

Molecular systematics and taxonomic revision of the Lineated Woodcreeper complex (*Lepidocolaptes albolineatus*: Dendrocolaptidae), with description of a new species from southwestern Amazonia

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The Lineated Woodcreeper (*Lepidocolaptes*⁴ *albolineatus*), a canopy-dwelling bird endemic to the Amazonian lowlands and surrounding foothills, is currently recognized as a polytypic species, with five described subspecies (Marantz *et al.* 2003). J. T. Zimmer (1934) was the first to lump the taxa *fuscicapillus*, *layardi*, *madeirae*, along with the new taxon he described in the same publication (*duidae*), with taxon *albolineatus* under the polytypic *Lepidocolaptes albolineatus* according to the theoretical background of the Biological Species Concept (BSC). Before that, Cory and Hellmayr (1925) recognized a polytypic *L. fuscicapillus* grouping the taxa *fuscicapillus*, *layardi*, and *madeirae* and a separate monotypic *L. albolineatus*. Over the next 78 years, Zimmer's taxonomic treatment of the *L. albolineatus* complex has been followed without change (e.g. Peters 1951, Ridgely and Tudor 1994), but more recently Cory and Hellmayr's older treatment was used to delimit subspecies groups in *L. albolineatus* (Marantz *et al.* 2003). Despite the overall morphological similarity among these taxa, patterns of vocal variation indicate that the *fuscicapillus* group is vocally heterogeneous, with taxa *fuscicapillus* and *layardi* being very distinct vocally, hence suggesting that the polytypic *L. albolineatus* may include more than a single species (Marantz *et al.* 2003). Consistent with this finding, a molecular phylogeny based on mitochondrial DNA data (Fig. 1) showed the existence of five reciprocally monophyletic groups in the *L. albolineatus* complex, each corresponding to already named taxa, except one including birds from south of the Solimões / Amazon and west of the Madeira rivers, to which the name *fuscicapillus* has been incorrectly applied (Fig. 2), as first pointed out by one of us (AW), based on vocal differences. Since no name is available for birds from this fully morphologically, vocally, and genetically diagnosable group, we propose to name these as:

Lepidocolaptes fatimalimae

Inambari Woodcreeper

arapaçu-do-inambari (Portuguese)



Holotype.— Museu Paraense Emílio Goeldi (MPEG) 74451, adult male (skull 100% ossified) from Brazil: Amazonas; municipality of Guajará (07°23'30.0"S / 72°45'32.53"W); collected 18 June 2012 by Alexandre Aleixo, prepared by Elton Pinho. Pectoral muscle tissue preserved in approximately 96% alcohol: MPEG 74451, field number CAM-058. Hologenotype (Chakrabarty 2010) sequences of the mitochondrial gene NADH subu-

nit 2 (ND2, 994 bp) deposited in GenBank (accession number KC874909).

Diagnosis: Morphology.— Alphanumeric color designations determined through direct comparison with Smithe (1975). Specimens of *L. fatimalimae* differ slightly from those of the morphologically similar *fuscicapillus*, the taxon with which it

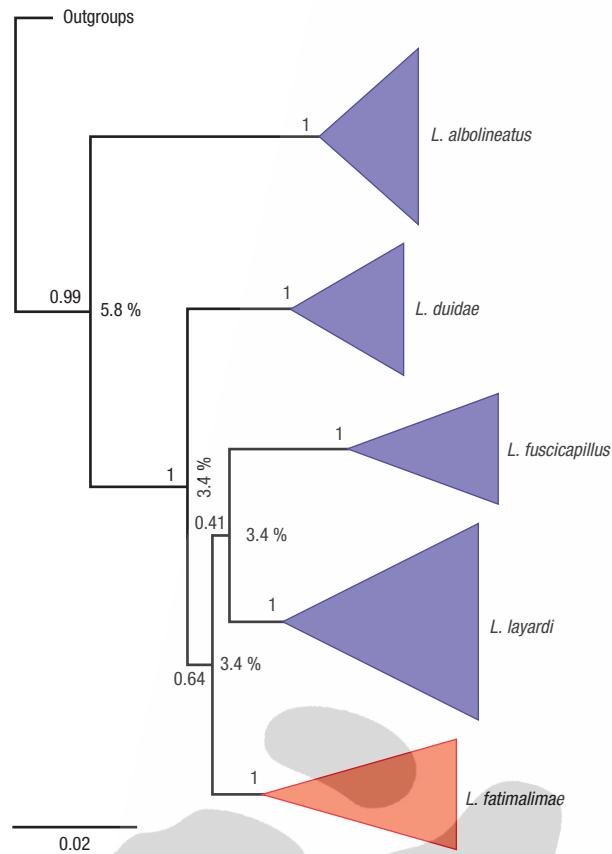
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⁴ Genus *Lepidocolaptes* 8: 439.

