



Avian Behavior, Ecology, and Evolution

Rufous Hornero (*Furnarius rufus*, Furnariidae) anointing with a millipede (Diplopoda, Spirobolidae) in southernmost Brazil

Unción con un milpiés (Diplopoda, Spirobolidae) por parte de *Furnarius rufus* en la región más al sur de Brasil

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ABSTRACT. Anointing is a rarely observed and poorly understood behavior performed by more than 200 species of birds in which individuals actively or passively rub ants or other animals/objects onto their feathers, presumably to remove ectoparasites, heal infections, or soothe irritated skin during molting. Millipedes can be used for anointing, probably because of their secretions, which are filled with chemical substances that may contribute to removing ectoparasites, treating dermal diseases, and enhancing olfactory communication. Only three records of millipede-anointing for two species of Neotropical birds are known; our observation identifies a third species. We observed and described a Rufous Hornero (*Furnarius rufus*) anointing with a millipede for 100 sec, as it mainly focused on its cloaca while pecking and hitting the millipede on the ground, which was possibly a tactic to obtain more fluids. The higher amount of time spent anointing the cloaca region could be linked to the elimination of bacteria or infections, or to reduce dermal irritation, possibly making it more attractive to the opposite sex, as it would seem healthy and clean. Another hypothesis is that the bird was self-stimulating, although most authors do not support this interpretation. Anointing is still not well understood by science, and more research as well as detailed observations are encouraged.

RESUMEN. La unción es un comportamiento raramente observado y poco comprendido realizado por más de 200 especies de aves en las cuales los individuos, activa o pasivamente frota hormigas u otros animales/objetos sobre sus plumas, presuntamente para remover ectoparásitos, sanar infecciones o aliviar la piel irritada durante la muda. Los milpiés pueden ser usados para la unción, probablemente por sus secreciones, las cuales están llenas de sustancias químicas que pueden contribuir a remover ectoparásitos, tratar enfermedades dérmicas o mejorar la comunicación olfativa. Solo se conocen tres registros de unción de milpiés por parte de dos especies de aves Neotropicales; nuestra observación identifica una tercera especie. Observamos y describimos un *Furnarius rufus* realizando unción con un milpiés por 100 segundos, lo cual fue posiblemente una táctica para obtener una mayor cantidad de fluidos. La mayor cantidad de tiempo de unción en la región de la cloaca puede estar asociado a la eliminación de bacterias o infecciones, o para reducir la irritación dermal, posiblemente haciéndose más atractivo al sexo opuesto pues puede parecer más limpia y sana. Otra hipótesis es que el ave se estaba auto estimulando, sin embargo, la mayoría de los autores no apoyan esta interpretación. La unción es aún poco comprendida para la ciencia y motivamos a que se realicen más investigaciones y observaciones detalladas.

Key Words: *anting; Neotropical bird; preening; self-anointing*

INTRODUCTION

Anting, more generally called anointing, is a poorly understood behavior performed by several mammals and by more than 200 mostly passeriform birds (Birkingshaw 1999, Craig 1999, VanderWerf 2005, Morozov 2015). The term “active anting” describes behavior in which individuals actively rub ants (Insecta, Formicidae) on their feathers or skin, and “passive anting” refers to behavior in which individuals allow ants to walk freely on their skin and feathers (Stresemann 1935, Wenny 1998, Morozov 2015). The term “anointing” currently designates similar behaviors using other organisms that produce the same effect by their stinging or toxic substances, such as millipedes (Diplopoda; Clunie 1974, 1976, Sazima 2009, Klavins et al. 2014), caterpillars (Insecta, Lepidoptera; Wenny 1998), peppertree fruits (Anacardiaceae, *Schinus* spp.; VanderWerf 2005), citrus peels (Rutaceae; Clayton and Vernon 1993), flowers (Dennis 1985), and even objects such as cigarette butts (Chisholm 1944), mothballs (Clark et al. 1990), and chimney smoke (Wee 2008).

