

COMPORTAMIENTO DEFENSIVO Y EXTENSIÓN DEL ÁREA DE DISTRIBUCIÓN DE LA SALAMANDRA DE CABEZA PLANA DE BERLÍN *OEDIPINA BERLINI* KUBICKI 2016 (CAUDATA: PLETHODONTIDAE)

DEFENSIVE BEHAVIOR AND RANGE EXPANSION OF BERLIN'S FLAT-HEADED SALAMANDER *OEDIPINA BERLINI* KUBICKI 2016 (CAUDATA: PLETHODONTIDAE)

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Resumen.— *Oedipina berlini* es una salamandra terrestre endémica de los bosques tropicales del Caribe de Costa Rica. El conocimiento actual de su historia natural es deficiente debido a las escasas observaciones desde su descubrimiento. En este artículo describimos un comportamiento antidepredador de esta especie, que consiste en un salto impulsado únicamente por su cola. Este nuevo método de defensa contra los depredadores nos dice cuán compleja y poco estudiada es la historia natural de las salamandras tropicales. Adicionalmente, reportamos la presencia de esta especie en el Parque Nacional Braulio Carrillo, siendo la quinta ubicación conocida para *O. berlini* y el punto más al norte de su distribución

Palabras clave.— Parque Nacional Braulio Carrillo, conservación, distribución, historia natural, salamandras sin pulmón.

Abstract.— *Oedipina berlini* is a terrestrial salamander endemic to the Caribbean tropical forests of Costa Rica. Current knowledge of its natural history is deficient due to scarce observations since its discovery. Herein, we describe an antipredator behavior, which consists of a jump powered only by its tail. This method of defense against predators shows the natural history of tropical salamanders is complex and understudied. Additionally, we report the presence of this species in the Braulio Carrillo National Park, which corresponds to the fifth locality for *O. berlini* and the northernmost point of its known distribution.

Keywords.— Braulio Carrillo National Park, conservation, distribution, natural history, lungless salamanders.

Salamanders of the genus *Oedipina* (Kerferstein, 1868) are found in Neotropical rainforests from Chiapas, Mexico, through Central America to the Magdalena Valley of Colombia and south-central Ecuador (Frost, 2024). Currently, this genus comprises 40 species and is composed of two subgenera, *Oedipinola* with fewer than 20 costal grooves and *Oedipina* with more than 20 costal grooves (Frost, 2024; Leenders, 2016). *Oedipina* spp. are terrestrial and semifossorial, commonly associated with forests, plantations, open areas and gardens (Savage, 2002; Leenders, 2023). Very little is known of salamanders within the subgenus *Oedipinola*; in Costa Rica, five species of this subgenus

are reported (*O. alleni*, *O. berlini*, *O. carablanca*, *O. nimaso* and *O. savagei*) (Leenders, 2016) and *O. berlini* was recently described as endemic to the Caribbean side of Costa Rica (Kubicki, 2016). The species has been reported in tropical rainforests between 540-850 m a.s.l. occurring leaf litter in young secondary to old-growth forests with varying topography. Similar to other species of this subgenus, very little is known about its natural history (Kubicki, 2016; IUCN, 2020).

Salamanders exhibit various anti-predatory behaviors, such as hiding after detection of chemical signals from predators,

