REPTILES & AMPHIBIANS

Herpetological Diversity in Forests of Portobelo National Park, Colón Biological Corridor, Panamá

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Abstract

Panama has 229 species of amphibians and 280 species of reptiles, of which 72 (31.4%) are threatened according to national legislation and 20 are endemic. The study area is of high ecological value and functions as a natural biological corridor; however, it has very few sites that have been studied. For two years we sampled the area, registering 55 species of amphibians and 58 reptiles, including species with local conservation categories, new records of distribution, and a new species for science that will be described in a later work.

Resumen

Panamá posee 229 especies de anfibios y 280 especies de reptiles, de las cuales 72 (31.4%) se encuentran amenazadas según la legislación nacional y 20 son endémicas. El área de estudio posee sitios muy poco estudiados, de alto valor ecológico y funciona como corredor biológico natural, al cabo de dos años muestreamos la zona logrando registrar 55 especies de anfibios y 58 de reptiles, incluyendo especies con categorías de conservación local, nuevos registros de distribución y una especie nueva para la ciencia que será descrita en un trabajo aparte.

The basins of the rivers Limoncito and Piedras and adjacent areas are located in the northeastern part of Panama and are part of the biological corridor located to the east of the Panamanian Caribbean slope. This territory includes little-known forested areas, which are home to populations of species of high ecological value, including the endemic and endangered Harlequin Frog (*Atelopus limosus*) (MiAmbiente 2016; IUCN SSC Amphibian Specialist Group 2019), as well as some species potentially new to science.

Within the study area is the Cerro Bruja massif, which reaches elevations above 900 m asl in several of its main peaks, from which several rivers of importance flow through Costa Arriba de Colón and feed the Panama Canal. These rivers include the Gatún, Boquerón, Cascajal, Guanche, and Piedras, the latter two flowing through the study area.

Herpetological research in Panama has increased in recent decades, leading to the listing of 229 species of amphibians (11 gymnophionans, 35 caudates, and 188 anurans) and 280 species of non-avian reptiles (Batista et al. 2020), of which 20 are endemic to Panama and 72 (31.4%) are threatened at the national level.

Herpetofauna, like other groups, face an alarming rate of species decline, caused mainly by the loss of habitat, illegal poaching and trafficking, climate change, and diseases such as chytridiomycosis, which affects amphibians primarily and has been implicated in declines of amphibian populations in Panama and globally (Blaustein et al. 1990; Lips et al. 1999; Young et al. 2001; Ibáñez et al. 2002; Young et al. 2004; Lips et al. 2006; Collins et al. 2009; Crawford et al. 2010). Also, as forests are destroyed for anthropogenic development and rivers and their tributaries are contaminated by livestock and chemicals used in agriculture, conservation concerns have increased dramatically (Fuentes 2013).

The study area is home to several vulnerable species listed by national and international entities. These include the Harlequin Frog (*Atelopus limosus*), a species endemic to

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Panama and critically endangered (CR) (MiAmbiente 2016; IUCN SSC Amphibian Specialist Group 2019), and the Caribbean Bushmaster (*Lachesis stenophrys*), listed as vulnerable (VU) on the MiAmbiente Red List (2016) and as near threatened on the IUCN Red List (Acosta Chaves et al. 2021).

Few biodiversity studies have been conducted in Portobelo National Park since its creation, except those focused on a private reserve in the Sierra Llorona. The most geographically proximate studies were those monitoring amphibians and reptiles in the vicinity of the Panama Canal and the Serrania de Piedras-Pacora and Alto Chagres areas (Ibáñez et al. 1994; Ibáñez et al. 1999; Myers et al. 2012; Sosa and Guerrel 2013). However, the sites where we conducted this biodiversity study are largely unexplored.

Methods

Study area. —The study area is located mainly in Portobelo National Park (a 359-km^2 area created in 1976) and part of Chagres National Park (a 1,290-km^2 area created in 1984). We focused specifically on montane ridges adjacent to the middle and upper basins of the Limoncito and Piedras Rivers, sources of the Brazuelo, Iguanita, and Aguas Calientes Rivers, middle basins of the Guanche River, and some tributaries of these rivers.

Much of the park is covered with lowland tropical broadleaf ombrophilous evergreen forest, with some patches of undisturbed lowland forest (ANAM 2010). Also present is a swampy tropical ombrophilous evergreen forest dominated by dicotyledons with some intervening mangrove forests. According to the life zone system of Holdridge et al. (1971), the park comprises a very humid premontane forest, a very humid tropical forest, and a small portion of the premontane pluvial forest.

The Piedras, Iguanita, and Guanche Rivers supply water to many communities that are located within the national parks. On the coast above Colón, these rivers are used for fishing, agriculture, and as a means of transporting people and goods, forming an essential part of the economy of these communities. According to the World Wildlife Fund (2014), the climate in the area is characteristic of the Caribbean Region and is influenced by migration from the intertropical convergence zone. The rainy season lasts from May to December and is longer on the Caribbean slope than on the Pacific versant.

We established a series of transects (Fig. 1) located in the mountains of the middle and upper basins of the Limoncito and Piedras rivers and their tributaries that included three important waterfalls (Salto del Mono, 75 m high, elevation 340 m asl; Salto del Tigre, 20 m high, elevation 190 m asl; Limoncito, 30 m high, elevation 320 m asl).