There are many hypotheses for this behavior in birds, the most accepted ones being those that affirm that the acid substances of

the objects remove ectoparasites, heal infections, or reduce dermal irritation during molting periods (Potter 1970, Simmons 1985, Ehrlich et al. 1986, Clayton and Vernon 1993, Morozov 2015). However, it is also possible that birds perform anointing to enhance olfactory communication, or simply only for self-stimulation, because they might appreciate the sensation that substances release on their skin (Whitaker 1957, Chisholm 1959, Birkinshaw 1999). The origins of anointing in birds are uncertain (Chisholm 1959), and it may be an opportunistic behavior induced by the chemical properties of the object (Chisholm 1959, Wenny 1998). Anointing has been observed both in adult and immature birds in both wild and captive situations (Chisholm 1944, 1959, Craig 1999). It is inconclusive if anointing is an innate behavior or if it is acquired through experiences while living among others (Chisholm 1959).

Millipedes, when disturbed, release through their lateral glands secretions that are repulsive or have a toxic effect on arthropod predators, especially arachnids (Meglitsch and Schram 1991, Berggren 2005, Sousa 2014). A range of chemicals, such as phenols, aldehydes, quinones, hydrogen cyanide, chlorine, and

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iodine are found in these secretions (Meglitsch and Schram 1991, Hopkin and Read 1992). However, the usage of these organisms for body maintenance in vertebrates is still poorly known, being restricted to occasional records in mammals, such as lemurs (Primates, Lemuridae; Vasey 1998, Birkinshaw 1999, Peckre et al. 2018), monkeys (Primates, Aotidae; Zito et al. 2002), opossums (Didelphimorphia, Didelphidae; Santori 1998), coatis (Carnivora, Procyonidae; Weldon et al. 2006), meerkats (Carnivora, Herpestidae; Doolan and Macdonald 1996), and birds (Clunie 1974, 1976, Parkes et al. 2003, Berggren 2005, Sazima 2009, Klavins et al. 2014, Wee 2017).

Anointing is done secretly among birds (Craig 1999) and therefore seldom observed (Wee 2008). Interestingly, most known records are from temperate zones, with few reports from tropical zones, where the prevalence of fungal and bacterial infections is probably greater because of a higher humidity level (Wenny 1998, Wee 2008). For Neotropical birds, anointing with a millipede is only known from three single observations of two bird species (Parkes et al. 2003, Sazima 2009, Klavins et al. 2014); we describe a new record of active anointing with a millipede for Neotropical regions and for a new bird species, the Rufous Hornero (*Furnarius rufus*).

METHODS

Study site

One individual Rufous Hornero was observed actively anointing with a millipede it found on the ground by the sides of a building at the Biology Institute of the Federal University of Pelotas, Capão do Leão, Brazil (-31.800207; -52.418166) at 08:46 on 26 September 2018. The municipality is located within the Pampas biome (Veloso et al. 1991), and has its climate classified as mesothermic, always humid, with hot summers, according to the Köppen classification (Moreno 1961).

Data gathering and analyses

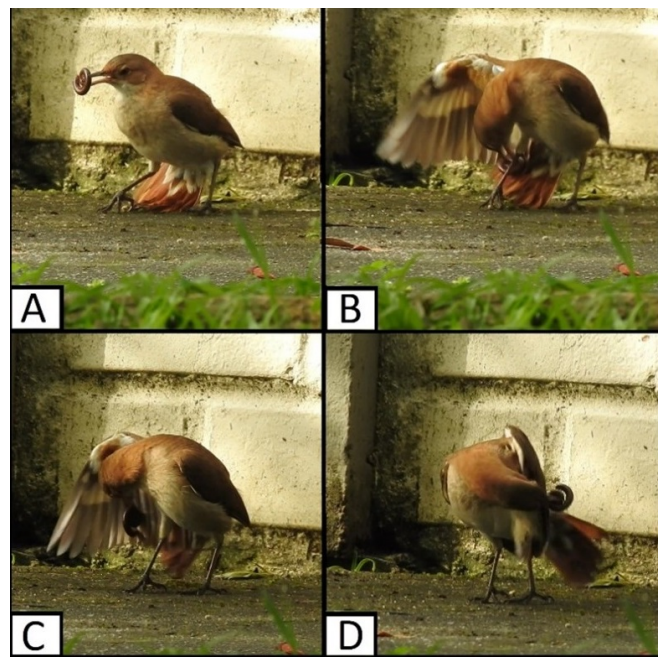
The action was recorded with a Nikon CoolPix p900 with the observer remaining about 6 m from the bird. Later, we analyzed the recording frame by frame, describing the entire action and the duration (seconds) of each movement. Every back and forward movement of the beak while holding the millipede against its feathers was called “rubbing”; every time the bird dropped the millipede and almost instantly grabbed it back was called “drop and grab”; the act of holding the millipede with its beak while not anointing we called “hold with beak.” The millipede could only be identified as Diplopoda, Spirobolidae.

