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Ultraviolet Light Reveals Cryptic Markings in Greater Antillean Long-tongued Bats (*Monophyllus redmani*) from Puerto Rico

Allen Kurta[1,*], Cara Rogers[1,2], Haley J. Gmutza[3], Ashley K. Wilson[1], Brian A. Schaetz[1], Olivia M. Münzer[1, 4], Robin M. Kurta[5], and Mark Kurta[1]

Abstract - Many *Monophyllus redmani* (Greater Antillean Long-tongued Bat) from Puerto Rico possessed small patches of white hairs that were difficult to discern in normal light, but they were easily differentiated under ultraviolet. Using photos taken with ultraviolet light, we showed that 53% of 91 adults possessed piebald spots; these marks were more common in females (67%) than males (29%), and spotting was more extensive in females than males. Individual bats could be identified, based on their markings. Similar spots occurred on museum specimens of *M. redmani*, from Hispaniola and Jamaica, and on *M. plethodon* (Insular Single-leaf Bat), from the Lesser Antilles. Determining the frequency, extent, and pattern of spotting may be another tool for examining gene flow among the islands of the West Indies.

Introduction

Biologists are often intrigued by atypical structures in adult animals. Gross abnormalities, such as missing, misshapen, or extraneous appendages, are often described (e.g., Bateman et al. 2022, Pourlis 2011), as are more subtle anomalies, such as supernumerary nipples or teeth (e.g., Hsu et al. 2000, Wolsan 1984). Although these and comparable abnormalities are frequently viewed as simple novelties, quantifying such phenotypic variation ultimately may help biologists investigate gene flow between groups and possibly phylogenetic relatedness among taxa (Esquivel et al. 2021, Glass 1954).

Chromatic aberrations, i.e., atypical coloration of the skin or fur, are the most commonly reported abnormalities in bats (Lucati and López-Baucells 2017, Ruckert da Rosa et al. 2017, Zalapa et al. 2016). Most instances have a genetic cause (Baxter et al. 2004, Caro and Mallorino 2020, Dessinioti et al. 2009, Hoekstra 2006), whereas environmentally induced changes (Constantine 1958, Heise 1990) are rare. Genetically controlled color abnormalities occasionally involve excess melanin (melanism) or altered pigment composition (e.g., flavism), but most are examples of hypopigmentation, which is the absence of melanin resulting from improper development of melanocytes (Hoekstra 2006).

Three broad types of hypopigmentation exist in bats (Lucati and López-Baucells 2017). Albinism involves total loss of pigment from the fur, skin, and eyes, whereas leucism entails complete loss of melanin from hair and skin but not the eyes. Piebaldism is similar to leucism in that the eyes are pigmented, but there is only a partial absence of pigment from the skin and/or fur. Thus, a piebald animal has white spots, blotches, or other markings on an otherwise normally colored integument. Most cases of hypopigmentation in bats are cases of albinism or piebaldism.

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Monophyllus redmani Leach (Greater Antillean Long-tongued Bat) is a small (6–15 g) phyllostomid nectarivore that is endemic to Cuba, Hispaniola, Jamaica, Puerto Rico, and the southern Bahamas (Rodríguez-Durán and Kurta 2023). Dorsal hairs vary from gray to smoky brown, whereas ventral hairs typically are tipped with a band of cream or silver that imparts an overall lighter appearance to the venter; similarly tipped hairs also form a collar at the dorsal neckline and/or a mid-dorsal stripe along the back of some individuals. Although the species was first described more than 200 years ago (Leach 1821) and its physical attributes have been detailed numerous times (Gannon et al. 2005, Genoways et al. 2005, Homan and Jones 1984, Rodríguez-Durán and Christenson 2012, Schwartz and Jones 1967; Silva Taboada 1979), no examples of hypopigmentation or any other chromatic aberration have been reported.

