Bats of Uaxactún, Maya Biosphere Reserve, Petén, Guatemala

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FLAAR and ACOFOP team in Uaxactún, Petén. July 20, 2024

Cover photo: *Mimon cozumelae, Uaxactún, Petén. Photograph by José Octavio Cajas.*

Contents

Summary

During the last days of July 2024, a visit was made to the village of Uaxactún in the Maya Biosphere Reserve (RBM by its acronym in Spanish), Petén, Guatemala. The purpose was to carry out two activities related to the conservation of bats in the country's rainforests. The first activity involved educational talks and the distribution of educational materials to students at the Uaxactún school. The second activity aimed to conduct a rapid assessment of bat species present in the area during the rainy season, using two complementary methodologies: mist net captures and analysis of high-frequency recordings.

A total of 20 species were recorded using both methods: 11 through captures and 9 through recordings. These species represent 6 of the 7 families present in Guatemala. The findings included 7 frugivorous species, 1 nectarivorous species, 1 hematophagous species, and 11 insectivorous species.

The species recorded represent approximately 30% of the species registered in the entire MBR, with 10 of them protected under Guatemalan legislation.

Most of the recorded species are considered widely distributed, while the species ***Mimon cozumelae*** **was the only one identified as an indicator of forests with a high level of conservation.** Many of the captured species contribute to forest conservation by dispersing seeds, both within well-preserved forests and in sites undergoing early stages of natural regeneration.

The results suggest that this area of the RBM harbors high bat species richness, considering the limited sampling effort. Further research is recommended to complete the inventory of species present.

This effort was made possible through the collaboration of various institutions: The Association of Forest Communities of Petén (ACOFOP), BQB Biosphere, The Foundation for Latin American Anthropological Research (FLAAR Mesoamérica), the Guatemalan Association of Mastozoology (ASOGUAMA), and the Program for Bat Conservation in Guatemala (PCMG).

Introduction

The Maya Biosphere Reserve (RBM) was designated a protected area in 1990 and spans 21,602 km² in northern Petén, Guatemala. It is the largest tropical rainforest in the country and is home to some of the largest—and in some cases, the last—populations of iconic species within this ecosystem, such as jaguars, pumas, white-lipped peccaries, tapirs, and scarlet macaws, among others.

A significant portion of the protected area within the MBR has been affected by various forms of forest degradation, with the most significant causes being invasions, fires, and deforestation for cattle ranching. The best-preserved areas of the MBR are located in the northern and northeastern regions of the reserve.

The MBR is divided into different zones, each with specific objectives and permitted activities. Among these zones, the Multiple-Use Zone (MUZ) covers 8,484 km², allowing sustainable use of forest resources. Extensive areas have been granted as forest concessions to various communities organized under the Association of Forest Communities of Petén (ACOFOP). Areas under this type of management show the lowest rates of fires, invasions, and deforestation, as well as the presence of reasonable populations of critically endangered fauna species. This demonstrates the effectiveness of sustainable forest management practices guided by biodiversity conservation principles.

The village of Uaxactún is located north of Tikal and is one of the forest concession areas. It is the last community before the route leading to the Mirador and Río Azul-Dos Lagunas parks. Near the village lies an archaeological site of great significance, which was an important astronomical center for the Maya civilization.

The MBR is perhaps the region with the richest floral diversity in the country and likely harbors great biodiversity in other, less-studied groups, including bats, which represent over 50% of Guatemala's terrestrial mammal species (McCarthy & Pérez 2006).

In Guatemala, 103 bat species across 7 families have been recorded (Kraker et al., 2016; Trujillo et al., 2022). Five of these families consist exclusively of insectivorous species (Emballonuridae, Molossidae, Mormoopidae, Natalidae, and Vespertilionidae). One of these families, Noctilionidae, includes a species that feeds on fish and another that is insectivorous. The remaining family, Phyllostomidae, includes insectivorous, carnivorous, hematophagous (blood-feeding), frugivorous, and nectarivorous species.

Phyllostomidae is the only bat family worldwide that includes species with multiple ecological roles, such as insect consumption, predation, pollination, and seed dispersal. It is also the family that includes the only blood-feeding bat species, two of which are found in Guatemala (Kraker et al., 2016).

