First record of the Normandia Caecilian *Caecilia crassisquama* Taylor, 1968 (Amphibia: Gymnophiona: Caeciliidae) from Peru

Primeiro registro da cecília-da-normandia, *Caecilia crassisquama* Taylor, 1968 (Amphibia: Gymnophiona: Caeciliidae), do Peru

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Abstract: We report the first record of *Caecilia crassisquama* Taylor, 1986 (Caeciliidae) in the Central Cordillera of the Andes, Peru. A single individual was found at the Tabaconas Namballe National Sanctuary, Cajamarca department, Northern Peru. The specimen was collected in a montane forest at an altitude of approximately 1,990 m. It was identified mainly by the count of primary grooves, the absence of secondary grooves, and other morphological characters. This represents the southernmost record for the species at 345.5 km from the type locality in Ecuador. We also present the coloration in life of the species. Our record increases the number of *Caecilia* species known in Peru to seven.

Keywords: Caecilians. Montane forests. Tabaconas Namballe. Central Andean Cordillera.

Resumo: Apresentamos o primeiro registro de *Caecilia crassisquama* Taylor, 1986 (Caeciliidae) na Cordilheira Central dos Andes, do Peru. Um único espécime foi encontrado no Santuário Nacional Tabaconas Namballe, Departamento de Cajamarca, no norte do país. O espécime foi coletado em uma floresta montana a aproximadamente 1.990 metros de altitude. Foi identificado principalmente pela contagem de sulcos primários, ausência de sulcos secundários e outros caracteres morfológicos. Este representa o registro mais ao sul para a espécie, a 345,5 km da localidade-tipo no Equador. Além disso, apresentamos a coloração em vida da espécie. Nosso registro incrementa para sete o número de espécies do gênero *Caecilia* no Peru.

Palavras-chave: Cecílias. Florestas montanas. Tabaconas Namballe. Cordilheira Central dos Andes.

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Gymnophiona (Caecilians) is an order of amphibians represented by species with elongate annulated bodies and no limbs or girdles; mostly wedge-shaped, heavily ossified heads and blunt tails; features associated with a burrowing lifestyle. This clade is primarily tropical and fossorial and contains mainly species living in moist soils usually adjacent to streams, lakes, and swamps, although many species of caecilians live far from water surfaces. Knowledge on their biology remains limited, largely because of their secretive habits and rarity in natural history collections (Gower & Wilkinson, 2005; Peloso, 2010; Maciel & Hoogmoed, 2011; Vitt & Caldwell, 2014).

Caeciliidae, the most diverse of the caecilian families in the Neotropics, contains two genera, *Caecilia* Linnaeus 1758 and *Oscaecilia* Taylor 1968 distributed in South and Central America. *Caecilia* includes 43 currently recognized species from Eastern Panama and northern South America, reaching Bolivia on the southern limit of its geographic distribution (Wilkinson et al., 2011; Frost, 2025), six of which occur in Peru (*Caecilia attenuata* Taylor, 1968; *C. corpulenta* Taylor, 1968; *C. disossea* Taylor, 1968; *C. gracilis* Shaw, 1802; *C. inca* Taylor 1973 and *C. tentaculata*, Linnaeus 1758).

Caecilia, one of the two largest and most complex genera in the order Gymnophiona, is differentiated from *Oscaecilia* by possessing eyes not covered by bone; however, it is a variable condition in some populations of *Caecilia gracilis* (Wilkinson et al., 2011; Maciel & Hoogmoed, 2011). According to the IUCN Red List of Threatened Species (IUCN, 2023), most species of *Caecilia* are listed as Least Concern (35%) and Data Deficient (32.5%). It is so that *C. crassisquama* Taylor, 1986 is categorized as Data Deficient because of the limited information about its distribution, natural history, taxonomy and population status. So far as we are aware, the species is only known from the type. The holotype deposited at American Museum of Natural History (catalogue number AMNH 23434: Figure 1) was collected in Normandia, Zuñía, Río Upana, at 1,400-1,800 m altitude (Figure 2), on the eastern slope of the Andes, Ecuador (Taylor, 1968; Taylor & Peters, 1974). Currently, this locality is part of the Morona-Santiago province, Morona canton, 1.4 km from Zuña village, near Upano river [corrected names]. Moreover, Taylor and Peters (1974) pointed out that the specimen USNM 160363 possesses some subtle differences from type material of *Caecilia pachynema*

