A Survey of the Reptiles and Amphibians at the University of Georgia Costa Rica Field Station in San Luis de Monteverde, Costa Rica

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A survey of the reptiles and amphibians at the University of Georgia Costa Rica field station in San Luis de Monteverde, Costa Rica

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Abstract
Reptiles and amphibians are experiencing declines across the globe. In Monteverde, Costa Rica, these declines and their underlying causes have been relatively well studied since the early 1990s, and many protected areas have been set aside to conserve these species. However, thorough surveys of the herpetofaunal diversity in these areas have been scarce over the last 20 years. We conducted a survey of all reptile and amphibian species at the University of Georgia Costa Rica (UGACR), a field station in San Luis de Monteverde. Herein, we present an annotated checklist of the 48 species (35 reptiles and 13 amphibians) that we encountered. While we did not find any exceptionally rare or endangered species, the number of species we encountered is disproportionately high given the small plot of land occupied by UGACR. This underscores the importance of conducting regular diversity surveys in biodiversity hotspots as a means to better inform conservation efforts.

Keywords
Biodiversity, frogs, herpetofauna, lizards, salamanders, snakes

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Introduction

Over the past several decades, documenting the diversity and abundance of amphibians and reptiles has become a pressing matter for conservation (Stuart et al. 2004; Mendelson III et al. 2006; Whitfield et al. 2007). Since the First World Congress of Herpetology in 1989, scientists have become increasingly concerned about what has come to be known as the "worldwide amphibian decline problem" (Stuart et al. 2004), and although it has received less attention, reptiles are declining globally in a similar fashion (Whitfield Gibbons et al. 2000; Whitfield et al. 2007). As with most animal groups, reptiles and amphibians are susceptible to human-induced activities such as deforestation and habitat alteration, but herpetofaunal species are disappearing at much faster rates than would be predicted if these were the only variables at play (Stuart et al. 2004; Whitfield et al. 2007). Such endangerment and/or extinctions often occur in areas that have appeared to remain relatively unaltered over the years, where groups like birds have continued to thrive (Pounds et al. 1997). One likely culprit is disease; the pathogenic chytrid fungus *Batrachochytrium dendrobatidis* Longcore et al., which causes the disease chytridiomycosis, has caused mass mortality in frogs across the globe (Berger et al. 1998). Moreover, the fungi *Ophidiomyces ophiodiicola* (Sigler et al.) and *Batrachochytrium salamandrivorans* Martel et al. have begun wreaking havoc on snakes (Lorch et al. 2016) and salamanders (Martel et al. 2014), respectively. When coupled with the effects of an increasingly warming climate, once-immune ecosystems may soon have the optimal conditions for such fungi to thrive, promoting more outbreaks (Carey and Alexander 2003; Lips et al. 2003; Pounds et al. 2006). Now more than ever, it is critically important to document reptile and amphibian diversity so that we can understand how much biodiversity we still have left and where our conservation efforts should be focused.

The Monteverde region of Costa Rica was one of the first areas implicated with amphibian declines. Around 1987, there was a huge population crash of the Golden Toad *Incilius periglenes* (Savage, 1967) and the Harlequin Frog *Atelopus varius* (Lichtenstein & Martens, 1856) in the Monteverde Cloud Forest Reserve, after which these species were not found again (Pounds and Crump 1994). Following intensive surveys of the area between 1990 and 1994, it was found that approximately 40% of the frog species had disappeared (Pounds et al. 1997). While other reptile and amphibian groups were not studied as intensively in Monteverde, data from La Selva Biological Station, a lowland site only about 90 km away, indicated that densities of leaf litter reptiles and amphibians have declined by approximately 75% since 1970 (Whitfield et al. 2007). Clearly, the threat to herpetofaunal biodiversity in Monteverde and the surrounding areas is enormous, and, at least for frogs, well-documented. The high number of preserves and protected areas in Monteverde is an excellent step in the conservation of these species; however, documentation of which species currently inhabit the region remains scarce.

In Monteverde, there are three major protected areas: the Monteverde Cloud Forest Reserve, the Santa Elena Reserve, and the Children's Eternal Rainforest. In addition, there are several smaller protected areas, including the Curi-Cancha Reserve, the Aguti Reserve, and Selvatura Park, as well as a network of private reserves. We conducted an intensive survey for reptiles and amphibians at one such private reserve, a field station formerly known as the University of Georgia Costa Rica (UGACR). In this paper, we present an annotated checklist of the 48 species (35 reptiles and 13 amphibians) that we encountered during our survey.

Methods

Study site. The UGACR property (center point at 10.2827°N, 084.7985°W) is about 1100 m above sea level on the Pacific slope of the Tilarán Mountain Range and shares boundaries with both the Monteverde Cloud Forest Reserve and the Children's Eternal Rainforest, making it an excellent location to document herpetofaunal biodiversity. The property is comprised of roughly 63 ha of land, including 50 ha of secondary forest, 9 ha of farmland, 3.8 ha of manicured lawns and campus buildings, an area bisected by a river, and a large botanical garden (Fig. 1). Originally purchased in 2001 as an

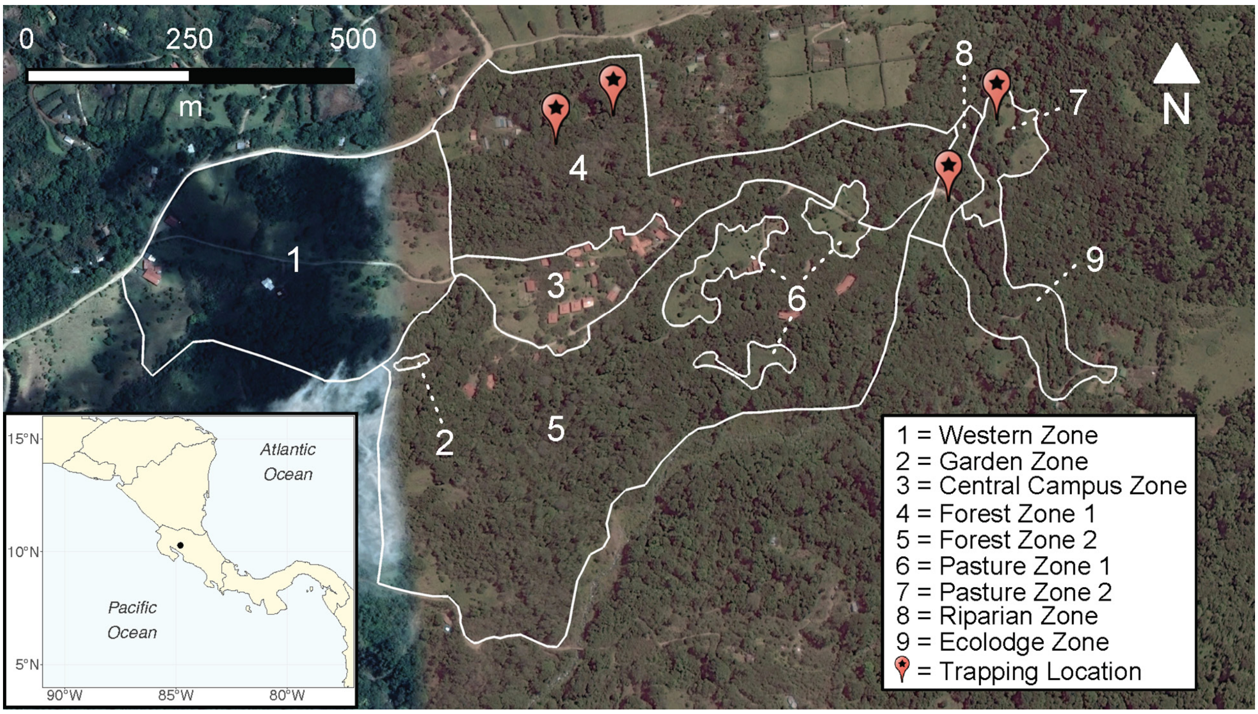

Figure 1. Map of survey area and zone designations at the University of Georgia Costa Rica field station. Figure created using Google Earth Pro (map data: CNES / Airbus, Maxar Technologies) and R v. 4.0.0 (R Core Team 2020).

international satellite campus for the University of Georgia, UGACR hosted study abroad students, ecotourists, naturalists, and researchers from around the world. As an aside, the property was sold to the Council on International Educational Exchange (CIEE) in 2019 and therefore no longer exists under the name UGACR; however, the research presented in this paper was conducted before CIEE's purchase of the land, so we will refer to the site as UGACR here. We conducted our herpetofaunal survey from 4 January 2018 to 18 September 2018, but survey effort varied considerably across that timespan, with the most intensive surveying occurring in the first five months. All research was conducted under research permit number M-P-SINAC-PNI-ACAT-019-2018 from the Ministerio de Ambiente y Energia in Costa Rica. We were not permitted to collect voucher specimens, so we primarily relied on photographs for documentation (all of which are available from JDC upon request). Our surveying approach was multifaceted, leveraging traditional sampling methods as well as citizen science and chance encounters to maximize the number of animals encountered. While exact geographic coordinates were recorded for every observation, we have designated different "zones" on the property (Fig. 1) for ease of reference in the following sections and tables. These zones include: the Western Zone, the area on either side of the road leading from UGACR's central campus to San Luis proper; the Garden Zone, the area of the botanical/medicinal garden; the Central Campus Zone, where all the classrooms, dining halls, offices, and manicured lawns are located; Forest Zone 1, the forested area north of the Central Campus Zone; Forest Zone 2, the forested area south of the Central Campus Zone; Pasture Zone 1, the areas of open pasture often occupied by farm animals; Pasture Zone 2, the areas of open pasture past Rio Alondra rarely occupied by farm animals; the Riparian Zone, the upriver and downriver areas of Rio Alondra on either side of the eastern road; and the Ecolodge Zone, the road and surrounding forest leading up to Finca Ecológica San Luis.

Trapping methods. We relied on three commonly-used types of traps for catching reptiles and amphibians: drift fences with pitfall traps and funnel traps (Farallo et al. 2010; Greenberg et al. 1994), coverboards (Grant et al. 1992), and frog tubes (Boughton et al. 2000). Trap sites contained one large drift fence array, five coverboards, and five frog tubes. Two sites (one in the forest interior and one in the forest edge) were located in Forest Zone 1, one site was located in the Riparian Zone, and one site was located in Pasture Zone 2. Traps were open from 20 March 2018 to 20 September 2018, and all traps were checked every 1–2 days. Any reptile or amphibian caught was removed from the trap, identified, photographed, and released <10 m from where it was captured. Most individuals were released immediately, but those that were too difficult to identify in the field were briefly taken back to the lab, identified, and then returned to the area from which they were captured. All animals were minimally handled to reduce stress, and none were kept in the lab for more than a few hours.

Our drift fence arrays consisted of two thin sheets of aluminum flashing (each 2.45 m long and 0.61 m high) that were arranged in a straight line and zip-tied upright to wooden stakes planted in the ground. In between the two fences, we placed a funnel trap, and on each extreme end of the line of fences, we buried a five-gallon bucket (the pitfall traps). Our custom-built funnel trap was essentially a 1 m × 0.4 m × 0.42 m wooden box with an openable screen lid on the top and a circular hole (7.5 cm in diameter) cut out of one side to serve as a funnel. Attached to the hole on the interior of the trap was a short cylindrical tunnel made of plastic and metal screening and tilted upward at an approximately 30° angle, allowing animals to enter the trap but making it difficult to exit. Drift fence arrays are effective when placed in areas where animals move from one location to another; because the smooth metal fencing cannot easily be climbed, drift fences encourage animals to try to move through the gap in between the fences or to navigate around the outside of them. In the gap, we bent the edge of the fences toward the small opening in the funnel trap to guide animals into it. We positioned the buckets so that animals trying to go around the fence would fall in and not be able to climb out. In both funnel and pitfall traps, we placed leaf litter and a moist sponge to provide cover and prevent desiccation, and we drilled small holes in the bottom of each trap to keep them from filling with rainwater.

Coverboards and frog tubes serve as artificial refuges for animals. In our study, coverboards consisted of pieces of 1 m × 0.82 m sheet metal that were placed on the ground. These objects not only provide cover but may also provide ideal temperature and moisture conditions for certain reptiles and amphibians (Halliday and Blouin-Demers 2015). We haphazardly placed these coverboards within each trapping site (accounting for the limits imposed by the landscape), but we attempted to vary the amount of shadiness and leaf litter each was subjected to, and we made sure the substrate under each allowed it to lay flat against the ground. Frog tubes were made of PVC pipe (31 cm long, 6 cm diameter) with a cap on one end, which were strapped to trees and oriented vertically with the opening facing upward. Frog tubes were also placed haphazardly within trapping sites, but we varied their height from the ground (1.25–2 m) and the size and species of the tree to which they were attached. Both coverboards and frog tubes were checked by simply looking under/in them to see if an animal was using them as refuge.

Encounter surveys and chance encounters. While the aforementioned trapping methods can prove effective for many terrestrial species, there are many species that simply cannot be sampled in this way. Notably, arboreal snakes and lizards may not come down to drift fences or use artificial refuges, and particularly large snakes and frogs may be able to simply climb or jump out of pitfall traps. As such, we routinely conducted visual and aural encounter surveys in which we searched for reptiles and amphibians by sight and by sound (calling frogs), respectively. We searched for animals in all habitats throughout the property of UGACR, looking in trees, in the leaf litter, around ponds, in sunny basking spots, and under natural cover objects like rocks and logs. We conducted these surveys at all times of day and frequently at night. In addition, we documented all "chance encounters" that occurred. These were observations of reptiles and amphibians that happened while not explicitly surveying for them. Given that the authors of this paper were all involved in the Resident Naturalist program at UGACR (see Citizen Science section below) and active researchers on various projects in the field, chance encounters of reptiles and amphibians were a near-daily occurrence.

