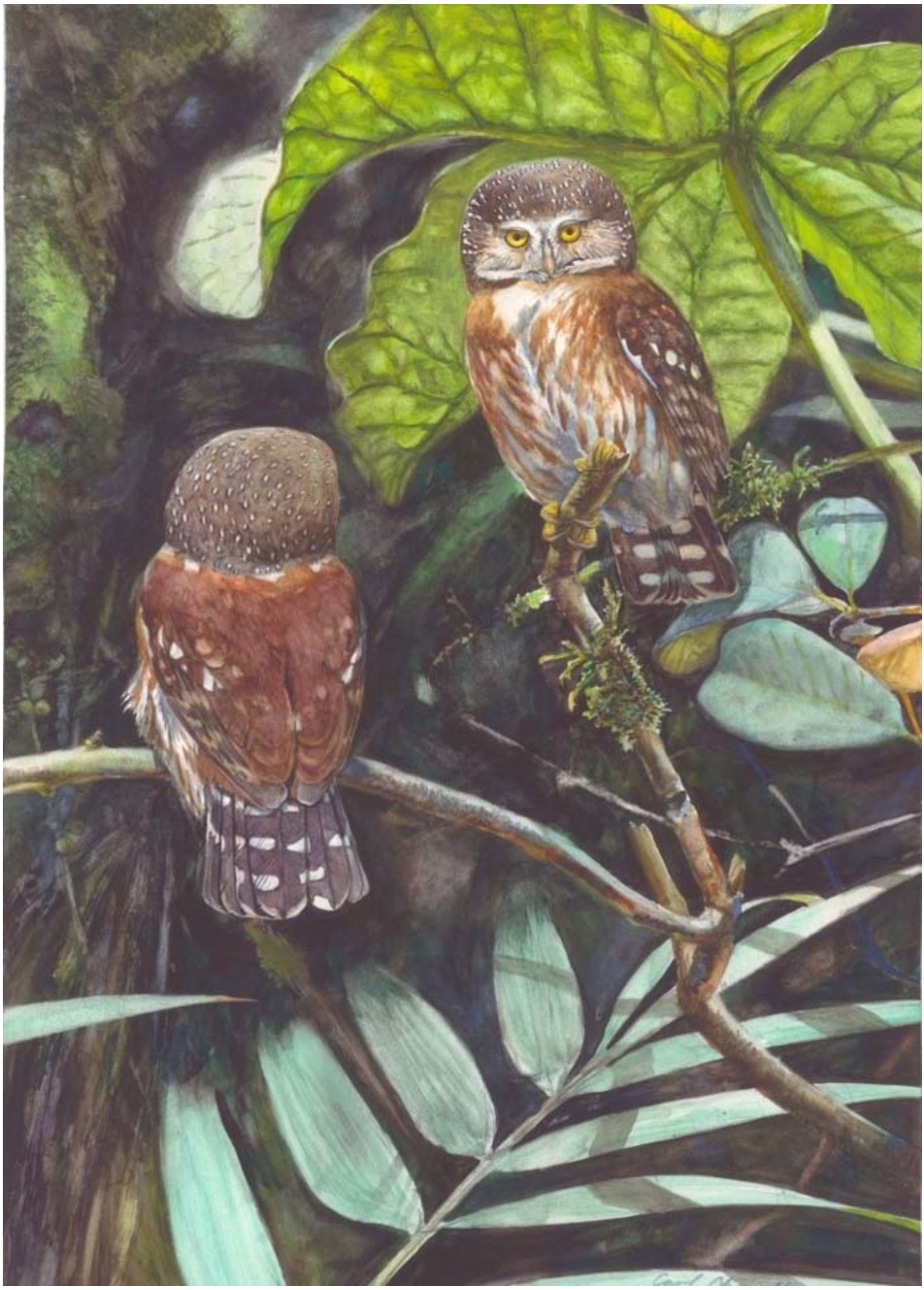

Frontispiece. Pernambuco Pygmy-Owl, a new species of the *Glaucidium minutissimum* complex from the vanishing Atlantic Forest of northeastern Brazil. From a watercolor painting by Carl Christian Tofte.

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Discovered on the brink of extinction: a new species of Pygmy-Owl (Strigidae: *Glaucidium*) from Atlantic Forest of northeastern Brazil

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RESUMO. **Descoberta à beira da extinção**: **uma nova espécie de caburé (Strigidae**: ***Glaucidium*) da Floresta Atlântica do nordeste do Brasil.** *Glaucidium mooreorum* sp. nov. é descrita com base em dois exemplares taxidermizados (Coleção Ornitológica da Universidade Federal de Pernambuco nº. 1030 [holótipo] e nº. 1017), procedentes da Reserva Biológica de Saltinho (8º44´S, 35º11´W, elevation 140 m), Rio Formoso, Pernambuco, Brasil. A nova espécie é conhecida somente de florestas secundárias altas de duas localidades de baixa altitude (< 150 m) em Pernambuco, sendo possivelmente associada ao complexo de espécies *G. minutissimum*. As duas espécies desse complexo geograficamente mais próximas são *G. hardyi* (da Amazônia) e *G. minutissimum* (do sudeste do Brasil), das quais *G. mooreorum* sp. nov. difere pela coloração da plumagem, dados morfométricos e vocalização. A região onde esta espécie ocorre é uma área de endemismo (Centro Pernambuco) bastante distinta para aves e outros grupos de organismos sul-americanos. Do ponto de vista histórico, a avifauna endêmica dessa área pode ser classificada como composta, pois ela possui espécies ou subespécies que têm os seus táxons mais próximos ou na Amazônia ou na Floresta Atlântica ao sul do rio São Francisco. A nova espécie está aparentemente à beira da extinção e evidências são apresentadas para classificá-la como "criticamente ameaçada". Um planejamento biorregional envolvendo a restauração de floresta em áreas críticas e o estabelecimento de corredores ecológicos para conectar os poucos fragmentos grandes de floresta remanescentes é sugerido como a melhor estratégia para resgatar a biota singular do Centro Pernambuco da extinção.
Palavras-Chave: biogeografia, conservação, *Glaucidium*, Mata Atlântica, Strigidae, taxonomia.

