Bats of the Potaro Plateau region, western Guyana

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ABSTRACT
This paper present species records and inferable habitat preferences of a total of 35 bat species in 25 genera that were captured during three separate studies on the Potaro Plateau, western Guyana. One, *Carollia castanea*, is a new country record. Reproductive data is presented for seven species. Measurements and habitat data given for *Platyrrhinus aurarius*, a little-known species. The composition of the Potaro Plateau bat community is contextualized by comparison with 13 other sites in the north-east South America. A map shows all known bat collection localites in Guyana, for which a gazetteer provides supporting information.

KEY WORDS
Chiroptera,
Guyana,
Potaro,
Platyrrhinus,
Carollia castanea,
ecology,
distribution.

RÉSUMÉ

Les chauve-souris du Plateau de Potaro en Guyane occidentale.

Ce travail recense la présence et l'habitat de 35 espèces et 25 genres de chauve souris capturées au cours de trois sessions différentes sur le Plateau de Potaro (Guyane occidentale). La présence de *Carollia castanea* est nouvelle pour le pays. Les données de la reproduction sont présentées pour 7 espèces. La biométrie et l'habitat sont précisés pour *Platyrrhinus aurarius*, espèce peu connue. La composition de la communauté de chauve-souris du plateau de Potaro est comparée à 13 autres sites du Nord-Est de l'Amérique du Sud. Une carte montre toutes les localités de collecte pour la Guyane, elle est accompagnée d'un gazetter.

MOTS CLÉS
Chiroptera, Guyana, Potaro, *Platyrrhinus*, *Carollia castanea*, écologie, distribution.

INTRODUCTION

Though rich in species, the bat fauna of Guyana is comparatively little known (Table 1). Recent bat research has been concentrated in the lowland site of Iwokrama (see Smith & Kerry 1996; Lim & Engstrom 2001). There are scattered reports of work from elsewhere in the country, much of it a half-century old or more. In many areas of Guyana the chiropterofauna remains unsurveyed (Fig. 1; Appendix 1).

One area from which no bat surveys appear to have been published is the Potaro Plateau, western Guyana (Fig. 2). The plateau covers an area of some 11,655 ha (Schüerholtz 1991; Parker *et al.* 1993). It forms the eastern-most extension of the Guayana Highlands (Maguire 1970; Haffer 1974). On the eastern edge of the plateau is the Kaieteur Falls, a popular tourist destination (Schüerholtz 1991; Anderson 1996; World Bank 1998), one of Guyana's two National Parks, and the only part of the Plateau to receive any intensive scientific study (Kelloff & Funk 1998; Funk *et al.* 1999).

Here we report on three bat surveys, all previously unpublished: one conducted in three separate visits by Adrian Warren between 1968 and 1971, another undertaken in 1989 by Don E. Wilson, and the third made in 1998 as part of the Potaro Plateau Zoological Expedition (PPZE). Together, the surveys cover the lowlands at the base of the plateau, the plateau's main vegetation types and one mountainous area of higher altitude. As far as is known, the three surveys represent the only studies of bats to be conducted on the Plateau and surrounding region (Lim & Engstrom 2000, 2001; M. Engstrom pers. comm.). Although mammal work has been

TABLE 1. — Comparison of number of papers published on bats of six northern South American countries, January 1980-August 2000. **1**, Zoological Records electronic data base, 1980-current (on 15 August, 2000) (fieldwork only, taxonomic and veterinary papers excluded); **2**, Brazil, da Fonseca *et al.* (1996); Colombia, Eisenberg (1989); French Guiana, Simmons *et al.* (2000); Guyana, Lim & Engstrom 2001; Suriname, Williams *et al.* (1983); Venezuela, Linares (1998); **3**, *The Times Atlas of the World* (1985). John Bartholomew & Son, London.

Country	No. papers[1]	No. confirmed bat species[2]	Country area (Km^2) [3]
Brazil	54	141	8,511,965
Colombia	23	154	1,138,915
French Guiana	7	102	91,000
Guyana	6	121	214,970
Suriname	9	96	163,820
Venezuela	19	163	912,045

conducted in the Pakariamas and on Mount Roraima (de Winton 1900; Thomas 1911; Tate 1939), none of these reports included bats. The current paper, therefore, provides a first published list for the bat species present in this part of Guyana, the nearest comparable survey having been conducted by Lim & Engstrom (2000) on the upper Mazaruni River (spot 62, Fig. 1).

Taxonomy follows Koopman (1993) and Simmons & Voss (1998). Order follows Eisenberg & Redford (1999). Habitat descriptions for each study site are presented in Table 2. Data on species, locality, habitat and reproductive status are presented in Table 3. Reproductive data from the 1989 survey is not available.

STUDY SITES AND METHODS

The Potaro Plateau, effectively a huge tepui, has a basal altitude of some 500 m, with additional peaks to over 1200 m (e.g., Mts. Ayanganna 2042 m, Kopinang 1594 m, Wokamung 1470 m, Kowa 1300 m). Like much of the Guayana Highlands, the Plateau consists of pink Proterozoic Roraima Formation sandstone (1600-1800 m.y.b.p.), capped with younger volcanic dolerites (Gansser 1954). The soils, derived solely from these ancient rocks, are old and nutrient-poor (Haffer 1974; Maguire 1970). Vegetation types range from whitesand scrub to flooded riparian forest, basimontane forest, montane forest, upper montane forest, high tepui forest and high tepui scrub (Huber *et al.* 1995; Kelloff & Funk 1998). We report on surveys at nine localities on the Potaro Plateau (Fig. 2).

THE KARISPARU AND ECHERAK SURVEYS, 1968-1971

Adrian N.Warren made three collections of bats on the Potaro Plateau: between 15 July-17 August, 1968, as part of a wider zoological collecting trip within Guyana (Wood 1972); between 14 and 28 August 1969 as part of a zoological expedition that also studied four other lowland sites in Guyana (spots 11 and 13, Fig. 1. See also Appendix 1 and Warren 1969a) and the bats of Trinidad (Warren 1969b); and in June 1971 as a side-project of the of the British Mount Roraima Expedition (Warren 1971).

