

A new species of *Cyanocorax* jay from savannas of the central Amazon

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On 23 August 2002, MCH hiked into a remote area of natural savanna (called *campina*; 4°15'S/60°32'W) in the Brazilian Amazon, 140 km south of Manaus. In the low-stature savanna woodland surrounding the open savanna, he briefly observed a jay (probably an immature on the basis of its dark iris), apparently belonging to the genus *Cyanocorax*³. The bird did not closely resemble the adult of any known species, but immature plumages of South American jays are poorly documented; thus, the individual could not be positively identified. However, as no jays were known from this region, the sighting was surmised to represent either a range extension of a named species across one or more major rivers known to be important barriers in the distribution of other Amazonian birds (Sick 1967, Haffer 1992), or an undescribed species.

On the next opportunity to visit a *campina* within the same general region, nearly two and one-half years later, documentation of the jay was our highest priority. During the 18-km hike into the site, MCH and AMF encountered one flock while completely unprepared to photograph, record or collect, and then did not find the birds again during our one full day there! Fortunately, the botanical crew with us did encounter the jays, and at our request they collected a single specimen. In a series of expeditions over subsequent years, we have encountered these jays at numerous sites throughout their limited range and have by now obtained eight specimens, clearly representative of a new species, which we name:

Cyanocorax hafferi

Campina Jay

Cancão-da-campina (Portuguese)



Holotype.— Instituto Nacional de Pesquisas da Amazônia (INPA) 650; adult male from Brazil: Amazonas; state road AM-464; 65 km north by northwest of Manicoré, “Campo do Matupiri-Amapá” (5°21.5'S/61°41'W); collected on 16 January 2005 by Abelor Finzis de Jesus, José Lima dos Santos, and Dionésio Hipy do Espírito Santo; prepared by Alexandre Mendes Fernandes and Mario Cohn-Haft (field catalog no. AMF 187); stomach contents and frozen tissue sample (INPA A-590) preserved. Hologenotype (Chakrabarty 2010) sequences of the mitochondrial genes ND2 (1002 bp) and cytochrome *b* (999 bp) deposited in GenBank (accession numbers KC852070 and KC852071, respectively).

Diagnosis: Morphology.— The species clearly belongs to the genus *Cyanocorax* on the basis of its stiff frontal crest covering the nostrils (Ridgway 1904) and overall size and plumage similarity to other members of the genus. The new species is the only member of the genus with the following combination of characteristics: pale iris, pale-tipped tail, three blue facial marks, and pale blue breast. It is most similar to *C. heilprini* (Fig. 1), from which it differs in having a pale azure-blue versus dark purplish-blue wash to underparts and three blue facial marks (supraocular, subocular, malar) versus one (malar). Dorsally, *C. heilprini* and

C. hafferi are more similar, differing in the latter's paler and duller blue tone of the back, wings and tail. All other congeners with pale eyes and white-tipped tail have a white breast (or yellowish-white, with no hint of blue) below the black bib. **Voice.**— Similar to congeners and may not differ diagnosably from *C. heilprini* (see *Vocalizations*, below). The only even partially sympatric jay, *C. violaceus*, is not especially similar or closely related (Bonaccorso *et al.* 2010) and differs vocally in having a more grating, drawn-out, higher-pitched primary call. **Genetic divergence.**— All eight specimens are extremely similar genetically (<0.3% divergence) and differ from their nearest relatives, *C. heilprini* and *C. affinis*, by approximately 0.7 and 1.8% sequence divergence, respectively, in the mitochondrial genes ND2 and cytochrome *b* (see *Phylogenetic relationships*, below).

