

## **First records of 10 bat species in Guyana and comments on diversity of bats in Iwokrama Forest**

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Ten species of bats (*Centronycteris maximiliani*, *Diclidurus albus*, *D. ingens*, *D. isabellus*, *Peropteryx leucoptera*, *Micronycteris brosetti*, *M. microtis*, *Tonatia carrikeri*, *Lasiurus atratus*, and *Myotis riparius*) collected in the Iwokrama International Rain Forest Programme site represent the first records of these taxa from Guyana. This report brings the known bat fauna of Guyana to 107 species and the fauna of Iwokrama Forest to 74 species. Measurements, reproductive data, and comments on taxonomy and distribution are provided.

*Key words:* Chiroptera, Neotropics, Guyana, Iwokrama Forest, inventory, species diversity

### INTRODUCTION

The mammalian fauna of Guyana is poorly documented in comparison with neighbouring countries in northern South America. Most of its species and their distributions are inferred (e.g., Eisenberg, 1989) from mammals reported in Venezuela (e.g., Handley, 1976) and Suriname (e.g., Husson, 1978). Two recent publications (Parker *et al.*, 1993; Smith and Kerry, 1996) reported on separate, small single-site collections from Guyana and indicate a renewed interest in the diversity of Guyanese mammals. Herein, we record 10 additional species of bats for the country and provide comments on taxonomy, distribution, measurements, and reproductive data. This report is based primarily

on the first of two field trips that constituted the mammal portion of the faunal survey for Iwokrama Forest coordinated through The Academy of Natural Sciences of Philadelphia. Records from previously unreported specimens at the Royal Ontario Museum are also presented to augment distributional data.

### MATERIALS AND METHODS

#### *Study Sites*

Fieldwork was conducted primarily from 9 March to 12 April 1997 in the Iwokrama International Rain Forest Programme site in central Guyana (Fig. 1). Iwokrama Forest encompasses 3,600 km<sup>2</sup> of primary mixed lowland tropical rainforest set aside by the government of Guyana in 1990 under the auspices of the Commonwealth Secretariat for sustainable management and conservation of biodiversity (Hawkes and



FIG. 1. Map of Guyana showing Iwokrama Forest and the collecting sites of the 10 new records of bat species for the country reported in this paper: (1) Georgetown; (2) Bada Creek; (3) Pakatau Falls; (4) Clearwater Camp; (5) Iwokrama Field Station, Kurupukari; (6) Three Mile Camp; (7) 30 km NE of Surama; (8) Surama Sawmill; (9) Illia Wau River; (10) Gunn's Strip; (11) 7 km S of Gunn's Strip; and (12) Chodikar River

Wall, 1993). One all-season access road, approximately 70 km in length, bisects Iwokrama Forest from the northeast near Kurupukari on the Essequibo River to the southwest near Surama, bordering the North Rupununi Savannas.

The collecting sites (Fig. 1; see also Gazetteer) within Iwokrama Forest included: (1) Pakatau Falls is on the Siparuni River near the mouth of Pakatau Creek in the northwest in mixed, poorly drained forest near high hills dominated by *Mora*, *Pentaclethra*, and *Licania*. Collections were made from 9 to 16 March 1997; (2) Three Mile Camp is in the northeast along the road approximately 5 km southwest of Kurupukari in undulating terrain on well-drained brown sand with lowland forest dominated by *Licania*, *Chlorocardium*, and *Eschweilera*. Collections were made from 18 to 28 March 1997; (3) Clearwater Camp along the Burro Burro River approximately 25 km WNW of Kurupukari is in the north in mixed lowland forest dominated by *Chlorocardium*, *Eperua*, and *Eschweilera* on well-drained white sand. Collections were made from 30 March to 11 April 1997; (4) Iwokrama Field Station is in the northeast on the Essequibo River about 1 km N of Kurupukari in disturbed alluvial

forest with a clearing and road in the vicinity. Collections were made on 29 March and 12 April 1997.

Before the access road was constructed and Iwokrama Forest was established, collections were made on 4, 5, 10, and 11 October 1990, 30 km NE of Surama in mixed lowland forest in what is now the south-central portion of Iwokrama Forest. From 17 to 31 July 1994 collections were made at Surama Sawmill, 5 km SE of Surama adjacent to the southwestern extent of Iwokrama Forest in mixed lowland forest, which recently had been selectively logged.

Additional records from previously unreported specimens at the ROM, which augment distributional information for the species recorded herein, are also presented (Fig. 1). These include collections made on 26 October and from 21 to 24 November 1996 at Gunn's Strip in the Upper Takutu-Upper Essequibo Region in southern Guyana. Gunn's Strip is a Wai-Wai village situated in seasonally flooded riparian forest bordering interior lowland shrub savanna. Other collections were made on the upper Essequibo River about 7 km S of Gunn's Strip from 15 to 20 November 1996. The habitat there was tall evergreen hill-land forest. Collections were made from 28 October to 6 November 1996 at Chodikar River, about 55 km SW of Gunn's Strip near the border with Brazil in tall evergreen non-flooded hill-land forest. Other records were derived from specimens made by other collectors and are described in the species accounts.

