

Herpetofauna of the Bilsa Biological Station, province of Esmeraldas, Ecuador

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ABSTRACT: The Bilsa Biological Station is located on the Mache-Chindul mountains and protects some of the last rainforest remnants in the province of Esmeraldas, northwestern Ecuador. Since 2004, we have been inventorying the amphibians and reptiles of Bilsa. We found 109 species of herpetofauna (37 amphibians and 72 reptiles), representing 8 % and 18 % of the known species from Ecuador, respectively. We report distribution extensions for *Sachatamia albomaculata*, *Hyalinobatrachium valerioi*, *Pristimantis muricatus*, and *P. rosadoi*, and report the presence of several putatively undescribed species. We propose the Mache-Chindul mountains as a Key Biodiversity Area within the West Ecuadorian Endemic Area.

INTRODUCTION

The Mache-Chindul mountains are on the West Ecuadorian biogeographic region, recently identified as an endemic area in western South America (Anderson and Jarrín 2002; Cisneros-Heredia 2006b). These mountains preserve an important portion of the last remnants of coastal tropical forest on northwestern Ecuador; a region characterized by high species diversity (Clark *et al.* 2006; Conservation International 2007). The Bilsa Biological Station (BBS) was established in 1994 to protect 3,300 hectares of threatened coastal forest and its high diversity of flora and fauna, with a unique composition of species renowned by its endemism and rarity (Cerón *et al.* 1999; Josse 2001; Clark *et al.* 2006; Clay *et al.* 1995; Cuesta-Camacho *et al.* 2007; Guayasamin 2008). Although physically isolated from the Andes, Bilsa possesses both plant and animal species usually restricted to higher elevations in the Andes.

Unfortunately, the West Ecuadorian region is greatly threatened by habitat loss and fragmentation caused by rural-urban development, agricultural activities, uncontrolled logging, and an inadequate management of natural resources (Sierra 1996; Cisneros-Heredia 2006b). Less than 4% of the original northwestern Ecuadorian forests remain (Cerón *et al.* 1999). The massive habitat loss and fragmentation of surrounding areas called for an urgent inventory of the herpetofauna of the Bilsa Biological Station, in order to understand its diversity and to propose conservation plans. Previous knowledge of the herpetofauna of the Mache-Chindul mountains was reviewed by Almendáriz and Carr (1992). The aim of this article is to present an extensive updated list of the amphibians and reptiles recorded until 2004 in the Bilsa Biological Station, with comments on new distributional records and putative undescribed species.

MATERIALS AND METHODS

Study Site

The Bilsa Biological Station (BBS; 00°21'33"N 79°42'02"W; 300-750 m; Figure 1) is a private reserve of 3,300 hectares owned and managed by Fundación Jatun Sacha and located in the province of Esmeraldas, northwestern Ecuador. BBS shows a complex mosaic of disturbed and undisturbed habitats within the Mache-Chindul mountains, preserving remnants of tropical humid (300-600 m) and pre-montane forest (600-750 m, called foothill evergreen forest by Cerón *et al.* 1999). The average rainfall is between 1500-2000 mm per year. The dry season runs from July to December and the wet season from January to June. Most surrounding areas have been largely deforested for small-scale agriculture, although several forest fragments remain. Thirteen places on eleven trails inside BBS were studied (Figure 1): (a) Scientific station, (b) Red trail, (c) Monkey trail, (d) Duchas stream, (e) Aguacatal-Dos Bocas stream, (f) Orange trail, (g) Brown trail, (h) Piscinas trail, (i) Rompefrente stream, (j) White trail, (k) Duchas stream-Red trail, (l) Green trail, (m) Scientific station-Dógola road, and (n) Yellow trail. These sites represent remnants of pre-montane primary forest (site b), streams with small waterfalls (sites d, e, h, i, j, n), 15-25 year old-secondary forest partially logged with some large primary-forest trees (sites j, l, m), reforested areas with fruit and hardwood species (site a), and remnants of primary forest (sites c, f, g, k). In general, we differentiate three major habitats at BBS: evergreen forest, gallery forests (next to streams and waterfalls), and disturbed areas.

Data Collection

We conducted extensive field work, studied most herpetological collections with BBS material at Ecuadorian museums, and review all relevant literature. We carried out exhaustive visual encounter surveys (VES) during four sampling periods: 10-15 December 2006 (30 hours/person), 26 February-03 March 2007 (30 hours/person), 13-25 April 2008 (53 hours/person),

and 09-17 May 2008 (36 hours/person); always at 09:00h-13:00h and 20:00h-23:00h. We prepared voucher specimens only for species that were caught for the first time or presented difficulties for field identification (Appendix 1). Photographic vouchers (but not specimens) were subsequently obtained from February 2004 to January 2009. Measurements were taken with a 0.5 mm precision dial caliper. Anuran calls were recorded with a Sony microcassette-corder M-670V and analyzed with Sound Ruler Acoustic Analysis®, following bioacoustics parameters suggested by Angulo (2006).

We recognize three categories of records: confirmed, unconfirmed, and unidentified species. Confirmed species are those with voucher specimens deposited at the División de Herpetología of the Museo Ecuatoriano de Ciencias Naturales (DHMECN, Quito, Ecuador). Unconfirmed species correspond to species captured and released, but supported by photographic vouchers. Unidentified species correspond to specimens (collected or photographed) still in need of specific verification pending additional collections.

We follow Frost (2008) for amphibian taxonomy and UETZ Reptile Database (1995-2008) for reptilian taxonomy. Information on the conservation status is based on UICN (2008). Each species of the checklist is assigned to one or

more habitat types based on field records and knowledge of its life history. Regional distribution, diel activity, and local distribution data are included. The Jaccard Index (J) was used to analyze community similitude between Bilsa Biological Station (BBS), and three nearby areas where extensive field sampling has been conducted: Buffer zone of the Cotacachi Cayapas Natural Reserve (ZACC; 00°51'51"N 78°44'02"W, 39-350 m, Morales *et al.* 2002), Galeras-San Francisco del Cabo (SFC; 00°39'00"N 80°03'29"W, 0-220 m; H. M. Ortega-Andrade unpublished data) and Reserva Biológica Canandé (RBC; 00°27'04"N 79°08'45"W, 700 m, M. H. Yáñez-Muñoz unpublished data). Governmental research permit #002 was obtained from the Ministerio del Ambiente del Ecuador.

RESULTS AND DISCUSSION

Thirty-seven species of amphibians and 72 species of reptiles were recorded in total at the Bilsa Biological Station (Appendix 1-3). The families Colubridae (34 spp.) and Polychrotidae (11 spp.) were diverse in the reptiles assemblage, while the families Hylidae (8 spp.) and Strabomantidae (8 spp.) were the most diverse families for amphibians (Table 1). About 33 % of Bilsa's herpetofauna is rare, with only one specimen registered for each species.

