A range extension and ecology of Boat-billed Tody-Tyrant *Hemitriccus josephinae* in central Amazonian Brazil

by Erik I. Johnson, Claudeir F. Vargas, Thiago V. V. Costa &
Christian B. Andretti

SUMMARY.—Boat-billed Tody-Tyrant *Hemitriccus josephinae* occurs in north-east South America, but there are large gaps in its distribution and we know little of its natural history. We discovered a small population of *H. josephinae* at the Biological Dynamics of Forest Fragmentation Project (BDFFP), 80 km north of Manaus, Brazil, a range extension of 60 km. In 2007–09, we located five territories at the BDFFP. The species foraged in disturbed areas within mature forest by hopping sideways along small horizontal branches in the subcanopy and by upward-strikes or aerially hawking for insects. We described four vocalisations, two of which have not been previously described. Home range size is between 4.6 ha (minimum convex polygon method) and 5.7 ha (95% kernel density estimate). We provide one of the first ecological descriptions of an Amazonian *Hemitriccus* and comparisons against closely related species should be conducted to understand the complicated phylogenetic relationships of this group.

Although most Neotropical species have been described, we still know little concerning the natural history and distributional details for many species. Small canopy birds are particularly problematic because of difficulties in detecting and accurately identifying them, as exemplified by Boat-billed Tody-Tyrant *Hemitriccus josephinae*, a tiny (9-g) flycatcher of north-east South America; we know little of its natural history other than its general distribution. It is known from Guyana, Surinam, French Guiana and northern Brazil (i.e. the Guianan Shield), although nowhere is it considered common (Donahue 1985, Thiollay 1994, Thiollay 2002, Fitzpatrick 2004, Robbins *et al*. 2007). There is a large gap in its distribution between its regular range in the north-east Guianan Shield and an isolated record from Balbina, Amazonas, Brazil, *c*.140 km north of Manaus (Cohn-Haft *et al*. 1997), leaving us to speculate on the significance of the Balbina record. Around Balbina, the topography is similar to the majority of the Guianan Shield with steep slopes, rocky caves and outcrops, and combisol or orthic ferrasol soils contrasting with the gentle topography and xanthic ferrasol soils of the nearby Manaus region (Sombroek 2000).

Here, we describe the discovery of *H. josephinae* at the Biological Dynamics of Forest Fragmentation Project (BDFFP), 80 km north of Manaus, representing a minor range extension. We also describe aspects of the natural history of this little-known bird, including its foraging behaviour, vocal repertoire and home range size.

Study area

The BDFFP is dominated by *terra firme* lowland forest on clay-rich ferrasols, typical of the region. The forest is typically 30–35 m tall, with emergents reaching 55 m. There are many small streams, some only seasonal, with some topography (at 100–150 m elevation). The area receives *c*.2,500 mm of rain p.a., mainly in January–May, but with annual variation. The site is described in greater detail by Gascon *et al*. (2001).

The BDFFP has a long history of avian research, starting with a mist-netting programme initiated in 1979 to examine the consequences of Amazonian deforestation. Over the following ten years, continuous forest was cleared and converted to agriculture, creating 11 isolated fragments. The farms were mostly abandoned by the early 1990s and these areas are naturally regenerating into secondary forest. The surrounding landscape is still largely undisturbed continuous forest, but the Brazilian state of Amazonas is being deforested rapidly, especially south of the BDFFP as Manaus expands (Fearnside 2005).

In addition to understanding fragmentation affects on the avian community, there has been a continual goal at the BDFFP of describing the avian community as a whole. A species list was first published by Stotz & Bierregaard (1989) followed by Cohn-Haft *et al*. (1997), resulting in 394 species from an area of *c*.50,000 km^2. A four-CD series of recordings of birds from the BDFFP area has also been published (Naka *et al*. 2008).

Discovery of *Hemitriccus josephinae* at the BDFFP

Despite intensive efforts to inventory the avian community at the BDFFP since 1979 (Stotz & Bierregaard 1989, Cohn-Haft *et al*. 1997, Naka *et al*. 2008), *H. josephinae* was not known from the area. In September 2007, we sound-recorded an unknown *Hemitriccus* near a camp in continuous forest (km 37); the call was clearly unlike the only congener present at the BDFFP, White-eyed Tody-Tyrant *H. zosterops*. Almost simultaneously a pair of *H. josephinae* was fortuitously captured and colour-banded *c*.40 km to the west, in a 10-ha forest fragment (BDFFP fragment 2206; Fig. 1). Identification of the mystery *Hemitriccus* at km 37 was soon confirmed as *H. josephinae* by comparing vocalisations to those of the colour-banded birds. Not only do these observations represent a *c*.60 km range extension to the south-west, they are the first away from the rocky slopes typical of the Guianan Shield and Balbina area.