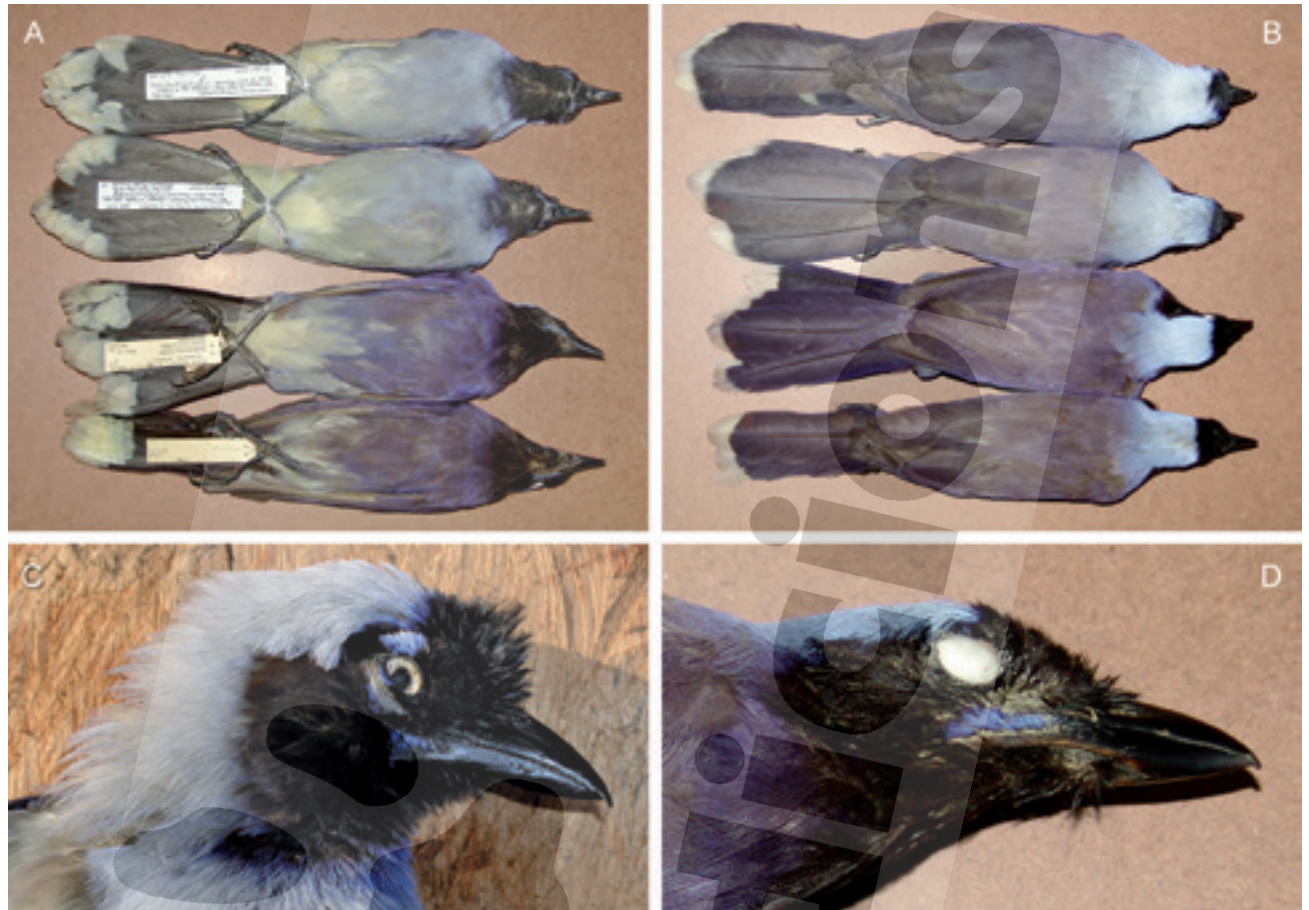
Distribution.— Endemic to the Brazilian Amazon, where known almost entirely from within the Madeira-Purus interfluvium (Fig. 2), strictly associated with *campina* habitats (see *Ecology and behavior*, below). The only locality known west of the Rio Purus is a small *campina* (6°28'44.33"S/64°35'25.66"W) where Dante Buzzetti observed, recorded, and photographed the species on 5 September 2010 (Fig. 3). Other small patches of similar habitat can be detected in satellite images along a southwest-northeast-orient-

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³ Genus *Cyanocorax* 14: 579.

