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Notes on Bats from Montserrat (Lesser Antilles) with Comments Concerning the Effects of Hurricane Hugo

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ABSTRACT. — From August 1993 to August 1994, bats were surveyed on Montserrat, Lesser Antilles. Four years after this small volcanic island was struck by Hurricane Hugo (1989), there remains a 20-fold decrease in bat populations as compared to levels before Hugo. After the hurricane, composition of the community shifted from smaller frugivorous species to one of more omnivorous and larger frugivorous species. With the addition of a new record for *Sturnira thomasi*, voucher specimens from Montserrat exist for ten species of Chiroptera: *Noctilio leporinus*, *Monophyllus plethodon*, *Sturnira thomasi*, *Chiroderma improvisum*, *Artibeus jamaicensis*, *Ardops nichollsi*, *Brachyphylla cavernarum*, *Natalus stramineus*, *Tadarida brasiliensis*, and *Molossus molossus*.

INTRODUCTION

From August 1993 to August 1994, one of us (SCP) surveyed the bats on Montserrat, Lesser Antilles. Ten species of bats have been reported on Montserrat, but no more than seven have been collected at any one time (Jones and Baker, 1979; Pierson and Warner, 1990; present study).

This small volcanic island of 100 square kilometers was devastated by Hurricane Hugo on 17 September 1989, causing near total defoliation with some uprooted trees across the island (although quantitative data are not available for Montserrat, the qualitative description is similar to the effects of Hurricane Hugo on Puerto Rico; Brokaw and Walker, 1992). Aerial photographs of the island showed defoliation in all but the most remote ravines. By fall 1993, 30% of Montserrat was arable and 40% of the island had been revegetated by woodland. By local accounts, edible fruit production had recovered in 1993, but "non-edible" (non-marketable) fruits had not yet recovered because they come from trees that are either large or long-lived.

Hurricanes are frequent, catastrophic disturbances in the Caribbean (Walker et al., 1992). An average of 4.6 hurricanes have occurred annually in the Caribbean between 1871 and 1964 with a return time of 10 to 60 years for islands in the hurricane belt (Waide, 1992b). Although hurricanes have

long-lasting impacts on the flora and fauna of the islands, these effects have not been documented well until recently. Hurricanes rearrange the structure of the vegetation (Brokaw and Walker, 1992) and affect many of the basic processes that control animal population size and composition (Covich et al., 1992; Willig and Camilo, 1992; Woolbright, 1992; Reagan, 1992; Waide, 1992a, 1992b; Askins and Ewert, 1992; Lynch, 1992; Will, 1992; Gannon and Willig, 1994; Bronstein and Hossaert-McKey, 1995). These recent studies have focused primarily on the larger islands of the Greater Antilles and mainland areas. We found no reference to the effects of hurricanes on the animal populations on islands of the Lesser Antilles, and only the work on St. John in the Virgin Islands (Askins and Ewert, 1992) concerns a land mass of size comparable to Montserrat.

We compare results from two surveys taken before Hurricane Hugo (Jones and Baker, 1979; Pierson et al., 1986; Pierson and Warner, 1990) with our survey made five years after Hurricane Hugo.

MATERIALS AND METHODS

One of us (SCP) sampled each location (Fig. 1) every 4-5 weeks over the 12 month study using collection techniques similar to those used in the previous studies. Two or three mist-nets were set at each site and monitored for 4 to 7 hours depending on