H. josephinae is immediately distinguished from *H. zosterops* by chestnut-red, not creamy-white, irides. *H. josephinae* also lacks pale yellow fringes to the greater and median coverts and has more extensive grey on the face compared to *H. zosterops*. The tarsus of *H. josephinae* is peculiarly covered in nodules, which are lacking in *H. zosterops* (Fig. 1). We took measurements from the pair of captured *H. josephinae*; one was distinctly larger

Figure 1. Boat-billed Tody-Tyrant *Hemitriccus josephinae* (and its noduled tarsi), near Manaus, Brazil (E. I. Johnson)

than the other in wing-chord, tail length and mass, with the larger probably a male as in other tody-tyrants (M. Cohn-Haft pers. comm.). We made repeated monthly visits to the 10-ha fragment through December 2007 and again in June–July 2009 to make behavioural observations and understand the spatial use of this colour-banded pair. We also confirmed their continued presence during brief visits in 2008. When we returned in 2009, one of the colour-banded individuals could not be located and an unbanded bird was paired with the presumed female.

In June–November 2008, we surveyed four 100-ha plots within continuous forest and recorded the presence or absence of this species. It was absent from three of these plots, but present in the fourth, *c*.500 m from the km 37 camp. We located three territories in the 100 ha, while the original territory found in 2007 near the camp *c*.500 m south-west of the plot was still occupied. The km 37 area was not surveyed by previous avian inventories (e.g. Stotz & Bierregaard 1992, Cohn-Haft *et al*. 1997) and the extremely patchy distribution of *H. josephinae* at the BDFFP may explain why the species was previously overlooked, although we cannot eliminate the possibility of recent colonisation. Below, we describe the vocalisations, home range size, and the foraging behaviour of *H. josephinae* at the BDFFP.

Foraging behaviour.—At the PDBFF, *H. josephinae* mainly forages in the subcanopy 10–20 m above ground. The five territories were in dense tangles in somewhat disturbed mature forest on steep slopes (*n*=2), flat seasonally flooded depressions (*n*=1), or heavily wind-damaged areas (*n*=2), but many seemingly suitable patches of disturbed forest were unoccupied. *H. josephinae* has a distinctive foraging behaviour that it does not share with *H. zosterops*, Double-banded Pygmy Tyrant *Lophotriccus vitiosus* or Helmeted Pygmy Tyrant *L. galeatus*. Most notably, it hops sideways along small horizontal branches, regularly spinning 180°, continuing to hop while scanning for invertebrates (P. Benham pers. comm.). It examines nearby leaf clusters for insects and makes frequent short (<3 m) upward-strikes (*sensu* Fitzpatrick 1980) to take insects off branches or leaves, or occasionally flushed or flying insects on the wing. It often spends several minutes in the subcanopy of a single canopy tree before moving to the next tree. We never observed pairs foraging in the same tree.

Vocalisations.—We recorded 25.2 minutes of *H. josephinae* vocalisations. *H. josephinae* does not call as part of the dawn chorus (± 30 minutes of sunrise); it often did not begin to vocalise until *c*.1 hour after sunrise. Otherwise, the species calls at any hour of the day, but again less near sunset. It also did not call during periods of heavy insect noise, which would drown out its relatively weak voice.