Figure 1. Comparison of specimens of *Cyanocorax hafferi* (INPA 754, 650; males) and *C. heilprini* (MPEG 31733 female, 17461 male). Ventral (A) and dorsal (B) views, in which top two specimens are *C. hafferi* and lower are *C. heilprini*. Head views of *C. hafferi* holotype (C) and *C. heilprini* (D).



ed line between this point and the southwesternmost record near Boca do Acre (Fig. 2), suggesting the existence of a population on the Purus' left bank in this region, at least. The northernmost locality known is that of the original 2002 sight record. There are no records east of the Rio Madeira, where we have found appropriate habitat to be occupied consistently by *C. chrysops*, which we believe entirely excludes the possibility of the new species' occurrence there. The only jay species that overlaps in range is *C. violaceus*, which occurs in *várzea* forest along the floodplains of the Rio Purus and not in *campinas*. To date, *C. hafferi* has been found only within the state of Amazonas, although seemingly appropriate habitat occurs just into Rondônia near Humaitá, where we believe the species must have occurred at least historically. However, current agricultural practices in this area may have entirely eliminated appropriate habitat (see *Conservation*, below).

Description of holotype.— See color illustration and frontispiece. Plumage slightly worn; light body, wing and tail molt; no fat; skull 100% ossified; testes 13×7 mm; no bursa. Forecrown black, composed of stiff erect feathers forming a laterally compressed tuft extending from base of nares to above eye. Chin, throat, upper chest and face, including lores, postoculars and auriculars, black. Three blue facial marks on each side of head: one small sky-blue supraocular patch, darkest at edges; small subocular mark and short malar streak at base of mandible both bright blue. Mid-crown, nape and upper mantle sky blue with visible bright blue feather bases immediately posterior to forecrown tuft. Back, wings and most of tail dorsal surface dull brownish gray, faintly washed purplish blue, strongest on upper wing coverts; dull white band 15–22 mm wide at tail tip, with nearly black subterminal margin fading anteriorly to brownish gray; ventral surface of wings and tail as in dorsal, but lacking blue tones; underwing coverts dull brownish gray with faint purplish-blue wash. Azure-blue breast, merging gradually into and washing over dull brownish gray belly; thighs faintly washed sky blue. Lower belly dull “dirty” white merging to distinctly yellowish on undertail coverts. **Bare parts:** (noted and photographed [Fig. 1C] at time of collection): iris pinkish white mother-of-pearl, bill glossy black, tarsi and toes dull black. **Standard measurements:** (from prepared specimen): total length 333 mm; bill (from base at skull) 37 mm; wing (chord) 158 mm; tail 153 mm; tarsus 49 mm; mass (fresh) 172 g.

Etymology.— The species is named for Jürgen Haffer (1932–2010), whom we feel honored to have befriended and who, to our

great satisfaction, knew of our intent to name the bird for him. Haffer was a pioneer in South American biogeography. Beginning in the 1960s, his compilations of bird species' distributions and astute observations of patterns, coupled with a solid understanding of avian biology, practically reinvented the field of biogeography in the Neotropics (Haffer 1969, 1974, 1978, 1987, 1997). The patterns he described continue to be upheld and strengthened by the active ongoing research that he is in large part responsible for stimulating, and his analyses of the possible processes that could cause these patterns continue to represent the most detailed, profound, and coherent insights on the subject to date. His fame for developing the Pleistocene Refuge Hypothesis (Haffer 1969, 1982), which may or may not turn out to be correct, should not overshadow what we believe to be his greatest contribution: the careful description of patterns and a mature and thoughtful application of biological, physical, and historical principles to attempt to explain them. Species complexes, such as the one in which this jay seems to fit, of allopatric replacement forms often but not exclusively separated by major rivers and differing from one another by distinctly colored variations on a plumage theme are the classic South American pattern to which Haffer drew the world's attention. The common names we propose refer to the specialized habitat in which the species occurs, the Portuguese name being derived in part from that (*canção*) used by local residents.

