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PENSOFT

# First record of the White-winged Vampire bat, *Diaemus youngii* (Jentink, 1893) (Chiroptera, Phyllostomidae) for the state of Goiás, Brazil, with a revised distribution map

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**Abstract**

*Diaemus youngii* (Jentink, 1893) is a widespread species occurring from southern Mexico to northern Argentina. Along its distribution, however, this bat is rare to uncommon. Here, we report its record for the state of Goiás, central-western Brazil, based on a specimen found in the mammal collection of the Instituto Nacional da Mata Atlântica, former Museu de Biologia Professor Mello Leitão. *Diaemus youngii* is known from 129 unique localities, with 81 (over 62%) in Brazil, followed by Peru (7), Bolivia (6) and Venezuela (6). It is absent in the west of the Andes, southern Argentina, Uruguay, and Caribbean islands, except for Trinidad.

**Key words**

Cerrado, Desmodontinae, Neotropical region, scientific collection.

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## Introduction

Bats are still widely held as evil, disease-carrying, blood-sucking animals, especially in the western world, where old myths persist (Teixeira and Papavero 2003). However, only 3 among the more than 1,300 extant bat species feed on blood: *Desmodus rotundus* (É. Geoffroy Saint-Hilaire, 1810), *Diphylla ecaudata* Spix, 1823, and *Diaemus youngii* (Jentink, 1893). These 3 species belong to the Desmodontinae subfamily and are endemic of the Americas. These bats also share several adaptations that allow the consumption and digestion of blood: sharp, canine-like incisors, saliva with anticoagulant components, and a sac-like elastic stomach, specialized for liquid absorption (Kwon and Gardner 2008). Due to their feeding habits, vampire bats are of epidemiological concern, especially for their role in the transmission of rabies in rural areas, affecting humans and other mammals (Calisher et al. 2006, Dantas-Torres 2008).

*Diaemus youngii* has a wide distribution, occurring from Mexico to northern Argentina (Kwon and Gardner 2008). Along its distribution, however, it is a rare to uncommon species (Aguiar et al. 2006). In Brazil, few records are available for most states where this bat has been found, and some well-studied states still lack records (e.g., Espírito Santo, Mendes et al. 2010). While