Donahue (1985) described the call as a falling *pic-pic-pic*, but did not indicate the context of this call. This also oversimplifies the vocal repertoire of *H. josephinae*; we describe four vocalisation types. The first (type I) is a single short *pic* with a 4.4 ± 0.2 seconds (mean ± SE) pause between *pic* notes. This call was given repeatedly, sometimes lasting at least five minutes. The single *pic* was the most frequently given call, representing 80% of all call notes recorded (*n*=280). The second call (type II), representing 17% of all calls, was similar in frequency and length to the first call and is that described by Donahue (1985), but it was doubled or tripled with the first note being slightly higher in pitch than the subsequent note or notes (Fig. 2a). A third call (type III), representing 3% of all calls, involved 4–5 *pic* notes given in rapid succession, all different in pitch with the second note the highest and the following 2–3 notes consecutively descending (Fig. 2b). Type II and III vocalisations were seemingly randomly inserted within a series of type I calls, but with a 9.4 ± 0.7 seconds (mean ± SE) pause before the next call. Pauses after type II and III calls were significantly longer than pauses after type I calls (t-test, t = 8.85, *P*< 0.001; Fig. 3). A fourth vocalisation (type IV) was rarely given and we were unable to sound-record it; we describe it as a rapid
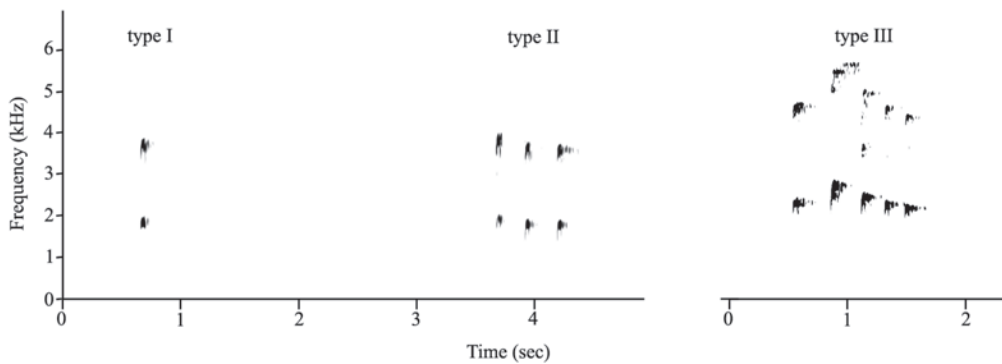
Figure 2. Sonograms of type I, II (a), and III (b) calls given by Boat-billed Tody-Tyrant *Hemitriccus josephinae* near Manaus, Brazil. Note that the type III call has considerable foliage-related reflectance, but that each note is shaped as in type I and II calls. Recordings were made using a Song TCM-5000V and Sennheiser ME-66 microphone (a) and using a Canon G2 digital camera in video mode with the sound file extracted using VirtualDub 1.6.19 (www.virtualdub.org; b). Sonograms were prepared using Raven Pro 1.4 (Cornell Lab of Ornithology, Ithaca).

swelling and then descending series of 7–15 quick *pic* notes similar in quality to other call notes. To our knowledge, type III and IV vocalisations have not been previously described.

The context of these calls is still unknown, although type I, II and III vocalisations may serve as contact calls between foraging individuals rather than for territory maintenance. These vocalisations were also not given at dawn, supporting the hypothesis that these are contact calls. Only one bird of each pair would give a type I, II or III call, while the other remained silent; both sexes made these vocalisations, but never simultaneously. Vocalisations were regularly given while

Figure 3. The pause length after type I (*n*=224) and type II or III (*n*=47) vocalisations by Boat-billed Tody-Tyrant *Hemitriccus josephinae* near Manaus, Brazil.

foraging and did not appear to interrupt this activity. The pair did not forage together (e.g. in the same tree), but when both birds were occasionally located, the silent individual was usually at a lower strata <100 m away. A pair was once observed 150 m apart when the pair members took turns alternating between a call series and an interval of silence. The type IV vocalisation may be the true song but, because it was so rarely given, we do not yet understand its significance. One reason it may be infrequently given is because neighbours in continuous forest were separated by >200 m, i.e. beyond the range where vocalisations were audible to us; thus, counter-singing is probably not regular between neighbours due to their patchy distribution. This vocal behaviour is similar to other Amazonian flycatchers, including some *Tolmomyias* and *Lophotriccus* spp., where call notes are frequently repeated throughout the day, but the true song is rarely and seemingly randomly inserted into long periods of calling (K. J. Zimmer *in litt*. 2010). Although it is possible that we overlooked the true song, we have an intimate knowledge of the vocalisations of the bird community at the BDFFP, such that an unfamiliar song would be readily apparent, especially near known *H. josephinae* territories.
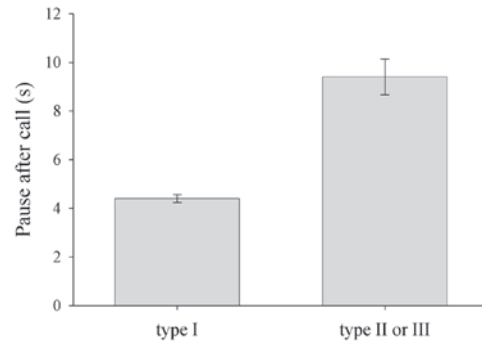
Home range size and stability.—To estimate home range use, we spot-mapped the territory in the 10-ha fragment. We did not spot-map territories in the continuous forest plot because parallel trails were 200 m apart and lacked perpendicular trails, limiting our ability to effectively spot-map species with weak voices like *H. josephinae*. In the 10-ha plot, however, parallel trails were 80–100 m apart with cross trails every 160 m. Our general impression of home range use in continuous forest was that it was consistent with our estimates from the 10-ha fragment.