The primary method used to capture bats was standard-weight (70-denier) mist nets of various sizes set in different microhabitats usually opened from dusk to midnight. Bats flying below 3 m in the forest understorey were caught in regular-sized mist nets (2.6×6.0 m or 2.6×12.0 m) typically set across flyways such as streams and trails or near clearings and fruiting trees. Bats flying upwards to 20 m in the forest canopy were caught with large-sized mist nets (9.1×30.5 m) set over roads or rivers within rainforest. Mist netting was supplemented with 4-bank harp traps usually set across narrow streams or trails, and shotguns (12 gauge and 0.410 calibre) with ammunition ranging from number 6 to 12 shot. Although the searching for roost sites was not an active part of our field protocol, we checked potential roosts when encountered.

### Specimens and Measurements

Specimens were prepared as dried skins with skeletons or fixed in 10% formalin with storage in 70% ethanol. All specimens had tissue samples (heart, kidney, spleen, liver) frozen initially in liquid nitrogen with later storage in an ultracold freezer (−80°C). Voucher specimens were deposited at the Angelo State Natural History Collection (ASNHC), Royal Ontario Museum (ROM), U.S. National Museum of Natural

History (USNM), University of Guyana, Centre for the Study of Biological Diversity (UG/CSBD), and University of Kansas Natural History Museum (KU).

Each species account includes a list of specimens examined (sample size in parentheses) followed by Region in Guyana, specific locality, and museum catalogue numbers for specimens examined. Details of reproductive condition included testes (T) length by width in mm for males. For females we report presence or absence of an embryo with crown-rump length (CR) if present and note whether the individual was lactating. Details of capture, such as microhabitat, date, and time were recorded for each species. External measurements (in mm) and body mass (in g) were recorded in the field as described in Nagorsen and Peterson (1980) and presented in Table 1, including total length, length of tail, length of hindfoot, length of ear from notch, length of tragus, length of forearm, and body mass. Cranial measurements (in mm) for adult specimens (complete ossification of phalanges and

basisphenoid region) were recorded as described by Genoways and Williams (1979), including greatest length of skull, zygomatic breadth, mastoid breadth, postorbital breadth, length of maxillary toothrow ( $C-M^1$ ), and breadth across upper molars ( $M^1-M^3$ ; see Table 2).

## SPECIES ACCOUNTS

### Family Emballonuridae

#### *Centronycteris maximiliani* (Fischer, 1829)

Specimens examined (3). — Potaro–Siparuni; Clearwater Camp (KU 156014); Pakatau Falls (ROM 107081, 107082).

Two adult females were netted together about 10 m above the ground in the forest

TABLE 1. Range of six external measurements (in mm), including total length (TL), tail length (TAIL), hindfoot length (HFL), ear length (EAR), tragus length (TRAGUS), forearm length (FAL), and body mass (MASS, in g) of 10 new country records of bats for Guyana. Sample sizes differing from those reported under *n* are given in parentheses after the measurement or mass

Species	<i>n</i>	TL	TAIL	HFL	EAR	TRAGUS	FAL	MASS
Emballonuridae								
<i>Centronycteris maximiliani</i>	3♀♀	56–63(2)	17–23	6–7	14–17	4–6	44–46	5–6
<i>Diclidurus albus</i>	1♀	98	22	12	16	8	66	18
<i>D. ingens</i>	1♀	106	23	12	14	9	73	26
<i>D. isabellus</i>	13♀♀	83–92	15–24	12–14	15–17	6–9	58–65	14–18
	1♂	86	20	11	16	7	62	14
<i>Peropteryx leucoptera</i>	1♀	56	5	8	16	7	43	—
	2♂♂	59–61	9–11	7–9	16–17	5–7	41–44	6(1)
Phyllostomidae								
<i>Micronycteris brosetti</i>	1♀	51	12	10	19	6	32	5
	1♂	56	11	10	17	7	32	5
<i>M. microtis</i>	1♀	59	12	9	22	8	35	6
	3♂♂	53–60	13–15	9–10	20–21	7	34–36	6
<i>Tonatia carrikeri</i>	7♀♀	77–95	9–16	15–17	26–30	10–11	46–51	18–33
	2♂♂	74–88	15	16–17	27–29	10	49–52	23–27
Vespertilionidae								
<i>Lasiurus atratus</i>	1♀	115	52	10	13	8	49	12
<i>Myotis riparius</i>	8♀♀	78–85	35–39	7–10	12–13	6–7	35–40	4–8
	9♂♂	80–83	33–38	8–9	12–14	6–7	36–39	5–6

TABLE 2. Range of six standard cranial measurements (in mm) of 10 new country records of bats for Guyana, including greatest length of skull (GLS), zygomatic breadth (ZB), mastoid breadth (MB), postorbital breadth (POB), length of maxillary toothrow (C-M<sup>3</sup>), and breadth across upper molars (M<sup>3</sup>-M<sup>3</sup>)