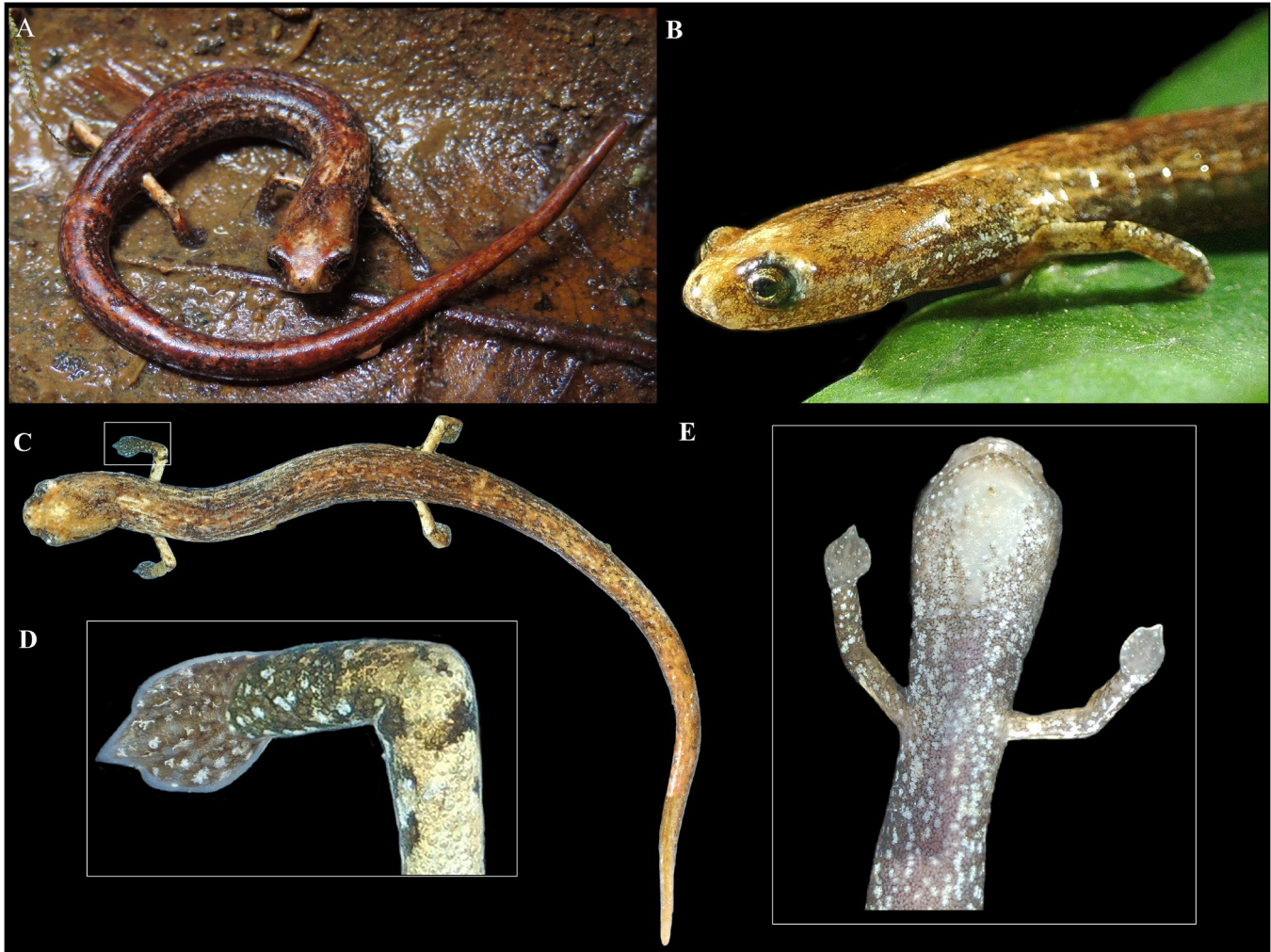


Figure 1. Diagnostic characteristics of a male individual of *Oedipina berlini* found in the Braulio Carrillo National Park. (A) Lighter-colored ring at the base of the tail, (B) lateral view, (C) dorsal view, (D) dorsal view of the hand with the longest digit terminating in a fleshy point, (E) ventral view, showing a central pale gular patch and large snout. Photos: Juan G. Abarca.

Figure 1. Características diagnósticas de un individuo de *Oedipina berlini* macho encontrado en el Parque Nacional Braulio Carrillo. (A) *O. berlini* con un anillo de color más claro en la base de la cola, (B) vista lateral, (C) vista dorsal, (D) vista dorsal de la mano con el dedo más largo que termina en una punta carnosa, (E) vista ventral, que muestra una mancha gular pálida central y un hocico grande. Fotos: Juan G. Abarca.

caudal autotomy (Sullivan et al., 2002; Bliss & Cecala, 2017), poisonous secretions in the skin (Hopkins & Migabo, 2010), crypsis, mimicry, aposematism and thanatosis (Myette et al., 2019). Jumping has also been reported for several species of the Plethodontidae family (Cochran, 1911; Murphy, 1917; Ryerson, 2013; Ryerson et al., 2016; Hessel & Nishikawa, 2017; Brown & Deban, 2020). However, for the genus *Oedipina*, this behavior has not been reported. Here we describe for the first time a defensive jumping behavior in *O. berlini*. The locality where we carried out the observation also represents the northernmost point of its known distribution.

On November 25, 2023, at 13:40 h, a small slender salamander was observed in a plot sampling as part of an inventory of amphibians and reptiles in Braulio Carrillo National Park, El Ceibo region, San Ramón, La Virgen de Sarapiquí, Heredia, Costa Rica (10.327° N, 84.079° W, WGS 84, elev 530 m a.s.l.). The species was temporarily collected for identification and photographic documentation (SINAC-ACC-PI-re-069-2023). While taking photographs, the defensive behavior described below was observed, after which the individual was released where it was captured.