We used a 95% fixed kernel density estimator (KDE) to construct a utilisation distribution (UD) based on spot-mapped points to estimate the home range size of the pair in the 10-ha fragment using Home
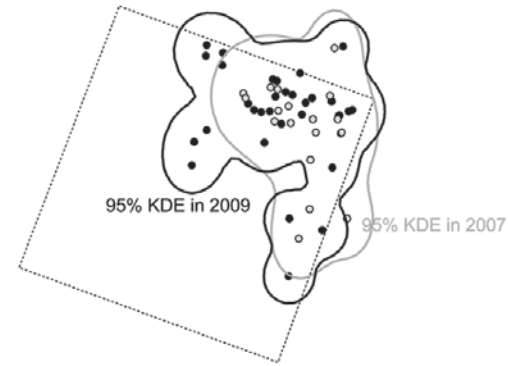

Figure 4. Home range estimates for *H. josephinae* based on 95% kernel density estimates (KDE) using spot-mapped points in a 10-ha fragment (dotted black line indicating the border) in 2007 (grey) and 2009 (black) near Manaus, Brazil.

Range Tools for ArcGIS (Rodgers *et al*. 2007). We chose a fixed KDE because it generates less biased estimates than adaptive KDEs in simulation evaluations (Seaman & Powell 1996). We used the Gaussian (bivariate normal) kernel form with least-squares cross-validation to automate bandwidth selection ('smoothing'). We chose kernels with a grid cell resolution of 10 m. Contouring was performed by volume and we used a scaling factor of 1,000,000 to rescale home ranges to unit variance. We also calculated minimum convex polygons (MCP) for each year separately and combined. We spot-mapped 19 points in 2007 and 32 in 2009 and estimated home range size for each year separately as well as pooled.

The territory in the 10-ha forest fragment was occupied at least in 2007–09, even though one bird (probably the male) emigrated or died during this time; he was replaced by an unbanded bird. The 95% KDE estimated home range use to be 4.9 ha in 2007 and 6.0 ha in 2009 (Fig. 4). The shape of the territories was highly similar between years so we combined the points from the two years to give a 5.7 ha home range. The MCP around points collected was 2.0 ha in 2007, 4.4 ha in 2009, 4.6 ha for both years combined. This pair nearly exclusively used the inside of the forest fragment and only three of 51 (6%) observations came from surrounding second growth.

Discussion

H. josephinae is a poorly known forest bird apparently restricted to the Guianan Shield by the rios Negro and Branco to the west and rio Amazonas to the south. It usually occurs in disturbed areas of humid forest and is associated with rocky slopes in dense midstorey or subcanopy vegetation where the canopy is reduced in stature (Ridgely & Tudor 1994). Robbins *et al*. (2007) found it in seasonally flooded forest and forest edge in southern Guyana, but not in *terra firme* forest. We discovered five territories at the BDFFP in *terra firme*, including three in a 100-ha continuous forest plot. This suggests that the species may be regular, although highly patchy, further south into the central Amazon basin than previously expected and may occasionally occupy other *terra firme* forests across the Guianan Shield.

Our MCP home range size estimate of 4.6 ha for *H. josephinae* is fairly small compared to other Amazonian forest species (Terborgh *et al*. 1990, Stouffer 2007; EIJ unpubl.), but it

is consistent with estimates from other closely related tyrant flycatchers. Terborgh *et al*. (1990) reported home range sizes, based on spot-mapped MCP estimates, to be 3.0 ha in Short-tailed Pygmy Tyrant *Myiornis ecaudatus* and White-bellied Tody-Tyrant *Hemitriccus griseipectus*, and 7.0 in Yellow-browed Tody-Flycatcher *Todirostrum chrysocrotaphum* in Cocha Cashu, Peru. Based on spot-mapping and MCP estimates at the BDFFP, *Lophotriccus vitiosus* has a home range of 3.8 ha and *H. zosterops* a home range of 3.9 ha (EIJ unpubl.). We estimated the home range of *H. josephinae* to be 5.7 ha using a 95% KDE or 4.6 ha using a MCP from 51 points. Barg *et al*. (2005) suggested that a sample of 100–150 points may be required to find congruence between MCP and KDE estimates, suggesting that true home range size is somewhere between the 4.6 ha MCP estimate and 5.7 ha KDE estimate.