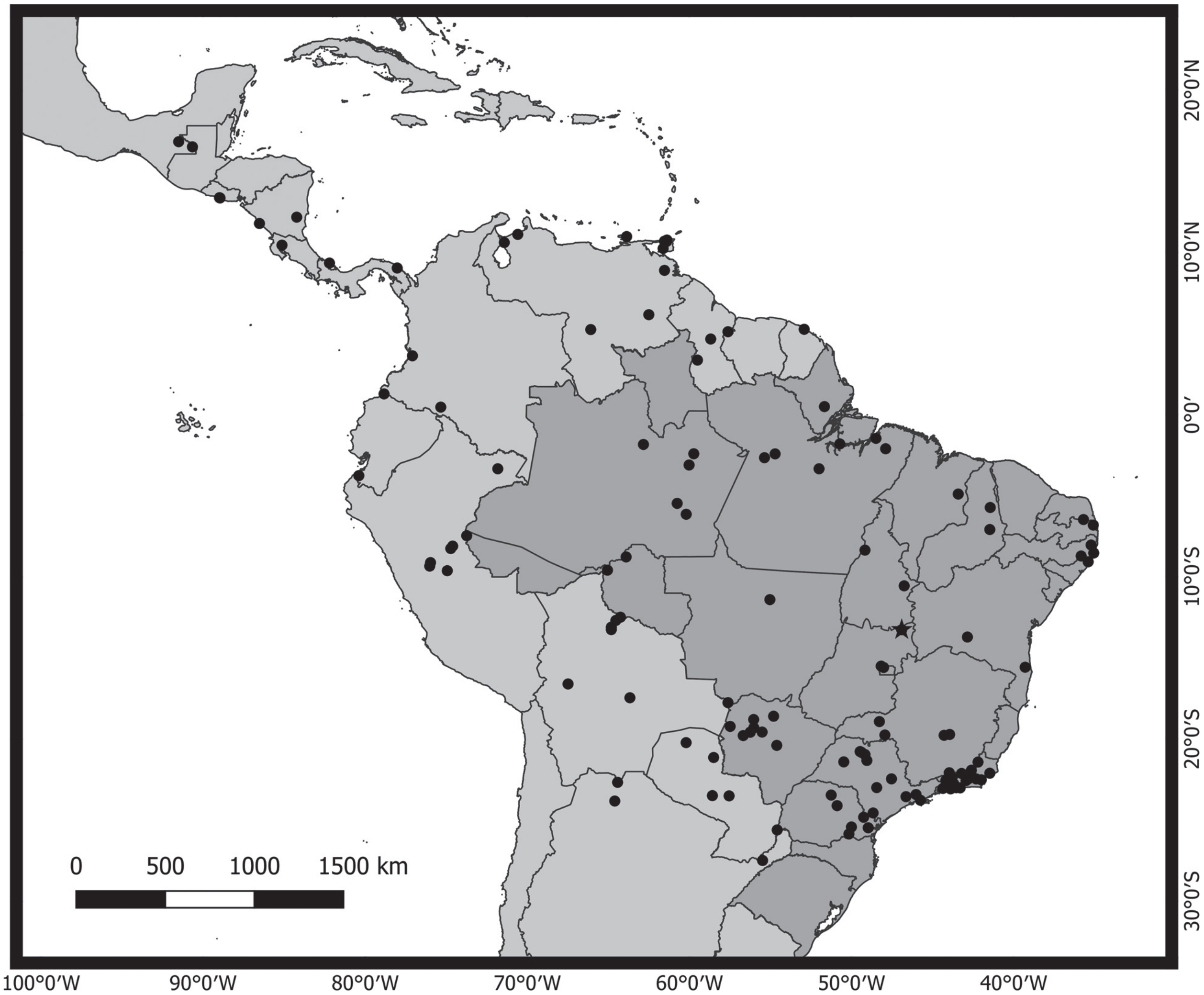


**Figure 1.** Known localities of *Diaemus youngii*. The star points the new occurrence at Monte Alegre de Goiás, state of Goiás, Brazil. See supplementary material for coordinates and literature sources.

examining material in a museum mammal collection, we discovered a specimen of *D. youngii* that fills the gap for the state of Goiás. Here we report this finding and provide an updated map covering the whole distribution of the species.

## Methods

The specimen of *D. youngii* is housed in the mammal collection of the Instituto Nacional da Mata Atlântica, Santa Teresa (INMA), Brazil, formerly known as Museu de Biologia Professor Mello Leitão. Craniodental measurements were obtained using a digital caliper calibrated to the nearest 0.01 mm, following the protocol devised by Vizotto and Taddei (1973). We gathered all available published records of *D. youngii* from the literature, giving preference to the primary sources (see Appendix).

## Results

**New records and distribution map.** *Diaemus youngii*, MBML 2005, previously ISDF 1047, adult female, orchard next to a poultry farm, Monte Alegre de Goiás, Goiás, Brazil (13º15′23″ S, 046º54′02″ W) . The species is known from 129 unique localities from 16 countries, with Brazil (81 localities), Peru (7), Bolivia (6) and Venezuela (6) being the most represented (Fig. 1). Craniodental measurements (Table 1). A. Bredt, E. Magalhães, P.H. Oliveira, 25 April 1995.

**Identification.** We used the identification keys of Kwon and Gardner (2008) and Díaz et al. (2016) to identify our specimen. *Diaemus youngii* can be differentiated from *De. rotundus* and *Di. ecaudata*, by presenting moderately elongated thumbs with 1 basal pad, white wingtips, and 2 upper molars on each side (Greenhall and Schutt 1996). Our specimen was confidently identified based on these characteristics (Fig. 2), and overall agrees with descriptions in the literature. The inner lower incisors are described as trilobated (Kwon and Gardner 2008), but in our specimen these teeth are worn down (Fig. 2A). Notwithstanding, Greenhall and Schutt (1996) have noticed that the lower incisors in *Diaemus* tend to vary in kind and degree of lobation. Mensural data from our specimen are close to those reported for the holotype (Carter and Dolan 1978), and for specimens from central-western and northern Brazil (Pedroso et al. 2018), and Venezuela and Trinidad (Greenhall and Schutt 1996) (Table 1). These data suggest little size variation within *D. youngii*, but larger samples are required to further investigate this aspect.

# Discussion

Desmodontinae are known to feed on mammalian and avian blood, with *Di. ecaudata* regarded as an avian blood specialist, while *De. rotundus* and *D. youngii* feed on a broader spectrum (Ito et al. 2016). However, *D. youngii* seems to prefer avian blood, perhaps to avoid competition of resources with *De. rotundus* (Gardner 1977, Sazima and Uieda 1980, Greenhall and Schutt 1996). Our specimen was collected in an orchard, but next to a poultry farm containing a few dozen chickens. Unfortunately, the records did not mention if the fowl presented bite marks or signs of decaying health.

Vampire bats are habitually exposed to blood, even by sharing blood meals with conspecifics in their roost places (Wilkinson 1984), increasing the odds of acquiring rabies virus (RABV). RABV are frequently isolated from *De. rotundus*, but less commonly in other hematophagous bats (Castilho et al. 2010). There are a few positive RABV isolates from *D. youngii*, with reports from the Brazilian states of Piauí and Maranhão (Castilho et al. 2010, Póvoas et al. 2012), and also Mexico and Trinidad and Tobago (Escobar et al. 2015). Before donation to INMA, the specimen reported here was screened for RABV by the Instituto de Saúde do Distrito Federal (ISDF, number 1047), with negative results. *Desmodus rotundus* can efficiently digest mammal blood and was thought to be the only vampire bat preying on humans. However, there are at least 2 records of *Di. ecaudata*, an avian blood specialist with physiological adaptations similar to *D. youngii* (see Ito et al. 2016), feeding on humans (Ruschi 1953, Ito et al. 2016). Housing conditions may influence the foraging behavior of vampire bats, especially in rural or poor areas where domestic animals, often maintained together, are in close proximity with human facilities. *Diaemus youngii* has also been captured in urban areas (Urbieta et al. 2017). These conditions favor the transmission of RABV, even if indirectly (Turner 1975).