Species	n	GLS	ZB	MB	POB	C-M <sup>3</sup>	M <sup>3</sup> -M <sup>3</sup>
Emballonuridae							
<i>Centronycteris maximiliani</i>	2♀♀	14.7-14.9	8.7-8.8	7.2-7.3	3.0-3.2	5.8-6.0	6.3-6.7
<i>Diclidurus albus</i>	1♀	18.7	12.2	9.7	5.7	8.0	8.6
<i>D. ingens</i>	1♀	21.9	14.1	10.7	5.9	9.9	10
	1♂	21.3	13.5	10.8	5.9	9.6	9.6
<i>D. isabellus</i>	8♀♀	17.9-18.5	11.3-11.9	9.3-10.0	5.2-5.7	7.1-7.7	7.6-8.1
<i>Peropteryx leucoptera</i>	1♀	—	9.5	8.0	3.3	6.2	6.9
	1♂	15.5	9.6	7.9	3.1	6.2	6.9
Phyllostomidae							
<i>Micronycteris brosetti</i>	1♀	17.6	8.5	8.1	3.8	6.6	5.8
	1♂	17.5	8.3	8.0	3.8	6.7	5.7
<i>M. microtis</i>	1♀	18.2	9.1	8.4	4.0	6.9	6.1
	3♂♂	18.3-18.7	8.6-9.1	8.3-8.5	3.8-4.2	6.8-7.1	5.9-6.0
<i>Tonatia carrikeri</i>	4♀♀	23.9-25.4	11.0-11.5	11.4-12.2	3.5-4.0	7.9-8.6	7.4-7.9
	2♂♂	25.6-26.7	12.0-12.2	12.0-13.4	3.9-4.1	8.7-8.8	7.7-8.3
Vespertilionidae							
<i>Lasiurus atratus</i>	1♀	14.4	9.8	8.0	4.4	4.8	6.8
<i>Myotis riparius</i>	4♀♀	14.0-14.1	8.8-9.3	7.2-7.6	3.4-3.6	5.2-5.3	5.7-6.0
	5♂♂	13.8-14.6	9.0-9.5	7.2-7.6	3.4-3.7	5.2-5.5	5.7-5.9

canopy at Pakatau Falls on 13 March 1997 at approximately 2100 h. A third adult female was shot near the Burro Burro River while flying at about 1700 h in a slight depression in semi-open forest near an old tree fall on 1 April 1997. None of these females was pregnant or lactating.

*Centronycteris maximiliani*, as recently restricted by Simmons and Handley (1998), is widely distributed but uncommon from southern Venezuela to southeastern Brazil. In the Guianan subregion, this species was known by one specimen from Venezuela (McCarthy and Ochoa, 1991), two from Suriname (Husson, 1962; Williams *et al.*, 1983), and one from French Guiana

(Simmons and Handley, 1998). Previously, the genus was considered monotypic. However, based on cranial morphology including a larger anterior upper premolar and smaller basisphenoid pits, *C. centralis* was considered a distinct species found from southern Mexico to Amazonian Peru (Simmons and Handley, 1998). Their generic revision incorporated our three specimens from Guyana.

#### *Diclidurus albus* Wied-Neuwied, 1820

Specimen examined (1). — Potaro-Siparuni; Clearwater Camp (ROM 107435).

One non-pregnant adult female was shot while flying high above the Burro Burro

River early in the evening of 10 April 1997. One female *Diclidurus ingens* (see next account) was shot at the same time flying at a similar height over the river, and four female *D. isabellus* were also shot flying lower over the river.

*Diclidurus albus* is rare but widely distributed from Mexico to eastern Brazil (Ceballos and Medellín, 1988). This species has been documented by only 24 specimens from four localities in Venezuela (Handley, 1976; Ochoa G., 1995) and one specimen from Suriname (Ojasti and Linares, 1971). It has not been reported from French Guiana. The external and cranial measurements for our specimen fit within the range reported by Ceballos and Medellín (1988) except for a marginally smaller mastoid breadth.

*Diclidurus ingens* Hernández-Camacho, 1955

Specimens examined (2). — Demerara-Mahaica; Georgetown (ROM 31981). Potaro-Siparuni; Clearwater Camp (ROM 107434).

One non-pregnant, adult female *D. ingens* was shot while flying high above the Burro Burro River during the early evening on the 10th of April 1997. An adult male was caught by Mr. Ram Singh after it flew into a school classroom in Georgetown on 16 March 1961.

*Diclidurus ingens* was known previously only by the holotype from southeastern Colombia (Hernández-Camacho, 1955) and from Venezuela by six specimens (Ojasti and Linares, 1971; Handley, 1976). This species has been listed as occurring in Peru without reference to specimens (Pacheco *et al.*, 1995) possibly because the type locality is on the border with northern Peru. It has not been reported from Suriname or French Guiana. The large size of this ghost bat sets it apart from all other species of *Diclidurus* (Ceballos and Medellín, 1988).

*Diclidurus isabellus* (Thomas, 1920)

Specimens examined (14). — Potaro-Siparuni; Clearwater Camp (KU 154878-154884; ROM 107389, 107390, 107436-107439; UG/CSBD M161).

Thirteen non-pregnant adult females and one adult male (T = 2x1 mm) were shot while flying low over the Burro Burro River during the evenings of 4, 5, 6, and 10 April 1997.

This species was known previously by only the type specimen found in northwestern Brazil (Thomas, 1920) and 28 specimens from three localities in Amazonas, Venezuela (Handley, 1976). There have been no reports from Suriname or French Guiana. Our new records of *D. isabellus* for Guyana increase the number of known specimens by another 50%, highlighting the collecting bias associated with some species of bats. We never caught this bat in mist nets or harp traps; however, collecting with a shotgun indicates that they can be locally common, flying over relatively large open rivers.