In 2007, 3 of the authors (AK, BAS, OMM) initiated a long-term study of ectoparasites gathered from adult *M. redmani*, at Culebrones Cave on Puerto Rico (Kurta et al. 2010). While examining each bat under a dissecting microscope (10x), the authors frequently noticed obscure patches of hairs (1–4 mm in width) that were white from the base to the tip and located primarily on the head; all bats had normally pigmented eyes and skin and showed no evidence of injury or scarring near the white hairs. Incidental notes made during those inspections mentioned spotting on 33 individuals that were captured in May, September, and November 2007, as well as February 2008, and similar marks were observed on 18 bats in January and February 2019 (Kurta and Whitaker 2019). During this latter period, the senior author borrowed an ultraviolet flashlight and examined the fur of a few bats for bioluminescence. Although none glowed pink, green, blue, or lavender (Toussaint et al. 2021), the obscure white spots were suddenly no longer difficult to discern but were starkly contrasted against the normal, darker-colored hairs (Fig. 1).

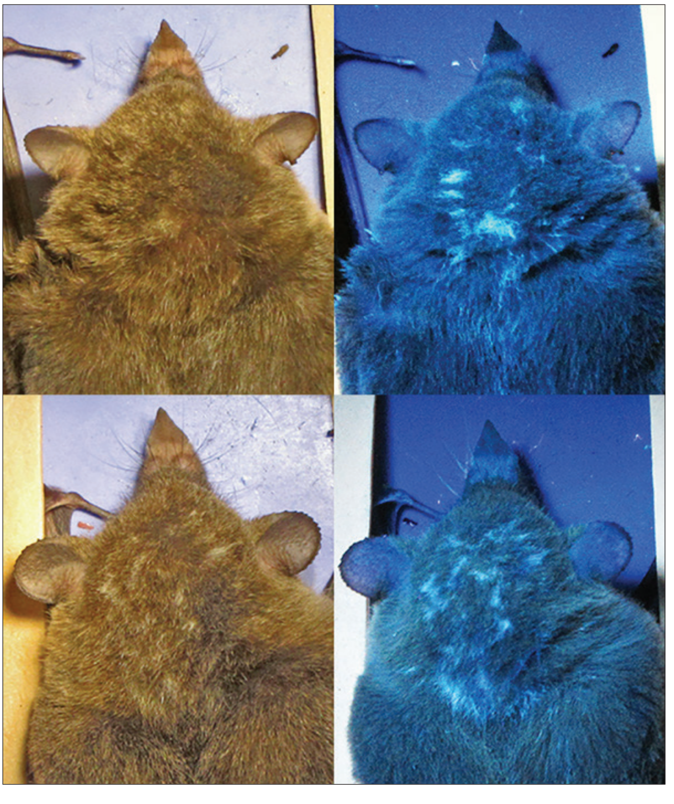

Figure 1. Photographs of the heads of 2 adult *Monophyllus redmani* taken under white light (left) and ultraviolet light (right), in January 2023, showing the presence of white markings. In all photos, width of the snout immediately behind the nose leaf is about 3 mm, and distance from right ear tip to left ear tip is about 24 mm.

The purpose of the current project was to detail the occurrence of white spots in *M. redmani*, using ultraviolet light. Our goals were to quantify the frequency of piebald individuals in the population, to determine whether differences occurred in the frequency or extent of the markings between adult males and females, and to examine whether the pattern of spotting was affected by body size. In addition, we investigated whether these markings were sufficiently variable and common for use as a biometric indicator (Hoque et al. 2011), allowing the identification of individual animals, as in much larger vertebrates, ranging from fish (Kitchen-Wheeler 2010) to felids (Kelly 2001). A final goal was to assess whether spotting was unique to Culebrones Cave or whether these marks also occurred at other locations in the West Indies.

Field-site Description

We captured *M. redmani* at Mata de Plátano Field Station and Nature Reserve (https://oire.bayamon.inter.edu/fieldstation/), which is jointly operated by Universidad Interamericana and a private conservation group, Ciudadanos del Karso. The station is located 7 km SW of Arecibo (18°24'51.59" N, 66°43'43.58" W), in the karst region of northwestern Puerto Rico, and consists of 54 ha of subtropical, successional forest. We caught the bats near Culebrones Cave, a 600-m-long "hot cave" (Ladle et al. 2012) that is used as a day-roost by 75,000–160,000 mormoopid and phyllostomid bats from 6 species, including an estimated 2300–4700 *M. redmani* (Rodríguez-Durán et al. 2023).