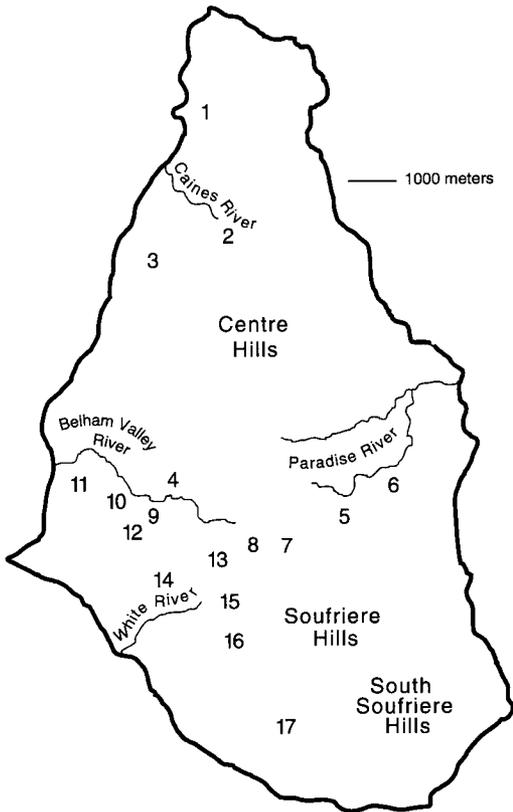


FIG. 1. Collection localities on Montserrat. Numbers in parentheses refer to locations shown in the figure. *Parish of Saint Peter*. — (1) Rendezvous Bluff Cave: 1.25 km. N Davy Hill; (2) Caines River: 1 km. SW Saint Johns, 600 m.; (3) Town of Saint Peters, 200 m.; (4) Waterworks Estate: 0.5 km. SE Happy Hill, 300 meters. *Parish of Saint George's*. — (5) Paradise Estate: 1 km. S Harris, 1000 m.; (6) Paradise River: 0.5 km. E Harris, 450 m.; (7) Riley's Estate: 0.75 km. E Dyer's, 950 m.; (8) Dyer's River Bridge: 0.25 km. N Dyer's, 600 meters. *Parish of Saint Anthony*. — (9) Belham Valley Bridge: 0.5 km. S Happy Hill, 50 m.; (10) Belham Valley River: Golf course, along 7th fairway, 1 km. S Old Towne, 50 m.; (11) Golf Course pump house, 0.5 km. E. of Iles Bay beach, 25 m.; (12) Woodsville Condominiums: 1 km. NW Cork Hill, 250 m.; (13) Glen Mohr Apartments: 2 km. NE Plymouth, 600 m.; (14) The Groves: Marie's Guest House, 1 km. N Plymouth, 100 m.; (15) Webbs Estate: 0.5 km. NE Parsons, 650 m.; (16) American University of the Caribbean, Montserrat Campus: Amersham, 450 m.; (17) White River below Great Alp Falls: 1 km. E Saint Patrick's, 600 meters.

activity and weather. Covered flyways were netted wherever possible. All collection sites were within 600 m of main roads and were chosen so that a variety of habitats could be sampled (mist-netted) simulta-

neously. Diverse localities were not difficult to find because the island is covered with bamboo thickets, open meadows, and small streams. These streams provide drinking pools for bats and water for small pockets of cultivated and wild fruit trees. The Belham Valley River and Paradise Estate sites received more attention (50%) than other sites because they had been used by Jones and Baker (1979), and Pierson and Warner (1990). Because the northeast quadrant of the island is xeric and the southeast portion is not accessible by car, these regions were not surveyed. Sites that did not produce captures are not listed. Most locations would have benefited from nets set high (10 meters off of the ground) to sample the molossidids that were abundant on the island. All voucher specimens are deposited in the research collections at the University of Nebraska State Museum.

SPECIES ACCOUNTS

Noctilio leporinus mastivus (Vahl, 1797)

Specimens Examined (13). — Belham Valley Bridge (6); Belham Valley River along Golf course (6); Golf Course pump house (1).

This taxon was common along the Belham Valley River. Visual counts of *Noctilio* foraging over a well-illuminated pool under the Belham Valley bridge suggest that the 1994-capture success clearly underestimates the number of *Noctilio* in the Belham Valley drainage. Males were captured more often than females (11:2). Average forearm length and body mass for 11 males was 85.3 mm and 67.2 g, respectively, whereas the same for two females was 84.5 mm and 48.5 grams, respectively (Table 1). One of the females was pregnant and was immediately released on April 18 (Table 2).

Monophyllus plethodon luciae Miller, 1902

Specimens Examined (24). — Paradise Estate (19), Paradise River (1); Waterworks Estate (3); Town of Saint Peters (1).

Average forearm length and body mass for 13 males was 42.0 mm and 16.5 g, respectively, whereas the same for nine females was 41.2 mm and 16.1 g, respectively (see also Table 1). None of the females were lactating or pregnant (Table 2).

TABLE 1. External and cranial measurements of seven species of bats from Montserrat.