Two locations were surveyed: the Karisparu savanna and the primary forest around Echerak River (Fig. 2). Karisparu was surveyed in all three visits, Echerak in

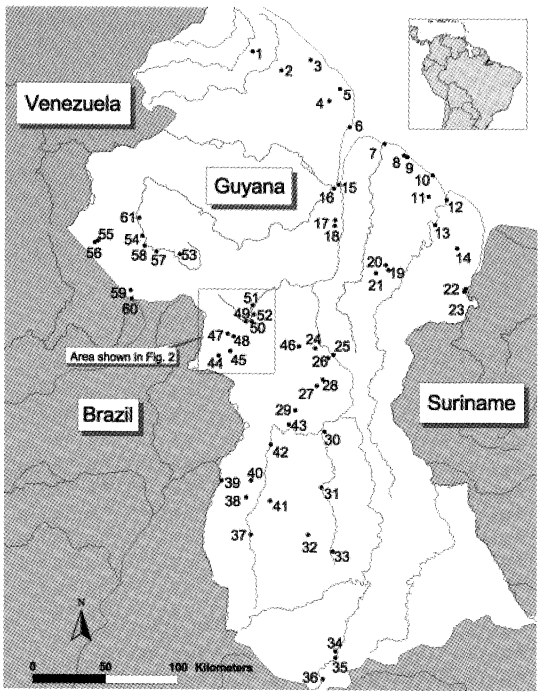

FIG. 1 – Distribution of bats collecting localities in Guyana (see Appendix 1 for sources, key and grid refs).

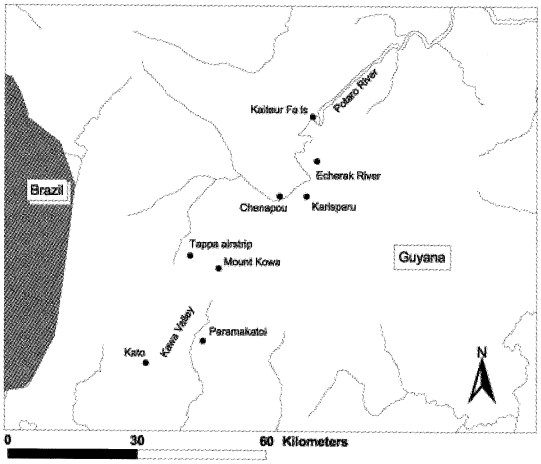

FIG. 2 – Potaro Plateau bat collection localities

TABLE 2. — Site descriptions ; A, the 1968-1971 surveys; B, the 1989 survey; C, the 1998 survey.

A

1) Karisparu Savannah (5°00'N, 59°30'W, 615 m)
open savannah
15-18, 25 July, 6-10 August '68; 14, 17-28 August '69; 1-14 June '71 (part of).
Karisparu is an open 16 x 2 km area of rolling savannah, dissected by narrow gallery forests fringing blackwater rivers and creeks. The vegetation comprised of low shrubs, interspersed with coarse grasses and succulents. Termite mounds are numerous. The site was surrounded by steep, forest-clad escarpments.
2) Echerak River (5°10'N, 59°30'W, 460 m)
Primary lowland montane forest
26-27 August '69, 1-14 June '71 (part of).
The study site was on the Echerak River, close to its junction with the Potaro River. The region has thick primary forest.
3) Other (brief surveys made while *en route* with the British Roraima Expedition, 1971):
Pipilipai, Kukai River (05.43N,60.39W, 609 m): Cave on edge of savannah sampled by dust shot. Human dwellings present.
Makuripai, Kako River (05.45N,60.50W, 762 m): Savannah. Riverine forest.
Upper Waruma River (05.12N,60.50W, 1372 m): Lower montane forest.
Camp 5 (05.10N,60.48W, 1524 m): near Mt. Roraima.

B

1) Paramakatoi (4°42'N, 59°43'W, 210 m)
lowland forest and agricultural habitats.
11-15 March.
Habitat recorded in vicinity include dense/tall forest on brown sand or lateritic clay, pink to red clays.
11, 12, 15 March: stream and riverside forests, cliff base.
13,14 March: banana and mango groves.
2) Kato (approx. 4°39'N, 59°48'W, 260 m)
lowland forest and agricultural habitats.
15-19 March.
Habitats recorded in vicinity include: Dry forest, low to medium height evergreen forest ("mesic"), secondary forest, scrub, savanna with riparian forest in valleys, savanna with forest islands, on pale red clay. The trail between Kato and Paramakatoi has been described as medium to tall forest interspersed with savanna, and as secondary forest and scrub.
16,17,19 March: streamside forest
16, 18 March: banana grove
3) Kaieteur Falls (5°10'N, 59°28'W, 500 m)
lower montane forest.
29-30 March.
A mist-laden environment characterized by giant terrestrial bromeliads (*Brocchinia micrantha*) in open areas, and short (to 8 m) forests of *Distictella elongata* (Bignoniaceae), *Clusia grandifora* and *Morouobea jenmanii* (Guttiferaceae) and *Dicymbe altsonii* (Fab.: Caes.). Nearby there is a large natural area of low open savanna dominated by terrestrial bromeliads with sparse grass cover and occasional trees and shrubs.

C

1) Chenapou village (04°59'N, 59°34'W, 600 m) and surrounding forest.
lower montane forest and agricultural habitats.
567 m^2 net hours over 6 nights, 24, 25, 29, 30 June, 2, 25 July.
The forest around the village (pop. approx. 300) included greenheart (*Ocotea radioi*: Lauraceae), mora (*Dimorphandra mora*) and wallaba (*Eperua* sp.) (both Fab.: Caes.), crabwood (*Carapa guianensis*: Meliaceae), *Caryocar nuciferum* (Caryocaraceae) and species of *Parkia*, *Inga* and *Hymaneia* (Fabaceae). Maximum observed canopy height was 20-25 m. There was a well-developed understory of melastomataceous and rubiaceous shrubs. Vines were large and frequent, the macro-epiphytic cover was moderate and consisted mostly of Araceae. The village has fruit trees and cassava fields, but has not cleared the surrounding forests to a great extent.
29, 30 June, 25 July: agricultural habitats (village houses, banana grove, cashew grove, manioc plots)
24, 25 June, 2 July: riverside forest near village.