Methods

To capture bats, we primarily used mist nets set in forest openings and over trails and occasionally set a harp trap at the entrance to the cave. We deployed nets alone on 32 evenings; netting and trapping occurred simultaneously on 1 night, and trapping alone happened on 2 additional dates, for a total effort of 34 nights. We caught bats between 29 December 2022 and 11 February 2023, mostly between 1 and 4 hours after sunset.

After capture, each *M. redmani* was carried in a cloth bag to the station laboratory, where the animal was examined and photographed before being released unharmed. The bat was sexed, aged (adult vs. juvenile, based on phalangeal ossification), weighed on a portable electronic balance, and had the length of the right forearm measured with dial calipers. In addition, we clipped the tips of hairs in a 5-mm-long section of fur on the right hip with iris scissors, to ensure that we did not include recaptures in our analyses. Average handling time in the laboratory, from opening the holding bag to releasing the animal, was 9.3 ± 1.2 (*SD*) minutes, based on a sample of 16 animals collected over 4 evenings.

We photographed each bat with an inexpensive, auto-focusing, digital camera (Power Shot ELPH 360HS, Canon, Melville, New York), with macro mode selected and flash disabled. Our parasite examinations indicated that spotting was restricted to the dorsal fur, so we only photographed the back of the animal's body and head for the current study. Before taking pictures, the fur was gently brushed from the ears to the rump, so that the hairs laid flat and covered the underlying skin. After mounting the camera on a table-top tripod, we took multiple photographs at different magnifications, using white light and then ultraviolet, in a room that otherwise was totally dark. The white light was produced by a headlamp developed for cavers (Stenlight S7+, Karst Sports, Fairmont, West Virginia), whereas the ultraviolet (385 nm) was supplied by a small (15-cm-long), low-intensity flashlight used by mineral collectors (51 LED UVA Flashlight, WayTooCool, Glendale, Arizona). Lights were supported on ring stands, and the ultraviolet flashlight was positioned behind and to the side of the bat to prevent direct ultraviolet radiation from entering the animal's eyes (Majdi et al. 2014). All personnel wore protective goggles, and animal-handling techniques were approved by the Institutional Animal Care and Use Committee of Eastern Michigan University (#2022-107).

Preliminary observations confirmed that white hairs in the dorsal fur often were not distinct in full-spectrum light (Fig. 1), so we visually determined the presence/absence of hypopigmented spots and their location on the body based solely on photographs taken under ultraviolet. We subjectively placed each animal into a category of zero, low, medium, or high that represented the size, extent, and intensity of white markings that were present. We also recorded whether white spots were located anterior to the ears (front of head), between the ears (middle of head), from the posterior edge of the ears to the shoulders including the neckline (back of head), or from the shoulders to the rump (body). We only considered clumps of completely white hairs and did not quantify other types of aberrations, such as occasional black patches that presumably represented clusters of melanistic hairs.

To determine whether individual bats could be identified by their markings, the senior author first created a photo library, with 1 high-quality picture of every bat with spots. Using different photos of each animal, he assembled 3 sets of photographs, each including 10 different bats that were selected from the overall sample of spotted animals with the aid of a random-number generator (https://www.calculator.net/random-number-generator.html). Three of the authors (AKW, CR, and HJG) were each assigned one of the randomly generated sets of 10 photos and were asked to identify the individuals, based on visual comparison with photos in the library.

To ascertain whether cryptic spotting was unique to Culebrones Cave, we photographed study skins that were housed at the Royal Ontario Museum, in Toronto, Canada, on 28 April 2023. However, unlike our field methods, we did not brush the fur prior to taking pictures, to prevent damage to the fragile specimens. We examined skins of *M. redmani* from each of the main islands of the Greater Antilles, and we also photographed specimens of *Monophyllus plethodon* Miller (Insular Single-leaf Bat), a species that is endemic to the Lesser Antilles and the only other member of the genus.

Statistics

We used chi-squared tests of independence to determine whether spotting occurred with equal frequency between males and females and whether the frequency of spotting on the head versus the body varied between sexes. Because of the presence of zeros in some cells, we calculated Fisher's exact probability to assess whether amount of spotting (zero, low, medium, or high) differed among males and females. We used an analysis of variance to examine whether forearm length or body mass differed among females having zero, low, medium, or high spotting, and a *t* test to decide whether body size varied between males with versus without markings. Means are stated ± *SD*, and alpha was set at 0.05 for all statistical tests. All statistical procedures were described and performed in VassarStats (http://vassarstats.net/).

