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Two intergeneric hybrids between motmots from the Amazon forest: Rufous Motmot (*Baryphthengus martii*) x Amazonian Motmot (*Momotus momota*)

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Abstract

Hybridization is a relatively common phenomenon in birds, but it is probably underestimated due to our poor knowledge on the reproductive biology of several species. Here we present the second case of intergeneric hybrid in family Momotidae and the first case between Amazonian Motmot (*Momotus momota*) and Rufous Motmot (*Baryphthengus martii*). In addition to the field record documented herein, we searched for possible hybrids among 57 study skins and 175 photographs and videos publicly available in online databases. The overall plumage pattern of the hybrid individual recorded in the field was similar to that of the Rufous Motmot, except for the following features, which appear to have been inherited from the Amazonian Motmot: two narrow blue lines in the facial mask; distinct blue feathers on the pectoral spot; and central rectrices with terminal racquets. Among the database photos examined, we found a second possible hybrid, with the same diagnostic features present in the hybrid recorded in the field. Similarities in behavior and vocalizations, in addition to the scarcity of mates in the limits of the distributions of Amazonian and Rufous motmots, may explain the occurrence of hybrids between them.

Keywords: citizen science, hybridization, introgression, Momotidae, Neotropic, scarcity of mates

Declarations

Conflicts of interest/Competing interests: The authors declare that they have no conflict of interest

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Consent for publication: All authors agree

Code availability: Not applicable

Hybridization is the outcome of a cross between different species and the resulting offspring usually present a mixture of characters present in each of the parental species (Avice 2004, McCarthy 2006).

Hybridization is a relatively common phenomenon in birds. McCarthy (2006) estimated that 9.2% of all birds species hybridize with at least another bird species, but more recent data indicate that 16.4% of all bird species are known to hybridize in nature and these numbers are most probably underestimated due to our poor knowledge on the reproductive biology of several bird species (Ottenburghs et al. 2015). Recently, hybrids were detected between common cryptic species pairs occurring across the headwaters of major Amazonian rivers (Weir et al. 2015) and even species with hybrid origin (Barrera-Guzmán et al. 2017).

Although hybrids are relatively common in birds, hybridization instances in the family Momotidae are scarce. Few such hybrids are known. One instance report an intergeneric hybrid between the Amazonian Motmot *M. momota* and the Rufous-capped Motmot *Baryphthengus ruficapillus* from the Cerrado biome in central Brazil (Marcondes et al. 2013). Another report involved just a brief comment with no physical evidence between Andean Motmot *Momotus aequatorialis* and the Amazonian Motmot *Momotus momota* (McCarthy 2006), which are sometimes regarded as conspecific (Monroe and Sibley 1993). In addition to these cases, a mixed pair of Keel-billed Motmot *Electron carinatum* and Broad-billed Motmot *Electron platyrhynchum* was reported, but no offspring was observed (Stiles and Skutch 1989, Snow 2001).

The Amazonian Motmot is a mid-sized to large motmot, with total length and corporal weight ranging 38–43cm and 85–160g, respectively, among subspecies; it inhabits humid forest, seasonal forest, riparian forests, second growth forest, plantations and locally gardens (Sick 1997, Snow and Kirwan 2019a). The Rufous Motmot is a very large motmot, with total length and corporal weight ranging 42–47cm and 153–208g, respectively, among the different subspecies; it inhabits humid forest, older second-growth woodland and semi-open areas (Sick 1997, Snow and Kirwan 2019b). These two motmots have a large overlap in their geographic distributions (Fig. 1). The Amazonian Motmot occurs throughout the Amazon basin, central and northeastern Brazil (Piauí, Ceará, Atlantic forest north of São Francisco River) whereas the Rufous Motmot occurs in Central America from Honduras to western Colombia and Ecuador, and from southern Colombia, Bolivia to the east bank of the Tapajós River in the southern Amazon basin (Snow 2001).

Here, we report on two apparent intergeneric hybrids in Momotidae between Amazonian Motmot and Rufous Motmot from two distinct localities from Amazon basin.

In addition to the intergeneric hybrid field record presented here, we checked for possible additional hybrids among 57 study skins of Rufous Motmot housed at the Museu Paraense Emílio Goeldi (MPEG), Belém, Brazil, and Museu de Zoologia da Universidade de São Paulo (MZUSP), São Paulo, Brazil. We examined only Rufous Motmot specimens due their overall plumage similarity with the hybrid seen in the field, which was impossible to be confused with Amazonian Motmot. Furthermore, we also searched for putative intergeneric hybrids among 175 photographs and videos of Rufous motmots publicly available at the following online databases: 1) Wikiaves (www.wikiaves.com.br); 2) eBird/Macaulay Library (<https://search.macaulaylibrary.org/catalog>); and 3) Internet Bird Collection (<http://ibc.lynxeds.com>). A complete list of specimens, photographs, and videos examined is provided in Supplemental Table S1.