2) Others (Tappa airstrip, 04°53'N, 59°32'W, 800 m; Camp 3 04°52'N, 59°37'W, 820 m): Lower montane forest, agricultural habitats.
1117 m^2 net hours combined (2 nights).7 July, 22 July.
All of the following were common to abundant: *Pithecelobium recemosum* (Leg., Mim.), *Eschweilera decolorans* (Lecthyidaceae) (in valley bottoms) *Escweilera pernetorum* (replaces *E. decolorans* on ridges and higher ground) *Eperua falcata* (Fab., Caes.), *Aspidosperma excelsum* (Apocynaceae), *Arrabidaea nigrescens* (Bignoniaceae), *Caryocar nuciferum* (Caryocaraceae). The canopy height was to some 15-20 m. The understory was sparser than at Chenapou, with some well-developed cane breaks. The epiphyte flora was more diverse, with more ferns and more mosses.
3) Mt. Kowa (04°51'N, 59°41'W, 1300 m)
undisturbed upper montane forest
700 m^2 net hours over 6 nights, 11, 12, 14, 15, 17, 19 July.
On the top of Mt. Kowa, the common tree species included: *Eschweilera odorata* (Lecythidaceae), *Spondias mombim* (Anacardiaceae), *Guarea silvatica* (Meliaceae), *Dioclea macrantha* (Leg.: Pap.), *Catostemma fragrans* (Bombacaceae), *Cheiloclinium sp.* (Celastiaceae). The canopy was at some 10-12 m. Epiphyte cover was extensive and rich covering both boles and limbs. It included many small orchids (notably *Lepanthes* and *Pleurothallis*), epiphytic Ericaceae (inc. *Cavendishia* and *Psamisia*) and abundant ferns (inc. Hymenophyllaceae), mosses and lichens. There was an extensive open understory of melastomes, Marantaceae and gesnerid shrubs (including *Alloplectus savannarum*). The air was perpetually misty and the mountain often coated in cloud. Along watercourses *Swartzia grandiflora* (Fab. Pap.) and *Pagamea aff. capitata* (Rubiaceae) were locally abundant. In a low-lying area there was a swamp dominated by itare palm (*Euterpe sp.* (prob. *E. roraimensis*)).

1969 and 1971. On each occasion, mistnets were set from ground level to 3 m, opened at dusk, visited at two-hour intervals until midnight. Nets were revisited after dawn and closed. Captured animals were measured and routinely made into museum specimens. Roosts were searched for and any bats therein caught with hand-nets. Once, bats were shot at a roost with .22 dust shot. All captured individuals, except *Desmodus rotundus*, were made into specimens. Field identifications were confirmed by J. E. Hill at the Natural History Museum, London. A duplicate series of specimens was deposited with the National Museum, Georgetown.
Fieldwork was conducted for 32 nights, yielding 70 individuals captured, and 63 specimens of 16 species in 15 genera. Five species (*Peropteryx macrotis*, *Carollia castanea*, *Vampyressa bidens*, *Artibeus planirostris*, and *Trachops cirrhosus*) were not collected in subsequent surveys.
In addition, ANW conducted brief *en route* bat surveys while part of the 1971 British Mount Roraima Expedition. The data from these localities are included here, and presented in Table 2A and Table 3 under "other" (Fig. 1, collection localities 57, 58, 59 and 60).

The Kato, Paramakatoi, Kaieteur Falls Survey, 1989

In March 1989, DEW surveyed bats in the lowlands below the eastern edge of the plateau and on the Plateau. This survey was mentioned in Lim & Wilson (1993: 767), but is reported here in full.
Between 11 and 19 March surveys were conducted in three habitat types in the Kawa Valley, in and around the villages of Kato and Paramakatoi (Fig. 2). Around Paramakatoi forest is dense tall, but often degraded, forest. Kato, on the forest/savanna border, has savanna, gallery low- to medium-height evergreen forest, and secondary vegetation. Mistnets were set in a representative variety of habitats, including degraded and little-visited forest, streamsides, rocky gullies and cliff-faces, groves of banana and fruit trees, and around human habitations.
On 29 and 30 March 1989, nets were erected near Kaieteur Falls, an area of the Potaro Plateau not covered by the other two surveys. Between 1989 and 1998, taking specimens in Kaieteur National Park was prohibited, hence this work in 1989 is particularly valuable. Netting was restricted to the low (6 m), moist *Dicymbe-Distictella-Clusia* forests directly adjacent to the falls (elevation: 500 m). The open, whitesand-scrub vegetation nearby was not netted. At all sites, nets were opened at dusk and attended for several hours, after which they were left open. Nets were revisited just after dawn and then closed. Captured animals were removed,

measured and routinely made into museum specimens. Field identifications were confirmed at the Smithsonian Institution collections in Washington, D.C.

This study caught 175 individuals of 25 species in 19 genera. Over 11 nights of mist-netting, 143 individuals of 20 species in 15 genera were caught at lower altitudes (elevations: 210-260 m) and 32 individuals of 11 species from 10 genera were caught at Kaieteur. Six species in six genera were common to both.

The Chenapou-Mt. Kowa Survey, 1998

The PPZE survey took place between June 20 and August 3, 1998. Eight habitat types were surveyed over four sites (see Table 2C), ranging from 500 m to the top of Mount Kowa (1300 m), north of Kawa Valley (Fig. 2).

Prior to netting, local residents were interviewed to identify suitable roosts and flyways. Bats were captured using one horizontal 6 m x 2.6 m and one horizontal 9 m x 2.6 m mist net (greatest length set horizontally), and two 9 m x 3 m canopy nets (Avinet, New York, USA: set with the greatest length vertically). These were either suspended *in-situ* from vegetation to a height of 10 m, or elevated to heights of 6-8 m, using a rig modified from Gardner *et al.* (1989: see Shapley *et al.* 2001). Nets were positioned in probable flight corridors of forest clearings, watercourses, edges of agricultural land, around fruit trees and domestic animal pens, by roosts in buildings and at the entrance to a small cave.

Nets were attended continuously while open. Captured bats were removed, placed in a soft cloth drawstring bag and then processed. Standard measurements were taken from each bat following Simmons & Voss (1998). Age class was judged by the status of the phalangeal epiphyses (Cosson *et al.* 1993). Additional information for identification was taken as required. This included such measurements as length of tibia, length of fur at nape, observations on pelage, colour banding of pelage or hairiness of tail membrane.

Bats were identified in the field using Eisenberg (1989), Emmons & Feer (1997), Reid (1997), and Lim (unpublished). Whenever a bat could be satisfactorily identified to species, it was released. Bats not identifiable in the field were collected as specimens. Export permits were obtained from the Environmental Protection Agency of Guyana. Specimens were identified through comparison with the collections at the Smithsonian Institution, and with the kind assistance of the late Charles O. Handley, Jr. and Renato Gregorin (U. São Paulo). All specimens and deposited at the Centre for the Study of Biological Diversity, University of Guyana.

Sixty two bats of 13 species were captured and observed in the hand. Fifty-seven of these were caught during netting efforts (2414 m^2 net hours over 14 nights), four were caught with a mist net suspended across a cave mouth, and one was caught by hand. In addition, there were sightings of *Noctilio* (*leporinus*), *Diclidurus* sp., and *Saccopteryx* (*canescans*).

