, metal work, paper products, wood products, chemicals, plastics, fishing, lumber, and oil exploration / extraction. In the Sierra region of northeastern Ecuador approximately 60% of cropland has been hastily abandoned because of inappropriate agricultural practices creating severe soil erosion and degradation (Southgate & Whitaker, 1992). The Ministry of Agriculture and Livestock report that 84% of soils in hill forest areas should never have been cleared for pastures because of increased erosion of soil that is already limited in fertility (Southgate & Whitaker, 1992).

Deforestation is the most dangerous threat to all physiographic regions of Ecuador (western coastal lowland, central Andean highlands, and eastern Amazonian lowlands). Deforested slopes eventually become a mix of strip agriculture for consumable crops, timber plantations, cash crops, or grassland for livestock. The western coastal lowlands were heavily forested but have suffered over many years due to expanding shrimp ponds supplying the export trade. Nearly 95% of western lowland slopes are farmed, mostly for bananas (Rachoweiki, 1997). The less disturbed western provinces of Los Rios, Manabi and El Oro are threatened by oil extraction and increasing human population. Unfortunately, highland cloud forest areas on and below paramó habitats are often clear felled and planted with pine trees for the timber trade. *Pinus patula* and *P. radiata* are widely used in the areas surrounding Cashca Totoras. They are highly competitive and can dominate the landscape. Even selective removal of timber from cloud forest areas can easily be a threat and cause alteration of the ecosystem. Studies by Pearman (1997) have shown that removal of trees from sensitive areas (i.e. those with less hardy and often endemic species) can alter the species composition of amphibians within a forest.

Pristine alpine paramó is a unique and threatened ecosystem that takes a long time to recover from human disturbance. The widely used name 'paramó' encompasses many natural grasslands and can sometimes be confused with grassland for grazing. Much of the existing paramó-type habitat with bunch grass that occurs below 4300 m is not natural habitat (Laegaard, 1992). Evidence suggests that a large proportion of the high Andes (4000-4300 m) was probably covered by *Polylepis* woodland in ancient times (Ellenberg, 1958; Fjeldså & Kessler, 1996). Pristine paramó that has not been grazed can exhibit oddly shaped 'frailejon' plants and spine ridden 'achupalla' that grow to more than three metres in height. Distinguishing which grassland areas need priority protection could be essential in the creation of reserves (see Battersby, 1999). Over 4500 ha of paramó is protected compared with 1400 ha of forest habitats (for Bolivar

region). Such designation of restricted status can also help prevent illegal poaching, provided the land is monitored. Pine timber and the clear felling of forest areas for cattle grazing are currently the major threats to Cashca Totoras paramó areas due to the unsuitably harsh conditions preventing the successful cultivation of alternative crops.

Cashca Tortoras' montane forest is at risk from encroaching human activities. The site has already reduced significantly in size and this reduction could affect the 'carrying capacity' for its biodiversity. It is slowly becoming isolated by increasing pressures on and around the buffering zone that separates it from agricultural plots. Agriculture is encroaching from the eastern slopes (mainly clear felling for livestock), and an area on the steep northern tip of the forest area had been burned and exhibited a scar on the landscape. If the areas above the gullies are ever used for crop cultivation (even though it may have limited success), leaching of agrochemicals could become a potential threat to aquatic flora and fauna (due to steep slope run off and persistent precipitation). Local farmers and communities are informed that the area is a reserve and relationships between the University and satellite villages remains healthy, providing an element of security for this pocket of rainforest.

Illegal stripping of land tenure is also common in parts of Ecuador. Some large organisations support colonisers who occupy and clear forested land even though the original land titles are not their own. After land is cleared, the colonisers sell their parcels of land to the supporting organisations at a meagre cost. The original landowners are then left with nothing and have no means of rectifying any habitat change (Southgate & Whitaker, 1994). In recent years the Equadorean government has had much trouble in financing the protection of land. One example is the forests of the Mache-Chindul mountains in the northeast of the country. The forests here are a sanctuary for many threatened species, including Jaguars (*Panthera onca*) and Giant Anteaters (*Myrmecophaga tridactyla*). Ecuadorian conservationists had asked INEFAN (the Ministry of Parks and Conservation) to set aside 20,234 ha of the region as a national park but only a fraction of this has been protected because INEFAN's budget is too small to buy the land titles. This has let the way clear for loggers to buy land rights from indigenous communities and local landowners (BBC Wildlife, 1997).