Transect descriptions. —**T1**: Forested areas on montane slopes at an elevation to 750 m asl until reaching the Piedras River, where ravines descend to 450 m asl; does not include cloud forest and is used by a few residents in areas between Limoncito and the beach camp**. T2**: Extends from the intersection with T1 at the Piedras River and runs along the southern side of the river on the south side, crossing the Zamia camp, until it reaches Salto del Tigre; the elevational range is 450 m asl at its highest point to 350 m asl at the Tigre Waterfall. **T3**: Starts at the mouth of a tributary on the northern side of the Piedras River at an elevation of 400 m asl, approximately 1 km from the beginning of T2 and ascends until it reaches the Folofa camp at an elevation of 720 m asl. **T4**: The only transect with cloud forest (Frío I and Frío II at elevations of 850 and 825 m asl, respectively), begins at the Folofa camp at 720 m asl and ends at Salto del Mono at 225 m asl. **T5**: Starts at Salto del Mono (225 m asl) and ends at Dos Bocas (50 m asl), passing through an emerald green pool at 166 m asl; this is the closest to the Caribbean coast. **T6**: This is the transect most disturbed by human activities since it, except for the streams, serves as an access route between Limoncito and the beach.

General search methods. —We surveyed transects by day and night, recording amphibians and reptiles by direct observation and anuran vocalization (Ibáñez 1999), removing rotten logs, rocks, and leaf litter to locate secretive species. Photographs of all individuals were used to confirm identification. We express the effort made during each survey in number of man-hours.

Species identification. —For identification, we used dichotomous keys (Savage 2002; Lotzkat 2014), field guides, and recordings of anuran calls (Ibáñez 1999; Savage 2005; Köhler 2008; Sonoteca del Dr. Abel Batista, unpublished). We considered distribution, habitat, and climatic conditions (Köhler 2008; Jaramillo et al. 2010; Köhler 2011; Leenders 2017, 2019; Ray 2017) and used nomenclature proposed by Frost (2021) and Uetz et al. (2021).

Specimen collection. —We collected only individuals of potentially new species or those representing new distributional records; all will be deposited in the Vertebrate Museum of the University of Panama, Harmodio Arias Madrid Central Campus, Panama City, or the herpetological collection of the Autonomous University of Chiriqui (UNACHI) in David, Panama. Collected specimens were sacrificed using a euthanasia solution T61, fixed in a solution of 5 ml of formalin (36%) in 1 of ethanol (94%), labeled, and stored in ethanol (70%).

Conservation status assessment. —We prepared a table (Table 1) listing the conservation status for each species. We used the IUCN Red List and the list of endangered species in MiAmbiente (2016).

Table 1. Species of amphibians and reptiles observed in transects (T1 to T6) of the study area, with their conservation categories assigned globally by the International Union for Conservation of Nature (IUCN) and locally by the Ministry of Environment of the Republic of Panama (Miambiente: MA); the latter only considers three categories under the same criteria as the IUCN (CR, EN, and VU). *New species to be described ** Represents species that require further review; in both cases, they do not have any type of category due to their condition (*, **).

AMPHIBIANS								
Species	T1	T2	T3	T4	T5	T6	IUCN	MA
Dermophis glandulosus Taylor 1955	X						LC	
Oscaecilia ochrocephala (Cope 1866)						X	LC	
Oedipina complex (Dunn 1924)		X					LC	
Oedipina parvipes (Peters 1879)				X			LC	
Bolitoglossa biseriata Tanner 1962	X						LC	
Bolitoglossa medemi Brame & Wake 1972	X			X			LC	VU
Bolitoglossa schizodactyla Brame & Wake 1966	X			X			LC	
Incilius coniferus (Cope 1862)		X				X	LC	
Rhaebo haematiticus (Cope 1862)	X	X	X	X		X	LC	
Rhinella alata (Thominot 1884)		X				X	LC	
Rhinella horribilis (Wiegmann 1833)	X					X	LC	
Andinobates fulguritus (Silverstone 1975)	X						LC	VU
Andinobates minutus (Shreve 1935)	X	X		X			LC	VU
Dendrobates auratus (Girard 1855)					X		LC	VU
Allobates talamancae (Cope 1875)		X	X				LC	
Silverstoneia flotator (Dunn 1931)	X	X	X			X	LC	
Colostethus aff. *pratti* (Boulenger 1899)		X	X				**	**
Colostethus panamansis (Dunn 1933)	X				X		LC	EN
Hyalinobatrachium tatayoi Castroviejo-Fisher, Ayarzagüena, & Vilà 2007		X			X		LC	
Hyalinobatrachium colymbiphyllum (Taylor 1949)	X	X			X	X	LC	
Sachatamia albomaculata (Taylor 1949)	X	X		X		X	LC	
Sachatamia ilex (Savage 1967)	X	X		X		X	LC	
Teratohyla pulverata (Peters 1873)	X	X				X	LC	
Teratohyla spinosa (Taylor 1949)	X	X	X			X	LC	
Cochranella euknemos (Savage & Starrett 1967)	X			X			LC	
Espadarana prosoblepon (Boettger 1892)	X					X	LC	
Craugastor crassidigitus (Taylor 1952)	X	X	X	X	X	X	LC	
Craugastor fitzingeri (Schmidt 1857)	X	X				X	LC	
Craugastor gollmeri (Peters 1863)	X					X	LC	
Craugastor opimus (Savage & Myers, 2002)	X						LC	
Craugastor aff. *polyptychus* (Cope 1885)	X		X	X			**	**
Craugastor talamancae (Dunn 1931)	X		X		X		LC	
Diasporus diastema (Cope 1875)	X				X		LC	
Diasporus quidditus (Lynch 2001)	X				X	X	LC	
Diasporus sp.1				X			*	*
Diasporus sp.2	X		X	X		X	**	**
Pristimantis caryophyllaceus (Barbour 1928)				X	X		LC	
Pristimantis cerasinus (Cope 1875)			X	X			LC	
Pristimantis cruentus (Peters 1873)		X	X	X		X	LC	
Pristimantis aff. cruentus (Peters 1873)				X			**	**