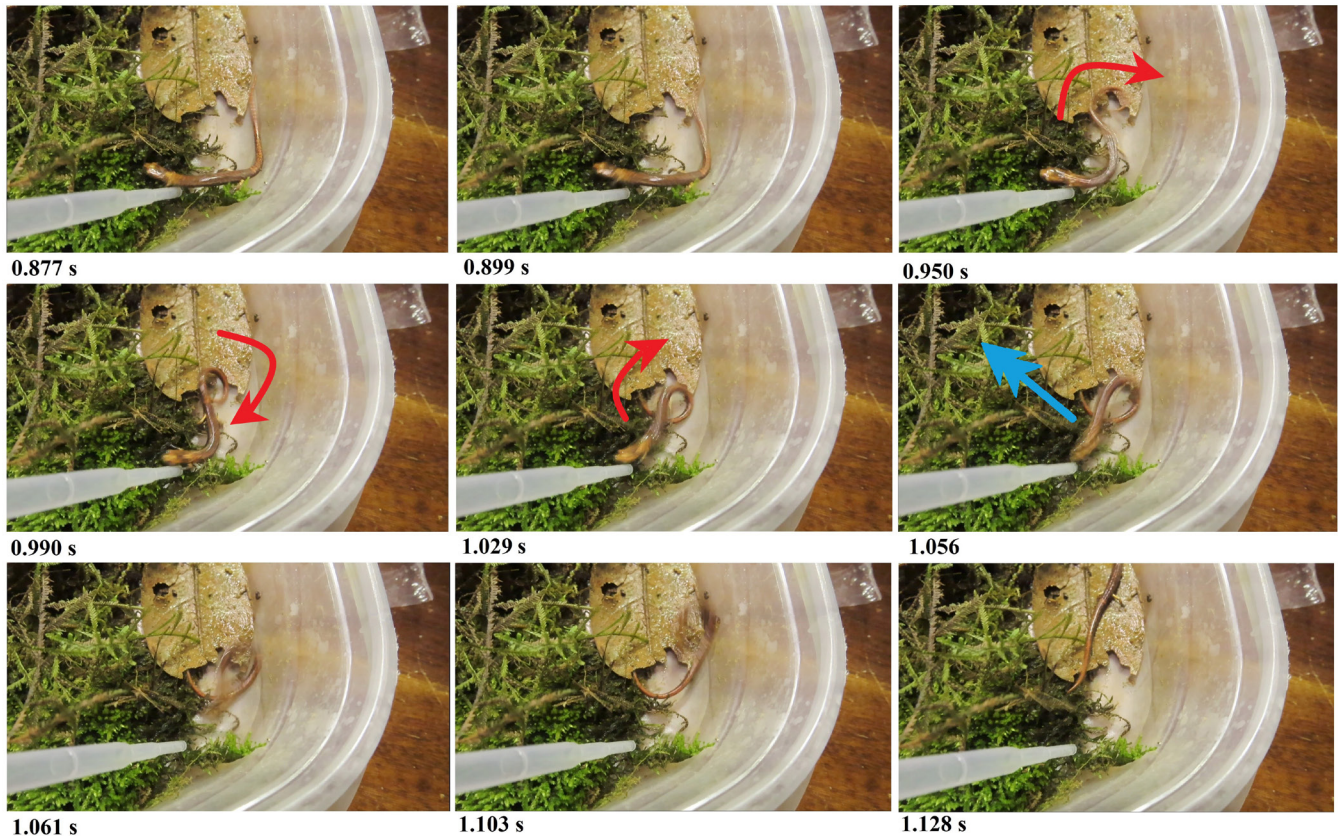


Figure 2. Defensive jumping behavior of *Oedipina berlini*. When the salamander detects the stimulus on its side, it begins to curl its tail, indicated by the red arrows. Once the tail is under the salamander's body, the individual uses momentum from the pelvic area and then extends the tail like a trigger, pushing the body backwards; a double blue arrow shows the direction of the jump.

Figura 2. Comportamiento defensivo de salto de *Oedipina berlini*. Cuando la salamandra detecta el estímulo en su costado, comienza a curvar la cola, indicado por las flechas rojas. Una vez que la cola está debajo del cuerpo de la salamandra, el individuo toma impulso con la zona pélvica y luego estira la cola a modo de gatillo, empujando el cuerpo hacia atrás; una doble flecha azul indica la dirección del impulso.

The species was identified as *O. berlini* based on the following characteristics: more than 13 and fewer than 20 costal grooves, fully webbed hands and feet with the longest digit terminating in a fleshy point (Fig. 1d), webbed margin of the hand lacking any evident indentation at the interdigital spaces, flat head, long prehensile tail, pale coloration in the central and anterior gular region (Fig. 1e), and being similar to the fourth individual shown in figure 8 of Kubicki (2016).

