

LISTS OF SPECIES

Amphibians, Machalilla National Park, province of Manabí, western Ecuador

Diego F. Cisneros-Heredia

College of Biological & Environmental Sciences,
Universidad San Francisco de Quito, Campus
Cumbayá. Casilla 17-12-841, Quito, Ecuador.
E-mail: diegofrancisco_cisneros@yahoo.com

Abstract

Fifteen species of amphibians are reported from the Machalilla National Park, located in coastal western Ecuador. *Scinax quinquefasciatus*, *Trachycephalus venulosus*, and *Leptodactylus ventrimaculatus* are reported from the area for the first time. Several amphibian species are range-restricted and endemic. The amphibian fauna of this national park is related to the Tumbesian endemic region. Updated information is presented for *Ceratophrys stolzmanni* and *Leptodactylus ventrimaculatus*.

Introduction

The Machalilla National Park (MNP) is among the most renowned protected areas in mainland Ecuador because of its biological importance and tourism attractions. The MNP is located in the Tumbesian Region, a zone classified as an area of high endemism (Stattersfield et al. 1998, Cisneros-Heredia in press). This national park protects some of the last remnants of two globally endangered ecosystems, the seasonal dry forest and the seasonal evergreen forest (Stattersfield et al. 1998, Cisneros-Heredia in press). Both ecosystems in western Ecuador are under high risk of complete destruction due to continuous unsustainable human activities. It is very important to improve the knowledge on the biodiversity of the Machalilla National Park in order to develop sounding conservation strategies.

Information on the amphibians and reptiles of the Machalilla National Park is scarce, and most data are still unpublished. Some information on the herpetofauna of the zone were reported by Almendáriz and Carr (1992) and Albuja and Muñoz (2000). Until 2000, just 7 species of amphibians were reported from the MNP (Iturralde and Josse 2000). Coloma (1995), Lynch and Duellman (1997) and Ron et al. (2004) analyzed

samples of *Colostethus*, *Eleutherodactylus*, and *Engystomops* from the MNP.

The aim of this article is to present updated information on the amphibians of the Machalilla National Park.

Material and methods

Study site

The Machalilla National Park (MNP) (Figure 1) protects a mainland track of ca. 55.000 hectares, plus some islands like Salango and La Plata, and a marine area of two nautical miles. Politically, the MNP is part of the province of Manabí, Ecuador; the mainland area under the jurisdiction of the cantón Jipijapa and the insular area under the cantón Montecristi. The MNP includes two main vegetation formations, towards the lowland areas there are relicts of seasonal dry semideciduous forest, while the highland areas are covered by seasonal evergreen forest (Albuja and Muñoz 2000, Cisneros-Heredia in press). The monthly precipitation has an average of 300 mm between December and May, and 20 mm between June and November.



Figure 1. Map of Ecuador showing the National System of Protected Areas, with the Machalilla National Park encircled.

The limits of the MNP area (*sensu* Albuja and Muñoz 2000) are: to the north, the extreme of

LISTS OF SPECIES

Puerto Cayo beach (01°21'S, 80°44'W); to the south, a point in Ayampe river (01°40', 80°43'W); to the east, a point located in the course of the Plátano river, between Cerro de Agua Dulce and Cerro la Chocuana (01°33'S, 80°37'W); to the west, a point located on La Tortuga cliff (01°33'S, 80°50'W).

Surveys were conducted at the MNP on nine mainland localities:

- a. Cerro La Tungurahua (seasonal foothill dry semideciduous forest, 01°24'S, 80°43'W, ca. 350 m),
- b. foothills of Cerro La Mocora (seasonal foothill dry semideciduous forest, ca. 01°36'S, 80°45'W, between ca. 150 to 300 m; and seasonal foothill evergreen forest, between ca. 300 to 450 m),
- c. top hill of Cerro La Mocora (seasonal low montane evergreen cloud forest, ca. 01°37'S, 80°42'W, 500 – 600 m),
- d. Agua Blanca (seasonal lowlands dry semideciduous forest, ca. 01°31'S, 80°44'W, 130 – 200 m),
- e. Vueltas Largas (seasonal lowlands dry semideciduous forest, ca. 01°31'S, 80°42'W, 200 m),
- f. Puerto López (seasonal lowlands dry semideciduous forest and scrub, 01°34'S, 80°49'W, ca. 0 – 50 m),
- g. Puerto Rico (seasonal lowlands dry semideciduous forest and scrub, 01°37'S, 80°50'W, 0 – 80 m),
- h. Punta Piqueros (seasonal lowlands dry semideciduous forest and scrub, 01°33'S, 80°49'W, 0 – 50 m),
- i. La Playita beach (seasonal lowlands dry semideciduous forest and scrub).