Thomas (1920) described a new genus (*Depanycteris*) for *D. isabellus* because it was brownish in colour (not white as in other *Diclidurus*), had a more developed thumb, relatively longer hindfoot compared to the tibia, morphologically distinct groove on the inner side of the tibia, and deeply emarginated palate in the skull. Ojasti and Linares (1971), however, suggested that the cranial or external characteristics were not sufficient to warrant generic separation of *D. isabellus*. We follow Koopman (1993, 1994) in placing this species in the genus *Diclidurus*.

*Peropteryx leucoptera* Peters, 1867

Specimens examined (3). — Potaro-Siparuni; Iwokrama Field Station (ROM 107458). Upper Demerara-Berbice; Bada Creek, 18 km NE Ituni (ROM 70688). Upper Takutu-Upper Essequibo; Illia Wau River, 3 days below Kuitaro River mouth (ROM 41530).

An adult male (T = 3×2 mm) was netted at approximately 2000 h about 1 m above the ground along a trail in disturbed alluvial forest near Iwokrama Field Station on 12 April 1997. Additional specimens have been collected by Mr. Stan Brock who obtained an adult female from the Illia Wau River in 1967 and Mr. Baldwin Persaud who netted an adult male in Wallaba (*Eperua* sp.) bush near Bada Creek on 17 October 1973.

This species is documented in northern South America east of the Andes by five specimens from three localities in Peru (Thomas, 1924; Woodman *et al.*, 1991), 34 specimens from three localities in the eastern Amazon basin of Brazil (Sanborn, 1937; Thomas, 1920), and one specimen from Amazonian Colombia (Lenke *et al.*, 1982). Three specimens were reported from two localities in Amazonas, Venezuela (Sanborn, 1937; Ochoa G., 1984), as well as two specimens from two localities in northeastern Suriname (Husson, 1962; Genoways *et al.*, 1981), and twelve specimens from two localities in northern French Guiana (Brosset and Charles-Dominique, 1990; Simmons and Voss, 1998).

Miller (1907) elevated *Peronymus*, with *P. leucopterus* as its only species, to the rank of genus based on a less inflated rostrum, connected ears, and white wings in comparison with *Peropteryx*. Sanborn (1937) distinguished *Peronymus* based on a relatively broader rostrum and larger pterygoid pits at the anterior end of the basisphenoid pit. The taxon was synonymized with *Peropteryx* by Cabrera (1958) without explanation. Simmons and Voss (1998) followed this synonymy because the taxa share a unique antebrachial wing sac morphology, and the white wing membranes of *P. leucoptera* constitute a uniquely derived character. Based on hyoid morphology, Griffiths and Smith (1991) suggested a sister-taxa relationship based on two shared unique hyoid features; however, they retained *Peropteryx*

and *Peronymus* as separate genera without further comment.

### Family Phyllostomidae

#### *Micronycteris brosseti* Simmons and Voss, 1998

Specimens examined (2). — Potaro–Siparuni; Three Mile Camp (KU 155162; ROM 111469).

One adult male (T = 2×1 mm) and one non-pregnant adult female were caught in a mist net set in terra firme forest at Three Mile Camp on 24 March 1997.

*Micronycteris brosseti* was recently described from French Guiana with other specimens known from eastern Peru and southeastern Brazil (Simmons and Voss, 1998). Our two specimens from Guyana have pale grey ventral fur, short hairs on the leading edge of the ears, and a calcar longer than the hindfoot. It is the smallest *Micronycteris* presently known from Guyana.

We collected a single species of batfly, *Strebla alvarezzi* Wenzel, 1966 (Diptera: Streblidae) from *M. brosseti*. This poorly known batfly seems to be associated with bats of the genus *Micronycteris* (Wenzel *et al.*, 1966), although this is the first report of a parasite from *M. brosseti*.

#### *Micronycteris microtis* Miller, 1898

Specimens examined (4). — Potaro–Siparuni; Clearwater Camp (ROM 107354); Three Mile Camp (ROM 107172); Kurupukari (ROM 98159); Upper Takutu–Upper Essequibo; Gunn's Strip (ROM 106788).

One non-pregnant adult female was caught in a ground-level mist net in terra firme forest near Kurupukari on 20 October 1990. Three adult males, all with T = 2×1 mm, were caught in mist nets. One was netted near the village of Gunn's Strip on 23 November 1996, another was caught in a

canopy-level net at Three Mile Camp on 22 March 1997, and the third was caught at Clearwater Camp on 3 April 1997.

*Micronycteris microtis* was initially described as a new species known from only the holotype (Miller, 1898). Andersen (1906), however, questioned the validity of the condition of the ear as a diagnostic character and synonymized it under *M. megalotis*. With a larger sample size, Simmons (1996) found the taxa occurring sympatrically in Colombia, Venezuela, French Guiana, and Brazil, with the length of fur on the leading edge of the ear distinguishing the two species (*M. microtis* < 4 mm). We tentatively follow this taxonomic arrangement but note that this character is variable. Identifications are especially difficult given that, 'no consistent differences in craniodental measurements or fur colour were found when large samples of *megalotis* and *microtis* from many different localities were compared' (Simmons and Voss, 1998: 76). We did not find the features listed by Simmons and Voss (1998) for distinguishing sympatric species in French Guiana to be completely reliable in differentiating these taxa in Guyana.

