Short Communication

Endemic Ecuadorian glassfrog *Cochranella mache* is Critically Endangered because of habitat loss

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Abstract Amphibians are one of the most threatened animal groups. In the Family Centrolenidae c. 50% of the species are declining and threatened with extinction. One of these is the glassfrog *Cochranella mache,* endemic to seasonal evergreen forests of the West Ecuadorian region and restricted to highly fragmented forest of < 100 km^2 in the Cordillera Mache-Chindul, north-western coastal Ecuador, at 100–640 m. We surveyed this region to elucidate the distribution and conservation status of *C. mache*. We located it in three new localities and also found a museum specimen from a further new locality. We recommend that the species should be categorized as Critically Endangered because of the continuous and progressive destruction of its increasingly fragmented habitat. Recent surveys of glassfrog species sympatric with *C. mache* showed low relative abundances compared to surveys in the 1970s and 1980s. Because of the relationship between forest and local climate we suggest that gradual declines of lowland glassfrog populations may be caused by local climate changes produced by forest destruction. In situ conservation is required to halt and mitigate these impacts. Further research on the effects of habitat loss, fragmentation, and associated climate changes on Neotropical amphibians is required.

Keywords Amphibian decline, Centrolenidae, climate change, *Cochranella mache*, Critically Endangered, Ecuador, habitat degradation

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Nearly one-third of amphibian species worldwide are threatened and many are already extinct (Stuart et al., 2004). A large proportion of these threatened amphibians inhabit tropical America, where habitat degradation and loss, infectious diseases and climate change are the major threats (Stuart et al., 2004; Lips et al., 2005). While most attention has focused on the interactions between disease and climate change because of a link with dramatic declines (Lips et al., 2006; Pounds et al., 2006; Lawrence, 2008), little research and few conservation efforts have focused on the effects of habitat change on tropical amphibians (Becker et al., 2007; Gardner et al., 2007). About 50% of the glassfrog species (family Centrolenidae) are declining and 40% are threatened (Bustamante et al., 2005; IUCN, 2008). Diseases and global warming have been linked to some of these declines (Pounds et al., 1999; Lips et al., 2006) but the causes of most remain poorly understood (IUCN, 2008).

Cochranella mache is a recently described glassfrog endemic to Ecuador, categorized as Endangered on the IUCN Red List based on the limited information available from its original description (Guayasamin & Bonaccorso, 2004; IUCN, 2008). To provide further information on the species we undertook visual encounter surveys and standardized visual transect sampling (≥ 25 person-hours per site) across 14 localities in western Ecuador over 2004–2007 (Appendix 1) and examined museum collections (Appendix 2).

The species was previously known only from its type-locality, Bilsa (Site 6; Table 1, Fig. 1; Guayasamin & Bonaccorso, 2004; Cisneros-Heredia & McDiarmid, 2007). We found *C. mache* in three new localities and a museum specimen from one additional locality (Site 15): one male at Monte Saino (Site 5) after c. 96 person-hours of searching, one female at Canandé (Site 4) after c. 40 person-hours, and a male near Quinindé (Site 7) after c. 25 person-hours (Table 1). At Bilsa a male was found previously after 85 person-hours (G. Vigle, pers. comm.) and two males after 40 person-hours (Guayasamin & Bonaccorso, 2004) but we did not record any individuals in 40 person-hours of searching in the same location in December 2006.

C. mache is known to deposit egg clutches on the top of leaves over well-oxygenated streams and its tadpoles fall into the water and burrow in debris (Guayasamin & Bonaccorso, 2004; Cisneros-Heredia & McDiarmid, 2007; Cisneros-Heredia et al., 2008) but otherwise little is known

TABLE 1 Details of all known records of *Cochranella mache* (see numbered sites in Fig. 1). All are in the Province of Esmeraldas, Ecuador.

