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ORIGINAL PAPER

# A novel mode of bathing behavior of hummingbirds recorded in the Brazilian ruby *Heliodoxa rubricauda* and allies (Aves: Trochilidae)

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## Abstract

The Brazilian ruby, *Heliodoxa rubricauda*, is a forest species of hummingbird endemic to the Atlantic Forest. It belongs to an Andean clade of birds with robust and strong legs and adapted to feed on inflorescences of plants from high regions and influenced by strong winds. It occurs from northeastern to southern Brazil on slopes, sierras, and mountains and has the little-known behavior of bathing in waterfalls and forest streams. Based on five field observations made in the state of São Paulo, and records available from online photo platforms, we concluded that *H. rubricauda* is the only species of hummingbird in Brazil that bathes by settling on rocks of forest waterfalls with medium to strong currents. This behavior is made possible by the robust and strong legs the species inherited from its evolutionary lineage, which, in the Atlantic Forest, are used for feeding, defense, and bathing. We hypothesize that this behavior is more efficient for body hygiene than other existing behaviors because it allows a greater amount of water to pass over the body, thereby eliminating traces of food and parasites, in addition to reducing risks of predation.

**Keywords** Hummingbird · Atlantic Forest · Serra do Mar · Natural history

Bird feathers perform several functions essential to these animals lives, requiring constant maintenance. Bathing behavior complements preening as an important way to keep feathers clean and smooth, while helping to remove ectoparasites as well (Bostwick 2016). The hummingbird family, Trochilidae, comprises about 350 species and 107 genera of birds that are restricted to the Americas (Dickinson and Remsen 2013). Due to their nectar-based feeding, hummingbirds constantly need to clean themselves due to daily contact with the viscous liquid of flowers, and thus exhibit several ways to bathe, such as leaning on wet leaves, using the rain or even splashing in waterfalls and grass sprinklers, or immersing themselves in clear water streams and even the central part of bromeliads (Sick 1997).

Among the nine phylogenetic groups of hummingbirds presented by McGuire et al. (2007), the Andean clade of the "brilliants" is formed by species that occur at high altitudes, including representatives of the genus *Heliodoxa*. Stiles (2008) reports that the larger and stronger feet of the brilliants endow them with the ability to fixate on inflorescences of Paramo plants allowing them to feed despite strong winds in these high regions of the Andes. Four representatives of the brilliants clade occur farther away from the Andean mountains: the velvet-browed brilliant *Heliodoxa xanthogonys* in the Tepui mountains of the Guiana Shield, the black-throated brilliant *H. schreibersii* and Gould's jewelfront *H. aurescens* in the Amazon basin, and the Brazilian ruby in the Atlantic Forest, which is endemic to Brazil (Pacheco et al. 2021). The Brazilian ruby is a forest species

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restricted to the Atlantic Forest and occurs in mountainous regions (Sick 1997; Vale et al. 2018).

The bathing behavior of the Brazilian ruby was first described by Ruschi (1973), who reported it occurring in the splash zones of waterfalls, with the birds landing on rock or even by direct flight into the water jet, and repeating this several times until they perch to clean their plumage (but see Pacheco and Bauer 1999 for a criticism on the reliability of Ruschi's data). Later, Ruschi (1986) rather described the bath of the species as being "on large moist leaves, such as Heliconia, but [the birds] prefer to put themselves among the short mosses on a branch and thus pass the bill, head and body when the moss is moist from dew or rain" (free translation from Portuguese). However, Vasconcelos and Pontes Junior (1998) reported a different behavior observed in a shallow and flat stream over a granite outcrop, with the bird dipping the lower parts lightly in the water, shaking the body and flapping its wings repeatedly before perching on nearby branches. Because waterfall bathing by the Brazilian ruby is little known, and given some inconsistencies on the bathing behavior described for this species, we present new information obtained in the field and on online databases and propose a hypothesis for hygienic advantages of their bathing behavior compared to other forest hummingbirds of syntopic occurrence in the Atlantic Forest.

