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Finding a shadow in the dark: rediscovery of Fugler's Shadow Snake (*Emmochliophis fugleri* Fritts & Smith, 1969) after 54 years, with comments on its conservation status, distribution, and the tribe Diaphorolepidini

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Abstract

Herein we report the second known record of *Emmochliophis fugleri* Fritts & Smith, 1969, present the first color images of the species, extend its known distribution and elevational range, provide the snout–vent and tail lengths of the holotype, and demonstrate that the condition of fused prefrontals is an unreliable diagnostic character for the genus *Diaphorolepis*. Considering the rarity of this snake as well as the imminent threat that mining poses to the Río Manduriacu Reserve, we recommend a conservation status of Critically Endangered for *E. fugleri*.

Keywords

Critically Endangered, Ecuador, Imbabura, Río Manduriacu Reserve, threatened, threatened by mining

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Introduction

The snake tribe Diaphorolepidini was recently validated and defined to include the genera *Diaphorolepis* Jan, 1863, *Emmochliophis* Fritts & Smith, 1969, and *Synophis* Peracca, 1896 (Pyron et al. 2016). These snakes are relatively small and slender, distributed in the Darien of Panama and northern Andes of South America, and are reportedly diagnosed by the following apomorphies: fused prefrontals, an expanded vertebral scale row (*Diaphorolepis*), and expanded zygapophyses and neural spines in adults (*Emmochliophis* and *Synophis*; Pyron et al. 2016). However, even though the state of the prefrontal in *Diaphorolepis* is noted to be fused or divided

by Bogert (1964) and Pérez-Santos and Moreno (1988, 1991), such variation is not recognized in more recent literature (e.g., Pyron et al. 2015, 2016). A recent molecular phylogeny supports this grouping, although the position of *Emmochliophis* remains unclear as tissue from this taxon has been unavailable but is suspected to be the sister-taxon of *Synophis* (Hillis 1990; Pryron et al. 2015, 2016).

Emmochliophis is an enigmatic genus that was described by Fritts and Smith (1969) following the discovery of a museum specimen collected from Santo Domingo de los Tsáchilas Province, Ecuador (considered within Pichincha Province at the time), which exhibited a unique condition of the trunk vertebrae that consists of expanded zygapophyses that form a rod-and-groove mechanism. As a result, Fritts and Smith (1969) designated this specimen as the holotype for *E. fugleri*. Due to a lack of additional material, the taxon remained poorly described for 21 years following its original description. Hillis (1990) later determined that *Synophis miops* Boulenger, 1898 warranted a transfer to *Emmochliophis* on the basis of numerous shared characters with *E. fugleri*, but without knowledge of the condition of the vertebrae in *E. miops*. The latter character was later described by Sheil (1998). Despite the addition of *E. miops* to the genus, it did not yield new material as it was also known only from the holotype, collected by W.F.H. Rosenberg in northwest Ecuador in the late 19th century (Boulenger 1898). Additional specimens of either taxon would not be reported until 2018, when *E. miops* was observed from Parque Nacional Natural Munchique, Cauca Department, Colombia (Vera-Pérez et al. 2018). The discovery marked the first record of the species in 120 years and yielded the first color photographs and a redescription of the species (Vera-Pérez et al. 2018, 2020). The authors also proposed standardized common names for *Emmochliophis* spp., suggesting Fugler's Shadow Snake for *E. fugleri*—a more appropriate name compared to Pinchinda Snake (a misspelling of Pichincha) listed on the Reptile Database (http://reptile-database.org, accessed: 2020-9-18) and therefore iNaturalist (Vera-Pérez et al. 2020).