OBSERVATIONS

Species-specific observations

Peropteryx macrotis

Four individuals were caught emerging from roosts. These were either under over-hanging roosts in open-savanna or in a cave formed by a jumble of large boulders. Brosset & Charles-Dominique (1990) and Charles-Dominique *et al.* (2001) record a similar roosting habitat in French Guiana.

Phyllostomus elongatus

In 1969, 12 individuals were taken over two nights from a roost in a hollow tree near a river in primary forest. The entrance was a long, wide split some 3 m above the ground. All individuals were males (possibly young and/or non-harem holding males: see Kunz *et al.* 1998).

Carollia castanea

Listed as "Possible" by Smith & Kerry (1996), who apparently overlooked the Natural History Museum, London specimen (1971.116) collected

by ANW at Echerak on 26 August 1969. *Contra* Eisenberg (1989), this species has not been recorded before in the Guyanas (see Brosset & Charles-Dominique 1990 for French Guiana; Genoways & Williams 1979 for Suriname; Lim & Engstrom 2001 for the Guyanas as a whole). Measurements for the specimen (a non-reproductive female), lie within the range of measurements of *C. castanea* (see Pine 1972; Eisenberg 1989), and are as follows (mm): HB 50; T 11; HF 10; E 17; FA 35. *Carollia castanea* is a species of dense forest (Handley 1976), and appears not to favour secondary habitats as does *C. perspicillata.*

Vampyressa bidens
Caught at 2 m, in a net spanning a stream in a patch of trees bounded on two sides by open savannah on 17 August 1969. Measurements (mm): HB 45.2; T -; HF 10.8; E 13.5; FA 35.5. Although unreported at the time, when captured this constituted the second record for the country. The first was netted near Bartica in 1963 by J.N. Davies (spot 18 on Fig. 1), as reported by Hill (1964). It is now known from several widely-spread sites in Guyana (see Smith and Kerry 1996). Charles-Dominique *et al.* (2001) believe *V. bidens* to be rare in the Guyanas, where only a handful of specimens have been reported. It appears to be a primary forest specialist (e.g., Ochoa-G. *et al.* 1988; Kalko & Handley 2001). The *Vampyressa* sp. individual listed in Table 3 may well also have been of this species, but unfortunately escaped before full identification could be made.

Sturnira lilium
Patches of yellow-red colour were noted in the fur on the shoulders of several adult female *S. lilium.* This is counter to the general assertion that it is only the adult males of the genus that possess the shoulder glands from which the fur-staining secretions originate (e.g., see Husson 1978; Reid 1997; Eisenberg & Redford 1999).

Sturnira tildae
The seven animals caught at Chenapou were all netted in one short period (< 40 minutes) in one portion of a mist set close to the ground in the village orange grove. The spatial and temporal clumping indicates that this species has habitual, highly-used flying pathways or may forage in groups. This has been observed for several other phyllostomids (e.g., see Heithaus *et al.* 1975). In contrast, *S. lilium* is believed to forage singly (Heithaus *et al.* 1975; Charles-Dominique *et al.* 2001).

Tonatia silvicola
The presence of this species on Mt. Kowa (1300 m) is unusual since, according to Eisenberg & Redford (1999), it is rare for any of the region's five *Tonatia* species to be found above 460 m.

Platyrrhinus aurarius
Four individuals were netted from a colony of 10 *P. aurarius* in a shallow pocket cave on the steep sides of Mount Kowa, a few meters from the top. It was a large overhang 2-3 m deep and 3 m high at the entrance and contained the source of a stream. Five other individuals were caught in mist nets in the early evening while they flew low in the forest.
There was notable variation in the intensity and colour of the facial stripes. For the three males, and one female, these were buffy to reddish-ginger. In four others they were white, but varied in their distinctness. Sanborn (1955) also remarked that facial stripes vary greatly in intensity within species of this genus. One near-melanistic individual was netted. It had almost no lower facial stripe and also lacked the yellow ear tips of the other specimens.
This species is infrequent in collections and appears to be a montane forest specialist, being known only from altitudes between 1000-1400 m (Eisenberg 1989). Our measurements (Table 4) correspond closely to those given by Handley & Ferris (1972) in the original description of the species from Amazonas State, Venezuela, and those for a specimen from Mazaruni, Guyana (Lim & Engstrom 2000). The habitat appears typical, closely resembling that described by Williams *et al.* (1983) for *P. aurarius*

TABLE 3. — Bats captured on the Potaro Plateau, by location and habitat. Numbering of sites as in Table 2. **Sites**, 1969-1971: **A1**, Karisparu; **A2**, Echerak; **A3**, other sites. 1989: **B1**, Paramakatoi; **B2**, Kato; **B3**, Kaieteur Falls.1998: **C1**, Chenapou; **C2**, Mt. Kowa; **C3**, other sites. **Habitats: sav.**, savanna; **lmf**, lower montane forest; **ag.**, Agricultural; **lrf**, lowland rainforest; **umf**, upper montane forest. Captures are given as N°. females, then N°. males. Any third numeral indicates the number of juvenile or unsexed bats. **Codes** in parentheses: **P**, pregnant, **L**, lactating, **C**, carrying young, **S**, scrotal testes, **J**, juvenile, **U**, unsexed. **X**, present (only presence/absence data available). ‡ indicates a record not validated with a specimen. **Obs.**, observation only. **Rep.**, reported in interviews. **Notes**, **1**, *Carollia brevicauda* was distinguished from *C. perspicillata* by its shorter forearm length and lighter body weight.; **2**, *Sturnira lilium* was distinguished by overall size from *S. tildae,* with *S. ludovici* being unlikely at such higher altitudes. Additionally, characters of the ear and fur distinguish *S. tildae* from *S. ludovici* (see Eisenberg 1989).

	Sites	**A1**	**A2**	**A3**	**B1**		**B2**	
Species	**Habitat**	**sav.**	**lmf**	**various**	**ag.**	**lrf**	**ag.**	**lrf**
Rhynchonycteris naso				X				
Saccopteryx sp.								
Cormura brevirostris		2C, 0, 2J	2,1					
Peropteryx macrotis		3,4(1J),1U						
Diclidurus sp.								
Noctilio sp.								
Pteronotus parnelli								
Pteronotis gymnonotus								1,1
Tonatia silvicola								
Phyllostomus elongatus			0,6					
Phyllostomus hastatus							1,0	0,1
Trachops cirrhosus		1,0‡						
Vampyrum spectrum				Obs.				
Glossiphaga commissarissi								0,1
Glossiphaga longirostris						0,1		
Glossiphaga soricina		7 (3P),1			0,1			
Lionycteris spurelli		0,2						0,1
Lonchophylla thomasi								
Anoura geoffroyi		3,0			1,1	1,1	1,1	
Choeroniscus godmani						0,1		1,0
Choeroniscus minor					1,0			
Carollia brevicauda								
Carollia castanea			1,0					
Carollia perspicillata		3,1		X	5,7	6,6	0,1,11U	7,6
Rhinophylla pumilio			1,0	X				
Sturnira tildae		2,0				0,1		
Sturnira lilium					1,1	12,2	2U	67,1,2U
Uroderma bilobatum		4,0,1U			1,5		0,1	
Platyrrhinus aurarius								
Vampyressa bidens		1						
Vampyressa sp.								
Artibeus amplus					1,0	3,1	0,1,5U	9,3
Artibeus cinereus		1,2		X	0,1		0,1	1U
Artibeus planirostris		2,2		X				
Desmodus rotundus		1,4						2,1
Myotis nigricans		2,0		X		1,0		
Eptesicus furinalis								1,0
Molossus ater								1,0
Molossus molossus				X				
Eumops auropendulus								1,0