REMARKS

Type series.— Paratypes of *C. hafferi* are the following seven specimens, all adults from the Brazilian state of Amazonas (AM): INPA 754 male (AM, left bank Rio Madeira, 39 km W Novo Aripuanã at “Campo do Lago Preto”, $5^{\circ}09'S/60^{\circ}44'W$); 1641 male, 2235 male, 2236 female, 2238 male (AM, ca. 50 km W Porto Velho at “Campo do Ramal do Mucum,” km 37, $8^{\circ}40'S/64^{\circ}22'W$); 1642 female (AM, ca. 240 km S Manaus at “Campo da Catuquira”, $4^{\circ}55'S/61^{\circ}07'W$); 2239 male (AM, ca. 45 km NE Boca do Acre at “Bom Lugar”, $8^{\circ}32'S/67^{\circ}03'W$). No other specimens are known to exist.

The female specimens have a very subtle, but noticeably darker, blue cast to the wings and tail, perhaps representing

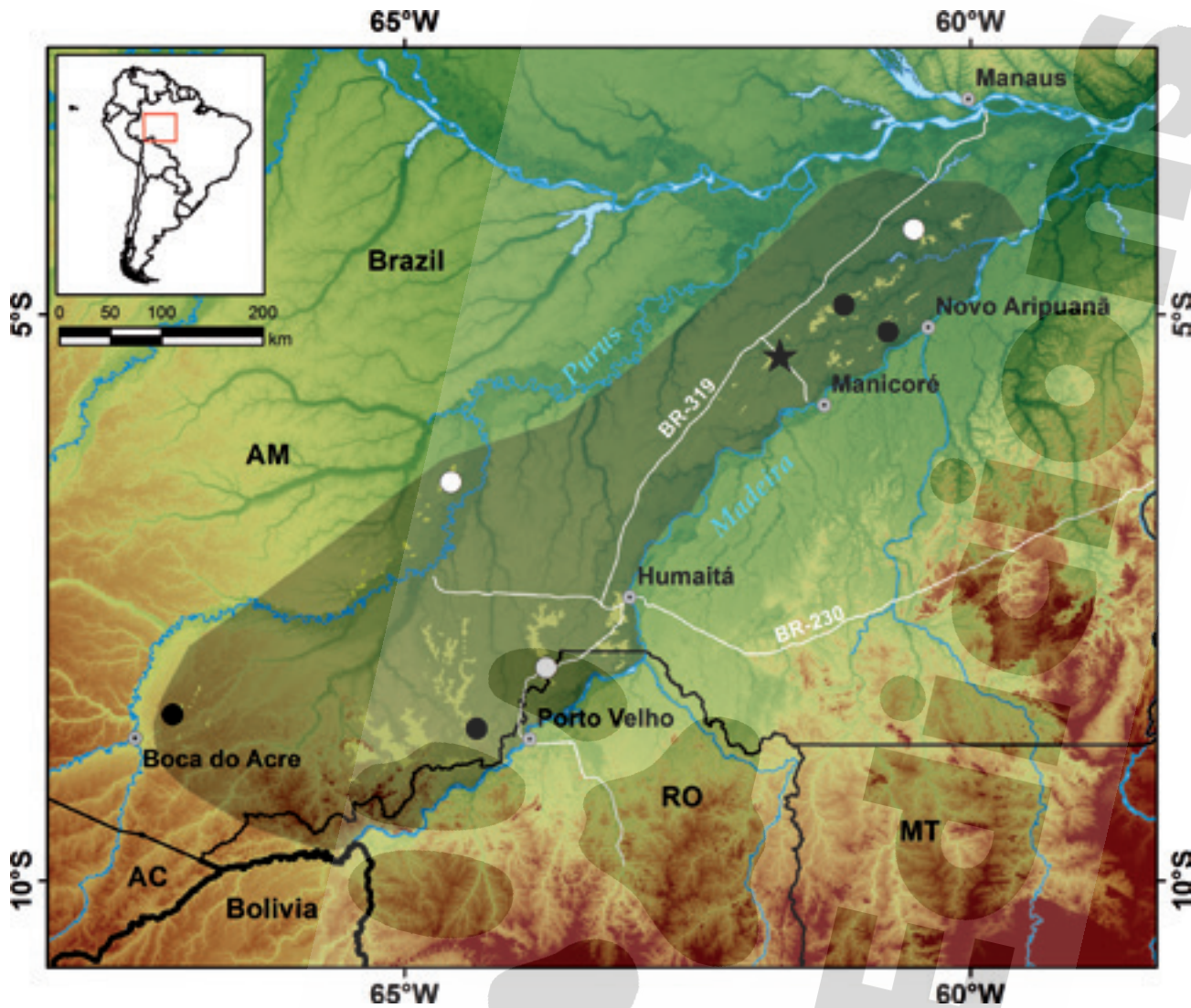


Figure 2. Estimated distribution (shaded area) of *Cyanocorax hafferi*, showing the type locality (black star), localities of the other collected specimens (black dots), and the three sight records mentioned in the text (white dots). Numerous other observations were made within this distribution as part of a detailed study (Santos Junior 2008) to be presented elsewhere. The natural savannas (campinas) where the jay occurs are shown as pale regions within the shaded area. Black lines mark boundaries of Brazilian states, names abbreviated: AM (Amazonas), AC (Acre), RO (Rondônia), MT (Mato Grosso), and highways are shown in white.

sexual dimorphism in this trait. A similar difference can be observed between male (Museu Paraense Emílio Goeldi [MPEG] 17461, 31734) and female (MPEG 17462, 31733) specimens of *C. heilprini* (Fig. 1). All specimens of *C. hafferi* exhibit the diagnostic characters listed above, and no other noteworthy individual variation was observed in the specimens or in any adult individuals observed in the field. Immatures, recognized as such by the suggestion of a pale gape and begging behavior, were seen on several occasions but not collected; they showed a grayish-brown breast with little or no blue cast, reduced or absent facial markings, and dark eyes.

Ecology and behavior.— Over the more than ten years since we first encountered this jay, we have accumulated dozens of hours of observations of scores of individuals throughout the known range. One of us, MASJ, made an intensive study as part of his master's thesis (Santos Junior 2008), many of the results of which will be published separately. Here we summarize just a few aspects of ecology and behavior relevant to encountering and preserving the species in the wild.