While conducting fieldwork at the Río Manduriacu Reserve (RMR) in western Imbabura Province, Ecuador, we came across a small, dark snake and initially thought it to be one of two relatively common species of *Ninia* Baird & Girard, 1853 known from the region—*N. atrata* (Hallowell, 1845) is already known to occur at RMR—albeit a peculiar looking individual. However, upon closer inspection of photographs taken of the snake and a review of relevant literature, the observation was instead identified as *E. fugleri*. As a result, we herein report the first record of *E. fugleri* in 54 years, extend its known distribution nearly 100 km north-northeast of the type locality and expand the elevational range more than 600 m higher than that of the holotype, evaluate its conservation status, and present the first color photographs of the species. We also report meristic and morphometric data and reaffirm variation in the state of the prefrontals in *Diaphorolepis wagneri* Jan, 1863, thereby

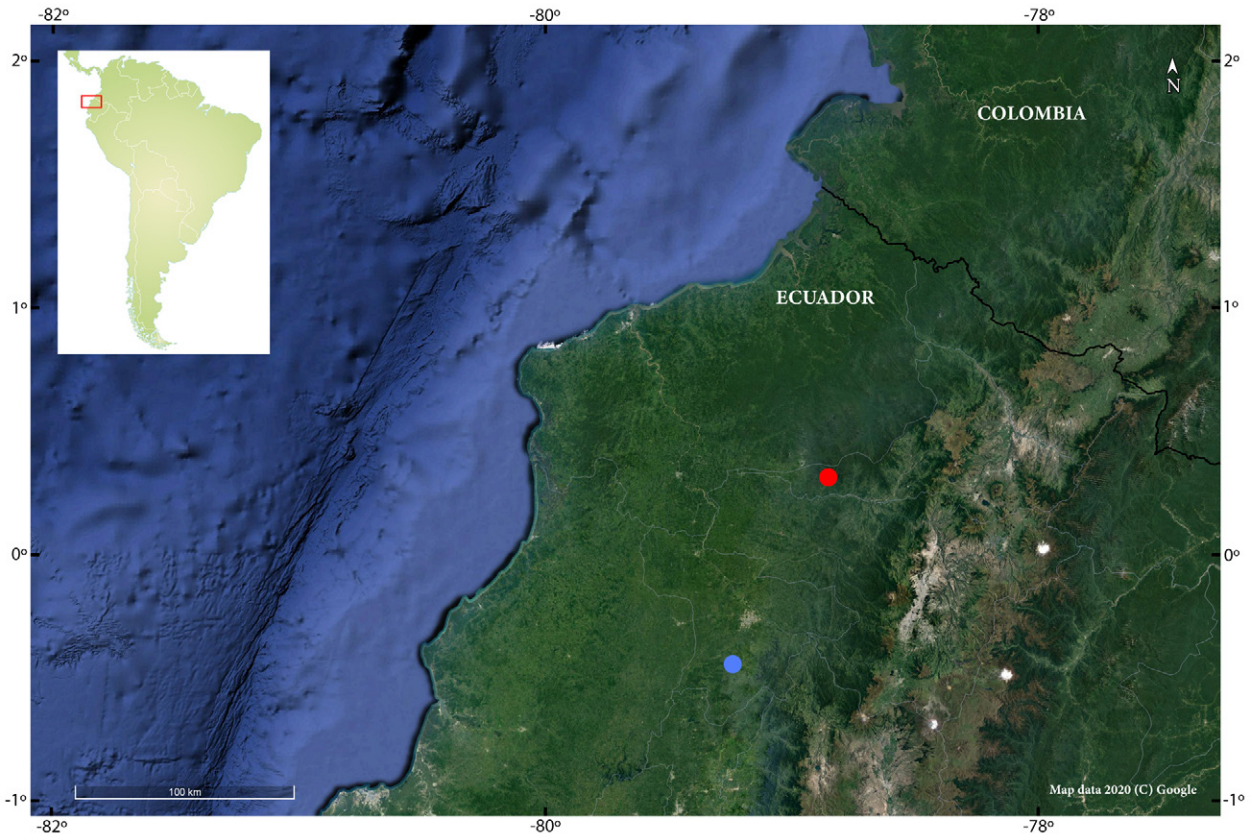

Figure 1. Distribution map depicting the two known records of *Emmochliophis fugleri*. Blue circle marks the type locality in Pinchincha Province, Ecuador; red circle represents the Río Manduriacu Reserve, Imbabura, Ecuador. Map data © 2020 Google.