	Sites	B3	C1		C2	C3
Species	**Habitat**	**lmf**	**ag.**	**lmf**	**lmf**	**umf**
Rhynchonycteris naso				1‡,0		
Saccopteryx sp.						Obs.
Cormura brevirostris		1,0				
Peropteryx macrotis						
Diclidurus sp.						Rep.
Noctilio sp.						Rep.
Pteronotus parnelli		0,1				
Pteronotis gymnonotus						
Tonatia silvicola					0,1	
Phyllostomus elongatus				1,0		
Phyllostomus hastatus						
Trachops cirrhosus						
Vampyrum spectrum						
Glossiphaga commissarissi						
Glossiphaga longirostris						
Glossiphaga soricina						
Lionycteris spurelli		2,0				
Lonchophylla thomasi		4,1,1U				
Anoura geoffroyi		4,3				
Choeroniscus godmani						
Choeroniscus minor						
Carollia brevicauda		0,1			0,1[1]	
Carollia castanea						
Carollia perspicillata		5,2				
Rhinophylla pumilio		2,0				
Sturnira tildae			7‡(3L),2(2S)		3	
Sturnira lilium					1[2],4	
Uroderma bilobatum						
Platyrrhinus aurarius					5(1L),4(2S)	
Vampyressa bidens						
Vampyressa sp.			0,1			
Artibeus amplus		1,1,1U				
Artibeus cinereus					0,2	
Artibeus planirostris						
Desmodus rotundus		0,1				1,3 (3 S)
Myotis nigricans		1,0				
Eptesicus furinalis					1, 0	
Molossus ater						
Molossus molossus			26(1P,4L),3(3S)			
Eumops auropendulus						

from the Tafelberg in Suriname and Lim & Engstrom (2000)'s Mazaruni specimen (see below). Information on the species is poor, but the genus commonly uses small caves as roosts (see Eisenberg 1989; Sanborn 1955 as *Vampyrops*).

Little is known about the feeding ecology of *P. aurarius*. It is unfortunate that, upon dissection,

TABLE 4. — Measurements (mm) for *Platyrrhinus aurarius* from Mt. Kowa. **ST**, scrotal testes; **NST**, no scrotal testes; **Lac**, lactating; **NA**, not active.

Sex	Age	Rep. status[1]	Weight (g)	Fore-arm	HB	Ear	Tragus	Hind-foot	Calcar
male	adult	ST	40	54.5	80	18	5	10	-
male	adult	ST	37	54	78	19	8	9	4
male	adult	NST	37	54	78	15	4	12	6
male	adult	NST	33.5	52	72	15.5	4	11	5.5
female	adult	NA	36	53	82	-	6	12	5.5
female	adult	NA	35	51	76	15	4.5	10	-
female	adult	NA	48	55	84	15	6	11.5	5
female	adult	Lac	37	54	74	17	4	10	6
female	subadult	NA	36.5	56	80	16	4	13	6

the stomachs of both specimens proved empty and that the roost was over running water, precluding the collection of faeces.

Mt. Kowa appears to be the third locality record for *P. aurarius* in Guyana. The other two are from Paraima on the Mazarumi River (Fig. 1, spot 55) where a reproductive female (ROM 108220) was caught at 800 m near a creek in near-primary in September 1997 forest (Lim & Engstrom 2000) and near the Maipuri Falls on the Karowrieng River, Upper Mazaruni District (Fig. 1, spot 53) where three specimens (including BMNH 1980.744-6) were collected in rocky scrub by N. S. Weller, between December 1978 and January 1979. No altitude data accompanies the London specimens, but those in the region are around 570-600 m (Tom Hollowell pers. comm.). According to Huber *et al.* (1995), vegetation at this altitude in the Upper Mazaruni Valley is "Tall/medium, evergreen, lower montane forest" of unknown floristic composition.

P. aurarius is known from Bolívar State, Venezuela (Ochoa-G. *et al.* 1988, 1993), close to the Potaro study site, but has yet to be recorded from the Kanuku Mountains (see Parker *et al.* 1993), despite the apparently suitable elevation (see Huber *et al.* 1995), and the relatively intensive bat work that has occurred there (see Parker *et al.* 1993).

Desmodus rotundus

According to Emmons & Feer (1997), both *Diaemus youngi* and *Diphylla ecaudata* are specialist avian sanguinivores, while *D. rotundus* prefers to feed on domestic ungulates and only rarely feeds on birds (Charles-Dominique *et al.* 2001). In 1998, the residents of Tappa village claimed that vampire bats visited their four cows, one donkey, and chickens. Attempts to net the visiting bats, however, resulted in one previously-lactating female *D. rotundus* and three males in reproductive condition being netted directly in front of a chicken coop. The female was caught early in the evening, with the three males caught during the middle of the night to early morning. The 1968 survey also caught several *D. rotundus* visiting a chicken coop at the village of Karisparu. This situation, *contra* Emmons & Feer (1997), was also recorded for French Guiana by Brosset & Charles-Dominique (1990) and in Suriname by Husson (1978). Warren (1970) notes that the 1969 bat survey at Karisparu found the chickens ignored in favour of the recently-arrived pigs. Records of avian sanguinivory by *D. rotundus* are from areas with few or no domesticated mammals. Under these circumstances they also appear to attack non-domesticated free-living bird species (Warren, pers. obs.). *Desmodus* seems to be more of a generalist, and likes to revisit its victims night after night. Neither *Diaemus youngi* nor *Diphylla ecaudata* have been recorded from the Plateau.

Eptesicus furinalis

Found both on Mt. Kowa and in streamside forests at Kato, this record supports neither Eisenberg (1989)'s opinion that Neotropical populations of *E. furinalis* are most commonly found in undisturbed montane forest, nor that of

Brosset *et al.* (1996) who consider *E. furinalis* to be a bat of disturbed lowland habitats.