Pristimantis gaigei (Dunn 1931)	X						LC	
Pristimantis pardalis (Barbour 1928)	X	X		X			LC	
Pristimantis ridens (Cope 1866)	X			X		X	LC	
Pristimantis taeniatus (Boulenger 1912)	X					X	LC	
Agalychnis callidryas (Cope 1862)					X	X	LC	
Dendropsophus ebraccatus (Cope 1874)					X		LC	
Hyloscirtus colymba (Dunn 1931)	X						EN	CR
Hyloscirtus palmeri (Boulenger 1908)		X				X	LC	VU
Scinax boulengeri (Cope 1887)					X		LC	
Smilisca phaeota (Cope 1862)	X					X	LC	
Smilisca sila Duellman & Trueb 1966		X			X		LC	
Boana boans (Linnaeus 1758)	X	X					LC	
Boana rosenbergi (Boulenger 1898)						X	LC	
Leptodactylus savagei Heyer 2005					X		LC	
Engystomops pustulosus (Cope 1864)		X			X	X	LC	
REPTILES								
Species	**T1**	**T2**	**T3**	**T4**	**T5**	**T6**	**IUCN**	**MA**
Caiman crocodilus (Linnaeus 1758)					X		LC	
Rhinoclemmys annulata (Gray 1860)				X			LC	
Kinosternon leucostomum (Duméril, Bibron & Duméril 1851)					X		LC	
Diploglossus monotropis (Kuhl 1820)		X					LC	EN
Loxopholis southi (Ruthven & Gaige 1924)	X						LC	
Lepidoblepharis sanctaemartae (Ruthven 1916)	X						LC	
Lepidoblepharis xanthostigma (Noble 1916)	X	X					LC	
Sphaerodactylus homolepis (Cope 1886)					X		LC	
Sphaerodactylus aff. *lineolatus* Lichtenstein & Martens 1856					X		**	**
Thecadactylus rapicauda (Houttuyn 1782)	X	X	X			X	LC	
Iguana rhinolopha (Breuil 2020)					X		LC	
Corytophanes cristatus (Merrem 1820)	X	X	X				LC	
Basiliscus basiliscus (Linnaeus 1758)	X	X				X	LC	
Enyalioides heterolepis (Bocourt 1874)	X	X	X				LC	
Anolis capito Peters 1863				X			LC	
Anolis frenatus Cope 1899		X					LC	
Anolis humilis Peters 1863	X						LC	
Anolis lionotus Cope 1861	X				X	X	LC	
Anolis poecilopus Cope 1862		X					LC	
Anolis vittigerus Cope 1862	X					X	LC	
Marisora unimarginata (Cope 1862)					X		LC	
Ameiva praesignis (Baird & Girard 1852)	X	X			X	X	LC	
Holcosus festivus (Lichtenstein & Martens 1856)	X	X				X	LC	
Holcosus leptophrys (Cope 1893)	X	X			X	X	LC	
Lepidophyma flavimaculatum Duméril 1851					X		LC	
Boa imperator Daudin 1803					X		LC	
Corallus annulatus (Cope 1875)	X					X	LC	VU
Epicrates maurus Gray 1849					X		LC	VU
Chironius grandisquamis (Peters 1869)	X					X	LC	

Coniophanes bipunctatus (Günther 1858)	X						LC	
Dipsas articulata (Cope 1868)	X						LC	
Dipsas aparatiritos sp. nov. (Ray et al. 2023)				X			LC	
Dendrophidion nuchale (Peters 1863)	X						LC	
Dendrophidion apharocybe Cadle 2012				X			LC	
Enuliophis sclateri (Boulenger 1894)					X		LC	
Geophis aff. brachycephalus (Cope 1871)				X			**	**
Hydromorphus concolor Peters 1859	X						LC	EN
Imantodes cenchoa (Linnaeus 1758)	X	X	X	X	X	X	LC	
Imantodes inornatus (Boulenger 1896)	X				X		LC	
Leptodeira sp.	X	X			X	X	**	**
Leptophis occidentalis (Gunther 1859)	X					X	LC	
Leptophis depressirostris (Cope 1861)						X	LC	
Oxybelis brevirostris (Cope 1861)	X	X				X	LC	
Pliocercus euryzonus Cope 1862	X	X				X	LC	
Phrynonax poecilonotus (Günther 1858)						X	LC	
Rhadinaea decorata (Günther 1858)					X		LC	
Tantilla supracincta (Peters 1863)					X		LC	
Sibon irmelindicaprioae sp. nov. (Arteaga & Batista 2023)				X			LC	VU
Sibon argus (Cope 1875)	X						LC	
Sibon nebulatus (Linnaeus 1758)	X						LC	
Bothriechis schlegelii (Berthold 1846)				X			LC	
Bothrops asper (Garman 1883)		X				X	LC	
Lachesis stenophrys Cope 1875			X	X	X		LC	VU
Porthidium nasutum (Bocourt 1868)	X						LC	
Micrurus alleni Schmidt 1936	X						LC	EN
Micrurus clarki Schmidt 1936	X	X	X				LC	EN
Micrurus multifasciatus Jan 1858	X			X			LC	