Figure 1. Phylogenetic relationships within the *Lepidocolaptes albolineatus* complex recovered by Bayesian analyses based on 994 bp of ND2 sequences. Numbers refer to posterior probabilities values and genetic distances (% of average uncorrected p sequence divergence) between sister groups associated with the labeled nodes. High support values (i.e., 1) associated with nodes grouping samples of *albolineatus*, *duidae*, *fuscicapillus*, *layardi*, and *fatimalimae* in reciprocally monophyletic clades are consistent with their recognition as species-level taxa.



had been associated until now, by the following characters: 1) coloration of the pectoral spots and foremost throat buffier (Buff color# 24); 2) head concolor with back and unspotted or, when spots are present, these are smaller and indistinct; 3) post-ocular stripes absent or, when present, interrupted and less conspicuous; and 4) tips of pectoral spots averaging narrower and brownish rather than black. **Voice.**— The song is immediately distinguishable in the field from those of all other members of the complex and, in spectrographic analysis, by note shape, number of notes, and pace (Fig. 3). Note shape, average number of song notes, and pace readily distinguish the loudsong of *L. fatimalimae* from those of closely related taxa *duidae*, *madeirae*, and *layardi* (Fig. 3; see also Table 1 in the SI). On the other hand, the loudsongs of *fatimalimae* and the more distantly related nominate *albolineatus* are mainly distinguished by note shape and frequency, with the notes in the latter taxon having a sharper peak at their highest frequency, so they appear more as an inverted “V”, as opposed to a rounded inverted “U” in *fatimalimae*, particularly in the first half of the song (Fig. 3; see also Table 1 in the SI). Furthermore, the second half of *fatimalimae* song tends to be more accelerated, with longer inter-note intervals gradually becoming shorter,

as opposed to a more uniform pace throughout the entire song’s length as in *albolineatus* (Fig. 3). **Genetic divergence.**— Separated from its close relatives *fuscicapillus* and *layardi* by approximately 3% sequence divergence in the mitochondrial gene ND2 (Fig. 1).

Distribution.— *Lepidocolaptes fatimalimae* has been documented from numerous localities throughout lowland Amazonia west of the Madeira and south of the Solimões rivers in the states of Acre and Amazonas in Brazil (Fig. 2). The species is also found in the departments of Cuzco, Huánuco, Junín, Loreto, Madre de Dios, Pasco, San Martín, and Ucayali in Peru, and Beni, Cochabamba, La Paz, Pando, and Santa Cruz in Bolivia (Zimmer 1934, Schulenberg *et al.* 2007; Fig. 2).

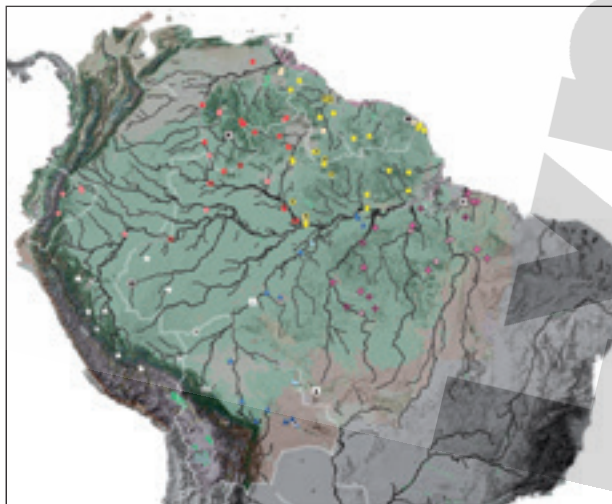
Description of holotype.— See color illustration. Alphanumeric color designations determined through direct comparison with Smithe (1975). Plumage worn on nape and upper back, tail and wing not in molt; skull 100% ossified. Head Hair Brown (119A) with short, indistinct light-brownish stripes on the forehead and lores. Cheeks heavily streaked with Buff (24). Upper mantle unmarked and concolor with head. Primaries, secondaries, and wing coverts Warm Sepia (221A); tips and inner webs of primaries with a contrasting Fuscous (21) tinge. Lower mantle and rump Warm Sepia (221A). Rectrices concolor with wings and rump. Tail graduated, each rectrix with a stiff shaft, softer at the tips. Throat Tawny Olive (223D). Lower throat and breast Army Brown (219B) with arrow-shaped bright buffy streaks with contrasting black edges. Upper belly Army Brown (219B) with paler buffy streaks. Lower belly paler than upper belly and covered with indistinct buffy streaks varying in length. Undertail coverts Cinnamon-Brown (33) covered with narrow Buff (24) streaks with contrasting black edges. **Soft parts in life:** Iris dark brown. Maxilla Grayish Horn Color (91) with a dark brownish base and wash around the nostrils; mandible Grayish Horn Color (91); tarsi and feet Grayish Olive (43). **Measurements of holotype:** wing 92 mm, tail 95 mm, tarsus-metatarsus 19.50 mm, bill length 27 mm, bill height 7.5 mm, and bill width 5 mm.