The Campina Jay occurs in a very specific habitat: the edge of Amazonian savannas, which we refer to as *campinas* (Anderson 1981, Pires and Prance 1985). The terminology used for naturally occurring open vegetation types within the Amazon has not been consolidated in a single, generally accepted classification, and we do not wish to suggest a scheme here. For example, the distinction often made between *campina* and *cerrado* includes differences in plant species composition and soil types, and a few of the jay's localities might be called *cerrado* by some professionals. However, we have encountered what appear to us as mixed or intermediate vegetation types; nevertheless, as long as the vegetation structure described below persists, the jay occurs there.

Nearly all of our observations of the species occurred well within 100 m (usually within 20 m) of the edge of open *campinas*, especially in the islands of low forest (*capões de mata*) within them. The vegetation is a roughly 3–8 m high forest that forms a transition between the open shrubby or herbaceous *campina* and the typical, tall *terra firme* forests in which these savannas are embedded. Common tree species include members of the genera *Clusia* (Clusiaceae) and *Pagamea* (Rubiaceae) and the palms *Mauritiella armata* (called *buritirana* in Portuguese) and *Mauritia carana* (*caraná*). The association with this habitat is so strong that, in localities that burn frequently, eliminating the transitional vegetation between tall forest and savanna, the jay has not been found. The savannas around which the jays live have waterlogged soils and flood shallowly during heavy rains, and thus are best considered “interfluvial wetlands” (Junk *et al.* 2011).

A handful of observations in or at the edge of tall forest, albeit within a few hundred meters of *campinas*, have been noted by us and colleagues (L. M. Lima, pers. comm., see Fig. 4; A. P. Antunes, pers. comm.; B. M. Whitney, pers. comm.), two in the months of November and December. These observations, together with the species' very low intraspecific genetic diversity, suggest that the birds disperse freely through *terra firme* forest and may occupy it with some regularity outside of the breeding season.