Cochranella mache, globally classified as Critically

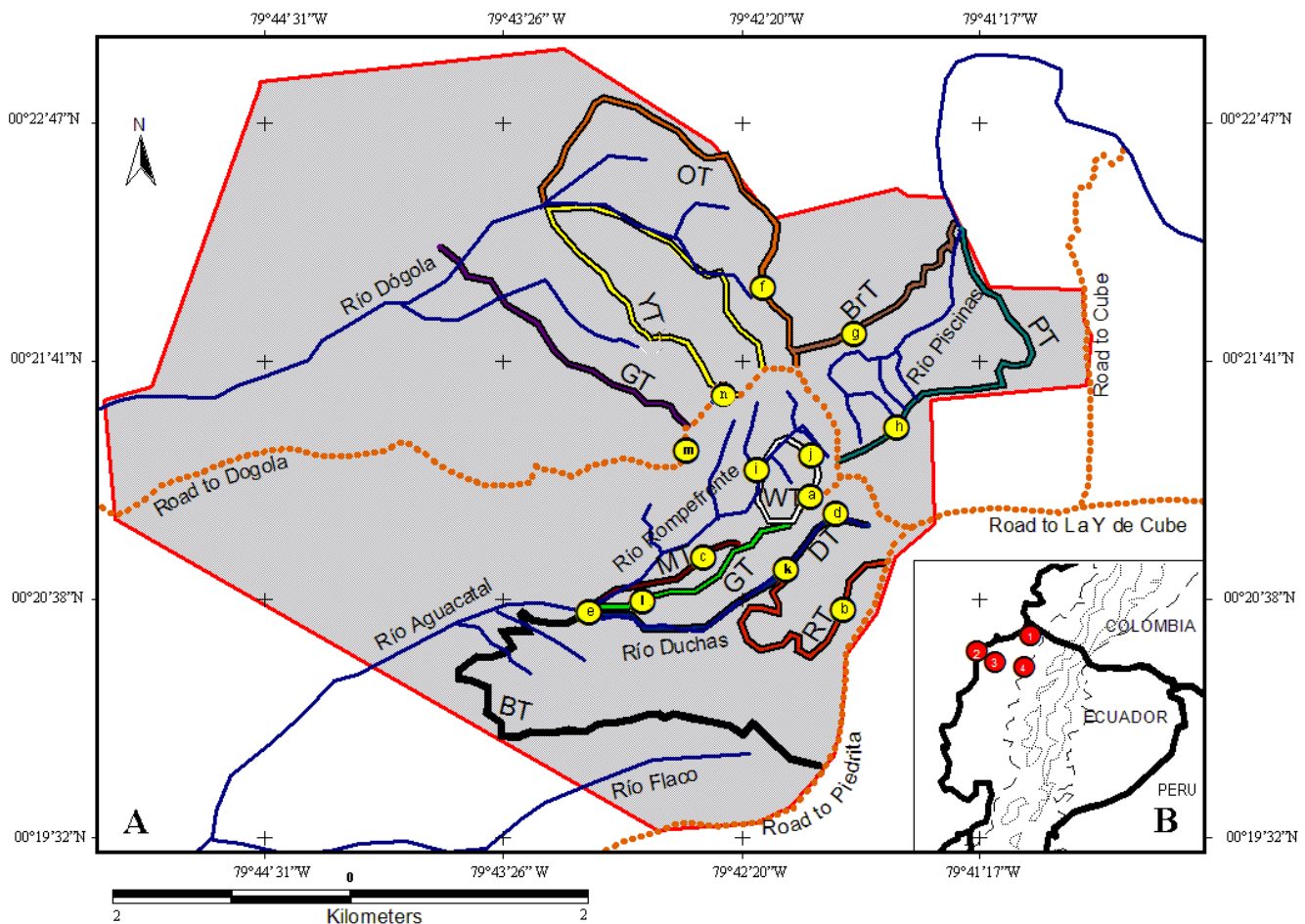


FIGURE 1. Map of the Bilsa Biological Station (A) and four areas in northwestern Ecuador (B). Numbers in map A are localities of herpetofauna surveys: (a) Scientific Station, (b) red Trail, (c) monkey trail, (d) duchas stream, (e) Aguacatal stream, (f) orange trail, (g) brown trail, (h) piscinas Trail, (i) rompefrente stream, (j) white trail, (k) duchas stream-red trail, (l) green trail, (m) Scientific Station-Dógola road, and (n) yellow trail. Localities in map B: (1) Zona de Amortiguamiento de la Cotacachi-Cayapas, (2) San Francisco del Cabo, (3) Bilsa Biological Station, and (4) Reserva Biológica Canandé; a darker interspaced line indicates elevations above 1000 m; a pointing line indicates elevations above 3000 m.

TABLE 1. Composition of the herpetofauna by families at Bilsa Biological Station.

TAXA	NUMBER OF SPECIES
AMPHIBIA	37
Anura	32
Bufo	3
Centrolenidae	6
Craugastoridae	1
Dendrobatidae	4
Hylidae	8
Leptodactylidae	2
Strabomantidae	8
Caudata	3
Plethodontidae	3
Gymnophiona	2
Caeciliidae	2
REPTILIA	72
Geoemydidae	1
Amphisbaenidae	1
Anguillidae	1
Corytophanidae	1
Gymnophthalmidae	7
Hoplocercidae	2
Iguanidae	1
Phyllodactylidae	1
Polychrotidae	11
Sphaerodactylidae	3
Teiidae	1
Boidae	1
Colubridae	34
Elapidae	3
Tropidophiidae	1
Viperidae	3
TOTAL	109

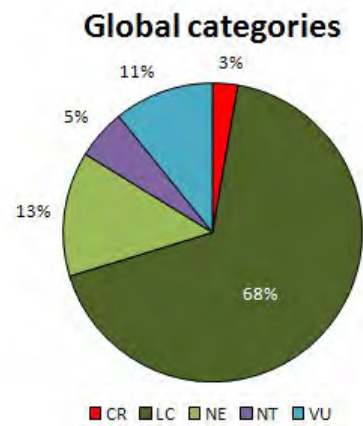


FIGURE 2. Global threat categories for amphibians from Bilsa Biological Station (UICN 2008). Nomenclature: DD= Data Deficient, CR= Critically Endangered, LC= Least Concern, NE= Not Evaluated, NT= Near Threatened, VU= Vulnerable.

endangered by Cisneros-Heredia *et al.* (2009), was recorded, together with four species classified as Vulnerable: *Bolitoglossa sima*, *Hyloxalus awa*, *Pristimantis muricatus*, and *Pristimantis rosadoi* (Figure 2; Appendix 1). Forty-four percent of species recorded has a wide Neotropical distribution, 27 % are characteristic to the Chocoan region, and 18 % are endemic to the West Ecuadorian region. Four species are distributed in Ecuador and Peru (Appendix 1). Similarity indexes reveal that the Bilsa Biological Station is most similar to the Galeras-San Francisco del Cabo coastal tropical forest (SI = 0.48, 58 shared species), linked to a second cluster formed by the Zona de Amortiguamiento de la Cotacachi-Cayapas (SI = 0.34, 50 species shared) and Reserva Biológica Canandé (SI = 0.38, 45 species shared; Figures 1B and 3).

Extension ranges

Pristimantis muricatus: This Ecuadorian-endemic species was previously known from six localities in humid lowlands and pre-montane slopes of the provinces of Pichincha and Esmeraldas, Ecuador, at elevations between 60 and 1380 m (Lynch and Duellman 1997; Morales *et al.* 2002; Figure 4). We collected a female specimen (DHMECN 3652; 36.52 mm in SVL) at the White trail on 13 December of 2006 (Figure 1A). This specimen was about 1 m above the ground on streamside vegetation at night.

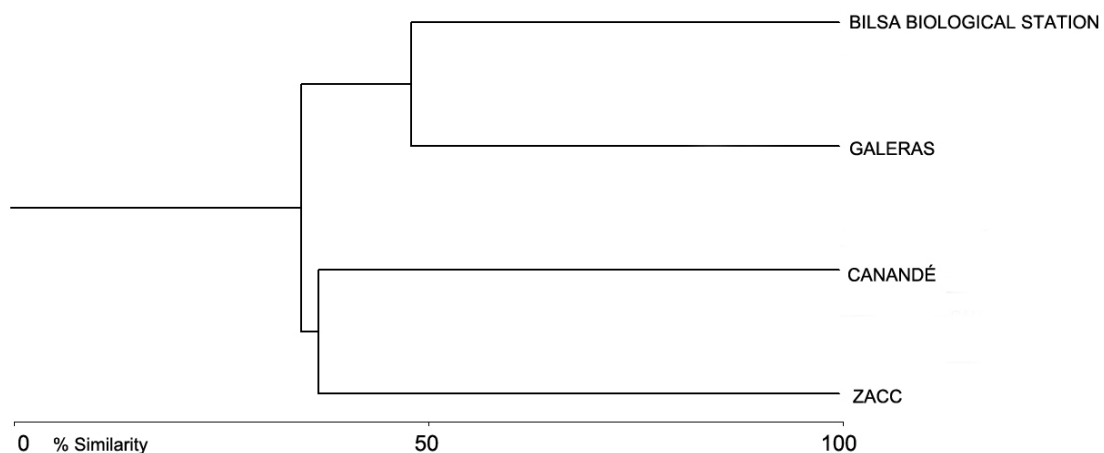


FIGURE 3. Cluster analysis with Jaccard's index showing similitude between four areas at northwestern Ecuador: Zona de Amortiguamiento de la Cotacachi-Cayapas (ZACC), Bilsa Biological Station, Reserva Biológica Canandé (CANANDÉ) and Galeras-San Francisco del Cabo (GALERAS).

Additional individuals were recorded (but not collected) on 15 October 2004, 16 November and 10 December 2006. A single female taking care of her eggs was recorded on a leaf 1.5 m above ground on the Orange trail. These records extend its distribution by *ca.* 109 km from the closest northern locality (near Tsejpi, province of Esmeraldas; Morales *et al.* 2002), and *ca.* 109 km from the closest southern locality (near Centro Científico Río Palenque, province of Los Ríos; Lynch and Duellman 1997). Coloma *et al.* (2008) presented a map for *P. muricatus* comprising an estimated area of occurrence of approximately 7,849 km². Based on the new records from the Mache-Chindul mountains, the estimated area of occurrence of *P. muricatus* is *ca.* 8,705 km² (Figure 5).

Pristimantis rosadoi is a species distributed at Isla Gorgona, Colombia, and northwestern Ecuador, up to 800 m (Lynch and Duellman 1997; Cisneros-Heredia *et al.* 2004). New material (Figure 4) from the province of Esmeraldas was collected at the following localities: (a) Bilsa Biological Station, on 11 December 2006, an immature female (DHMECN 3638, 21.5 mm SVL); (b) Reserva Monte Saíno (00°42'16"N 80°01'31"W, 160-220 m), three gravid females (DHMECN 2758, 27.2 mm SVL; DHMECN 2760, 26.3 mm SVL; DHMECN 2781, 24.25 mm SVL) and three males (DHMECN 2757, 19.3 mm SVL; DHMECN 2759, 18.3 mm; DHMECN 2782, 17.0 mm SVL), on 13 February, 19 March, 21-22 April and 16 September 2004; (c) Reserva Biológica Canandé, (00°27'04"N 79°08'45"W, 700 m), two gravid females (DHMECN 2823, 22.0 mm SVL; DHMECN 2824, 25.65 mm SVL) and one male (DHMECN 2820, 17.45 mm SVL), on August 2004. An amplexant pair (DHMECN 2781-82) was captured on a leaf at night on 22 April 2004; the female specimen contained 52 mature eggs in the oviduct. The record at Reserva Monte Saíno extends the species' distribution *ca.* 108 km from the closest northern locality (near Tangareal, province of Esmeraldas; Morales *et al.* 2002), and *ca.* 122 km from the closest southern locality (near to Río Caoní, province of Pichincha; Lynch and Duellman 1997). Based on the records presented herein, the estimated area of occurrence of *P. rosadoi* is *ca.* 11,884 km² (Figure 5).