Site no, location (altitude, m), distance to type locality	Date	Sex	Museum reference no.*
4, Reserva Canandé (270), c. 60 km ENE	24 June 2005	F	DHMECN 3560
5, Monte Saino, Punta Galeras area (100), c. 50 km NNW	21 Oct. 2004	M	DHMECN 2611
6, Reserva Bilsa (510), type locality	3 July 2000 8 Jan. 2003	M	KU 291176, QCAZ 22412–13
7, 3 km NW Quininde (150), c. 25 km E	23 Mar. 2005	M	DFCH-USFQ LQ23 (photograph)
15, Río La Carolina (650), c. 140 km NE	Nov. 2005		QCAZ 27747

*See Appendix 2

of its biology. All known records are from riverine areas in primary and old secondary forests. It has not been found in recent secondary forest, small isolated forest patches, or agricultural/suburban areas. All known localities (Table 1) are restricted to the Cordillera Mache-Chindul and surrounding areas in the Province of Esmeraldas. This is an isolated mountain range in the northernmost portion of Cordillera de la Costa, the mountain chain that runs parallel and independently from the Andes along the Pacific coast of Ecuador. The species is restricted to altitudes of 100–640 m. All records are from seasonal evergreen forests, a moist forest formation endemic to the West Ecuadorian region (the biogeographical area between the humid non-seasonal Chocó and xeric highly-seasonal Tumbesian regions; Cisneros-Heredia, 2006, 2007). The northernmost record is consistent with the distribution patterns of most endemic species of the West Ecuadorian region (Cisneros-Heredia, 2006, 2007). Based on the distribution of seasonal evergreen forests along the Cordillera Mache-Chindul, *C. mache*'s range may extend to the south, reaching the Mache-Chebe-Tabiaza Rivers, the southernmost limit of the Cordillera.

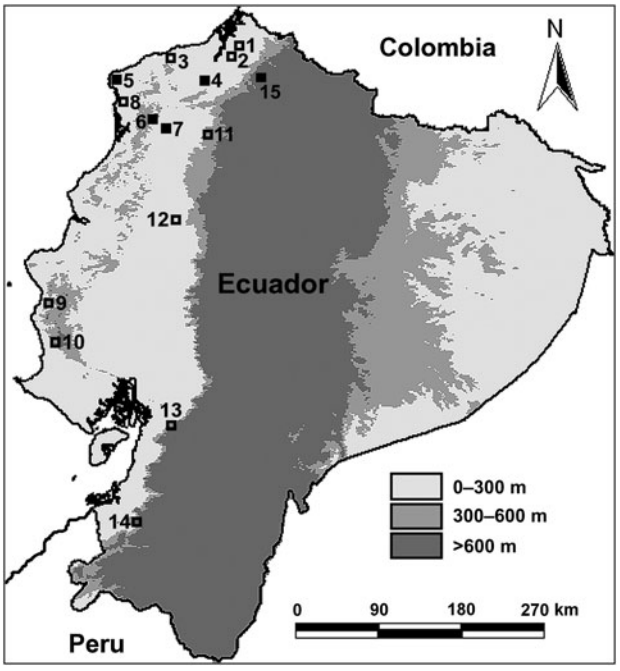

FIG. 1 Ecuador, showing the 14 localities surveyed for *Cochranella mache* in western Ecuador (Appendix 1) and the four where the species was found (shaded squares; Table 1): 4, Reserva Canandé; 5, Monte Saino, Punta Galeras area; 6, Reserva Bilsa (type locality); 7, Quinindé. Site 15, Río La Carolina, is the location of a museum specimen.

Deforestation in western Ecuador is extensive (Dodson & Gentry, 1991) and < 100 km^2 of primary or old secondary forests remain on the Cordillera (18–20% of the original forested area). The remnant forests are highly fragmented, with the largest single block < 16–18 km^2, and deforestation rates are c. 3–5% per year (Dodson & Gentry, 1991; Mudd, 1991; Paredes & Tapuyo, 1998; Conservation International, 2001; Kvist et al., 2004; and remote-sensing analyses by DFC-H based on Hansen et al., 2006 and Mulligan, 2007). Although the range of *C. mache* is partially within the Mache-Chindul Ecological Reserve, most conservation measurements are ineffective because of institutional and funding restrictions and a lack of law enforcement. Some of the larger fragments are preserved by private organizations but many remain unprotected. Habitat degradation is mainly caused by unsustainable timber extraction, uncontrolled expansion of the agricultural frontier, and replacement by non-native plantations.