Citizen science. As a field station located in the biodiversity hotspot that is Monteverde, Costa Rica, UGACR attracted ecotourists and study-abroad students from as far as Europe and as close as San José. In turn, UGACR had a thriving Resident Naturalist program, in which interns with a bachelor's degree or higher would live on the campus and lead natural history-oriented workshops, lectures, activities, and hikes for all visitors. Coupled with the fact that UGACR saw a very high number of visitors during the time period in which our herpetofaunal survey took place, this meant that at any given time, it was likely that there was a large number of people exploring the property with the explicit goal of observing nature. We leveraged this unique opportunity by inviting fellow resident naturalists and guests to submit observations of reptiles and amphibians while they stayed on campus. To ensure the accuracy of identifications, we asked these citizen scientists to provide photographs, details, and geographic coordinates of all observations that they submitted. Identifications were only confirmed if the photo evidence was unambiguous. Citizen scientists were not asked nor encouraged to touch or harass the wildlife in any way.

Identification. All reptiles and amphibians encountered during the survey were identified using the field marks presented in the publications of Hayes et al. (1989), Savage (2002), Savage and Bolaños (2009), and Leenders (2016). The latter field guide by Leenders is by far the most up-to-date of these publications, but it only includes amphibians. Luckily, Leenders (2019) recently published a companion field guide for reptiles, and although we were unable to use this guide during the survey period, we were able to use it to later confirm our reptile species, for which we had photographs of nearly all observations.

Results

During our herpetofaunal survey of UGACR, we documented a total of 48 species (Tables 1–3). This included 13 amphibian species from seven families: Plethodontidae (1 species), Bufonidae (1 species), Craugastoridae (3 species), Eleutherodactylidae (1 species), Hylidae (4

Table 1. List of all amphibian species documented during the survey period, as well as the specific areas in which they were found and the number of times they were encountered. See Figure 1 for zone locations. A dagger symbol (†) denotes an unconfirmed species.

	Survey Zone									
Taxa	Western	Garden	Central Campus	Forest 1	Forest 2	Pasture 1	Pasture 2	Riparian	Ecolodge	Total encounter frequency
SALAMANDERS										
Plethodontidae										
Oedipina uniformis			X	X						2
FROGS										
Bufonidae										
Rhinella horribilis	X	X	X	X		X	X	X	X	90
Craugastoridae										
Craugastor fitzingeri				X			X	X		7
Craugastor stejnegerianus		X	X	X	X		X	X		65
Craugastor underwoodi				X						3
Eleutherodactylidae										
Diasporus diastema †				X	X					24
Hylidae										
Dendropsophus microcephalus		X			X			X		4
Duellmanohyla rufioculis								X		4
Isthmohyla pseudopuma								X		1
Smilisca sordida	X			X						5
Ranidae										
Rana forreri		X	X			X		X	X	127
Rana warszewitschii		X			X	X		X		13
Strabomantidae										
Pristimantis ridens		X		X	X		X			29

Table 2. List of all lizard species documented during the survey period, as well as the specific areas in which they were found and the number of times they were encountered. See Figure 1 for zone locations. A dagger symbol (†) denotes an unconfirmed species.

	Survey Zone									
Taxa	**Western**	**Garden**	**Central Campus**	**Forest 1**	**Forest 2**	**Pasture 1**	**Pasture 2**	**Riparian**	**Ecolodge**	**Total Encounter Frequency**
LIZARDS										
Corytophanidae										
Basiliscus basiliscus †								X		1
Dactyloidae										
Anolis biporcatus		X	X	X	X					17
Anolis capito									X	1
Anolis cupreus	X	X	X	X		X	X	X		11
Anolis humilis				X	X		X		X	34
Anolis laeviventris			X	X	X					6
Anolis oxylophus	X							X		36
Eublepharidae										
Coleonyx mitratus				X						3
Gekkonidae										
Hemidactylus frenatus			X							41
Gymnophthalmidae										
Anadia ocellata	X		X					X		3
Phrynosomatidae										
Sceloporus malachiticus	X		X	X	X	X	X			37
Scincidae										
Scincella cherriei			X	X		X	X	X		9

Table 3. List of all snake species documented during the survey period, as well as the specific areas in which they were found and the number of times they were encountered. See Figure 1 for zone locations. A dagger symbol (†) denotes an unconfirmed species.

	Survey Zone									
Taxa	**Western**	**Garden**	**Central Campus**	**Forest 1**	**Forest 2**	**Pasture 1**	**Pasture 2**	**Riparian**	**Ecolodge**	**Total Encounter Frequency**
SNAKES										
Boidae										
Boa imperator				X	X			X		6
Colubridae										
Chironius exoletus †					X					1
Dendrophidion percarinatum			X		X					2
Drymobius margaritiferus		X					X			2
Lampropeltis micropholis				X						2
Masticophis mentovarius						X				1
Mastigodryas melanolomus			X	X	X		X			11
Oxybelis fulgidus		X	X	X	X					7
Phrynonax poecilonotus				X						1
Senticolis triaspis			X	X	X					11
Spilotes pullatus			X	X	X				X	10
Tantilla armillata †	X									1
Dipsadidae										
Erythrolamprus bizona	X									1
Geophis hoffmanni					X					1
Imantodes gemmistratus				X		X				2
Leptodeira septentrionalis									X	1
Ninia maculata	X		X							3
Rhadinella serperaster								X		1
Trimetopon pliolepis			X							1
Elapidae										
Micrurus nigrocinctus			X	X	X	X			X	6
Viperidae										
Bothriechis lateralis					X					1
Bothriechis schlegelii			X	X	X					12
Bothrops asper					X					2

species), Ranidae (2 species), and Strabomantidae (1 species) (Table 1). This also included 35 reptile species from 12 families: Corytophanidae (1 species), Dactyloidae (6 species), Eublepharidae (1 species), Gekkonidae (1 species), Gymnophthalmidae (1 species), Phrynosomatidae (1 species), Scincidae (1 species), Boidae (1 species), Colubridae (11 species), Dipsadidae (7 species), Elapidae (1 species), and Viperidae (3 species) (Tables 2, 3). We recorded a total of 659 individuals, but we note that this number (and those in the subsequent Materials examined sections) may be inflated due to multiple observations of the same individual(s), which we had no way of marking after each observation. It is also worth noting that zones were surveyed with highly unequal frequencies; observations in the Western Zone and Ecolodge Zone came strictly from chance encounters and citizen science, while all other zones were actively surveyed by the authors on a near-daily basis.

Annotated list. Here, we present an annotated list for all 48 species we encountered at UGACR. Taxonomy and nomenclature follow the most recent field guides by Leenders (2016; 2019), although we recognize that the elevation of former Colubridae subfamilies to family level is particularly controversial (Zaher et al. 2019). With the exception of a few members of the frog genus *Craugastor* Cope, 1857 and the lizard genus *Anolis* Daudin, 1802, identification of most reptile and amphibian species that we encountered was straightforward. This was aided by the fact that most genera present in Monteverde are represented by only one or two species. In the following sections, we include important field marks for identification and notes on distribution in Costa Rica, as well as whether or not the species is likely to be confused with another in Monteverde. Four species, which we denote with a dagger symbol (†), are considered unconfirmed because we do not possess photographs of them from UGACR; nevertheless, we are confident in their identification and explain in their respective sections how we came to the conclusion of their presence. Unless otherwise noted, the descriptions of diagnostic traits and distributions are based on Leenders (2016; 2019) and Savage (2002). For information on which species were recorded in which of our designated zones of UGACR, consult Tables 1, 2, and 3.

SALAMANDERS

Family Plethodontidae

Oedipina uniformis **Keferstein, 1868**
Figure 2A

Materials examined. COSTA RICA • 1; Puntarenas Province, Santa Elena de Monteverde, University of Georgia Costa Rica; 10.2824°N, 084.7990°W; 1090 m a.s.l.; 25 May 2018; UGACR Herp Survey Team leg. • 1; same locality; 10.2841°N, 084.7987°W; 1151 m a.s.l.; 20 May 2018; UGACR Herp Survey Team leg.

Identification. Extremely long, slender salamander (SVL 37–57 mm, total length 101–215 mm) with very short limbs. Uniformly dark gray, brown, or black, with very tiny light speckles on body and tail. Morphologically indistinguishable from several other *Oedipina* Keferstein, 1868 species, but only overlaps with *Oedipina poelzi* Brame, 1963 in Monteverde, which is mottled brown on dorsum and black on venter.

Distribution. Common in premontane and montane areas of Guanacaste, Tilarán, Central, and Talamanca Mountain Ranges in Costa Rica.

Remarks. Both individuals found crossing roads or paths late at night.

FROGS

Family Bufonidae

Rhinella horribilis **(Wiegmann, 1833)**
Figure 2B

Materials examined. COSTA RICA • 1; Puntarenas Province, Santa Elena de Monteverde, University of Georgia Costa Rica; 10.2826°N, 084.8029°W; 1089 m a.s.l.; 5 May 2018; UGACR Herp Survey Team leg. • 25; same locality; 10.2812°N, 084.8013°W; 1090 m a.s.l.; 16 Mar.–1 Jul. 2018; UGACR Herp Survey Team leg. • 14; same locality; 10.2824°N, 084.7990°W; 1090 m a.s.l.; 10 May–13 Jun. 2018; UGACR Herp Survey Team leg. • 13; same locality; 10.2841°N, 084.7987°W; 1151 m a.s.l.; 27 Mar.–7 Jun. 2018; UGACR Herp Survey Team leg. • 34; same locality; 10.2830°N, 084.7960°W; 1092 m a.s.l.; 26 Feb.–12 Jul. 2018; UGACR Herp Survey Team leg. • 1; same locality; 10.2844°N, 084.7929°W; 1113 m a.s.l.; 25 May 2018; UGACR Herp Survey Team leg. • 1; same locality; 10.2835°N, 084.7938°W; 1087 m a.s.l.; 25 Apr. 2018; UGACR Herp Survey Team leg. • 1; same locality; 10.2820°N, 084.7931°W; 1079 m a.s.l.; 28 Jun. 2018; UGACR Herp Survey Team leg.

Identification. Very large tan to brown toad (SVL 85–175 mm). Prominent cranial crests. Parotoid glands at least twice the size of upper eyelids. Adults unlikely to be confused with any other species in Monteverde.

Distribution. Abundant throughout Costa Rica.

Remarks. Extremely common in disturbed habitats, yet not often observed deep in forested areas. Large breeding aggregations encountered multiple times in ephemeral ponds located in northeastern section of Pasture Zone 1.

Family Craugastoridae

Craugastor fitzingeri **(Schmidt, 1857)**
Figure 2C, D

Materials examined. COSTA RICA • 2; Puntarenas Province, Santa Elena de Monteverde, University of Georgia Costa Rica; 10.2841°N, 084.7987°W; 1151 m a.s.l.; 9 May–14 May 2018; UGACR Herp Survey Team leg. • 4; same locality; 10.2844°N, 084.7929°W; 1113 m

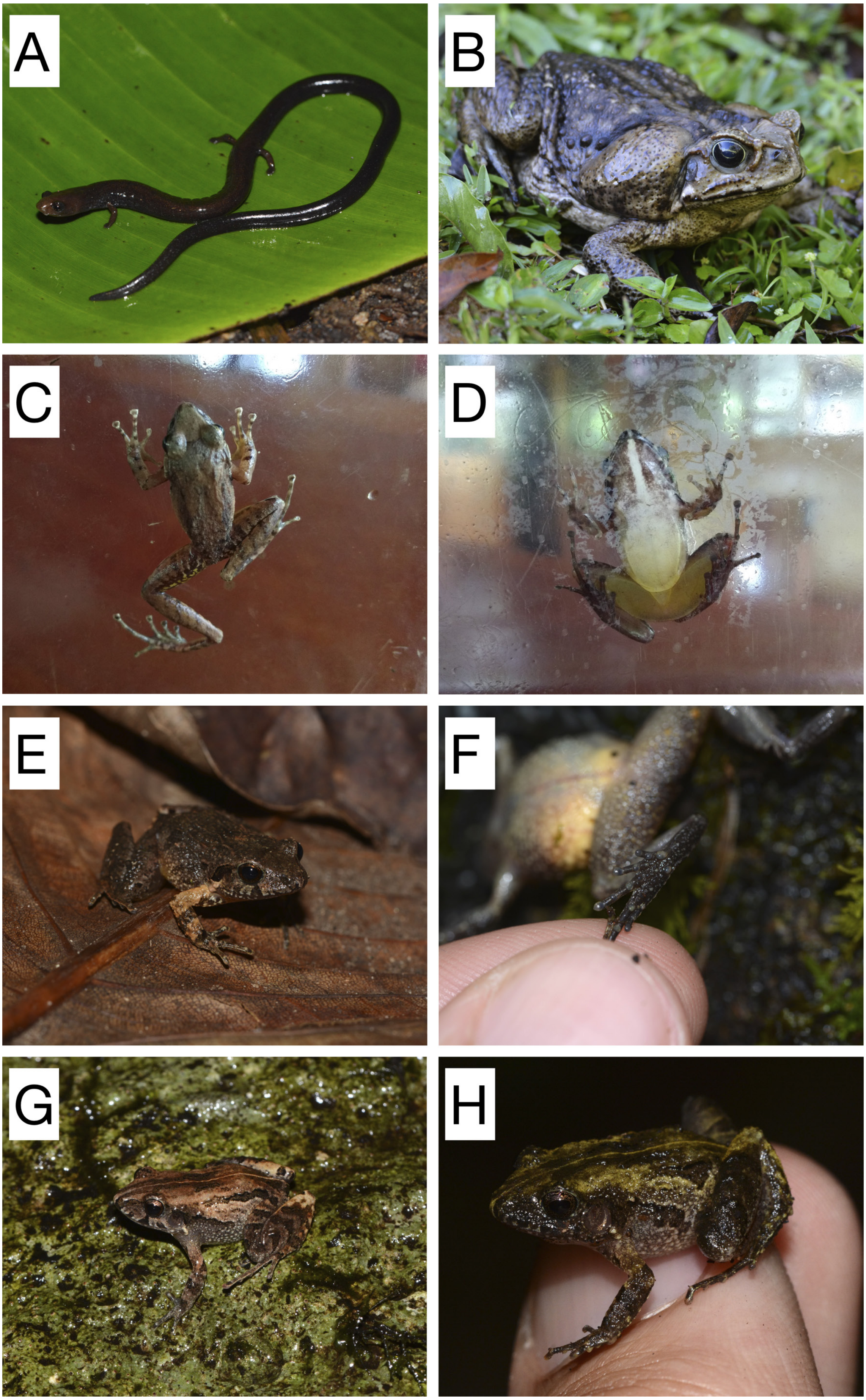

Figure 2. Salamanders and frogs from the University of Georgia Costa Rica. **A.** *Oedipina uniformis*. **B.** *Rhinella horribilis*. **C, D.** *Craugastor fitzingeri*. **E, F.** *Craugastor stejnegerianus*. **G, H.** *Craugastor underwoodi*.