Hyalinobatrachium valerioi (Figure 4) is widely distributed from central Costa Rica, through Panama and the Pacific lowlands of western Colombia and western Ecuador (Duellman and Burrowes 1989; Cisneros-Heredia and McDiarmid 2007; Solís *et al.* 2008). We report the first record of *Hyalinobatrachium valerioi* from the province of Esmeraldas. This record is the westernmost locality of the species, *ca.* 186 km from the nearest locality (Maldonado, province of Carchi, Duellman & Burrowes 1989) and *ca.* 116 km from the most southeastern locality (Centro Científico Río Palenque, province of Pichincha; Figure 7). A male (Figure 4) was recorded, but not collected, on the underside of a *Heliconia* leaf, 2.5 m above ground, near the Duchas stream at night on 27 January 2008. A metamorphic individual was observed in the Aguacatal-Dos Bocas Stream at night on 10 May 2008 (Figure 4D); eight masses with 20-72 eggs ($x = 41.3$, $N = 8$) were recorded between 13 April and 16 May 2008 on the underside of leaves 0.3-6 m above a stream. Eggs clutches were guarded by calling males on the underside of leaves. We analyzed 13 calls from a single male (SVL = 22.57 mm;

not collected) recorded on 13 April 2008 at the Duchas stream, *ca.* 3 m above water. Calls consist of a single note with an average dominant frequency of 6393.7 kHz \pm 217.2 Hz, fundamental frequency 3196.85 KHz \pm 108.60 Hz, and average call duration 0.0517s \pm 0.02s (Figure 6). Cisneros-Heredia and McDiarmid (2007) suggested that several species maybe under the name *H. valerioi*.

Sachatamia albomaculata (Figure 4) was reported for the first time for Ecuador by Guayasamin *et al.* (2006), thus extending its distribution range from humid lowlands and premontane slopes from north-central Honduras to northwestern Ecuador. In April 2007 two amplexant specimens were recorded, but not collected, by G. Jongsma and R. Hedley, near the Piscinas Trail (Figure 1). The Bilsa Biological Station is the southernmost locality in the distributional range of *S. albomaculata*, extending the known geographic range by 66.8 km from its closest northern locality (Reserva Biológica Canandé; Guayasamin *et al.* 2006; Figure 7). At BBS, *S. albomaculata* and *Hyalinobatrachium valerioi* were found in sympatry with *Cochranella mache*, *Teratohyla pulverata* and *Espadarana prosoblepon*.

Comments on unconfirmed species

Ecnomiohyla sp. (cf. *phantasmagoria*): A juvenile (uncollected; Figure 10) was found on a leaf close to the ground at a stream next to the Duchas stream at night on 30 January 2008. This frog had a dorsum mottled brown, black, and dark green; areolated belly, chest, and throat white with black blotches; ventral surfaces of limbs bright yellow with black blotches; large digital discs and extensive webbing; and scalloped dermal flaps along the outer limb margins. *Ecnomiohyla phantasmagoria* is known to occur at two localities separated by 1,000 km: Río Cauca, near the border of the departments of Antioquia and Bolívar in north-western Colombia; and, extreme north-western province of Esmeraldas, Ecuador, at 500 m (Frost 2008; Jungfer and Renjifo 2008). We revised photographs of the specimen reported as *E. phantasmagoria* by Jungfer and Renjifo (2008) deposited at the National History Museum of Vienna (NHMW 32168). It coincides with the characteristics described for the species and is morphologically similar to the juvenile from Bilsa, although differ in the ventral color pattern and presence of the supratympanic fold.

Atractus sp. (cf. *microrhynchus*): A specimen of a unicolor *Atractus* with a light collar (Figure 8) was found (uncollected) on 24 October 2007. It has the following characteristics: (1) 17 scale rows; (2) smooth dorsal scales; (3) dorsal scales rows same number through body; (4) loreal longer than the eye diameter; (5) 7 infralabials; (6) 35 divided subcaudals; (7) uniform black dorsum; and (8) complete cream collar. Additional characters of its lepidosis are: One rostral, two internasals, two prefrontals, one frontal, one supraocular, two parietals, two nasals, one large loreal, no preoculars, two postoculars, 1+2 temporals, 7 supralabials, 7 infralabials, 17 scale rows, 35 divided subcaudals, 148 mm total length. The only other uniform dark snake with collar in northwestern Ecuador that could be confused with this species is *Ninia atrata*, which has 19 rows at midbody with all dorsal scales keeled.



FIGURE 4. *Prisimantis muricatus* (A), *Pristimantis rosadoi* (B), *Hyalinobatrachium valerioi* (C-D) and *Sachatamia albomaculata* (E) from Bilsa Biological Station, northwestern Ecuador. Photos: J. Bermingham, C. Aulestia and C. Paucar.

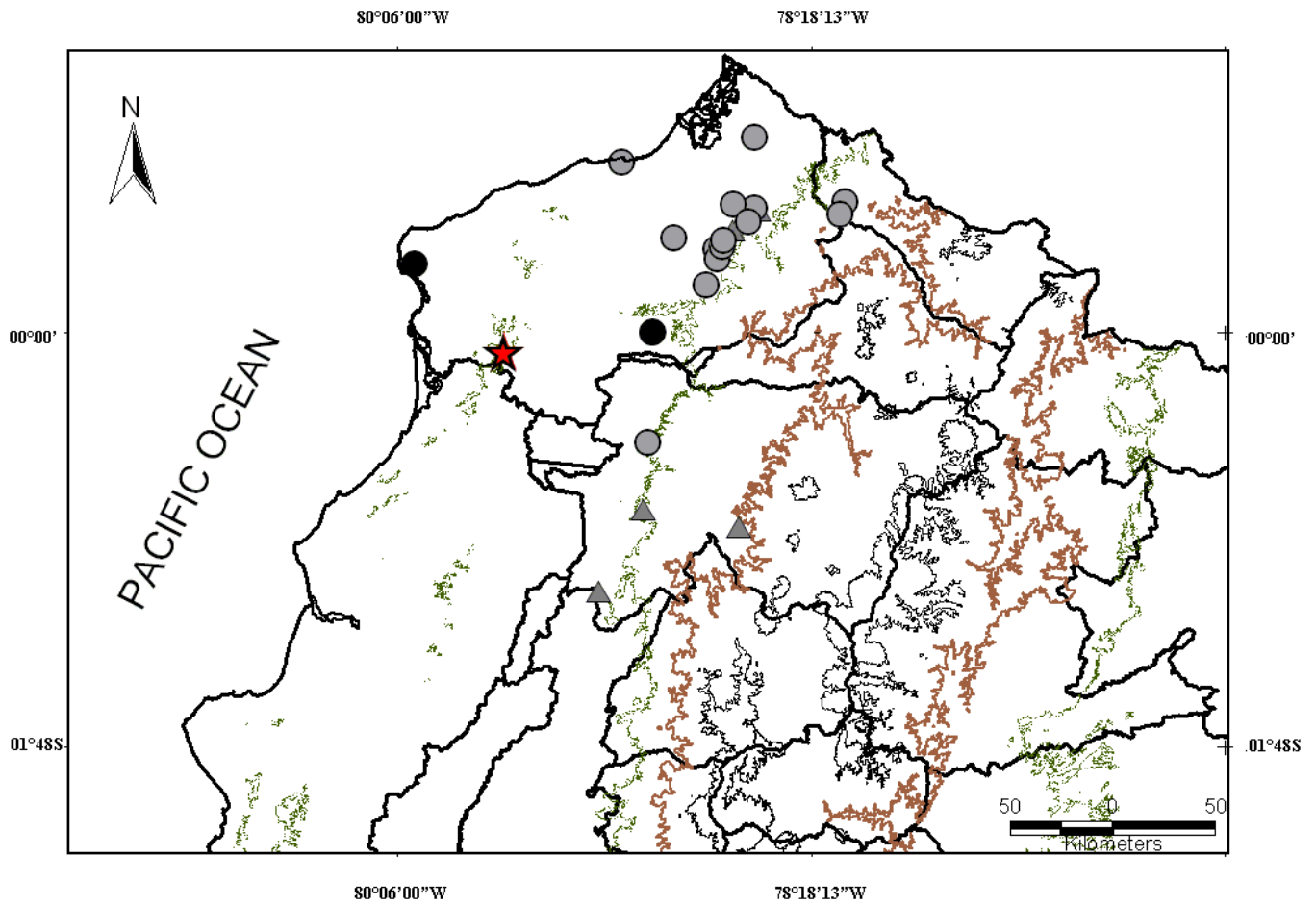


FIGURE 5. Distribution map of *Pristimantis muricatus* (triangles) and *P. rosadoi* (circles) for Ecuador. Red star: Bilsa Biological Station; black circles: collections of DHMECN in Reserva Monte Saino and Reseva Biológica Canandé; grey circles and triangles: literature records (Lynch and Duellman 1997, Morales in litt.). A green line indicates elevations above 500 m, a darker brown line indicates elevations above 2000 m, and a black thin line indicates elevations above 3800 m.

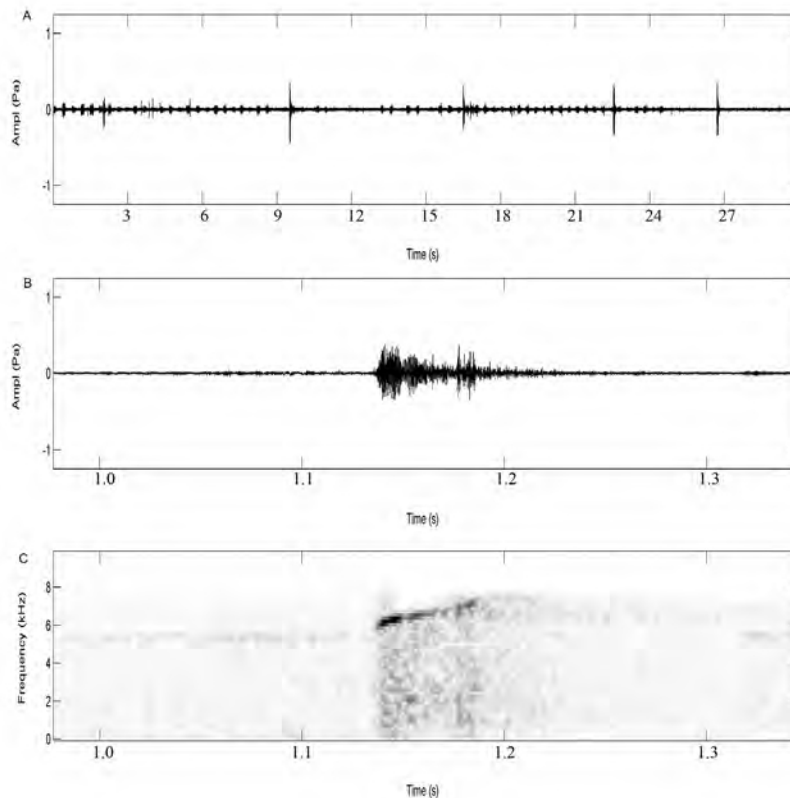


FIGURE 6. A continuous sequence of four calls emitted by *Hyalinobatrachium valerioi* (A), waveform of a single call (B) and its spectrogram (C). Recorded on 13 April 2008 at Duchas stream, single male (SVL = 22.57 mm; not collected).