ABSTRACT. *Glaucidium mooreorum* sp. nov. (Pernambuco Pygmy-Owl) is described based on two study skins (Ornithological Collection of the Universidade Federal de Pernambuco No. 1030 [holotype] and No. 1017) from the Reserva Biológica de Saltinho (8º44'S, 35º11'W, elevation 140 m), Rio Formoso, Pernambuco, Brazil. This new species is only known from tall second-growth forests at two lowland (< 150 m) localities in the state of Pernambuco, being possibly related to the Least Pygmy-Owl (*G. minutissimum*) species complex. *Glaucidium mooreorum* sp. nov. differs from the two geographically closest species (*G. hardyi*, from Amazonia, and *G. minutissimum* from southeastern Brazil) of this complex by plumage coloration, morphometric data, and vocalization. The region in which *G. mooreorum* sp. nov. was found is a quite distinctive area of endemism (Pernambuco Center) for birds and other groups of organisms in South America. From a historical viewpoint, the avifauna of this area is composed of two distinct elements, as its endemic taxa have their closest relatives either in Amazonia or in the Atlantic Forest south of the São Francisco River. The new species is apparently on the brink of extinction and we present evidence to rank it as "critically endangered". A bioregional planning involving forest restoration in critical areas as well as the establishment of ecological corridors to connect the few remaining large forest fragments is suggested as the best strategy to rescue the unique biota of the Pernambuco Center from extinction.
Key Words: Atlantic forest, biogeography, conservation, *Glaucidium*, Strigidae, taxonomy.

Birds are generally considered as a particularly well-studied taxon, as most species are thought to have been described (Diamond 1985). New bird species are currently described at a rate of three per year, a rate possibly lower than any other class of vertebrates (LeCroy and Vuilleumier 1992). However, it does not mean that avian taxonomy at the species level is stable, because new studies on morphological, vocal and genetic variation have revealed that numerous taxa described as subspecies are in fact distinct biological species. A good example is the genus *Glaucidium* that comprises a set of small owls widespread in the Americas, Eurasia and Africa (Peters 1940, Sibley and Monroe 1990). The number of species recognized in this genus has increased dramatically in the last 50 years, going from 13 species listed by Peters (1940) to 29 (Sibley and Monroe 1990, Howell and Robbins 1995, Robbins and Stiles 1999).

The species of *Glaucidium* in the Americas are separated into four major groups (Howell and Robbins 1995, Robbins and Stiles 1999): The *G. gnoma* complex (western Canada to Colombia), the *G. brasilianum* complex (southwestern United States to southern South America), the *G. jardinii* complex (Costa Rica to South America), and the *G. minutissimum* complex (Mexico to South America). The *G. minutissimum* (Least Pygmy-Owl) complex currently comprises six monotypic species that inhabit tropical and subtropical forests from Mexico to southern Brazil and Paraguay (Howell and Robbins 1995).

With the exception of *G. palmarum*, which inhabits tropical deciduous forests, all species of the Least Pygmy-Owl complex inhabit the upperstorey of tall, humid forests, helping to explain why they are often overlooked and why there are so few specimens in museums (Howell and Robbins 1995).

Species of the *G. minutissimum* complex generally have small and nearly linear ranges, the only exception being Amazonian Pygmy-Owl (*Glaucidium hardyi*), whose known range includes most of Amazonia (Brazil, Bolivia, Peru and Guyana) and a single record from Pernambuco (Reserva Biológica de Saltinho) in the Atlantic Forest of northeastern Brazil (Vielliard 1989, Howell and Robbins 1995, M. Robbins pers. comm.). Although this record in the Atlantic Forest is generally referred to in all taxonomic publications about this species complex, the specimens upon which it was based have never been examined and compared with other specimens of *G. hardyi*.

We examined the only two specimens of pygmy-owls collected in Pernambuco, and compared them with specimens of Amazonian Pygmy-Owl from Amazonia as well as with specimens of Brazilian Pygmy-Owl (*G. minutissimum*) from southern Atlantic Forest, the geographically closest species. In addition, we compared the only vocal record available for this population with the voices of other species of the *G. minutissimum* complex. We conclude that specimens from northeastern Brazil represent an undescribed species (see frontispiece). We propose to call this new owl:

Glaucidium mooreorum sp. nov.
Pernambuco Pygmy-Owl

Holotype. Ornithological Collection of the Universidade Federal de Pernambuco, No. 1030; adult male (testes 7 x 4 mm). Brazil: Pernambuco, Rio Formoso, Reserva Biológica de Saltinho, 08º44'S, 35º11'W, elevation 140 m, collected 6 November 1980 by Galileu Coelho.