a.s.l.; 23 Apr.–14 May 2018; UGACR Herp Survey Team leg. • 1; same locality; 10.2835°N, 084.7938°W; 1087 m a.s.l.; 25 Apr. 2018; UGACR Herp Survey Team leg.

Identification. Medium-sized *Craugastor* (SVL 23–53 mm), highly variable in color and pattern. Greatly enlarged truncated disks on two outer fingers of each hand. Rugose dorsum. Diagnosed by a light stripe on the center of the throat, as well as cream or yellow spots on brown posterior thigh surfaces. Most easily confused with *Craugastor crassidigitus* (Taylor 1952), which has uniform reddish-brown posterior thigh surfaces.

Distribution. Common and widespread in Costa Rica.

Remarks. Encountered almost exclusively during or after rainfall.

***Craugastor stejnegerianus* (Cope, 1893)**
Figure 2E, F

Materials examined. COSTA RICA • 2; Puntarenas Province, Santa Elena de Monteverde, University of Georgia Costa Rica; 10.2812°N, 084.8013°W; 1090 m a.s.l.; 30 Mar.–28 Jun. 2018; UGACR Herp Survey Team leg. • 1; same locality; 10.2824°N, 084.7990°W; 1090 m a.s.l.; 14 Jan. 2018; UGACR Herp Survey Team leg. • 37; same locality; 10.2841°N, 084.7987°W; 1151 m a.s.l.; 26 Feb.–4 Jul. 2018; UGACR Herp Survey Team leg. • 7; same locality; 10.2806°N, 084.7985°W; 1052 m a.s.l.; 19 Mar.–14 May 2018; UGACR Herp Survey Team leg. • 7; same locality; 10.2844°N, 084.7929°W; 1113 m a.s.l.; 23 Mar.–9 May 2018; UGACR Herp Survey Team leg. • 11; same locality; 10.2835°N, 084.7938°W; 1087 m a.s.l.; 24 Mar.–9 Jun. 2018; UGACR Herp Survey Team leg.

Identification. Very small *Craugastor* (SVL 12–22 mm), highly variable in color and pattern. Short limbs, no webbing between toes. Dark marking above tympanum. Short, diagonal row of light-colored tubercles below tympanum. Dorsum rugose, often with scattered tubercles and ridges. Whitish ventral surface. Prominent, rounded tubercles on soles of hands and feet. Similar to *Craugastor bransfordii* (Cope, 1885), which is only on Atlantic slope, *Craugastor podiciferus* (Cope, 1876), which has one to three distinct tubercles on the heel and relatively smooth dorsum, and *Craugastor underwoodi* (Boulenger, 1896), which has low, rounded tubercles on soles of hands and feet.

Distribution. Widespread on Pacific slope of Costa Rica.

Remarks. By far most common species captured in pitfall traps, but also frequently encountered hopping through leaf litter or under coverboards.

***Craugastor underwoodi* (Boulenger, 1896)**
Figure 2G, H

Materials examined. COSTA RICA • 3; Puntarenas Province, Santa Elena de Monteverde, University of Georgia Costa Rica; 10.2841°N, 084.7987°W; 1151 m a.s.l.; 10–16 May 2018; UGACR Herp Survey Team leg.

Identification. Small *Craugastor* (SVL 16–30 mm), highly variable in color and pattern. Short limbs, no webbing between toes. Lips show alternating cream and dark blotches or bars. Sometimes have light vertebral pinstripe on dorsum. Few low, rounded tubercles on soles of hands and feet. Lacks heel tubercles. Yellowish ventral surface. Similar to *Craugastor bransfordii*, which is only on Atlantic slope, *Craugastor podiciferus*, which has one to three distinct tubercles on the heel and relatively smooth dorsum, and *Craugastor stejnegerianus*, which has projecting, rounded tubercles on soles of hands and feet.

Distribution. Middle elevations on Atlantic and Pacific slopes of Tilarán, Central, and Talamanca Mountain Ranges in Costa Rica.

Remarks. Only encountered in pitfall traps.

Family Eleutherodactylidae

Diasporus diastema (Cope, 1875)
† - unconfirmed

Materials examined. COSTA RICA • 6; Puntarenas Province, Santa Elena de Monteverde, University of Georgia Costa Rica; 10.2841°N, 084.7987°W; 1151 m a.s.l.; 26 Feb.–21 May 2018; UGACR Herp Survey Team leg. • 18; same locality; 10.2806°N, 084.7985°W; 1052 m a.s.l.; 4 Jan.–25 May 2018; UGACR Herp Survey Team leg.

Identification. Very small frog (SVL 16–24 mm), highly variable in color and known to change color drastically between day and night. Dorsum usually smooth but occasionally with scattered tubercles. Often has pair of light dorsolateral stripes each marked at posterior end with pinkish or orangish tubercle. Lacks finger and toe webbing and has expanded finger and toe disks. Individuals often call from concealed perch above eye level, making them much easier heard than seen. Similar in appearance and call to *Diasporus hylaeformis* (Cope, 1875) but can often be distinguished by range and elevation.

Distribution. Abundant on the Atlantic slope and the Pacific slope of the Talamanca Mountain Range in Costa Rica. Locally abundant on Pacific slope of Guanacaste and Tilarán Mountain Ranges. In Monteverde region, may overlap with *Diasporus hylaeformis*. However, *Diasporus hylaeformis* does not frequent elevations lower than 1500 m and has not been documented below 1300 m in Monteverde, while *Diasporus diastema* has indeed been found at elevations of 690–1300 m in same area (Pounds and Fogden 2000).

Remarks. We only documented this species by sound, which we heard frequently on night hikes. The authors have heard, caught, and positively identified *Diasporus diastema* elsewhere in Costa Rica.

Family Hylidae

***Dendropsophus microcephalus* (Cope, 1886)**
Figure 3A

Materials examined. COSTA RICA • 2; Puntarenas Province, Santa Elena de Monteverde, University of

Georgia Costa Rica; 10.2812°N, 084.8013°W; 1090 m a.s.l.; 2–3 Apr. 2018; UGACR Herp Survey Team leg. • 1; same locality; 10.2806°N, 084.7985°W; 1052 m a.s.l.; 5 Jun. 2018; UGACR Herp Survey Team leg. • 1; same locality; 10.2835°N, 084.7938°W; 1087 m a.s.l.; 25 Apr. 2018; UGACR Herp Survey Team leg.

Identification. Small treefrog (SVL 18–31 mm), yellow to tan in color. Often has thin, dark dorsolateral line bordered above by a thin white line. May have network of dark lines on dorsum. Fingers have little webbing between them. Can potentially be confused with *Dendropsophus ebraccatus* (Cope, 1874) and *Dendropsophus phlebodes* (Stejneger, 1906), but former usually has extensive finger webbing and blotched dorsal pattern, and latter has short dorsolateral line never bordered by white line.

Distribution. Abundant on Pacific slope of Costa Rica, although usually not higher than 810 m in elevation. *Dendropsophus ebraccatus* found on both slopes of Costa Rica but on Pacific slope further south than Monteverde. *Dendropsophus phlebodes* found exclusively on Atlantic slope.

***Duellmanohyla rufioculis* (Taylor, 1952)**
Figure 3B

Materials examined. COSTA RICA • 4; Puntarenas Province, Santa Elena de Monteverde, University of Georgia Costa Rica; 10.2835°N, 084.7938°W; 1087 m a.s.l.; 18 Sep. 2018; UGACR Herp Survey Team leg.

Identification. Medium-sized treefrog (SVL 25–40 mm) with olive-green dorsum and white venter. Red eyes with horizontal pupils. Distinct pale stripe begins below eye or on upper lip and extends to groin. Adults unlikely to be confused with any other species in Monteverde.

Distribution. Fairly common on both Atlantic and Pacific slopes (700–1580 m elevation) in Costa Rica.

***Isthmohyla pseudopuma* (Günther, 1901)**
Figure 3C

Materials examined. COSTA RICA • 1; Puntarenas Province, Santa Elena de Monteverde, University of Georgia Costa Rica; 10.2835°N, 084.7938°W; 1087 m a.s.l.; 25 Apr. 2018; UGACR Herp Survey Team leg.

Identification. Medium-sized treefrog (SVL 37–52 mm), highly variable in color. Adult males bright yellow during breeding season (April–May), females brown to tan. Sometimes has dark brown band between front and hind limbs with yellow or cream spots. Dark tubercles on soles of feet. Juveniles often with bands on hind limbs and white lip stripe or white mark below eye. In Monteverde, juveniles may be confused with rare *Isthmohyla rivularis* (Taylor, 1952), but this species has distinctively angular snout and lacks dark tubercles on soles of feet.

Distribution. Common at middle elevations of Tilarán, Central, and Talamanca Mountain Ranges in Costa Rica.

Remarks. While this species was seen commonly at higher-elevation Monteverde Cloud Forest Reserve, we encountered only one juvenile *Isthmohyla pseudopuma* at UGACR. We consulted with J. Alan Pounds (pers. comm.) for aid in identification.

***Smilisca sordida* (Peters, 1863)**
Figure 3D

Materials examined. COSTA RICA • 2; Puntarenas Province, Santa Elena de Monteverde, University of Georgia Costa Rica; 10.2841°N, 084.7987°W; 1151 m a.s.l.; 3–12 Jul. 2018; UGACR Herp Survey Team leg. • 3; same locality; 10.2826°N, 084.8029°W; 1089 m a.s.l.; 12 Jul. 2018; UGACR Herp Survey Team leg.

Identification. Large treefrog (SVL 32–64 mm), variable in color but usually gray, tan, or brown. Often with large dark blotches on dorsum and dark bands on hind limbs. Hidden groin surfaces dark with cream and blue speckles. Large hands and feet. Basal webbing between innermost two fingers on hands, feet extensively webbed.

Distribution. Common on both Atlantic and Pacific slopes in Costa Rica.

Family Ranidae

***Rana forreri* Boulenger 1883**
Figure 3E

Materials examined. COSTA RICA • 38; Puntarenas Province, Santa Elena de Monteverde, University of Georgia Costa Rica; 10.2812°N, 084.8013°W; 1090 m a.s.l.; 4 Jan.–14 May 2018; UGACR Herp Survey Team leg. • 2; same locality; 10.2824°N, 084.7990°W; 1090 m a.s.l.; 29 Apr.–17 May 2018; UGACR Herp Survey Team leg. • 78; same locality; 10.2830°N, 084.7960°W; 1092 m a.s.l.; 26 Feb.–12 Jul. 2018; UGACR Herp Survey Team leg. • 7; same locality; 10.2835°N, 084.7938°W; 1087 m a.s.l.; 25 Apr.–16 Jun. 2018; UGACR Herp Survey Team leg. • 2; same locality; 10.2820°N, 084.7931°W; 1079 m a.s.l.; 29 Apr.–28 Jun. 2018; UGACR Herp Survey Team leg.

Identification. Large frog (SVL 65–114 mm) with long legs. Dorsum gray, green, or tan, with bold dark spots. Pale, uninterrupted dorsolateral ridges present. No webbing on hands but extensive webbing on feet. Very similar to *Rana taylori* (Smith, 1959), but this species has discontinuous dorsolateral ridges that are posteriorly inset.

Distribution. Common throughout northwestern Costa Rica. Similar *Rana taylori* only on Atlantic slope.

Remarks. The only relatively large species found in funnel traps (Riparian Zone drift fence array). More than 50 individuals seen breeding in single large puddle on 23 May 2018 in pasture.