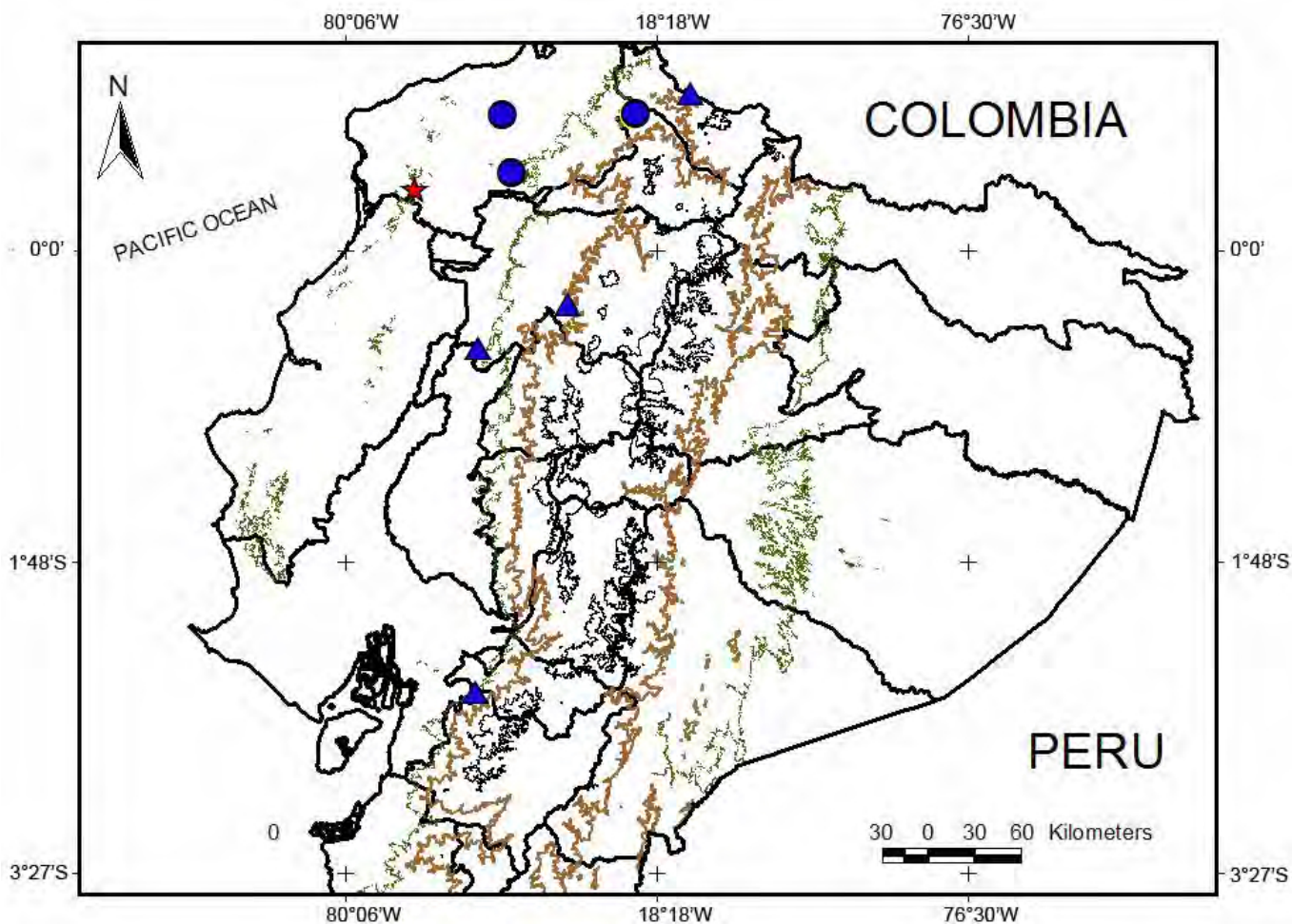


FIGURE 7. Distribution map of *Hyalinobatrachium valerioi* (triangles) and *Sachatamia albomaculata* (circles) for Ecuador. Red star: Bilsa Biological Station; blue circles and triangles: literature records (Duellman and Burrowes 1989; Guayasamin et al. 2006; Cisneros-Heredia and McDiarmid 2007; Solís et al. 2008). A green line indicates elevations above 500 m, a darker brown line indicates elevations above 2000 m, and a black thin line indicates elevations above 3800 m.



FIGURE 8. *Atractus* sp. (cf. *microrhynchus*), not collected, from Bilsa Biological Station, northwestern Ecuador. Photos: H. M. Ortega-Andrade.



FIGURE 9. *Atractus* sp. (cf. *melas*) (A) and *Sibon* sp. (B) from Bilsa Biological Station, northwestern Ecuador. Photos: J. Bermingham.

Atractus sp. (cf. *melas*): This snake (Figure 9) is characterized by: (1) medium-sized body (about 400-500 mm); (2) cylindrical body; (3) head not differentiated from the body; (4) small eyes; (5) short tail; (6) smooth dorsal scales, lacking apical pits; (7) dorsally there is a series of alternate, white regular bands separated by dark black interspaces; head black with a bright red collar on the neck extending through the labial scales; (8) ventral surfaces red. The only similar snake in northwestern Ecuador is the elapid *Micrurus mipartitus*, which has complete black and cream rings through the body and a bright red tail.

Sibon sp. (Figure 9) is characterized by: (1) medium-sized body (450-550 mm); (2) 15 row scales, (3) body laterally compressed; (4) neck pronounced; (5) seven supralabials, commonly 5-7 in contact with the ocular orbit; (6) dark red eyes, vertical elliptic pupils; (7) dorsal scales smooth, without apical pits; (8) dorsally there is a series of 42 alternate, reddish, regular bands separated by green and white interspaces bordered with black. *Sibon* sp. may be an undescribed species of the *Sibon annulatus* species group (J. Savage pers. comm.). Members of this group are *Sibon annulatus*, *S. argus*, *S. dimidiatus*, *S. longifrenis*, *S. lamari*, *S. manzanaresi* and *S. miskitus*, all from Central America (Savage and McDiarmid 1992;

Uetz 1995-2008). The dorsal color pattern, vertebral scales slightly enlarged than other dorsal scales, and 7 supralabial scales immediately differentiate *Sibon* sp. from *Sibon nebulata*, *Dipsas andiana* and *D. gracilis* at Bilsa.

Four specimens (DHMECN 3632, 3649, 3785, 3786) are assigned to *Colostethus* (Grant et al. 2006) and seem to correspond to a putatively undescribed species characterized by: (1) finger III not swollen in adult males; (2) dorsolateral stripe absent; (3) cream oblique lateral stripe present, constricted, discontinued, fading to gray in inguinal region, but continuing; (4) ventral surface of body immaculate cream to white in females; throat and chest marbling or blotched as brown-dark grey in adult males, belly uniform cream; (5) dorsum reddish brown in life; (6) bright yellow axillary, inguinal and shank flash marks. *Colostethus panamensis* is the only species in the Choco Region that has yellow bright marks in the armpit, groin and shanks (Grant 2004). *Colostethus* sp. (Figure 10) differs from *C. panamensis* in being the oblique pale stripe extending from the groin to eye (extending only midway to eye in *C. panamensis*), by has pale brown with scattered diffuse cream flecks in the flanks, between the ventrolateral and oblique lateral stripes, whereas that region is solid dark brown in *C. panamensis* and adult



FIGURE 10. *Ecnomiohyla* sp. (cf. *phantasmagoria*) (A-B), *Colostethus* sp. (C) and *Pristimantis* sp. (D) from Bilsa Biological Station, northwestern Ecuador. Photos: J. Bermingham and H. M. Ortega-Andrade.

males with blotched chest (Grant 2004). Relative tympanic size is also diagnostic between both species: conspicuous and large in *Colosthetus* sp., while inconspicuous and small in *C. panamensis*. Other sympatric dendrobatids at Bilsa are *Oophaga sylvatica*, *Epipedobates boulengeri* and *Hyloxalus awa*.

Pristimantis sp. (Figure 10) is apparently the same undescribed species cited as *Eleutherodactylus* sp. by Cisneros-Heredia (2006a) from Parque Nacional Machalilla, in the Province of Manabí. Two specimens were captured by C. Aulestia on the night of 16 November 2006 and by C. Paucar on 25 April 2008, both near to the Duchas stream. These specimens had granular ventral skin and white marks on the dorsal surfaces of the body and legs.

A specimen (DHMECN-HMOA 1360) assigned to the genus *Euspondylus* was found dead on the road that leads from the scientific station to la Yecita by L. M. Krogstad on 9 November 2007 (Figure 11). The specimen is characterized by: (1) Head slightly longer than wide; (2) no granular dorsal scales; (3) nasal scales separated from each other by the rostral and frontonasal scales; (4) presence of ear opening with recessed tympani; (5) moveable eyelids; (6) limbs each with five well developed, clawed digits; (7) interparietal scale larger than the length of parietal scales, and together, their posterior border not forming an aligned transverse straight suture across the back of the head; (8) no granular scales on the neck; (9) lateral scales reduced in size; (10) dorsum brown with black marks through the body; (11) ventral surfaces with black scales bordered with bright yellow. Only *Euspondylus guentheri* and *Euspondylus maculatus* are currently reported for Ecuador, but both occur on the eastern flanks and tropical lowland forest of Ecuador (Coloma *et al.* 2000-2009).