The dorsal coloration was a mixture of pale earthy tones ranging from tan to dark reddish brown, with fine white and dark brown to black spots and irregular markings scattered throughout (Figs. 1a and 1c) (Kubicki, 2016; Leenders, 2023). Species identification was corroborated by Erick Arias from Zoology Museum of the University of Costa Rica and Twan Leenders from Yale Peabody Museum of Natural History.

The observed individual was identified as a male, which are characterized by having a lighter ring at the base of the tail (Fig. 1a) and a larger snout than females (Fig. 1e).

Most of the time the individual walked slowly, but when it felt threatened and the side of its body was touched, it jumped between 3 to 10 cm from its original position. During the jumping process (Fig. 2), the salamander arched its body in a "S" shape pattern, primarily in the posterior region (seconds 0.950 and 0.990). The tail was placed below the body until it formed a complete circle (seconds 1.029). Once the tail was placed on the ground, it worked as support to propel the anterior part, and thus the body was propelled in the opposite direction (seconds 1.056 and 1.061). In this way, the salamander that was facing one direction (original position) completely rotated its body during the jump to place its head in the opposite direction (final



Figure 3. IUCN range polygon showing the known distribution of *Oedipina berlini* in the Caribbean side of Costa Rica, the historical records (sky blue dots), and the new record (yellow triangle) located in El Ceibo region of Braulio Carrillo National Park, the northernmost location reported for this species.

Figure 3. Polígono de distribución de la IUCN que indica la distribución conocida de *Oedipina berlini* en el lado Caribe de Costa Rica, mostrando los registros históricos (círculos celestes) y el nuevo registro (triángulo amarillo) ubicado en el sector de El Ceibo en el Parque Nacional Braulio Carrillo, punto más al norte reportada en esta especie.

position). The recorded jump took an average of 250 milliseconds (Fig. 2). Two of these jumps were video-recorded (<https://youtu.be/3mMhyBQjXEo>). The behavior was observed repeatedly until the individual was released.

The first observation of jumping behavior in plethodontid salamanders was described in *Plethodon cinereus* (Cochran, 1911).

Since then, it has been reported in *Aneides aeneus*, *A. lugubris*, *A. flavipunctatus*, *A. vagrans*, *Desmognathus ocoee*, *D. aeneus*, *D. fuscus*, *D. ochrophaeus*, *D. quadramaculatus*, *Plethodon cinereus*, *P. glutinosus*, *P. metcalfi*, *Eurycea guttolineata*, *E. wilderae*, *E. bislineata* and *E. longicauda* (Murphy, 1917; Ryerson, 2013; Ryerson et al., 2016; Hessel & Nishikawa, 2017; Brown & Deban, 2020). The jumping mechanism in most of these species occurs when salamanders

bend their body into a U-shaped pattern along one side, moving the anterior portion of the body toward the tail and then quickly straightening the torso (Ryerson, 2013). This rapid straightening of the body is driven by the axial musculature (Ryerson et al., 2016), the resulting wave from which propels the individual away from the stimulus with the forelimbs abducted (Hessel & Nishikawa, 2017; Brown & Deban, 2019). The jump we observed in *O. berlini* seems to differ greatly from those descriptions, since it initiated from the tail, and the impulse was made towards the opposite side of the head. Therefore, it does not seem to use the muscles of the trunk or the extremities, but rather those of the tail as the main driver. This way of jumping, powered by the tail, allows it to move greater distances quickly, which its tiny legs do not allow.

In addition, this species was previously reported in two localities, Guayacán and La Alegría, both of which are private reserves in the Cantón de Siquirres, in the province of Limón, within the Cordillera Volcánica Central (Kubicki, 2016). Prior to that, it was observed in 2011, in the Rara Avis Reserve (8.2 linear kilometers from El Ceibo); however, it was not reported as *O. berlini* until 2023 (Leenders, 2023). The species was also reported in 2019 in Veragua Rainforest Private Reserve, which is its southernmost distribution point in the country (IUCN, 2020). El Ceibo sector is the fifth known locality for the species, confirming its presence within Braulio Carrillo National Park and being the northernmost point of its distribution (Fig. 3).

The presence of *O. berlini* in this national park highlights the importance of species inventories within national conservation areas, since new salamander species and range extensions have been documented in recent years (Kubicki et al., 2022; Arias et al., 2023). All known observations of *O. berlini* have occurred in forested areas (public or private reserves), which suggests that habitat loss and deforestation could pose a significant threat for this species. Therefore, establishing and maintaining protected areas and furthering natural habitat connectivity within the current distribution of these species are fundamental conservation strategies.

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