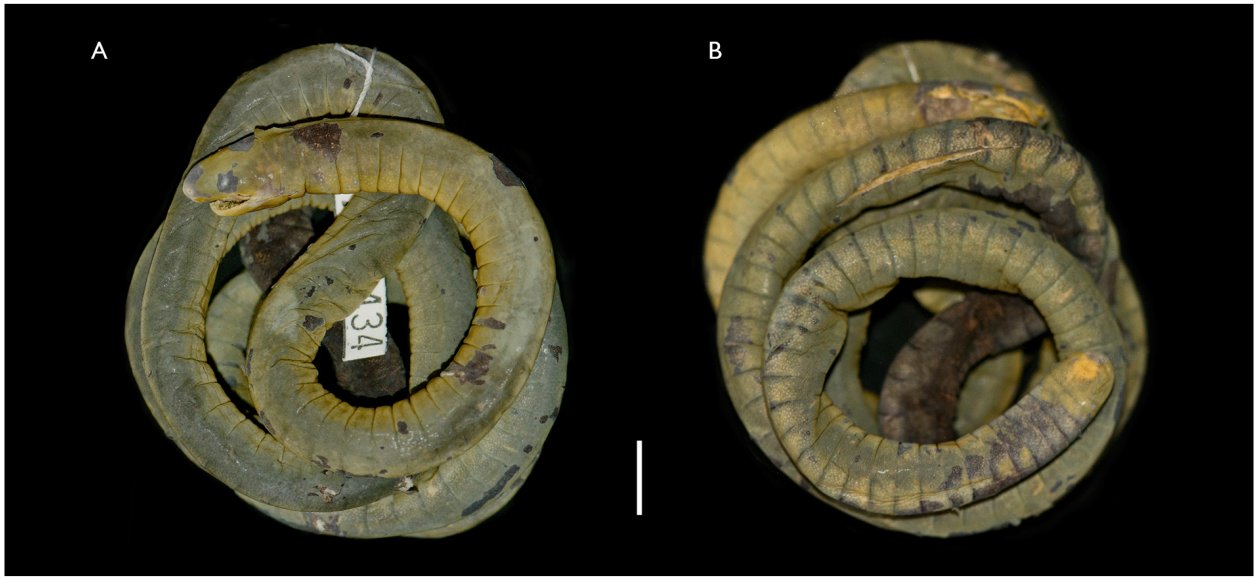

Figure 1. The holotype of *Caecilia crassisquama* (AMNH 23434), from Normandia, Zuñía, Río Upana, Ecuador, in (A) dorsal, and (B) ventral view of the body. Scale bar = 10 mm. Photos: P. L. V. Peloso (2015).

Günther, 1859; but they did not consider it could be *C. crassisquama*. As this if it occurred with AMNH 23434 being removed of the synonymy of *C. pachynema* and raised to the status of valid species by Taylor (1968). Almendáriz et al. (2014) reported a specimen of caecilian assigned as *C. crassisquama* placed to 190.5 km south away from the type locality on the Ecuadorian flank of the Cordillera del Cóndor within Sangay National Park (03.8976° S, 78.4824° W, 1,850-2,400 m altitude), Alto Machinaza, Zamora canton, Zamora-Chinchipe province, Ecuador, but they don't provide any details of the Museum code (*voucher*) and morphological traits which convinces that they have correctly identified the specimen they found. So, we consider it as a doubtful record of the species (Figure 2).

