

# Morphometric insights into the existence of a new species of *Cichlocolaptes* in northeastern Brazil

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**ABSTRACT:** Mazar Barnett & Buzzetti (2014) described a new species, *Cichlocolaptes mazarbarnetti*, from the Atlantic forests of northeastern Brazil. The holotype of the new species is a female that shows remarkable similarities with the sympatric *Philydor novaesi*. Here I analyze eight morphometric variables to assess phenotypic similarities among specimens of *Philydor novaesi*, *Cichlocolaptes mazarbarnetti* and other species in these two genera. The holotype of *C. mazarbarnetti* differs from *Philydor novaesi* and falls in a region of the morphometric space occupied by specimens of *Cichlocolaptes leucophrus*. Therefore, morphometric data is consistent with other morphological, behavioral, and vocal data that suggest the existence of a new species *Cichlocolaptes* in the northern Atlantic forest.

**KEY-WORDS:** *Cichlocolaptes mazarbarnetti*, *Philydor novaesi*, Furnariidae, measurements, taxonomy.

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## INTRODUCTION

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The avifauna of the northern stretch of the Atlantic Forest is one of the least known, yet most endangered on Earth. Habitat destruction has outpaced ornithological research and conducting research on some species today is difficult because of their scarcity and vulnerability. The inventory of the taxonomic composition of this avifauna is incomplete, as demonstrated by continuous discoveries of new species in the last decades (e.g. Teixeira 1987; Teixeira & Gonzaga 1983, Silva *et al.* 2002). One such species is the Alagoas foliage-gleaner *Philydor novaesi*, discovered at Pedra Branca, Murici, a relict of foothill forest in Alagoas State (Teixeira & Gonzaga 1983b), and found later in a small reserve in Pernambuco State (Mazar Barnett *et al.* 2005). The species is considered critically endangered (BirdLife International 2013). In a surprising turn of events, Mazar Barnett & Buzzetti (2014) described yet another new foliage-gleaner from Murici, *Cichlocolaptes mazarbarnetti*, based on field observations and examination of museum specimens. The new species is extremely similar to *P. novaesi* in plumage pattern and color but its behavior and vocalizations resemble those of *Cichlocolaptes leucophrus*. In particular, like *C. leucophrus*, the new species shows a preference for foraging on bromeliads. Upon examination of specimens identified as *P. novaesi* at the Museu Nacional in Rio de Janeiro, Mazar Barnett & Buzzetti (2014) concluded that one specimen

originally identified as *P. novaesi* is an exemplar of the new foliage-gleaner; diagnostic characters include a larger body size, a longer beak, absence of buffy orbital feathers, and rounded tail feather tips. Although Mazar Barnett & Buzzetti (2014) measured and discussed some biometric data, comparisons were limited to single variables and few species. As part of a large-scale morphometric analysis of the Furnariidae (Claramunt 2010; Claramunt *et al.* 2013), I examined and measured all specimens identified as *P. novaesi* at the Museu Nacional, including the holotypes of *P. novaesi* and *C. mazarbarnetti*. Here I present a morphometric analysis of those specimens and discuss its implications regarding their taxonomic status.

## METHODS

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Measurements were taken with a Mitutoyo Digimatic Point Caliper (resolution: 0.01 mm) with an output interface. Variables were the same as in previous morphometric studies of the Furnariidae (Claramunt *et al.* 2010; Claramunt *et al.* 2013). Here, I analyzed only two variables from each body region because some measurements were highly correlated in foliage-gleaners: 1) wing length; 2) wing length to the first secondary feather; 3) tail length to central rectrices; 4) tail length to the most external rectrix; 5) bill length from the anterior border of the nostril to the tip of the bill; 6) bill width at

the level of the anterior border of the nostrils; 7) tarsus length; and 8) hallux length with claw (Baldwin *et al.* 1931; Claramunt *et al.* 2010).