***Rana warszewitschii* (Schmidt, 1857)**
Figure 3F

Materials examined. COSTA RICA • 9; Puntarenas Province, Santa Elena de Monteverde, University of Georgia Costa Rica; 10.2812°N, 084.8013°W; 1090 m a.s.l.; 24 Feb.–18 May 2018; UGACR Herp Survey Team

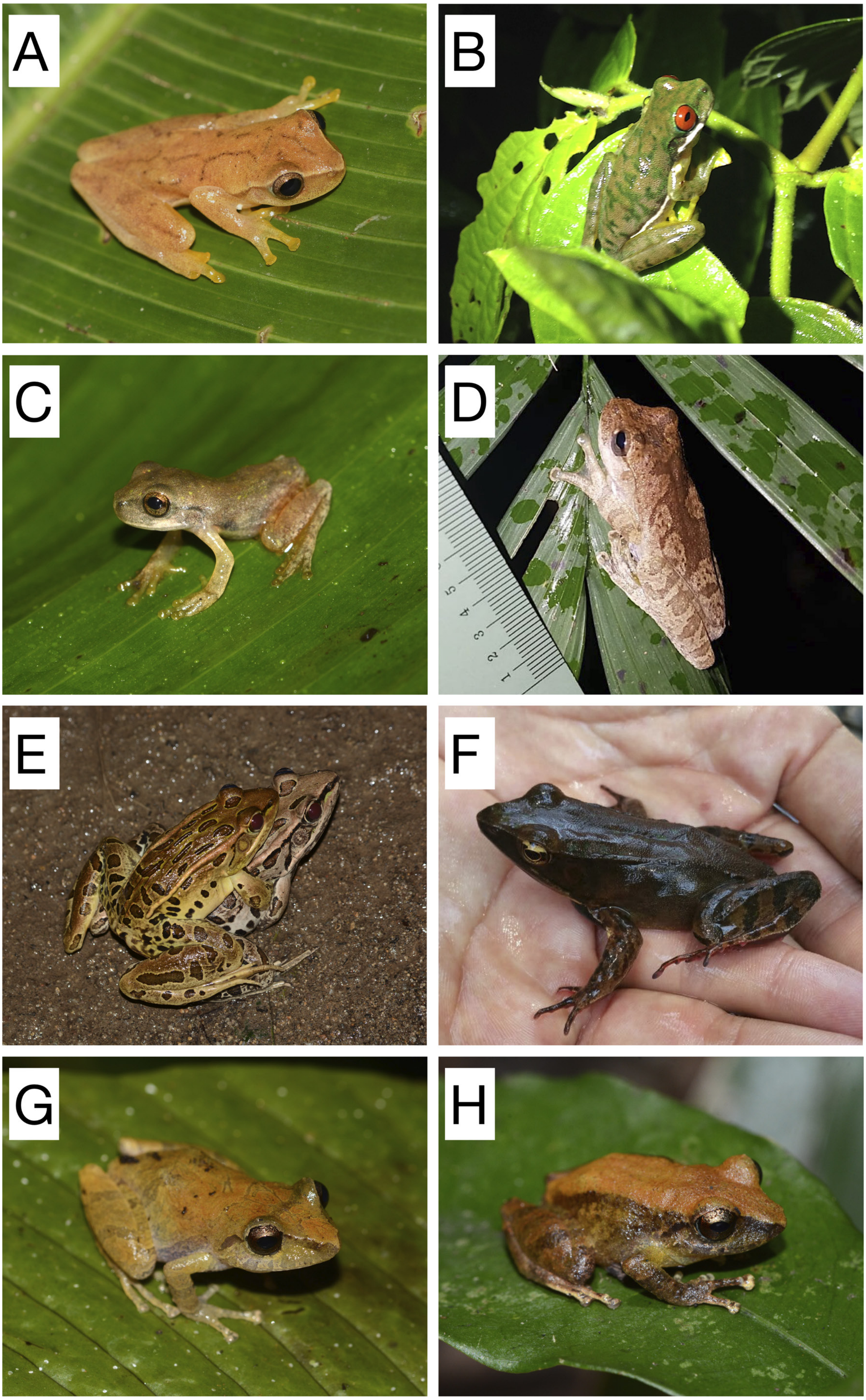

Figure 3. Frogs from the University of Georgia Costa Rica. **A.** *Dendropsophus microcephalus*. **B.** *Duellmanohyla rufioculis*. **C.** *Isthmohyla pseudopuma*. **D.** *Smilisca sordida*. **E.** *Rana forreri*. **F.** *Rana warszewitschii*. **G, H.** *Pristimantis ridens*.

leg. • 1; same locality; 10.2806°N, 084.7985°W; 1052 m a.s.l.; 7 Jul. 2018; UGACR Herp Survey Team leg. • 1; same locality; 10.2830°N, 084.7960°W; 1092 m a.s.l.; 16 May 2018; UGACR Herp Survey Team leg. • 2; same locality; 10.2835°N, 084.7938°W; 1087 m a.s.l.; 6 May–15 Jun. 2018; UGACR Herp Survey Team leg.

Identification. Medium-sized frog (SVL 37–63 mm), bronze to brown in color. Thin dorsolateral ridge present. Hind limbs often banded. Bright yellow spots on hidden surfaces of hind limbs. No webbing on hands but extensive webbing on feet.

Distribution. Common on both Atlantic and Pacific slopes of Costa Rica but absent from much of northeastern lowlands.

Family Strabomantidae

***Pristimantis ridens* (Cope, 1866)**
Figure 3G, H

Materials examined. COSTA RICA • 9; Puntarenas Province, Santa Elena de Monteverde, University of Georgia Costa Rica; 10.2812°N, 084.8013°W; 1090 m a.s.l.; 25 Feb.–14 May 2018; UGACR Herp Survey Team leg. • 16; same locality; 10.2841°N, 084.7987°W; 1151 m a.s.l.; 6 Jan.–9 Jul. 2018; UGACR Herp Survey Team leg. • 3; same locality; 10.2806°N, 084.7985°W; 1052 m a.s.l.; 16 Mar.–25 Apr. 2018; UGACR Herp Survey Team leg. • 1; same locality; 10.2844°N, 084.7929°W; 1113 m a.s.l.; 27 Mar. 2018; UGACR Herp Survey Team leg.

Identification. Small frog (SVL 16–25 mm), extremely variable in coloration and pattern. Dorsum tan, red, or brown with or without stripes and other markings. Diagnostic dark marking above tympanum. Hands and feet with no webbing. Raised nostrils and fleshy bump on tip of snout present. Also has enlarged tubercles on top of eyelids. Two other *Pristimantis* Jiménez de la Espada, 1870 species, *Pristimantis cerasinus* (Cope, 1875) and *Pristimantis cruentus* (Peters, 1873), could potentially occur in vicinity of UGACR, but former has W-shaped ridge on dorsum and lacks enlarged tubercles on eyelids, and latter has distinct enlarged heel tubercle and bold reticulated pattern on eyes.

Distribution. Abundant on Atlantic slope and on central and southern Pacific slope in Costa Rica.

Remarks. Only species found in frog tubes.

LIZARDS

Family Corytophanidae

***Basiliscus basiliscus* (Linnaeus, 1758)**
† - unconfirmed

Materials examined. COSTA RICA • 1; Puntarenas Province, Santa Elena de Monteverde, University of Georgia Costa Rica; 10.2835°N, 084.7938°W; 1087 m a.s.l.; 5 May 2018; UGACR Herp Survey Team leg.

Identification. Large lizard (SVL 130–250 mm, total length 430–520 mm) with long limbs and tail. Olive-brown in color with lateral light stripes and dark transverse bars on body and tail. Adult males with large head crest and fin down length of body and tail. Unlikely to be confused with any other species in Monteverde.

Distribution. Very common on Pacific slope of Costa Rica. The fairly similar *Basiliscus vittatus* Wiegmann, 1828 is found exclusively on Atlantic slope of Costa Rica.

Remarks. We observed one adult male basking on rocks near river. Upon seeing us, this individual immediately dove into water, so no photos were obtained. We have seen, photographed, and positively identified *Basiliscus basiliscus* elsewhere in Costa Rica and in Panama.

Family Dactyloidae

***Anolis biporcatus* (Wiegmann, 1834)**
Figure 4A

Materials examined. COSTA RICA • 1; Puntarenas Province, Santa Elena de Monteverde, University of Georgia Costa Rica; 10.2812°N, 084.8013°W; 1090 m a.s.l.; 25 Feb. 2018; UGACR Herp Survey Team leg. • 4; same locality; 10.2824°N, 084.7990°W; 1090 m a.s.l.; 14 Feb.–13 Mar. 2018; UGACR Herp Survey Team leg. • 8; same locality; 10.2841°N, 084.7987°W; 1151 m a.s.l.; 20 Feb.–11 Jun. 2018; UGACR Herp Survey Team leg. • 4; same locality; 10.2806°N, 084.7985°W; 1052 m a.s.l.; 31 May–12 Jul. 2018; UGACR Herp Survey Team leg.

Identification. Large, arboreal anole (SVL 73–99 mm, total length up to 330 mm). Bright green in color (distinguishing it from all other anoles in area). Males with large dewlap that is whitish blue in center and reddish orange on margin.

Distribution. Locally common on both Atlantic and Pacific slopes in Costa Rica.

Remarks. Although diurnally active, we only encountered this species while sleeping on vegetation at night.

***Anolis capito* Peters, 1863**
Figure 4B

Materials examined. COSTA RICA • 1; Puntarenas Province, Santa Elena de Monteverde, University of Georgia Costa Rica; 10.2820°N, 084.7931°W; 1079 m a.s.l.; 6 May 2018; UGACR Herp Survey Team leg.

Identification. Large anole (SVL 78–96 mm, total length up to 266 mm) usually found in leaf litter or on low vegetation. Coloration variable, usually brown or green and highly cryptic. Distinctively chunky head and "pug-nosed" snout. Males with medium-sized greenish-yellow dewlap.

Distribution. Common, but at low densities on Atlantic and southern Pacific slopes in Costa Rica.

***Anolis cupreus* Hallowell, 1860**
Figure 4C

Materials examined. COSTA RICA • 1; Puntarenas Province, Santa Elena de Monteverde, University of

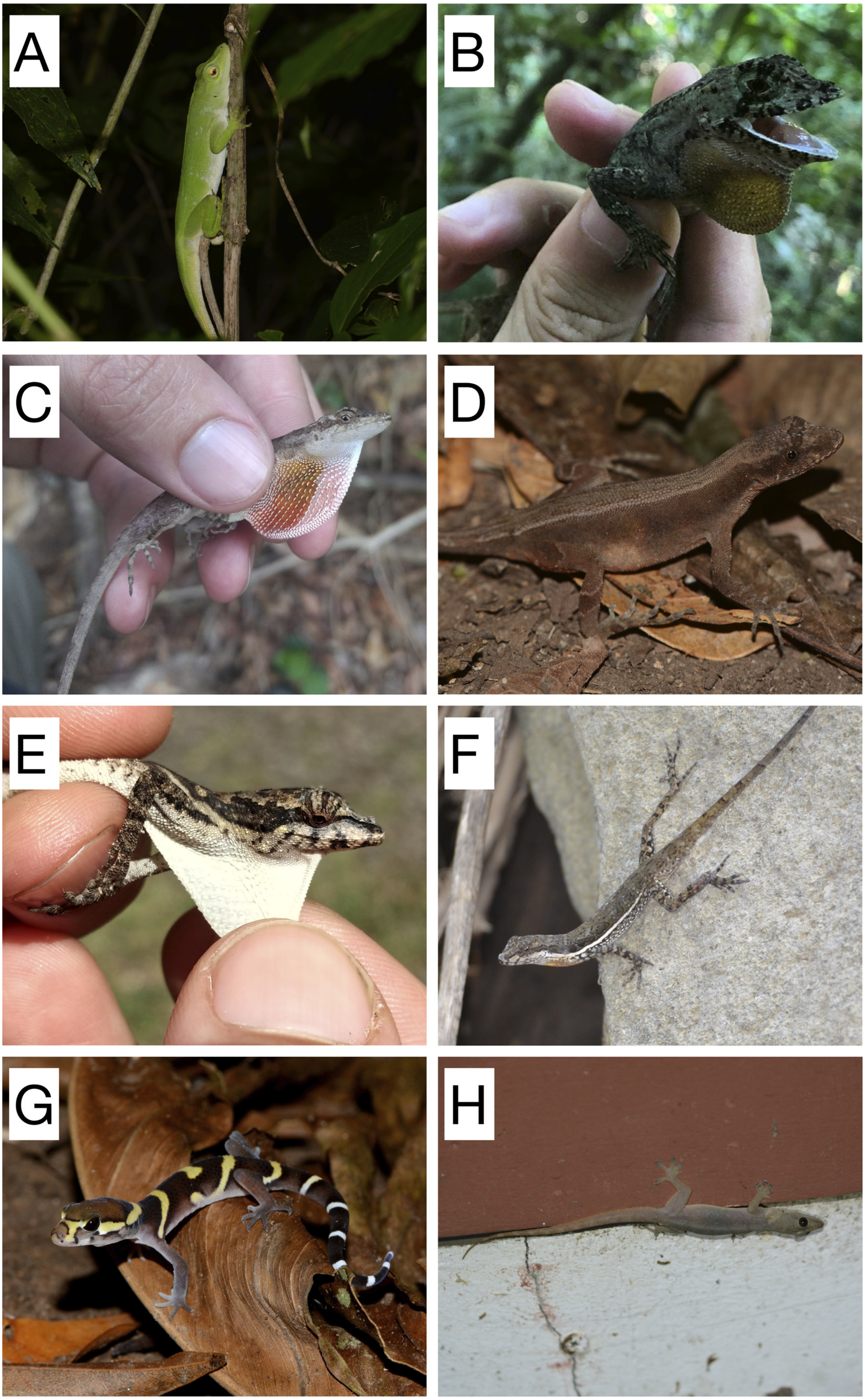

Figure 4. Anoles and geckos from the University of Georgia Costa Rica. **A.** *Anolis biporcatus*. **B.** *Anolis capito*. **C.** *Anolis cupreus*. **D.** *Anolis humilis*. **E.** *Anolis laeviventris*. **F.** *Anolis oxylophus*. **G.** *Coleonyx mitratus*. **H.** *Hemidactylus frenatus*.