Cerro La Tungurahua and Cerro La Mocora were studied for longer periods than the other stations (>300 human-hours). The following description of Cerro La Tungurahua is extracted from Josse (*in litt.* 1986), and presents the general characteristics of the seasonal foothill dry semideciduous forests: irregular terrains with angles up to 35° inclination, soils usually formed by clay mixed with rocks and a medium volume of organic matter. The canopy goes up to ca. 12 m, up to 65% of the tree species are deciduous during the dry season, and epiphytes are abundant (mosses, ferns,

bromeliads) but not much diversified. Annual temperature is constant around 24.8°C (Josse *in litt.* 1996). The area of La Tungurahua has been severely exploited by human activities, including intensive wood extraction and large-size crops, at least for the last 40 years. The following description of Cerro La Mocora is extracted from Josse (*in litt.* 1986), and presents the general characteristics of seasonal foothill and low montane evergreen forests: well-drained soils formed by clay and a high volume of organic matter; irregular terrain with angles over 35° inclination at certain zones. The canopy goes up to 20 m and covers ca. 85% of the area, epiphytes are abundant and diverse; the floor is covered by a dense leaf litter (Josse *in litt.* 1996). The top hill of La Mocora has been affected by some selective extraction of wood and small to medium-size crops of corn. The low hills have been more affected by human activities than the top hill. Agua Blanca, Vueltas Largas, Puerto López, and Puerto Rico are localities severely affected by urbanization, extensive and intensive wood extraction, and agriculture. Punta Piqueros, Los Frailes beach, and La Playita beach still preserve some secondary area of seasonal dry forest and shrubs, but are also affected by some unsustainable activities (like extensive extraction of Palo Santo, *Bursera graveolens*). Three insular localities were studied at Isla de La Plata (a 14.2 Km² volcanic island located ca. 30 Km off the coast), but no amphibians were found thus the insular area of MNP is not further included in this paper.

Data collection

Surveys were conducted at the MNP in August 1995, July 1998, June 1999, June to August 2000, August 2002, and December 2005. Collecting methods included visual encounter surveys, transects, quadrants, pitfall traps, and opportunistic observations, under authorization of the Ministry of Environment of Ecuador granted to Fundación Natura (Ecuador), Parks in Peril project. Voucher specimens of each species are deposited at the Universidad San Francisco de Quito, Ecuador (DFCH-USFQ). Additionally, specimens from the collections of the Fundación Herpetológica G. Orcés, Quito, Ecuador (FHGO), and Museo Comuna de Agua Blanca, town of Agua Blanca, province of Manabí, Ecuador, were studied. I follow the proposed classifications for

LISTS OF SPECIES

Amphibia by Frost et al. (2006) and for Hylidae by Faivovich et al. (2005).

Results

A total of 15 species of amphibians have been recorded at the Machalilla National Park (Appendix 1). All species of amphibians are anurans, no caecilians or salamanders are known from the area. Five species seem to be endemic to Ecuador, seven to have their distribution range restricted to the Tumbesian region, and one to the West Ecuadorian region (Appendix 1) (endemic regions *sensu* Cisneros-Heredia in press). The number of species herein reported double the total number of species previously recorded in the area (Iturralde and Josse 2000). The seasonal dry forests with eleven species have greater species richness than the seasonal evergreen forests that had six species (Appendix 1), but several species were recorded from both habitats at varying abundance (e.g. *Eleutherodactylus achatinus*, *Trachycephalus jordani*, *Chaunus marinus*).

Accounts of species

Family Brachycephalidae

Eleutherodactylus achatinus (Figure 2)

This widely distributed frog occurs from eastern Panama south to southwestern Ecuador from 0 to 1800 m (Lynch and Myers 1983, Lynch and Duellman 1997) and is mainly found in seasonal and non-seasonal evergreen forests, but 17 % of the localities mentioned by Lynch and Duellman (1997) were located in semideciduous or deciduous habitats. Several individuals of *Eleutherodactylus achatinus* (DFCH_USFQ MC001-MC0025, 236–239) were collected at the top hill of Cerro La Mocora on 06–07 June 2000 by D. F. Cisneros-Heredia, D. Mosquera, A. Baquero, and K. Dammer. The species was particularly abundant on leaves 0.5–1.5 m above ground.

Eleutherodactylus walkeri (Figure 2)

Eleutherodactylus walkeri is endemic to Ecuador, where it inhabits the lowlands and lower slopes of the Andes between 100 to 1270 m (Lynch and Duellman 1997). A single specimen of *Eleutherodactylus walkeri* (DFCH-USFQ 240) was collected at the top hill of Cerro La Mocora on 06 June 2000 by D. F. Cisneros-Heredia, D. Mosquera, A. Baquero, and K. Dammer, but three additional individuals were observed. This species

was fairly rare on the area, mainly on leaves 0.5–1 m above ground. This is the second record of *E. walkeri* from the isolated low montane cloud forest hills in the Cordillera de la Costa, as compared with data provided by Lynch and Duellman (1997).