Data analysis. —We analyzed the similarity between transects using the Jaccard index, which uses the overlap in species present in the data groups to quantify the coexistence of species and shows which groups are more similar to each other (Chung et al. 2019). For this, we used the PRIMER-e v7 program (Clarke and Gorley 2015), in which the data matrix was transformed into binary data. After the Jaccard index, we generated a dendrogram using the average clustering method and a SIMPROF test with 5% significance, 10,000 permutations, and 10,000 simulations.

In addition, we conducted a principal component analysis based on the Hellinger transformation due to a large number of zeros present in the database (presence/absence of species) to visualize the grouping of transects according to the composition and richness of species. For this, we used the RDA files function in the Vegan package (Oksanen et al. 2020) of the R platform (RStudio Team 2020). For the analysis of species richness, we employed the iNext package (Hsieh et al. 2020), with which a rarefaction/extrapolation curve was generated based on the number of species and the number of samples with the following parameters: replicates per Bootstrap 10,000, the maximum sample size to calculate extrapolation 50, and confidence interval 95%. For this analysis, we used only the data of the species observed within the transects (n = 102). The efficiency of the sampling design in detecting species was evaluated by employing the sample coverage estimator (Chao and Jost 2012).

Results

We conducted survey sampling over two years starting in October 2019 and ending in October 2021. We carried out nine field trips using permanent camps with infrastructure (Limoncito and Playita) and temporary camps (Zamia, Salto del Tigre, Folofa, Salamandra, Frío I, Frío II, Verde Esmeralda). An average of four people per survey invested a total of 1,335 man-hours.

We recorded a total of 113 species, 55 amphibians (Anura 24 genera, 48 species; Caudata 2 genera, 5 species;

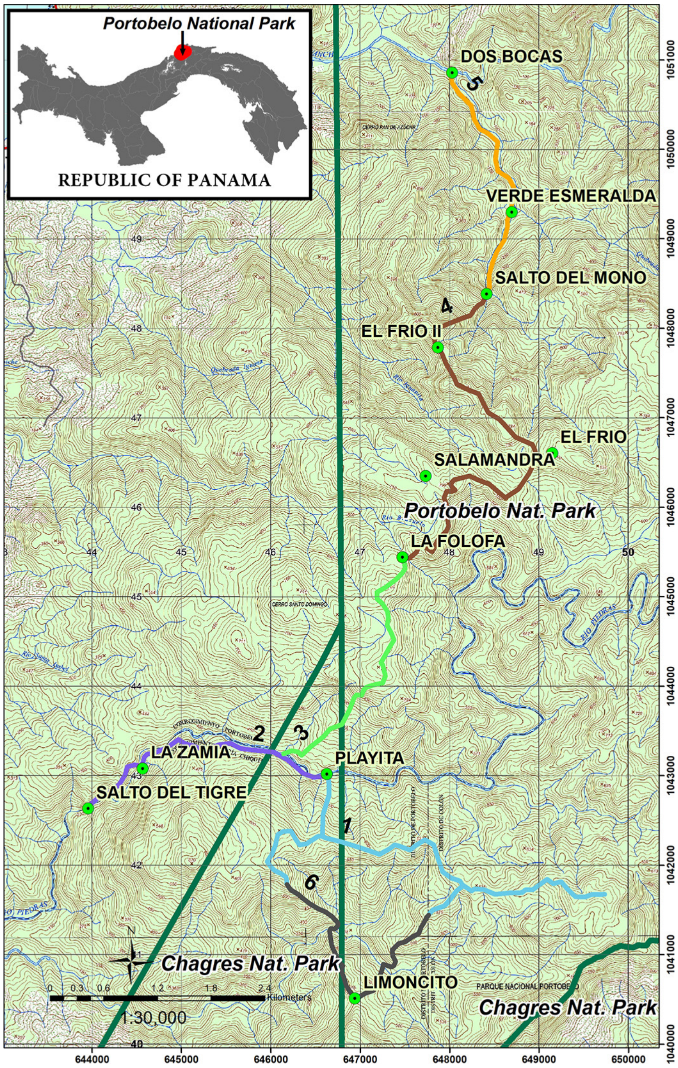

Fig. 1. Map of the study area. Transects and camps. Transect 1 (light blue), 2 (purple), 3 (lime green), 4 (brown), 5 (mustard), and 6 (olive gray). The green circles represent the camps used, and dark green lines indicate the boundaries of Chagres and Portobelo National Parks.

Gymnophiona 2 genera, 2 species) and 58 reptiles (Crocodilia 1 genus, 1 species; Squamata: Gekkota 4 genera, 6 species; Iguania 11 genera, 18 species; Serpentes 24 genera, 32 species; Testudines 2 genera, 2 species) (Table 1). MA only considers the categories EN, VU, CR, based on the IUCN criteria, but at a local level (Republic of Panama).