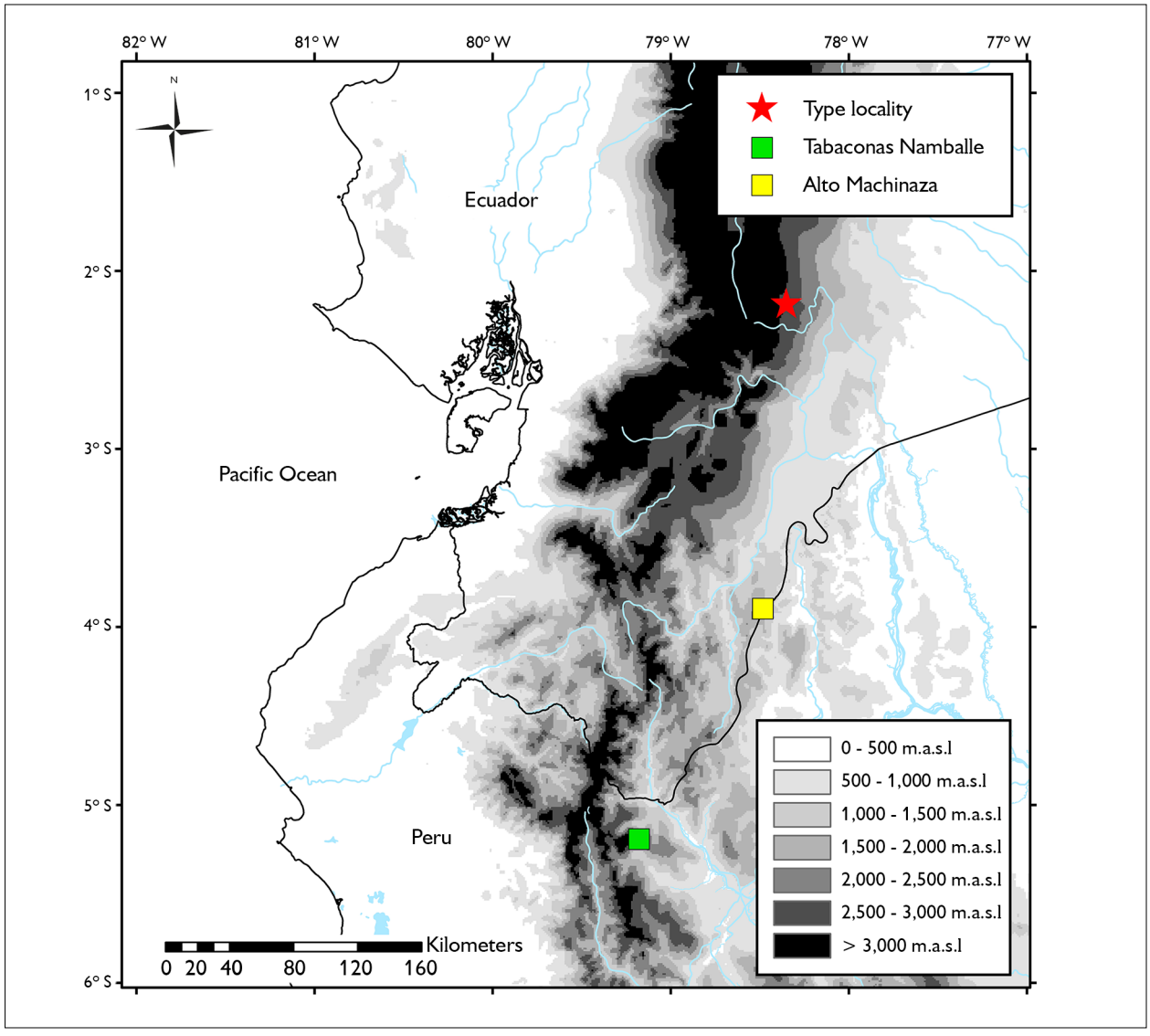

Figure 2. Distribution map of *Caecilia crassisquama* in Ecuador and Peru: (red star) Upano river, 1.4 km from Zuña, Morona, Morona-Santiago, Ecuador (type locality) and (green square) El Sauce, Tabaconas Namballe National Sanctuary, Namballe, San Ignacio, Cajamarca, Peru. Doubtful record (yellow square) for the species from Alto Machinaza, Sangay National Park, Zamora, Zamora-Chinchipe, Ecuador. Map: Juan C. Cusi (2021).