Diagnosis. A typical Neotropical pygmy-owl of the *Glaucidium minutissimum* species complex (see Howell and Robbins 1995). The two geographically closest species (*G. hardyi*, from Amazonia, and *G. minutissimum* from southern Atlantic Forest) are similar in plumage coloration (figure 1), but the new species differs from both in the coloration of the following body parts (capitalized color descriptions and numbers follow Smithe 1975, 1981): (a) crown between Raw Umber (223) and Raw Umber (123) rather then between Dark Grayish Brown (20) and Fuscous (21); (b) back between Raw Umber (223) and Burnt Umber (22) rather than Dark Grayish Brown; and (c) flanks Raw Sienna (136) rather than between Raw Umber (123) and Cinnamon (123a). In addition, there are differences in body proportions and vocalizations (see below).

Description of holotype. Crown between Raw Umber (223) and Raw Umber (123). Entire pileum and sides of face with conspicuous white spots bordered with Sepia (119). Concealed white nuchal collar, followed by a narrow belt of Raw Sienna (136). Back, scapulars, upper wing coverts and rump between Raw Umber (223) and Burnt Umber (22). Remiges are darker than back, with conspicuous, irregularly shaped Cinnamon (39) spots on the outer web and concealed large buffy white (between Chamois 123D and Buff 124) spots on the inner web. Tail dark brown (closest to Dusky Brown 19) with 12 rectrices that have five incomplete white bands that appear as irregularly shaped dots. The two central rectrices have all five white bands in both sides. The outer retrices have the inner side presenting five white bands while the outer side presents none or only one white band. Center of underparts, from chin to crissum, white. Sides of chest Raw Sienna (136) with a few inconspicuous white spots. Sides and flanks Raw Sienna with a few white streaks. Abdomen white with Raw Sienna streaks. Soft part colors: irides yellow, bill greenish-yellow, tarsi and toes orange-yellow.

Measurements of the holotype. Wing chord 87 mm, tail length 51.2 mm, bill length (from cere to tip) 11.2 mm, body mass 51 g.

Paratype. Ornithological Collection of the Universidade Federal de Pernambuco, No. 1017; adult male (testes 7 x 4.5 mm) from the same locality as the holotype, collected 27 November 1980 by Galileu Coelho.

Measurements of the paratype. Wing chord 87 mm, tail length 50.6 mm, bill length (from cere to bill) 10.2 mm.

Etymology. We take great pleasure in naming this owl in honor of the Dr. Gordon Moore and his wife Betty Moore who have greatly contributed to biodiversity conservation worldwide and in particular Brazil through a clear vision and understanding that conservation should be driven by science and deliver concrete results in the field.

Specimens examined (see acknowledgments for institutional acronyms). *Glaucidium mooreorum* sp. nov.: type locality (2 males, UFPE). *Glaucidium hardyi*: Brazil: Rondônia, Cachoeira Nazaré, Rio Jiparaná (3 males, MPEG; 1 male, FMNH); Parque Estadual de Guajará Mirim, Guajará Mirim (1 male, MPEG); Pará, Rio Trombetas (1 male, MPEG), Capim (1 male, MZUSP). Peru: Madre de Dios, Rio Tambopata (1 male, FMNH). *Glaucidium minutissimum*: Mato Grosso do Sul, Santana do Parnaíba (1 male, MZUSP). São Paulo, Campos do Jordão (1 male, MZUSP), Ipiranga (1 female, MZUSP), Presidente Venceslau (1 female, MZUSP).

REMARKS

Body size. The new species has, on average, longer tail and smaller wing chord than *G. hardyi* and longer tail than *G. minutissimum* (figure 2). There is overlap in tail length and no overlap in wing chord with *G. hardyi* but