The genus *Hemitriccus* forms part of a poorly understood (ecologically and taxonomically) group of birds called 'tody-tyrants' (subfamily Todirostrinae *sensu* Tello *et al*. 2009), which includes *Todirostrum*, *Poecilotriccus*, *Lophotriccus*, *Atalotriccus*, *Myiornis* and *Oncostoma* (Lanyon 1988, Cohn-Haft 2000, Tello & Bates 2007, Tello *et al*. 2009). Although the tody-tyrant clade is monophyletic, *Hemitriccus* is not (Tello & Bates 2007). *H. josephinae* was previously placed in its own genus, *Microcochlearius* (e.g. Meyer de Schauensee 1970), because of its unique morphologic features including the broad bill and rounded tail. It was briefly merged with *Idioptilon* based on shared plumage affinities (Fitzpatrick 1976), which genus was subsequently named *Hemitriccus* according to nomenclatural rules (Traylor 1977). The taxonomic placement of *H. josephinae* remains unclear as it was not included in recent species-level phylogenies based on morphological and genetic characters of tody-tyrants (Lanyon 1988, Tello & Bates 2007).

H. josephinae is unique among *Hemitriccus* in several respects. First, it is the most north-eastern *Hemtriccus* in Amazonia. While other *Hemitriccus* occur in the Guianan Shield, *H. josephinae* is the only species endemic to this region (Thiollay 1994, Fitzpatrick 2004). Second, its foraging behaviour of hopping sideways along subcanopy horizontal branches is unique among *Hemitriccus* to our knowledge. Third, its bill is broader than other *Hemitriccus*, although not to the degree of the closely allied flatbills. It appears to use this bill by occasionally sallying to flying insects, perhaps more so than other tody-tyrants which typically upward-strike their prey (Fitzpatrick 1980, Gabriel & Pizo 2005). Fourth, its noduled tarsi appear to be unique among *Hemitriccus* and the tody-tyrant clade. Finally, its vocalisations, based entirely on variations in the pitch and regularity of clear *pic* notes, are relatively simple compared to buzzy notes given by many other tody-tyrants (Cohn-Haft *et al*. 1997, Cohn-Haft 2000). Although none of these characters alone are evidence for its taxonomic placement, they warrant a closer examination of its relationship with other tody-tyrants.

References:

Barg, J. J., Jones, J. & Robertson, R. J. 2005. Describing breeding territories of migratory passerines: suggestions for sampling, choice of estimator, and delineation of core areas. *J. Anim. Ecol.* 74: 139–149.

Cohn-Haft, M., Whittaker, A. & Stouffer, P. C. 1997. A new look at the 'species-poor' central Amazon: the avifauna north of Manaus, Brazil. Pp. 205–235 *in* Remsen, J. V. (ed.) *Studies in Neotropical ornithology honoring Ted Parker*. Orn. Monogr. 48.

Cohn-Haft, M. 2000. A case study in Amazonian biogeography: vocal and DNA-sequence variation in *Hemitriccus* flycatchers. Ph.D. dissertation. Louisiana State Univ., Baton Rouge, LA.

Donahue, P. K. 1985. Notes on some little known or previously unrecorded birds of Suriname. *Amer. Birds* 39: 229–230.

Fearnside, P. M. 2005. Deforestation in Brazilian Amazonia: history, rates, and consequences. *Conserv. Biol.* 19: 680–688.

Fitzpatrick, J. W. 1976. Systematics and biogeography of the Tyrannid genus *Todirostrum* and related genera (Aves). *Bull. Mus. Comp. Zool.* 147: 435–463.

Fitzpatrick, J. W. 1980. Foraging behavior of Neotropical tyrant flycatchers. *Condor* 83: 43–57.

Fitzpatrick, J. W. 2004. Family Tyrannidae (tyrant flycatchers). Pp. 170–462 *in* del Hoyo, J., Elliott, A. & Christie, D. A. (eds.) *Handbook of the birds of the world*, vol. 9. Lynx Edicions, Barcelona.

Gabriel, V. D. A. & Pizo, M. A. 2005. Foraging behavior of tyrant flycatchers (Aves, Tyrannidae) in Brazil. *Rev. Bras. Zool.* 22: 1072–1077.