Table 1. Meristic and morphometric data for *Emmochliophis fugleri* compared to similar species. Data for similar species were taken from the reference listed below each taxon; measurement ranges demonstrate variation presented by those sources. Abbreviated characters correspond to: DSR (dorsal scale rows), VSR (vertebral scale row), VSK (vertebral scale keel), SVL (snout–vent length), TL (tail length).

Character	*Emmochliophis fugleri*		*E. miops*	*Diaphorolepis wagneri*	*Ninia atrata*	*N. teresitae*	*Synophis bicolor*	*S. calamitus*
	UIMNH 78795	LBE-USFQ-F-2020-001	(Vera-Pérez et al. 2020)	(Pyron et al. 2015)	(Angarita-Sierra & Lynch 2017)		(Pyron et al. 2016)	
Loreal	Absent	Absent	Absent	Present	Present	Present	Present	Present
Prefrontals	Fused	Fused	Fused	Fused/divided	Divided	Divided	Fused	Fused
Supralabials	8	8	8	8–9	6–8	7	8	7–9
Infralabials	8	8	8	10–13	7–9	8	9–11	8–11
Preoculars	1	1	1–2	—	—	—	—	—
Postoculars	2	2	1–2	1–3	1–2	—	2	0–2
Temporals	1+2	1+2	1+2	—	1+(2–3)	1+2	—	—
DSR	19-19-19	19-19-19	19-19-19	21(19)-19-17	19-19-19	19-19-19	19-(17–19)-17	(19–23)-19-(16–17)
VSR	Unexpanded	Unexpanded	Unexpanded	Expanded	Unexpanded	Unexpanded	Unexpanded	Unexpanded
VSK	Single	Single	Single	Double	Single	Single	Single	Single
Ventrals	140	134	137–141	181–197	133–169	143–160	174–183	157–166
Subcaudals	97	88	90–94	98–141	36–70	53–69	129–143	96–125
SVL	259 mm	229 mm*	142–258 mm	276–524 mm	102–370 mm	198–346 mm	361–406 mm	142–507 mm
TL	132.5 mm	116 mm*	68–135 mm	129–259 mm	—	—	233–245 mm	66–283 mm
Nuchal collar	Absent	Absent	Present	Absent	Present/absent	Present/absent	Absent	Absent

* Denotes estimated value (see Results)

demonstrating it to be an unreliable diagnostic character for *Diaphorolepis*.

Methods

We conducted field surveys at the Río Manduriacu Reserve (RMR), Imbabura, Ecuador (Fig. 1). Habitat at RMR consists of mature lower montane forest and primary cloud forest, with small, moderately disturbed forest areas at the lower reaches. Data reported here was collected during an ongoing effort to study the amphibian and reptile assemblages at the reserve, with a focus on threatened taxa. Sampling methodology primarily included nocturnal visual encounter surveys along established trails in both primary and secondary forest, within small streams, and adjacent to larger streams and rivers situated within and just outside of the reserve. Time frames for when herpetofauna have been sampled for are outlined by Guayasamin et al. (2019) and Maynard et al. (2020).

The key to the species of Diaphorolepidini presented in Pyron et al. (2016) combined with the description of *Emmochliophis fugleri* by Fritts and Smith (1969) was used for identification. Scale counts and scutelation follow Dowling (1951). Ambient temperature and humidity were measured using a Kestrel 3500 Weather Meter. Photographs of the live specimen are indexed in the digital repository of Universidad San Francisco de Quito (USFQ). We searched for potentially overlooked observations of *E. fugleri* by utilizing the CalPhotos (http://calphotos.berkeley.edu), iNaturalist (http://inaturalist.org), and VertNet (http://portal.vertnet.org) databases. Images of similar species to *E. fugleri* were examined for distinguishing meristic and morphological characters (see Results; Table 1). Similar species were limited to those that have overlapping or nearby distributions to that of *E. fugleri* (i.e., *Diaphorolepis wagerni*, *Ninia atrata*, *N. teresitae* Angarita-Sierra & Lynch, 2017, *Synophis bicolor* Peracca, 1896, and *S. calamitus* Hillis, 1990). Research was conducted under permit no. 019-2018-IC-FAU-DNB/MAE, authorized by the Ministerio del Ambiente del Ecuador, and carried out in accordance with the guidelines for the use of live amphibians and reptiles in field and lab research (Beaupre et al. 2004) compiled by the American Society of Ichthyologists and Herpetologists, the Herpetologists' League, and the Society for the Study of Amphibians and Reptiles.