According to the literature, *D. youngii* has a wide distribution in the Neotropical region, occurring from southern Mexico to northern Argentina. It seems to be absent, however, from the west of the Andes and most Caribbean islands (except for Trinidad). Suriname, Chile, and Uruguay, in South America, and Belize and Honduras, in Central America also lack records (Fig. 1; see also Greenhall and Schutt 1996). The distribution of this species seems to be influenced by thermoregulation issues (e.g. intolerance to colder climates), shared with *Diphylla*, but not with *Desmodus* (McNab 1969). The latter genus of bat has a greater ability to maintain its body temperature, and its distribution is known to reach as far as Chile and Uruguay (Acosta y Lara 1950, Delpietro et al. 2017). The absence of *D. youngii* in Honduras (Goodwin 1942, Valdez and LaVal 1971), Belize (Fenton et al. 2001), and Suriname, however, may represent sampling gaps. In northern South America, all countries bordering Suriname have reported its occurrence (Piccinini 1974, Peracchi et al. 1984, Bernard and Fenton 2002).

The large number of records of *D. youngii* in southeastern Brazil, especially in Rio de Janeiro and São Paulo, can be attributed to the long-duration surveys conducted in those states (Esbérard and Bergallo 2005, Garbino 2016). Contrasting with the situation in this region, however, the majority of the Brazilian territory is poorly sampled (Bernard et al. 2011), including the northeastern region. Some efforts have been made recently in this region, but no record of *D. youngii* is currently available from Rio Grande do Norte (Vargas-Mena et al. 2018), Ceará (Silva et al. 2015) and Roraima (Capaverde Junior

**Table 1.** Craniodental measurements (in mm) of *Diaemus youngii* from Monte Alegre de Goiás, Goiás, Brazil (MBML 2005), and comparative data for the holotype (Upper Canje Creek, Guyana; RNH 12088; Carter and Dolan 1978), and for material from central-western and northern Brazil (Pedroso et al. 2018), and from Trinidad and Venezuela (Greenhall and Schutt 1996).

| Variables | MBML 2005 (GO) | Holotype | Greenhall and Schutt 1996† | Pedroso et al. 2018‡ |
|---|---|---|---|---|
| Greatest length of skull | 24.35 | 25.0 | 24.8 | 25.61 |
| Condylobasal length | 21.58 | 23.0 | — | 21.01 |
| Condylo-canine length | 19.63 | — | — | — |
| Basal length | 19.63 | — | — | — |
| Palatal length | 8.72 | — | — | 7.84 |
| Upper toothrow length | 3.10 | 3.5 | 3.5 | 5.61 |
| Width across upper molars | 6.28 | — | — | 6.58 |
| Postorbital length | 6.34 | 6.5 | 6.2 | 6.32 |
| Braincase breadth | 13.17 | 13.5 | 13.0 | 13.02 |
| Zygomatic breadth | 13.91 | 14.3 | 13.9 | 13.99 |
| Mandibular length | 14.70 | 15.2 | — | 15.15 |
| Lower toothrow length | 4.17 | 4.2 | — | — |

†Mean values for 3 males.
‡Mean values for 5 females.