Conservation status of species. — At a global level, based on the red list published by the International Union for Conservation of Nature (IUCN), an anuran with the DD category, an anuran and a snake in the NT category, and the frog *Hyloscirtus colymba* categorized as EN, with 6 species. already described that are not listed with any category.

At the local level, based on the red list published by the Ministry of the Environment of the Republic of Panama (MA), we registered in the case of amphibians 5 VU, 1 EN and 1 CR, which represent 12.7% of amphibian species and reptiles 4 VU and 4 EN, representing 13.8% of all reported species (Table 1)

Statistical analysis (Jaccard index).—Transects T1 and T6 were most similar with an index of similarity (IS) of 41.33, followed by T2 and T6 at 39.65, resulting in these three transects being treated as a single group distinct from the group formed by T3 and T4 with an IS of 21.62; however, the IS of 24.44 between T2 and T3 excludes T5, which has an IS of only 15 with all of the other transects (Figs. 1–2; Table 2). Similarly, the tb-PCA ordination graph (Fig. 3) shows similar groupings, with T1 and T6 being the most similar and T5 being the most different from the rest of the transects.

The rarefaction/extrapolation curve (Fig. 4) showed that doubling the sampling effort to 20 surveys could approach an asymptote of 133 ± 13 species (an increase of 30% over the results of our study). Likewise, the sampling coverage curve (Fig. 5) indicated that we recorded 84.8% ± 4.3% of possible species, suggesting that, although considerable progress has been made, extending the sampling effort is both possible and necessary.

Table 2. Jaccard indices show the similarity between the worked transects based on the number of species observed in each (see also text).

Transects	T1	T2	T3	T4	T5	T6
T1						
T2	30.38					
T3	17.39	24.44				
T4	17.95	13.56	21.62			
T5	13.95	14.06	8.51	6.90		
T6	41.33	39.65	15.69	12.90	15.15	

Discussion

The Portobelo National Park, known mostly for its cultural importance, supports extensive biodiversity and its forests, together with Chagres National Park and surrounding areas, serve as a natural biological corridor facilitating the movement of species. The extensive range in elevations (0–900 m asl) and the variety of forest cover provide suitable habitats for various species.

The area's rich herpetofaunal biodiversity represents 22.2% of that reported in the country, 24.0% of amphibians, and 20.8% of reptiles; nevertheless, our analyses suggest that more species will be discovered with a greater sampling effort involving additional transects (Fig. 6). Our current work included cloud forest at only two small areas along transect 4 (El Frío I and II; Fig. 1); however, with additional transects focusing on cloud forest, we anticipate finding species

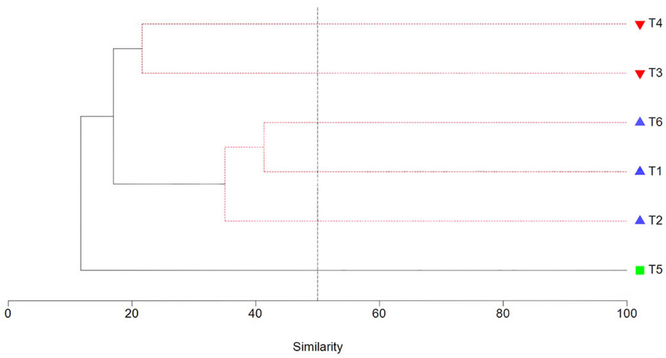

Fig. 2. Dendrogram that describes the similarity between transects based on the presence and absence of species, grouping them into two large groups, the first (blue triangles) covering three transects (T1, T2, and T6), the second (inverted red triangles) with the transects (T3 and T4) and an isolated group (green square) that shares less than 20 species with the other groups.

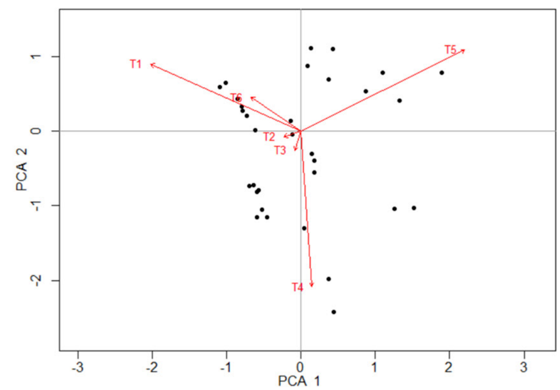

Fig. 3. Principal Component Analysis with data transformed using the Hellinger distance (tb-PCA) showing that according to species composition and richness, transects 1 and 6 are the most similar, and T5 is the more different transect.

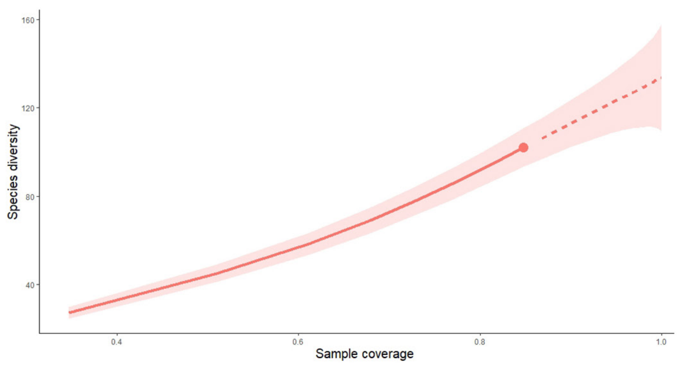

Fig. 4. Rarefaction/extrapolation curve based on species richness and sampling periods. Showing the projected species richness over an extended period of samplings.