REPRODUCTIVE ACTIVITY

Reproductive activity was recorded for seven species:
– Two female *Cormura brevirostris*, each carrying young, were netted on 6 August 1968.
– Pregnant females of *Lionycteris spurelli* were captured on 19 and 22 August 1969.
– A pregnant *Glossophaga soricina* was caught on 23 rd August 1969.
– Captures from a colony of *Molossus molossus* on June 25 and 27 1998 included one pregnant and four lactating females, and three males with scrotal testes.
– Three female *Sturnira tildae* captured between July 14 and July 19 1998 were lactating and two males exhibited scrotal testes.
– One adult male *Sturnira lillium* captured July 25 1998 showed scrotal testes.
– Of the 8 captures of *P. aurarius* made between July 11 and 19, 1998, five were clearly adults, two of the four adult males displayed scrotal testes, and the one female was lactating (see Table 4).

DISCUSSION

Observations on the bat community of the Potaro Plateau

Twenty seven bat species are confirmed for the higher area of the Potaro Plateau, with one species unidentified and an additional three species probable from visual sightings and reports. Twenty species are known from the adjacent lowlands. Twelve species occur in both lowlands and highlands, making for a total of 35 confirmed species in 25 genera for the area, or nearly one-third of the country's known species total (see Table 1). Given the short periods of study, this compares well with species numbers from other localities in the region (see Table 5) and is comparable with other short-duration bat studies in other parts of northern South America (e.g., Ochoa-G. *et al.* 1988; Nogueira *et al.* 1999; Lim & Engstrom 2000; Bernard 2001).

The species list for each study contributed new species to the overall list for the region. There is very little overlap between the plateau-top samples, with only two species common to the DEW/PPZE studies, and a further two shared by the ANW/DEW studies. Two species, *Sturnira tildae* and *Desmodus rotundus*, were common to all three studies. The low level of overlap between the species lists of the three studies could be due to habitat differences, seasonal differences, or an altitudinal separation in the region's bat fauna.

Together, the studies covered forest, grassland, and human-impacted habitats at low and medium altitudes and, at higher altitude, primary montane forest. Although habitat-specificity appears to occur, samples in similar habitats still resulted in different species lists. Seasonal differences could explain differential captures of nectivores (see below), but are unlikely to explain all the inter-catch difference. Clearly, further sampling is required for clarification and to tease out the confounding effect of small-size sampling error.

Altitudinal separation within the Plateau's bat fauna remains unproven, partly due to sampling size. Though only 12 out of the recorded 35 species occurring in both lowland habitats and on the Plateau, the highest point surveyed, Mt. Kowa, had only one higher elevation specialist: *Platyrrhinus aurarius*. Most of the other species encountered appear to have quite wide altitudinal ranges. However, the Plateau's highest mountains, including Mt. Ayanganna, remain unsurveyed for bats. Some altitudinal zonation might be found once this occurs.

Comparing the Potaro Plateau to other sites in Guyana

The Potaro Plateau and the Kanuku Mountains, 220 km to the south (Fig. 1, spots 38 and 41), appear to be biologically quite similar (see Kelloff & Funk 1998; Funk *et al.* 1999; Parker *et al.* 1993). The Kanukus have been surveyed for bats several times (see summary by Louise Emmons in

TABLE 5. — Comparative bat species diversity at sites in northern South America. [1], from species-accumulation curves these authors believe "the total number of bat species present at Nouragues is probably close to 70".

Locality	Country	Habitat type	No. species	No. genera	Source
Maracá Ecological Station	Brazil, Roraima State	Primary lowland forest, secondary forest and llanos	51	26	Robinson (1998)
APEG Forest Reserves	Brazil, Belém	Primary lowland forest, várzea, igapó	49	33	Kalko & Handley (2001)
ECEREX Field Station	French Guiana	Lowland forest and savanna, no caves	62	–	Brosset *et al*. (1996)
Paracou	French Guiana	Lowland forest.	78	42	Simmons & Voss (1998)
Saül	French Guiana	Primary lowland forest and agricultural areas	54	35	Simmons *et al*. (2000)
Piste St-Elie	French Guiana	Savanna, secondary forest and agricultural habitats	57	39	Brosset & Charles-Dominique (1990)
Nouragues	French Guiana	Primary lowland forest, with cliffs and caves.	62	37	Brosset *et al*. (2001)[1]
Bartica	Guyana	Primary lowland forest	31	22	Hill (1964)
Iwokrama	Guyana	Primary lowland forest	86	44	Lim & Engstrom (2001)
Kanuku Mts., (east)	Guyana	montane forest, granite cliffs	71	43	Parker *et al*. (1993)
Kanuku Mts. (west)	Guyana	montane forest, granite cliffs	44	28	Parker *et al*. (1993)
Rupanuni Region	Guyana	Savanna and dry forest mosaic. High level of human disturbance.	10	8	Parker *et al*. (1993)
Kurupukari	Guyana	Primary lowland forest	35	21	Smith & Kerry (1996)
Potaro Plateau - top	Guyana	Agricultural habitats, secondary forest, primary forest, primary montane forest	22	17	this study
Potaro/Paramakatoi	Guyana	Savanna, cliffs, agricultural habitats, degraded lowland forest.	15	12	this study

Parker *et al.* 1993), and 85 bat species are now known from there. All species so-far recorded from the Potaro Plateau have also been recorded from the Kanukus, with the exception of *Platyrrhinus aurarius*, *Anoura geoffroyi* and *Carollia castanea*.

A short survey of the highlands of the upper Mazaruni (Fig. 1, spots 53 and 54) by Lim & Engstrom (2000) recorded 28 different species of bats, of which 12 (*Chrotopterus auritus*, *Micronycteris megalotis*, *Mimon crenulatum*, *Anoura latidens*, *Ametrida centurio*, *Artibeus glaucus*, *A. gnomus*, *A. lituratus*, *A. obscurus*, *Chiroderma trinitatum*, *C. villosum*, *Platyrrhinus helleri*, *Vampyressa pusilla*) have not been found on the Potaro Plateau. The five study sites are 60-80 km from Potaro Plateau sites (see Fig. 1 and Lim & Engstrom 2000). Although there are some habitat differences (see Huber *et al.* 1995), these are not enough to account for the inter-catch differences since, with the exception of *Anoura latidens* and *Ametrida centurio*, the species concerned are widely distributed (see e.g., Eisenberg 1989; Eisenberg & Redford 1999). The difference may be partly attributable to methodological differences. *V. pusilla* and *A. latidens* were recorded during the survey but not caught in understory nets (Lim pers. comm.). Lim & Engstrom (2000) set canopy nets and made extensive use of harp traps, a trapping method not used by the three surveys on the Potaro Plateau. Differences in current species lists are likely to simply reflect the fact that both the Potaro Plateau and the Upper Mazaruni areas have yet to be intensively sampled (Lim pers. comm.)