Museum no., sex, locality	*Ear	Foot	Arm	Weight	GLS	ZB	IOC	POC	MB	LMT	MM
<i>Noctilio leporinus</i>											
UNSM 20067 F, Belham Valley Bridge	28.0	30.0	85.0	—	25.1	18.3	10.1	7.1	16.1	10.0	11.6
<i>Monophyllus plethodon</i>											
UNSM 20065 F, Paradise Estate	12.0	13.0	40.0	17.5	22.6	10.0	4.6	4.7	9.2	7.7	5.5
<i>Sturnira thomasi</i>											
UNSM 20062 F, Paradise Estate	16.0	14.0	46.0	27.7	24.9	11.6	5.8	5.8	10.9	7.3	7.6
<i>Artibeus jamaicensis</i>											
UNSM 20063 M, Great Alp Waterfall	20.0	16.0	61.0	46.7	29.4	17.6	10.2	7.5	15.3	10.0	13.0
UNSM 20064 F, Great Alp Waterfall	20.0	15.0	59.0	43.1	28.2	17.4	9.9	7.3	14.6	9.8	12.8
<i>Ardops nicholsi</i>											
UNSM 20059 M, Waterworks Estate	17.0	14.0	51.0	25.7	22.9	14.9	6.5	5.7	12.2	7.1	9.5
UNSM 20060 F, Paradise Estate	18.0	14.0	56.0	30.2	24.9	16.5	7.4	6.1	13.3	8.1	10.6
<i>Brachyphylla cavernarum</i>											
UNSM 20057M, Rendezvous Bluff Cave	20.0	18.0	65.0	50.2	32.0	16.5	8.2	6.2	14.6	11.3	11.1
UNSM 20058M, Rendezvous Bluff Cave	21.0	20.0	66.0	47.7	30.6	17.1	8.4	6.8	14.9	11.3	11.4
<i>Molossus molossus</i>											
UNSM 20066 F, Golf Course	11.0	9.0	37.0	—	16.1	10.3	4.6	3.4	9.5	5.8	7.6

* *Abbreviations:* Ear—length of ear measured in the field; Foot—length of foot measured in the field; Arm—length of forearm measured in the field; Weight—weight in grams (electronic scale accurate ± 0.01 g); GLS—greatest length of skull; ZB—zygomatic breadth; IOC—breadth of the interorbital constriction; POC—breadth of the postorbital constriction; MB—mastoid breadth; LMT—length of maxillary toothrow; MM—width across upper molars.

Sturnira thomasi de la Terre and Schwartz,
1966

Specimen Examined (1). — Paradise Estate (1).

This species was unknown from Montserrat. Our adult female (UNSM 20062) carried a near term fetus, suggesting that a reproductive population of *S. thomasi* exists on, Montserrat. The species was originally

described and known only from the island of Guadeloupe (de la Terre and Schwartz, 1966; Genoways and Jones, 1975; Jones and Genoways, 1975; Jones and Phillips, 1976; Baker et al., 1978). This occurrence on Montserrat is not surprising because Guadeloupe is located about 55 kilometers southeast of Montserrat. Another species of bat thought to be endemic to Guadeloupe, *Chiroderma improvisum* Baker and Genoways, 1976, has been found on Montserrat (Jones and Baker, 1979).

Our specimen exhibits interesting morphological differences compared to two adult females from Guadeloupe (TTU 19906, 19907). These three specimens were first compared with two adult females of *Sturnira lilium* from Grenada (UNSM 16488, 16494) to verify the identification of the Montserrat specimen. The specimen from Montserrat is morphologically similar to specimens of *S. thomasi* from Guadeloupe in characters that differentiate *S. thomasi* from *S. lilium* that occur in the southern An-

TABLE 2. Synopsis of female reproductive data for bats on Montserrat.

Species	Jan.	April	May	June	July	Aug.
<i>N. leporinus</i>		P			L* J*	
<i>M. plethodon</i>	P**					
<i>S. thomasi</i>			P			
<i>A. jamaicensis</i>		L		P	P* L* J*	
<i>A. nicholsi</i>				L	P	
<i>B. cavernarum</i>				L	L* LJ	L
<i>M. molossus</i>				J	P* L*	J

Abbreviations: P—pregnant; L—lactating; J—juvenile; (*)—Jones and Baker, 1979; (**)—Pierson et al., 1986.

tines (Jones and Phillips, 1976: 13–15; Jones, 1989:651–552).