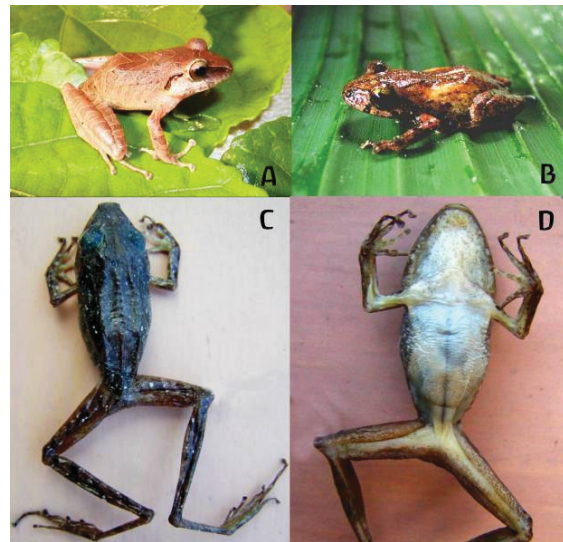


Figure 2. Frogs of the genus *Eleutherodactylus* (family Brachycephalidae). (A) *E. achatinus* (photo by D. F. Cisneros-Heredia); (B) *E. walkeri* (photo by M. Ortega); dorsal (C) and ventral (D) view of preserved specimen of *Eleutherodactylus* sp.

Eleutherodactylus sp. (Figure 2)

One specimen of *Eleutherodactylus* (DFCH-USFQ 247) was collected during day from the top of a fallen tree (cut down less than 15 minutes before it was inspected) at the foothills of Cerro La Mocora on 07 June 2000 by D. F. Cisneros-Heredia, D. Mosquera, A. Baquero, and K. Dammer. The specimen is apparently a member of the *E. conspicillatus* group similar to *Eleutherodactylus achatinus*, however it lacks the punctuations on the posterior surfaces of thighs, has white marks on the dorsal surfaces of the body and legs, has an areolated venter skin, and it is probably arboreal. It could belong to a new species related to *E. achatinus*, but more material is needed to confirm this hypothesis.

Family Hylidae

Scinax quinquefasciatus (Figure 3)

This frog was observed and heard in low abundance in gardens and agricultural areas in

LISTS OF SPECIES

Puerto López and Puerto Rico. The taxonomic status of the populations of *Scinax* assigned to *S. quinquefasciatus* (Fowler, 1913) is still controversial. *Scinax quinquefasciatus* has been reported from Colombia, but those populations probably correspond to *S. elaeochroa* (Cope, 1875) (J. D. Lynch and K.-H. Jungfer in Coloma et al. 2004), and it has been suggested that *S. elaeochroa* and *S. quinquefasciatus* could be synonyms (K.-H. Jungfer in Coloma et al. 2004).

However, K. Miyata, R. W. McDiarmid and B. Jayne, on an unpublished manuscript included as an addendum to Miyata's M.S. thesis, proposed that two taxa are involved under the same name, the true *S. quinquefasciatus* occurring in seasonal dry semideciduous forest of central and southern western Ecuador, and an undescribed form in northwestern Ecuador and southwestern Colombia.

Trachycephalus jordani (Figure 3)

One calling male was heard and observed during late evening and early night inside an arboreal bromeliad ca. 5 m over the floor on the top hill of Cerro La Mocora on 06 June 2000. A specimen (FHGO 979) was collected on the Machalilla - Salango road (01°35'S, 80°49' W, 0 m elevation) on 03 April 1992 by O. Asser. Specimens reported by Almendariz and Carr (1992) as deposited in the "Centro de Interpretación del Parque Nacional Macha-lilla", at Puerto López, were apparently destroyed at the end of 1999 due to bad preservation by the center keepers.

Trachycephalus venulosus (Figure 3)

One male was observed calling from a bush at the border of a pond 3 Km S of Salango between 14 and 17 February 2002. It was found in syntopy with *Engystomops pustulatus* and *E. montubio*. The species was previously classified under the genus *Phrynohyas* (Faivovich et al. 2005).

Family Leptodactylidae

Engystomops montubio (Figure 4)

This recently described species was commonly found calling in ephemeral and permanent ponds at night, in agricultural areas, secondary forests and bushy areas at Puerto López, Puerto Rico, and Punta Piqueros. Two adult male specimens were collected 3 Km S of Salango between 14 and 17

February 2002 (DFCH-USFQ MC0030, SVL = 21.46 mm; DFCH-USFQ MC0031, SVL = 22.48 mm). *Engystomops montubio* and *E. pustulatus* were previously classified under *Physalaemus* (Nascimento et al. 2005).