As currently defined, *M. microtis* is distributed from southern Mexico to Amazonian Brazil (Simmons, 1996). It has been reported from throughout southern Venezuela (Handley, 1976) and French Guiana (Brosset *et al.*, 1996; Simmons, 1996). *Micronycteris megalotis* has been reported from Suriname (Husson, 1962; Genoways and Williams, 1986), but Brosset and Charles-Dominique (1990) consider the specimens listed in Husson (1962) to be referable to *M. microtis* based on the published measurements. The distinction used by Brosset and Charles-Dominique (1990) of length of ear for *M. megalotis* averaging 20 mm and 15 mm for *M. microtis*, however, is greater than the 22 mm versus 20 mm difference reported in Simmons (1996).

*Tonatia carrikeri* (J. A. Allen, 1910)

Specimens examined (9).—Potaro–Siparuni; Clearwater Camp (KU 155249–155251; ROM 107391, 107392); Three Mile Camp (ROM 107190; UG/CSBD M156); Iwokrama Field Station (KU 155252; ROM 107461).

A non-pregnant adult female and an adult male (T = 11×7 mm) were caught in a canopy net set within terra firme forest at Three Mile Camp on 24 March 1997. Two non-pregnant adult females were netted on 31 March and 2 April 1997, a lactating female and a male (T = 4×2 mm) were netted on 6 April 1997, and a pregnant female (CR = 25 mm) was netted on 8 April 1997 at Clearwater Camp. Two non-pregnant adult females were netted in alluvial forest near the Iwokrama Field Station on 12 April 1997.

As summarized by McCarthy *et al.* (1992), *T. carrikeri* is found in northern South America east of the Andes from northern Bolivia, eastern Peru, Colombia, southern Venezuela, Suriname, and northern Brazil. More specifically, there are five reported localities from southern Venezuela, three for Suriname, and one specimen from Roraima State in Brazil between southern Venezuela and Guyana. The specimen from Guyana reported by Swanepoel and Genoways (1979) as *T. carrikeri* (ROM 67468) actually is *T. schulzi* (McCarthy *et al.*, 1992).

Our nine specimens from Guyana and the two reported from French Guiana (Brosset *et al.*, 1996; Simmons and Voss, 1998) indicate that *T. carrikeri* is distributed throughout the Guianan region. *Tonatia carrikeri* is the only species in the genus with a pure white venter (McCarthy *et al.*, 1992), although older individuals of *T. schulzi* tend to have paler, almost white, bellies (Simmons and Voss, 1998).

## Family Vespertilionidae

*Lasiurus atratus* Handley, 1996

Specimens examined (1). — Potaro–Siparuni; Three Mile Camp (ROM 107228).

A non-pregnant adult female was caught in a canopy net set over the road within terra firme forest at Three Mile Camp on 27 March 1997.

This species was recently described based on the holotype from Suriname, 15 specimens from two localities in southern Venezuela, and another reported specimen from French Guiana (Handley, 1996). Our specimen from Guyana has black wings, reddish fur, and the range of measurements falls within those reported in Handley (1996) except for greatest length of skull and forearm, which are both slightly larger. *Lasiurus egregius* is larger still, with well developed lachrymal and supraorbital processes that are lacking or poorly developed in *L. atratus*. As presently known, *L. atratus* is the only species of bat that is considered endemic to the Guianan subregion.

*Myotis riparius* Handley, 1960

Specimens examined (18). — Potaro–Siparuni; Clearwater Camp (ROM 107278); Surama Sawmill (ASNHC 9016–9018, 9020; ROM 103133, 103136, 103138, 103150; UG/CSBD M305; USNM F36598, F36604, F36605; these last three specimens have their field numbers reported as cross references because they have not been officially deposited at the USNM); Kurupukari (BMNH 1997.42; Smith and Kerry, 1996); 30 km NE of Surama (ROM 98056). Upper Takutu–Upper Essequibo; Chodikar River (ROM 106580); 7 km S of Gunn's Strip (ROM 106751); Gunn's Strip (ROM 106773).

An adult male (T = 8×5 mm) was caught in a ground-level mist net set in forest 30 km NE of Surama on 11 October 1990. Twelve

individuals were found roosting in a small crack and hollow in a branch of a 15 cm diameter tree felled by local inhabitants near Surama Sawmill on 25 July 1994. All were adults except for one juvenile male. Testes measurements for six adult males ranged from 7×5 to 10×8 mm, and two of five females were pregnant with CR of 14 and 20 mm. One lactating adult female was caught in a ground-level mist net set in the forest beside standing water in an intermittent stream near the Chodikar River on 30 October 1996. Another lactating adult female was caught in a ground-level mist net beside a creek about 7 km S of Gunn's Strip near the Essequibo River on 17 November 1996. An adult male (T = 8×6 mm) was caught in a ground-level mist net set at Gunn's Strip on 21 November 1996. A pregnant female (CR = 11 mm) was caught in a mist net at Clearwater Camp on 31 March 1997.