Georgia Costa Rica; 10.2826°N, 084.8029°W; 1089 m a.s.l.; 6 Jan. 2018; UGACR Herp Survey Team leg. • 2; same locality; 10.2812°N, 084.8013°W; 1090 m a.s.l.; 28 Mar.–29 Mar. 2018; UGACR Herp Survey Team leg. • 3; same locality; 10.2824°N, 084.7990°W; 1090 m a.s.l.; 1 Apr.–15 May 2018; UGACR Herp Survey Team leg. • 1; same locality; 10.2841°N, 084.7987°W; 1151 m a.s.l.; 8 May 2018; UGACR Herp Survey Team leg. • 2; same locality; 10.2830°N, 084.7960°W; 1092 m a.s.l.; 28 Apr.–24 May 2018; UGACR Herp Survey Team leg. • 1; same locality; 10.2844°N, 084.7929°W; 1113 m a.s.l.; 22 Jun. 2018; UGACR Herp Survey Team leg. • 1; same locality; 10.2835°N, 084.7938°W; 1087 m a.s.l.; 18 Apr. 2018; UGACR Herp Survey Team leg.

Identification. Medium-sized, slender anole (SVL 38–57 mm, total length up to 170 mm) found in variety of habitats, including in leaf litter, on vegetation, in gardens, on fences, and on rocks near water. Tan to brown in coloration, sometimes with white spots or bars on sides, females often with light dorsal stripe bordered by dark stripes. Male dewlap large, reddish orange basally with thick pink margin. Females sometimes tough to distinguish from other anoles, but *Anolis cupreus* can be diagnosed by four middorsal scale rows with enlarged keeled scales.

Distribution. Very common on Pacific slope of northwestern and western Costa Rica.

Anolis humilis **Peters, 1863**
Figure 4D

Materials examined. COSTA RICA • 20; Puntarenas Province, Santa Elena de Monteverde, University of Georgia Costa Rica; 10.2841°N, 084.7987°W; 1151 m a.s.l.; 28 Mar.–7 Jul. 2018; UGACR Herp Survey Team leg. • 1; same locality; 10.2806°N, 084.7985°W; 1052 m a.s.l.; 24 Mar. 2018; UGACR Herp Survey Team leg. • 11; same locality; 10.2844°N, 084.7929°W; 1113 m a.s.l.; 25 Mar.–22 May 2018; UGACR Herp Survey Team leg. • 2; same locality; 10.2820°N, 084.7931°W; 1079 m a.s.l.; 27 Jan.–24 May 2018; UGACR Herp Survey Team leg.

Identification. Small, ground-dwelling anole (SVL 29–45 mm, total length up to 114 mm). Brown in coloration, highly cryptic. Often shows dark band between eyes on top of head. Males with medium-sized, bright reddish-orange dewlap with yellow margin. Can be difficult to distinguish from other anoles, but *Anolis humilis* can be diagnosed by broad middorsal band (8–10 rows) of enlarged keeled scales, as well as deep axillary pit in each armpit.

Distribution. Abundant on Atlantic slope of Costa Rica.

Remarks. By far most commonly encountered reptile in pitfall traps and funnel traps.

Anolis laeviventris **(Wiegmann, 1834)**
Figure 4E

Materials examined. COSTA RICA • 1; Puntarenas Province, Santa Elena de Monteverde, University of Georgia Costa Rica; 10.2824°N, 084.7990°W; 1090 m a.s.l.; 11 Jan. 2018; UGACR Herp Survey Team leg. • 2; same locality; 10.2841°N, 084.7987°W; 1151 m a.s.l.; 25 Mar.–27 Mar. 2018; UGACR Herp Survey Team leg. • 3; same locality; 10.2806°N, 084.7985°W; 1052 m a.s.l.; 16 Apr.–25 May 2018; UGACR Herp Survey Team leg.

Identification. Medium-sized anole (SVL 39–54 mm, total length up to 145 mm) typically found perched on branches or trunks of trees. Coloration variable but usually gray, cream, or tan, often with mottling or other markings. Males with low nuchal and caudal crests, as well as diagnostic medium-sized white dewlap. Females especially can be difficult to distinguish from other anoles, but *Anolis laeviventris* can be diagnosed by mixture of tiny and enlarged scales on flanks.

Distribution. Common in foothills and mountains in northern and central Costa Rica.

Remarks. Taxonomic status under debate. May also be referred to as *Anolis intermedius* in Costa Rica.

Anolis oxylophus **Cope, 1875**
Figure 4F

Materials examined. COSTA RICA • 1; Puntarenas Province, Santa Elena de Monteverde, University of Georgia Costa Rica; 10.2826°N, 084.8029°W; 1089 m a.s.l.; 14 Mar. 2018; UGACR Herp Survey Team leg. • 35; same locality; 10.2835°N, 084.7938°W; 1087 m a.s.l.; 29 Mar.–18 Jun. 2018; UGACR Herp Survey Team leg.

Identification. Medium-sized to large, semi-aquatic anole (SVL 56–85 mm, total length up to 243 mm). Coloration diagnostic: dorsum olive-brown, ventral surfaces white, and distinct white lateral stripe. Often has line of dark-outlined white spots on flanks. Males with large, yellow-orange dewlap.

Distribution. Locally abundant near streams and rivers on both Atlantic and Pacific slopes in Costa Rica.

Family Eublepharidae

Coleonyx mitratus **(Peters, 1863)**
Figure 4G

Materials examined. COSTA RICA • 3; Puntarenas Province, Santa Elena de Monteverde, University of Georgia Costa Rica; 10.2841°N, 084.7987°W; 1151 m a.s.l.; 20 Feb.–29 May 2018; UGACR Herp Survey Team leg.

Identification. Unique, nocturnal, ground-dwelling gecko (SVL 55–97 mm, total length up to 190 mm). Large head, big eyes, moveable eyelids, vertically elliptical pupils. Patterned with yellow-tan and dark brown bars and blotches. Body covered in tiny granular scales and irregular rows of enlarged tubercles.

Distribution. Common, but secretive, on Pacific slope of northwestern and western Costa Rica.

Family Gekkonidae

***Hemidactylus frenatus* Duméril & Bibron, 1836**
Figure 4H

Materials examined. COSTA RICA • 41; Puntarenas Province, Santa Elena de Monteverde, University of Georgia Costa Rica; 10.2824°N, 084.7990°W; 1090 m a.s.l.; 26 Jan.–1 Jul. 2018; UGACR Herp Survey Team leg.

Identification. Medium-sized, nocturnal gecko (SVL 50–65 mm, total length up to 135 mm) commonly seen on or in buildings. Head and body flattened. Has vertically elliptical pupils, lacks moveable eyelids. Gray to brown in color, often mottled or with blotches, but known to change color between day and night. Fingers and toes with expanded lamellae and end in exposed claw. Tail with whorls of pointed tubercles.

Distribution. Invasive species abundant throughout most of Costa Rica.

Family Gymnophthalmidae

***Anadia ocellata* Gray, 1845**
Figure 5A

Materials examined. COSTA RICA • 1; Puntarenas Province, Santa Elena de Monteverde, University of Georgia Costa Rica; 10.2826°N, 084.8029°W; 1089 m a.s.l.; 26 Mar. 2018; UGACR Herp Survey Team leg. • 1; same locality; 10.2824°N, 084.7990°W; 1090 m a.s.l.; 20 Jan. 2018; UGACR Herp Survey Team leg. • 1; same locality; 10.2835°N, 084.7938°W; 1087 m a.s.l.; 16 May 2018; UGACR Herp Survey Team leg.

Identification. Elongate, arboreal lizard with extremely long tail and short limbs (SVL 50–75 mm, total length up to 216 mm). Brown in color with dark wavy bands (females) or lateral row of black-outlined white spots (males). Unlikely to be confused with any other species in Monteverde.

Distribution. Rarely seen, abundance unknown (a canopy-dwelling species). Disjunct populations in foothills of several areas in Costa Rica.

Remarks. Although known to inhabit crowns of rainforest trees, all three individuals encountered during survey were on ground. This species is thought to rarely visit forest floor (Leenders 2019), so our sightings may potentially suggest high abundance of these lizards in canopy.

Family Phrynosomatidae

***Sceloporus malachiticus* Cope, 1864**
Figure 5B

Materials examined. COSTA RICA • 6; Puntarenas Province, Santa Elena de Monteverde, University of Georgia Costa Rica; 10.2826°N, 084.8029°W; 1089 m a.s.l.; 7–14 Mar. 2018; UGACR Herp Survey Team leg. • 17; same locality; 10.2824°N, 084.7990°W; 1090 m a.s.l.; 26 Jan.–18 Jul. 2018; UGACR Herp Survey Team leg. • 5; same locality; 10.2841°N, 084.7987°W; 1151 m a.s.l.; 8 May–8 Jul. 2018; UGACR Herp Survey Team leg. • 1; same locality; 10.2806°N, 084.7985°W; 1052 m a.s.l.; 11 May 2018; UGACR Herp Survey Team leg. • 5; same locality; 10.2830°N, 084.7960°W; 1092 m a.s.l.; 17 Mar.–20 Jun. 2018; UGACR Herp Survey Team leg. • 3; same locality; 10.2844°N, 084.7929°W; 1113 m a.s.l.; 19 Mar.–28 Apr. 2018; UGACR Herp Survey Team leg.

Identification. Medium-sized, spiny lizard (SVL 64–98 mm, total length up to 190 mm) often found on trees, logs, rocks, and fence posts. Adult males bright green with black collar and bright blue belly and throat patches. Females and juveniles greenish brown with dark mottling or blotches.

Distribution. Common in highlands of central Costa Rica.

Family Scincidae

***Scincella cherriei* (Cope, 1893)**
Figure 5C

Materials examined. COSTA RICA • 1; Puntarenas Province, Santa Elena de Monteverde, University of Georgia Costa Rica; 10.2824°N, 084.7990°W; 1090 m a.s.l.; 29 Mar. 2018; UGACR Herp Survey Team leg. • 2; same locality; 10.2841°N, 084.7987°W; 1151 m a.s.l.; 23 May–25 Jun. 2018; UGACR Herp Survey Team leg. • 1; same locality; 10.2830°N, 084.7960°W; 1092 m a.s.l.; 1 Mar. 2018; UGACR Herp Survey Team leg. • 4; same locality; 10.2844°N, 084.7929°W; 1113 m a.s.l.; 30 Apr.–8 May 2018; UGACR Herp Survey Team leg. • 1; same locality; 10.2835°N, 084.7938°W; 1087 m a.s.l.; 3 Jul. 2018; UGACR Herp Survey Team leg.

Identification. Small skink (SVL 49–68 mm, total length up to 178 mm) almost always found in leaf litter. Dorsum brown, dark eye mask and lateral stripe present. Lower half of body lighter, often with black and cream speckles. Scales extremely smooth.

Distribution. Common on both Atlantic and Pacific slopes in Costa Rica.

SNAKES

Family Boidae

***Boa imperator* Daudin, 1803**
Figure 5D

Materials examined. COSTA RICA • 1; Puntarenas Province, Santa Elena de Monteverde, University of Georgia Costa Rica; 10.2841°N, 084.7987°W; 1151 m a.s.l.; 22 Feb. 2018; UGACR Herp Survey Team leg. • 2; same locality; 10.2806°N, 084.7985°W; 1052 m a.s.l.; 13 Apr.–26 May 2018; UGACR Herp Survey Team leg. • 3; same locality; 10.2835°N, 084.7938°W; 1087 m a.s.l.; 1 Jul.–4 Jul. 2018; UGACR Herp Survey Team leg.