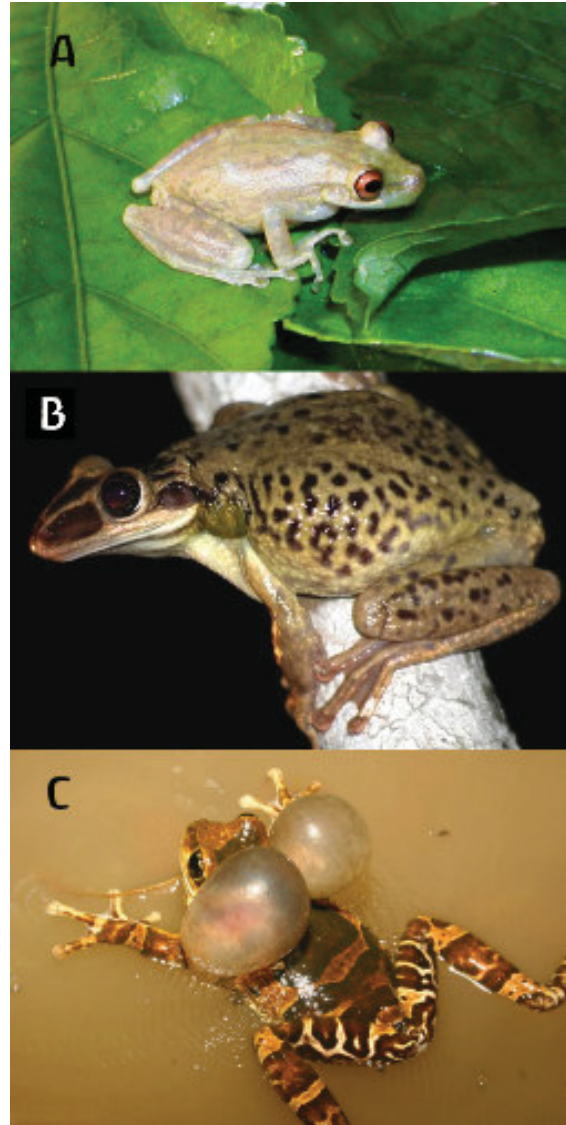


Figure 3. Frogs of the family Hylidae. (A) *Scinax quinquefasciatus* (photo by D. F. Cisneros-Heredia); (B) *Trachycephalus jordani* (photo by C. Martínez); (C) *Trachycephalus venulosus* (photo by S. Ron).

Engystomops pustulatus (Figure 4)

It was found syntopically with *E. montubio* at all localities mentioned above for the latter. An adult

LISTS OF SPECIES

specimen was collected 3 Km S of Salango between 14 and 17 February 2002 (DFCH-USFQ MC0032, SVL = 27.63 mm). This species is probably endemic to Ecuador as the Peruvian population seems to correspond to an undescribed taxon (Ron et al. 2004, 2005).

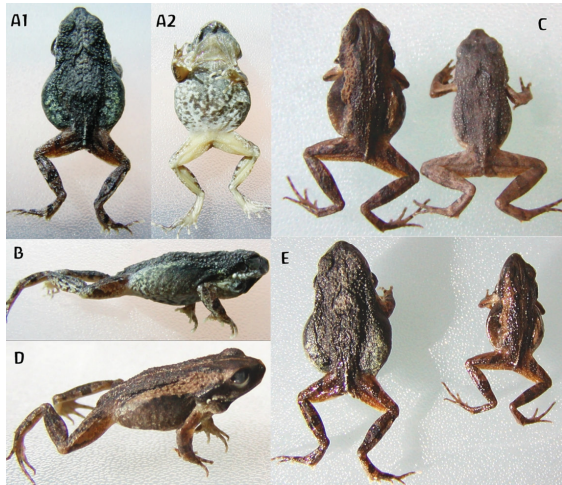


Figure 4. Frogs of the genus *Engystomops* (family Leptodactylidae). Dorsal (A1), ventral (A2), and lateral (B) view of a preserved male specimen of *E. pustulatus*; (C) dorsal view of two preserved male specimens of *E. montubio*; (D) Lateral view of a male specimen of *E. montubio*; (E) adult males of *E. pustulatus* (left) and *E. montubio* (right) for size comparison.

Leptodactylus labrosus (Figure 5)

One adult individual was observed along the margins of the Buena Vista River, near Agua Blanca on 03 June 2000. This species is the only *Leptodactylus* known to inhabit seasonal dry semideciduous forest. Other specimens collected at the same location were reported by Albuja and Muñoz (2000).

Leptodactylus ventrimaculatus (Figure 5)

One juvenile specimen (DFCH-USFQ MC0026) of *Leptodactylus* was collected at the top hill of Cerro La Mocora on 21 July 2000. This specimen possesses some scattered white tubercles on the sole of foot; a character that usually distinguish well *L. ventrimaculatus* from *L. labrosus*. However, some specimens of *L. labrosus* can have these tubercles (Heyer 1978, pers. obs.), and the distinction of both species is difficult in areas

where they are sympatric or at least closely distributed, like the MNP. However, I consider this specimen as *L. ventrimaculatus* based also on ecological factors. *Leptodactylus ventrimaculatus* is the only member of the genus known to occur in low montane cloud forest. *Leptodactylus labrosus* inhabits seasonal dry semideciduous forest and can be found up to 600 m above sea level but only in foothill evergreen forests, near semideciduous forest, not in low montane cloud forest (Heyer 1978, Cisneros-Heredia in press). *Eleutherodactylus walkeri* and *E. achatinus* have distribution patterns rather similar to *L. ventrimaculatus*, with populations in the lowland non-seasonal evergreen forests of northwestern Ecuador and in the low montane cloud forest of the Cordillera de la Costa and the Cordillera de Los Andes.