## Methods

We report five field observations of bathing behavior by the Brazilian ruby made in areas of dense ombrophilous forest (Atlantic Forest) in the Serra do Mar region in São Paulo state, Southeast Brazil. The first observation was made by K.R. on 26 May 2012 in Fazenda Maravilha (23°56′44.09″S, 46°43′15.79″W; 760 m above sea level), in southernmost São Paulo municipality along a stretch of rapids of the Capivari River called Cachoeira do Sagui (Fig. 1A). This locality borders on Núcleo Curucutu of Parque Estadual da Serra do Mar (PESM) and has a canopy of about 25 m in height. The second observation was made by M.S. on 3 November 2013 at Núcleo Pedra Grande in Parque Estadual da Cantareira in the north region of the municipality of São Paulo (23°26′11.45″S, 46°38′7.47″; 1,030 m a.s.l.) (Fig. 2). The forest at the site has a canopy of about 25 in height and many epiphytic plants. The third observation was made by the authors F.S., K.R. and M.S. on 9 April 2016, in the same region as the first record but in a waterfall called Raio de Sol (first part), about 1,500 m from Cachoeira do Sagui, and inside Núcleo Curucutu (Figs. 1B and 3). The fourth observation was made by F.S. on 28 December 2019 again in Raio de Sol waterfall, about 50 m away from the location of the third record (Fig. 1C). The fifth observation was made by C.P. and C.A. on 30 May 2016 in Trilha dos Tucanos (24°0′16.05″S, 47°33′42.91″; 725 m a.s.l.), municipality of Tapiraí, in a well preserved forest with some fast-running streams (Supplementary Material 1). Details of the behavior in each record are presented in Supplementary Material 2.

We further examined 6,471 images and 30 videos of *H. rubricauda* available on the two online platforms of ornithological images, with 5,454 images from WikiAves (WA — https://www.wikiaves.com.br/) and 1,017 images and 30 videos from Macaulay Library (ML — https://www.macaulaylibrary.org/) — up to 15 August 2021 (Table 1). For comparison with the most common forest hummingbirds syntopic to *H. rubricauda*, we also searched the images of the scale-throated hermit *Phaethornis eurynome* (3,375 images) and the violet-capped woodnymph *Thalurania glaucopis* (13,750 images) available at WikiAves. Lastly, we looked at the same online ornithological platforms for images of the other brilliants to check whether


**Fig. 1** Waterfalls of Fazenda Maravilha and Núcleo Curucutu of PESM. **A** Cachoeira do Sagui (Capivari River), **B** Cachoeira Raio de Sol (first part), and **C** Cachoeira Raio de Sol. Photos: Fabio Schunck

**Fig. 2** Brazilian ruby bathing in Serra da Cantareira. Photo: Marco A. G. Silva

**Fig. 3** Sequence of the Brazilian ruby bath at Cachoeira Raio de Sol (first part). Photos: Fabio Schunck

**Table 1** Number of images of *Heliodoxa* consulted on online ornithological platforms, including results obtained. The WikiAves platform only presents data on species occurring in Brazil

| Species | Online data platforms | | Results (bath images) | References |
|---|---|---|---|---|
| | WikiAves (WA) | Macaulay Library (ML) | | |
| *H. rubricauda* Brazilian ruby | 5454 | 1017 (30 videos) | 13 (11 WA and 2 ML) | WA295387, 572808, 1227735, 1345901, 1514927, 3529137, 3673729, 187507, 2062186, 2058731, 2813009, 1856734; ML286626561, 26305061 |
| *H. xanthogonys* velvet-browed brilliant | 24 | 33 (+2 videos) | 0 | |
| *H. aurescens* Gould's jewelfront | 79 | 393 (+12 videos) | 0 | |
| *H. schreibersii* black-throated brilliant | 05 | 190 (+10 videos) | 0 | |
| *H. s. schreibersii* | | 29 (+9 videos) | 0 | |
| *H. gularis* pink-throated brilliant | | 12 | 0 | |
| *H. branickii* rufous-webbed brilliant | | 06 | 0 | |
| *H. rubinoides* fawn-breasted brilliant | | 1.665 (+67 videos) | 0 | |
| *H. jacula* green-crowned brilliant | | 3.789 (+89 videos) | 1 | ML136616841 |
| *H. imperatrix* empress brilliant | | 923 (+30 videos) | 0 | |
| *H. leadbeateri* violet-fronted brilliant | | 972 (+38 videos) | 0 | |

the bathing behavior of the Brazilian ruby is shared among its phylogenetic allies, for a total of over 8,000 photos and 250 videos (Table 1). Due to the low number of records of baths for the brilliant species, we further present documentation of our own for the empress brilliant *H. imperatrix* bathing in flowing water of a waterfall in Mashpi, Ecuador, on 15 June 2011.

## Results and discussion

Among all the media available for *Heliodoxa rubricauda*, we found only 13 (0.20%) records of this species bathing, all of which (100%) were in waterfalls with running water. The geographic distribution of the records includes the states of Paraná (WA295387 and 572808), São Paulo (WA1227735, 1345901, 1514927, 3529137 and 3673729), Rio de Janeiro (WA187507, 2062186, ML286626561 and 26305061), Espirito Santo (WA2813009), and Minas Gerais (WA1856734), located in the southeast and south regions of Brazil. This material did not allow detailed descriptions to be made of the behaviors performed by the birds while bathing, but based on a video made together with a photo in Petrópolis, RJ (WA2058731), it is possible to see the bird swinging its body sideways, touching the sides of the head, chest, wings, and tail in the water film, in addition to shaking its wings and tail during the bath. Although little documented, the use of streams and mainly forest waterfalls with running water to bathe seems to be a typical behavior of this species, corroborating the descriptions made by Vasconcelos and Pontes Junior (1998) and, in some ways, that of Ruschi (1973).