Identification. Largest Costa Rican snake (total length of most adults 2–3 m, maximum known total length 4.5 m). Body heavy and robustly muscular. Dorsum gray, tan, or brown with spots, bars, or diamonds of various

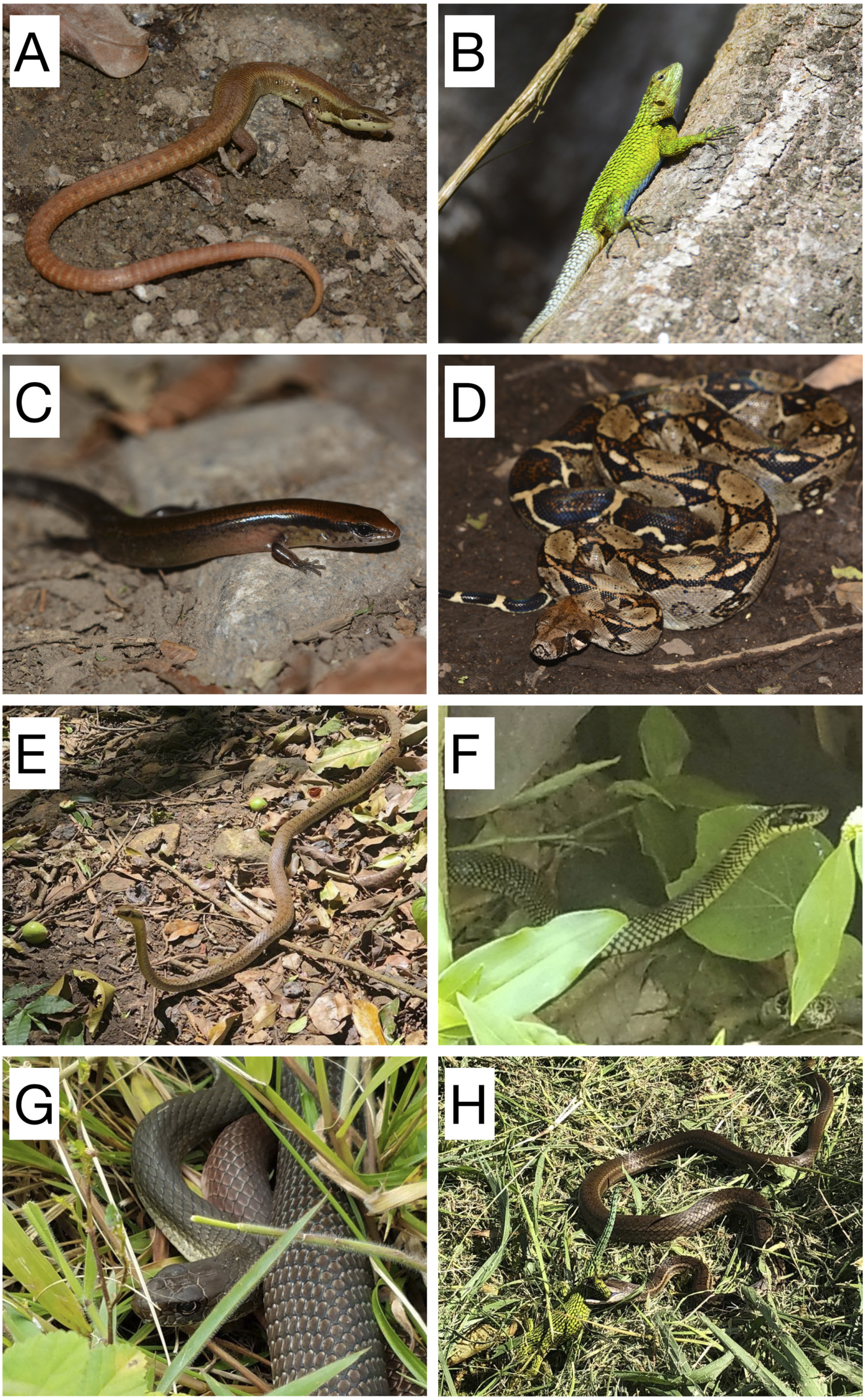

Figure 5. Lizards and snakes from the University of Georgia Costa Rica. **A.** *Anadia ocellata*. **B.** *Sceloporus malachiticus*. **C.** *Scincella cherriei*. **D.** *Boa imperator*. **E.** *Dendrophidion percarinatum*. **F.** *Drymobius margaritiferus*. **G.** *Masticophis mentovarius*. **H.** *Mastigodryas melanolomus* (eating *Sceloporus malachiticus*).

colors. Markings on tail often reddish brown. Scales small, smooth, and iridescent.

Distribution. Common throughout most of Costa Rica.

Remarks. Previously considered a subspecies of *Boa constrictor* Linnaeus, 1758. One individual seen subduing and consuming an adult Central American Agouti *Dasyprocta punctata* (Gray, 1842).

Family Colubridae

***Chironius exoletus* (Linnaeus, 1758)**
† - unconfirmed

Materials examined. COSTA RICA • 1; Puntarenas Province, Santa Elena de Monteverde, University of Georgia Costa Rica; 10.2806°N, 084.7985°W; 1052 m a.s.l.; 11 Mar. 2018; UGACR Herp Survey Team leg.

Identification. Medium-sized, slender snake (total length up to 162 cm). Bright green in color. Usually seen searching for prey on forest floor. Eyes large, pupils round. Scales very large and smooth, except for paravertebral scales, which are distinctly keeled. Unlikely to be confused with any other species in Monteverde, but somewhat-similar *Leptophis* Bell, 1825 species in area all have noticeable dark postocular stripe.

Distribution. Uncommon at middle elevations on both Atlantic and Pacific slopes in Costa Rica.

Remarks. Single individual encountered independently by two naturalists with tour groups (within 5 minutes of one another). Seen moving through leaf litter in dense forest during late morning. We attempted to capture snake by hand, but it quickly fled and escaped into burrow. Good views of snake were obtained while chasing it, but no photos were taken.

***Dendrophidion percarinatum* (Cope, 1893)**
Figure 5E

Materials examined. COSTA RICA • 1; Puntarenas Province, Santa Elena de Monteverde, University of Georgia Costa Rica; 10.2824°N, 084.7990°W; 1090 m a.s.l.; 18 Feb. 2018; UGACR Herp Survey Team leg. • 1; same locality; 10.2806°N, 084.7985°W; 1052 m a.s.l.; 6 Feb. 2018; UGACR Herp Survey Team leg.

Identification. Medium-sized, slender snake (total length up to 117 cm). Dorsum brown, with faint pattern of thin, dark-bordered crossbands on neck and body. Venter white, cream, or yellow. Often has faint dark stripe behind eye. Usually seen searching for prey on forest floor. Eyes large, pupils round. All other *Dendrophidion* Fitzinger, 1843 in Monteverde quite different in color pattern.

Distribution. Common on Atlantic slope and parts of Pacific slope in Costa Rica.

***Drymobius margaritiferus* (Schlegel, 1837)**
Figure 5F

Materials examined. COSTA RICA • 1; Puntarenas Province, Santa Elena de Monteverde, University of Georgia Costa Rica; 10.2812°N, 084.8013°W; 1090 m a.s.l.; 31 Mar. 2018; UGACR Herp Survey Team leg. • 1; same locality; 10.2844°N, 084.7929°W; 1113 m a.s.l.; 13 May 2018; UGACR Herp Survey Team leg.

Identification. Medium-sized snake (total length up to 135 cm) often seen searching for prey on ground in variety of habitats. Color pattern distinctive: dorsal scales green to black with orange or yellow spot in center of each. Top of head with yellowish Y-shaped marking. Only snake in Costa Rica with pale-centered dorsal scales.

Distribution. Common on both Atlantic and Pacific slopes in northern and central Costa Rica.

***Lampropeltis micropholis* Cope, 1860**
Figure not included (identification confirmed via video recording)

Materials examined. COSTA RICA • 2; Puntarenas Province, Santa Elena de Monteverde, University of Georgia Costa Rica; 10.2841°N, 084.7987°W; 1151 m a.s.l.; 23 Mar.–4 Jul. 2018; UGACR Herp Survey Team leg.

Identification. Medium-sized to large snake (total length up to 199 cm). Color pattern of red, white, and black rings, with red bordered on both sides by black. Shows marked ontogenetic change in color. Individuals darken with age, and adults may be nearly uniformly black. Closely related *Lampropeltis abnorma* (Bocourt, 1886) does not darken with age, and adult *Clelia* Fitzinger, 1826 species are black with light undersurfaces.

Distribution. Uncommon in northeastern, central, and southern Costa Rica.

Remarks. Formerly considered subspecies of *Lampropeltis triangulum* (LaCépède, 1788), which has been split. Based on range maps alone, any large milk snake at UGACR would likely be assumed *Lampropeltis abnorma*, which inhabits Pacific slope of Costa Rica. However, both individuals encountered during survey were black with very faint red bands, suggesting individuals were *Lampropeltis micropholis* transitioning to older age and displaying ontogenetic change from ringed to black. This does not occur in *Lampropeltis abnorma* (Leenders 2019). High-quality photos could not be obtained, as both encounters involved fast-moving individuals that were only recorded by phone video.

***Masticophis mentovarius* (Duméril, Bibron & Duméril, 1854)**
Figure 5G

Materials examined. COSTA RICA • 1; Puntarenas Province, Santa Elena de Monteverde, University of Georgia Costa Rica; 10.2830°N, 084.7960°W; 1092 m a.s.l.; 25 Aug. 2018; UGACR Herp Survey Team leg.

Identification. Large snake (total length up to 252 cm) often seen searching for prey on ground in open areas, such as grasslands, beachfronts, and farms. Dorsal coloration brown, with diagnostic cream to white mottling on sides of head and thin, pale lines on sides of neck.

Venter cream anteriorly and tan to reddish brown posteriorly. Eyes large, pupils round. Sharp ridge over top of eyes. Dorsal scales smooth.

Distribution. Common in dry habitats on Pacific slope in northwestern and western Costa Rica.

Remarks. Leenders (2019) notes that this species is found from sea level to 450 m elevation in Costa Rica, but according to Savage (2002), it is found from sea level to 1435 m.

***Mastigodryas melanolomus* (Cope, 1868)**
Figure 5H

Materials examined. COSTA RICA • 1; Puntarenas Province, Santa Elena de Monteverde, University of Georgia Costa Rica; 10.2824°N, 084.7990°W; 1090 m a.s.l.; 30 Jun. 2018; UGACR Herp Survey Team leg. • 6; same locality; 10.2841°N, 084.7987°W; 1151 m a.s.l.; 15 Feb.–22 Jun. 2018; UGACR Herp Survey Team leg. • 2; same locality; 10.2806°N, 084.7985°W; 1052 m a.s.l.; 28 Mar.–6 May 2018; UGACR Herp Survey Team leg. • 2; same locality; 10.2844°N, 084.7929°W; 1113 m a.s.l.; 16–19 May 2018; UGACR Herp Survey Team leg.

Identification. Medium-sized snake (total length up to 150 cm). Adults brown on dorsum, with faint pale lateral stripe. Venter salmon colored on Atlantic slope, white to yellowish on Pacific slope. Dark postocular stripe. Juveniles with checkerboard pattern of dark and light brown squares on top and sides of body. Juveniles also with bold white and brown markings on lower part of head. Juvenile pattern fades with age. Eyes large, pupils round.

Distribution. Common to abundant on both Atlantic and Pacific slopes in Costa Rica.

***Oxybelis fulgidus* (Daudin, 1803)**
Figure 6A

Materials examined. COSTA RICA • 1; Puntarenas Province, Santa Elena de Monteverde, University of Georgia Costa Rica; 10.2812°N, 084.8013°W; 1090 m a.s.l.; 4 Jan. 2018; UGACR Herp Survey Team leg. • 2; same locality; 10.2824°N, 084.7990°W; 1090 m a.s.l.; 20 Mar.–7 Jul. 2018; UGACR Herp Survey Team leg. • 1; same locality; 10.2841°N, 084.7987°W; 1151 m a.s.l.; 9 May 2018; UGACR Herp Survey Team leg. • 3; same locality; 10.2806°N, 084.7985°W; 1052 m a.s.l.; 9 Feb.–18 Mar. 2018; UGACR Herp Survey Team leg.

Identification. Large, arboreal snake (total length up to 220 cm). Coloration bright green, with light ventrolateral line. Diagnostic pointed head with sharp-tipped snout.

Distribution. Uncommon but localized in northwestern and western Costa Rica.

***Phrynonax poecilonotus* (Günther, 1858)**
Figure 6B

Materials examined. COSTA RICA • 1; Puntarenas Province, Santa Elena de Monteverde, University of Georgia Costa Rica; 10.2841°N, 084.7987°W; 1151 m a.s.l.; 8 Jun. 2018; UGACR Herp Survey Team leg.

Identification. Very large snake (total length up to 250 cm) often encountered on ground in wide range of habitat types. Extremely variable in color pattern, but adults often dark brown or bluish-gray on dorsum and yellow on venter. Some individuals with red to brown markings on dorsum. Well-known defensive display involves flattening of head, puffing of neck, and gaping/striking.

Distribution. Common on both Atlantic and Pacific slopes of Costa Rica.

***Senticolis triaspis* (Cope, 1866)**
Figure 6C

Materials examined. COSTA RICA • 3; Puntarenas Province, Santa Elena de Monteverde, University of Georgia Costa Rica; 10.2824°N, 084.7990°W; 1090 m a.s.l.; 6–26 Mar. 2018; UGACR Herp Survey Team leg. • 5; same locality; 10.2841°N, 084.7987°W; 1151 m a.s.l.; 12 Mar.–26 Jun. 2018; UGACR Herp Survey Team leg. • 3; same locality; 10.2806°N, 084.7985°W; 1052 m a.s.l.; 23 Feb.–8 Apr. 2018; UGACR Herp Survey Team leg.

Identification. Medium to large snake (total length up to 127 cm). Elongate head with bluntly rounded snout. Adults tan to golden in dorsal coloration. Juveniles gray with dark blotches on top and sides of body. Juvenile coloration fades with age.

Distribution. Common on Pacific slope in northwestern and western Costa Rica.

***Spilotes pullatus* (Linnaeus, 1758)**
Figure 6D

Materials examined. COSTA RICA • 4; Puntarenas Province, Santa Elena de Monteverde, University of Georgia Costa Rica; 10.2824°N, 084.7990°W; 1090 m a.s.l.; 5 Mar.–26 Jun. 2018; UGACR Herp Survey Team leg. • 2; same locality; 10.2841°N, 084.7987°W; 1151 m a.s.l.; 22 Mar.–28 Apr. 2018; UGACR Herp Survey Team leg. • 3; same locality; 10.2806°N, 084.7985°W; 1052 m a.s.l.; 5 Mar.–3 Jul. 2018; UGACR Herp Survey Team leg. • 1; same locality; 10.2820°N, 084.7931°W; 1079 m a.s.l.; 13 Jan. 2018; UGACR Herp Survey Team leg.