Here, we provide new distributional data for *Caecilia crassisquama* based on fieldwork conducted at the Tabaconas Namballe National Sanctuary (TNNS), Cajamarca department in Northern Peru. During field surveys conducted along an elevational gradient in TNNS between 1,800 and 3,600 meters of altitude (total sampling effort = 238.5 hour/person), we recorded one specimen of *Caecilia crassisquama* (MUSM 31909, field code: JCM 303, TL 1,160 mm, 271.4 g, Figure 3) collected by J. C. Cusi, Victor Vargas and Francis Vargas on 22 February 2013 in a montane forest located at El Sauce sector (05.1924° S, 79.1783° W, 1,989 m), Namballe district, San Ignacio province, Cajamarca department, Peru. El Sauce sector, northeastern side of the TNNS, harbours three types of forests (montane forests, cloud forests and elfin forests) with the major threat on montane forests caused by deforestation and coffee crops. The new specimen of *Caecilia crassisquama* was found underground, after one of us (FV) disturbed the soil when walking along a trail; the observation occurred during intense rain in the afternoon (13:45 h). Ground and air temperatures were recorded as 16 °C, and 19.6 °C respectively, measured by a handheld infrared thermometer (RayTek MiniTemp MT6, Boeco Temp). The *voucher* specimen was euthanized with benzocaine, subsequently fixed and stored in 70% ethanol. This specimen was subsequently deposited in the herpetological collection at the Museo de Historia Natural, Universidad Nacional Mayor de San Marcos, Lima, Peru (catalogue number MUSM 31909). Identification of the species was based mainly by using the keys and descriptions by Taylor (1968, 1972), Taylor and Peters (1974) and Maciel and Hoogmoed (2011). Morphological observations were made using a stereoscope microscope. Morphometric measurements and meristic characters are shown in the Table 1.