Figure 5. Frogs of the genus *Leptodactylus* (family Leptodactylidae). (A) *L. labrosus* (photo by D. F. Cisneros-Heredia); (B) *L. ventrimaculatus* (photo by M. Yáñez-Muñoz).

Family Ceratophryidae

Ceratophrys stolzmanni (Figure 6)

Three specimens (DFCH-USFQ MC0035–38) were collected at Punta Piqueros on 10–12 August

LISTS OF SPECIES

2000. *Ceratophrys stolzmanni* has been mentioned few times in the literature. It is known in Ecuador just from three localities from the province of Guayas (reported in the original description by Peters 1967) and one imprecise location in the province of Manabí (Machalilla National Park, Almendáriz and Carr 1992). Thus, I take this opportunity to report an additional locality for the species: Hacienda Anhalzer, Isidro Ayora. (80°08'W, 01°52'S, 28 m), province of Guayas, where eight specimens of *C. stolzmanni* (FHGO-USFQ 295, 298, 317, 364, 634, 681-683) were collected on 25 March 1991 and 01 January 1992 by J. Anhalzer.

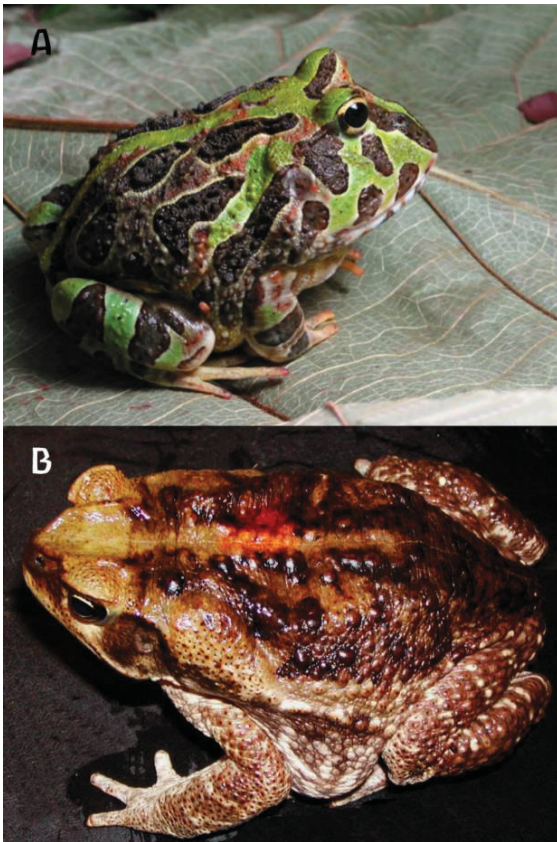


Figure 6. Frogs of the families Bufonidae and Ceratophrynidae. (A) *Ceratophrys stolzmanni* (photo by S. Ron); (B) *Chaunus marinus* (photo by D. F. Cisneros-Heredia).

The specimens of *Ceratophrys stolzmanni* reported herein from the province of Guayas were kept in captivity for up to two years, and specimens from Machalilla from up to one month.

Observations in captivity of these specimens provided the first data on its burrowing behavior. *Ceratophrys stolzmanni* proved to be an excellent burrower, preferring sandy soils, where it burrows backwards using their hind feet, similar to other burrowing frogs (e.g., *Scaphiopus* spp., Stebbins 1985). It is unknown for how long a specimen can stay buried and which are the physiological factors involved, but apparently they can remain in their chambers for at least one season until the rains reactive the frog and they concentrate around ponds to reproduce. The observed frogs did not secrete a protective cocoon-like covering while in the chamber, but it can not be assumed that they do not produced it, because the captivity experiments were performed during short periods only (J.-M. Touzet and J. Faivovich pers. comm.). These observations confirm predictions made by Peters (1967).

Specimens reported by Almendariz and Carr (1992) as deposited in the “Centro de Interpretación del Parque Nacional Machalilla”, at Puerto López, were apparently destroyed at the end of 1999 due to bad preservation by the center keepers.

Family Dendrobatidae

Colostethus infraguttatus (Figure 7)

Two *Colostethus infraguttatus* were observed in sympatry with *C. machalilla* along the margins of rivulets in the foothills of the Cerro La Mocora, on 07 June 2000. The species is known to occur only in Ecuador, but it ranges very close to the limits with Peru, and probably also occurs there (Cisneros-Heredia et al. 2004).