Identification. Very large snake (total length up to 270 cm). Distinctive "tiger stripe" pattern of cream/yellow and black markings on dorsum. Venter with alternating cream/yellow and black bands, often solid black posteriorly.

Distribution. Common on both Atlantic and Pacific slopes in Costa Rica.

***Tantilla armillata* Cope, 1875**
† - unconfirmed

Materials examined. COSTA RICA • 1; Puntarenas Province, Santa Elena de Monteverde, University of Georgia Costa Rica; 10.2826°N, 084.8029°W; 1089 m a.s.l.; 29 Jan. 2018; UGACR Herp Survey Team leg.

Identification. Small, slender snake (total length up to 49 cm). Diagnostic black cap with two pairs of cream or yellow dots. Black cap bordered by cream/yellow nuchal

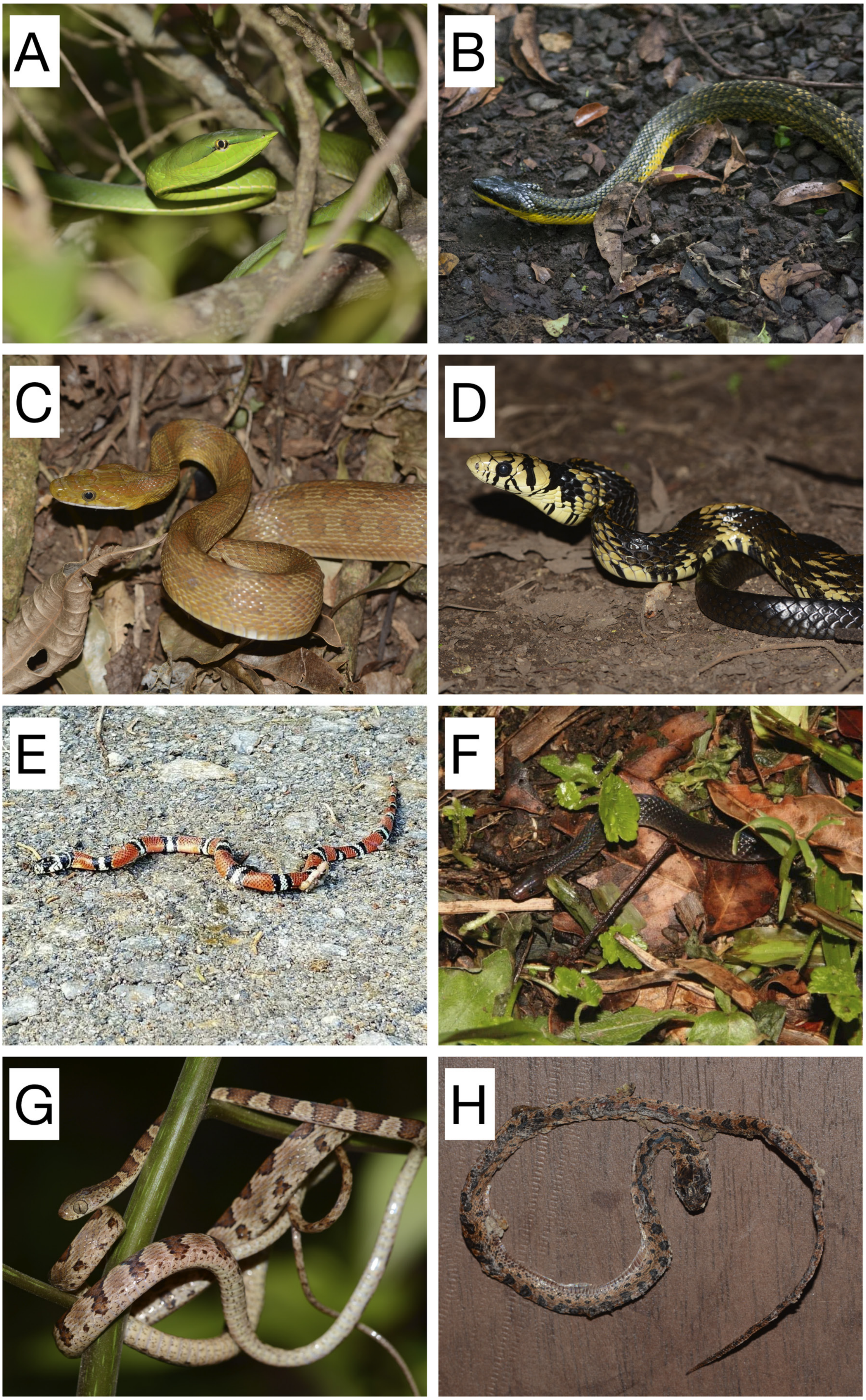

Figure 6. Colubrid and dipsadid snakes from the University of Georgia Costa Rica. **A.** *Oxybelis fulgidus*. **B.** *Phrynonax poecilonotus*. **C.** *Senticolis triaspis* (subadult). **D.** *Spilotes pullatus*. **E.** *Erythrolamprus bizona*. **F.** *Geophis hoffmanni*. **G.** *Imantodes gemmistratus*. **H.** *Leptodeira septentrionalis* (dead).

collar, which is split by middorsal dark stripe. Dark stripe continues onto rest of gray to brown dorsum. Venter uniformly pale.

Distribution. Fairly common on Pacific slope in northwestern and western Costa Rica.

Remarks. Found and photographed by resident naturalist on road in Western Zone. Photograph was brought to us and specimen was positively identified as *Tantilla armillata*, but photograph was deleted before it could be included in our dataset. Could clearly see head markings in photograph.

Family Dipsadidae

***Erythrolamprus bizona* Jan, 1863**
Figure 6E

Materials examined. COSTA RICA • 1; Puntarenas Province, Santa Elena de Monteverde, University of Georgia Costa Rica; 10.2826°N, 084.8029°W; 1089 m a.s.l.; 22 Jan. 2018; UGACR Herp Survey Team leg.

Identification. Medium-sized snake (total length up to 100 cm) often seen on ground. Pattern of red, black, and white rings. Red rings bordered on either side by black. Head white to cream, with black cap and many black markings. Only coral snake mimic in Costa Rica with two black rings separated by white on neck. Tail tricolor, not bicolor; all five Costa Rican coral snakes (genus *Micrurus* Wagler, 1824) have bicolored tails (Leenders 2019).

Distribution. In Costa Rica, uncommon on Pacific slope but absent from Nicoya Peninsula and much of southwestern Costa Rica, present on Atlantic side of Central Valley.

***Geophis hoffmanni* (Peters, 1859)**
Figure 6F

Materials examined. COSTA RICA • 1; Puntarenas Province, Santa Elena de Monteverde, University of Georgia Costa Rica; 10.2806°N, 084.7985°W; 1052 m a.s.l.; 4 Jun. 2018; UGACR Herp Survey Team leg.

Identification. Very small, semi-fossorial snake (total length up to 30 cm). Dorsal coloration bluish gray to black. Venter uniformly white. Dorsal scales smooth. Supraocular scales present. Small head, tiny eyes. Two other *Geophis* Wagler, 1830 species potentially at UGACR: *G. brachycephalus* (Cope, 1871) has keeled dorsal scales (and often has red blotches on dorsum); *G. godmani* Boulenger, 1894 lacks supraocular scales and has conspicuous yellow venter.

Distribution. Common in disjunct populations on both Atlantic and Pacific slopes in Costa Rica. Does not overlap with similar *Geophis ruthveni* Werner, 1925 at UGACR.

***Imantodes gemmistratus* (Cope, 1861)**
Figure 6G

Materials examined. COSTA RICA • 1; Puntarenas Province, Santa Elena de Monteverde, University of Georgia Costa Rica; 10.2841°N, 084.7987°W; 1151 m a.s.l.; 1 May 2018; UGACR Herp Survey Team leg. • 1; same locality; 10.2830°N, 084.7960°W; 1092 m a.s.l.; 8 Mar. 2018; UGACR Herp Survey Team leg.

Identification. Long, extremely slender, arboreal snake (total length up to 93 cm). Large blunt head, enormous eyes with vertical pupils. Dorsum tan to brown, with brown bands or blotches that have pale centers and dark borders. Can be difficult to distinguish from *Imantodes cenchoa* (Linnaeus, 1758), but this species has widely expanded middorsal scale row (3–5× as wide as lateral scales), while *Imantodes gemmistratus* has moderately expanded middorsal scale row (1.5–2.5× as wide as lateral scales).

Distribution. Common on Pacific slope and in localized populations on Atlantic slope in Costa Rica.

Remarks. One individual found in electrical box by maintenance staff.

***Leptodeira septentrionalis* (Kennicott, 1859)**
Figure 6H

Materials examined. COSTA RICA • 1, dead; Puntarenas Province, Santa Elena de Monteverde, University of Georgia Costa Rica; 10.2820°N, 084.7931°W; 1079 m a.s.l.; 15 Apr. 2018; UGACR Herp Survey Team leg.

Identification. Small to medium-sized snake (total length up to 105 cm). Broad head, large eyes with vertical pupils. Dorsal coloration highly variable, often brown to reddish-brown with dark brown or black blotches. Venter pale. Quite similar to *Leptodeira rhombifera* (Günther, 1872), but this species has dark neck band connected to longitudinal stripe that extends onto head. In *Leptodeira septentrionalis*, if longitudinal stripe on head is present, it does not connect with first neck band.

Distribution. Common to abundant on both Atlantic and Pacific slopes in Costa Rica.

Remarks. Single individual encountered dead on road, possibly hit by car. Although features somewhat obscured, longitudinal stripe on head is clearly separate from first band on neck.

***Ninia maculata* (Peters, 1861)**
Figure 7A

Materials examined. COSTA RICA • 1; Puntarenas Province, Santa Elena de Monteverde, University of Georgia Costa Rica; 10.2826°N, 084.8029°W; 1089 m a.s.l.; 23 May 2018; UGACR Herp Survey Team leg. • 2; same locality; 10.2824°N, 084.7990°W; 1090 m a.s.l.; 25 Feb.–13 Jul. 2018; UGACR Herp Survey Team leg.

Identification. Small, thick-bodied snake (total length 233–352 mm). Highly variable dorsal color, but usually reddish-brown to gray with black nuchal band and many black spots or bars on either side of body. Venter with bold black and white checkerboard pattern. Distinctively keeled dorsal scales.

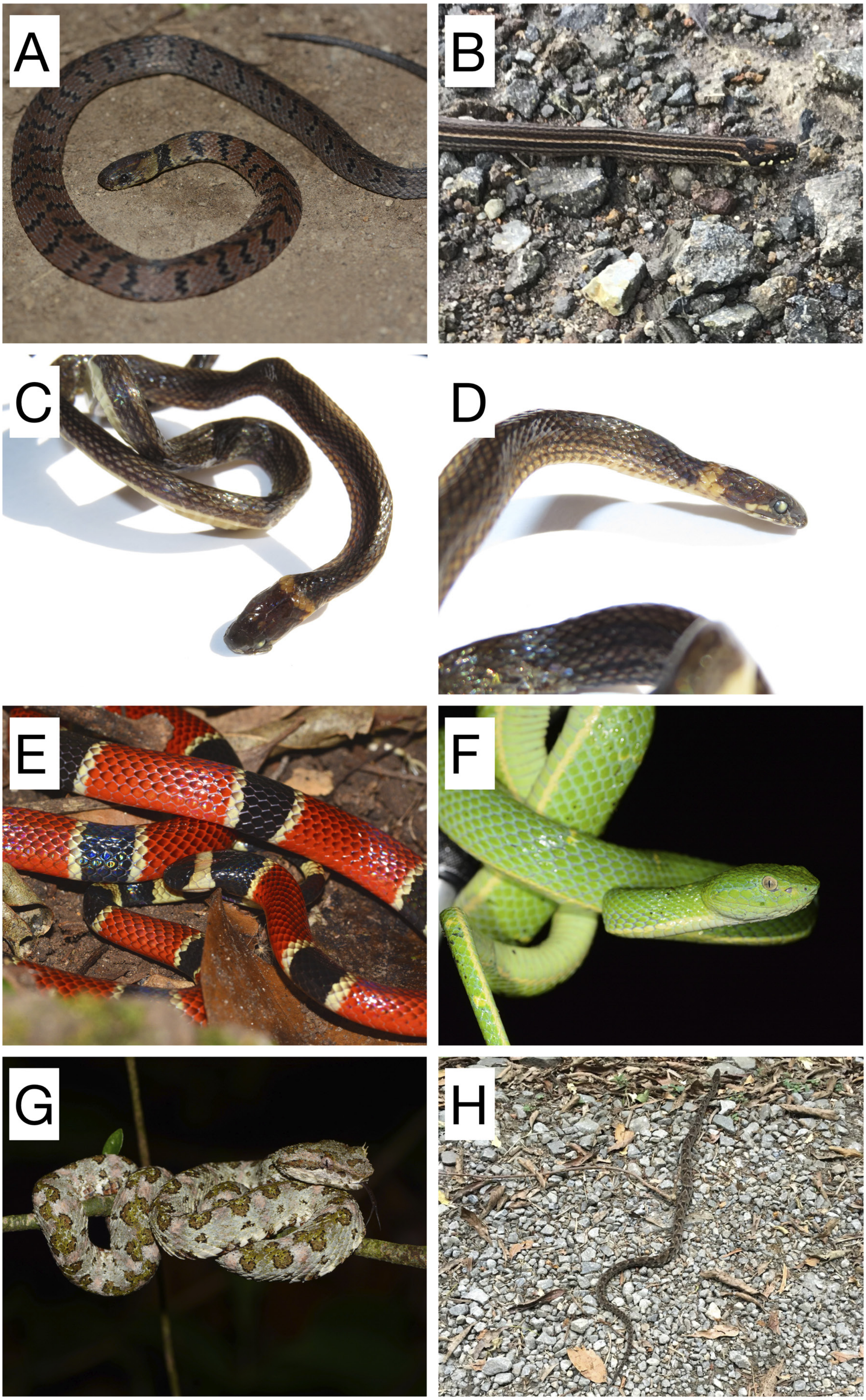

Figure 7. Dipsadid, elapid, and viperid snakes from the University of Georgia Costa Rica. **A.** *Ninia maculata*. **B.** *Rhadinella serperaster*. **C, D.** *Trimetopon pliolepis* (dead). **E.** *Micrurus nigrocinctus*. **F.** *Bothriechis lateralis*. **G.** *Bothriechis schlegelii*. **H.** *Bothrops asper*.