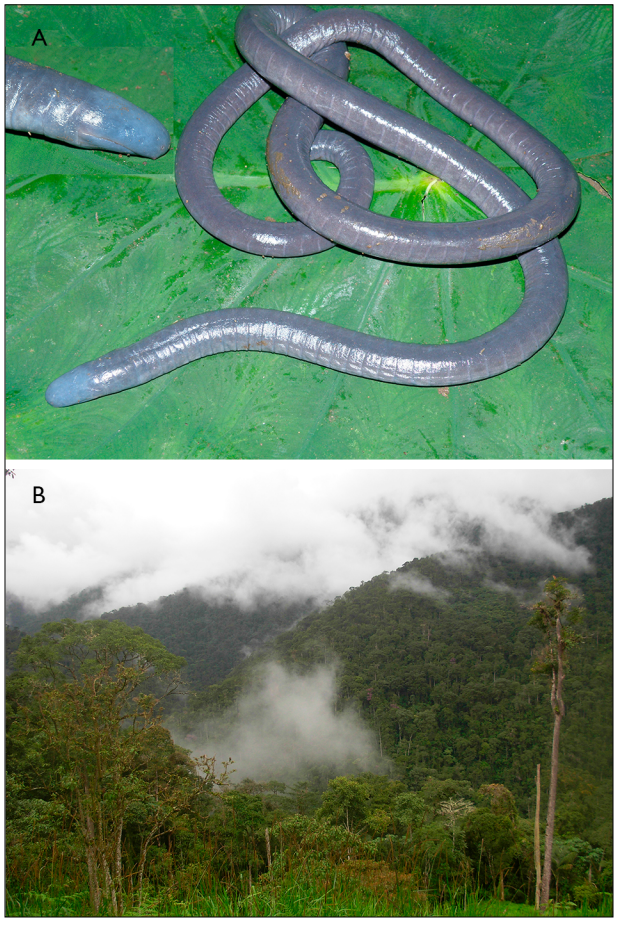

Figure 3. Alive new specimen of *Caecilia crassisquama* MUSM 31909 (A). Montane forests from El Sauce, Tabaconas Namballe National Sanctuary, Namballe, San Ignacio, Cajamarca, Peru (B). Photos: Juan C. Cusi (2013).

We examined the holotype and took photos of the preserved specimen (Figure 1). After the analysis of the holotype and the original description of *Caecilia crassisquama* (Taylor, 1968) we observed that the new specimen shares the diagnostic characters of this species. The individual MUSM 31909 lacks secondary grooves and has a similar number of primary grooves to the holotype AMNH 23434 (170 *versus* 174). Most of the primary grooves in MUSM 31909 are incomplete, with only the last 11 being marked below, compared to 15 in the holotype. Other morphological character that validates the species identification is the absence of subdermal scales and the presence of small dermal scales only in the posterior folds (scales appear from the last six grooves in MUSM 31909 and in the holotype). A dermal scale extracted from the 168th groove of MUSM 31909 has 3.6 mm in wide and 1.7 in height (Figure 4), more elongate than scales of holotype (Taylor, 1972). Taylor (1972) described the scales of the holotype as 'small and seemingly inflexible'.

Table 1. Morphometric measurements (in mm) and characters count (annular grooves and dentition) of the holotype and the new specimen of *Caecilia crassisquama* from Peru.

Measurements	AMNH 23434 (Holotype)	MUSM 31909
Total length (TL)	685	1160
Head width (HW)	9.2	15.4
Body width (BW)	11	18.9
Snout projection beyond mouth (SP)	3	4.7
Snout tip to first groove (S1G)	14	21.2
Distance tentacle to nostril (TN)	1.9	2.8
Distance eye-tentacle (ET)	5	8.6
Primary grooves	174	170
Secondary grooves	0	0
Premaxillary–maxillary teeth	19	17
Prevomeropalatine teeth	19	13
Inner mandibular teeth	19	16
Splenial teeth	6	1
TL/HW	74.4	75.3
TL/BW	62.3	61.4
SP/HW	0.33	0-31
S1G/HW	1.52	1.38
TN/HW	0.21	0.18
ET/HW	0.54	0.56

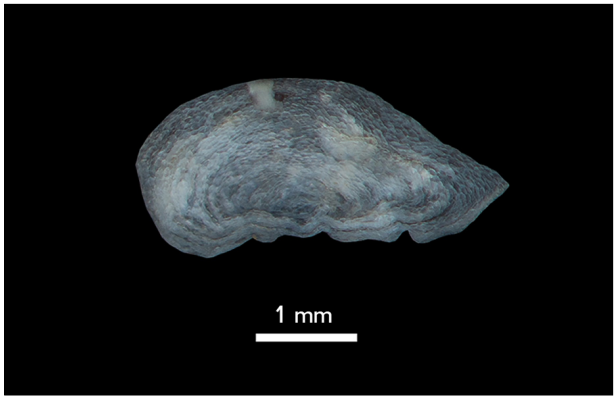

Figure 4. Dermal scale obtained from the 168th posterior primary groove of *Caecilia crassisquama* MUSM 31909. Photo: A. O. Maciel (2024).