Results

During the 34 nights, we captured 36 male and 58 female *M. redmani*. One male, however, had a large bald spot (8 by 3 mm) on the head, and that animal was deleted from the sample. Additionally, we removed 1 male and 1 female that were mistakenly photographed under ultraviolet while the white light remained on, making detection of spots uncertain. Thus, 91 individuals, 34 males (37%) and 57 females (63%) were available for determination of spotting patterns. Because early winter is largely a period of reproductive quiescence in this seasonally breeding species (Gannon et al. 2005), all individuals were classified as adults, and most (88%) showed no overt signs of reproductive activity.

Forty-eight animals (53%) displayed white patches under ultraviolet light (Table 1), and the trait exhibited variable expressivity (Zlotogora 2003), with differences in the intensity and location of white marks among different bats. The pattern of markings was never bilaterally symmetrical. Individual spots and lines were often ≤ 2 mm in greatest dimension, but adjacent marks frequently connected, resulting in complex patterns (Fig. 1) that were unique to each individual. Based on the size, shape, and location of the markings, each of the 3 authors correctly identified the 10 randomly selected photos that they had been assigned.

Spotting was less frequent ($X^2_1 = 10.41$, $P = 0.001$) in males (29%) than females (67%). Furthermore, the amount of white markings differed between the sexes (Fisher's Exact $P < 0.0001$); all 10 spotted males were classified as low, whereas 32 (84%) of the 38 females with white spots were labeled as medium or high. Male and female *M. redmani* did not differ in whether markings occurred anywhere on the head versus the body ($X^2_1 = 0.26$, $P = 0.78$). Only about half (54%) the marked animals had any spots or lines on the body behind the neck, but these were never dense and rarely widespread. However, all spotted bats displayed some marks on the back of the head, and 95% of these animals also had white areas between the pinnae. Only 52% of affected bats exhibited spots anterior to the ears.

Body mass was not measured for 8 animals when the balance malfunctioned, and 1 bat was mistakenly released before its forearm was measured, which left 83 measurements of body mass and 90 for forearm length (Table 1). For males, neither body mass ($t_{30} = 0.16$, $P = 0.36$) nor forearm length ($t_{32} = 0.82$, $P = 0.42$) differed between animals with spots versus those without markings. Similarly, in females, body mass ($F_{3,\,49} = 0.86$, $P = 0.47$) and forearm length ($F_{3,\,52} = 0.92$, $P = 0.44$) were statistically the same among groups having zero, low, medium, or high spotting.

Table 1. Number of males and females, forearm lengths, and body masses for different categories of piebald spotting in adult *Monophyllus redmani* from Puerto Rico. All means are ± *SD*, followed by *n*.

Variable	Amount of spotting				Mean
	Zero	Low	Medium	High	
Number of males	24	10	0	0	
Number of females	19	6	19	13	
Mean forearm length of males (mm)	36.9 ± 3.4, 24	36.7 ± 2.8, 10			36.8 ± 4.4, 34
Mean forearm length of females (mm)	36.7 ± 1.1, 18	37.1 ± 0.9, 6	36.7 ± 0.7, 19	36.4 ± 0.6, 13	36.6 ± 0.8, 56
Mean body mass of males (g)	8.8 ± 2.3, 20	8.6 ± 1.4, 10			8.8 ± 2.8, 30
Mean body mass of females (g)	8.9 ± 0.8, 17	9.1 ± 0.9, 5	8.7 ± 0.6, 19	8.6 ± 0.6, 12	8.8 ± 0.7, 53

At the Royal Ontario Museum, we examined 38 dry specimens of adult *M. redmani*, including 5 from Puerto Rico, 6 from Cuba, 11 from Hispaniola, and 16 from Jamaica (Table 2, App. 1). One bat from the municipality of Corozal and 2 from Aguas Buenas, Puerto Rico, exhibited white markings; these sites were about 45 and 70 km, respectively, east of Mata de Plátano. Similarly, we detected such marks on 3 bats from Hispaniola and 13 from Jamaica (Fig. 2), although none of the 6 Cuban bats appeared spotted. Similar to the bats at

Table 2. Frequency of piebaldism in male and female *Monophyllus*, based on 44 study skins in the collection of the Royal Ontario Museum.