All known specimens of *Philydor novaesi* and the holotype of *Cichlocolaptes mazarbarnetti* were examined and measured (Appendix). For comparison, I included in the analysis other *Philydor* and *Cichlocolaptes* taxa. Although DNA sequences of *P. novaesi* are not available, its overall morphology and plumage suggest a close relationship with *P. atricapillus* (Teixeira & Gonzaga 1983b) from southeastern Brazil, which belongs to a clade including *P. pyrrhodes*, *Cichlocolaptes leucophrus*, and *Heliobletus contaminatus* (Derryberry *et al.* 2011; Appendix). I did not include *H. contaminatus* in the analysis because of its small size and very distinctive morphology compared to the other species examined. In addition, I analyzed specimens of *P. fuscipenne* and *P. erythrocerum* (Appendix), which are more distantly related but share several phenotypic similarities with *P. novaesi*, and cannot be discarded as potential close relatives. Finally, I also analyzed specimens of the genus *Pseudocolaptes* (Appendix), another genus of Furnariidae that specialized in bromeliad foraging (Sillet *et al.* 1997, Martínez 2003), to investigate patterns of morphological variation related to bromeliad specialization. I examined scatter plots of all variables obtained and conducted a Principal Components Analysis on the covariance matrix of log-transformed values for all measured specimens.

## RESULTS

All species analyzed showed sexual dimorphism in which males are larger than females (Table 1). The size dimorphism is particularly pronounced in wing and tail length, for which males of some species average 10 mm longer than females. Exceptions to this pattern are *Cichlocolaptes* and *Pseudocolaptes*, which show reversed sexual dimorphism in bill length, with females having longer bills (Table 1). *P. novaesi* is larger than other species of *Philydor*. Whereas males are relatively uniform (small standard deviations), females previously assigned to *P. novaesi* (including the holotype of *C. mazarbarnetti*) are unusually heterogeneous, particularly in wing, bill, and tarsus length (Table 1). Female 33873 is about 90% smaller than males' averages in wing, tail, and feet variables. Female 34531 is about the same size as males in all variables. Female 34530, the type of *C. mazarbarnetti*, has long wings and bill, surpassing all specimens of *P. novaesi*, including males. The tail of 34530 is not longer than that of *P. novaesi*, however, rectrices 1 and 2 may not be fully grown, as their rachises still show basal sheaths. It is possible to estimate the expected tail length of 34530 from the length of rectrix 6, using the average ratio between these two measurement among specimens of *Philydor* and

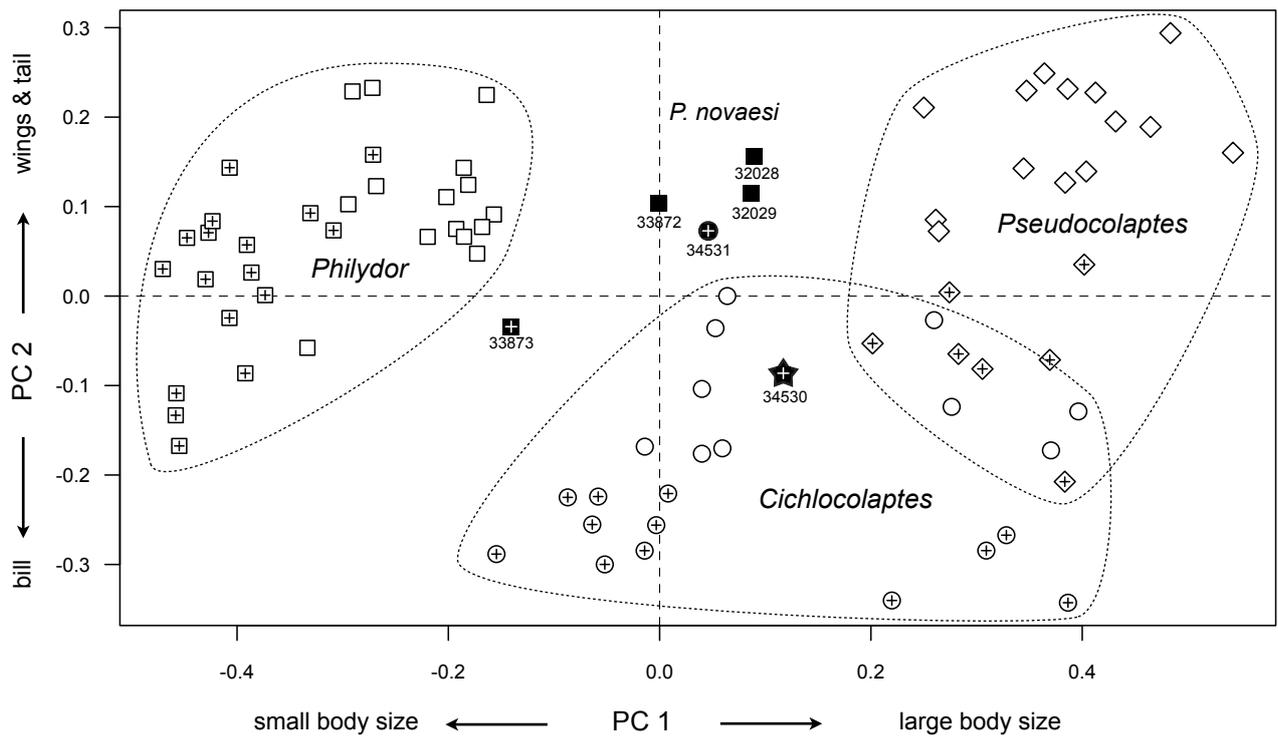
*Cichlocolaptes* examined. Given a ratio of 1.32, rectrix 1 should be around 82.6 mm when fully-grown, not much longer than the actual measurement (Table 1).