In the MBR, bats from this family play a crucial role in forest regeneration as seed dispersers. Unlike birds, bats benefit from the cover of night, making them less hesitant to cross open areas, resulting in a higher volume of seeds being transported between distant sites compared to birds (Lou & Yurrita, 2005; Cajas et al., 2015).

For example, species such as *Carollia perspicillata* and *Sturnira parvidens* contribute significantly to seed dispersal in forests and areas undergoing recovery in the MBR and other rainforests in Guatemala (Lou & Yurrita, 2005; Kraker et al., 2015).

Although bats are a highly diverse and ecologically important group, studies in the MBR are scarce, and existing research does not even cover a full annual cycle. Some of the sites within the MBR where studies have been conducted include the San Miguel La Palotada-El Zotz (Schulze et al., 2000; Lou & Yurrita, 2005; Pérez et al., 2007; Colombo, 2017; Núñez, 2020).

To date, 57 bat species have been recorded in the MBR (Núñez, 2020). Of these, 30 species belong to the subfamily Phyllostominae, which is highly specialized for forests with a high degree of conservation (Schulze et al., 2020).
This rapid assessment of bat richness in the village of Uaxactún constitutes a significant contribution to the knowledge of the bat community in the area, marking the first preliminary species list reported for this region.

Beyond their ecological role, bats also hold significant cultural value within the Maya worldview, as reflected in their history and iconography. Bats frequently appear as messengers, often accompanied by birds. They are associated with fertility and rebirth and, in some instances, with disease. One of their most well-known appearances is in the Popol Vuh, where Camazotz, an underworld deity, is described. Camazotz is depicted as a humanoid figure with bat-like features who challenges the heroic twins, Hunahpu and Xbalanque, to a ballgame. Bats are also mentioned when the Lords of the Underworld, or "Xibalba," challenge the twins to survive a night in the House of Bats, or "Zotzi Ha," as a test of endurance.

Some researchers have speculated on the species that might have inspired the figure of Camazotz, with *Chrotopterus auritus* being one of the candidates. However, this remains a subject of ongoing discussion in this report.
This effort was made possible through the collaboration of various institutions: The Association of Forest Communities of Petén (ACOFOP), BQB Biosphere, The Foundation for Latin American Anthropological Research (FLAAR Mesoamérica), the Guatemalan Association of Mastozoology (ASOGUAMA), and the Program for Bat Conservation in Guatemala (PCMG)

Figure 1. *Map showing the location of sampling points in the village of Uaxactún, Petén, Guatemala*

Methods

Talks and educational material

During the last days of July 2024, a visit was made to the area of Uaxactún village, located within the multiple-use zone of the MBR. On the first day of the visit, in the morning, two educational talks were given to secondary school students at the village school. The first talk, led by biologist José Octavio Cajas Castillo, focused on bats. It covered general aspects of their morphology, biology, ecological importance, and their diversity within the MBR.

A second talk was given on the importance of bats in Maya culture, covering topics such as their presence in the Popol Vuh, stelae, and Maya art. This presentation was given by Engineer Vivian Hurtado. In addition to the talks, educational materials prepared by FLAAR and a book on the mammals of Guatemala, published by the Guatemalan Association of Mastozoology (ASOGUAMA), were distributed.

The activity with the young students included a second part at night, where they had the opportunity to participate in one of the capture sessions. They received an introductory talk on the methodology for studying bats and the possible species that could be captured that night. They witnessed the entire process of capturing, identifying, and releasing the captured bats.

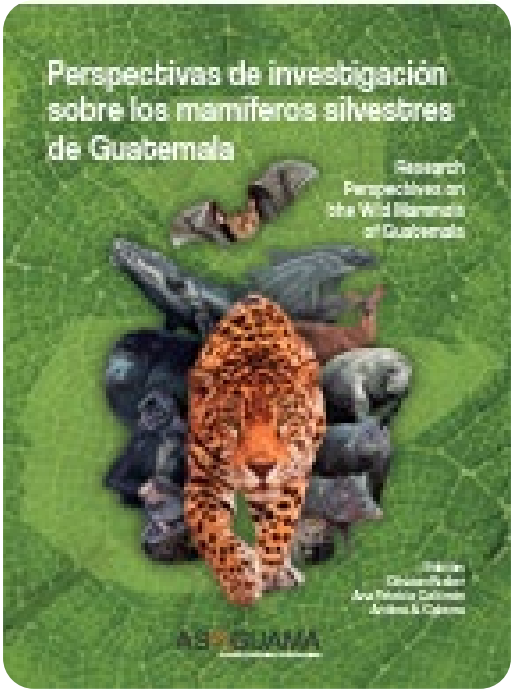
Talk about bats in Mayan culture given by Vivian Hurtado and young attendees. Photographs by: Edwin Solares, Uaxactún Community, Petén, Guatemala, July 19, 2024.