Species	Location	Number of bats examined	Number of bats with white marks (male:female)	Number of bats without white marks (male:female)
M. redmani	Cuba	6	0:0	3:3
	Hispaniola	11	1:2	7:1
	Jamaica	16	0:13	1:2
	Puerto Rico	5	0:3	2:0
	Total	38	1:18	10:3
M. plethodon	Barbados	1	0:1	0:0
	Montserrat	5	2:2	1:0
	Total	6	2:3	1:0

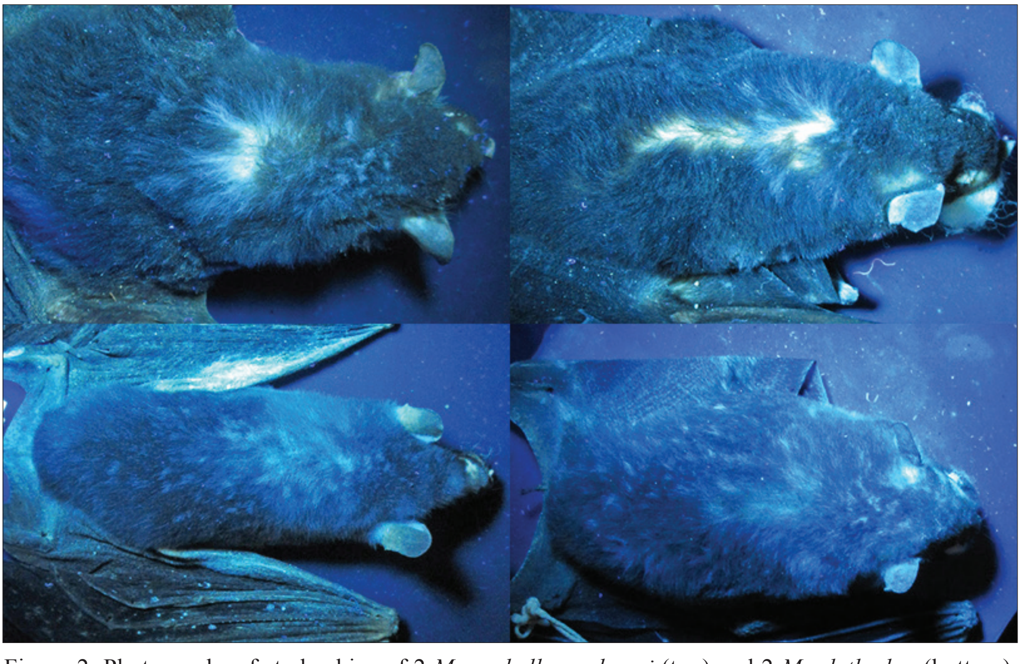

Figure 2. Photographs of study skins of 2 *Monophyllus redmani* (top) and 2 *M. plethodon* (bottom), taken under ultraviolet light at the Royal Ontario Museum (ROM), on 28 April 2023. Capture localities and dates were as follows: Jamaica, 7 March 1984 (ROM #90008; top left); Hispaniola, 2 February 2015 (#125392; top right); Barbados, 13 May 1975 (#74345; bottom left); and Montserrat, 25 May 2019 (#126437; bottom right). The fur was not brushed before photography, and bright areas with a yellowish tint on the body represent the dried epidermis at the base of parted hairs.

Culebrones Cave, the study skins suggested a sexual bias; 95% of *M. redmani* with white spots from the museum were female, whereas 77% of unmarked bats were male (Table 2). However, in contrast to the animals caught near Culebrones Cave, 85% of the animals from Jamaica (11 of 13) had diffuse white marks on the body behind the neck, and these were often widespread (Fig. 2).