The future for bat work on the Potaro Plateau

The mist nets used in all three surveys were never positioned above 10 m, while the forest canopy frequently exceeded 15 m (Barnett & Shapley 1999). We are, therefore, unlikely to have sampled those species that habitually fly only in or above the upper stratum of the canopy. This would include *Diaemus youngi*, *Micronycteris nicefori*, *Diclidurus scutatus* and mollosids such as *Eumops* and *Nyctimops* spp. (Brosset *et al.* 1996; Kalko & Handley 2001). Even with high-canopy nets the capture of such high-flying species is a rare event and ultrasonic call recording is the only current method to sample them non-destructively. The species list for the Plateau would likely be increased increased with the use of harp traps, which complement mist nets by catching some of the non-phyllostomid bats that avoid mist nets (e.g., Tideman & Woodside 1978; Francis 1989; Kalko & Handley 2001).

Species tallies for a location always increase with effort (Brosset *et al.* 1996; Simmons & Voss 1998; Charles-Dominique *et al.* 2001). Recent intensive surveys at Iwokrama (Fig. 1, spot 25) have increased the number of bats known at this locality from 45 species (Smith & Kelly 1996) to 74 (Lim *et al.* 1999), then 86 (Lim & Engstrom 2001). As noted by Lim & Engstrom (2001), Iwokrama has a smaller elevational range than do either the Kanukus or the Potaro Plateau (which includes Guyana's highest mountain, Mt. Ayanganna).

On the Plateau, montane forest remains under-sampled while high tepui forest and high tepui scrub has yet to be sampled for bats. Further studies should add considerably to ecological knowledge and species tallies of bats from the Potaro Plateau. Species likely to be added include *Anoura latidens*, a species known from neighbouring areas in Venezuela, and added to the list of known Guyanese bats by a recent survey of the upper Mazaruni region (spots 53-56 on Fig. 1; Lim & Engstrom 2000).

Several of the bats of the Potaro Plateau are of conservation interest. Two, *Platyrrhinus aurarius* and *Choeroniscus godmani*, are designated as "near threatened" by the IUCN (Baillie and Groombridge 1996), another, *Glossophaga longirostris*, is one of three species considered restricted to a single biogeographic region within Guyana (Lim & Engstrom 2001). Comparison with Brosset *et al.* (1996) and with Smith & Kerry (1996) show that eight of the Plateau's bats occur primarily or only in primary forest (*Cormura brevirostris*, *Tonatia silvicola*, *Phyllostomus elongatus*, *Choeroniscus godmani*,

Rhinophylla pumilio, *Platyrrhinus aurarius*, *Carollia brevicauda*, *Vampyressa bidens*). Bat species diversity and abundance provides a sensitive indicator of disturbance and is useful for assessing an area's conservation value (Medellin *et al.* 2000). Though preliminary, our results suggest that, by such criteria, the Potaro Plateau appears to hold a rich and diverse chiropterofauna and is an area very worthy of conservation.

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Appendix 1

Gazetteer for bat collection localities shown in Figure 1. Greenhall (1959) does not give localities for the species in his list of Guyanese bats, and so could not be included in the figure. The type locality for *Cyttatrops alecto* given by Thomas (1913) as 'the Mazaruni River' was considered too vague to warrant a precise location spot. **Sources**: Stephens & Traylor (1985); Maps: Topographic Division, Lands & Surveys Dept., Ministry of Agriculture (1975) and Survey Department of Guyana (1968). For other citations, see bibliography.

No.	LOCALITY	GRID REF	SOURCE collected by [reported by]	NOTES
1	North West District	07°45'N, 59°30'W	Quelch (1892)	grid. ref. from Stephens & Traylor (1985)
2	Kwabanna/Santa Cruz, Waini River	07°34'N, 59°12'W	Lim (1991)	position approximated using maps (see above)
3	Kumara, Moruka River (= Kumaka)	07°38'N, 59°04'W	Lim (1991)	grid. ref. approximated using maps (see above)
4	Maccasseema, Pomeroon River	07°15'N, 58°43'W	W. L. Sclater, 1886 [Thomas 1887]	grid. ref. from Stephens & Traylor (1985)
5	Marakka, "20 miles up Pomeroon River"	07°22'N, 59°37'W	W. L. Sclater, 1886 [Thomas 1887]	grid. ref. approximated using maps (see above)
6	Supinaam River (mouth of)	06°59'N, 58°30'W	F. V. McConnell [Thomas 1910]	grid. ref. approximated using maps (see above)
7	Georgetown (inc. St. Andrew's Church, Timeri Airport, Botanic Gardens)	06°49'N, 58°09'W	Quelch (1892), Lim (1992)	Grid. ref. as cited by Lim *et al.* (1999)
8	Plantation Hope	06°42'N, 57°57'W	W. L. Sclater, 1886 [Thomas 1887]	grid. ref. from Stephens & Traylor (1985)
9	Plantation Melville	06°41'N, 57°55'W	Quelch (1892)	grid. ref. approximated using maps (see above) and Stephens & Traylor (1985)
10	Bengal #41	06°30'N, 57°40'W	Warren (1969a)	
11	Mitchell Rice Plantation, Abery River	06°08'N, 57°35'W	Warren (1969a)	
12	New Amsterdam [= Berbice]	06°15'N, 57°31'W	Jentink (1893), Young (1896)	grid. ref. from Stephens & Traylor (1985)
13	Abary Creek, Berbice River/Berbice River, beyond Mara	06°00'N, 57°58'W	Young (1896)	grid. ref. is for 'Mara', approximated using maps (see above)
14	Canje Creek/ Richmond Hill	05°45'N, 57°24'W	Young (1896)	grid. ref. approximated using maps (see above)
15	Calicoon [= Kalakun]	06°24'N, 58°39'W	W.L. Sclater, 1886 [Thomas 1887]	grid. ref. from Stephens & Traylor (1985)
16	Bartica	06°24'N, 58°37'W	W. Beebe, 1916-1921 [Anthony 1921]	grid. ref. from Stephens & Traylor (1985)
17	24 Miles along Potaro-Bartica Road	06°02'N, 58°39'W	J. N. Davies, 1963 [Hill 1964]	grid. ref. approximated using maps (see above)
18	27 miles along Potaro-Bartica Road	05°57'N, 58°39'W	J. N. Davies, 1963 [Hill 1964]	grid. ref. approximated using maps (see above)
19	Loo Creek, Berbice River	06°05'N, 59°44'W	Lim (1990)	grid ref. from Lim (pers. comm.)
20	Bada Creek, Berbice River	05°35'N, 58°08'W	Lim *et al.* (1999)	
21	Arampa, near Ituni, Demerera River	05°30'N, 58°14'W	Baldwin Persaud, 1971 [Peterson 1972]	grid. ref. from Stephens & Traylor (1985)