Colostethus machalilla (Figure 7)

At least 12 active adult individuals were observed during morning and early afternoon on the rocks along the margins and inside water of rivulets and streams at the foothills of the Cerro La Mocora, on 07 June 2000, in the contact zone of the seasonal dry and evergreen forests (DFCH-USFQ 240). One adult was observed carrying six tadpoles on the back.

Colostethus machalilla was named in honor of the Machalilla National Park by Coloma (1995) because its type-locality is at the southern border of the park, at the Ayampe River, a place where

LISTS OF SPECIES

the species is still common (FHGO 608, pers. obs.).

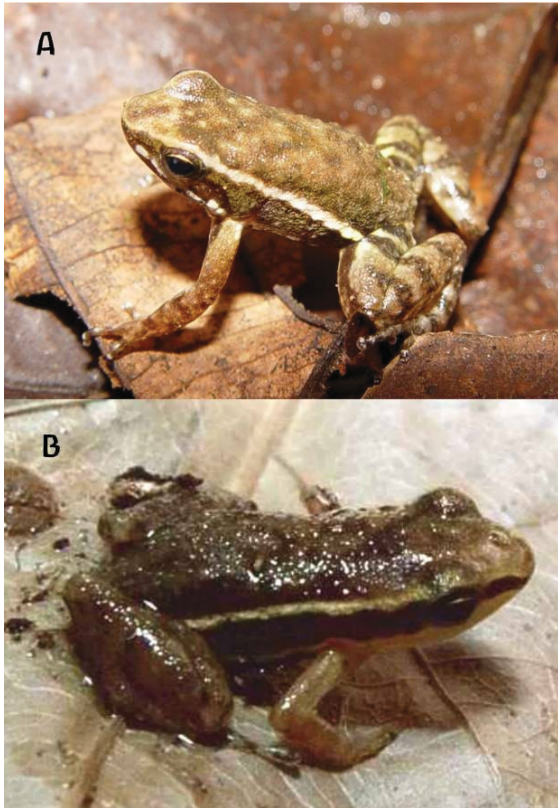


Figure 7. Frogs of the genus *Colostethus* (family Dendrobatidae). (A) *C. infraguttatus* (photo by M. Yáñez-Muñoz); (B) *C. machalilla* (photo by M. Yáñez-Muñoz).

Family Bufonidae

Chaunus marinus (Figure 6)

Several dozens of adult *Chaunus marinus* were commonly observed during late afternoon and night on the floor in roads, gardens, and soccer courts of towns like Puerto López or Puerto Rico, and around agricultural areas. Thousands of egg strings, dozens of recently-metamorphosed juveniles, and several adults were observed during day along the margins of the Buena Vista River, near Agua Blanca. However the species was rare in forested habitats, *C. marinus* was not recorded at Cerro La Tungurahua; and only one adult female specimen (DFCH-USFQ MC0040) was collected at Cerro La Mocora, found during early afternoon under a palm leaf in leaf-litter. The species was previously classified under the genus *Bufo*

(Frost et al. 2006).

Two amphibian taxa: *Centrolene prosoblepon* (Centrolenidae) and *Hypsiboas pellucens* (Hylidae) could also occur in the MNP area. Both species were collected at surveys on localities on the Cordillera de la Costa to the north and south of MNP (e.g., Lalo Loor, Punta Galeras, Loma Alta). *Centrolene prosoblepon* lives on the margins of streams, and *Hypsiboas pellucens* near lentic or lotic wetlands. Both species could occur on the hills covered by seasonal evergreen forest at the MNP, but those habitats were not effectively sampled due to its inaccessibility, and its occurrence could be influenced by weather seasonality, as observed in other arboreal species (e.g., *Trachycephalus venulosus*, *Scinax quinquefasciatus*).

Discussion

The Machalilla National Park protects one of the last large tracks of primary and old-secondary forest in coastal Ecuador. Several range-restricted, endemic, and threatened species of amphibians occur in the area (Appendix 1). The Tumbesian region is exceptionally rich in locally endemic species (Jiggins 1998, Stattersfield et al. 1998); unfortunately own to its climatic characteristics, it is commonly seen as an area without a well-defined amphibian fauna and poor in unique amphibians. In fact, few research and conservation initiatives have focused on the amphibians of the Tumbesian region. Most scientific studies and conservation strategies in the Tumbesian region are focused on plants or birds; and most Ecuadorian efforts towards amphibian research and conservation are focused on other ecosystems such as the subtropical, cloud and montane forests. However, this vision is bias; based on the little representation of this region in herpetological collections, insufficient geographic coverage with wide non-studied areas, and especially the lack of studies during representative periods of the year. The last point is especially important for the Tumbesian region biological diversity because it is subjected to severe weather changes (depending on the season, rainy or dry, or during the El Niño or La Niña periods). There are dramatic changes in the taxonomic and spatial composition of the community of amphibians of the Machalilla National Park depending on the

LISTS OF SPECIES

season. The weather is a key factor that influences the distribution patterns of plants and animals, and their evolutive and speciation patterns (Diamond 1973, Woodward 1987, Lindenmayer 2000, Fisher et. al. 2001). It is extremely important to establish monitoring protocols that takes into account the biological and ecological changes of the herpetofauna in the Tumbesian area.