The skull of the female from Montserrat is relatively large and has the long, narrow cranium characteristic of *S. thomasi*. In fact, the cranium of the Montserrat specimen is even narrower than specimens from Guadeloupe. Forearm and cranial measurements (in mm) of the Montserrat and two Guadeloupe specimens of *S. thomasi*, respectively, are as follows: length of forearm, 44.7, 46.1, 47.7; greatest length of skull, 24.9, 24.9, 25.1; condylobasal length, 23.3, 22.9, 23.6; zygomatic breadth, 11.6, 12.2, 12.5; mastoid breadth, 10.9, 11.7, 11.8; breadth of braincase, 9.3, 9.8, 9.6; breadth of the interorbital constriction, 5.8, 5.9, 6.0; breadth of the postorbital constriction, 5.8, 5.5, 5.9; length of the maxillary toothrow, 7.3, 6.9, 6.9; width across upper molars, 7.6, 8.0, 8.0; length of mandibular toothrow (i-m2), 8.4, 7.7, 7.8 (Table 1). Generally, the cranium of the adult female from Montserrat has a more delicate appearance than crania of the two adult females from Guadeloupe. Its cranium is proportionately and absolutely narrower than that of the two specimens from Guadeloupe. All crests and ridges of the Montserrat female are less pronounced than those of the Guadeloupe specimens, and the weakly developed sagittal crest of the Montserrat specimen closely resembles those of the adult females of *S. liliu* from Grenada.

The specimen from Montserrat and the two specimens from Guadeloupe lack m3 on both sides of the mandible, but this is a variable character throughout Antillean populations of *Sturnira*. Pelage of the specimen from Montserrat is uniformly grayish brown dorsally and ventrally, whereas specimens from Guadeloupe are reddish brown. The female from Montserrat has no “yellow shoulder” characteristic of the genus, yet the reddish-yellow shoulder is clearly evident on the two specimens from Guadeloupe.

Sturnira thomasi on Montserrat can be distinguished easily from the population on Guadeloupe with the material at hand. These differences may eventually prove to be taxonomically significant. Finding another population of *S. thomasi* with unique

characteristics supports the position of Jones and Phillips (1976) that *S. thomasi* is a distinct species. Koopman (1968) was “inclined to regard *paulsoni*, *angeli*, and even *thomasi* as successive modifications of *liliu* out of contact with the other species of *Sturnira*.” However, we believe that there has been a major shift in cranial characteristics between populations of *Sturnira* on Dominica and those on Guadeloupe. This shift would make the recognition of *Sturnira thomasi* as a distinct species a justifiable taxonomic decision.

Artibeus jamaicensis jamaicensis Leach, 1821

Specimens Examined (46). — Caines River (1); Waterworks Estate (6); Paradise Estate (24); Riley’s Estate (3); Dyer’s River Bridge (1); Belham Valley Bridge (1); Glen Mohr Apartments (2); The Groves: Marie’s Guest House (2); Webbs Estate (1); White River (5).

Artibeus jamaicensis was distributed across the island. Average forearm length and body mass for 23 males was 60.1 mm and 45.4 g, respectively, whereas the same for 23 females was 60.6 mm and 49.0 g, respectively (Table 1). Jones and Baker (1979) collected seven lactating and two pregnant females in July. In 1994, one of us (SCP) collected one lactating female in April, and two pregnant females were collected in June. The timing of these reproductive events is not unusual (Wilson, 1979) and indicates that reproduction is not synchronized. Perhaps these bats are polyestrous, as they are on nearby Guadeloupe (Baker et al., 1978) and Puerto Rico (Gannon and Willig, 1994). One female was covered by mange, her remaining hair was gray, and most of her teeth were missing, yet she was still lactating.

Ardops nichollsi montserratensis
(Thomas, 1894)

Specimens Examined (7). — Paradise Estate (2); Waterworks Estate (4); Dyer’s River Bridge (1).

This small fruit bat was not abundant. Average forearm length and body mass for two males was 49.5 mm and 25.8 g, respectively, whereas the same for four females was 51.2 mm and 28.0 g, respectively (Table

1). A lactating female was captured June 18 and a pregnant female was captured July 9 (Table 2). On several occasions, bats of this size were observed hawking moths around street lamps below the town of Dyer's, but no stomach or fecal analyses were done to examine the extent of omnivory.