In addition to *M. redmani*, we photographed 6 study skins of *M. plethodon*, comprising 5 specimens from Montserrat and 1 animal from Barbados. All *M. plethodon*, except 1 male from Montserrat, had obvious white markings (Fig. 2). The study skins of *M. redmani* with white spots were collected during 4 decades, the 1960s–1980s and 2010s, and those of *M. plethodon* were obtained in 1975 and 2019 (App. 1), indicating that piebald spotting is not a new phenomenon.

Discussion

The occurrence of albinism, leucism, and piebaldism is widespread geographically and taxonomically among mammals (Abreu et al. 2013, Mahabal et al. 2019, Romero et al. 2018), including bats (Lucati and López-Baucells 2017, Münzer and Kurta 2008, Ruckert da Rosa et al. 2017, Zalapa et al. 2016). Most observations, though, involve fortuitous encounters with an affected bat. Consequently, the frequency of these chromatic disorders in any given population is seldom known, and when the rate of occurrence is quantified, it is usually low. For example, among 16 species of bat, the average incidence of color abnormalities was only 0.3 ± 0.6 % (Boada and Tirira 2010, Cichocki et al. 2017, da Silva Reis et al. 2019, López Baucells et al. 2013, López-Wilchis and León Galván 2012).

At Culebrones Cave, though, piebald *M. redmani* were unusually common, with 53% of all individuals displaying white spots (Table 1). Only 2 other studies of bats, both dealing with molossids, reported such a high rate of incidence. Glass (1954) found white hairs along the lower jaw of 60% (n = 60) of *Tadarida brasiliensis* (I. Geoffroy St. Hilaire) (Brazilian Free-tailed Bat) captured at 2 caves in Texas, and Smith et al. (2019) discovered that 81% (n = 172) of *Eumops floridanus* (G. M. Allen) (Florida Bonneted Bat) from 1 location in east-central Florida displayed extensive white patches on the body.

Most reports of piebald bats involve large splotches of white hairs that are easily seen when the animal is held or even observed at a distance. Indeed, most reports of hypopigmented bats are from dark roosts, like caves or buildings (Lucati and López-Baucells 2017), where the affected animal becomes conspicuous in the beam of a headlamp. However, the cryptic spots on piebald *M. redmani* could never be discerned on such a tiny mammal hanging high on the ceiling of a cave, and the marks are not readily apparent even when the animal is in hand, which explains why this common phenomenon has not been reported previously.

Quantitative comparisons of body size, age, sex, or any other parameter of bats with aberrant markings to those with a normal appearance are rare, probably because of consistently small samples. For example, 97% of the 354 reports of hypopigmentation catalogued by Lucati and López-Baucells (2017) involve 4 or fewer individuals, with a mode of 1. Herreid and Davis (1960), though, examined over 40,000 Brazilian free-tailed bats and indicated that white hairs were more common in older males than older females, with age based on tooth wear, and Červený (1980) claimed that hypopigmentation in *Barbastella barbastellus* Schreber (Western Barbastelle) was more common in males than females; however, neither study provided statistical support for their conclusions. In the only statistical analysis involving chromatic aberrations in bats, Smith et al. (2020) noted no difference in the frequency of piebaldism, based on sex, age, or reproductive condition, for the Florida Bonneted Bat.

Although we could not test for an effect of age or reproductive status, because of the time of year during which our study occurred, our data suggest that spotting in *M. redmani* is a sex-influenced trait. Near Culebrones Cave, white marks were more than twice as common on adult females (67%) than adult males (29%), and the amount and intensity of spotting was significantly greater in females (Table 1). Furthermore, 75% of the 24 female museum specimens of this species had spots, compared with only 9% of the 14 males (Table 2).

Reports of hypopigmented bats occasionally state that the body size of an affected animal is within the "normal range" (Ruckert da Rosa et al. 2017:74) or is "consistent" with measurements reported for the species (Boada and Tirira 2010:756). However, our project is the first to demonstrate statistically that size (mass and forearm length) of a large sample of piebald bats is the same as that of unaffected animals that were measured at the same time and location. Although the genes responsible for chromatic aberrations often have deleterious pleiotropic effects (Reissmann and Ludwig 2013), the similarity in body size between marked and unmarked *M. redmani*, as well as the high frequency of spotting in the population, indicates that this trait is not maladaptive, nor is it likely related to nutritional or other forms of physiological stress (Zhang et al. 2020).