We have photographs of an unidentified caecilian, a lizard of the genus *Ptychoglossus*, and two Colubrid snakes that could not be assigned to any known species from the western Ecuador (Figure 11).

The documented herpetofauna of Bilsa Biological Station represents the 8 % and 18 % of the total number of amphibians and reptiles recorded for Ecuador, respectively (Coloma *et al.* 2000-2009; Torres-Carvajal 2000-2009; Coloma 2005-2009). Bilsa Biological Station is the second richest area in the Pacific slopes of Ecuador, surpassed only by the Centro Científico Río Palenque, west-central Ecuador (Miyata *in litt.*), where 145 species were reported. Since most of Palenque's forest have been lost due to fragmentation and uncontrolled logging (Wilson 1991), the Mache-Chindul Mountains are the last remnants of tropical-subtropical forests in the northwestern Ecuador, identified as a Priority Area of Conservation (Cuesta-Camacho *et al.* 2007).

Amphibian and reptile communities are known to be sensitive to environmental changes and are easily affected by fragmentation, logging and changes in microclimatic variables through a disturbed gradient in the habitat structure (Pearman 1997; Alcalá *et al.* 2004; Urbina-Cardona *et al.* 2006). After 149 hours/person sampling with VES, a total of 668 individuals of 58 species were captured (29 amphibian and 29 reptiles). In forested areas we captured 196 specimens from 13 amphibians and 24 reptiles. The most frequent amphibian species were *Pristimantis achatinus* (30 %), *Oophaga sylvatica* (28%),

Pristimantis latidiscus (20 %) and *Rhinella margaritifera* (7 %). For reptiles, the most frequent species were *Alopoglossus festae* (21 %), *Lepidoblepharis ruthveni* (12 %), *Anolis gracilipes*, *Oxybelis brevirostris* and *Enyalioides heterolepis*, with 8 specimens each one. In forested areas with streams/waterfalls we captured 463 specimens of 19 amphibians and 8 reptiles. In contrast with the forested areas, the most frequent amphibians were *Espadarana prosoblepon* (29 %), *Hypsiboas picturatus* (28 %), *Cochranella mache* (11 %) and *Pristimantis achatinus* (10 %). We captured only 9 individuals corresponding to the lizards *Anolis lynchi* (2), *Basiliscus galeritus*, *Enyalioides heterolepis*, *Echinosaura horrida* and the snakes *Dipsas gracilis*, *Imantodes cenchoa*, *Leptodeira septentrionalis ornata* and *Trachyboa boulengeri*. In disturbed areas near to streams, swamps or roads on station, we captured 21 individuals of 10 amphibians and 9 reptiles. We found five anurans (*Hypsiboas boans*, *Hypsiboas pellucens*, *Hypsiboas rosenbergi*, *Leptodactylus labrosus*, *Scinax quinquefasciatus*) solely associated to this type of habitat. The lizard *Anadia rhombifera* was observed moving on the roof and walls of the station building, near to the kitchen. *Iguana iguana* was observed on the canopy of a remnant tree, near to the station entrance. We observed a reduction in the amphibian richness (41 %) through the habitat gradient. Hylid frogs were closely associated to swamps and remnants forest in disturbed areas, while most Glassfrogs, Strabomantid and Dendrobatid frogs were associated to forested areas. A similar pattern of species replacement was found at Isla Gorgona, Colombia (Urbina-Cardona and Londoño 2003).

The lowland forests of the Pacific slopes of Ecuador are home to many unique species of plants and animals (Dodson and Gentry 1978; Albuja 1999; Cisneros-Heredia 2006b; Albuja and Arcos 2007). Separated by millions of years from their relatives in the Amazon basin by the Andes, they evolved here in geographic isolation (Duellman 1979; 1999; Ron 2000). Lynch and Duellman (1997) mentioned a gradual latitudinal displacement of related species of Strabomantid frogs through the Choco, with two major breaks: the first located in northern Departamento del Valle, Colombia with a considerable endemism of species, and a second major break between La Munchique in Departamento del Cauca, Colombia, and La Planada in southern Departamento de Nariño, Colombia. According to their analysis, the authors observed a disruption in the replacement of sister species like *Strabomantis anatis* and *S. zygodactylus* – the former to the north of the Río San Juan Valley and the latter to the south of the river. Composition of *Pristimantis* species at Bilsa (Appendix 1) match with the southernmost Chocoan community reported by Lynch and Duellman (1997), with only *Craugastor longirostris* and *Pristimantis achatinus* distributed from Panama to western Ecuador. Low values in community similarity index between Bilsa and three other localities in northwestern Ecuador (Figures 1 and 3), reveals a replacement of species through the study area, therefore a high beta diversity in the province of Esmeraldas marked by an important component of endemic species (Appendix 1). Some differences may be explained by different sampling efforts between the studies compared here. However, 18 % of the species at

Bilsa are unique to lowland and foothill evergreen forest of Ecuador (0-800 m), supporting that the West Ecuadorian Area, is a biogeographic region different from the Choco and Tumbesian regions (Cisneros-Heredia 2006b). The lowlands of the Department of Nariño in southwestern Colombia have not been collected intensively (Lynch and Duellman 1997), and it is possible that some species like *P. colomai*, *P. muricatus*, *Hyloxalus awa* or the lizards *Alopoglossus festae* and *Anolis peraccae* could extend the limit of the West Ecuadorian Endemic Area to southwestern Colombia.

Current knowledge of Ecuadorian herpetofauna still does not allow us to develop an adequate conservation assessment for most populations of amphibians and reptiles in the country, and Bilsa is not the exception. The presence of new distributional records and new species are clear evidences that the Pacific slopes of Ecuador are

understudied. Much of the herpetofauna diversity in the Pacific slopes of Ecuador is threatened by habitat loss, high deforestation rates due to unsustainable development, fragmentation, extension of the agricultural frontier, global climate change, among others. Future studies at Bilsa must include population and community ecology assessment and studies of the effects of habitat loss and fragmentation. New herpetological collections are urgently necessary to obtain specimens of species herein reported as putatively undescribed. We encourage prioritizing conservation actions on endemic and key areas, as well as increasing herpetofaunal research. We propose that the Mache-Chindul Mountains should be recognized as a Key Biodiversity Area (Gascon *et al.* 2007), globally important site that is large enough and sufficiently interconnected to ensure the persistence of remaining populations of endangered and endemic species in northwestern Ecuador.



FIGURE 11. Caecilid sp. (A), *Ptychoglossus* sp. (B), *Euspondylus* sp. (C), *Chironius* sp. (D), and Colubrid sp. (E) from Bilsa Biological Station, northwestern Ecuador. Photos: J. Bermingham, K. Maier and H. M. Ortega-Andrade.

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APPENDIX 1. Species list of amphibians and reptiles from the Bilsa Biological Station, province of Esmeraldas, Republic of Ecuador. Trail: (a) Scientific Station, (b) Red Trail, (c) Monkey trail, (d) Duchas stream, (e) Aguacatal-Dos Bocas stream, (f) Orange trail, (g) Brown trail, (h) Piscinas Trail, (i) Rompefrente stream, (j) White trail, (k) Duchas stream-Red trail, (l) Green trail, and (m) Scientific Station-Dógola road. Habitat: D = disturbed areas; F = forest, R = river, S = stream, Sw = swamp, Fs = fosorial. Diel activity: D = diurnal, N = nocturnal, ? = unknown. Distribution pattern: CO = Colombia, EC = Ecuador, PA = Panama, PE = Peru, ND = no data, W = wide distribution. Conservation Status according to UICN (2008): DD = Data Deficient, EN = Endangered, LC = Least Concern, NE = Not Evaluated, NT = Near Threatened, VU = Vulnerable.

CLASS/ Order/ Family/ Species	Trail	Habitat	Diel Activity	Distribution Pattern	Conservation Status
AMPHIBIA					
Anura					
Bufonidae					
1 <i>Rhaebo haematiticus</i>	d,e,h,i	S	N	W	LC
2 <i>Rhinella margaritifera</i>	b,c,d,e,g,h	F,S	D	W	LC
3 <i>Rhinella marina</i>	a	S,D	N	W	LC
Centrolenidae					
4 <i>Cochranella mache</i>	d,e,h,i	S	N	EC	EN
5 <i>Espadarana prosoblepon</i>	b,d,e,h,i,j	S	N	W	LC
6 <i>Hyalinobatrachium fleischmanni</i>	h	S	N	W	LC
7 <i>Hyalinobatrachium valerioi</i>	d,e	S	N	W	LC
8 <i>Sachatamia albomaculata</i>	h,i	S	N	W	LC
9 <i>Teratohyla pulverata</i>	d	S	N	W	LC
Craugastoridae					
10 <i>Craugastor longirostris</i>	h	F,S	N	PA-CO-EC	LC
Dendrobatidae					
11 <i>Colostethus</i> sp.	a,b,c,e,i,k	S	D	EC	LC
12 <i>Epipedobates boulengeri</i>	c,e,h	S,Sw	D	CO-EC	NT
13 <i>Hyloxalus awa</i>	b,c,e,j,k	S,D	D	EC	VU
14 <i>Oophaga sylvatica</i>	b,c,g,j,k	F,S	D	CO-EC	NT
Hylidae					
15 <i>Agalychnis spurrelli</i>	a,h	Sw,D	N	W	LC
16 <i>Ecnomiohyla</i> sp. (cf. <i>phantasmagoria</i>)	l	F,S	N	CO-EC	EN
17 <i>Hypsiboas boans</i>	a	R	N	CO-EC-PE	LC
18 <i>Hypsiboas pellucens</i>	a	R,S,Sw	N	CO-EC	LC
19 <i>Hypsiboas picturatus</i>	b,d,e,h,i,j	S	N	CO-EC	LC
20 <i>Hypsiboas rosenbergi</i>	a	Sw,R,D	N	W	LC
21 <i>Scinax quinquefasciatus</i>	a	Sw,D	N	CO-EC	LC
22 <i>Smilisca phaeota</i>	j	Sw,D	N	W	LC
Leptodactylidae					
23 <i>Leptodactylus labrosus</i>	a,m	R,Sw,D	N	EC-PE	LC
24 <i>Leptodactylus rhodomerus</i>	a,d,i	F,S,R,Sw,D	N	CO-EC	NE