22	Mapenna Creek, Courantine River	05°21'N, 57°19'W	Lim (1992)	grid. ref. approximated using maps (see above)
23	Orealla, Courantine River.	05°19'N, 57°20'W	Lim (1992)	grid. ref. from Stephens & Traylor (1985)
24	Clearwater Camp	04°44'N, 58°51'W	Lim *et al.* (1999)	
25	Kurupakari	04°40'N, 58°40'W	Lim *et al.* (1999)	
	Iwokrama Field Station	04°40'N, 58°41'W		
26	Three Mile Camp	04°38N, 58°43W	Lim *et al.* (1999)	
27	Surama, 30 km NE	04°20'N, 58°51'W	Lim *et al.* (1999)	
28	Surama, 40 km NE	04°21'N, 58°50'W	Lim (1990)	grid. ref. approximated using maps (see above)
29	Surama Sawmill	04°06'N, 59°03'W	Lim *et al.* (1999)	
30	Rewa River	03°53'N, 58°45'W	Stanley E. Brock, mid-1960's [Peterson 1968]	grid. ref. from Stephens & Traylor (1985)
31	Kwitaro River (river mouth)	03°19'N, 58°47'W	Stanley E. Brock, mid-1960's [Peterson 1968]	grid. ref. from Stephens & Traylor (1985)
32	Oshiwau, near Marurawaunowa	02°50'N, 58°55'W	Stanley E. Brock, 1966 [Peterson 1968]	type locality for *Vampyressa brocki*. Note: Given name unlocatable on available maps: 'Awaruwanawa' is 32km WSW of grid. reference given by Peterson (1968)
33	Illia Wau River	02°40'N, 58°40'W	Lim *et al.* (1999)	
34	Gunn's Strip	01°39'N, 58°38'W	Lim *et al.* (1999)	
35	Gunn's Strip, 7 km S	01°35'N, 58°38'W	Lim *et al.* (1999)	
36	Chodikar River, Acari Mts.	01°22'N, 58°46'W	Lim *et al.* (1999)	
37	Dadanawa Ranch	02°50'N, 59°30'W	Stanley E. Brock, mid-1960's [Peterson 1968]	grid. ref. from Stephens & Traylor (1985)
38	West Kanuku Mountains	03°13'N, 59°33'W	F. V. McConnell & J.J. Quelch 1900 [Thomas 1901]	grid. ref. is for 'Mt. Arimerak-Tain', approximated using maps (see above). (grid. ref. in Stephens & Traylor, 1985 is for 'the Kanukus')
39	Letham	03°23'N, 59°48'W	Lim (1990)	grid. ref. from Stephens & Traylor (1985)
40	Maipaima Creek, Kanuku Mts. (a tributary of the Nappi River)	03°23'N, 59°30'W	Parker *et al.* (1993)	Base camp, Conservation International RAP team, west expedition
41	East Kanuku Mountains	03°11'N, 59°19'W	Stanley E. Brock, mid-1960's [Peterson, 1968] Lim (1990)	grid. ref. is for 'Mt. Makka-Watta', approximated using maps (see above). (grid. ref. in Stephens & Traylor, 1985 is for 'the Kanukus')
42	Karanambo	03°45'N, 59°18'W	Lim (1990)	grid. ref. from Stephens & Traylor (1985)
43	Annai	03°57'N, 59°08'W	Lim (1990)	grid. ref. approximated using maps (see above)
44	Kato	04°40'N, 59°48'W	D. E. Wilson, 1989 [this paper]	grid. ref. approximated using maps (see above)

45	Paramakatoi	04°42'N, 59°43'W	D. E. Wilson, 1989 [this paper]	grid. ref. from Stephens & Traylor (1985)
46	Pakatau Falls, Siparuni River	04°45'N, 59°01'W	Lim *et al*. (1999)	
47	Tappa airstrip and Camp Three	04°53'N, 59°32'W (Tappa)	this paper	
48	Mount Kowa	04°51'N, 59°41'W	this paper	
49	Chenapou	04°59'N, 59°34'W	this paper	
50	Karisparu	05°00'N, 59°30'W	Warren (1971) [and this paper]	
51	Kaiteur Falls	05°11'N, 59°29'W	D. E. Wilson, 1989 [this paper]	grid. ref. from Stephens & Traylor (1985)
52	Echerak River	05°10'N, 59°30'W	Warren (1971) [and this paper]	
53	Maipuri Falls, Karowrieng River (nr. Imbaumedai)	05°41'N, 60°14'W	N. S. Weller 1978-1979 [Lim & Engstrom 2000; this paper]	grid. ref. from label of specimen BMNH 1980.744-6 of *Platyrhinnus aurarius*
54	Kamarang, confluence of Mazeruni and Kamarang rivers	05°52'N, 60°37'W	Lim & Engstrom (2000)	
55	Paraima, confluence of Paruima Creek and Kamarang rivers	05°49'N, 61°04'W	Lim & Engstrom (2000)	
56	Namai Creek, 5 km W. of Puraima (=Paruima)	05°48'N, 61°06'W	Lim & Engstrom (2000)	
57	Pipilipai, Kukai River	05°43'N, 60°28'W	British Mt. Roraima Expedition 1971 [Warren (1971) and this paper]	grid. ref. is for mouth of Kukai River, approximated using maps (see above)
58	Makuripai, Kako River	05°46'N, 60°35'W	British Mt. Roraima Expedition 1971 [Warren (1971) and this paper]	grid. ref. is for mouth of Kako River, approximated using maps (see above)
59	Upper Waruma River (tributary of Kako River)	05°19'N, 60°44'W	British Mt. Roraima Expedition 1971 [Warren (1971) and this paper]	grid. ref. approximated using maps (see above)
60	Camp 5, near Mount Roraima	05°14'N, 60°43'W	British Mt. Roraima Expedition 1971 [Warren (1971) and this paper]	grid. ref. approximated using maps (see above)
61	Kuwaima Falls, Upper Mazaruni River	06°03'N, 60°39'W	Lim & Engstrom (2000)	