Although identifying individual animals from differing patterns of pigmentation in skin, scales, plumage, or fur is a common tool (Hoque et al. 2011), the technique has previously been applied only once to bats, the second largest order of mammals. Hodgkison et al. (2003) successfully recognized individuals of a small pteropodid, *Balionycteris maculata* (Thomas) (Spotted-wing Fruit Bat), in Peninsular Malaysia, based on the arrangement of cream-colored marks on the skin of the wings. Our brief study shows that spotted *M. redmani* can be differentiated based on their pelage markings. However, the most useful biometric indicators are those that are universally found in a population (Jain et al. 2004), and presence of white spots on only 53% of the bats (67% of females) near Culebrones Cave would limit applicability of the technique at that specific location.

Nevertheless, our work demonstrates that these highly variable markings are unique to each animal, and this method of individual recognition could readily be extended to other populations of *M. redmani* or to species in which aberrant or normal spotting occurs with greater frequency. For example, all individuals of *Glauconycteris superba* Hayman (Pied Butterfly Bat), *Casinycteris argynnis* Thomas (Short-palated Fruit Bat), and *Nyctimene robinsoni* Thomas (Eastern Tube-nosed Fruit Bat), as well as their congeners, have large, obvious marks that seem to vary from animal to animal (Hassanin 2014, Ing et al. 2016, Reinhold 2022), and many other species have smaller lines or spots (Santana et al. 2011) that may be sufficiently variable in size, shape, and location to identify individuals. Given the detrimental effects of many marking techniques (e.g., Ellison 2008), a non-invasive approach to identification, using physical characteristics of the animals, is worth pursuing.

Studying the obscure white spots and lines in *M. redmani* required use of ultraviolet light to visualize the hypopigmented areas. The pattern of vivid white marks against a dark background in this bat (Fig. 1) appears similar to the white and black stripes on the body of *Dactylopsila trivirgata* Gray (Striped Possum), when it is illuminated with ultraviolet. In that marsupial, the white stripes "glow" against the backdrop of neighboring black bands (Reinhold 2021:3), because the white fur of the possum photoluminesces while the adjacent dark hairs absorb the short-wave radiation (Reinhold 2023). High visual contrast from the differential reflection, absorption, or photoluminescence of ultraviolet light is a well-known biophysical phenomenon (Cronin and Bok 2016, Silberglied 1979), helping birds to distinguish ripe fruits (Tedore and Nilsson 2021), cervids to find lichens in a snow-covered landscape (Tyler et al. 2014), nectarivorous bats to detect flowers in a cluttered forested (Domingos-Melo et al. 2021, Winter et al. 2003), and even biologists to count seals on floating ice packs (Lavigne 1976). Future studies of micro-differences in pelage markings, among or within populations of other small mammals, might benefit from the use of ultraviolet light, and it may reveal that the frequency of piebaldism is higher than previously reported.

Although a field survey throughout the West Indies or a comprehensive study of specimens of *Monophyllus* in North American museums is beyond the scope of this project, our visit to the Royal Ontario Museum shows that cryptic markings are not unique to Mata de Plátano, the island of Puerto Rico, or even the Greater Antilles. In other wild mammals, a high frequency of chromatic aberrations is rare and typically is reported from only a small, isolated population (e.g., Lidicker 1963, Parsons and Bondrup-Nielsen 1995). However, cryptic spotting in *M. redmani* appears common in multiple populations separated by up to 1,000 km, on Hispaniola, Jamaica, and Puerto Rico, and probably on other small and large islands in the Greater Antilles and Bahamas.

Cryptic marks also occur in *M. plethodon*, which lives up to 850 km from Puerto Rico, but unlike *M. redmani*, *M. plethodon* usually forms small colonies of fewer than 100 individuals and roosts in cooler caves (Soto-Centeno 2023). Presence of spots on *M. redmani* that were captured on different islands, during various months, and over multiple decades, as well as on individuals of a closely related species with a different lifestyle, reinforces the view that piebald markings in *M. redmani* do not result from site-specific conditions and likely are genetically controlled, as in other mammals (Baxter et al. 2004, Dessinioti et al. 2009). Future work could examine whether the patterns that we observed in *M. redmani* change with age or reproductive status, by capturing animals throughout summer, when volant juveniles are abundant and adults in various reproductive conditions are present. Nevertheless, detailed examination of the frequency, extent, and pattern of spotting in different populations of either species of *Monophyllus* may be another tool that provides insight into gene flow within and among the islands of the West Indies (Esquivel et al. 2021, van der Geer 2019).