APPENDIX 1. Species list of amphibians and reptiles from the Bilsa Biological Station, province of Esmeraldas, Republic of Ecuador. Trail: (a) Scientific Station, (b) Red Trail, (c) Monkey trail, (d) Duchas stream, (e) Aguacatal–Dos Bocas stream, (f) Orange trail, (g) Brown trail, (h) Piscinas Trail, (i) Rompefrente stream, (j) White trail, (k) Duchas stream–Red trail, (l) Green trail, and (m) Scientific Station–Dógola road. Hábitat: D = disturbed areas; F = forest, R = river, S = stream, Sw = swamp, Fs = fosorial. Diel activity: D = diurnal, N = nocturnal, ? = unknown. Distribution pattern: CO = Colombia, EC = Ecuador, PA = Panama, PE = Peru, ND = no data, W = wide distribution. Conservation Status according to UICN (2008): DD = Data Deficient, EN = Endangered, LC = Least Concern, NE = Not Evaluated, NT = Near Threatened, VU = Vulnerable. **(CONTINUED)**

CLASS/ Order/ Family/ Species	Trail	Habitat	Diel Activity	Distribution Pattern	Conservation Status
Strabomantidae					
25 <i>Pristimantis achatinus</i>	b,c,d,e,f,g,h,i,j,l	F,S,Sw;D	N	PA-CO-EC	LC
26 <i>Pristimantis latidiscus</i>	c,d,e,f,g,h,i,j,l	F,S	N	CO-EC	LC
27 <i>Pristimantis muricatus</i>	j	F,S,D	N	EC	VU
28 <i>Pristimantis parvillus</i>	g,l	F	N	CO-EC	LC
29 <i>Pristimantis rosadoi</i>	e,h	F	N	CO-EC	VU
30 <i>Pristimantis</i> sp.	d	S	N	EC	NE
31 <i>Pristimantis subsigillatus</i>	b	F,D		CO-EC	LC
32 <i>Pristimantis walkeri</i>	a	F	N	EC	LC
Caudata					
Plethodontidae					
33 <i>Bolitoglossa biseriata</i>	j,l	F,S	N	W	LC
34 <i>Bolitoglossa sima</i>	d,j,l	F,S	N	EC	VU
35 <i>Oedipina complex</i>	l	F	N	PA-CO-EC	LC
Gymnophiona					
Caeciliidae					
36 <i>Caecilia nigricans</i>	a	Fs,F,D	?	W	LC
37 <i>Caecilid</i> sp. 1	l	Fs,F,D	?	ND	NE
REPTILIA					
Chelonia					
Geoemydidae					
1 <i>Rhinoclemmys annulata</i>	c	R,S,Sw,F	N/D	W	
Squamata-Amphisbaenia					
Amphisbaenidae					
2 <i>Amphisbaena fuliginosa varia</i>	a	Fs,S,F	?	W	
Squamata-Sauria					
Anguidae					
3 <i>Diploglossus monotropis</i>	m	F,D	D	W	
Corytophanidae					
4 <i>Basiliscus galeritus</i>	h	R,S	D	W	
Gymnophthalmidae					
5 <i>Alopoglossus festae</i>	a,b,c,g,j	F,D	D	EC	
6 <i>Anadia rhombifera</i>	a	F,D	D	CO-EC	
7 <i>Echinosaura horrida</i>	d,k	S	D	CO-EC	
8 <i>Euspondylus</i> sp.	m	F	D	EC	
9 <i>Ptychoglossus gorgonae</i>	a	F	D	CO-EC	
10 <i>Ptychoglossus</i> sp.	a	F	D	ND	
11 <i>Teuchocercus keyi</i>	n	S,F	D	EC	
Hoplocercidae					
12 <i>Enyalioides heterolepis</i>	c,d,e,f,g,j,l	F,S	D	CO-EC	
13 <i>Enyalioides oshaughnessyi</i>	g	F,S	D	W	
Iguanidae					
14 <i>Iguana iguana iguana</i>	a	F	D	W	
Phyllodactylidae					
15 <i>Thecadactylus rapicauda</i>	g	F,D	D	W	
Polychrotidae					
19 <i>Anolis biporcatus</i>	l	F,S,D	D	CO-EC	
20 <i>Anolis chocorum</i>	g	F,D	D	PA-CO-EC	
21 <i>Anolis fraseri</i>	a	F,D	D	CO-EC	
22 <i>Anolis gracilipes</i>	c,e,f,g,j,l	F,S,D	D	EC	
23 <i>Anolis granuliceps</i>	a	F,S,D	D	CO-EC	
24 <i>Anolis lynchi</i>	e,h,i,j	S	D	CO-EC	
25 <i>Anolis lyra</i>	c	F,D	D	W	
26 <i>Anolis maculiventris</i>	a	F	D	CO-EC	
27 <i>Anolis peraccae</i>	a,j	F,D	D	EC	
28 <i>Anolis princeps</i>	c,e	F,D	D	CO-EC	
Sphaerodactylidae					
16 <i>Lepidoblepharis buchwaldi</i>	a,b,c	S,F	D	EC	
17 <i>Lepidoblepharis grandis</i>	a,e	S	D	EC	
18 <i>Lepidoblepharis ruthveni</i>	a,c,j	S	D	CO-EC	
29 <i>Polychrus gutturosus</i>	a	F	D	W	
Teiidae					
30 <i>Ameiva septemlineata</i>	b,g	S,R,D,F	D	EC	
Squamata-Serpentes					
Boidae					
31 <i>Boa constrictor imperator</i>	a	F,D	N/D	W	

APPENDIX 1. Species list of amphibians and reptiles from the Bilsa Biological Station, province of Esmeraldas, Republic of Ecuador. Trail: (a) Scientific Station, (b) Red Trail, (c) Monkey trail, (d) Duchas stream, (e) Aguacatal–Dos Bocas stream, (f) Orange trail, (g) Brown trail, (h) Piscinas Trail, (i) Rompefrente stream, (j) White trail, (k) Duchas stream–Red trail, (l) Green trail, and (m) Scientific Station–Dógola road. Hábitat: D = disturbed areas; F = forest, R = river, S = stream, Sw = swamp, Fs = fosorial. Diel activity: D = diurnal, N = nocturnal, ? = unknown. Distribution pattern: CO = Colombia, EC = Ecuador, PA = Panama, PE = Peru, ND = no data, W = wide distribution. Conservation Status according to UICN (2008): DD = Data Deficient, EN = Endangered, LC = Least Concern, NE = Not Evaluated, NT = Near Threatened, VU = Vulnerable. **(CONTINUED)**

CLASS/ Order/ Family/ Species	Trail	Habitat	Diel Activity	Distribution Pattern	Conservation Status
Colubridae					
32 <i>Atractus</i> sp. (cf. <i>melas</i>)	l	D,F	D	CO-EC	
33 <i>Atractus</i> sp. (cf. <i>microrhynchus</i>)	a	F	D	EC	
34 <i>Chironius grandisquamis</i>	l	F,D	D	W	
35 <i>Chironius monticola</i>	l	F,D	D	W	
36 <i>Chironius</i> sp.	a	F	D	ND	
37 <i>Clelia clelia</i>	a	F,D,S,Sw	F,D,S,Sw	W	
38 Colubrid sp.	a	F	D	ND	
39 <i>Coniophanes fissidens</i>	a,b	F,S,D	N	W	
40 <i>Dendrophidion brunneus</i>	l	F	D	EC-PE	
41 <i>Dendrophidion nuchale</i>	a	F	D	W	
42 <i>Dendrophidion percarinatus</i>	g	F,D	D	W	
43 <i>Dipsas andiana</i>	j	F,S	N	EC	
44 <i>Dipsas gracilis</i>	h	F,S,D	N	EC	
45 <i>Erythrolamprus mimus micrurus</i>	l	D,F	D	W	
46 <i>Imantodes cenchoa</i>	c,d,l	F,S,D	N	W	
47 <i>Imantodes inornatus</i>	a	F	N	W	
48 <i>Leptodeira septentrionalis</i>	g,h	F,S,Sw	N	EC-PE	
49 <i>Leptophis ahaetulla</i>	l	F	D	W	
50 <i>Leptophis riveti</i>	a	F	D	W	
51 <i>Liophis epinephelus albiventris</i>	a	F,S	N	EC	
52 <i>Mastigodryas heathii</i>	a	F,D	D	EC-PE	
53 <i>Mastigodryas pulchriceps</i>	a,j	F	D	W	
54 <i>Ninia atrata</i>	l	F,D	N	W	
55 <i>Oxybelis brevirostris</i>	c,f,g,j	F,S	D	W	
56 <i>Oxyrhopus petola sebae</i>	l	F,S,D	N	W	
57 <i>Pliocercus euryzonus</i>	a	D,F	N	W	
58 <i>Pseustes shropshirei</i>	l	F,S	D	W	
59 <i>Rhadinaea</i> cf. <i>decorata</i>	l	D,F	D/N	ND	
60 <i>Sibon nebulata</i>	g	F,S,D	N	W	
61 <i>Sibon</i> sp.	a	S	N	EC	
62 <i>Stenorrhina degenhardtii</i>	a	F,D	D	W	
63 <i>Tantilla melanocephala</i>	a	F	D	W	
64 <i>Urotheca</i> cf. <i>decepiens</i>	l	F,D	D/N	ND	
65 <i>Urotheca fulviceps</i>	a	F	D/N	W	
Elapidae					
66 <i>Micrurus ancoralis ancoralis</i>	l	F,D	D/N	CO-EC	
67 <i>Micrurus dumerilii transandinus</i>	a	F,D	D	W	
68 <i>Micrurus mipartitus decussatus</i>	l	F,Sw,S	N	CO-EC	
Tropidophiidae					
69 <i>Trachyboa boulengeri</i>	d	R,S,Sw	N	W	
Viperidae					
70 <i>Bothriechis schlegelii</i>	a	F	N	W	
71 <i>Bothrops asper</i>	e,m	F,R,Sw,S,D	N	W	
72 <i>Lachesis acrochorda</i>	a,l	F,R,S,D	N	W	

APPENDIX 2. Collected material from Bilsa Biological Station, province of Esmeraldas, northwestern Ecuador.