Two principal components explained 86% of the variance among all specimens measured (Table 2). Principal component 1 is positively correlated with all variables; thus, it is associated with overall size. Principal component 2 is a contrast between variables of the bill and variables of the flight apparatus (wings and tail). The three genera, *Philydor*, *Cichlocolaptes*, and *Pseudocolaptes*, occupy different parts of the morphospace defined by components 1 and 2, with limited overlap (Figure 1). Within each genus, females and males are almost completely segregated. Females tend to have lower scores than males in both components, indicating smaller overall size but relatively larger bills. *P. novaesi* is in an intermediate position among the three genera. The three males of *P. novaesi* are tightly clustered, with intermediate scores on component 1 (intermediate size) and high scores on component 2 (relatively long wings and tail but short bill). Females, in contrast, are heterogeneous. Female 33873 has lower scores in both components, compared to males, and its position matches the relative position of females due to sexual dimorphism. Female 34531, in contrast, is positioned near males *P. novaesi*. Female 34530, the type of *C. mazarbarnetti*, has a slightly larger component 1 score but a considerably lower component 2 score compared to male *P. novaesi*; has a result, it is positioned in a region of the morphospace occupied by *Cichlocolaptes leucophrus*, and closer to females of *Pseudocolaptes* than to males of *P. novaesi*. The use of the estimated fully-grown tail length of 34530 instead of its actual length had a negligible effect on the position of this specimen in the multivariate space.

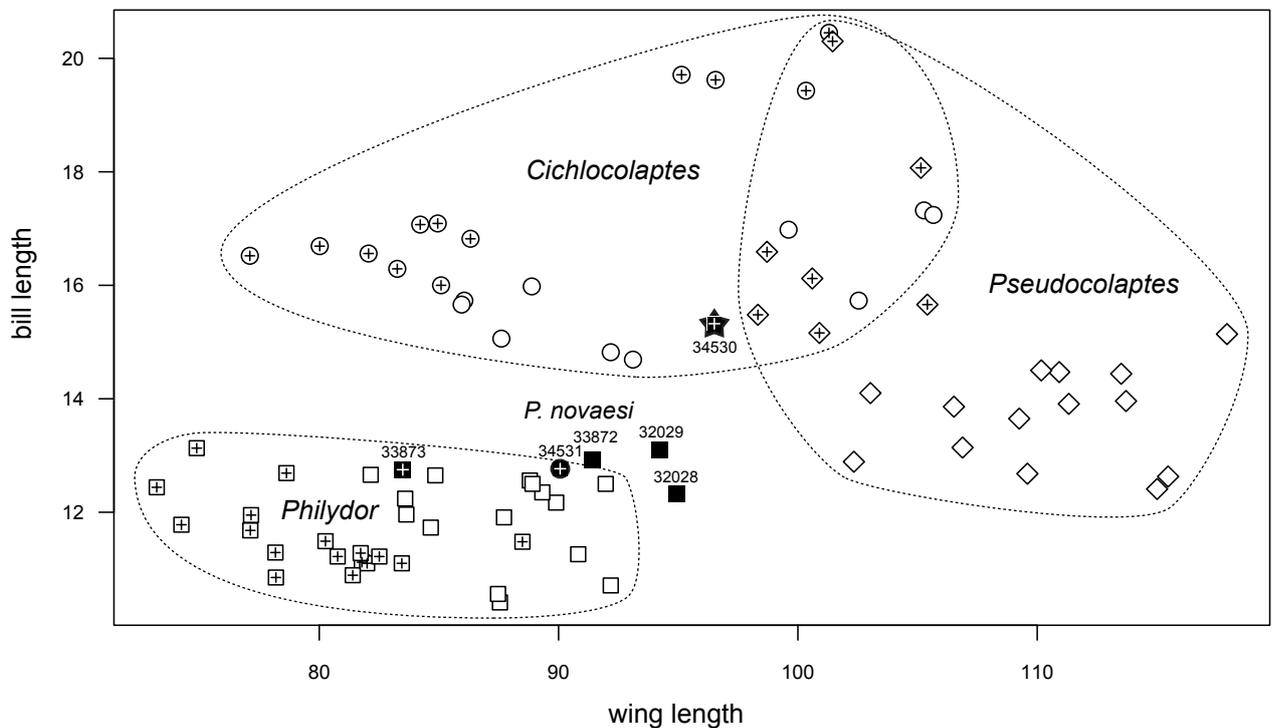
A simple plot of wing and bill length shows a similar pattern (Figure 2). *P. novaesi* specimens are closer to other species of *Philydor*. Note, again, the nearly complete segregation of males and females along the wing-length axis, and, for *Cichlocolaptes* and *Pseudocolaptes*, along the bill-length axis. Again, female 34530 is closer to *Cichlocolaptes* and *Pseudocolaptes* rather than to other specimens of *P. novaesi* and specimens of *Philydor* in general.