Results

Emmochliophis fugleri **Fritts & Smith, 1969**
Figures 2, 3

New records. ECUADOR • Imbabura Province, Río Manduriacu Reserve; 00.3095°N, 078.8573°W, 1221 m; 07 Mar. 2019; Scott Trageser and Ross Maynard leg.; observed in mature lower montane forest at 22:20 h, slowly moving through leaf litter adjacent to moss-covered boulders along the embankment of a narrow, 15-m wide

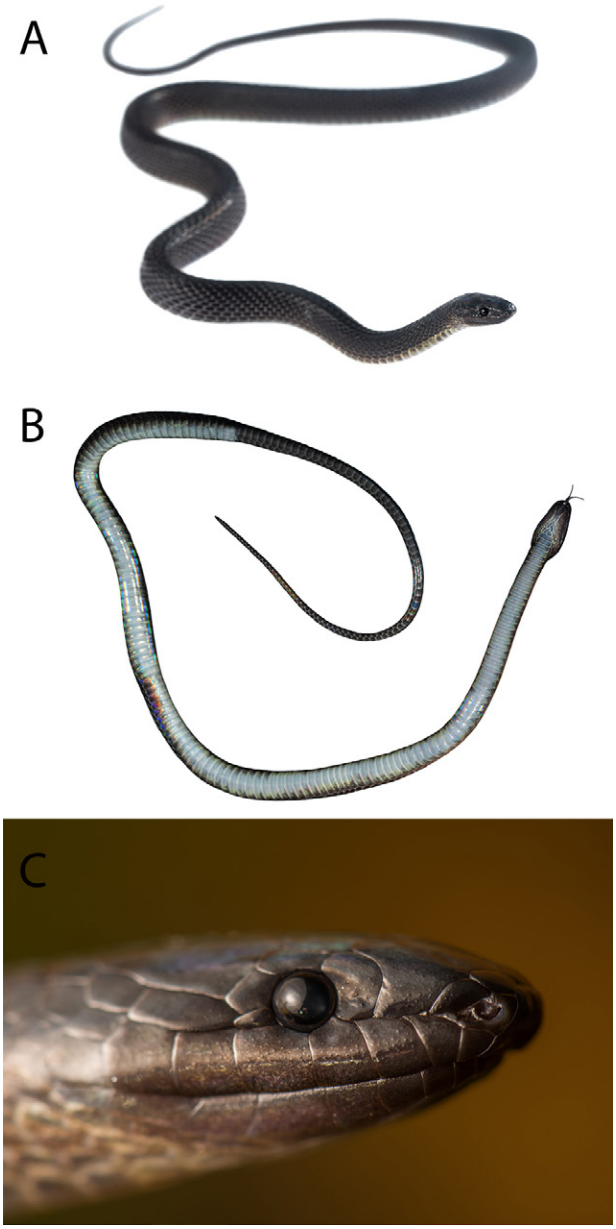

Figure 2. *Emmochliophis fugleri* in life. **A.** Dorsal view, LBE-USFQ-F-2020-001. **B.** Ventral view, LBE-USFQ-F-2020-002. **C.** Lateral view of head, LBE-USFQ-F-2020-003. Images: RJM (A,B); SJT (C).