Talk about bats in Mayan culture given by Vivian Hurtado and young attendees.
Photographs by: Edwin Solares, Uaxactún Community, Petén, Guatemala, July 19, 2024.

FLAAR Mesoamerica team distributing educational materials created by the MayanToons team to children at the Uaxactún Rural Mixed School.
Photographs by José Cajas, July 22, 2024.

FLAAR Mesoamerica team distributing educational materials created by t he MayanToons team to children at the Uaxactún Rural Mixed School. Photographs by José Cajas, July 22, 2024.

Copies of MayanToons donated to the Uaxactun Rural Mixed Official School: (1) Looking for medicinal plants for Grandma. (2) Coloring with the Pest Control Service. (3) Coloring the trilingual ABCs: Spanish-English-Q'eqchi.



Publication prepared by ASOGUAMA and donated to the Uaxactun Secondary School "Research perspectives on wild mammals of Guatemala (2019)

José Cajas giving a talk about bats during a practical bat-capture activity. Photograph by Edwin Solares, July 19, 2024

Bat study

Bats were captured over three consecutive nights at three different sites near the village of Uaxactún. Points 1 and 2 were located in forested areas close to the village, while the third point was located farther away in an area with a lower level of disturbance.

Captures began at nightfall, from 18:30 to 22:30 hrs. For this, 36 x 3 m^2 mist nets were used per night (Figure 2). For each individual captured, various data were recorded, including forearm length, weight, sex, and reproductive condition.

In addition to the captures, a complementary method was used to compile the inventory of species present in the area. High-frequency recordings were made to document insectivorous bat species. The Anabat II device was used for this purpose, and the frequency analysis was conducted using the Analook program (Titley Scientific).

Placement of mist nets by José Cajas and students from Uaxactún Secondary School. Photograph by Edwin Solares, July 19, 2024

Character review of individual captured by José Cajas.
Photograph by: Edwin Solares, July 19, 2024.

Measurement of individual captured by José Cajas.
Photograph by: Edwin Solares, July 19, 2024.

High-frequency recorder Anabat SD2.
Photograph by José Octavio Cajas Castillo, July 20, 2024.

Bats in Uaxactún

We recorded 20 bat species, 11 species through captures and 9 through acoustic recordings. We documented 6 of the 7 families present in Guatemala, with the only family absent during the sampling being Noctilionidae. This is understandable, as members of this family feed on fish and aquatic insects.

In addition to the captured and recorded species, colonies of no more than twenty individuals of *Saccopteryx bilineata* were observed in the temples of the archaeological site, and two females with a pup of *Glossophaga mutica* in a colony of no more than 10 individuals. Near the site, there is also a small underground cave where individuals of *Artibeus spp.*, *Carollia spp.*, and *Desmodus rotundus* were observed. It is estimated that the predominant species in this cave was the latter, with approximately 20 individuals.

Next, we describe the results obtained at each of the sampling points and with each of the two methodologies used.

Captures

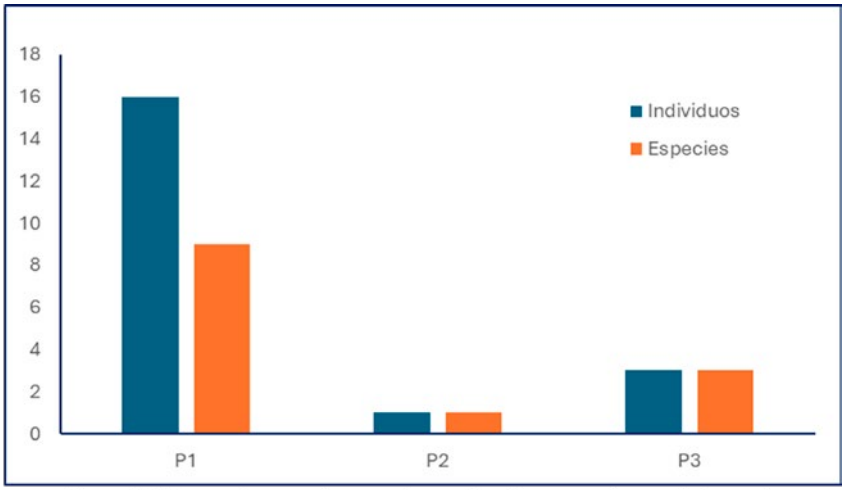
Using this method, we recorded 11 species and a total of 20 individuals. Seven of the species were frugivores, one was nectarivorous, one was hematophagous (feeding on blood), and two were insectivorous.