*Myotis riparius* is widely distributed from Honduras to northern Uruguay (LaVal, 1973). It has been reported from throughout southern Venezuela (Handley, 1976) and French Guiana (Brosset and Charles-Dominique, 1990; Simmons and Voss, 1998) but not from Suriname although it is most surely also found there. The colour of the fur is quite variable, ranging from light grey-brown to dark red-brown to black-brown, making it difficult to distinguish some individuals from *M. nigricans* in the field. *Myotis albescens*, however, has a distinctive frosting on the tips of its fur which distinguishes it from the other two sympatrically-occurring congeners in Guyana. Nevertheless, the skull of *M. riparius* has a sagittal crest, and the second upper premolar is minute, usually less than one-fourth the height of the first premolar (LaVal, 1973). On average, *M. riparius* is larger than *M. nigricans* and *M. albescens*, with the zygomatic breadth (> 8.7 mm) and breadth across upper canines (> 3.7 mm) consistently larger. Additional characters useful in identi-

fying neotropical *Myotis* are given in Timm and LaVal (1998).

## DISCUSSION

Although the Royal Ontario Museum (ROM) collected in the Iwokrama Forest area in 1990, no published reports of mammals from this region existed until Smith and Kerry (1996) listed 36 species of bats as part of a biodiversity survey by the Open University in 1992. They also included an additional nine species based on an unpublished preliminary field report made by the ROM in 1990, bringing the total to 45 species of bats. Smith and Kerry (1996) extrapolated beyond their biodiversity survey of Iwokrama Forest and reported 96 species of bats from Guyana based primarily on literature references. This total is reduced by one because, as discussed in Goodwin (1959), a single specimen from New Amsterdam in Guyana that was originally identified as *Natalus stramineus*, and cited in Jentink (1893), Young (1896), Beebe (1919), and Sanborn (1941), actually is referable to *Furipterus horrens*, a previously reported species from Guyana. Twelve of the 50 country records listed by Smith and Kerry (1996) from outside Iwokrama Forest were based on material that had not been recently reviewed (Parker *et al.*, 1993). In addition to species listed by Smith and Kerry (1996), as part of the description of *Artibeus gnomus*, Handley (1987) mentioned specimens of this species from Guyana. *Molossus pretiosus* also has been reported from Guyana (Koopman, 1993, 1994). Our new records bring the currently known bat fauna of Guyana to 107 species. In addition, there are 29 new species records for Iwokrama Forest bringing the total number of bats in this area to 74 species (B. K. Lim and M. D. Engstrom, unpubl. data). The chiropteran diversity of Iwokrama Forest represents about 69% of the total bat diversity in Guyana, a larger proportion than the 43% reported by

Smith and Kerry (1996). Preliminary work on the second Iwokrama Faunal Survey and on older collections alluded to by Parker *et al.* (1993) suggests that additional species may occur in Iwokrama Forest and in Guyana.

Interestingly, the ten new species recorded in Guyana are primarily insect feeding bats. Seven are considered aerial insectivores, and three are gleaners. *Micronycteris microtis* is probably relatively common in museum collections but is cryptic and difficult to distinguish from *M. megalotis*. *Myotis riparius* is also commonly captured, but the remaining eight species are not well represented in collections. Our success in using non-traditional collecting techniques for bats such as large nets set high in the mid to upper canopy and shotguns indicates the need to supplement ground-level nets to attain a more complete inventory of species richness (Voss and Emmons, 1996; Simmons and Voss, 1998). Likewise, estimates of relative abundances of species of bats can be greatly biased by survey techniques. For example, prior to this study *D. isabellus* was considered rare, but is actually locally common. As suggested by our study, the diversity of aerial insectivores in particular is underestimated by the traditional technique of setting nets only 1–3 m above the ground.

## GAZETTEER

Bada Creek, 5°35'N, 58°08'W, 50 m a.s.l.;  
 Chodikar River, 1°22'N, 58°46'W, 240 m a.s.l.;  
 Clearwater Camp, 4°44'N, 58°51'W, 90 m a.s.l.;  
 Georgetown, 6°48'N, 58°10'W, at sea level;  
 Gunn's Strip, 1°39'N, 58°38'W, 240 m a.s.l.;  
 Gunn's Strip, 7 km S, 1°35'N, 58°38'W, 240 m a.s.l.;  
 Illia Wau River, 2°40'N, 58°40'W, —;  
 Iwokrama Field Station, 4°40'N, 58°41'W, 70 m a.s.l.;  
 Kurupukari, 4°40'N, 58°40'W, 70 m a.s.l.;  
 Pakatau Falls, 4°45'N, 59°01'W, 90 m a.s.l.;  
 Surama, 30 km NE, 4°20'N, 58°51'W, 70 m a.s.l.;  
 Surama Sawmill, 4°06'N, 59°03'W, 80 m a.s.l.;  
 Three Mile Camp, 4°38'N, 58°43'W, 75 m a.s.l.