Etymology.— We are pleased to name the new species after the Goeldi Museum bird collection’s manager Fátima Lima. Fátima has been in charge of the every-day routine of the Goeldi bird collection for 30 years (since 1983), witnessing an increase of over 40,000 specimens in the collection’s holdings and working in close association with three different curators. During this time, Fátima has collected some specimens herself, but foremost provided invaluable support for specimen curation, mainly identification to subspecific level and registration into the collection. Thanks to her diligent work and in-house support, different Goeldi Museum curators were able to concentrate their efforts on the collection’s expansion, which more than doubled in size during this time.

REMARKS

Type series.— Paratypes of *L. fatimalimae* are the following five specimens: LSUMZ 132478: skin, adult female, ovary 12 × 7 mm, ova 4 × 3 mm, shot on 2 August 1986 at Nicolás Suarez; ca 12 km by road S of Cobija, ca 8 km W on road to Mucden, Pando, Bolivia; prepared by M. Sánchez under field number 3071. Tissue samples deposited at LSUMZ under tissue catalog # B-9720. NADH subunit 2 sequences deposited in GenBank (KC874906). LSUMZ 170826: skin, adult male, skull 100% ossified, testes 15 × 9 mm, shot in humid tall hill forest on 1 August 2000 at ca. 86 km SE of Juanjui on E bank of upper Rio Pauya (07°33'40"S / 75°54'58"W), Loreto, Peru, and prepared by Thomas Valqui under field number 209. Voice recorded by Thomas Valqui, original number TVM 000706; Macaulay Library of Natural Sounds (ML) # 175665. Tissue samples deposited at LSUMZ under tissue catalog # B-40638. NADH subunit 2 sequences deposited in GenBank (KC874908). MPEG 70000: skin, adult male, skull 100% ossified, testes 3 × 2 mm, collected in forest edge on 17 February 2010 by A. Aleixo at the mouth of Rio Jurupari (07°51'32.4"S / 70°03'10.5"W), municipality of Feijó, Acre, Brazil, and prepared by J. Nilton da Silva Santa-Brígida under field number JUR 004. Tissue samples deposited at MPEG under field number JUR 004. MUSM 17621: skin, adult female, collected in hilly *terra-firme* forest on 30 July 1996 at 79 km WNW of Contamana (07°08'S/75°41'W), Loreto, Peru,

Figure 2. Geographic distribution of specimens, recordings, and tissues of taxa within the *Lepidocolaptes albolineatus* complex analyzed in this study. Each color and symbol represent a single taxon. Yellow squares: *L. albolineatus*; red circles: *L. duidae*; white stars: *L. fatimalimae*; blue triangles: *L. fuscicapillus*; and pink crosses: *L. layardi*. Museum specimens are depicted as bright symbols, whereas audio recordings are represented by pale ones. Dots within specimen symbols represent tissues sequenced in this study. All type localities are represented by their respective taxon symbols placed within a white square. The type locality of *L. a. madeirae*, synonymized herein with *L. fuscicapillus*, is represented by a grey triangle within a white square.