## DISCUSSION

The morphometric analysis presented here provides a quantitative assessment of all specimens of *P. novaesi* and *C. mazarbarnetti* (Mazar Barnett & Buzzetti 2014). The analysis indicates that *P. novaesi* is larger compared to the other species of *Philydor*, evident in both univariate and multivariate analyses (Table 1, Fig. 1 and 2). The three male specimens of *P. novaesi* are fairly homogeneous, occupying a small sector of the morphospace, but the three females are unusually heterogeneous. Female 33873



**FIGURE 1.** Principal component analysis of eight morphometric variables for male (plain symbols) and female (cross) specimens of *Philydor*, *Cichlocolaptes*, and *Pseudocolaptes*, including *Philydor novaesi* (black squares), the holotype of *Cichlocolaptes mazarbarnetti* (black star) and a specimen of uncertain affinities (black circle). Numbers below symbols are Museu Nacional specimen numbers. An approximate interpretation is given for each component but see Table 2 for variable loadings.



**FIGURE 2.** Position of male (plain) and female (cross) specimens of *Philydor*, *Cichlocolaptes*, and *Pseudocolaptes* in the morphometric space defined by wing length and bill length, including specimens of *Philydor novaesi* (black squares), the holotype of *Cichlocolaptes mazarbarnetti* (black star) and a specimen of uncertain affinities (black symbol). Numbers below symbols are Museu Nacional (specimen number).

**TABLE 1.** Morphometric data for species of *Philydor*, *Cichlocolaptes*, and *Pseudocolaptes*, including individual data for all specimens of *Philydor novaesi* and *Cichlocolaptes mazarbarnetti* (holotypes marked with \*), and average and standard deviations for a combination of female specimens of *P. novaesi* and *C. mazarbarnetti*, which were originally identified as the former species only. See discussion for the placement of MN 34531 in *P. novaesi* or *C. mazarbarnetti*.