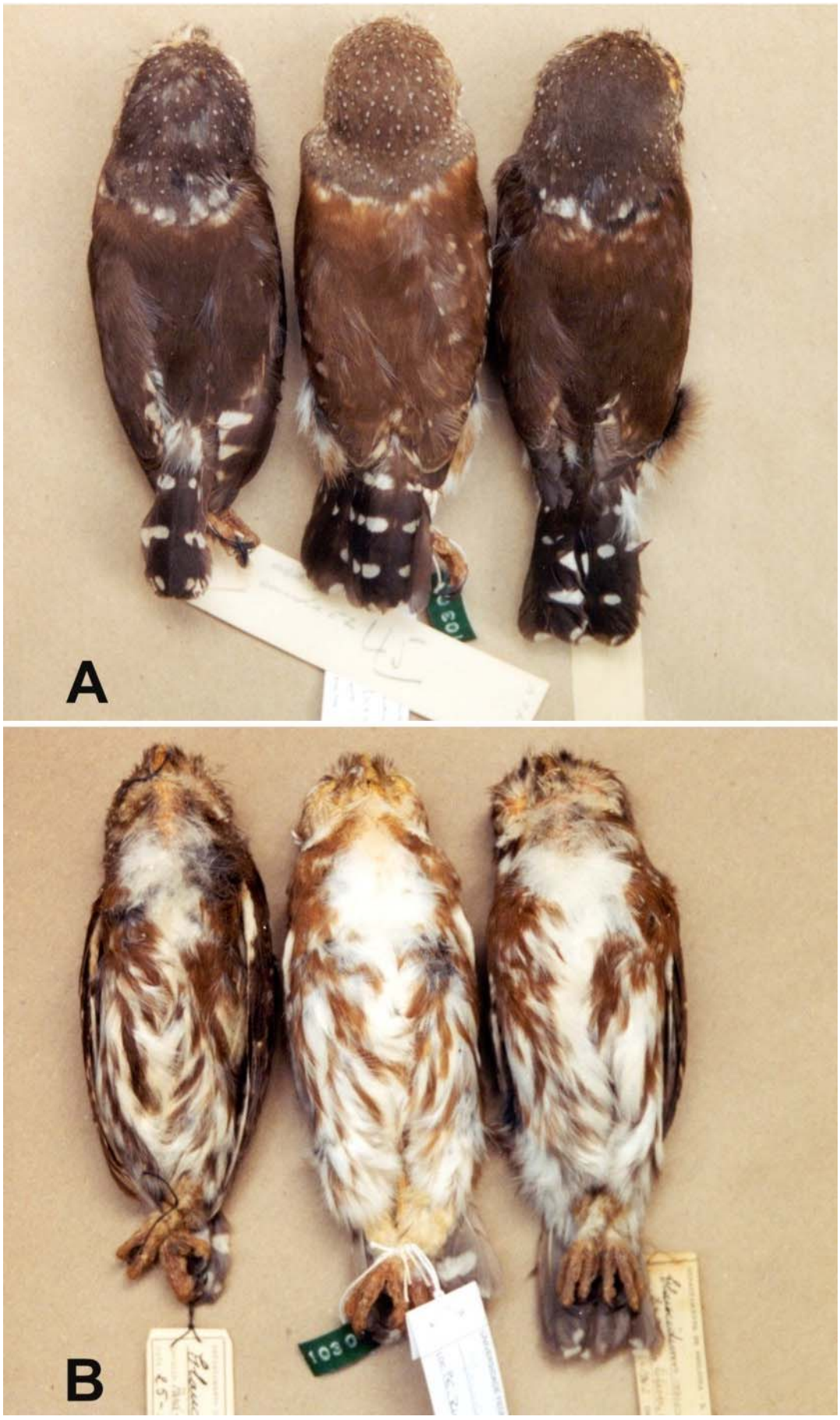

Figure 1. Comparisons of *Glaucidium hardyi* (left), the type of *G. mooreorum* sp. nov. (middle), and *G. minutissimum* (right). (a) dorsal aspect; (b) ventral aspect.

there are overlaps in both body measurements with *G. minutissimum*. The ratio tail/wing is useful to separate these three species, as it ranges between 0.47 and 0.55 in *G. hardyi*, between 0.56-0.60 in *G. minutissimum* and is above 0.6 in *G. mooreorum* sp. nov. (figure 2). The validity of these comparisons needs to be evaluated when more specimens become available.

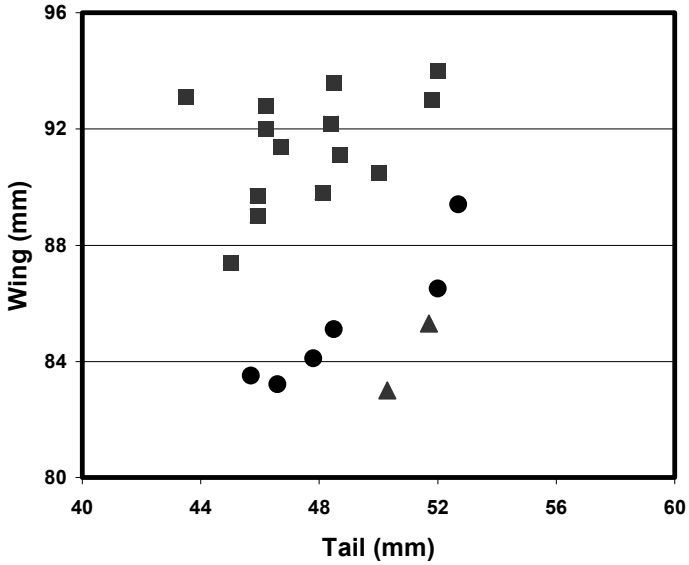

Figure 2. The relationship between wing length (chord) and tail length in *Glaucidium hardyi* (squares), *G. minutissimum* (circles) and *G. mooreorum* sp. nov. (triangles). Body measurements of *G. hardyi* and *G. minutissimum* include, in addition to the specimens examined for this study, other specimens listed in Robbins and Howell (1995).

Song. The only available tape recording of the natural vocalization (i.e. no playback involved) of *G. mooreorum* sp. nov. was made by G.C. on 24 October 1990 at the type locality, using a National RQ 5015 open-reel tape recorder with a National WM 2095N dynamic microphone at a tape speed of 9.5 cm/s, and is housed at the Arquivo Sonoro Prof. Elias Coelho (ASEC No. 11204), Departamento de Zoologia, Universidade Federal do Rio de Janeiro. This recording was digitized at 44.1 kHz, 16-bit and sound measurements and spectrograms were made in a Power Macintosh 7200/120 microcomputer with Canary software (v. 1.2.4) from Cornell Laboratory of Ornithology (Bioacoustics Research Program).

The song characters examined were number of notes and duration of each note in a song, song duration (measured from the beginning of the first note to the end of the last one), pace (derived from number of notes and song duration), inter-song intervals, dominant frequency of notes and relative amplitude of notes in a song. Time measurements were made in the waveform after the sound has been filtered above 1.5 kHz and below 1.0 kHz to remove most of background noise. In spite of this, accurate measurements of note duration were not possible in most songs due to strong reverberation that could not be filtered out. Frequency measurements were made in the spectrogram; given values correspond to the "peak frequency", that is the frequency at which the highest amplitude in a given time interval occurs (Charif *et al.* 1995: 88). Only seven songs in the available recording were suitable for accurate frequency measurements. Comparisons with vocal characters of other species of New World *Glaucidium* were based on the values and spectrograms presented in Vielliard (1989), Howell and Robbins (1995), and Robbins and Stiles (1999), which are not repeated here.