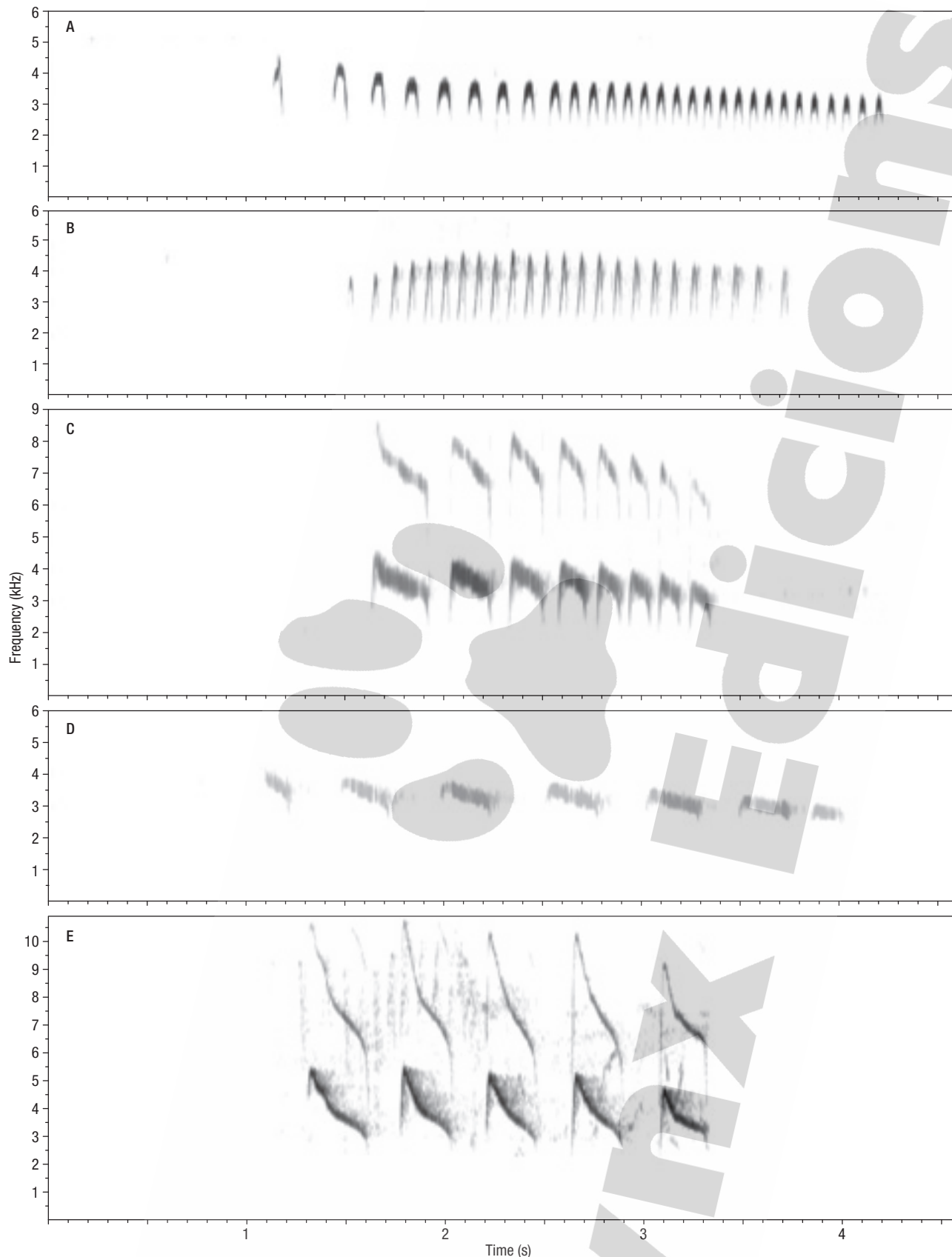


Figure 3. Representative spectrograms of songs of taxa grouped in the *Lepidocolaptes albolineatus* complex: A) *fatimalimae*: Brazil: Amazonas, Careiro do Castanho (LNS 127556); B) *albolineatus*: Guyana: Demerara-Mahaica, Madewini Lodge (LNS 85005); C) *duidae*: Venezuela: Amazonas, Gavilán Road (GAV 024); D) *fuscicapillus*: Bolivia, Santa Cruz Department, Noel Kempff Mercado National Park, Campamento Los Fierros (LNS 51900); and E) *layardi*: Brazil, Pará, Santarém, Floresta Nacional do Tapajós (LNS 115196).