The most abundant species were *Artibeus jamaicensis*, followed by the other two frugivorous species from the same genus, *A. lituratus* and *A. intermedius*. Other frugivorous bat species captured included *Carollia perspicillata* and *Sturnira parvidens*, and the hematophagous bat *Desmodus rotundus*. For the rest of the species, only one capture was made (Table 1). **Four of the captured species are considered threatened by Guatemalan legislation** (CONAP 2021).

Table 1. *List of bats captured from the Phyllostomidae (Phyll) and Natalidae families at different capture points (P) in Uaxactún village. Trophic group (GT): Frugivores (FR), Nectarivores (NE), Insectivores (IN), Hematophagous (HE). Category of the Guatemalan Protected Species List (LEA).*

	Species	Subfamily	GT	LEA	P1	P2	P3	TOTAL
1	*Aritbeus intermedius*	Phyll.: Stenodermatinae	FR		2			2
2	*Aritbeus jamaicencis*	Phyll.: Stenodermatinae	FR		4			4
3	*Artibeus lituratus*	Phyll.: Stenodermatinae	FR		2			2
4	*Carollia spp.*	Phyll.: Carollinae	FR		1			1
5	*Carollia perspicillata*	Phyll.: Carollinae	FR	3	2			2
6	*Carollia sowelli*	Phyll.: Carollinae	FR	3	1			1
7	*Dermanura watsoni*	Phyll.: Stenodermatinae	FR				1	1
8	*Desmodus rotundus*	Phyll.: Desmodontinae	HE		2			2
9	*Glossophaga mutica*	Phyll.: Glossophaginae	NE	2	1			1
10	*Mimon cozumelae*	Phyll.: Phyllostominae	IN	2			1	1
11	*Natalus stramineus*	Natalidae	IN				1	1
12	*Sturnira parvidens*	Phyll.: Stenodermatinae	FR		1	1		2
	Individuals				**16**	**1**	**3**	**20**
	Species				**8**	**1**	**3**	

Regarding the richness and structure of the studied points, P1 was the site where 75% of all captured species were recorded and nearly all captures occurred. The other two points had relatively low species richness and captures (Figure 8).



Number of species and captures obtained at each of the evaluated points (P)

P3 was the site farthest from the other two, and also the most distant from the community, located in a forest with less disturbance and better conservation. Three species not recorded at P1 were captured here (Figure 8), including Natalus stramineus and Mimon cozumelae (Figure 7, Table 1). The latter species has few reports for the country (Schulze et al. 2000; Pérez et al. 2007; Cajas et al. 2019).

N. stramineus is the only species from the Natalidae family in Guatemala (Kraker et al. 2016), and *M. cozumelae* belongs to the subfamily Phyllostominae, which mainly includes insectivorous and carnivorous bat species that predominantly inhabit well-conserved forests (Schülze et al. 2000).

Most of the captured individuals were females. Of the species *A. intermedius, A. lituratus, Carollia perspicillata,* and *Glossophaga mutica,* only females were recorded. Meanwhile, for *C. sowelli*, *Dermanura watsoni*, *M. cozumelae*, and *Sturnira parvidens*, only males were captured. Only *A. jamaicensis* and *D. rotundus* had both sexes recorded.

Both females and males with reproductive activity were found, with the most common condition being post-lactating females (those who have passed the breastfeeding stage) of the species *A. jamaicensis*. Pregnant females were recorded for *A. lituratus* and *Carollia spp.*, while a lactating female was observed in *C. perspicillata*. One-third of the captured individuals were juvenile adults. Males with scrotal testes, indicating reproductive activity, were recorded only in *D. watsoni* and *Desmodus rotundus*.