The behaviors were divided into five major categories each with some subcategories: (1) Explore: every action of exploring the millipede such as (a) pecking, (b) dropping and grabbing, (c) observing, and (d) hitting it against the ground; (2) Maintenance: every action involving (a) anointing and (b) shaking its feathers; (3) Containment: every action of (a) holding with beak, and (b) holding with feet; (4) Feeding: every action involving (a) eating the millipede and (b) foraging on the ground; and (5) Locomotion: every action involving displacing. The anointing actions were then classified by where on the body it was performed as (1) wings and (2) tail. Repetitions of each subcategory behavior and on each body part were counted and their frequency (%) was calculated by multiplying the time spent on each subcategory/body part by 100 and then dividing it by the total of time.

RESULTS

The entire sequence lasted around 100 sec, because it began a few seconds before the video started being recorded (which lasts 82 sec; Fig. 1). Every time the Rufous Hornero pecked, held, and manipulated the millipede while anointing, it closed its eyes, probably for safety against the secretions of the millipede. Once it stopped moving the millipede around while still holding it with the beak or once it dropped it on the ground, the bird opened its eyes again. Despite all of the manipulations performed by the bird, the body of the millipede was not in bad shape by the end of the action, even though it was dead with only the frontal portion of the body being a bit torn.

Fig. 1. Rufous Hornero, *Furnarius rufus* (a) holding the millipede with its beak, (b) rubbing the millipede on its cloaca, (c) rubbing the millipede on the ventral side of its right wing, and (d) rubbing the millipede on the dorsal side of its left wing.



Despite being the focus of our description, the anointing itself did not last long, being the third most frequent behavior that the Rufous Hornero performed (Table 1). Rubbing actions were even faster and not observable in their fullness to the naked eye, being mostly performed on its tail (Table 1). Every rubbing on the tail was on its ventral side, starting near the cloaca and later moving to the middle and end of the rectrices. Every rubbing on wings was rapidly performed on the borders of the dorsal side of the last primary. Sometimes, while anointing, it opened one of its wings and lifted one of its feet to reach distant regions, losing balance occasionally. In addition, a few attempts of anointing were frustrated as the bird lost the millipede once it fell on the ground. The Rufous Hornero also shook its feathers once after anointing (Table 1).

The most performed action was “Explore,” mainly by holding the millipede in its beak or feet, the left foot being used most (Table 1). It also hit the millipede against the ground, sometimes falling far away from the bird, making it have to walk or turn around to

Table 1. Categories and subcategories of the behaviors performed by a Rufous Hornero, *Furnarius rufus*, its repetitions, frequency (%), and time spent (seconds) anointing, subdivided by tail and wings.

Categories	Repetitions	Frequency (%)	Time (sec)
Explore			
Peck	55	18.2	14.9
Drop and grab	46	25.4	20.8
Observe	16	11.1	9.1
Hit against ground	3	2.3	1.9
Maintenance			
Anointing	28	24.3	19.9
Tail	19	80.9	16
Wings	9	19.6	3.9
Shake feathers	1	0.7	0.6
Containment			
Hold with feet	8	5.2	4.3
Hold with beak	4	2.1	1.7
Feeding			
Eat	2	2.1	1.7
Forage	1	1.8	1.5
Locomotion	8	6.8	5.6
Total	172	100	82

take it again (Table 1). Only once did the bird appear to attempt eating the millipede, right after holding it with its left foot, munching a small fragment of it (Table 1). The other action involving eating was when it began foraging on the ground after the interaction with the millipede ended and was moving away from it, which is when we stopped recording (Table 1).