Distribution. Common on Atlantic slope and in scattered populations on Pacific slope in Costa Rica.

***Rhadinella serperaster* (Cope, 1871)**
Figure 7B

Materials examined. COSTA RICA • 1; Puntarenas Province, Santa Elena de Monteverde, University of Georgia Costa Rica; 10.2835°N, 084.7938°W; 1087 m a.s.l.; 27 Aug. 2018; UGACR Herp Survey Team leg.

Identification. Small, semi-fossorial snake (total length up to 50 cm). Small head, eyes with round pupils. Dorsum brown, with several dark and light longitudinal stripes that extend to sides. Venter white to pale yellow. Top of head dark brown with pair of pale brown blotches. Labial scales dark with white or cream spot. Unlikely to be confused with any other species in Monteverde.

Distribution. Present, but rarely seen, in isolated populations in Tilarán, Central, and Talamanca mountain ranges in Costa Rica.

***Trimetopon pliolepis* Cope, 1894**
Figure 7C, D

Materials examined. COSTA RICA • 1, dead; Puntarenas Province, Santa Elena de Monteverde, University of Georgia Costa Rica; 10.2824°N, 084.7990°W; 1090 m a.s.l.; 11 Jul. 2018; UGACR Herp Survey Team leg.

Identification. Very small, semi-fossorial snake (total length up to 277 mm). Small head, eyes with round pupils. Dorsum dark brown with darker longitudinal stripes. Pale yellow nuchal collar often connects to yellow-white venter. Nuchal collar often interrupted by dark middorsal line. Prefrontal scales fused into single plate. Very similar to *Trimetopon gracile* (Günther, 1872) in Monteverde, but this species has pair of light-colored spots (sometimes fused) on nape and not connected to pale ventral color.

Distribution. Rare in isolated populations in Atlantic lowlands, Central Valley, and Tilarán, Central, and Talamanca mountain ranges in Costa Rica.

Remarks. Single individual encountered dead on road.

Family Elapidae

***Micrurus nigrocinctus* (Girard, 1854)**
Figure 7E

Materials examined. COSTA RICA • 2; Puntarenas Province, Santa Elena de Monteverde, University of Georgia Costa Rica; 10.2824°N, 084.7990°W; 1090 m a.s.l.; 26 Jan.–10 May 2018; UGACR Herp Survey Team leg. • 1; same locality; 10.2841°N, 084.7987°W; 1151 m a.s.l.; 22 May 2018; UGACR Herp Survey Team leg. • 1; same locality; 10.2806°N, 084.7985°W; 1052 m a.s.l.; 7 Jul. 2018; UGACR Herp Survey Team leg. • 1; same locality; 10.2830°N, 084.7960°W; 1092 m a.s.l.; 10 May 2018; UGACR Herp Survey Team leg. • 1; same locality; 10.2820°N, 084.7931°W; 1079 m a.s.l.; 1 Feb. 2018; UGACR Herp Survey Team leg.

Identification. Medium-sized coral snake (total length up to 115 cm). Patterned with red, black, and cream to white rings. Red rings bordered on both sides by cream to white rings. Tail bicolor (black and cream/white) rather than tricolor. Body slender, cylindrical. Small, rounded head. Tiny, black eyes. Black cap covering snout and eyes has straight border with cream/white head band. Only other coral snake in Monteverde, *Micrurus alleni* Schmidt, 1936, has a black cap that extends backward into V-shape along center of head.

Distribution. Common, but often secretive, on Pacific slope of Costa Rica.

Remarks. On one individual, third black ring was present only on one half of body.

Family Viperidae

***Bothriechis lateralis* Peters, 1862**
Figure 7F

Materials examined. COSTA RICA • 1; Puntarenas Province, Santa Elena de Monteverde, University of Georgia Costa Rica; 10.2806°N, 084.7985°W; 1052 m a.s.l.; 24 May 2018; UGACR Herp Survey Team leg.

Identification. Large, arboreal pitviper (total length up to 95 cm). Adult coloration bright green with light ventrolateral stripe and short transverse bars or spots. Often has dark green postocular stripe. Pupils vertical.

Distribution. Common in montane forests of Guanacaste, Tilarán, Central, and Talamanca mountain ranges in Costa Rica.

***Bothriechis schlegelii* (Berthold, 1846)**
Figure 7G

Materials examined. COSTA RICA • 2; Puntarenas Province, Santa Elena de Monteverde, University of Georgia Costa Rica; 10.2824°N, 084.7990°W; 1090 m a.s.l.; 26 Mar.–15 Jul. 2018; UGACR Herp Survey Team leg. • 4; same locality; 10.2841°N, 084.7987°W; 1151 m a.s.l.; 6 Jan.–29 Jun. 2018; UGACR Herp Survey Team leg. • 6; same locality; 10.2806°N, 084.7985°W; 1052 m a.s.l.; 10 Jan.–6 Jul. 2018; UGACR Herp Survey Team leg.

Identification. Small to medium-sized, arboreal pitviper (total length up to 82 cm). Extremely variable in color pattern; all individuals encountered during survey were pale green to olive-green with brown, red, or pink blotches on dorsum, with white, black, and rufous blotches on venter. Can be identified by 1–3 spiky scales protruding above eyes. Pupils vertical.

Distribution. Common on both Atlantic and Pacific slopes of Costa Rica.

***Bothrops asper* (Garman, 1883)**
Figure 7H

Materials examined. COSTA RICA • 2; Puntarenas Province, Santa Elena de Monteverde, University of Georgia Costa Rica; 10.2806°N, 084.7985°W; 1052 m a.s.l.; 14 May–4 Jul. 2018; UGACR Herp Survey Team leg.

Identification. Large, mostly terrestrial pitviper (total length up to 246 cm). Distinctive color pattern: dorsum brown overall, with pale-edged triangular blotches on sides often fusing on midline to create a series of X-shaped or chevron markings. Underside of head yellow to cream. Unlikely to be confused with any other species in Monteverde.

Distribution. Common to abundant on both Atlantic and Pacific slopes in Costa Rica, excluding the Nicoya Peninsula.

Discussion

To our knowledge, this is the first peer-reviewed publication of a broad-scale herpetofaunal biodiversity survey in Monteverde in 20 years. Despite the high number of protected areas in the region, we were only able to find published herpetofauna lists for the Monteverde Cloud Forest Reserve (Hayes et al. 1989; Pounds and Fogden 2000). According to the most recent of these, 60 amphibians and 101 reptiles have been documented at the reserve. Species that we encountered that are not on this list (after accounting for taxonomic changes) include *Dendropsophus microcephalus*, *Coleonyx mitratus*, and *Hemidactylus frenatus*. This is not particularly surprising, as UGACR is lower in elevation than the Monteverde Cloud Forest Reserve; the first two species are more commonly found in lowland areas, and the third is invasive (Leenders 2016, 2019). At first pass, it may seem that UGACR's 48 herpetofauna species pales in comparison to the 161 in the Monteverde Cloud Forest Preserve, and much of this could potentially be attributed to the difference in habitat quality (primary vs secondary forest; Barlow et al. 2007) or the difference in sheer area of habitat (MacArthur and Wilson 1967). However, it is also unclear how accurate the Monteverde Cloud Forest Reserve's list is at the current time. For example, it includes both *Incilius periglenes* and *Atelopus varius,* neither of which has been seen in decades (Pounds and Crump 1994). We point this out not to be critical, but because it undermines any meaningful comparisons between the two lists. It also emphasizes the need for more current sampling of Monteverde, especially considering its known implications with herpetofaunal declines.

While we are unable to compare our list to that of any nearby reserves, we did find several relevant research projects conducted by undergraduates taking part in tropical ecology courses with the Council on International Educational Exchange (CIEE). Some of these projects have involved herpetofaunal surveys in the Monteverde region, with scopes ranging from all reptiles and amphibians to a single genus (Benjamin 2003; Place 2005; Schlimm 2007; Brossard 2011; Siebert 2017). Although the reports of these projects are not peer-reviewed, they offer valuable data regarding the presence or absence of species in the area. Generally speaking, the species that these projects have documented greatly overlap with those in our list, with the majority of discrepancies likely explained by differences in sample site elevation (many of the projects were done at higher elevations in Monteverde, which have notably different species assemblages than UGACR). However, at least two projects involved reptile and amphibian surveys in and around UGACR's property (a third is cited by Benjamin (2003), but the referenced report does not appear to be available anywhere). From 20 October 2003 to 14 November 2003, Benjamin (2003) found 14 species along transects at UGACR and an additional nine species in nearby San Luis. Of those 23 total species in the report, our survey documented 18. A more recent project targeted amphibian diversity at UGACR, using pitfall traps and drift fences to document two species of frogs (Brossard 2011), one of which was not documented in our survey. The species that were found during these two projects but not during our study were *Bolitoglossa robusta* (Cope, 1894), *Rana vaillanti* Brocchi, 1877, *Anolis woodi* (Dunn, 1940), *Holcosus undulatus* (Wiegmann, 1834), *Imantodes cenchoa* (Linnaeus, 1758), and *Leptodeira annulata* (Linnaeus, 1758). Although we are unable to confirm the accuracy of these observations based on the reports alone, we suspect that *Rana forreri* may have been mistaken for *Rana vaillanti*, as *R. forreri* was not documented in Brossard (2011) but is abundant in the exact location where the traps were installed, and because *R. vaillanti* is not known to occur above 880m in elevation anywhere in Costa Rica (Savage 2002; Leenders 2016). Nevertheless, it is entirely plausible that the other five of these species could be present on the campus of UGACR. We may have been unable to detect these species due to timing (wet vs dry season) or simply due to the low detection probability of many of these species (see below). In any case, we hope that our data can be combined with data generated during such CIEE projects to get a better sense of the species present in Monteverde.

Our results also highlight a fact that is often overlooked in herpetofaunal conservation studies: snakes are particularly hard to sample. Of the 23 species of snakes we encountered, nearly 70% of them were observed fewer than four times, and over 40% were observed only once. This may be attributable to low population densities for many species, but it could also be influenced by low detection probabilities (De Fraga et al. 2014), potentially inadequate (or nonexistent) trapping methods, or sampling bias towards diurnally active, non-fossorial snakes. These are important factors to consider when assessing trends in the presence and/or density of snake species in an area; are "observed" changes in biodiversity true changes or rather artifacts of detection probabilities and sampling biases? Moreover, it is worth noting that we had high proportions of infrequently encountered species even during a relatively long survey (more than eight months), suggesting that any sort of rapid assessment of biodiversity may have seriously underrepresented the true number of species present. We present these numbers and words of caution for snakes, but the same could be said for many secretive, nocturnal, and/or fossorial taxa.

Finally, our findings demonstrate the importance of Monteverde as a local biodiversity hotspot within the world-renowned biodiversity hotspot that is Costa Rica. Because the UGACR campus covers approximately 0.63 km^2, and Costa Rica as a country encompasses roughly 51,100 km^2, this means that UGACR takes up approximately 0.001% of the country's land. On UGACR's property, the forest is not particularly "pristine", and there are agricultural fields, roads, buildings, and manicured lawns interspersed throughout. Despite all of this, on this tiny sliver of land, we documented 13 amphibian and 35 reptile species, representing 6.3% and 14.3% of Costa Rica's amphibian and reptile diversity, respectively (Leenders 2016, 2019). This disproportionately high diversity of reptiles and amphibians compared to the small fraction of land area encompassed by UGACR speaks to the ideal combination of environmental conditions that facilitate the persistence of these species in the Monteverde region of Costa Rica. It also suggests that human-altered areas like UGACR are perhaps not the dead zones they were once considered to be and are certainly worthy of study, despite being relatively neglected by ecologists (Martin et al. 2012). Other well-known areas of diversity throughout Costa Rica, both inside and outside of protected areas, would benefit from similar up-to-date surveys of biodiversity. Moreover, the importance of not only conducting such surveys, but also getting them published, cannot be understated, as they are invaluable to understanding the status and trends of local populations and are therefore critical to making well-informed conservation decisions. Despite much evidence of species in decline, there is clearly much left to conserve, and biodiversity surveys like these are how we know where to start.

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Authors' Contributions

JDC conceptualized the study design, collected the data, provided the majority of photos, served as the authority on species identification, and wrote the manuscript. ECF, WKM, and JM assisted with trap setup, collected the data, provided photos, and assisted with species identification. JDC and JM constructed the map figure. MGC and JJMR provided guidance and advice on study design, as well as assisted with permit acquisition and project logistics.

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