The categorization of *C. mache* as Endangered (IUCN, 2008) underestimates its threatened status. Our data suggest that, inferred from the destruction of its habitat, *C. mache* has suffered a large reduction in its range since the mid 1990s. The current known range is small and even if it extends across the entire Cordillera Mache-Chindul it will be < 100 km^2. We recommend that *C. mache* be categorized as Critically Endangered based on criteria A2c, B1ab(i,ii,iii,iv) (IUCN, 2001) as its range is extensively fragmented and continued declines of its extent, habitat quality and number of localities and subpopulations are inferred.

While many lowland glassfrogs are conspicuous members of riverine communities, *C. mache* is scarce even in well-preserved areas. It may be naturally rare or not easily detected because of sampling bias (common survey methods fail to record canopy specialists, D.F. Cisneros-Heredia,

pers. obs.), or it may have been affected by gradual population declines such as those reported by Whitfield et al. (2007). Lack of long-term data hinders drawing further conclusions but data available for two glassfrogs sympatric with *C. mache*, *Centrolene prosoblepon* and *Hyalinobatrachium fleischmanni*, suggest that lowland glassfrog populations in western Ecuador may have suffered gradual population declines in the past 3 decades. *C. prosoblepon* and *H. fleischmanni* were the most abundant glassfrogs in surveys by KU and USNM (see Appendix 2 for museum abbreviations) in the late 1970s and early 1980s, and also in surveys by us, DHMECN and QCAZ in the 2000s. Combined relative abundances in the earlier surveys were 0.4–2.0 per person-hour in three localities, whereas they were 0.1–0.4 per person-hour in recent surveys in the same localities (Bustamante et al., 2005; R.W. McDiarmid & K. Miyata, unpubl. data; Cisneros-Heredia et al., unpubl. data; DHMECN, unpubl. data; QCAZ, unpubl. data).

Deforestation in lowland areas has been found to modify micro- and meso-scale climate through changes in albedo, evapotranspiration, roughness, cloudiness, rainfall and seasonality patterns (Lawton et al., 2001; Durieux et al., 2003; Ray et al., 2006; Pielke et al., 2007). As $>70\%$ of forests across western Ecuador have been felled (Dodson & Gentry, 1991; Sierra, 1999; Kvist, 2004) this may have induced changes in local climate patterns of nearby well-preserved areas and thus affected amphibians. Further studies are required to test this hypothesis. However, most areas with rich amphibian diversity are undergoing high rates of habitat degradation (Gallant et al., 2007), the effects of which may be as deleterious as the extirpations caused by disease and global warming. In situ conservation actions are urgently needed and should include reinforcement of existing protected areas, establishment of new ones, and development of mitigation strategies, including habitat restoration and creation of incentives to foster conservation. Future research on the distribution, habitat preferences, population ecology, home ranges and dispersal capacity of glassfrogs is required, along with knowledge of the impacts of edge effects, habitat modification, and micro- and meso-scale climate changes. Researchers at DHMECN have begun these studies for West Ecuadorian endemics.

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Appendices 1-2

The appendices for this article are available online at http://journals.cambridge.org

Biographical sketches

Diego F. Cisneros-Heredia studies the systematics, biogeography and conservation of Ecuadorian biodiversity, particularly amphibians and reptiles, and is a member of the IUCN Amphibian Specialist Group. Jesse Delia has conducted herpetological surveys in Ecuador since 2004, studying the ecology and reproductive biology of riparian amphibians. Mario H. Yánez-Muñoz studies the taxonomy, biogeography and conservation of amphibians and reptiles in Ecuador and is a member of the IUCN Amphibian Specialist Group. H. Mauricio Ortega-Andrade has conducted herpetological surveys across Ecuador, with an emphasis on threatened species.