DISCUSSION

Anointing with millipedes by Neotropical birds is known only for three recordings involving two species of Dendrocolaptidae, the Strong-billed Woodcreeper (*Xiphocolaptes promeropirhynchus* Lesson 1840; Parkes et al. 2003) and the White-throated Woodcreeper (*X. albicollis* Vieillot 1818; Sazima 2009, Klavins et al. 2014), closely related to the Rufous Hornero (family Furnariidae; Irestedt et al. 2002). However, other species that are not so closely related to these three species, have also been recorded anointing with millipedes, such as the Black-faced Shrikebill (*Clytorhynchus nigrogularis* Layard 1875; Monarchidae; Clunie 1974), two species of Sturnidae (Jungle Myna *Acridotheres fuscus* Wagler 1827; Clunie 1976), and Javan Myna (*A. javanicus* Cabanis 1850; Wee 2017), and the North Island Robin (*Petroica longipes* Garnot 1827; Petroicidae; Berggren 2005), suggesting that this behavior might be unrelated to phylogeny.

Similar to what we observed, Clunie (1974) mentions the act of holding the millipede with feet and pecking it before rubbing it against the feathers, and Clunie (1976) and Sazima (2009) also mention hitting the millipede against surfaces; however, in our observation, little damage was done to the millipede. Hitting and rubbing food against the ground is known to diminish toxic and unpalatable secretions (Fry 1969, Willis 1972, Judson and Bennett 1992), and, in this case, hitting it against the ground and pecking it might have helped break the hard exoskeleton of the millipede, permitting access to its interior, similar to the manner in which bee-eaters cope with venomous bees (Fry 1969). Dropping the millipede while anointing and staring at it before picking it up

also happened on both Javan Myna observations, which Wee (2017) suggests had been done on purpose, because of the unpleasant taste of the secretions of the millipede. Also Wee (2017) reported that the Javan Myna individual closed its nictitating membrane while manipulating the millipede, similar to what we observed the Rufous Hornero doing, suggesting the birds tried to protect their eyes from the body substances of the millipedes. Of all reported observations, only the White-throated Woodcreeper observed by Sazima (2009) and the Strong-billed Woodcreeper observed by Parkes et al. (2003) were reported to eat the millipede after anointing.

In our observation, the Rufous Hornero frequently focused on anointing near the cloaca. This could be to get rid of bacteria and infections, or to soothe irritated skin, probably also increasing its chances of mating by keeping itself healthy and clean. However, this could also be related to sensory or even sexual stimulation, due to the thermogenic action resulting from anointing, because it happened during mating season (spring–summer) and its gonads were likely in breeding condition (Whitaker 1957). Simmons (1966) questions Whitaker's hypothesis, asserting that birds who perform anointing just for pleasure purposes would be more vulnerable to predator attack. Similarly, Potter and Hauser (1974) asserted that birds acquire pre-copulatory stimuli by courtship feeding and mutual grooming, suggesting that anointing on the cloaca might be related to the molting of the anal ring feathers.

Simmons (1966) suggested that anointing is a strictly functional feather-maintenance behavior, and that performing it with non-ant substitute objects is an "error" in the learning process. However, because anointing with other animals and also with plants and objects is so commonly reported, it is plausible that it is not a learning mistake committed by birds; instead, it might be a more complex behavior not yet well understood. The scarcity of well-described anointing observations implies that more study and observations are needed to reach a better understanding of the true reasons for this behavior.

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Data Availability:

The data that support the findings of this study are available at https://figshare.com/articles/medialFurnarius_rufus_self-anointing_with_millipede/24498238.

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