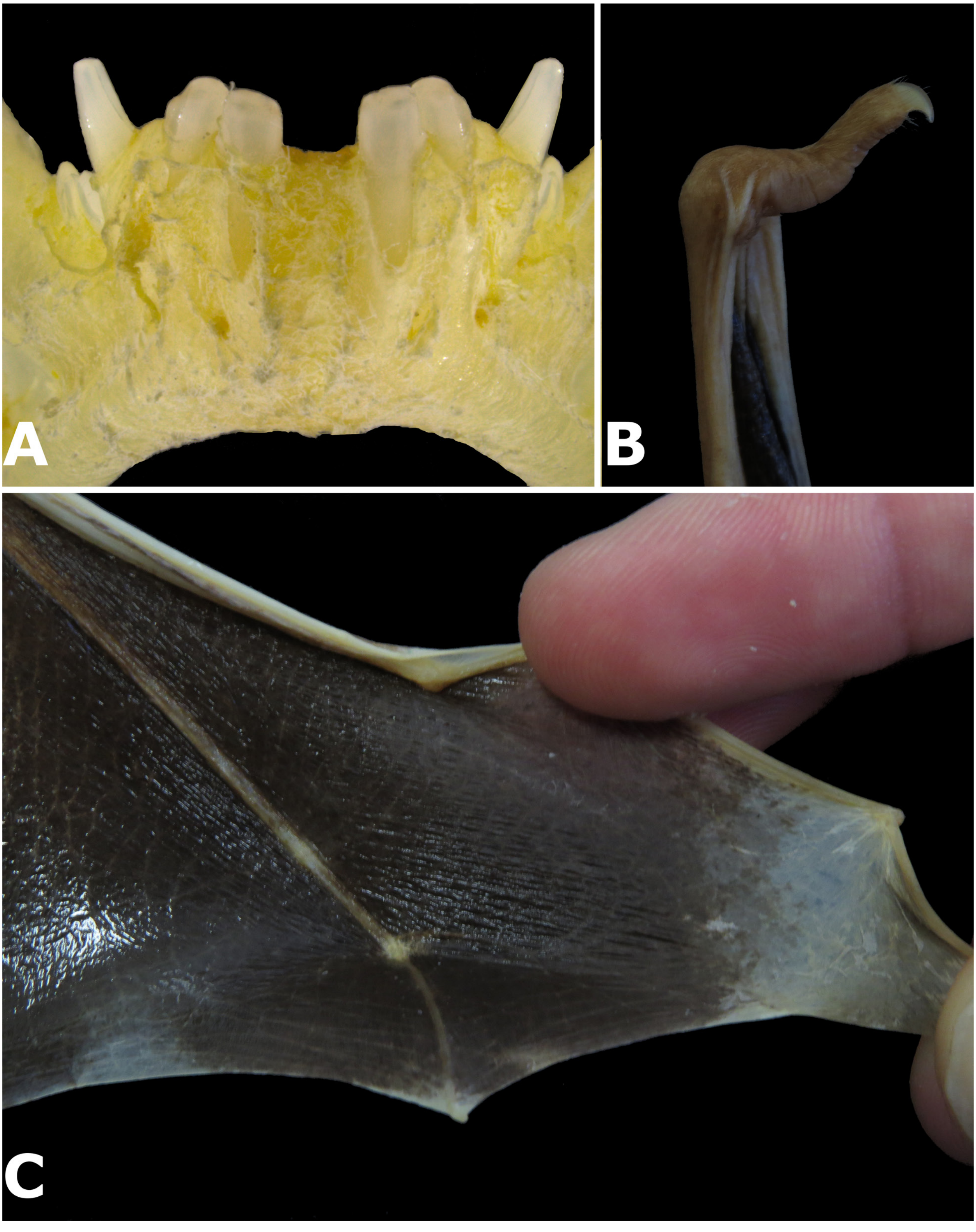


**Figure 2.** *Diaemus youngii* from Goiás state, Brazil (MBML 2005). **A.** Lower incisors. **B.** Right thumb, showing the single basal pad. **C.** Right wing, depicting the white wingtip characteristic of this species.

et al. 2014). Absences from the southern states of Rio Grande do Sul and Santa Catarina, on the other hand, may be related to their colder climates, as previously reported for Uruguay (Acosta y Lara 1950).

The new record of *D. youngii* reported here covers a gap in the middle of the Cerrado, with the closest localities known to harbor this species being, respectively, Brazlândia, Distrito Federal (280 km north; Aguiar et al. 2006) and Estação Ecológica Serra Geral do Tocantins, Jalapão (300 km south; Gregorin et al. 2011).

The first director of the Museum of Vertebrate Zoology (University of California), Joseph Grinnell, wrote in 1910 on the importance of museum collections (Grinnell 1910):

> It will be observed, then, that our efforts are not merely to accumulate as great a mass of animal remains as possible. On the contrary, we are expending even more time than would be required for the collection of the specimens alone, in rendering what we do obtain as permanently valuable as we know how, to the ecologist as well as to the systematist. It is quite probable that the facts of distribution, life history, and economic status may finally prove to be of more far-reaching value, than whatever information is obtainable exclusively from the specimens themselves.

Unfortunately, without proper care and maintenance, these fundamental repositories of biodiversity can be tragically lost, as recently seen in the Museu Nacional do Rio de Janeiro and in the Instituto Butantan, both in Brazil. It is widely recognized that most species in the world have yet to be described (Mora et al. 2011), and a significant part is already waiting for description in a museum collection (Fontaine et al. 2012). Our report, based on a specimen collected more than 20 years ago, reinforces the role of collections, in helping with the basic knowledge of "where" a species can be found.

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## Authors' Contributions

JPMH examined and identified the specimen, prepared the map and figures. GM took cranial measurements. All authors wrote, revised, and approved the manuscript.