During a birding tour with a group of Brazilian birders (Ester Ramirez and Marcos Holanda) on 5 October 2015, we observed a Rufous Motmot with some abnormal characteristics in the Amazonia National Park (04° 33' 7.74" S, 56° 18' 5.67" W), municipality of Itaituba, Brazil (Fig. 1). On the occasion, PVC used the song of Rufous Motmot to attract the species for observations and photographs, but instead, a mixed group of four motmots (with two Rufous Motmots and two Amazonian Motmots) were attracted, including one individual that phenotypically resembled a Rufous Motmot in general color but with some abnormal marks on the face (Fig. 2).

This individual was photographed in an area of humid forest ('terra firme') near the Tapajós River, the midstory and understory covered by abundant vine tangles. The local topography is very hilly due the influence of the Tapajós River valley.

The purported hybrid shows an intermediate face color pattern between those of Rufous Motmot and Amazonian Motmot (see Fig. 2a). The general pattern is consistent with Rufous Motmot, except for the following characters that appear to have been inherited from Amazonian Motmot: 1) two narrow blue lines above and below the black facial mask; 2) a patch of distinct blue feathers on the black pectoral spot (Fig. 2a); and 3) central rectrices with bare distal shafts and terminal racquets (Fig. 2b). The only population of Rufous Motmot to have a racquet-tipped tail is found across the Andes (*B. m. semirufus*), hence also supporting the notion that Amazonian Motmot is one of the parentals.

We did not find any evidence for intergeneric hybrids among the examined specimens, but one possible hybrid was detected in the photo database of the Wikiaves website. The photograph was taken by Glauco Correa at Abunã, a district of Porto Velho municipality on the east bank of the Madeira River (WA1830400, Silva 2015). This individual has the same

characteristics matching the diagnosis of the hybrid photographed at the Amazonia National Park: blue narrow lines bordering the black mask, tail with bare distal shifts and terminal racquets, and blue feathers on the black pectoral spot.

The most likely explanation for the origin of photographed birds as hybrids is possible due the unique and exclusive combination of characteristics that they share with both inferred parental species: Rufous Motmot and Amazonian Motmot. A third motmot species present in the area, Broad-billed Motmot, is significantly smaller and has a characteristic blue-green chin and very broad flat bill and therefore can be safely ruled out as a parental species.

It is also important to exclude the possibility that the purported hybrids are not in fact individual variants, new taxa or juveniles. Throughout the examined material, we find just one evidence of additional hybrid record, a specimen photographed in Rondônia state that correspond with the diagnostic characters of the field record. Both records presented here are located near to the limits of the Rufous Motmot distribution and in the middle of Amazonian Motmot distribution, this can be a fundamental factor to hybrids occur between these two species. The specimen observed in the field is an intermediate between Amazonian and Rufous motmots, and it was found in a mixed group composed by both Amazonian and Rufous motmots, which included at least a single mixed pair. The presence of racquets in the tail is an evidence that the purported hybrid was an adult, given the presence of this character only in mature individuals of Amazonian Motmot and that juveniles of both parental species are paler, duller and short tailed (Snow 2001).

We can think of two main reasons for the occurrence of these hybrids: 1) Scarcity of mates in the eastern edge of the range of Rufous Motmot, where apparently the Amazonian Motmot is more common; 2) Similarities in behavior, such as tail movements and courtship, indicate a shared feature between the Rufous Motmot and the Amazonian Motmot complex (Skutch 1983), facilitating interbreeding. Moreover, both motmots appear to be attracted by each other's voices as verified during the sight of the Amazonian National Park hybrid and mixed group.

Therefore, we expected the occurrence of more hybrids between Rufous and Amazonian motmots when more evidence is available to perform genetic analysis and to test our hypothesis. If the hybrids are restricted to the limits of Rufous Motmot distribution, the scarcity of mates in the limits of distribution is a main factor driving the hybridization; but if hybrids are found throughout the distribution this can be broader than expected by phenotypic characteristics.

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Figure Captions

Fig. 1 Geographic distributions of the Amazonian Motmot (*Momotus momota*) and Rufous Motmot (*Baryphthengus martii*). The green circles indicate the locations of all examined materials of Rufous Motmot (skins, photos and videos; see Supplemental Table S1). The black star indicates the location of the purported hybrid recorded at Amazonia National Park whereas the black circle indicates the location of the second Amazonian x Rufous Motmot hybrid found in the online database. Maps were modified from BirdLife International and NatureServe.

Fig. 2 Photograph showing the diagnostic features of the hybrid recorded at Amazonia National Park. a) close view of the face color and pectoral spot pattern: number 1 arrows indicate narrow blue lines above and below the black facial mask whereas number 2 arrow indicate the distinct blue feathers on black pectoral spot. b) wide view of the hybrid, with arrow number 3 indicating the central rectrices with bare distal shifts and terminal racquets. Photos by Ester Ramirez.

(a)

(b)