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## LITERATURE CITED

- ANDERSEN, K. 1906. On the bats of the genera *Micronycteris* and *Glyphonycteris*. *Annals and Magazine of Natural History*, 7(18): 50–65.
- BEEBE, W. 1919. Higher vertebrates of British Guiana with special reference to the fauna of Bartica District. *Zoologica*, 2: 205–227.
- BROSSET, A., and P. CHARLES-DOMINIQUE. 1990. The bats from French Guiana: a taxonomic, faunistic and ecological approach. *Mammalia*, 54: 509–560.
- BROSSET, A., P. CHARLES-DOMINIQUE, A. COCKLE, J.-F. COSSON, and D. MASSON. 1996. Bat communities and deforestation in French Guiana. *Canadian Journal of Zoology*, 74: 1974–1982.
- CABRERA, A. 1958. Catálogo de los mamíferos de América del Sur. *Revista del Museo Argentino de Ciencias Naturales "Bernardino Rivadavia"*, *Ciencias Zoológicas*, 4(1): 1–307.
- CEBALLOS, G., and R. A. MEDELLÍN. 1988. *Diclidurus albus*. *Mammalian Species*, 316: 1–4.
- EISENBERG, J. F. 1989. *Mammals of the Neotropics*, Vol. 1: the northern Neotropics: Panama, Colombia, Venezuela, Guyana, Suriname, French Guiana. University of Chicago Press, Chicago, x + 449 pp.
- GENOWAYS, H. H., and S. L. WILLIAMS. 1979. Records of bats (Mammalia: Chiroptera) from Suriname. *Annals of Carnegie Museum*, 48: 323–335.
- GENOWAYS, H. H., and S. L. WILLIAMS. 1986. Results of the Alcoa Foundation-Suriname expeditions. XI. Bats of the genus *Micronycteris* (Mammalia: Chiroptera) in Suriname. *Annals of Carnegie Museum*, 55: 303–324.
- GENOWAYS, H. H., S. L. WILLIAMS, and J. A. GROEN. 1981. Results of the Alcoa Foundation-Suriname expeditions. V. Noteworthy records of Surinamese mammals. *Annals of Carnegie Museum*, 50: 319–332.
- GOODWIN, G. G. 1959. Bats of the subgenus *Natalus*. *American Museum Novitates*, 1977: 1–22.
- GRIFFITHS, T. A., and A. L. SMITH. 1991. Systematics of emballonuroid bats (Chiroptera: Emballonuridae and Rhinopomatidae), based on hyoid morphology. Pp. 62–83, in *Contributions to mammalogy in honor of Karl F. Koopman* (T. A. GRIFFITHS and D. KLINGENER, eds.). *Bulletin of the American Museum of Natural History*, 206: 1–432.
- HANDLEY, C. O., JR. 1976. Mammals of the Smithsonian Venezuelan Project. *Brigham Young University Science Bulletin, Biological Series*, 20(5): 1–91.
- HANDLEY, C. O., JR. 1987. New species of mammals from northern South America: fruit-eating bats, genus *Artibeus* Leach. Pp. 163–172, in *Studies in Neotropical mammalogy: essays in honor of Philip Hershkovitz* (B. D. PATTERSON and R. M. TIMM, eds.). *Fieldiana, Zoology* (N. S.), 39: vii + 1–506.
- HANDLEY, C. O., JR. 1996. New species of mammals from northern South America: bats of the genera *Histiotus* Gervais and *Lasiurus* Gray (Chiroptera: Vespertilionidae). *Proceedings of the Biological Society of Washington*, 109: 1–9.
- HAWKES, M. D., and J. R. D. WALL. 1993. The Commonwealth and Government of Guyana Iwokrama Rain Forest Programme, Phase 1, Site Resource Survey, Main Report. *Natural Resources Institute*, Chatham, UK, 181 pp.
- HERNÁNDEZ-CAMACHO, J. 1955. Una nueva especie colombiana del género *Diclidurus* (Mammalia: Chiroptera): *Diclidurus ingens*. *Caldasia*, 7: 87–98.
- HUSSON, A. M. 1962. The bats of Suriname. *Zoologische Verhandelingen*, 58: 1–282.
- HUSSON, A. M. 1978. The mammals of Suriname. *Zoologische Monographiën van het Rijksmuseum van Natuurlijke Historie*, 2: 1–569.
- JENTINCK, F. A. 1893. On a collection of bats from the West-Indies. *Notes of the Leyden Museum*, 15: 278–283.