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# Appendix

**Table A1.** Gazetteer of all reported occurrences of *Diaemus youngii* (Jentink, 1893).

| Country | State/province | Locality | Latitude | Longitude | Reference | Page | Coll. number |
|---|---|---|---|---|---|---|---|
| Argentina | Jujuy | Agua Salada | 23°49′00″ S | 064°36′00″ W | Barquez 1984 | 67 | FML 1343 |
| | Misiones | Bonpland | 27°29′00″ S | 055°29′00″ W | Kwon and Gardner 2008 | 222 | — |
| | Salta | Arroyo Arrazayal | 22°39′51″ S | 064°25′31″ W | Barquez et al. 2011 | 17 | CML 7700 |
| Bolivia | Beni | 15 km above Horquilla, Rio Machupo | 12°41′00″ S | 064°32′00″ W | Anderson et al. 1982 | 15 | — |
| | Beni | 4 km S San Joaquin, San Juan | 13°06′00″ S | 064°49′00″ W | Anderson et al. 1982 | 15 | — |
| | Beni | Estancia Yutiole | 13°15′00″ S | 064°49′00″ W | Anderson et al. 1982 | 16 | — |
| | Beni | Rio Itenez, 4 km above Costa Marquez | 12°29′00″ S | 064°15′00″ W | Anderson et al. 1982 | 14 | — |
| | La Paz | Pasto Grande | 16°36′00″ S | 067°29′00″ W | Kwon and Gardner 2008 | 222 | — |
| | Santa Cruz | Buena Vista | 17°27′00″ S | 063°40′00″ W | Kwon and Gardner 2008 | 222 | — |
| Brazil | Acre | Parque Nacional da Serra do Divisor | 07°27′30″ S | 073°43′55″ W | Nogueira et al. 1999 | 366 | — |
| | Alagoas | Porto Calvo | 09°04′00″ S | 035°24′00″ W | Kwon and Gardner 2008 | 222 | — |
| | Amapá | Santa Luzia do Pacuí | 00°30′00″ N | 051°40′00″ W | Peracchi et al. 1984 | 97 | ALP |
| | Amazonas | Biological Dynamics of Forest Fragments Project (BDFFP), 80 km N Manaus | 02°24′26″ S | 059°43′40″ W | Bernard 2001 | 119 | INPA |
| | Amazonas | Manaus | 03°06′00″ S | 060°01′00″ W | Mok and Lacey 1980 | 339 | — |
| | Amazonas | Parque Nacional do Jaú | 01°50′00″ S | 062°50′00″ W | Barnett et al. 2006 | 108 | — |
| | Amazonas | Rio Aripuanã | 06°08′13″ S | 060°11′37″ W | Bobrowiec 2012 | 280 | INPA |
| | Amazonas | Rio Madeira | 05°27′58″ S | 060°45′07″ W | Bobrowiec 2012 | 280 | INPA |
| | Bahia | Baía do Rio São Francisco (Médio) | 13°42′25″ S | 042°51′00″ W | Sá-Neto and Marinho-Filho 2013 | 91 | DCN/UESB |
| | Bahia | Mascote, Fazenda São José | 15°34′05″ S | 039°17′07″ W | Falcão 2007 | 330 | DE 606 |
| | Distrito Federal | Brazlândia, Gruta do Sal (DF-005), Fazenda Palestina | 15°30′00″ S | 048°10′00″ W | Aguiar et al. 2006 | 895 | — |
| | Distrito Federal | Sobradinho, Área de Proteção Ambiental Cafuringa | 15°35′00″ S | 048°01′00″ W | Aguiar and Antonini 2016 | 3 | — |
| | Goiás | Monte Alegre de Goiás | 13°15′23″ S | 046°54′02″ W | This Study | - | — |
| | Maranhão | Área de Proteção Ambiental Municipal do Inhamum | 04°53′30″ S | 043°24′53″ W | Olímpio et al. 2016 | 3 | — |
| | Mato Grosso | Cláudia, Renato River | 11°24′00″ S | 055°02′00″ W | Pedroso et al. 2018 | 155 | MZUSP 35713 |
| | Mato Grosso | Fazenda Acurizal | 17°45′00″ S | 057°37′00″ W | Schaller 1983 | 11 | — |
| | Mato Grosso do Sul | Aquidauana | 19°33′58″ S | 055°30′43″ W | Oliveira et al. 2012 | 36 | UNIDERP |
| | Mato Grosso do Sul | Caimã Forest and Resort | 19°18′13″ S | 056°01′25″ W | Urbieta et al. 2017 | 3 | — |
| | Mato Grosso do Sul | Campo Grande, Lagoa da Cruz, Instituto São Vicente | 20°23′08″ S | 054°36′27″ W | Urbieta et al. 2017 | 1 | ZUFMS CHI02310 |
| | Mato Grosso do Sul | Coxim, Serra Coxim | 18°35′21″ S | 054°48′13″ W | Urbieta et al. 2017 | 3 | — |
| | Mato Grosso do Sul | Miranda-Abobral | 19°46′55″ S | 056°40′38″ W | Oliveira et al. 2012 | 36 | UNIDERP |
| | Mato Grosso do Sul | Nhecolândia | 18°47′28″ S | 056°02′03″ W | Oliveira et al. 2012 | 36 | UNIDERP |
| | Mato Grosso do Sul | Nhecolândia, Fazenda Rio Negro | 19°34′22″ S | 056°14′36″ W | Silva and Graciolli 2013 | 177 | — |
| | Mato Grosso do Sul | Nhecolândia, Fazenda Rio Negro | 19°34′22″ S | 056°14′36″ W | Herrera et al. 2011 | 383 | — |
| | Mato Grosso do Sul | Paraguay river | 19°13′00″ S | 057°29′00″ W | Bordignon and Shapiro 2018 | 259 | — |
| | Minas Gerais | Esmeraldas | 19°45′57″ S | 044°17′09″ W | Urbieta et al. 2017 | 3 | — |
| | Minas Gerais | Lagoa Santa | 19°42′44″ S | 043°56′32″ W | Torquetti et al. 2013 | 1148 | MZ 270 |
| | Minas Gerais | Uberaba | 19°44′50″ S | 047°56′21″ W | Stutz et al. 2004 | 190 | — |
| | Minas Gerais | Uberlândia | 18°55′08″ S | 048°16′39″ W | Urbieta et al. 2017 | 3 | — |
| | Pará | Belém | 01°27′21″ S | 048°29′15″ W | Handley 1967 | 213 | — |
| | Pará | Belém, Área de Pesquisas Ecológicas do Guamá, e áreas do Instituto de Pesquisa e Experimentação Agropecuárias do Norte | 02°39′00″ S | 055°22′00″ W | Kalko and Handley 2001 | 322 | — |
| | Pará | Melgaço, Estação Científica Ferreira Penna | 01°48′00″ S | 050°43′00″ W | Marques-Aguiar et al. 2003 | 2 | — |
| | Pará | Rio Xingu, Usina Hidrelétrica Belo Monte | 03°20′00″ S | 052°00′00″ W | Marques-Aguiar et al. 2009 | 2 | — |
| | Pará | Santarém | 02°24′52″ S | 054°42′36″ W | Piccinini 1974 | 20 | — |
| | Paraíba | Araruna, Parque Estadual Pedra da Boca, Mata Seca | 06°27′43″ S | 035°41′21″ W | Feijó et al. 2010 | 723 | UFPB 5573 |
| | Paraíba | Reserva Biológica Guaribas | 06°48′18″ S | 035°04′60″ W | Feijó et al. 2016 | 65 | UFPB 7456 |
| | Paraná | Bacia do Rio Tibagi | 24°06′07″ S | 050°53′06″ W | Reis et al. 2002 | 255 | — |