Brachyphylla cavernarum cavernarum Gray,
1834

Specimens Examined (64). — Rendezvous Bluff Cave (4); Town of Saint Peters (1); Waterworks Estate (5); Paradise Estate (42); Dyer's River Bridge (8); Belham Valley River (1); The Groves: Marie's Guest House (1); Webbs Estate (1); White River (1).

This robust, omnivorous bat was found in large numbers (25% of all captures). This species readily ate both hard-skinned fruits and large, hard-shelled beetles when temporarily held in captivity. Numbers of *Brachyphylla* may have increased because the species could capitalize on hardy food items that survived Hurricane Hugo. Females were captured nearly twice as often as males. Average forearm length and body mass for 24 males was 64.9 mm and 46.2 g, respectively, whereas the same for 40 females was 64.8 mm and 47.6 g, respectively (Table 1). Lactating females were collected from June through August with a peak in July.

Rendezvous Bluff Cave lies at the northwest tip of the island and is accessible only by sea. The cave is occupied periodically by a mixed (male, female, juvenile) population of approximately 5000 *Brachyphylla*: September 11 (present), November 6 (present), January 16 (present), April 7 (absent), June 5 (present), June 26 (absent), August 21 (absent). Sporadic use is likely tied to the habit of this species of flying in large groups and mobbing fruiting trees *en masse*. Apparently, as the mob tracks resources across the island, it utilizes other regional shelters. Occupancy of the cave was not correlated with seasonality or rainfall. The large size of this bat, the large size of population, and the small size of this island provide a unique opportunity to assess foraging behavior and resource utilization by this species using radio-tracking techniques.

Montserratians become upset when bats

raid their fruit orchards. A frequent, albeit unusual, complaint concerned the belief that bats stripped "pigeon-peas" directly from cultivated vines. This behavior seemed unlikely until one of us (SCP) observed *Brachyphylla* clamoring through "pigeon-pea" vines and stripping peas from new, succulent pea pods. It would be interesting to see whether this species regularly supplements its protein intake with immature legumes.

Molossus molossus molossus (Pallas, 1766)

Specimens Examined (109). — Waterworks Estate (10); Paradise Estate (9); Paradise River (1); Belham Valley Bridge (8); Belham Valley River (73); Golf Course pump house (3); Woodsville Condominiums (2); The Groves: Marie's Guest House (1); American University of the Caribbean Campus (2).

Plentiful in all locations, *Molossus* infested many dwellings on the island. Females were caught more frequently than were males at most locations. Average forearm length and body mass for 32 males was 38.1 mm and 12.7 g, respectively, whereas the same for 75 females was 37.3 mm and 12.4 g, respectively (Table 1). Although Jones and Baker (1979) collected both pregnant and lactating females in July, we found only volant juveniles (during June and August, Table 2).

DISCUSSION

In comparison with pre-Hurricane Hugo collections (1978: Jones and Baker, 1979; 1984: Pierson and Warner, 1990; Table 3), there was a dramatic 20-fold decrease in capture success during the present survey. This decrease in population size is certainly related to fatalities that occurred during the hurricane itself, but also to starvation resulting from defoliation and the susceptibility of juveniles to habitat destruction caused by the hurricane.

Although *A. jamaicensis* was well distributed across Montserrat, its population in 1994 was greatly reduced (17% of all captures) and was several times less abundant than expected. *Artibeus* composed almost 50% of all captures in both the 1978 and 1984 surveys. Specifically, Jones and Baker (1979) captured and released "several hun-

TABLE 3. Synopsis of collection data for bats on Montserrat.

	1978	1984	1994
<i>N. leporinus</i>	10	1	13
<i>M. plethodon</i>		78	24
<i>S. thomasi</i>			
<i>C. improvisum</i>	1		
<i>A. jamaicensis</i>	200*	99	46
<i>A. nichollsi</i>	12	5	7
<i>B. cavernarum</i>	9	9	64
<i>M. molossus</i>	200 [†]	2	109
Total no. of species	6	7	7
Total no. of bats	432*	195*	264
Total net-nights	5	17	63
Average no. of bats caught /net-night	86.4	11.5	4.2

* Jones and Baker (1979) did not break down their 1978 captures by night and "several hundred" *Artibeus* and "several hundred" *Molossus* are approximated at 200 individuals each. Pierson et al. (1986) include estimates of their 1984 captures of *Monophyllus* at "about 75" and *Artibeus* at "about 15".

dred" in their two-night 1978 survey, yet one of us (SCP) captured only 46 *Artibeus* during the entire year, and only one animal at the site that had been so successful for Jones and Baker in 1978.