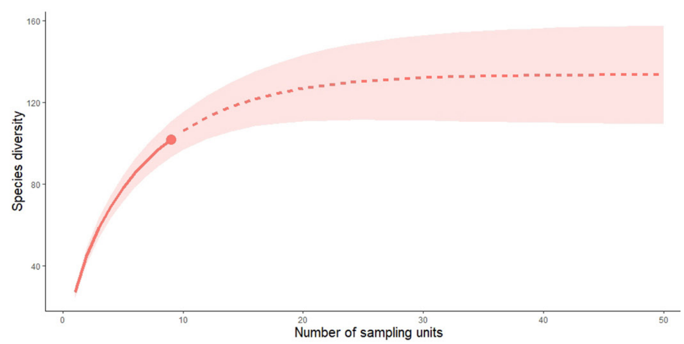

Fig. 5. The sampling coverage curve shows the sampling efficiency by estimating how much of the site's diversity has been recorded by our surveys—indicating that expanding the sampling periods and areas is necessary because of the probability of finding additional species.

Fig. 6. The map of the study area shows the transects used in this study (1–6) and those proposed for the next stage (1–7).

associated with this habitat that we failed to encounter in the current study.

We did find some species identified by the Red List of species of Panama (MiAmbiente 2016) according to conservation categories, such as *Bolitoglossa medemi* (Fig. 7), the poison dart frogs *Andinobates minutus*, *Andinobates fulguritus* (Fig. 8) and *Dendrobates auratus*, which are are in a vulnerable state (VU), and the frogs *Hyloscirtus colymba* and *H. palmeri* (Fig. 9), which are in critical danger (CR) and vulnerable (VU), respectively. Among reptiles, the diploglosid *Diploglossus monotropis* (Fig. 10), the water snake *Hydromorphus concolor* (Fig. 11), and the coral snakes *Micrurus clarki* and *M. alleni* (Fig. 12) are endangered (EN). Of those mentioned in this section, *H. colymba* has a category, EN, the rest are LC according to the IUCN Red List, none are included in CITES appendices (Table 1).

Using a dendrogram (Fig. 2), we describe the similarity between transects based on the presence and absence of species, grouping them into two large groups, the first, represented with blue triangles, which cover three transects (T1, T2, and T6), sharing 35 species among themselves, the second, inverted red triangles, groups the transects (T3 and T4), sharing around 22 species among themselves and, lastly, an isolated group, green square, that shares less than 20 spe-

Fig. 7. Some amphibians of Portobelo National Park, Colón Biological Corridor, Panama: *Dermophis glandulosus* (A), *Bolitoglossa medemi* (B), *B. schizodactyla* (C), *Oedipina parvipes* (D), *Rhaebo haematiticus* (E), *Incilius coniferus* (F), *Cochranella euknemos* (G), *Sachatamia ilex* (H). Photographs by Rogemif Fuentes (A, B, C, F); Jesse Aschcroft (E); Erick Barría (D, G, H).

Fig. 8. Some amphibians of Portobelo National Park, Colón Biological Corridor, Panama: *Craugastor* aff. *polyptychus* (A) *C. talamancae* (B) *C. opimus* (C) *Pristimantis cruentus* (D) *Andinobates fulguritus* (E) *Andinobates minutus* (F) *Allobates talamancae* (G) *Colostethus* aff. *pratti* (H). Photographs by Jesse Aschcroft (A, B, E, F); Erick Barría (C, D); Rogemif Fuentes (G, H)

Fig. 9. Some amphibians of Portobelo National Park, Colón Biological Corridor, Panama: *Diasporus diastema* (A) *Diasporus quidditus* (B) *Diasporus sp.1* (C) *Diasporus sp.2* (D) *Agalychnis callidryas* (E) *Boana boans* (F) *Hyloscirtus colymba* (G) *H. palmeri* (H). Photographs by Erick Barría (A, B, C, D); Rogemif Fuentes (E, G, H); Jesse Aschcroft (F)