**Table A1.** *Continued.*

| Country | State/province | Locality | Latitude | Longitude | Reference | Page | Coll. number |
|---|---|---|---|---|---|---|---|
| Brazil | Paraná | Cerro Azul | 24°49′00″ S | 049°15′00″ W | Graciolli and Carvalho 2001 | 935 | — |
| | Paraná | Londrina, Parque Estadual Mata dos Godoy | 23°27′00″ S | 051°15′00″ W | Reis et al. 2003 | 228 | — |
| | Paraná | Palmeira | 25°25′00″ S | 050°00′00″ W | Thomas 1899 | 547 | — |
| | Paraná | Parque Nacional do Iguaçu | 25°36′00″ S | 054°35′00″ W | Sekiama et al. 2001 | 752 | LZUEL |
| | Paraná | Ponta Grossa, Campos Gerais | 25°50′58″ S | 050°09′30″ W | Zanon and Reis 2007 | 329 | — |
| | Paraná | Roça Nova | 25°28′00″ S | 048°58′00″ W | Miller 1906 | 84 | USNM 140769 |
| | Pernambuco | Ipojuca, Usina Salgado, Mata do Mingú | 08°31′29″ S | 035°03′26″ W | Sotero-Caio et al. 2011 | 158 | — |
| | Pernambuco | Jaqueira, RPPN Frei Caneca | 08°42′37″ S | 035°50′01″ W | Silva et al. 2010 | 88 | — |
| | Pernambuco | São Lourenço da Mata, Estação Ecológica do Tapacurá | 08°02′00″ S | 035°13′00″ W | Mares et al. 1981 | 111 | — |
| | Piauí | Picos | 07°04′39″ S | 041°28′02″ W | Pinto and Bento 1986 | 32 | — |
| | Piauí | São Miguel do Tapuio | 05°43′13″ S | 041°26′28″ W | Castilho et al. 2010 | 1335 | — |
| | Rio de Janeiro | Angra dos Reis | 23°00′00″ S | 044°18′00″ W | Bolzan et al. 2010 | 589 | — |
| | Rio de Janeiro | Angra dos Reis, Ilha da Gipóia | 23°02′20″ S | 044°21′35″ W | Costa and Esbérard 2011 | 741 | — |
| | Rio de Janeiro | Baía de Sepetiba, Mangaratiba, Ilha de Marambaia, Praia Grande | 22°04′26″ S | 043°57′56″ W | Costa et al. 2008 | 218 | LDM 4314 |
| | Rio de Janeiro | Barra Mansa | 22°32′27″ S | 044°10′38″ W | Peracchi and Albuquerque 1971 | 410 | — |
| | Rio de Janeiro | Carmo | 21°55′00″ S | 042°36′00″ W | Costa et al. 2008 | 218 | — |
| | Rio de Janeiro | Casimiro de Abreu, Morro de São João | 22°29′96″ S | 041°58′92″ W | Costa et al. 2008 | 218 | — |
| | Rio de Janeiro | Guapiaçú, Reserva Ecológica de Guapiaçú | 22°25′53″ S | 042°45′20″ W | Souza et al. 2015 | 14 | MN 79877 |
| | Rio de Janeiro | Guapimirim, Parada Modelo | 22°33′24″ S | 042°55′71″ W | Costa et al. 2008 | 218 | — |
| | Rio de Janeiro | Mangaratiba | 22°56′34″ S | 044°02′26″ W | Bolzan et al. 2010 | 589 | — |
| | Rio de Janeiro | Mangaratiba, Fazenda Terras do Sahy | 22°56′00″ S | 044°00′00″ W | Costa and Esbérard 2011 | 741 | — |
| | Rio de Janeiro | Mangaratiba, Ilha de Marambaia | 23°04′03″ S | 043°53′14″ W | Costa and Esbérard 2011 | 741 | — |
| | Rio de Janeiro | Miracema | 21°24′55″ S | 042°11′39″ W | Barros et al. 2008 | 684 | — |
| | Rio de Janeiro | Quissamã, Parque Nacional Restinga de Jurubatiba | 22°06′14″ S | 041°28′12″ W | Costa et al. 2008 | 218 | — |
| | Rio de Janeiro | Rio de Janeiro, Barra da Tijuca | 23°00′22″ S | 043°17′49″ W | Costa et al. 2008 | 218 | — |
| | Rio de Janeiro | Rio de Janeiro, Barra de Guaratiba | 22°59′45″ S | 043°32′21″ W | Costa et al. 2008 | 218 | — |
| | Rio de Janeiro | RPPN Fazenda Bom Retiro | 22°27′13″ S | 042°18′29″ W | Menezes Junior et al. 2015 | 272 | — |
| | Rio de Janeiro | Seropédica, Campus da Universidade Federal Rural do Rio de Janeiro | 22°45′54″ S | 043°41′12″ W | Peracchi and Albuquerque 1986 | 67 | — |