Nests are large, bulky cups composed mostly of twigs and lined with plant fibers, especially those of the *caraná* palm. They are located in the partial shade of the canopy of these low woods, almost always in very small, isolated forest islands. Nests may be attended by more than two adults, and we suspect that the small flocks (3–8 individuals) are family groups made up of a single breeding pair and their offspring from previous seasons, much as described for other Neotropical jays (Brown 1987, Bosque and Molina 2002). We found active nests only during the dry season

Figure 3. Outside the Madeira-Purus interfluve, the Campina Jay was recently photographed just west of the Rio Purus in a small campina. The site appears to be part of a complex of several such savannas that probably all support jays. Photo by Dante Buzzetti.



(July-September), although our searching was considerably reduced at other times of year. Flocks appear to be territorial and to be separated by distances of a kilometer or more.

As is typical of jays, the small monospecific flocks are reasonably conspicuous and noisy, investigating intruders with apparent curiosity before moving on after just a few minutes. Flock members shift perches frequently among partially protected sites at all levels of the forest, making short hops, longer glides or brief silent flights and only occasionally sit in the open, atop the tallest trees. They appear to be omnivorous, both arthropod parts and seeds being present in specimens' stomach contents, and individuals have been observed carrying fruits and pecking vigorously at plant fruiting heads. They tend to feed in silence, but vocalize often in the presence of humans and predators and during group interactions. High-definition video by B. M. Whitney of *Cyanocorax hafferi* in natural habitat may be viewed at the Internet Bird Collection (IBC; <http://ibc.lynxeds.com>).

Vocalizations.— The new jay has a fairly large and varied repertoire of vocalizations, including sharp whistles, toots, mews, mostly monosyllabic, and softer burbling or nasal sounds (recordings may be heard at the IBC and the Macaulay Library of Natural Sounds, ML: 169992-169996). This is much like other jays, whose vocalizations these clearly resemble, being best termed calls, in the apparent absence of any more elaborate and stereotyped vocalization one might be tempted to term a song. The sounds are easily recognized in the field and readily call attention to the presence of the jays. However, it is not clear that they can be distinguished from those of other related jay species, especially the very similar *C. heilprini*. Having access to only a small sample of recordings of *C. heilprini* (from xeno-canto <www.xeno-canto.org> or graciously loaned by K. J. Zimmer), we are unable to confirm any vocal differences between it and the new species, which responds as strongly to these recordings as to recordings of analogous sounds from conspecifics. Thus, we tentatively suggest that *C. hafferi* and *C. heilprini* have indistinguishable vocal repertoires, pending more detailed analyses. There is considerable variation in the sounds, even in repetitions given by the same individual, and separating them into discrete sound types, if possible, is beyond the scope of this paper. The most conspicuous and familiar call of *C. hafferi* (and *C. heilprini*) is a sharp “tchew”, given repeatedly and sometimes in short bursts of two or three. This appears to serve as a group contact note, perhaps calling attention to the presence of a threat (alarm call). However, it can change during repetition into another frequently heard call we describe as a “mew”.

Phylogenetic relationships.— DNA sequencing of the mitochondrial ND2 and cytochrome *b* genes (2001 concatenated base

pairs) was performed on eight individuals of *C. hafferi* and individuals of all white-eyed, lowland species of South American jays (“group II” of Bonaccorso *et al.* 2010). Results of phylogenetic analyses (sample numbers and methods presented in Supplementary Information [SI] at the IBC website) place *C. hafferi* clearly within this group and reveal a close relationship between it, *C. heilprini*, and *C. affinis*, the three forming a well-supported clade (Fig. 5). There is no strong evidence for the exact relationships among these three (56% bootstrap support for *C. heilprini* as sister to *C. hafferi*), although there is less sequence divergence between *C. hafferi* and *C. heilprini* than between either of these and *C. affinis*, which is separated geographically from the other two by the northern Andes mountains. A sister relationship between *C. hafferi* and *C. heilprini* is consistent with their strong vocal and plumage similarity. Although separated by over 600 km of *terra firme* forest and at least two major rivers (the Amazon and Negro), the two species occupy very similar habitats and presumably descended from a common ancestor sometime within the last million years.