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Appendix 1. Specimens of *Monophyllus plethodon* and *M. redmani* examined at the Royal Ontario Museum. D.R. = Dominican Republic.

Species	Catalog number	Date of capture (year-month-day)	Sex	Spots (1 = yes; 0 = no)	Island	General location
M. plethodon	74345	19750513	F	1	Barbados	Harrison's Cave
	126437	20190525	M	1	Montserrat	Ginger Ground
	126438	20190525	M	1	Montserrat	Ginger Ground
	126445	20190527	F	1	Montserrat	Lower Cot
	126446	20190527	F	1	Montserrat	Lower Cot
	126455	20190528	M	0	Montserrat	Blackwood Allen
M. redmani	63146	19710801	M	0	Cuba	Cueva de los Murciélagos
	63147	19710801	M	0	Cuba	Cueva de los Murciélagos
	63148	19710801	M	0	Cuba	Cueva de los Murciélagos
	63149	19710801	F	0	Cuba	Cueva de los Murciélagos
	63150	19710801	F	0	Cuba	Cueva de los Murciélagos
	63151	19710801	F	0	Cuba	Cueva de los Murciélagos
	72764	19740831	M	0	Hispaniola	La Capilla Cueva, D.R.
	72769	19740831	M	0	Hispaniola	La Capilla Cueva, D.R.
	72770	19740831	M	0	Hispaniola	La Capilla Cueva, D.R.
	72773	19740831	M	0	Hispaniola	La Capilla Cueva, D.R.
	78507	19670224	M	0	Hispaniola	Cueva del Profugo, D.R.
	125316	20150124	M	0	Hispaniola	Cueva de Marazate, D.R.
	125338	20150127	F	0	Hispaniola	Parque Nacional Armando Bermúdez, D.R.
	125339	20150127	F	1	Hispaniola	Parque Nacional Armando Bermúdez, D.R.
	125361	20150130	M	1	Hispaniola	Cueva Honda de Julián, D.R.
	125368	20150131	M	0	Hispaniola	Cueva la Chepa, D.R.

Appendix 1. Continued.

Species	Catalog number	Date of capture (year-month-day)	Sex	Spots (1 = yes; 0 = no)	Island	General location
M. redmani	125392	20150202	F	1	Hispaniola	7 km SE Miches, D.R.
	37026	19651227	F	1	Jamaica	University of West Indies, Mono Campus
	78505	19670110	M	0	Jamaica	Moseley Hall Cave
	89985	19840307	F	1	Jamaica	Saint Clair Cave
	89986	19840307	F	1	Jamaica	Saint Clair Cave
	89987	19840307	F	1	Jamaica	Saint Clair Cave
	89988	19840307	F	1	Jamaica	Saint Clair Cave
	89989	19840307	F	1	Jamaica	Saint Clair Cave
	89990	19840307	F	1	Jamaica	Saint Clair Cave
	90007	19840307	F	1	Jamaica	Saint Clair Cave
	90008	19840307	F	1	Jamaica	Saint Clair Cave
	90009	19840307	F	1	Jamaica	Saint Clair Cave
	90010	19840307	F	1	Jamaica	Saint Clair Cave
	90011	19840307	F	1	Jamaica	Saint Clair Cave
	120775	20110221	F	0	Jamaica	Saint Clair Cave
	120811	20110306	F	0	Jamaica	1 km N Queen-hythe
	120828	20110316	F	1	Jamaica	Saint Clair Cave
	42753	19670530	F	1	Puerto Rico	Corozal
	44588	19680213	M	0	Puerto Rico	Aguas Buenas Caves
	44590	19680213	F	1	Puerto Rico	Aguas Buenas Caves
	44591	19680213	M	0	Puerto Rico	Aguas Buenas Caves
	44595	19680213	F	1	Puerto Rico	Aguas Buenas Caves