However, variation in the flexibility of dermal scales is common among caecilians, even within the same species and individual (Maciel, personal observation, 2024). Furthermore, Taylor (1972) also illustrated the variation in scale shape and size for several species of *Caecilia*. In MUSM 31909, a terminal region featuring an unsegmented terminal shield is observed, measuring 11.9 mm in length. The holotype exhibits a similar terminal shield, though smaller, with a length of 8 mm. There are three anterior and seven posterior denticulations in the semicircular vent in MUSM 31909 and five anterior and six in the holotype. MUSM 31909 is a relatively large specimen of body subcylindrical, total length is 61.4 times body width at mid body (62.3 times in holotype). In life, the coloration of the MUSM 31909 body is purplish grey blue, ventral surface paler than dorsum. The head is a sky-blue grey, noticeably lighter than the body. The lips are bright pink. In preservative, the head, lips, lateral of body and the vent are yellowish grey and the

body is greyish in dorsum and ventral surface, similarly to the holotype. The fixation of the new specimen in ethanol can lead to early loss of the coloration, which must be considered in posterior comparisons.

The new specimen is much larger than the holotype but the ratios of measurements SP/HW, S1G/HW, TN/HW, ET/HW and TL/HW are similar in accordance with the description of the type specimen by Taylor (1968) (Table 1). The dental formula is very similar to the formula for the type specimen of *C. crassisquama* as described by Taylor (1968, numbers in parentheses): pre-maxillary–maxillary 19 (17), vomeropalatine 19 (13), dentaries 19 (16), inner mandibular teeth (6–1). Thus, based on external morphology and dentition characters we decided to identify the specimen as *C. crassisquama*.

Following we present the distinctions from similar species distributed in Peru and Ecuador (composed of 19 species): *Caecilia crassisquama* lacks secondary grooves to differs from *C. abitaguae* Dunn, 1942; *C. albiventris* Daudin, 1803; *C. bokermanni* Taylor, 1968; *C. disossea*; *C. dunni* Hershkovitz, 1938; *C. gracilis*; *C. guntheri* Dunn, 1942; *C. leucocephala* Taylor, 1968; *C. nigricans* Boulenger, 1902; *C. pachynema*, *C. subterminalis* Taylor, 1968; *C. tentaculata*; *C. tenuissima* Taylor, 1973; *C. tesouro* Bock et al., 2024; and *C. truncata* Bock et al., 2024. Instead, the absence of secondary grooves from *Caecilia crassisquama* is shared with *C. attenuata*, *C. corpulenta*, *C. inca* and *C. orientalis* Taylor, 1968 (Gray, 1850; Hershkovitz, 1938; Dunn, 1942; Taylor, 1968, 1973; Taylor & Peters, 1974; Nussbaum & Hoogmoed, 1979; Lynch, 1999; Guayasamin & Funk, 2009; Maciel & Hoogmoed, 2011; Borges-Nojosa et al., 2017; Camper et al., 2021; Elizondo-Lara, 2021; Fernández-Roldán & Lynch, 2021; Fernández-Roldán & Rueda-Almonacid, 2022). *Caecilia crassisquama* (170–174 primary grooves) differs from *C. abitaguae* (139–150); *C. albiventris* (144–150); *C. corpulenta* (123); *C. dunni* (124); *C. guntheri* (110–127); *C. inca* (158); *C. leucocephala* (118–142); *C. orientalis* (106–123); *C. pachynema* (150–163); *C. tentaculata* (112–131); *C. tesouro* (117–121); and C. truncata (107–123), by having more primary grooves. *Caecilia crassisquama* differs from *C. attenuata* (182–199); *C. bokermanni* (180–192); *C. disossea* (216–252); *C. gracilis* (196–207); and *C. tenuissima* (186) by having fewer primary grooves (Gray, 1850; Hershkovitz, 1938; Dunn, 1942; Taylor, 1968, 1973; Taylor & Peters, 1974; Nussbaum & Hoogmoed, 1979; Lynch, 1999; Guayasamin & Funk, 2009; Maciel & Hoogmoed, 2011; Camper et al., 2021; Elizondo-Lara, 2021; Fernández-Roldán & Rueda-Almonacid, 2022). *Caecilia crassisquama* also lacks subdermal scales, as occurs in *C. corpulenta*, *C. gracilis* and *C. orientalis*, but differs from them in the count of primary grooves (Taylor, 1968; Nussbaum & Hoogmoed, 1979; Guayasamin & Funk, 2009; Maciel & Hoogmoed, 2011). *Caecilia crassisquama* differs from *C. albiventris* and *C. dunni* by having an unsegmented terminal shield (absent in the species aforementioned) (Gray, 1850; Taylor, 1968; Hershkovitz, 1938; Taylor & Peters, 1974). Contrary to *C. inca* (66 times); *C. disossea* (80–132 times); *C. pachynema* (68.8–90.4 times); and *C. tenuissima* (81 times), *Caecilia crassisquama* has 61.4–62.3 times body total length divided by the body width; which overlaps with *C. attenuata* (62–66 times); *C. gracilis* (30.9–90.6 times); *C. guntheri* (33.3–62.6 times); and *C. nigricans* (33–83 times) (Dunn, 1942; Taylor, 1968, 1973; Taylor & Peters, 1974; Nussbaum & Hoogmoed, 1979; Lynch, 1999; Maciel & Hoogmoed, 2011; Elizondo-Lara, 2021; Fernández-Roldán & Lynch, 2021; Fernández-Roldán & Rueda-Almonacid, 2022).