The primary song of *Glaucidium mooreorum* sp. nov. is a short phrase composed of 5-7 notes, most often (89%, n = 46 songs) six relatively short notes (87-170 ms, mean = 133.6 ms, SD = 16.32; n = 56 notes, 11 songs) with a mean dominant frequency of 1.28 kHz (SD = 0.05; n = 42 notes, 7 songs). Duration of six-note songs varied from 1.37 s to 1.52 s (mean = 1.44 s, SD = 0.04; n = 41 songs), resulting in a mean pace of 4.2 notes given per second. The interval between phrases (inter-song interval) is more variable (4.5-15.3 s, mean 6.5 s; SD = 2.31, n = 26). Each note shows slightly upward frequency modulation, starting at an average 1.24 kHz (SD = 0.01) and increasing to an average 1.33 kHz (SD = 0.03) at approximately the middle of the note (n = 42 notes, 7 songs). The point where this shift in frequency occurs corresponds to that of peak amplitude of the note (figure 3). The mean frequency of each note decreases slightly from the beginning (1.31 kHz, SD = 0.007) to the end (1.25 kHz, SD = 0.009) of the phrase (n = 7 songs). Notes with the greatest peak amplitude are most often the forth (33%) or the fifth (41%)

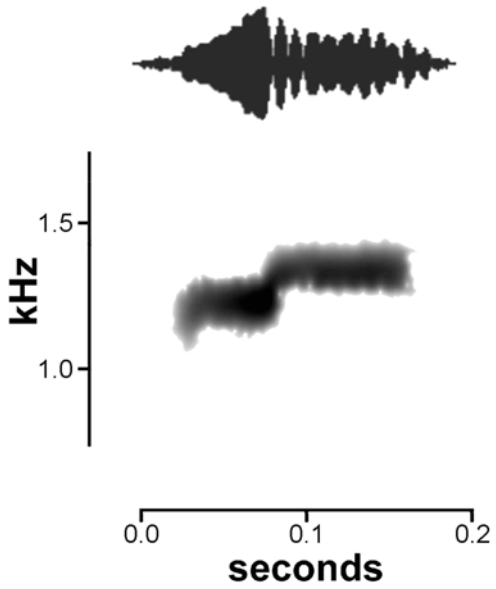

Figure 3. Oscillogram (top panel) and narrow-band (filter bandwidth 266 Hz, Blackman window) spectrogram (bottom panel) of a note of the song of *Glaucidium mooreorum* sp. nov., showing the amplitude peak at the time when upward frequency modulation occurs.

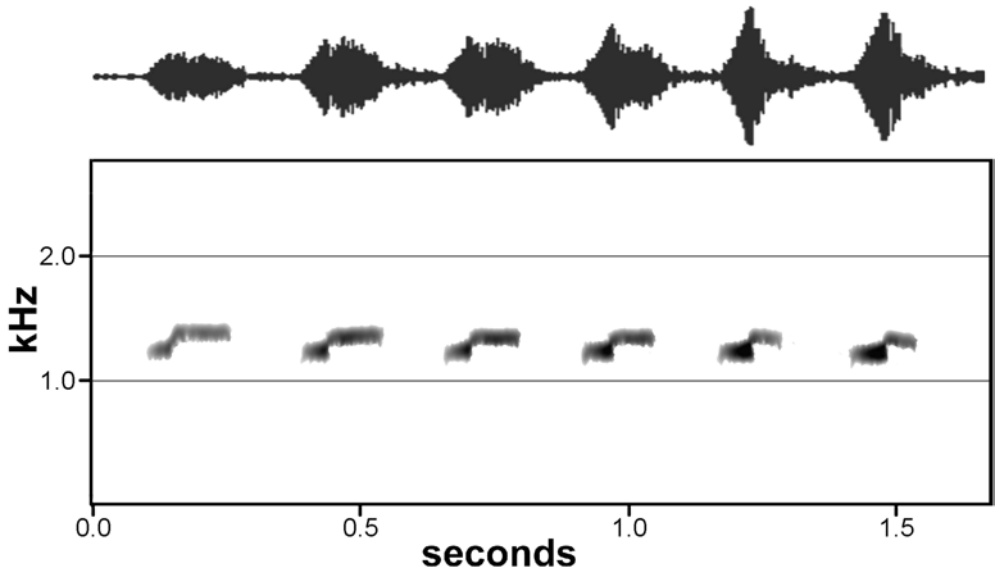

Figure 4. Oscillogram (top panel) and narrow-band (filter bandwidth 266 Hz, Blackman window) spectrogram (bottom panel) of a six-note song of *Glaucidium mooreorum* sp. nov., showing slight decrease in mean frequency of notes and amplitude peak at the fifth note.

(n = 42 songs), so that these phrases are slightly accented just before the end (figure 4).

Both the upward shift in frequency of individual notes and the decrease in mean frequency of notes along the song may prove to be unique among New World *Glaucidium*. These characters have not been reported for any other species in the *G. minutissimum* species complex (Vielliard 1989, Howell and Robbins 1995), nor for *G. brasilianum*, whose song has been described as having "arched" (i.e. with an upward followed by a downward modulation) notes (Howell and Robbins 1995), or species in the *G. gnoma* and *G. jardinii* complexes (Robbins and Stiles 1999). However, the shift in frequency of short notes cannot be easily distinguished in wide-band, small-scaled spectrograms (L. P. G. pers. obs.) such as those used by all these authors, so that further analyses are warranted for this character.