| | Rio de Janeiro | Três Rios, Bemposta | 22°07′00″ S | 043°12′20″ W | Costa et al. 2008 | 218 | — |
| | Rio de Janeiro | Valença, Refúgio da Vida Silvestre da Serra da Concórdia | 22°22′18″ S | 043°47′23″ W | Costa et al. 2008 | 218 | — |
| | Rio de Janeiro | Volta Redonda | 22°30′27″ S | 044°05′40″ W | Costa et al. 2008 | 218 | — |
| | Rio de Janeiro | Volta Redonda, Parque Natural Municipal Fazenda Santa Cecília do Ingá | 22°27′34″ S | 044°04′51″ W | Pereira et al. 2013 | 1018 | — |
| | Rondônia | Porto Velho | 08°46′00″ S | 063°54′00″ W | Tavares et al. 2017 | 96 | — |
| | Rondônia | Porto Velho, Abunã | 09°35′00″ S | 065°03′00″ W | Pedroso et al. 2018 | 155 | MZUSP 35712 |
| | São Paulo | Bilac | 21°24′16″ S | 050°28′30″ W | Garbino 2016 | 82 | DZSJRP 10705 |
| | São Paulo | Botucatu | 22°59′20″ S | 048°26′37″ W | Uieda and Chaves 2005 | 225 | — |
| | São Paulo | Grota Mirassol | 20°46′00″ S | 049°28′00″ W | Garbino 2016 | 82 | DZSJRP 2556 |
| | São Paulo | Guararema | 23°25′00″ S | 046°01′00″ W | Garbino 2016 | 82 | DZSJRP 15156 |
| | São Paulo | Iporanga, Parque Estadual Turístico Alto do Ribeira, Gruta do Alambari de Baixo (SP-012) | 24°33′15″ S | 048°39′55″ W | Trajano 1987 | 538 | — |
| | São Paulo | Itajobi | 21°19′00″ S | 049°03′00″ W | Garbino 2016 | 82 | DZSJRP 15025 |
| | São Paulo | Santa Gertrudes, Fazenda Paraguassu | 22°27′00″ S | 047°32′00″ W | Sazima and Uieda 1980 | 102 | ZUEC 1001 |
| | São Paulo | São José do Rio Preto | 20°49′11″ S | 049°22′45″ W | Garbino 2016 | 82 | DZSJRP 16978 |
| | São Paulo | São Paulo | 23°32′52″ S | 046°38′10″ W | Vieira 1942 | 380 | MZUSP 4036 |
| | São Paulo | São Sebastião, Barra do Una | 23°46′00″ S | 045°45′00″ W | Garbino 2016 | 82 | MZUSP 9462 |
| | São Paulo | Uchoa | 20°57′00″ S | 049°10′00″ W | Garbino 2016 | 82 | DZSJRP 16615 |
| | Tocantins | Couto Magalhães, near electric power transmission line | 08°21′00″ S | 049°10′00″ W | Pedroso et al. 2018 | 156 | MZUSP 35358 |
| | Tocantins | Estação Ecológica Serra Geral do Tocantins, Jalapão | 10°33′00″ S | 046°45′00″ W | Gregorin et al. 2011 | 303 | EG 323 |
| Colombia | Putumayo | Río Mecaya | 00°28′00″ N | 075°20′00″ W | Wenzel et al. 1966 | 600 | — |
| | Valle del Cauca | Río Raposo | 03°38′00″ N | 077°05′00″ W | Wenzel et al. 1966 | 600 | — |
| Costa Rica | Guanacaste | Finca La Pacífica | 10°27′16″ N | 085°07′41″ W | Gardner et al. 1970 | 723 | LSUMZ 22533 |
| Ecuador | Esmeraldas | San Lorenzo | 01°17′00″ N | 078°50′00″ W | Pinto et al. 2007 | 244 | TTU 85358 |
| El Salvador | La Paz | 1 mi N La Herradura | 13°21′52″ N | 088°57′00″ W | Owen et al. 1990 | 418 | — |
| | La Paz | 3 mi NW La Herradura | 13°22′51″ N | 088°58′53″ W | Greenbaum and Jones 1978 | 5 | TTU 27591 |
| French Guiana | Cayenne | Paracou | 05°16′00″ N | 052°55′00″ W | Bernard and Fenton 2002 | 1137 | — |
| Guyana | East Berbice-Corentyne | Upper Canje Creek | 05°07′00″ N | 057°37′00″ W | Jentink 1893 | 282 | RNH 12088 |
| | Potaro-Siparuni | Iwokrama Forest | 04°40′00″ N | 058°41′00″ W | Bernard and Fenton 2002 | 1137 | — |
| | Rupunini | Kanunu Mountains | 03°22′00″ N | 059°30′00″ W | Barnett et al. 2006 | 125 | — |