Acknowledgements

This research was partially carried out at an internship developed inside the “Plan de Monitoreo Socio-Ambiental del Parque Nacional Machalilla”, project Parks in Peril developed by Fundación Natura (Ecuador), and supported by Universidad San Francisco de Quito. I thank Andrés Baquero, Diego Mosquera, Karina Newman, Karina Dammer, and Jeffrey Arellano for their friendship and assistance. To Carlos Zambrano, former director, and the entire staff of the Machalilla National Park for their support to my work. I am extremelly grateful to Santiago Ron, Mario Yáñez-Muñoz, and Mauricio Ortega for their permissions to use their photographs, to Kelly Swing for sharing his information, and to Diego Baldo and Pablo Venegas for their comments on the manuscript. To the Institute of Applied Ecology ECOLAP of Universidad San Francisco de Quito and to the Museo de Zoología QCAZ of Pontificia Universidad Católica del Ecuador for free access to their libraries. My gratitude to María Elena and Laura Heredia for their continuous support.

Literature cited

- Albuja L. and R. Muñoz. 2000. Fauna del Parque Nacional Machalilla. Pp. 32–48. In: M. Iturralde and C. Josse (eds.), *Compendio de Investigaciones en el Parque Nacional Machalilla*. Quito, CDC and Fundación Natura.
- Almendáriz, A. and J. L. Carr. 1992. Amphibians and Reptile List; January-February Trip. Pp. 128–130. In: T. A. Parker III and J. L. Carr (eds.), *Status of Forest Remnants in the Cordillera de la Costa and Adjacent Areas of Southwestern Ecuador*. Washington, D. C. Conservation International, RAP Working Paper 2.
- Cisneros-Heredia, D., A. Almendáriz, M. Yáñez-Muñoz, L. A. Coloma and S. Ron. 2004. *Colostethus infraguttatus*. 2004 IUCN Red List of Threatened Species. Accesible at www.iucnredlist.org. IUCN, UK. Camptured on 01 March 2006.
- Cisneros-Heredia, D. F. in press. Distribution and ecology of the Neotropical frog *Leptodactylus labrosus* (Amphibia: Anura: Leptodactylidae), with considerations on Western Ecuador biogeography and endemism areas. *Zoological Research*.
- Coloma, L.A. 1995. Ecuadorian frogs of the genus *Colostethus* (Anura: Dendrobatidae). *University of Kansas Natural History Museum Miscellaneous Publication* 87:1-72.
- Coloma, L.A., S. Ron, D. Cisneros-Heredia, K.-H. Jungfer, and W. Bolívar. 2004. *Scinax quinefasciatus*. 2004 IUCN Red List of Threatened Species. Accesible at www.iucnredlist.org. IUCN, UK. Captured on 01 March 2006.
- Diamond, J.M. 1973. Distributional ecology of New Guinea birds. *Science* 179: 759– 769.
- Faivovich, J., C. F. B. Haddad, P. C. A. García, D. R. Frost, J. A. Campbell and W. C. Wheeler. 2005. Systematic review of the frog family Hylidae, with special reference to Hylinae: a phylogenetic analysis and taxonomic revision. *Bulletin of the American Museum of Natural History* 294: 1–240.
- Fischer, J., D. B. Lindenmayer, H. A. Nix, J. L. Stein, J. A. Stein. 2001. Climate and animal distribution: a climatic analysis of the Australian marsupial *Trichosurus caninus*. *Journal of Biogeography* 28: 293–304.
- Frost, D. R., Grant, T., Faivovich, J., Bain, R. H., Haas, A., Haddad, C. F. B., de Sa, R. O., Channing, A., Wilkinson, M., Donnellan, S. C., Raxworthy, C. J., Campbell, J. A., Blotto, B. L, Moler, P., Drewes, R. C., Nussbaum, R. A., Lynch, J. D., Green, D. M. and Wheeler, W. C. 2006. The Amphibian Tree of Life. *Bulletin of the American Museum of Natural History* 297: 1–370.
- Iturralde, M. and C. Josse. 2000. *Compendio de Investigaciones en el Parque Nacional Machalilla*. Quito, CDC and Fundación Natura.
- Heyer W. R. 1978. Systematics of the fuscus group of the frog genus *Leptodactylus* (Amphibia, Leptodactylidae). *Natural History Museum of Los Angeles County Science Bulletin* 29: 1–85.