Conservation.— Vulnerable - IUCN criteria B2b(iii).

The small total area combined with threats to habitat integrity create considerable concern for the future of this newly discovered species. Predictions based on modeling human population expansion along planned or existing routes of development have the entire range of the jay cleared of natural habitat within the next 30-50 years (Laurance *et al.* 2002, Soares-Filho *et al.* 2006). Although the geographic range (extent of occurrence) includes a reasonably large polygon (190,000 km²; Fig. 2), the species actually inhabits only a very restricted area of appropriate habitat within that region. Calculating the area of occupancy as a 100-meter-wide strip around the edge of all the *campinas* within its range, which we believe is a generous overestimate of the very narrow breeding habitat requirements of the species, leads to an area of only 1090 km², well below the threshold for classification as “vulnerable” where there is also an observed or projected decline in habitat quality and extent (IUCN 2001).

The most notable threat is the current repaving of the BR-319 highway, which passes through the heart of the species' range. Other activities in progress or projected for the near future include a gas pipeline that crosses the region and hydroelectric dams on the Madeira. As is well documented in the Brazilian Amazon, road construction and paving lead to a synergy of colonization and deforestation, mostly associated with timber extraction, cattle ranching, and agriculture (Fearnside 2002). Natural savannas are rapidly drained, burned and cleared for planting (Fearnside 2001). Even where unsuccessful agricultural experiences have led to their abandonment, savannas are routinely

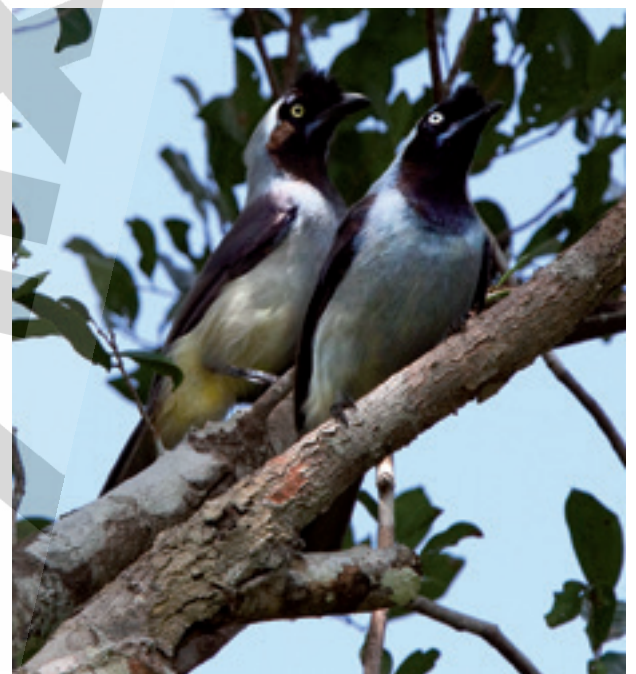
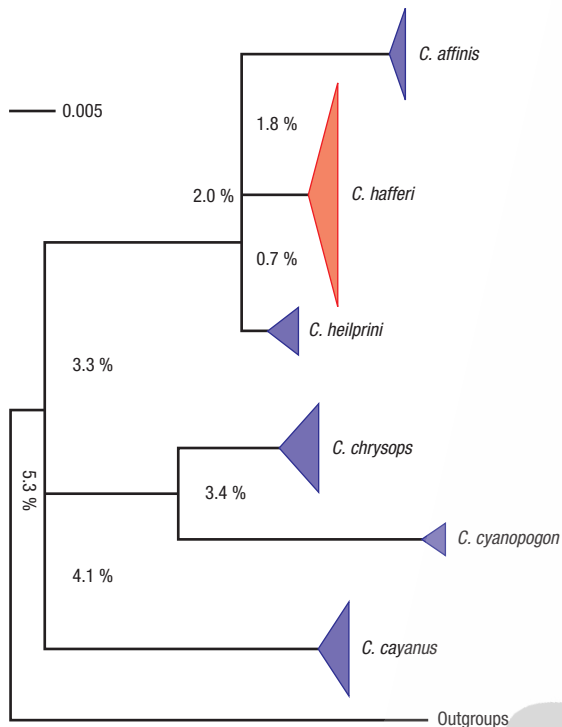