AMPHIBIA

ANURA: Bufonidae: *Rhinella haematitica* DHMECN 3631, *Rhinella margaritifera* DHMECN 3627 Centrolenidae: *Espadarana prosoblepon* DHMECN 3635; Dendrobatidae: *Colostethus* sp. DHMECN 3632, DHMECN 3649, DHMECN 3785, DHMECN 3786, *Epipedobates boulengeri* DHMECN 3793; *Hyloxalus awa* DHMECN 3628, DHMECN 3633; *Oophaga sylvatica* DHMECN 3629, DHMECN 3630; Hylidae: *Agalychnis spurrelli* DHMECN 3792; *Hypsiboas picturatus* DHMECN 3622; *Smilisca phaeota* DHMECN 3623; Leptodactylidae: *Leptodactylus labrosus* DHMECN 3789; Strabomantidae: *Pristimantis latidiscus* DHMECN 3637, DHMECN 3639, 3658, DHMECN 3662; *Pristimantis muricatus* DHMECN 3652; *Pristimantis parvillus* DHMECN 3656, DHMECN 3663; *Pristimantis rosadoi* DHMECN 3638; *Pristimantis subsigillatus* DHMECN 3796. CAUDATA: Plethodontidae: *Bolitoglossa biseriata* DHMECN 3653, DHMECN 3657; *Bolitoglossa sima* DHMECN 3654, DHMECN 3791; *Oedipina complex* DHMECN 2607.

REPTILIA

SQUAMATA: Anguillidae: *Diploglossus monotropis* DHMECN 3664; Colubridae: *Coniophanes fissidens* DHMECN 3659; *Dipsas andiana* DHMECN 3655; *Dipsas gracilis* DHMECN 3625; *Leptodeira septentrionalis* DHMECN 3624; *Mastigodryas pulchriceps* DHMECN 3645; *Oxybelis brevirostris* DHMECN 3651, *Sibon nebulata leucomelas* DHMECN 3660; Gymnophthalmidae: *Alopoglossus festae* DHMECN 3647; *Anadia rhombifera* DHMECN 3646; *Echinosaura horrida horrida* DHMECN 3787; *Euspondylus* sp. HMOA 1360; Hoplocercidae: *Enyalioides heterolepis* DHMECN 3636; *Enyalioides oshaughnessyi* DHMECN 3797; Phyllodactylidae: *Thecadactylus rapicauda* DHMECN 3661; Polychrotidae: *Anolis gracilipes* DHMECN 3641, DHMECN 3650; *Anolis lynchi* DHMECN 3626, DHMECN 3643, DHMECN 3644; *Anolis princeps* DHMECN 3640, *Anolis* sp. DHMECN 3794; Sphaerodactylidae: *Lepidoblepharis buchwaldi* DHMECN 3788, DHMECN 3795; *Lepidoblepharis grandis* DHMECN 3642; *Lepidoblepharis ruthveni* DHMECN 3648; Tropidophiidae: *Trachyboa boulengeri* DHMECN 3790; Viperidae: *Bothrops asper* DHMECN 3634.

APPENDIX 3. Amphibians and Reptiles from Bilsa Biological Station, northwestern Ecuador. Photographers: J.S. Bermingham (JB), C.F. Aulestia-Obanda (CA), H. M. Ortega-Andrade (MO), E. Neuschulz (EN) and Christian Paucar (CP).



Rhinella haematiticus (CP) - BUFONIDAE



Rhaebo haematiticus (JB) - BUFONIDAE



Rhinella margaritifera (JB) - BUFONIDAE



Rhinella margaritifera (JB) - BUFONIDAE



Rhinella margaritifera (JB) - BUFONIDAE



Rhinella marina (juvenile) (JB) - BUFONIDAE

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Espadarana prosoblepon (JB) - CENTROLENIDAE



Sachatamia albomaculata (CP) - CENTROLENIDAE



Cochranella mache (JB) - CENTROLENIDAE



Teratohyla pulverata (JB) - CENTROLENIDAE



Hyalinobatrachium valerioi (JB) - CENTROLENIDAE



Hyalinobatrachium fleischmanni (JB) - CENTROLENIDAE

APPENDIX 3. Amphibians and Reptiles from Bilsa Biological Station, northwestern Ecuador. Photographers: J.S. Bermingham (JB), C.F. Aulestia-Obanda (CA), H. M. Ortega-Andrade (MO), E. Neuschulz (EN) and Christian Paucar (CP). **(CONTINUED)**



Colostethus sp. (MO) - DENDROBATIDAE



Epipedobates boulengeri (MO) - DENDROBATIDAE



Hyloxalus awa (MO) - DENDROBATIDAE



Oophaga sylvatica (JB) - DENDROBATIDAE



Agalychnis spurrelli (MO) - HYLIDAE



Hypsiboas boans (JB) - HYLIDAE

APPENDIX 3. Amphibians and Reptiles from Bilsa Biological Station, northwestern Ecuador. Photographers: J.S. Bermingham (JB), C.F. Aulestia-Obanda (CA), H. M. Ortega-Andrade (MO), E. Neuschulz (EN) and Christian Paucar (CP). **(CONTINUED)**



Hypsiboas pellucens (JB) - HYLIDAE



Hypsiboas picturatus (JB) - HYLIDAE



Hypsiboas rosenbergi (JB) - HYLIDAE



Ecnomiohyla cf. phantasmagoria (JB) - HYLIDAE



Ecnomiohyla cf. phantasmagoria (JB) - HYLIDAE



Scinax quinquefasciatus (JB) - HYLIDAE

APPENDIX 3. Amphibians and Reptiles from Bilsa Biological Station, northwestern Ecuador. Photographers: J.S. Bermingham (JB), C.F. Aulestia-Obanda (CA), H. M. Ortega-Andrade (MO), E. Neuschulz (EN) and Christian Paucar (CP). **(CONTINUED)**



Scinax quinquefasciatus (JB) - HYLIDAE



Smilisca phaeota (JB) - HYLIDAE



Smilisca phaeota (JB) - HYLIDAE



Smilisca phaeota (JB) - HYLIDAE



Leptodactylus labrosus (JB) - LEPTODACTYLIDAE



Leptodactylus rhodomerus (JB) - LEPTODACTYLIDAE

APPENDIX 3. Amphibians and Reptiles from Bilsa Biological Station, northwestern Ecuador. Photographers: J.S. Bermingham (JB), C.F. Aulestia-Obanda (CA), H. M. Ortega-Andrade (MO), E. Neuschulz (EN) and Christian Paucar (CP). **(CONTINUED)**



Craugastor longirostris (JB) - CRAUGASTORIDAE



Pristimantis achatinus (JB) - STRABOMANTIDAE



Pristimantis latidiscus (CP) - STRABOMANTIDAE



Pristimantis latidiscus (JB) - STRABOMANTIDAE



Pristimantis latidiscus (CP) - STRABOMANTIDAE



Pristimantis muricatus (JB) - STRABOMANTIDAE

APPENDIX 3. Amphibians and Reptiles from Bilsa Biological Station, northwestern Ecuador. Photographers: J.S. Bermingham (JB), C.F. Aulestia-Obanda (CA), H. M. Ortega-Andrade (MO), E. Neuschulz (EN) and Christian Paucar (CP). **(CONTINUED)**



Pristimantis muricatus (JB) - STRABOMANTIDAE



Pristimantis parvillus (juvenile) (JB) - STRABOMANTIDAE



Pristimantis rosadoi (CA) - STRABOMANTIDAE



Pristimantis sp. (JB) - STRABOMANTIDAE



Pristimantis subsigillatus (JB) - STRABOMANTIDAE



Pristimantis subsigillatus (JB) - STRABOMANTIDAE

APPENDIX 3. Amphibians and Reptiles from Bilsa Biological Station, northwestern Ecuador. Photographers: J.S. Bermingham (JB), C.F. Aulestia-Obanda (CA), H. M. Ortega-Andrade (MO), E. Neuschulz (EN) and Christian Paucar (CP). **(CONTINUED)**



Pristimantis walkeri (JB) - STRABOMANTIDAE



Bolitoglossa biseriata (MO) - PLETHODONTIDAE



Bolitoglossa biseriata (MO) - PLETHODONTIDAE



Bolitoglossa sima (JB) - PLETHODONTIDAE



Caecilia nigricans (JB) - CAECILIDAE



Caecilia sp. (JB) - CAECILIDAE

APPENDIX 3. Amphibians and Reptiles from Bilsa Biological Station, northwestern Ecuador. Photographers: J.S. Bermingham (JB), C.F. Aulestia-Obanda (CA), H. M. Ortega-Andrade (MO), E. Neuschulz (EN) and Christian Paucar (CP). **(CONTINUED)**