Figure 3. *Emmochliophis fugleri* holotype UIMNH 78795 **A.** Dorsal view of head. **B.** Ventral view of head. **C.** Full body. Images provided by Daniel B. Wylie.

stream; 19.8 °C, 96% relative humidity, and light rain; photo vouchers LBE-USFQ-F-2020-001–03; 1 adult, uncollected.

Based on this record and the holotype, *E. fugleri* appears to be restricted to the foothills and lower occidental slopes of the Andes in northwestern Ecuador. The type specimen was reported from 4 km east of the Río Baba bridge, 24 km south of Santo Domingo de los Colorados, Santo Domingo de los Tsáchilas, ca. 600 m (Fritts and Smith 1969). Our record from western Imbabura Province extends its known distribution ca. 93 km in a straight-line to the north-northeast (Fig. 1) and expands the elevational range from 600 to 1221 m. Examination of photos from online databases of similar species (i.e., *Diaphorolepis wagneri*, *Ninia atrata*, *N. teresitae*, *Synophis bicolor*, *S. calamitus*) did not yield previously overlooked observations of *E. fugleri*.

Identification. Characters exhibited by the individual observed at RMR that confirm its identity as *Emmochliophis fugleri* include: (1) vertebral scale row not expanded, single keel; (2) dorsal scales keeled, in 19-19-19 rows; (3) fused prefrontals; (4) loreal absent; (5) one preocular; (6) two postoculars; (7) temporals 1+2; (8) eight supralabials, 4th and 5th in contact with orbit; (9) eight infralabials ; (10) 134 ventrals; (11) 88 subcaudals, divided (complete tail); (12) anal plate entire; (13) dorsum uniformly black/dark grey (in life), nuchal collar absent; (14) venter off-white from the second pair of chin shields to the anal plate, dark brown/copper where the dorsal/ventral colorations transition along the lower flanks/lateral peripheries of the venter; ventral surface of head dark grey/diffuse brown, ventral surface of tail dark grey (Fig. 2; Table 1).

The following characters exhibited by LBE-USFQ-F-2020-001–03 distinguish it from other members of Diaphorolepidini, as well as other similar species: prefrontals fused (divided in *Ninia* spp.), an unexpanded intervertebral scale row with a single keel (expanded with a double keel in *Diaphorolepis* spp.); loreal scale absent (present in *Diaphorolepis* spp., *Ninia* spp., and *Synophis* spp.); and lacking a white nuchal band (white nuchal band present in *E. miops*; Figs. 2, 4; Table 1). Members of the genus *Atractus* Wagler, 1828 are readily distinguished from *Emmochliophis* by the presence of smooth scales and a single pair of chin shields.

Conservation status. Despite *Emmochliophis fugleri* and *E. miops* being known only from their respective