In the recent years, the discovery of new species of *Caecilia* (*C. museugoeldi* Maciel & Hoogmoed, 2018; *C. pulchraserrana* Acosta-Galvis, Torres & Pulido-Santacruz, 2019; *C. goweri* Fernández-Roldán & Lynch, 2021; *C. aprix* Fernández-Roldán & Rueda-Almonacid, 2022; *C. atelolepis* Fernández-Roldán, Lynch & Medina-Rangel, 2023; *C. epicrionopsoides* Fernández-Roldán, Lynch & Medina-Rangel, 2023; *C. macrodonta* Fernández-Roldán, Lynch & Medina-Rangel, 2023; *C. wilkinsoni* Fernández-Roldán & Lynch, 2021; *C. yaigoje* Fernández-Roldán, Medina-Rangel & Lynch, 2023; *C. tesouro* and *C. truncata* Bock et al., 2024) has provided new insights about their recognition, taxonomy and phylogenetic relationships based on DNA sequences.

In Peru, low number of specimens and scarce fieldwork focused on the sampling of caecilians open new opportunities to redefine and study much better poorly known species.

Considering our decision, this record represents the third report (second well documented) of *Caecilia crassisquama* in the Neotropics, and the first record of the species for Peru on the Eastern Cordillera of the Andes. Additionally, this record represents the southernmost for the species (345.5 km from the type locality, Figure 2). As a result, seven species of *Caecilia* are now known in Peru: *Caecilia attenuata*, *C. corpulenta*, *C. crassisquama*, *C. disossea*, *C. gracilis*, *C. inca* and *C. tentaculata*.

Similarly, to was suggested by Gower and Wilkinson (2005), we recommend *Caecilia crassisquama* is considered inside conservation assessments of the amphibians conducted both by the Peruvian government (SERFOR, D.S. N° 034-2004-AG) and the IUCN Amphibian Specialist Group and the species should be categorized as 'Data Deficient' because of possesses limited distributional range, secretive habits (probably fully subterranean) and live in montane forested habitats associated to disturbed areas. Finally, our finding highlights the importance of extensive field research in remote montane areas such as the TNNS, and especially undisturbed forested ranges between Peru and Ecuador. Thus, new fieldworks are necessary to obtain ecological and life history data for this caecilian species.

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AUTHORS' CONTRIBUTION

J. C. Cusi Martinez contributed to conceptualization, funding acquisition, investigation, methodology, writing (original draft, review and editing); F. I. Vargas contributed to investigation, methodology, writing (review and editing); V. J. Vargas contributed to investigation, methodology); P. Peloso contributed to investigation, writing (review and editing); A. O. Maciel contributed to conceptualization, investigation, methodology, writing (original draft, review and editing).