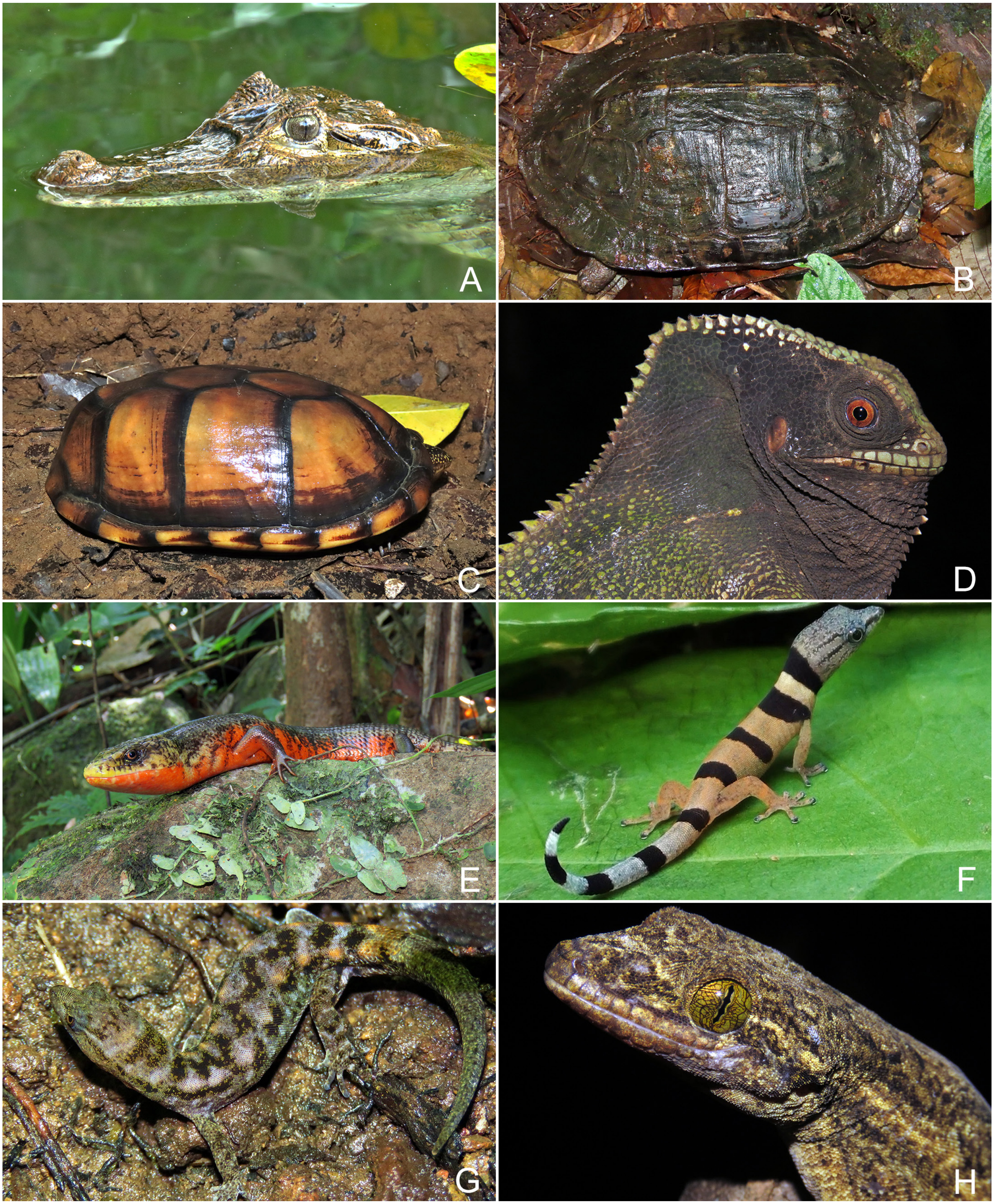

Fig. 10. Some reptiles of Portobelo National Park, Colón Biological Corridor, Panama: *Caiman crocodilus* (A) *Rhinoclemmys annulata* (B) *Kinosternon leucostomum* (C) *Corytophanes cristatus* (D) *Diploglossus monotropis* (E) *Sphaerodactylus lineolatus* (F) *Lepidoblepharis xanthostigma* (G) *Thecadactylus rapicauda* (H). Photographs by Jesse Aschcroft (A, B, C, F); Rogemif Fuentes (D, E, H); Erick Barría (G)

Fig. 11. Some reptiles of Portobelo National Park, Colón Biological Corridor, Panama: *Boa imperator* (A) *Corallus annulatus* (B) *Dendrophidion nuchale* (C) *D. apharocybe* (D) *Geophis* aff. *brachycephalus* (E) *Hydromorphus concolor* (F) *Dipsas aparatiritos* (G) *Imantodes inornatus* (H). Photographs by Rogemif Fuentes (A, B, C, D); Jesse Aschcroft (E, F); Erick Barría (G, H)