LISTS OF SPECIES

- Lindenmayer DB. 2000. Factors at multiple scales affecting distribution patterns and its implications for animal conservation - Leadbeater's possum as a case study. *Biodiversity and Conservation* 9: 15–35.
- Lynch, J. D. and C. W. Myers. 1983. Frogs of the *fitzingeri* group of *Eleutherodactylus* in eastern Panama and Chocóan South America (Leptodactylidae). *Bulletin of the American Museum of Natural History* 175 (5): 481–572.
- Lynch, J. D. and W. E. Duellman. 1997. *Frogs of the Genus Eleutherodactylus in Western Ecuador: Systematics, Ecology and Biogeography*. Lawrence. University of Kansas Natural History Museum Special Publication 23.
- Nascimento, L.B., U. Caramaschi, C.A.G. Cruz. 2005. Taxonomic review of the species groups of the genus *Physalaemus* Fitzinger, 1826 with revalidation of the genera *Engystomops* Jiménez-de-la-Espada, 1872 and *Eupemphix* Steindachner, 1863 (Amphibia, Anura, Leptodactylidae). *Arq. Mus. Nac. Rio de Janeiro* 63: 297–320.
- Peters, J.A. 1967. The generic allocation of the frog *Ceratophrys stolzmanni* Steindachner, with the description of a new subspecies from Ecuador. *Proceedings of the Biological Society of Washington* 80:105–112.
- Ron, S. R., D. C. Cannatella and L. A. Coloma. 2004. Two new species of *Physalaemus* (Anura: Leptodactylidae) from western Ecuador. *Herpetologica* 60: 261–275.
- Ron, S. R., L. A. Coloma, and D. C. Cannatella. 2005. A New, Cryptic Species of *Physalaemus* (Anura: Leptodactylidae) from Western Ecuador with comments on the call structure of the *P. pustulosus* species group. *Herpetologica* 61:178–198.
- Stattersfield, A. J., W. Crosby, W. Long and D. C. Wege. 1998. *Endemic Bird Areas of the World: Priorities for Biodiversity Conservation*. Cambridge. BirdLife Conservation Series No. 7.
- Stebbins, Robert C. 1985. *A Field Guide to Western Reptiles and Amphibians*. Boston, Houghton Mifflin.
- Woodward, F. I. 1987. *Climate and plant distribution*. Melbourne. Cambridge University Press.
- Received March 2006
Accepted May 2006
Published online May 2006

LISTS OF SPECIES

Appendix 1. List of the species of amphibians of the Machalilla National Park, province of Manabí, Republic of Ecuador. Endemism: E = Ecuador, T = Tumbesian region, W = West Ecuadorian region. See Material and Methods for locality codes. Some data taken from Almendáriz and Carr (1992), Coloma (1995), Lynch and Duellman (1997), Albuja and Muñoz (2000), and Ron et al. (2004).

FAMILY	Scientific Name & Endemism	Localities*
Brachycephalidae	<i>Eleutherodactylus achatinus</i>	c ¹
	<i>Eleutherodactylus subsigillatus</i>	c ²
	<i>Eleutherodactylus walkeri</i>	c ³
	<i>Eleutherodactylus</i> sp. - T?	b
Hylidae	<i>Scinax quinquefasciatus</i> - E?, T?	f, g, h
	<i>Trachycephalus jordani</i> - T	c, d, h, i
	<i>Trachycephalus venulosus</i>	a, d, h, i
Leptodactylidae	<i>Leptodactylus labrosus</i> - T	d, e, h
	<i>Leptodactylus ventrimaculatus</i>	c
	<i>Engystomops montubio</i> - E, T	h ⁴
	<i>Engystomops pustulatus</i> - E, T	h ⁵
Ceratophryidae	<i>Ceratophrys stolzmanni</i> - T	h
Dendrobatidae	<i>Colostethus machalilla</i> - E, W	b ⁶
	<i>Colostethus infraguttatus</i> - E, T	b ⁷
Bufonidae	<i>Chaunus marinus</i>	c, d, e, f, g, h

* Additional distributional notes:

1. Reported also from Cerro San Sebastián and the Ayampe River by Almendáriz and Carr (1992), Lynch and Duellman (1997), and Albuja and Muñoz (2000).
2. Reported from Cerro San Sebastián by Almendáriz and Carr (1992, as *Eleutherodactylus* sp. 1-2) and Lynch and Duellman (1997).
3. Reported also from Cerro San Sebastián by Almendáriz and Carr (1992, as *Eleutherodactylus* sp. 2-1) and Lynch and Duellman (1997).
4. Reported also from Puerto Rico, Puerto Cayo, and Río Chico by Ron et al. (2004).
5. Reported also from Puerto Rico by Ron et al. (2004).
6. Reported also from Cerro San Sebastián by Almendáriz and Carr (1992), and Ayampe River by Coloma (1995).
7. Reported also from Cerro San Sebastián, Ayampe River, and Puerto Rico by Almendáriz and Carr (1992, as *Colostethus* sp. 2) and Coloma (1995).