**Table A1.** *Continued.*

| Country | State/province | Locality | Latitude | Longitude | Reference | Page | Coll. number |
|---|---|---|---|---|---|---|---|
| Mexico | Chiapas | Ejido Benemérito de Las Américas | 16°31′02″ N | 090°39′11″ W | Urbano-Vidales et al. 1987 | 135 | — |
| | Mazu | Montes Azules | 16°50′00″ N | 091°30′00″ W | Bernard and Fenton 2002 | 1137 | — |
| Nicaragua | Managua | 0.75 mi N Masachapa | 11°47′24″ N | 086°31′00″ W | Greenbaum and Jones 1978 | 5 | TTU 30667 |
| | South Caribbean Coast Autonomous Region | 3 km NW Rama | 12°10′43″ N | 084°13′12″ W | Greenbaum and Jones 1978 | 5 | TTU 30668 |
| Panama | Bocas del Toro | Isla Bastimentos | 09°21′00″ N | 082°12′00″ W | Wenzel et al. 1966 | 600 | — |
| | Guna Yala | Río Armilla | 09°02′40″ N | 078°01′14″ W | Wenzel et al. 1966 | 496 | — |
| | Alto Paraguay | Estancia General Díaz, 100 km W Fuerte Olimpo | 21°08′00″ S | 058°30′00″ W | López-González et al. 1998 | 42 | FMNH 145266 |
| | Alto Paraguay | Estancia Parra Cue | 02°05′54″ S | 047°53′31″ W | López-González et al. 1998 | 42 | TTU 75276 |
| | Boquerón | Parque Nacional Defensores del Chaco, Cruce Cuatro de Mayo, destacamento Patricio Colmán | 20°13′00″ S | 060°12′00″ W | López-González et al. 1998 | 42 | MNHNP 823 |
| | Presidente Hayes | Estancia La Victoria | 23°29′02″ S | 058°34′47″ W | López-González et al. 1998 | 42 | TTU 75273 |
| | Presidente Hayes | Estancia Loma Pora | 23°29′56″ S | 057°32′53″ W | López-González et al. 1998 | 42 | TTU 75278 |
| Peru | Huánuco | Cueva de Castillo | 09°07′00″ S | 075°58′00″ W | Bowles et al. 1979 | 7 | — |
| | Huánuco | Cueva de Lechuzas | 09°20′00″ S | 076°01′00″ W | Bowles et al. 1979 | 7 | — |
| | Huánuco | Panguana Biological Station | 09°37′00″ S | 074°56′00″ W | Hutterer et al. 1995 | 5 | — |
| | Loreto | Colonia Calleria, 20 km from Río Ucayali | 08°06′00″ S | 074°36′00″ W | Wenzel et al. 1966 | 600 | — |
| | Loreto | Pebas | 03°20′00″ S | 071°49′00″ W | Thomas 1928 | 288 | NHM 1928.7.21.64 |
| | Tumbes | Distrito Pampas de Hospital, Angostura | 03°45′23″ S | 080°23′15″ W | Pacheco et al. 2007 | 412 | MUSM 22132 |
| | Ucayali | Yarinacocha | 08°15′00″ S | 074°43′00″ W | Sanborn 1949 | 282 | — |
| Trinidad & Tobago | Trinidad | Barataria | 10°39′00″ N | 061°28′00″ W | Kwon and Gardner 2008 | 222 | USNM 536938 |
| | Trinidad | La Brea | 10°15′00″ N | 061°37′00″ W | McBee et al. 1985 | 404 | TTU 26888 |
| | Trinidad | Las Cuevas | 10°46′00″ N | 061°23′00″ W | Greenhall 1963 | 397 | — |
| | Trinidad | Majuba Road, Petit Valley | 10°42′00″ N | 061°32′00″ W | Brennan 1967 | 154 | — |
| | Trinidad | Maracas Valley | 10°41′00″ N | 061°24′00″ W | McBee et al. 1985 | 404 | TTU 5232 |
| Venezuela | Amazonas | San Juan de Manapiare | 05°15′00″ N | 066°05′00″ W | Bernard & Fenton 2002 | 1137 | — |
| | Bolívar | Canaima National Park | 06°10′00″ N | 062°30′00″ W | Barnett et al. 2006 | 125 | — |
| | Delta Amacuro | Araguaimujo | 08°54′00″ N | 061°32′00″ W | Kwon and Gardner 2008 | 222 | — |
| | Falcón | 6 km SE Capatárida | 11°07′00″ N | 070°35′00″ W | Kwon and Gardner 2008 | 222 | — |
| | Nueva Esparta | El Valle | 10°59′00″ N | 063°52′00″ W | Kwon and Gardner 2008 | 222 | — |
| | Zulia | El Panorama, Río Aurare | 10°37′00″ N | 071°25′00″ W | Osgood 1912 | 63 | — |