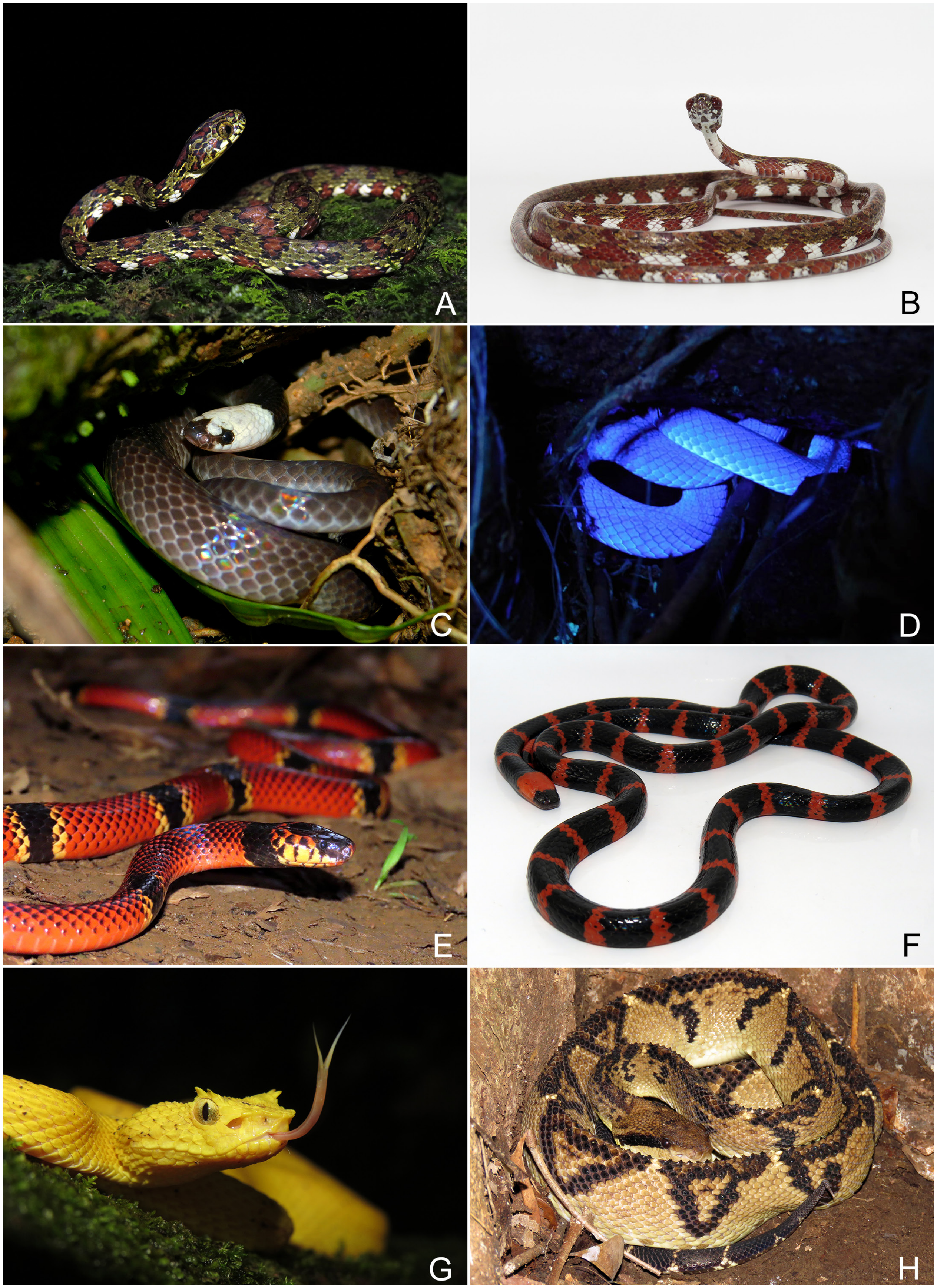

Fig. 12. Some amphibians of Portobelo National Park, Colón Biological Corridor, Panama: *Sibon argus* (A) *S. irmelindicaprioae* (B) *Enuliophis sclateri* (C) *Enuliophis sclateri* under ultraviolet light (D) *Micrurus clarki* (E) *M. multifasciatus* (F) *Bothriechis schlegelii* (G) *Lachesis stenophrys* (H). Photographs by Rogemif Fuentes (C, F, H); Jesse Aschcroft (D, E, G); Erick Barría (A, B)

cies with the other groups. The similarities and differences reflect the locations' topographic characteristics, proximity to one another and the rivers in the area, elevations, and differences in habitats of the transects. For example, T5, which has the lowest similarity index with other transects, includes the lower middle basin of the Guanche River, is closest to the Caribbean coast, and is at the lowest elevation (120 m asl) of any transect.

More sampling effort is needed (Figs. 3 and 4) to estimate the relative biodiversity and health of the populations. We propose to expand this study, for which we suggest the following transects: T7, T11 starting from transect 4 along the montane slopes toward Cerro Brujo, which would include extensive areas of cloud forest; T9 and T10, which would consist of parts of the Sierra Llorona slopes in the southeastern portion of the upper-middle basin of the Piedras River; and T8 which would include the connection between both ridges and cross the Piedras River. (Fig.4).

Despite the need for more studies, here we report for the first time in Portobelo National Park the presence of *Dermophis glandulosus* (39.68 km NW of the closest previous record) (Medina et al. 2011), *Bolitoglossa medemi* (75.35 km NW of closest previous record in Nusagandí, Guna Yala region) (Batista et al. 2014), and a new species of *Diasporus sp.* (designated here as *Diasporus sp.1*), which will be described elsewhere. We also found an individual of *R. annulata* with malformations in a limb previously published in conjunction with another individual found in the Altos de Campana National Park (Fuentes et al. 2021). We report the recently described *Dipsas aparatiritos* sp.nov. (Ray et al., 2023) and *Sibon irmelindicaprioae* sp. nov. (Arteaga and Batista, 2023) and *Enuliophis sclateri*, a snake that fluoresces under ultraviolet light (Fuentes et al. 2021).

Construction projects in the area are likely to have a detrimental impact on the environment, isolating ecosystems that are part of biological corridors, as is the case of a proposed road that connects the towns of Quebrada Ancha and María Chiquita in the Colón region, crossing an area of forest considered a protected reserve in Chagres National Park. Although it does not directly impact the study area, this construction would be a barrier for wildlife, divide the forest, and increase the human presence in the area. Such projects should consider the herpetofaunal communities that inhabit these areas, as habitat destruction will likely drive population declines.

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