In addition, the song of *G. mooreorum* sp. nov. differs from that of *G. hardyi* (12-36 notes, 30-40 ms long) by having fewer and longer notes, delivered at a slower pace and at much shorter inter-song intervals. From that of *G. minutissimum* (2-4, typically two notes, 260 ms long), the song of *G. mooreorum* sp. nov. differs by having more, shorter notes. The song of *G. mooreorum* sp. nov. also has more notes than that of Subtropical Pygmy-Owl (*G. parkeri*), which has 2-4, typically three, notes, and that of Tamaulipas Pygmy-Owl (*G. sanchezi*), which has 1-3 notes (Howell and Robbins 1995, Robbins and Howell 1995).

Distribution and habitat. *Glaucidium mooreorum* sp.nov. is known from only two localities in Pernambuco (figure 5): Reserva Biológica de Saltinho, a protected area of 4.8 km^2 composed primarily of old secondary forests; and Usina Trapiche, Sirinhaém (08º35'S, 35º07'W), where L. P. Gonzaga, A. Long and L. C. Marigo observed one individual of this species, eating a large cicada high up in the canopy near the edge of a forest belt, with about 100 hectares, on 19 November 2001. The elevation of these forests varies between 0 and 150 m a.s.l. The new species has not been recorded in other well-surveyed forest sites of the region, such as Murici and Usina Serra Grande, whose elevation varies from 400-600 m a.s.l..

Biogeography. The range of *G. mooreorum* sp. nov. is separated from the nearest records of *G. hardyi* and *G. minutissimum* by a straight line distance of 1,580 km and 820 km, respectively (figure 5). The gap between the ranges of *G. hardyi* and that of the new species is occupied by a tropical dry vegetation known as caatinga (Andrade-Lima 1981). Because both pygmy-owl species are associated with tall, humid forests at low elevations rather than other habitat types, they possibly do not occur in caatinga environments. However, within the Caatinga region there are small-to-medium size patches of humid forests located on the slopes of some old isolated plateaus (figure 5). These patches of humid forests are regionally known as "brejos". Some of these forest enclaves have been already sampled for birds, but only *G. brasilianum* has been recorded (Pinto and Camargo 1961; G. C. and J.M.C.S., unpubl. data). The ranges of *G. minutissimum* and *G. mooreorum* sp. nov. are apparently separated by the São Francisco River, although *G. minutissimum* has not been recorded yet in the few forest fragments between its northernmost record and this river (figure 5).

The region in which *G. mooreorum* sp. nov. was found is regarded as an important area of endemism in eastern South America for terrestrial vertebrates (Müller 1973), vascular plants (Prance 1987), forest butterflies (Tyler *et al.* 1994) and birds (Stattersfield *et al.* 1998). This region, named Pernambuco Center or the Pernambuco area of