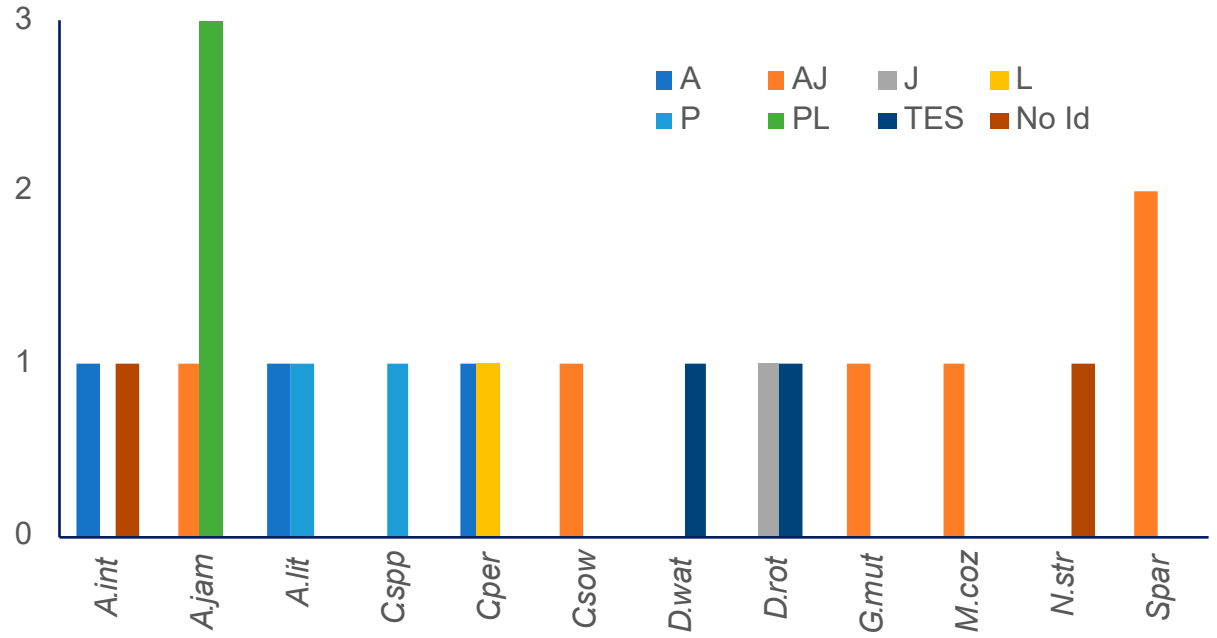
Individual of the species Natalus stramineus.
Photograph by: José Octavio Cajas Castillo.

Individual of the species Mimon cozumelae.
Photograph by Edwin Solares, July 20, 2024.

Thumb of the right wing of an individual of the species
Desmodus rotundus. Its length and callosity are distinctive characteristics of this species.
Photograph by José Octavio Cajas Castillo.

Colony of Saccopteryx bilineata in a temple at the Uaxactún archaeological site.
At the center, three grouped individuals of Glossophaga mutica can be observed, including a female with her nursing offspring.

Photograph by José Octavio Cajas Castillo at one of the ruins of the Uaxactún archaeological site on July 20, 2024.



Distribution of individuals with different reproductive conditions in species captured in Uaxactún village. Adult (A), Juvenile (J), Adult Juvenile (AJ), Male with Scrotal Testicles (TES), Lactating Female (L), Pregnant Female (P), Post-lactating Female (PL).

Six of the registered species showed reproductive activity, which aligns with other studies conducted on species in the rainforests of Guatemala, where the rainy season represents a period of high reproductive activity (Cajas et al. 2019)

Mammary gland of a lactating female Artibeus lituratus and phalangeal joint of a juvenile Artibeus jamaicensis.
Photographs by Edwin Solares, July 20, 2024.

High-Frequency Recordings

A total of 125 acoustic recordings of bats were obtained, representing 9 species of insectivorous bats from four families, with the Molossidae family having the highest number of species. *Rhogeessa tumida* was the species with the most records, followed by *Pteronotus fulvus* (Table 2).