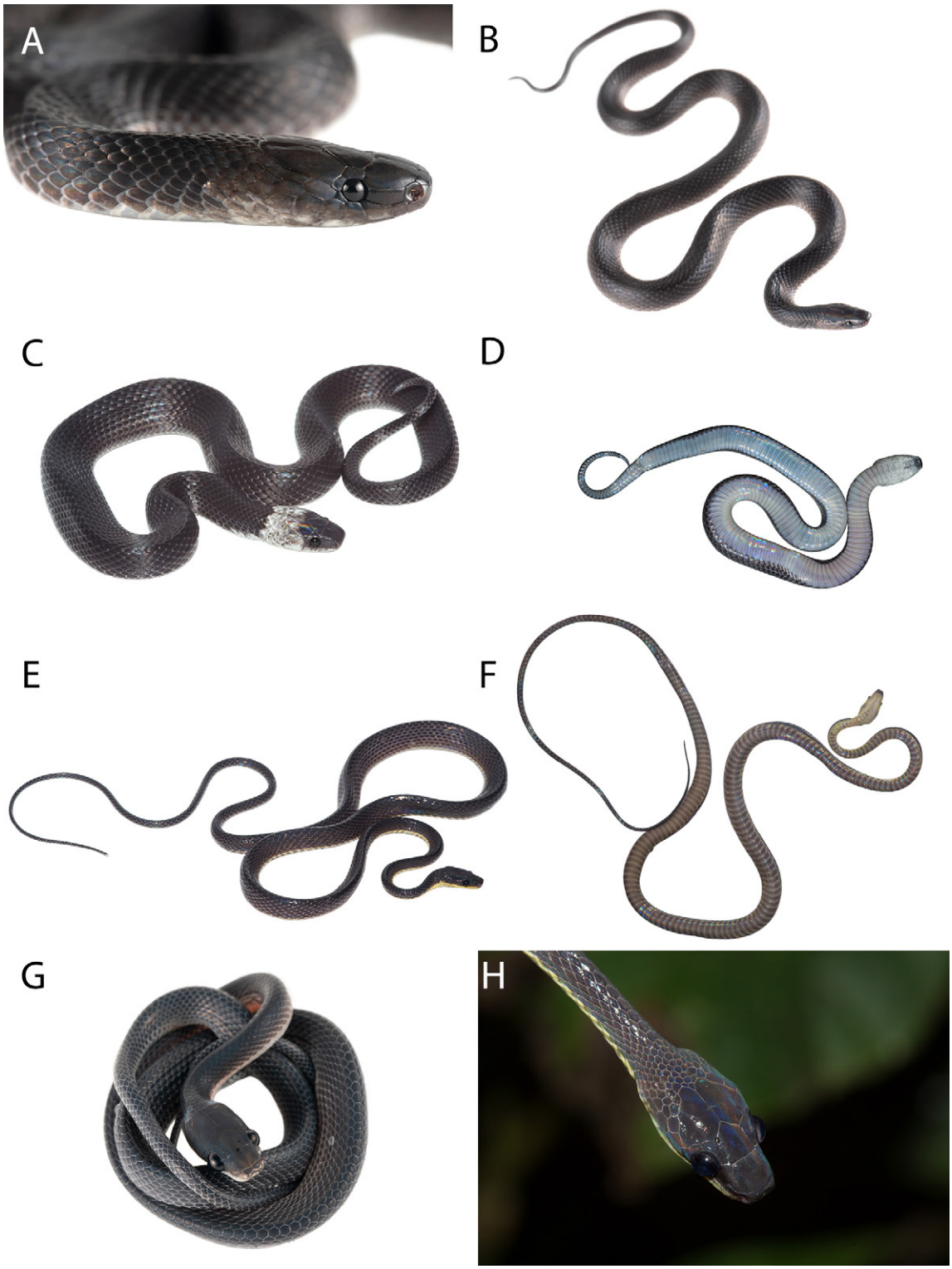

Figure 4. Similar species to *Emmochliophis fugleri* known from the Río Manduriacu Reserve and nearby sites. **A, B.** *Ninia teresitae* without white nuchal band (from Estación Biológica Jevon, Esmeraldas, Ecuador). **C, D.** Dorsal and ventral view of *Ninia atrata* from RMR with nuchal band **E, F.** Dorsal and ventral view of an adult *Diaphorolepis wagneri* from RMR. **G, H.** Examples demonstrating variation in the condition of the prefrontal in *D. wagneri*: (**G**) divided; (**H**) fused. Images: JC (A, B, G); RJM (C–F, H).

holotypes at the time they were last assessed for the IUCN Red List, *E. fugleri* was assessed as Data Deficient (Cisneros-Heredia and Yánez-Muñoz 2016) and *E. miops* as Critically Endangered (Cisneros-Heredia and Yánez-Muñoz 2017). We recommend the status of *E. fugleri* to be reclassified from Data Deficient to Critically Endangered based on criterion B2ab(ii,iii,iv), as this species has one location where the threat is mining (Roy et al. 2018; Guayasamin et al. 2019). Moreover, no additional specimens have been reported from within the area between the type locality and RMR, which is largely characterized by severe forest fragmentation due to timber extraction, agriculture, and cleared pastures, which continue to expand in the immediate area south of the reserve (Maynard et al. 2020).