Considering the number of nights spent netting at higher elevations, the number of *Monophyllus* collected was much reduced as compared to similar collections at the same sites by Pierson et al. (1986) in 1984 (Table 3). Because native and small-sized cultivated fruits are found at much higher elevations, it is not surprising that Jones and Baker (1979) did not find *Monophyllus* along the Belham Valley River. Indeed, bottom land along the Belham Valley River has been developed as a golf course and is dominated by large fig and almond trees (*Prunus* spp.). Only the large frugivores (*Artibeus*, *Brachyphylla*) were successful at ripping open these large, tough fruits.

Monophyllus, *Ardops*, *Artibeus*, *Sturnira*, and *Brachyphylla* composed the frugivore guild (Gardner, 1977) on Montserrat in 1994. Before Hugo, *Monophyllus*, *Ardops*, and *Artibeus* dominated this group (95% of all captures). Five years after the hurricane, *Monophyllus*, *Ardops*, and *Artibeus* composed only 54% of this group. This change is due

to the apparent dramatic increase in the *Brachyphylla* population: 4% of all pre-Hugo frugivore captures, 45% of all post-Hugo frugivore captures (Table 3). Frugivores were seriously affected by Hugo because of habitat destruction, whereas the more omnivorous *Brachyphylla* may have been able to capitalize on abundant insect populations and remaining hardy fruits after the hurricane. These results are similar to those found for bats on Puerto Rico (Gannon and Willig, 1994) and for birds in the Greater Antilles and on the mainland (Waide, 1992a, 1992b; Askins and Ewert, 1992; Lynch, 1992; Will, 1992) following the impact of a hurricane. Apparently, the non-frugivores, *Molossus* and *Noctilio*, were only marginally affected by Hugo.

After Hurricane Hugo struck Puerto Rico, populations of *Artibeus jamaicensis* and *Stenoderma rufum* decreased but not in a similar pattern. The *Artibeus* population decreased immediately, but rebounded after two years, probably because this strong-flying species moved to unaffected areas on Puerto Rico and then quickly reinvaded the damaged areas as conditions improved. The *Stenoderma* population, which was limited to the tabonuco rain forest on Puerto Rico, declined slowly, but did not recover and finally approached extirpation (Gannon and Willig, 1994). Reproductive data from our study are meager (Table 2), but this paucity may be related to similar crashes in reproduction noted by Gannon and Willig (1994) on post-Hugo Puerto Rico. There, 93% of female *Stenoderma rufum* were breeding before Hugo but decreased to 29% post-Hugo. The reproductive data available for Montserrat do not appear to deviate significantly from reproduction patterns known for these animals on adjacent islands (Baker et al., 1978; Wilson, 1979). Because of the great difference in land mass, it will be important to monitor bat communities on both Montserrat and Puerto Rico over the next decade to determine if pre-Hugo population levels and composition of the community will recover and how these recovery events compare on these two very different islands.

Birds in the Caribbean experienced similar population changes to that shown by

bats on Montserrat following hurricane-caused destruction. In areas on St. John, Puerto Rico, Mexico, and Nicaragua, resident populations of frugivorous and nectivorous species of birds decreased immediately following the hurricane. Populations had partially or fully recovered within 10 to 18 months on the larger island of Puerto Rico and the mainland areas, but had not recovered on the small island of St. John. Resident populations of omnivorous and insectivorous birds were not affected, and on Puerto Rico actually displayed a relative increase in abundance. Researchers have attributed these population trends in birds, as we do for populations of bats, to the shortage of food faced by frugivores and nectivores following a hurricane and the unchanged or even increased food resources available for insectivores and omnivores at such times (Waide, 1992a, 1992b; Askins and Ewert, 1992; Lynch, 1992; Will, 1992). Waide (1992a) believed that the existence of many generalist species of birds on the smaller Caribbean islands may be related to their susceptibility to repeated hurricanes. We believe that a comparable situation prevails for species of bats on the smaller Caribbean islands such as Montserrat.