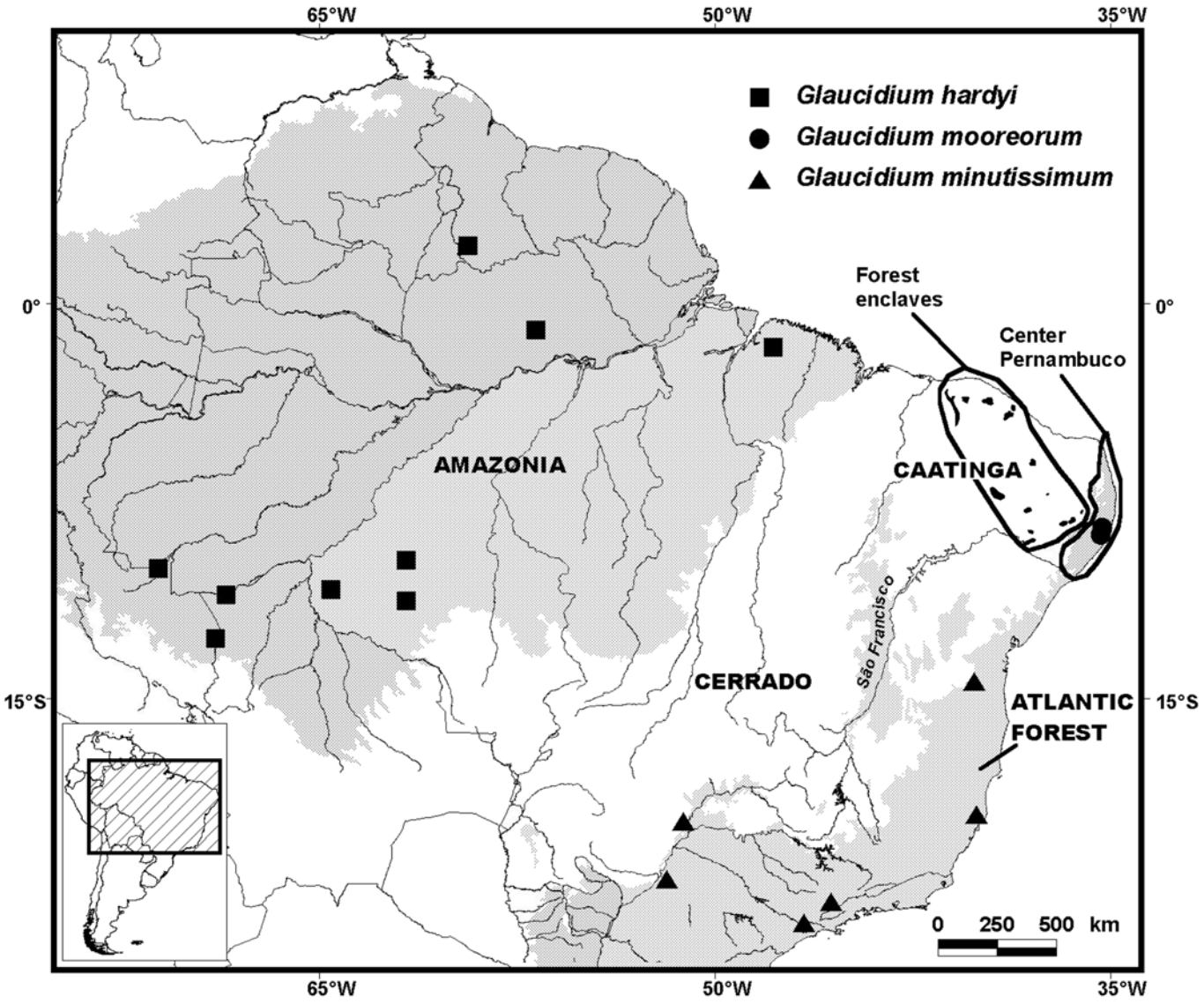

Figure 5. Ranges of *Glaucidium hardyi* (squares), *G. mooreorum* sp. nov. (circles), and *G. minutissimum* (triangles). These records are based on specimens examined, literature and a new record provided by M. Robbins.

endemism, includes the entire block of coastal Atlantic Forests north of the São Francisco River (figure 5). From a biogeographic viewpoint, the avifauna of the Pernambuco Center is composed of two distinct historical elements, as its endemic taxa have their closest relatives either in Amazonia or in Atlantic Forests south of the São Francisco River. Examples of endemic taxa with Amazonian sister relatives are *Mitu mitu*, *Pyriglena leuconota pernambucensis*, and *Cercomacra laeta sabinoi*. Examples of endemic taxa with southern Atlantic Forest closest relatives are *Philydor novaesi*, *Myrmotherula snowi*, *Terenura sicki*, and *Phylloscartes ceciliae*. Teixeira and Gonzaga (1983) suggested that these two biogeographic elements present an altitudinal segregation along the region, with the Atlantic Forest elements occurring, on average, at higher altitudes than the Amazonian ones. Based on this biogeographic pattern and in its known altitudinal distribution, *G. mooreorum* sp. nov. may be more closely related to *G. hardyi* than to *G. minutissimum*. However, this prediction needs to be evaluated with a phylogenetic survey of the entire *G. minutissimum* species complex.

Conservation. The Pernambuco Center is by far the most modified region of Atlantic Forest. From 39,567 km^2 of original forest, only 1,907 km^2 are left. The remaining forest does not form a single and large block, but it is distributed in more than 1,400 fragments that are mostly small (< 100 hectares) and isolated in a matrix dominated by agriculture fields and urban environments. There are 52 reserves in this region, summing up 238.9 km^2. However, this protected area system is far from adequate to protect regional biodiversity. There are two main reasons for this statement. First, reserves are small (78% are smaller than 5 km^2), isolated and do not encompass most of the environmental heterogeneity of the region. Second, although the creation of these reserves helped to halt deforestation of the targeted forest patches, most of them

are not fully functional, as they have not any structure and personal (Uchôa-Neto 2002).

Forest patches outside reserves, in spite of all legal restrictions approved in the last decades, continue to be logged and burned. Large vertebrates, such as birds and mammals, that play an important role as seed dispersers of key canopy tree species have been extirpated because of intensive illegal hunting (Silva and Tabarelli 2000, 2001). These factors plus edge effect contribute to that these fragments undergo dramatic changes in both composition and vegetation structure, leading to local extinctions of several species of plants and animals that are totally dependent of tall, mature forests (Tabarelli *et al.* 2002).

Glaucidium mooreorum sp. nov. is described already on the edge of extinction. Although it is known to occur in a biological reserve, this reserve seems to be small (4.8 km^2) to maintain viable populations of this species. Based on IUCN's criteria for classifying species at high risk of global extinction (BirdLife International 2000), the new species should be ranked as "critically endangered". Three reasons support this classification. First, the species' estimated extent of occurrence is less than 100 km^2. Second, forests within the species' range are severely fragmented. Third, these forests continue to decline in quality as a result of the ever-growing expansion of human activities in the region.