Rhinoclemmys annulata (JB) - GEOEMYDIDAE



Rhinoclemmys annulata (JB) - GEOEMYDIDAE



Amphisbaena fuliginosa (JB) - AMPHISBAENIDAE



Diploglossus monotropis (JB) - ANGUIDAE



Basiliscus galeritus (JB) - CORYTOPHANIDAE



Basiliscus galeritus (juvenile) (JB) - CORYTOPHANIDAE

APPENDIX 3. Amphibians and Reptiles from Bilsa Biological Station, northwestern Ecuador. Photographers: J.S. Bermingham (JB), C.F. Aulestia-Obanda (CA), H. M. Ortega-Andrade (MO), E. Neuschulz (EN) and Christian Paucar (CP). **(CONTINUED)**



Lepidoblepharis buchwaldi (JB) - SPHAERODACTYLIDAE



Lepidoblepharis grandis (JB) - SPHAERODACTYLIDAE



Lepidoblepharis ruthveni (JB) - SPHAERODACTYLIDAE



Thecadactylus rapicauda (MO) - PHYLLODACTYLIDAE



Alopoglossus festae (MO) - GYMNOPTHALMIDAE



Anadia rhombifera (MO) - GYMNOPTHALMIDAE

APPENDIX 3. Amphibians and Reptiles from Bilsa Biological Station, northwestern Ecuador. Photographers: J.S. Bermingham (JB), C.F. Aulestia-Obanda (CA), H. M. Ortega-Andrade (MO), E. Neuschulz (EN) and Christian Paucar (CP). **(CONTINUED)**



Echinosaura horrida (MO) - GYMNOPTHALMIDAE



Euspondylus sp. (JB) - GYMNOPTHALMIDAE



Ptychoglossus gorgonae (JB) - GYMNOPTHALMIDAE



Ptychoglossus sp. (JB) - GYMNOPTHALMIDAE



Teuchocercus keyi (JB) - GYMNOPTHALMIDAE



Enyalioides heterolepsis (JB) - HOPLOCERCIDAE

APPENDIX 3. Amphibians and Reptiles from Bilsa Biological Station, northwestern Ecuador. Photographers: J.S. Bermingham (JB), C.F. Aulestia-Obanda (CA), H. M. Ortega-Andrade (MO), E. Neuschulz (EN) and Christian Paucar (CP). **(CONTINUED)**



Enyalioides oshaughnessyi (JB) - HOPLOCERCIDAE



Anolis biporcatus (JB) - POLYCHROTIDAE



Anolis biporcatus (JB) - POLYCHROTIDAE



Anolis chocorum (JB) - POLYCHROTIDAE



Anolis fraseri (JB) - POLYCHROTIDAE



Anolis fraseri (JB) - POLYCHROTIDAE

APPENDIX 3. Amphibians and Reptiles from Bilsa Biological Station, northwestern Ecuador. Photographers: J.S. Bermingham (JB), C.F. Aulestia-Obanda (CA), H. M. Ortega-Andrade (MO), E. Neuschulz (EN) and Christian Paucar (CP). **(CONTINUED)**



Anolis gracilipes (JB) - POLYCHROTIDAE



Anolis granuliceps (JB) - POLYCHROTIDAE



Anolis lynchi (JB) - POLYCHROTIDAE



Anolis maculiventris (JB) - POLYCHROTIDAE



Anolis peraccae (male) (JB) - POLYCHROTIDAE



Anolis peraccae (female) (JB) - POLYCHROTIDAE

APPENDIX 3. Amphibians and Reptiles from Bilsa Biological Station, northwestern Ecuador. Photographers: J.S. Bermingham (JB), C.F. Aulestia-Obanda (CA), H. M. Ortega-Andrade (MO), E. Neuschulz (EN) and Christian Paucar (CP). **(CONTINUED)**



Anolis princeps (JB) - POLYCHROTIDAE



Anolis lyra (male) (JB) - POLYCHROTIDAE



Polychrus gutturosus (CA) - POLYCHROTIDAE



Ameiva septemlineata (JB) - TEIIDAE



Ameiva septemlineata (JB) - TEIIDAE



Boa constrictor imperator (JB) - BOIDAE

APPENDIX 3. Amphibians and Reptiles from Bilsa Biological Station, northwestern Ecuador. Photographers: J.S. Bermingham (JB), C.F. Aulestia-Obanda (CA), H. M. Ortega-Andrade (MO), E. Neuschulz (EN) and Christian Paucar (CP). **(CONTINUED)**



Atractus sp. (cf. *microrhynchus*) (MO) - COLUBRIDAE



Atractus sp. (cf. *melas*) (JB) - COLUBRIDAE



Chironius grandisquamis (JB) - COLUBRIDAE



Chironius monticola (JB) - COLUBRIDAE



Chironius sp. (JB) - COLUBRIDAE



Clelia clelia (JB) - COLUBRIDAE

APPENDIX 3. Amphibians and Reptiles from Bilsa Biological Station, northwestern Ecuador. Photographers: J.S. Bermingham (JB), C.F. Aulestia-Obanda (CA), H. M. Ortega-Andrade (MO), E. Neuschulz (EN) and Christian Paucar (CP). **(CONTINUED)**



Clelia clelia (juvenile) (EN) - COLUBRIDAE



Coniophanes fissidens (JB) - COLUBRIDAE



Dendrophidion brunneus (JB) - COLUBRIDAE



Dendrophidion nuchale (MO) - COLUBRIDAE



Dendrophidion nuchale (MO) - COLUBRIDAE



Dendrophidion percarinatus (JB) - COLUBRIDAE

APPENDIX 3. Amphibians and Reptiles from Bilsa Biological Station, northwestern Ecuador. Photographers: J.S. Bermingham (JB), C.F. Aulestia-Obanda (CA), H. M. Ortega-Andrade (MO), E. Neuschulz (EN) and Christian Paucar (CP). **(CONTINUED)**



Dipsas andiana (JB) - COLUBRIDAE



Dipsas gracilis (MO) - COLUBRIDAE



Erythrolamprus mimus micrurus (JB) - COLUBRIDAE



Imantodes cenchoa (JB) - COLUBRIDAE



Imantodes inornatus (JB) - COLUBRIDAE



Imantodes inornatus (JB) - COLUBRIDAE

APPENDIX 3. Amphibians and Reptiles from Bilsa Biological Station, northwestern Ecuador. Photographers: J.S. Bermingham (JB), C.F. Aulestia-Obanda (CA), H. M. Ortega-Andrade (MO), E. Neuschulz (EN) and Christian Paucar (CP). **(CONTINUED)**



Leptodeira septentrionalis (juvenile) (MO) - COLUBRIDAE



Leptodeira septentrionalis (MO) - COLUBRIDAE



Leptophis ahaetulla (JB) - COLUBRIDAE



Leptophis riveti (CA) - COLUBRIDAE



Liophis epinephelus (JB) - COLUBRIDAE



Mastigodryas heathii (JB) - COLUBRIDAE

APPENDIX 3. Amphibians and Reptiles from Bilsa Biological Station, northwestern Ecuador. Photographers: J.S. Bermingham (JB), C.F. Aulestia-Obanda (CA), H. M. Ortega-Andrade (MO), E. Neuschulz (EN) and Christian Paucar (CP). **(CONTINUED)**



Mastigodryas pulchriceps (MO) - COLUBRIDAE



Unidentified sp. (JB) - COLUBRIDAE



Ninia atrata (JB) - COLUBRIDAE



Oxybelis brevirostris (JB) - COLUBRIDAE



Oxyrophus petola sebae (JB) - COLUBRIDAE



Pliocercus euryzonus (JB) - COLUBRIDAE

APPENDIX 3. Amphibians and Reptiles from Bilsa Biological Station, northwestern Ecuador. Photographers: J.S. Bermingham (JB), C.F. Aulestia-Obanda (CA), H. M. Ortega-Andrade (MO), E. Neuschulz (EN) and Christian Paucar (CP). **(CONTINUED)**



Pseustes shropshirei (JB) - COLUBRIDAE



Rhadinea cf. decorata (JB) - COLUBRIDAE



Sibon sp. (JB) - COLUBRIDAE



Sibon nebulata (JB) - COLUBRIDAE



Stenorrhina degenhardtii (JB) - COLUBRIDAE



Tantilla melanocephala (JB) - COLUBRIDAE

APPENDIX 3. Amphibians and Reptiles from Bilsa Biological Station, northwestern Ecuador. Photographers: J.S. Bermingham (JB), C.F. Aulestia-Obanda (CA), H. M. Ortega-Andrade (MO), E. Neuschulz (EN) and Christian Paucar (CP). **(CONTINUED)**



Urotheca cf. decipiens (JB) - COLUBRIDAE



Urotheca fulviceps (JB) - COLUBRIDAE



Micrurus ancoralis (JB) - ELAPIDAE



Micrurus dumerilii transandinus (CA) - ELAPIDAE



Micrurus mipartitus (JB) - ELAPIDAE



Trachyboa boulengeri (CP) - TROPIDOPHIIDAE

APPENDIX 3. Amphibians and Reptiles from Bilsa Biological Station, northwestern Ecuador. Photographers: J.S. Bermingham (JB), C.F. Aulestia-Obanda (CA), H. M. Ortega-Andrade (MO), E. Neuschulz (EN) and Christian Paucar (CP). **(CONTINUED)**



Trachyboa boulengeri (head) (CP) - TROPIDOPHIIDAE



Bothriechis schlegelii (JB) - VIPERIDAE



Bothriechis schlegelii (JB) - VIPERIDAE



Bothrops asper (JB) - VIPERIDAE



Lachesis acrochorda (JB) - VIPERIDAE



Lachesis acrochorda (juvenile) (JB) - VIPERIDAE