Remarks. The snout–vent length (SVL) and tail length (TL) of the holotype (UIMNH 78795) have not previously been reported and are as follows: SVL = 259.0 mm; TL = 132.5 mm (tail slightly incomplete; Fig. 3). The SVL and TL of the specimen from RMR were not measured; however, we estimate the total length (SVL + TL) to be ca. 345.0 mm. Based on the size of the three measured specimens of *E. miops* (Vera-Pérez et al. 2020) as well as the holotype of *E. fugleri*, we suspect the individual of *E. fugleri* from RMR was a young adult. Our estimate of its TL is based on the snake's relative size to the glass plate on which it was placed for images of the venter. If we then take the average of the TL/SVL ratios for the two specimens of *E. miops* that have complete tails and the holotype of *E. fugleri* (only tip of tail missing), a rough estimate of the SVL and TL of voucher LBE-USFQ-F-2020-001 yields 229 mm and 116 mm, respectively (Table 1).

Diagnostic apomorphies in Diaphorolepidini. Although the presence of fused prefrontals is reported as diagnostic for all members of the tribe (Pyron et al. 2016), observations of *Diaphorolepis wagneri* from RMR have exhibited both divided and fused prefrontals (Fig. 4). Therefore, a fused prefrontal is not a definitive diagnostic character for *Diaphorolepis*, or rather should not be considered as an identifying meristic character used to distinguish *Diaphorolepis* when the prefrontals are divided.

Discussion

The discovery of *Emmochliophis fugleri* at the Río Manduriacu Reserve represents the first record of the species since the holotype was collected in 1966 (i.e., 54 years). Considering that our observation of *E. fugleri* and the recent rediscovery of *E. miops* by Vera-Pérez et al. (2020) were both tentatively field-identified as one of the more common *Ninia* species due to their similarities in appearance (i.e., small size, black dorsum, light venter, dark eyes, and a white nuchal band that may be present or absent), the absence of misidentified observations from our search of online databases is somewhat surprising and further suggests that these species are indeed rare. Moreover, although the site of observation of *E. fugleri* in RMR is the most thoroughly surveyed area of the reserve, no other observations have been made.

It appears that both members of *Emmochliophis* require humid, interior forest conditions (Cisneros-Heredia and Yánez-Muñoz 2016; Cisneros-Heredia and Yánez-Muñoz 2017; Vera-Pérez et al. 2020). When the holotype of *E. fugleri* was collected 54 years ago, the general area in which it was found was described as being "covered largely with banana plantations broken only occasionally by patches of rain forest" (Fritts and Smith 1969: 64). Considering the substantial amount of deforestation that has occurred in this region of western Ecuador, which largely began less than a decade prior to the holotype being collected (Dodson and Gentry 1991), it seems unlikely that this species still persists at the type locality. Based on the coordinates provided in Pyron et al. (2015), these small forest fragments lie immediately east of where the holotype was collected and represent a small chain of hills extending west from the base of the Andes that form a narrow backbone of higher elevation from the surrounding area (i.e., 700–950 m). However, it is unclear if deforestation had isolated these forested hills at the time the holotype was collected. Based on the two known localities of *E. fugleri*, it is also unclear whether or not the species is primarily an inhabitant of the humid forests of the Chocoan lowlands or the lower Andean forest of the Occidental slopes in northwestern Ecuador.

Future studies should assess the phylogenetic position of the genus, and to confirm that *E. fugleri* and *E. miops* are indeed distinct lineages. Nevertheless, the presence of *E. fugleri* at RMR further demonstrates the conservation importance of the reserve (Lynch et al. 2014; Guayasamin et al. 2019; IUCN SSC Specialist Group 2019, 2020; Maynard et al. 2020; Reyes-Puig et al. 2020).

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Authors' Contributions

RJM wrote the manuscript; RJM, JC, SK, and SJT conducted field work; RJM and JC performed the literature review; JC created the distribution map; RJM created the remaining figures, with photo contributions from RJM, SJT, and JC; JMG accessioned photo vouchers; SJT, JC, SK, and JMG reviewed and provided input on the manuscript.

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