It is not just Ecuadorean's who are placing pressure on their natural resource. In 1999 a US-based pharmaceutical company developed a powerful painkiller that had no side effect and whose active ingredient is derived from the poison secreted by a poison-dart frog of the *Dendrobates* genus (Saavedra, 1999). It was found only in the foothills of the Ecuadorean Andes. Two Ecuadorean environmental organizations believe that 750 poison-dart frogs were taken into the USA in 1996 without permission (Saavedra, 1999). The projected earnings from the new analgesic (ABT-594) should have enabled Ecuador to benefit from the discovery but the country has no legal means for seeking compensation because the USA has not ratified international conventions dealing with biological resources (Saavedra, 1999). Ecuador's economic climate has changed drastically since dollarisation. The government recently decided to replace the national currency with the US dollar in an attempt to pull the country out of the worst economic crisis in its 170-year history. This means the economy will need a serious injection of dollars — fast. Environmentalists and Amazon natives fear the government will do this by implementing a 'no holds barred' oil extraction program in the Amazon basin (Elton, 2000).

Despite the pressures on its environment, Ecuador still attracts thousands of visitors, particularly to its rainforests. The Indian natives and highland hiking attract many travellers. Tourism is perhaps the fourth largest source of revenue, although how much of this gets recycled back into conservation and preservation is unknown. In the Galapagos, ecotourism has fortunately been restricted by the avoidance of large resort hotels in favour of qualified warden-led tours. Galapagos would seem to be a successful example of how to exploit a highly sensitive habitat, and still keep it intact.

Fragmentation and its effects on the biodiversity of neotropical habitats are slowly beginning to be understood through the analysis of long term data (Battersby, 1999). However, even protected reserves that appear safe are at risk from declines (Pounds et al., 1997). New species are still being discovered every year in Ecuador (Wild, 1994; Gluesenkamp, 1995; Kizirian, 1996; Formas, 1997; Caramashci, 1998; Ron & Pramuk, 1999; Dixon, 2000; Dunn & Mathew, 2000) and their potential value to rainforest ecosystem, conservation and our society (Badio et. al., 1994; Harvey, 1999) is still poorly understood. It would thus seem vital to keep the pressure on studying these impressively diverse countries before we lose any more species that we never knew existed. With the spotlight currently focusing on the desperate issue of amphibian declines (Alford & Richards, 1999), herpetologists are indeed fast becoming, as one researcher recently phrased, 'extinction biologists' (Halliday, 2001).

## SUMMARY

This report documents species of herpetofauna found in three cloud forest habitats and comments on the conservation, ecology, and precarious situation of herpetofauna in tropical Ecuador. The expedition was organised with the Pontificia Universidad Catolica del Ecuador (PUCE) and 'Earthwatch' during October 2000. Thirteen species were observed over two weeks, however one species that was previously abundant had disappeared. Ecuador's diverse herpetofauna continues to be threatened by both anthropocentric and environmental changes to its habitats.

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## Appendix

List of Ecuadorian amphibian species that are believed to be facing severe population declines (see Reference section for source of data, QCAZ = Record from curators of vertebrates at Museo de Zoologica, Dept. Biol. Sci. Pont. Catol. Univ. Del Ecuador).

| **Species** | **Last recorded date of species in its natural habitat** | **Reference** |
|---|---|---|
| Bufonidae | | |
| *Atelopus arthuri* | 1987 | Coloma, 1992 |
| *Atelopus bomolochos* | 1994 | QCAZ |
| *Atelopus elegans* | 1987 | Coloma, 1992 |
| *Atelopus* sp. A. | 1988 | Coloma/in prep. |
| *Atelopus ignescens* | 1988 | QCAZ |
| *Atelopus longirostris* | 1987 | Coloma, 1992 |
| *Atelopus* sp. B. | 1989 | Coloma / in prep. |
| *Atelopus pachydermus* | 1996 | QCAZ |
| *Atelopus planispina* | 1983 | QCAZ |
| Centrolenidae | | |
| *Centrolene buckleyi* | 1989 | Coloma, 1992 |
| Dendrobatidae | | |
| *Colostethus jacobuspetersi* | 1990 | Coloma, 1995 |
| *Colostethus pulchellus* | 1996 | QCAZ |
| *Colostethus lehmanni* | 1990 | QCAZ |
| *Colostethus elachyhistus* | 1986 | QCAZ |
| *Colostethus delatorreae* | 1989 | Coloma, 1995 |
| *Colostethus vertebralis* | 1997 | QCAZ; Coloma, 1995 |
| *Minyobates abditus* | 1974 | Myers & Daly, 1976 |
| Hylidae | | |
| *Gastrotheca guentheri* | 1989 | QCAZ |
| Leptodactylidae | | |
| *Telmatobius niger* | 1992 | QCAZ |
| *Telmatobius vellardi* | 1987 | QCAZ |
| *Eleutherodactylus cryophilus* | 1989 | Coloma, 1992 |
| *Eleutherodactylus modipeplus* | 1970 | Coloma, 1992 |
| Microhylidae | | |
| *Nelsonophryne aecfuatorialis* | 1989 | Coloma, 1992 |