Taxon	sex	wing		secondary 1		rectrix 1		rectrix 6		bill length		bill width		tarsus		hallux	
		$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD
<i>Cichlocolaptes mazarbarnetti</i> 34530*	f	96.5		77.7		81.8		62.5		15.3		4.9		22.7		16.7	
	fj	90.1		76.0		84.0		64.4		12.8		4.6		22.7		17.7	
<i>Philydor novaesi</i>	f	83.5		68.5		76.3		58.8		12.8		4.8		20.8		16.7	
	m	94.2		76.6		84.2		65.5		13.1		4.1		22.7		18.7	
	m	94.9		77.6		84.8		67.8		12.3		4.3		22.6		18.5	
	m	91.4		75.0		79.9		62.7		12.9		4.0		22.2		17.9	
	m	93.5	1.8	76.4	1.3	82.9	2.7	65.3	2.5	12.8	0.4	4.2	0.2	22.5	0.3	18.4	0.4
<i>P. novaesi</i> + <i>C. mazarbarnetti</i>	f	90.0	6.5	74.1	4.9	80.7	4.0	61.9	2.8	13.6	1.5	4.8	0.2	22.1	1.1	17.0	0.6
<i>Philydor atricapillus</i>	f	77.9	2.7	63.8	3.0	72.1	2.3	50.7	3.1	11.4	0.4	4.0	0.1	19.7	1.0	16.4	0.7
	m	84.2	0.7	69.0	1.5	76.6	2.9	55.1	1.8	12.1	0.4	3.8	0.2	20.1	0.4	16.7	0.5
<i>Philydor pyrrhodes</i>	f	77.5	3.9	63.9	2.6	59.1	1.5	46.3	1.2	12.3	0.8	4.4	0.3	19.5	0.6	17.7	0.5
	m	87.8	3.9	72.6	2.9	64.9	3.5	53.1	4.3	12.2	0.6	4.1	0.1	21.1	0.3	18.5	0.3
<i>Philydor erythrocerum</i>	f	83.3	3.5	66.2	2.6	65.1	4.6	58.3	4.4	11.2	0.2	4.2	0.3	18.9	0.5	14.0	0.4
	m	88.7	2.3	71.8	1.9	69.6	3.6	62.2	3.3	10.9	0.7	4.0	0.2	19.8	0.8	15.1	0.7
<i>Philydor fuscipenne</i>	f	81.3	0.9	65.3	0.5	63.9	1.6	54.6	2.7	11.2	0.2	4.3	0.2	18.3	0.6	14.5	0.7
	m	90.2	1.6	72.9	1.9	69.9	1.2	63.7	1.8	12.4	0.2	4.1	0.1	19.3	0.3	15.6	0.1
<i>Cichlocolaptes l. leucophrus</i>	f	98.3	3.0	77.5	2.7	87.0	3.3	64.8	3.0	19.8	0.4	5.4	0.3	23.1	0.5	18.6	0.6
	m	103.3	2.8	83.3	2.0	86.5	2.2	68.9	1.6	16.8	0.7	5.1	0.4	23.7	1.1	19.2	1.2
<i>Cichlocolaptes l. holti</i>	f	82.9	3.1	67.9	1.8	74.9	2.0	55.7	1.5	16.6	0.4	4.8	0.4	21.5	0.5	17.2	0.3
	m	89.0	3.1	73.6	1.8	79.5	2.1	59.1	3.0	15.3	0.5	4.5	0.3	22.5	0.9	17.9	0.6
<i>Pseudocolaptes boissonneautii</i>	f	100.9	2.7	83.4	2.4	90.6	4.2	65.0	3.0	17.1	2.1	4.5	0.1	24.4	0.3	18.3	0.5
	m	110.4	5.5	89.6	3.0	93.8	6.3	69.2	7.0	13.7	0.8	4.2	0.2	26.1	0.9	20.4	1.9
<i>Pseudocolaptes laurencii</i>	f	103.0	3.4	83.3	3.7	92.1	3.6	66.5	4.3	15.9	0.3	4.6	0.3	25.3	0.4	20.8	0.5
	m	110.4	3.0	88.4	2.1	99.9	4.9	71.8	4.7	13.6	0.9	4.2	0.3	25.7	0.2	21.1	0.8

**TABLE 2.** Principal components analysis loadings and variance explained.

	PC 1	PC2
Wing length	0.37	0.23
Secondary 1	0.36	0.22
Tail length	0.48	0.15
Rectrix 6	0.36	0.27
Bill length	0.38	-0.78
Bill width	0.12	-0.44
Tarsus length	0.35	0.04
Hallux length	0.35	-0.01
% variance	67	19

is considerably smaller than males, particularly in wing and tail lengths; however, the magnitude and direction of the difference in the morphometric space is as expected given the strong sexual dimorphism in *Philydor*. In plumage coloration, this specimen is indistinguishable from males of *P. novaesi* (Mazar Barnett & Buzzetti 2014; pers. obs.). Therefore, phenotypic data suggest that 33873 is a true *P. novaesi* female.