Gascon, C., Bierregaard, R. O., Laurance, W. F. & Rankin-de Mérona, J. 2001. Deforestation and forest fragmentation in the Amazon. Pp. 21–30 *in* Bierregaard, R. O., Gascon, C., Lovejoy, T. E. & Mesquita, R. C. G. (eds.) *Lessons from Amazonia: the ecology and conservation of a fragmented forest*. Yale Univ. Press, New Haven, CT.

Lanyon, W. E. 1988. A phylogeny of the flatbill and tody-tyrant assemblage of tyrant flycatchers. *Amer. Mus. Novit.* 2923: 1–41.

Meyer de Schauensee, R. 1970. *A guide to the birds of South America*. Livingston, Wynnewood, PA.

Naka, L. N., Stouffer, P. C., Cohn-Haft, M., Marantz, C. A., Whittaker, A. & Bierregaard, R. O. 2008. *Voices of the Brazilian Amazon*, vol. 1. CDs. Ed. Instituto Nacional de Pesquisas da Amazônia, Manaus.

Ridgely, R. S. & Tudor, G. 1994. *The birds of South America*, vol. 2. Univ. of Texas Press, Austin.

Robbins, M. B., Braun, M. J., Milensky, C. M., Schmidt, B. K., Prince, W., Rice, N. H., Finch, D. W. & O'Shea, B. J. 2007. Avifauna of the upper Essequibo River and Acary Mountains, southern Guyana. *Orn. Neotrop.* 18: 339–368.

Rodgers, A. R., Carr, A. P., Beyer, H. L., Smith, L. & Kie, J. G. 2007. *HRT: home range tools for ArcGIS*. Ontario Ministry of Natural Resources, Centre for Northern Forest Ecosystems Research, Thunder Bay, Ontario.

Seaman, D. E. & Powell, R. A. 1996. An evaluation of the accuracy of kernel density estimators for home range analysis. *Ecology* 77: 2075–2085.

Sombroek, W. 2000. Amazon landforms and soils in relation to biological diversity. *Acta Amaz.* 30: 81–100.

Stotz, D. F. & Bierregaard, R. O. 1989. The birds of the fazendas Porto Alegre, Dimona and Esteio north of Manaus, Brazil. *Rev. Bras. Biol.* 49: 861–872.

Stouffer, P. C. 2007. Density, territory size, and long-term spatial dynamics of a guild of terrestrial insectivorous birds near Manaus, Brazil. *Auk* 124: 292–306.

Tello, J. G. & Bates, J. M. 2007. Molecular phylogenetics of the tody-tyrant and flatbill assemblage of tyrant flycatchers (Tyrannidae). *Auk* 124: 134–154.

Tello, J. G., Moyle, R. G., Marchese, D. J. & Cracraft, J. 2009. Phylogeny and phylogenetic classification of the tyrant flycatchers, cotingas, manakins, and their allies (Aves: Tyrannides). *Cladistics* 25: 429–467.

Terborgh, J., Robinson, S. K., Parker, T. A., Munn, C. A. & Pierpont, N. 1990. Structure and organization of an Amazonian forest bird community. *Ecol. Monogr.* 60: 213–238.

Thiollay, J. M. 1994. Structure, density and rarity in an Amazonian rain-forest bird community. *J. Trop. Ecol.* 10: 449–481.

Thiollay, J. M. 2002. Avian diversity and distribution in French Guiana: patterns across a large forest landscape. *J. Trop. Ecol.* 18: 471–498.

Traylor, M. A. 1977. A classification of the tyrant flycatchers (Tyrannidae). *Bull. Mus. Comp. Zool.* 148: 128–184.

Addresses: Erik I. Johnson, 227 School of Renewable Natural Resources, Louisiana State University and LSU AgCenter, Baton Rouge, Louisiana 70803, USA, and Biological Dynamics of Forest Fragments Project, Instituto Nacional de Pesquisas da Amazônia and Smithsonian Tropical Research Institute, C.P. 478, Manaus, AM 69011–970, Brazil, e-mail: ejohn33@lsu.edu. Claudeir F. Vargas, Thiago V. V. Costa & Christian B. Andretti, Biological Dynamics of Forest Fragments Project, Instituto Nacional de Pesquisas da Amazônia and Smithsonian Tropical Research Institute, C.P. 478, Manaus, AM 69011–970, Brazil.