and prepared by A. W. Kratter under field number #1050. Tissue samples deposited at LSUMZ under tissue catalog # 27990. NADH subunit 2 sequences deposited in GenBank (KC874907). MZUSP 42699: skin, adult male with large testes, collected on 24 July 1956 by M. Moreira and F. C. Novaes at Seringal Oriente, Marechal Taumaturgo, Rio Juruá, Acre, Brazil. **Variation in the type series:** The type series includes six specimens: four males and two females. No apparent sexual dimorphism exists in plumage. The most noticeable variation in the type series

pertains to the overall plumage brightness, with MUSM 17621 and MZUSP 42699 having the brightest plumage among all type specimens. Apparently, this variation has no seasonal or geographic basis, since the type series includes specimens collected in February, June, July, and August, with brighter (LSUMZ 132478) and drabber (LSUMZ 170826) specimens collected in August in Peru, and with both drabber (MPEG 70000) and brighter (MPEG 74451) specimens found in central-western Acre in Brazil. Thus, it is more likely that plumage brightness

has an individual basis that could possibly be explained by individual differences in the amount of wear due to individual differences in foraging and roosting, for example.

Ecology and behavior.— *Lepidocolaptes fatimalimae*, like other members of the *L. albolineatus* complex, forages mostly in pairs in the canopy of primary and disturbed *terra firme* and foothill forests, often along forest edge, almost exclusively in association with mixed-species canopy flocks, sometimes venturing into seasonally flooded *várzea* forest. Individuals typically forage by hitching along tree trunks and branches, where they glean for arthropods from the surface, crevices, or underneath the bark (Fig. 4). Tape-playback experiments by AW along a 5 km trail through *terra firme* at Tupana Lodge (state of Amazonas) revealed only two territorial birds. We suspect therefore that the species is a low density resident of *terra firme* forest. Its nest and eggs remain unknown; it presumably nests in tree cavities, as does *L. albolineatus* (Tostain *et al.* 1992).

Vocalizations.— The song of members of the *Lepidocolaptes albolineatus* complex is a short series of notes. It varies across taxa in characters such as the number of notes, note shape, and whether the song changes in pitch or pace. The song of *L. fatimalimae* is represented by a series of inverted U-shaped notes that fall in frequency and are delivered at a slightly accelerating pace toward the end (Fig. 3). The number of notes in each song ranged from 16 to 37 (with 70% of 24 songs ranging 26–33 notes), with a mean value of $29.5 (\pm 4.96)$ notes per song, and a mean pace (number of notes per second) of $10.60 (\pm 1.58)$ (see Table 1 in the SI file). Based on a sub-sample of six songs from each of six different birds (one per individual), the average dominant (peak) frequency was 3.52 ± 0.27 kHz, with the highest peak on the first note (3.67 ± 0.27 kHz), gradually decreasing on the second (3.56 ± 0.26 kHz) and third (3.55 ± 0.31 kHz) notes, until it reaches 3.35 ± 0.19 kHz on the middle notes, and the lowest peak frequency on the last song's note (2.85 ± 0.20 kHz). Based on the same sub-sample of six songs from each of six

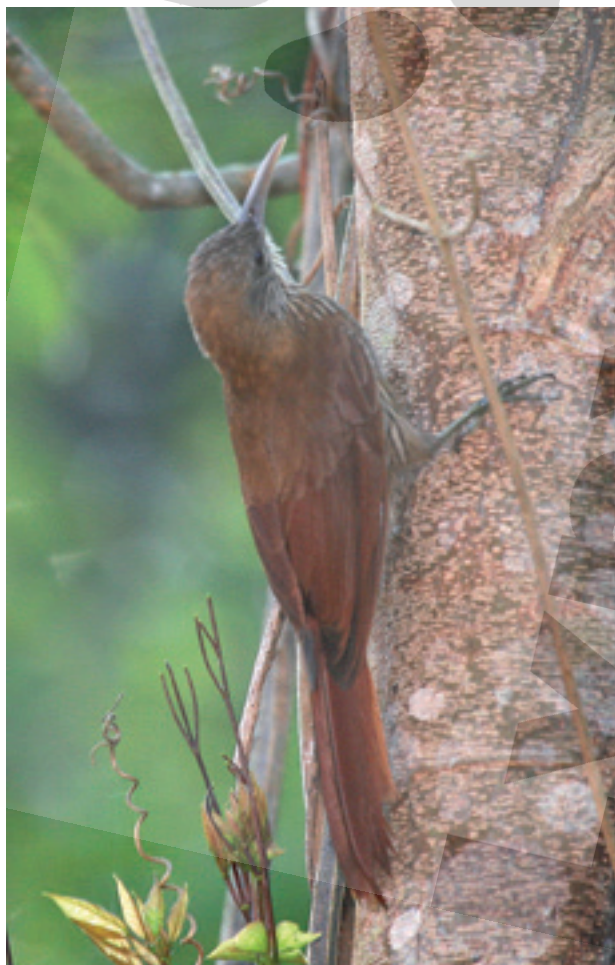


Figure 4.
The Inambari Woodcreeper (*Lepidocolaptes fatimalimae*) hitches along tree trunks where it searches for arthropods from the surface, from crevices, or under the bark. It often occurs along forest edge. This individual was photographed near Assis Brasil in the state of Acre on the Brazil-Bolivia-Peru border, September 2009 by Andrew Whittaker.