Figure 4. Jays typically move in small monospecific flocks and are curious about observers. These two were part of a noisy group of at least five, found in November of 2009 at the edge of forest along a small side road off the BR-319 highway between Humaitá and Porto Velho (8°7'7.38"S/63°44'50.22"W; see Fig. 2). Photo by Luciano Moreira-Lima.



burned by local residents and, where possible, mined for sand used in construction. Burning eliminates jay habitat quickly and effectively and usually coincides with the breeding (dry) season, thus increasing direct mortality as well as habitat reduction.

Brazilian federal and state governments have recently created a mosaic of parks and reserves including most of the *campinas* in the jay's range, in part justified by the presence of the jay itself (e.g., Mesquita *et al.* 2007). Since then, however, pressures from economic sectors have led to the reduction in size, softening of restrictions, or outright rescinding of protected areas throughout Brazil (e.g., Bragança 2012). Even if the areas currently declared as protected on paper survive the new anti-conservation wave in Brazilian politics, they still have no infrastructure or on-site staff, and so fires will be difficult to prevent or control. Thus, any actions that facilitate the arrival of people at the *campinas* are likely to result in their destruction under the current scenario. Savannas very close to population centers such as Porto Velho (Rondonia) and Humaitá (Amazonas) do not have jays, probably due to their long history of human occupation and frequent burning. The very difficulty of access to its remote habitat that caused this conspicuous bird to be completely overlooked by biologists until recently has also likely been the key to its survival fairly close to some of the Amazon's largest cities.

Acknowledgments.— Back in the late 1990s, Rita Mesquita, Marcos Pinheiro, and Summer Wilson split the cost of an overflight with MCH to glimpse some of these *campinas* for the first time, and in 2002, fifteen-year-old Isaac McAlister bravely participated in one of the first (and unsuccessful) attempts to reach one on the ground, unfortunately missing the chance to co-discover the jay with his uncle. Expeditions received financial or logistical support and authorizations from Brazil's Ibama/ICMBio, Amazonas State Secretariat of the Environment (SDS), PPBIO/MMA (project coordinated by Lúcia Rapp Py-Daniel), Rede Geoma/MCT, Petrobras, and the Fundação de Amparo à Pesquisa do Estado do Amazonas (Fapeam). Ingrid Macedo and Gisiane Lima helped with specimen preparation; Fátima Lima and Alexandre Aleixo (MPEG) and Kim Bostwick (Cornell University) facilitated specimen comparisons. Lais Coelho, João Capurucho, and Swati Patel helped with lab work. Elisa Bonaccorso generously provided primers, Marion Adeney helped with spatial analyses, and Tito Fernandes and Gustavo Bravo helped with the figures. Dante Buzzetti, Bret Whitney, Luciano Lima and André Antunes provided unpublished observations, recordings, photographs or videos, and Kevin Zimmer provided recordings of *C. heilprini*. The manuscript benefited greatly from

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Figure 5. Maximum likelihood tree topology of *Cyanocorax jays* (of species “group II”, sensu Bonaccorso *et al.* 2010), in which *C. hafferi* forms a clade of unresolved relationships with *C. heilprini* and *C. affinis*. Resolved nodes shown have > 95% bootstrap support in both maximum likelihood (100 replicates) and maximum parsimony (1000 replicates) analyses. Percentages are internode sequence divergences. Heights of triangles represent relative sample sizes, and depths represent relative amounts of intraspecific variation (see SI).