Of the recorded species, six are protected by Guatemalan legislation and are considered threatened, with the majority (4) belonging to the Molossidae family (Table 2). In the analyzed sonograms, feeding search calls and attack calls were found, indicating that these species were recorded while foraging in the jungle.

It is important to emphasize that, although this sampling represents a relatively small effort, the bat diversity is quite high, representing 30% of the species recorded for the RBM. These results highlight the importance of investing efforts and resources into implementing permanent research programs that include bats.

Table 2. *List of Bat Species Recorded by Acoustic Recorders. Threatened Species List (LEA); International Union for Conservation of Nature (IUCN), Least Concern (LC). Distribution (Dist), Neotropics (NTR), Mesoamerica.*

	Family / Species	LEA/IUCN	Distribution	Records
	Emballonuridae			
1	*Saccopteryx bilineata*	3	NTR	20
	Vespertilionidae			
2	*Rhogeessa tumida*		MA	33
3	*Eptesicus furinalis*	3	NTR	4
	Molossidae			
4	*Eumops ferox*	2	MA	7
5	*Molossus rufus*	2	NTR	10
6	*Molossus sinaloae*	2	NTR	6
7	*Nyctinomops laticaudatus*	2	NTR	19
	Mormoopidae			
8	*Pteronotus fulvus*		MA	24
9	*Pteronotus mesoamericanus*		MA	2
	Total de registros			**125**

Desmodus rotundus.
Photographs by: José Octavio Cajas Castillo

Carollia perspicillata.
Photographs by: José Octavio Cajas Castillo

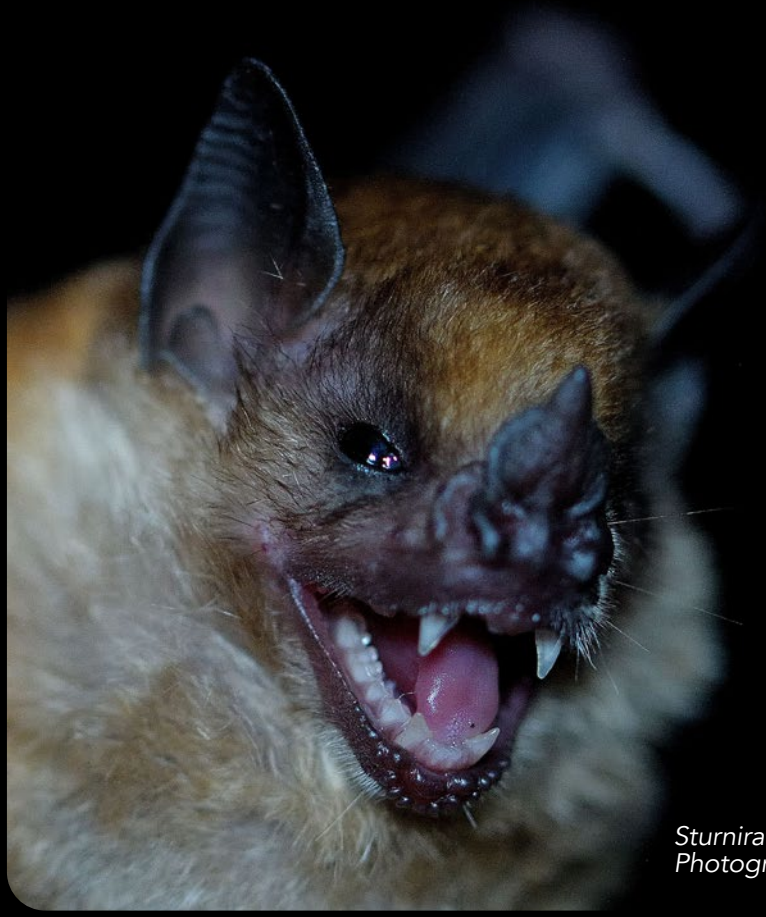
Glossophaga mutica.
Photographs by: José Octavio Cajas Castillo

Mimon cozumelae.
Photographs by: José Octavio Cajas Castillo

Dermanura watsoni.
Photographs by: José Octavio Cajas Castillo

Artibeus jamaicensis.
Photographs by: José Octavio Cajas Castillo

A. lituratus.
Photographs by: José Octavio Cajas Castillo



Sturnira parvidens.
Photographs by: José Octavio Cajas Castillo

Pteronotus mesoamericanus .
Photographs by José Octavio Cajas Castillo

Saccopteryx billineata.
Photographs by: José Octavio Cajas Castillo

Representations of bats in mayan art

In the following paragraphs, we present some conclusions from the review of a large number of bat images found in sculptures, engravings, paintings on vessels, plates, and other objects from Mayan art. All of the images have been compiled over several decades by Dr. Nicholas Hellmuth.