- KOOPMAN, K. F. 1993. Order Chiroptera. Pp. 137–241, in *Mammal species of the world: a taxonomic and geographic reference*. 2nd ed. (D. E. WILSON and D. M. REEDER, eds.). Smithsonian Institution Press, Washington, D.C., xviii + 1206 pp.
- KOOPMAN, K. F. 1994. Chiroptera: systematics. *Handbuch der Zoologie, Vol. VIII (Mammalia)*, 60: 1–217.
- LAVAL, R. K. 1973. A revision of the Neotropical bats of the genus *Myotis*. *Natural History Museum of Los Angeles County, Science Bulletin*, 15: 1–54.
- LEMKE, T. O., A. CADENA, R. H. PINE, and J. HERNÁNDEZ-CAMACHO. 1982. Notes on opossums, bats, and rodents new to the fauna of Colombia. *Mammalia*, 46: 225–234.
- MCCARTHY, T. J., A. L. GARDNER, and C. O. HANDLEY, JR. 1992. *Tonatia carrikeri*. *Mammalian Species*, 407: 1–4.
- MCCARTHY, T. J., and J. OCHOA G. 1991. The presence of *Centronycteris maximiliani* and *Micronycteris daviesi* (Chiroptera) in Venezuela. *Texas Journal of Science*, 43: 332–334.
- MILLER, G. S., JR. 1898. Descriptions of five new phyllostome bats. *Proceedings of the Academy of Natural Sciences of Philadelphia*, 50: 326–337.
- MILLER, G. S., JR. 1907. The families and genera of bats. *Bulletin of the United States National Museum*, 57: 1–282.
- NAGORSEN, D. W., and R. L. PETERSON. 1980. *Mammal collectors' manual: a guide for collecting, documenting, and preparing mammal specimens for scientific research*. Life Sciences Miscellaneous Publications, Royal Ontario Museum, 79 pp.
- OCHOA G., J. 1984. Nuevo hallazgo de *Peronymus leucopterus leucopterus* en Venezuela (Chiroptera: Emballonuridae). *Acta Científica Venezolana*, 35: 160–161.
- OCHOA G., J. 1995. Los mamíferos de la región de Imataca, Venezuela. *Acta Científica Venezolana*, 46: 274–287.
- OCHOA G., J., P. J. SORIANO, D. LEW, and M. OJEDA C. 1993. Taxonomic and distributional notes on some bats and rodents from Venezuela. *Mammalia*, 57: 393–400.
- OJASTI, J., and O. J. LINARES. 1971. Adiciones a la fauna de murciélagos de Venezuela con notas sobre las especies del género *Diclidurus* (Chiroptera). *Acta Biológica Venezolánica*, 7: 421–441.
- PACHECO, V., H. de MACEDO, E. VIVAR, C. ASCORRA, R. ARANA-CARDÓ, and S. SOLARI. 1995. Lista anotada de los mamíferos peruanos. *Occasional Papers in Conservation Biology, Conservation International*, 2: 1–35.
- PARKER, T. A., III, R. B. FOSTER, L. H. EMMONS, P. FREED, A. B. FORSYTH, B. HOFFMAN, and B. D. GILL. 1993. A biological assessment of the Kanuku Mountain region of southwestern Guyana. *Rapid Assessment Program Working Papers, Conservation International*, 5: 1–70.
- SANBORN, C. C. 1937. American bats of the subfamily Emballonurinae. *Zoological Series, Field Museum of Natural History*, 20: 321–354.
- SANBORN, C. C. 1941. Descriptions and records of Neotropical bats. *Zoological Series, Field Museum of Natural History*, 27: 371–387.
- SIMMONS, N. B. 1996. A new species of *Micronycteris* (Chiroptera: Phyllostomidae) from northeastern Brazil, with comments on phylogenetic relationships. *American Museum Novitates*, 3158: 1–34.
- SIMMONS, N. B., and C. O. HANDLEY, JR. 1998. A review of *Centronycteris* Gray (Chiroptera: Emballonuridae) with notes on natural history. *American Museum Novitates*, 3239: 1–28.
- SIMMONS, N. B., and R. S. VOSS. 1998. The mammals of Paracou, French Guiana: a neotropical lowland rainforest fauna, Part 1, bats. *Bulletin of the American Museum of Natural History*, 237: 1–219.
- SMITH, P. G., and S. M. KERRY. 1996. The Iwokrama Rain Forest Programme for sustainable development: how much of Guyana's bat (Chiroptera) diversity does it encompass? *Biodiversity and Conservation*, 5: 921–942.
- SWANEPOEL, P., and H. H. GENOWAYS. 1979. Morphometrics. Pp. 13–106, in *Biology of bats of the New World family Phyllostomatidae, Part III* (R. J. BAKER, J. K. JONES, JR., and D. C. CARTER, eds.). Special Publications, The Museum, Texas Tech University, 16: 1–441.
- THOMAS, O. 1920. On mammals from the lower Amazons in the Goeldi Museum, Para. *Annals and Magazine of Natural History*, 9(6): 266–283.
- THOMAS, O. 1924. On a collection of mammals made by Mr. Latham Rutter in the Peruvian Amazons. *Annals and Magazine of Natural History*, 9(13): 530–538.
- TIMM, R. M., and R. K. LAVAL. 1998. A field key to the bats of Costa Rica. *Occasional Publication Series, Center of Latin American Studies, The University of Kansas*, 22: 1–30.
- VOSS, R. S., and L. H. EMMONS. 1996. Mammalian diversity in Neotropical lowland rainforests: a preliminary assessment. *Bulletin of the American Museum of Natural History*, 230: 1–115.
- WENZEL, R. L., V. J. TIPTON, and A. KIEWLICZ. 1966. The streblid batflies of Panama (Diptera Calyptridae: Streblidae). Pp. 405–675, in *Ectoparasites*

- of Panama (R. L. WENZEL and V. J. TIPTON, eds.). Field Museum of Natural History, Chicago, xii + 861 pp.
- WILLIAMS, S. L., H. H. GENOWAYS, and J. A. GROEN. 1983. Results of the Alcoa Foundation-Suriname expeditions. VII. Records of mammals from central and southern Suriname. *Annals of Carnegie Museum*, 52: 329-336.
- WOODMAN, N., R. M. TIMM, R. ARANA C., V. PACHECO, C. A. SCHMIDT, E. D. HOOPER, and C. PACHECO A. 1991. Annotated checklist of the mammals of Cuzco Amazónico, Peru. *Occasional Papers of the Museum of Natural History, University of Kansas*, 145: 1-12.
- YOUNG, C. G. 1896. Note on Berbice bats. *Timehri (N. S.)*, 10: 44-46.

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