In addition to *G. mooreorum* sp. nov., the Pernambuco Center harbors 17 globally threatened species (BirdLife International 2000): one is already extinct in the wild (*Mitu mitu*), five are classified as critically endangered (*Synallaxis infuscata*, *Philydor novaesi*, *Myrmotherula snowi*, *Phylloscartes ceciliae*, and *Curaeus forbesi*), six are considered as endangered (*Amazona rhodocorytha*, *Touit surda*, *Terenura sicki*, *Myrmeciza ruficauda*, *Iodopleura pipra*, *Xipholena atropurpurea*, and *Tangara fastuosa*), and four are classified as vulnerable (*Leucopternis lacernulata*, *Herpsilochmus pectoralis*, *Hemitriccus mirandae*, and *Carpornis melanocephalus*). Because most of these threatened species are endemic to the Pernambuco Center, this region ranks as one of the South America's most important regions for urgent conservation action to prevent extinction of a number of bird species. Unfortunately, efforts for protecting forests in the Pernambuco Center have always been directed towards establishing protected areas that are small-to-medium size forest remnants selected based on the presence of one or more threatened species as well as of some critical environmental feature, such as headwaters. We suggest that a regional strategy, based on the guidelines proposed by Soulé and Terborgh (1999), rather than site-specific strategies, is required if the biodiversity of Pernambuco Center is to be rescued from the brink of extinction. Silva and Tabarelli (2000) pointed out three major strategies for the creation of an effective conservation network in this region: (a) protection of landscapes composed of archipelagos of fragments, including the present-day reserves, connected by corridors of original or restored vegetation which must represent several thousand hectares of forest; (b) in addition to connect local landscapes, it is necessary also to connect landscapes at a regional level to guarantee maximum representation of all important habitat types that exist in this region; (c) large fruit-eating birds and mammals should be elevated to the category of "umbrella species" to indicate the minimum area required in this regional network to maintain the key ecological processes responsible for forest maintenance and regeneration. Implementation of this conservation network will require visionary leaders, long-term funding schemes, good basic scientific data, new economic mechanisms to promote a new biodiversity-friendly regional economy, decision-support systems that take in account risks for biodiversity in major infra-structure and economic programs, and, mostly, permanent support from both local and international communities.

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REFERENCES

Andrade-Lima, D. (1981) The caatingas dominium. *Revista Brasileira de Botânica* 4:149-153.

BirdLife International (2000) *Threatened birds of the world*. Barcelona and Cambridge, UK: Lynx Editions and BirdLife International.

Charif, R. A., S. Mitchell and C. W. Clark (1995) *Canary 1.2 user's manual*. Ithaca, New York: Cornell Laboratory of Ornithology.

Diamond, J. (1985) How many unknown species are yet to be discovered? *Nature* 315:538-539.

Howell, S. N. G. and M. B. Robbins (1995) Species limits of the Least Pygmy-Owl (*Glaucidium minutissimum*) complex. *Wilson Bull.* 107:7-25.

Lecroy, M. and F. Vuilleumier (1992) Guidelines for the description of new species in ornithology. *Bull. Brit. Orn. Cl., Centenary Supplement* 112A:191-198.

Müller, P. (1973) *The dispersal centers of terrestrial vertebrates in the neotropical realm: a study in the evolution of the neotropical biota and its native landscapes*. Haag: Dr. W. Junk.

Peters, J. L. (1940) *Check-list of birds of the world*, v. 4. Cambridge, Massachusetts: Harvard Univ. Press.

Pinto, O. M. O. and E. A. de Camargo (1961) Resultados ornitológicos de quatro recentes expedições do Departamento de Zoologia ao Nordeste do Brasil, com a descrição de seis novas subespécies. *Arqs. Zool., São Paulo* 11:193-284.

Prance, G. T. (1987) Biogeography of neotropical plants, pp. 175-196. *In*: T. C. Whitmore and G. T. Prance (eds.).*Biogeography and quaternary history in tropical America*. Oxford, UK: Clarendon Press.

Robbins, M. B. and S. N. G. Howell (1995) A new species of Pygmy-Owl (Strigidae: *Glaucidium*) from the eastern Andes. *Wilson Bulletin* 107:1-6.

_____ and F. G. Stiles (1999) A new species of Pygmy-Owl (Strigidae: *Glaucidium*) from the Pacific slope of the Northern Andes. *Auk* 116:305-315.

Sibley, C. G. and B. L. Monroe Jr. (1990) *Distribution and taxonomy of birds of the world*. New Haven, Connecticut: Yale Univ. Press.

Silva, J. M. C. and M. Tabarelli (2000) Tree species impoverishment and the future flora of the Atlantic forest of northeast Brazil. *Nature* 404:72-73.

_____ and _____ (2001) The future of the Atlantic forest in Northeastern Brazil. *Cons. Biol.* 15:819-820.

Smithe, F. B. (1975) *Naturalist's Color Guide*. New York, New York: American Museum of Natural History.

_____ (1981) *Naturalist's Color Guide*, part III. New York, New York: American Museum of Natural History.

Soulé, M. E. and J. Terborgh (1999) *Continental conservation: scientific foundations of regional reserve networks*. Washington, D.C.: Island Press.

Stattersfield, A. J., M. J. Crosby, A. J. Long and D. C. Wege (1998) *Endemic bird areas of the world: priorities for bird conservation*. Cambridge, UK: BirdLife International.

Tabarelli, M., J. F. Marins and J. M. C. Silva (2002) La biodiversidad brasileña amenazada. *Investigacion y Ciencia* 308:42-49.

Teixeira, D. M. and L. P. Gonzaga (1983) A new antwren from northeastern Brazil. *Bull. Brit. Orn. Cl.* 103:133-135.

Tyler, H., K. S. Brown Jr. and K. Wilson (1994) *Swallowtail butterflies of the Americas*: *a study in biological dynamics, ecological diversity, biosystematics and conservation*. Gainesville: Scientific Publishers.

Uchôa-Neto, C. A. (2002) *Integridade, grau de implementação e viabilidade das unidades de conservação de proteção integral na Floresta Atlântica de Pernambuco*. M. Sc. Dissertation. Recife: Universidade Federal de Pernambuco.

Vielliard, J. (1989) Uma nova espécie de *Glaucidium* (Aves, Strigidae) da Amazônia. *Revta bras. Zool.* 6:685-693.