None of the photos documenting the bathing behavior of the scale-throated hermit or the violet-capped woodnymph shows these birds resting on rock or even bathing in cascades of running water. The baths of these two species and other forest hummingbirds that occur together with *H. rubricauda* are performed in different ways (Supplementary Material 2). Two species that exhibit a similar behavior to that observed for *Heliodoxa* — perching on rocks and bathing under running water — are the glittering-bellied emerald *Chlorostilbon lucidus* and white-vented violetear *Colibri serrirostris*, typical hummingbirds of forest edges and open environments. However, these species land on places that are flatter and with less volume of running water and do not fully immerse their bodies into the current, but instead make sequential movements so that the water passes over the body more smoothly. This behavior is intermediate between the diving and use of pools done by *T. glaucopis* and bathing in vertical waterfalls with medium to strong currents as done

by *H. rubricauda*. Bathing by the glittering-bellied emerald has been documented both in natural (*e.g.* WA 57935, 2270163) and artificial (*e.g.* WA 54183, 521186) areas, different behaviors from the bath described for the species. We document the white-vented violetear bathing on top of a waterfall (ML37684354) (Supplementary Material 2).

Among the other *Heliodoxa* species, we found only a single record for the green-crowned brilliant *Heliodoxa jacula* (ML136616841) in Costa Rica (Table 1), which shows perching on rocks of a waterfall. Additionally, C.A. recorded a female empress brilliant also bathing perched on a waterfall in Mashpi, Ecuador, on 15 June 2011 (Fig. 4). These couple records, although few in number, suggest the bathing behavior of the Brazilian ruby is shared among the remaining *Heliodoxa* brilliants.

Comparing the bathing behavior of *T. glaucopis*, *P. eurynome*, *C. lucidus*, *C. serrirostris*, and *H. rubricauda*, we note the frequency of records, and probable exclusivity (within species of eastern Brazil), of the last species for using forest waterfalls with relatively strong currents that make the water pass over the body without much effort. This shows that the Brazilian ruby uses its strong and robust legs — a likely adaptation that emerged in its Andean lineage, where birds need to land on the inflorescences of plants in open areas with strong winds to feed — to land and settle on steep rocks and slippery forest waterfalls of the Atlantic Forest as a classic type of exaptation. This use of strong legs for feeding, described by Stiles (2008), can also be seen in *H. rubricauda* (WA1712732). In addition, strong legs may also be advantageous when disputing territory and/or even fighting with individuals of other species (WA624050). Sick (1997) reports on the strength that hummingbirds have in their legs, a fact easily noticed when banding *H. rubricauda*, which stands out among other species of hummingbirds for having a stronger grip when closing the foot, probably due to its anatomical characteristics. The specific behavior of settling on forest waterfall rocks with medium to strong currents for bathing in areas where other options, such as flat streams, temporary puddles and bromeliads, among others, are available, leads us to hypothesize that this type of bathing is more efficient than the other known forms of body hygiene of these birds, by eliminating both food residues and parasites, in addition to reducing the risk of predation as such locations are difficult to access. When mist-netting in Núcleo Curucutu of PESM, we noticed fewer ectoparasites on *H. rubricauda* than, for example, on *P. eurynome* (F. Schunck — personal observation), but the lack of quantitative data on parasite load of Atlantic Forest hummingbirds leaves this hypothesis to be tested by future studies.

Our work summarized the available knowledge on the bathing behavior of the Brazilian ruby and other hummingbirds from the Atlantic Forest of eastern Brazil. Yet, the specific behavior of most hummingbird species remains to be properly described. Citizen science database proved helpful to fill some gaps, but we still lack data. The evidence of bathing in running water waterfalls by Brazilian ruby is very strong and indisputable; however, the non-use of these same conditions by other hummingbirds is still incipient and deserves further investigation. We thus appeal to researchers and other bird enthusiasts to try to document any episodic behavior and make them available, helping foster further studies with deeper ecological, natural history or even evolutionary approaches, among others.

**Fig. 4** Empress brilliant (female) bathing in flowing water of a waterfall in Mashpi, Ecuador, 15 June 2011. Photo: Ciro Albano

**Supplementary information** The online version contains supplementary material available at https://doi.org/10.1007/s10211-022-00393-2.

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## Declarations

**Ethics approval** Not applicable.

**Consent to participate** Not applicable.

**Consent for publication** Not applicable.

**Conflict of interest** The authors declare no competing interests.

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