Four taxa of bats previously reported from Montserrat (Koopman, 1968, 1989; Jones and Phillips, 1970; Varona, 1974; Baker and Genoways, 1978; Pierson et al., 1986) were not collected in 1993–1994: *Chiroderma improvisum* Baker and Genoways, 1976; *Natalus stramineus stramineus* Gray, 1838; *Myotis nigricans dominicensis* Miller, 1902; and *Tadarida brasiliensis antillarum* (Miller, 1902). However, specimens of three of these taxa have been recorded from Montserrat including *Chiroderma improvisum* (Jones and Baker, 1979; Pierson et al., 1986), *Natalus stramineus* (Koopman, 1968), and *Tadarida brasiliensis antillarum* (Shamel, 1931). Varona (1974) reported *Myotis nigricans* from Montserrat, but as stated by Jones (1989) Varona “did not divulge the basis for this record.” Although there is no solid basis for including *Myotis* in the chiropteran fauna of Montserrat, we would not be surprised if it is added in the future. LaVal (1973) reported *Myotis dominicensis* from Dominica and Masson and Breuil (1992)

have found this species on Guadeloupe to the south of Montserrat, and Husson (1960) reported a specimen of *Myotis* from St. Martin to the north of Montserrat under the name *Myotis nigricans nesopolus*. Clearly, the distribution and systematic of small *Myotis* in the Lesser Antilles need additional study.

Sturnira thomasi first reported from Montserrat in this paper was originally described and known only from the island of Guadeloupe. *Chiroderma improvisum* Baker and Genoways, 1976, a bat previously thought to be endemic to Guadeloupe, has been found on Montserrat as well (Jones and Baker, 1979). We suspect that *Eptesicus guadeloupensis* Genoways and Baker, 1975, a third species endemic to Guadeloupe, may also be found on Montserrat (Genoways and Baker, 1975). Of the 12 species of Chiroptera that we believe could potentially occur on Montserrat, 10 are confirmed by existing specimens.