different birds, the time between notes also decreases towards the end of the song, with an average 0.075 ± 0.02 s between the first and second notes, 0.072 ± 0.16 s between the second and third, and stabilizing at roughly 0.04 s in the final two thirds of the song.

Phylogenetic relationships.— DNA sequence data for the mitochondrial gene NADH subunit 2 (ND2, 994 base pairs) were obtained for 38 individuals (see Table 2 in SI for a list of specimens sequenced) of all taxa currently grouped under the *L. albolineatus* complex. Trees were rooted in *Lepidocolaptes affinis*, *L. falcinellus*, and *L. lacrymiger*. The phylogeny estimated by Bayesian inference recovered with high statistical support a topology whereby five main lineages not corresponding entirely to current subspecific limits within the polytypic *L. albolineatus* were found (Fig. 1). The first clade includes specimens from the Guiana area of endemism (*sensu* Silva *et al.* 2005), i.e., east of the Negro / Branco rivers in Brazil, Venezuela, Guyana, Suriname, and French Guiana, and attributable to the nominate form. The second clade groups specimens from between the Negro and the northern bank of the Amazon / Solimões in Brazil, Colombia, Ecuador, Peru, and Venezuela and to which the name *duidae* applies. The third clade consists of birds inhabiting the Madeira – Tapajós interfluvium in Brazil and Bolivia, to which two names are in fact applicable: *fuscicapillus* (the name with priority) and *madeiraae* (Peters 1951, Marantz *et al.* 2003). The fourth clade groups birds east of the Tapajós and south of the Amazon rivers and to which the name *layardi* is unambiguously applied. Finally, the fifth clade includes specimens from west of the Madeira and south of the Amazon / Solimões rivers to the foothills of the Andes in Brazil, Bolivia, and Peru; these birds were formerly regarded as *fuscicapillus*, but are here shown to be genetically and vocally distinct from birds to which this name truly applies, hence highlighting the need to recognize them as a new taxon (*L. fatimalimae*). Thus, based on the reciprocal monophyly and phenotypic diagnoses of these taxa, we recommend the recognition of five species and vernacular names in the *L. albolineatus* complex: Lineated Woodcreeper (*L. albolineatus*; distributed on the Guianan shield north of the Amazon and east of the Branco and Negro rivers in Venezuela, Brazil, Guyana, Suriname, and French Guiana); Duida Woodcreeper (*L. duidae*; found west of the Branco and Negro rivers in Amazonian Brazil and Venezuela westward towards the base of the Andes in Colombia, Ecuador, and Peru north of the Amazon / Solimões rivers); Inambari Woodcreeper (*L. fatimalimae*; distributed west of the Madeira and south of the Amazonas / Solimões rivers in Amazonian Brazil and towards the base of the Andes in Bolivia and Peru); Rondônia Woodcreeper (*L. fuscicapillus*; found in the Madeira – Tapajós interfluvium in Amazonian Brazil south to eastern and northern Bolivia in Depts. of Beni and Santa Cruz); and Layard's Woodcreeper (*L. layardi*; distributed east of the Tapajós River to northwestern Maranhão in the Tapajós, Xingu and Belém areas of endemism). We documented a single specimen with the plumage characters and NADH subunit 2 sequences of *L. fatimalimae* (LSUMZ 137058) within the range of *L. a. fuscicapillus* in eastern Santa Cruz, Bolivia (Fig. 2); whether this instance of sympatry is accompanied by introgression between these taxa remains a subject for further research.

Conservation.— *Lepidocolaptes fatimalimae* is a low-density species in its preferred habitat. Because it is endemic to one of the least disturbed parts of Amazonia (the Inambari area of endemism) and shows some tolerance of habitat disturbance, it is not currently threatened by anthropogenic alteration of its habitat or other sources.

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