Measurements of female 34531 do not differ much from those of males of *P. novaesi*. Although Mazar Barnett & Buzzetti (2014) concluded that this specimen is larger than males of *P. novaesi*, differences in weight (2 grams heavier than the heaviest male) and total length (2 mm longer than the longest male) are relatively minor and involved two variables with high measurement error. Female 34531 had a ca. 2 mm smooth ovary according to its label data, indicating immaturity. In addition to its size, the plumage of 34531 is closer to that of 34530, the type of *C. mazarbarnetti*, than other specimens of *P. novaesi*, which led Mazar Barnett & Buzzetti (2014) to speculate that it may represent a juvenile *C. mazarbarnetti*. Another possibility is that 34531 represents a young male *P. novaesi* and its small testicle was mistaken for a small, smooth ovary. In any case, because of its young age, it is safer to set this specimen aside for taxonomic considerations.

Female 34530, the holotype of *C. mazarbarnetti*, is different from all specimens of *P. novaesi* examined. It is similar to males of *P. novaesi* in most measurement except for its much longer bill. However, given the strong sexual dimorphism in *Philydor*, females are not expected to be similar to males. The multivariate analysis placed this specimen apart from *P. novaesi* and in a region of the morphospace occupied by *Cichlocolaptes*. Therefore, the morphometric data is at least consistent with two aspects of Mazar Barnett & Buzzetti's (2014) hypothesis: that female 34530 is not a specimen of *P. novaesi*, and that it belongs to *Cichlocolaptes*.

One alternative to this hypothesis is that *P. novaesi* itself is a *Cichlocolaptes*, or at least, a bromeliad specialist.

That would explain behavioral similarities between *P. novaesi* and *Cichlocolaptes* noted in the field, and a strong reversed bill size dimorphism that would explain the longer bill of female 34530. Although *P. novaesi* has always been considered related to *P. atricapillus* based on plumage similarity (Teixeira & Gonzaga 1983b; Remsen 2003), it has never been the subject of phylogenetic analysis. *P. atricapillus* and *Cichlocolaptes leucophrus* are part of a clade that also includes *P. pyrrhodes* and *Heliobletus contaminatus* (Derryberry *et al.* 2011). *P. novaesi* may belong to this clade but, at least from a morphometric perspective, it is not clear whether it is closer to *P. atricapillus* or *C. leucophrus* since it occupies an intermediate position in the morphometric space (Figure 1). However, this hypothesis does not explain the morphometric disparity between female specimens 33873 and 34530 (both adult), neither explain the long wings of female 34530, since even among bromeliad specialists, *Cichlocolaptes* and *Pseudocolaptes*, females have considerable shorter wings than males. Although bromeliad specialists *Cichlocolaptes* and *Pseudocolaptes* tend to be morphometrically heterogeneous (see morphospace occupation in Figure 1 compared to *Philydor*), except for the sexual dimorphism in the bill, this heterogeneity most likely represents geographically structured differentiation. For example, *Cichlocolaptes leucophrus* is composed of two very distinct subspecies, *C. l. leucophrus* in northern Atlantic forests and *C. l. holti* in the south (specimens with a PC 1 score lower than 0.2; Figure 1). Within each subspecies, levels of variation among females are not greater than those of species of *Philydor* (Table 1). *Pseudocolaptes* is also composed of multiple lineages that vary geographically (Remsen 2003). In contrast, females 33873 and 34530 are from the same geographic locality.

A third possibility is that specimen 34530 is some sort of aberrant individual of *P. novaesi*, and similarities with *Cichlocolaptes* are just a coincidence. This hypothesis is difficult to test since, in principle, it does not predict a particular pattern of variation or position in the morphospace in relation to other individuals or species. However, it is not a simple case of gigantism in which an individual is isometrically larger than others in all variables. Specimen 34530 is larger than *P. novaesi* in bill and wing lengths but not in tarsus or hallux lengths. This pattern is unusual for intraspecific variation in birds since genetic changes that affect forelimb length will more likely affect hindlimb length rather than bill length (Nemeschkal 1999; Magwene 2001). Other aspects of this hypothesis can be tested with additional data. For example, comparison of levels of asymmetry can be used to evaluate whether specimen 34530 experienced an anomalous development (Palmer & Strobeck 1986).

I conclude that the existence of a new *Cichlocolaptes* species, *C. mazarbarnetti*, is a plausible explanation for the morphometric data analyzed. The reduced number

of specimens available limits any definite conclusion and any taxonomic recommendation should consider also the morphological and behavioral evidence presented by Mazar Barnett & Buzzetti (2014). A source of information that may be powerful in this case is genetic material extracted from study skins (Mundy *et al.* 1997) with which the phylogenetic affinities of *P. novaesi* and specimen 34530 can be determined with more confidence. Given the high levels of genetic divergence between members of the *Cichlocolaptes-Philydor* clade (Derryberry *et al.* 2011), even a short fragment of mitochondrial DNA may prove useful in determining relationships.