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LITERATURE CITED

- Askins, R. A., and D. N. Ewert. 1992. Impact of Hurricane Hugo on bird populations on St. John, U. S. Virgin Islands. *Biotropica* 23:481-487.
- Baker, R. J., and H. H. Genoways. 1978. Zoogeography of Antillean bats. *Acad. Nat. Sci. Philadelphia, Spec. Publ.* 13:563-597.
- Baker, R. J., H. H. Genoways, and J. C. Patton. 1978. Bats of Guadeloupe. *Occas. Papers Mus., Texas Tech Univ.* 50:1-16.
- Brokaw, N. V. L., and L. R. Walker. 1992. Summary of the effects of Caribbean hurricanes on vegetation. *Biotropica* 23:442-447.
- Bronstein, J. L., and M. Hossaert-McKey. 1995. Hurricane Andrew and a Florida fig pollination mutualism: Resilience of an obligate interaction. *Biotropica* 27:373-381.
- Covich, A. P., T. A. Crowl, S. L. Johnson, D. Varza, and D. L. Certain. 1992. Post-Hurricane Hugo increases in atyid shrimp abundance in a Puerto Rican montane stream. *Biotropica* 23:448-454.
- de la Torre, L., and A. Schwartz. 1966. New species of *Sturnira* (Chiroptera: Phyllostomidae) from the islands of Guadeloupe and Saint Vincent, Lesser Antilles. *Proc. Biol. Soc. Washington* 79:297-303.
- Gannon, M. R., and M. R. Willig. 1994. The effects of Hurricane Hugo on bats of the Luquillo Experimental Forest of Puerto Rico. *Biotropica* 26:320-321.
- Gardner, A. L. 1977. Feeding habits. In Baker, R. J., J. K. Jones, Jr., and D. C. Carter (eds.), *Biology of bats of the New World family Phyllostomatidae. Part II. Special Publ. Mus., Texas Tech Univ.* 13:293-250.
- Genoways, H. H., and R. J. Baker. 1975. A new species of *Eptesicus* from Guadeloupe, Lesser Antilles (Chiroptera: Vespertilionidae). *Occas. Papers Mus., Texas Tech Univ.* 34:1-7.
- Genoways, H. H., and J. K. Jones, Jr. 1975. Additional records of the stenodermine bat, *Sturnira thomasi*, from the Lesser Antillean Island of Guadeloupe. *J. Mamm.* 56:924-925.
- Husson, A. M. 1960. De zoogdieren van de Nederlandse Antillen (Mammals of the Netherland Antilles). *Uitg. Natuurwet. Werkgr.* pp. 170. N. A., Curacao, 12, Martinus Nijhoff, Gravenhage.
- Jones, J. K. Jr. 1989. Distribution and systematic of bats in the Lesser Antilles. In C. A. Woods (ed.), *Biogeography of the West Indies*, pp. 645-660. Sandhill Crane Press, Inc., Gainesville, Florida.
- Jones, J. K. Jr., and R. J. Baker. 1979. Notes on a collection of bats from Montserrat, Lesser Antilles. *Occas. Papers Mus., Texas Tech Univ.* 60:1-6.
- Jones, J. K., Jr., and H. H. Genoways. 1975. *Sturnira thomasi*. *Mamm. Spec.* 68:1-2.
- Jones, J. K., Jr., and C. J. Phillips. 1970. Comments on the systematic and zoogeography of bats in the Lesser Antilles. *Stud. Fauna Curacao and other Carib. Is.* 32:131-142.
- Jones, J. K., Jr., and C. J. Phillips. 1976. Bats of the genus *Sturnira* in the Lesser Antilles. *Occas. Papers Mus., Texas Tech Univ.* 40:1-16.
- Koopman, K. F. 1968. Taxonomic and distributional notes on Lesser Antillean bats. *Amer. Mus. Novitates* 2333:1-13.
- Koopman, K. 1989. Distribution and systematic of bats in the Lesser Antilles. In C. A. Woods (ed.), *Biogeography of the West Indies*, pp. 635-644. Sandhill Crane Press, Inc., Gainesville, Florida.
- LaVal, R. K. 1973. A revision of the Neotropical bats of the genus *Myotis*. *Sci. Bull., Nat. Hist. Mus. Los Angeles Co.* 15:1-54.
- Lynch, J. F. 1992. Effects of Hurricane Gilbert on birds in a dry tropical forest in the Yucatan Peninsula. *Biotropica* 23:488-496.
- Masson, D., and M. Breuil. 1992. Un *Myotis* (Chiroptera, Vespertilionidae) en Guadeloupe (Petites Antilles). *Mammalia* 56:473-475.
- Pierson, E. D., and R. M. Warner. 1990. Chapter: Bats. In J. R. Blankenship (ed.), *The Wildlife of Montserrat*, pp. 91-96. Publ. Montserrat National Trust, Montserrat, West Indies.
- Pierson, E. D., W. E. Rainey, R. M. Warner, and C. C. White-Warner. 1986. First record of *Monophyllus* from Montserrat, West Indies. *Mammalia* 50:269-271.
- Reagan, D. P. 1992. The response of *Anolis* lizards to hurricane-induced habitat changes in a Puerto Rican rain forest. *Biotropica* 23:468-474.
- Shamel, H. H. 1931. Notes on the American bats of the genus *Tadarida*. *Proc. U. S. Nat. Mus.* 78(19):1-27.
- Varona, L. S. 1974. Catalogo de los mamiferos vivientes y extinguidos de las Antillas. *Acad. Cien. Cuba, Habana*, 139 pp.
- Waide, R. B. 1992a. The effect of Hurricane Hugo on bird populations in the Luquillo Experimental Forest, Puerto Rico. *Biotropica* 23:475-480.
- Waide, R. B. 1992b. Summary of the response of animal populations to hurricanes in the Caribbean. *Biotropica* 23:508-512.
- Walker, L. R., D. J. Lodge, N. V. L. Brokaw, and R. B. Waide. 1992. An introduction to hurricanes in the Caribbean. *Biotropica* 23:313-316.
- Will, T. 1992. Birds of a severely hurricane-damaged Atlantic coast rain forest in Nicaragua. *Biotropica* 23:497-507.
- Willig, M. R., and G. R. Camilo. 1992. The effect of Hurricane Hugo on six invertebrate species in the Luquillo Experimental Forest of Puerto Rico. *Biotropica* 23:455-461.
- Wilson, D. E. 1979. Reproductive patterns. In R. J. Baker, J. K. Jones, Jr., D. C. Carter (eds.), *Biology of bats of the New World Family Phyllostomidae. Part III. Spec. Publ. Mus., Texas Tech Univ.* 16:317-377.
- Woolbright, L. L. 1992. The impact of Hurricane Hugo on forest frogs in Puerto Rico. *Biotropica* 23:462-467.