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## APPENDIX:

Specimens examined and measured in the collections of the American Museum of Natural History (AMNH), Louisiana State University Museum of Natural Science (LSUMZ), Museu Nacional, Rio de Janeiro (MN), and Museu de Zoologia, Universidade de São Paulo (MZUSP):

*Cichlocolaptes mazarbarnetti*. MN 34530 (holotype) adult female collected on 16 January 1986, 48 g, globulous 12 mm ovary with one ovum > 2 mm, ossified skull, 221 mm total length; MN 34531 (tentative assignation), young female collected on 20 January 1986, 36 g, smooth 2 mm ovary, according to a drawing in the label, 207 mm total length.

*Cichlocolaptes leucophrus leucophrus*. Males: AMNH 243297, 317611, MZUSP 33324, 34530. Females: AMNH 317612, 316817, MZUSP 33322, 28506.

*Cichlocolaptes leucophrus holti*. Males: AMNH 314749, 314748, 524356, LSUMZ 68015, 31666, MZUSP 49762. Females: AMNH 314750, 314751, 314752, 524357, LSUMZ 53001, 63359, MZUSP 32147, 54949.

*Philydor novaesi*. MN 32029 (holotype) adult male collected on 7 November 1979, 32 g, enlarged testis, 205 mm total length; MN 32028 (paratype) adult male, 34 g, enlarged testis, 195 mm total length; MN 33872, male, 32 g, small testis; 33873: adult female collected on 21 November 1983, 30 g, granulated 9 mm ovary, ossified skull, 195 mm total length.

*Philydor atricapillus*. Males: LSUMZ 63354, 70433, AMNH 314701, 243301. Females: LSUMZ 62951, AMNH 243302, 243303, 317614, 524190.

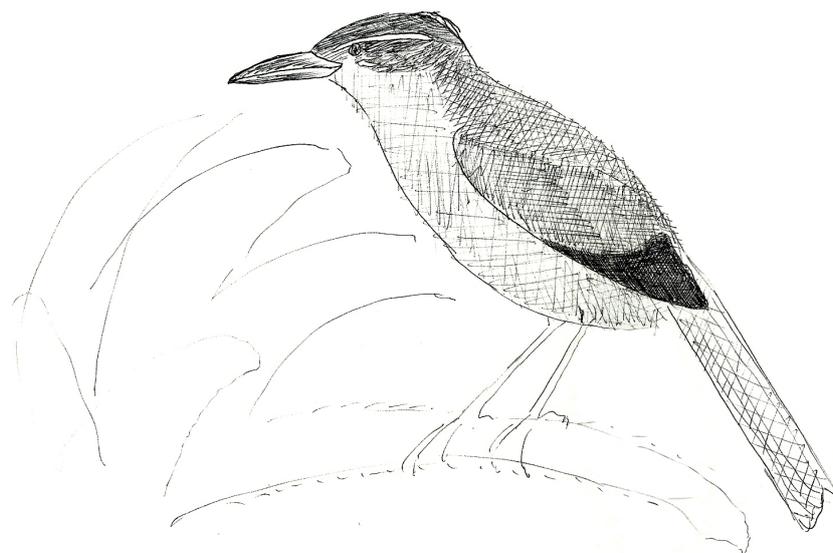
*Philydor pyrrhodes*. Males: LSUMZ 109768, 115010, 156423, AMNH 286828. Females: LSUMZ 137071, AMNH 430943, 824593, 142492, 274140.

*Philydor erythrocerum*. Males: LSUMZ 132520, 87888, 175383, 96027. Females: AMNH: 429578, 256099, 283973, 819937.

*Philydor fuscipenne*. Males: LSUMZ 108297, AMNH 246775, 136619. Females: AMNH 135827, 136620, 135826.

*Pseudocolaptes boissonneautii*. Males: AMNH 124519, 167340, 124520, 820955, 820474, LSUMZ 45349, 178990, 169854. Females: AMNH 820956, 820779, 820420, LSUMZ 81936.

*Pseudocolaptes lawrencii*. Males: LSUMZ 63643, 154029, AMNH 524041, 102195, 102196. Females: AMNH 811839, LSUMZ 154031.



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