Our goal is to attempt to identify the species represented and, above all, to identify the identity of the figure of Camazotz (Figures 12-14). To do this, we used some morphological characteristics of this character and compared them with features of different bat species, among which one stands out as the most likely candidate: the giant frugivorous bat (*Artibeus lituratus*).

Some of the characteristics that lead us to propose this bat as the Camazotz are: **both (Camazotz and A. lituratus) have a wide jaw and short face, possess a similar shaped leaf-nose, their dentition features prominent upper and lower canines with short incisors, and they have relatively large eyes, which are characteristic of frugivorous and nectarivorous bats.**

Bat-Copan-Museum. This is the bat most often pictured in discussions of Maya bat iconography. The sexual parts raise the question of whether it was considered a sex symbol. Due to the large size of this bat, its inspiration was most likely a very large bat native to the Maya areas. Copán, museum. There are several other large frontal Copán bats, but we have photos only of this one. Since the nose sticks out from the head, it is the first part of the sculpture to be chipped off over centuries of falling trees, rocks, etc.

In some representations, eyebrows are included, which, for us, represent the facial white stripes of *A. lituratus*. The ears are rounded, separated, and small, and the wings are wide and rounded, unlike species of fast and agile flying bats, whose wings are narrow and pointed. The giant frugivorous bat is the sixth largest among the 103 species found in Guatemala.

In reproductive males, the sexual organs are quite prominent due to their size, which is also highlighted in the figure of Camazotz. **Since this character was used as a fertility symbol,** it is worth noting that, in addition to its prominent genitalia, it is one of the most abundant bats in Central American tropical forests, reflecting its high fertility.

Bat sculpture, from Izabal or Alta Verapaz, Guatemala. Photo taken by Guillermo Mata, July 1966. This photo is now widely circulated on the internet, taken from our Maya-archaeology.org website. The current location of this bat sculpture is not known.

This stone bat sculpture is in the Museo Popol Vuh, Universidad Francisco Marroquín. It has a vertical Sky Band descending from its waist area. The pattern on the wings reminds me of a pattern on turtle shells, ears of Maya rabbits, and water lilies. This motif on a turtle and lily pad is pictured by Brady and Coltman 2016: Fig. 4). All photos by Nicholas Hellmuth, FLAAR Photo Archive, Dumbarton Oaks, Trustees for Harvard University.

In mature forests, this bat is possibly one of the most important animal species in the seed dispersal of a wide variety of plants. They have the habit of carrying fruits to their shelters (in trees) to eat them, so it is common to see clusters of seeds from different plant species under their shelters when walking in the jungle. It is also common to find shoots from these seeds in these clusters. The Maya likely observed and understood their importance in maintaining the forest. Fertility may have been associated not only with their high reproductive capacity but also with the fertility of the jungle.

Among the tree species dispersed by these bats that had special relevance to the Maya for their uses and symbolic significance, we can mention the chico zapote (*Manilkara zapota*), whose wood was used to make lintels that adorned the temples. The resin was used (as it is today) to make chewing gum, which they chewed for dental cleaning.

An interesting point we would like to contribute to the identification of the Camazotz is the fact that it is considered the guardian of the entrance to the underworld. This relationship may stem from the abundance of bats in caves, as mentioned in the Popol Vuh. However, this is not very related to this species, as these bats are found rarely and in low numbers in caves. Rather, as mentioned earlier, they are bats that take refuge in trees during the day.

Another interpretation of why this species is represented as the Camazotz could be related to *Ceiba pentandra*, the sacred tree for Maya culture (the national tree of Guatemala), which connects the three realities: the underworld (through its roots), our world (the trunk), and the upper world (the canopy).

Bats are the main pollinators of this sacred tree. In the rainforests of Guatemala, the giant frugivorous bat is probably the most important of its pollinators. When the trees bloom, they are visited by large numbers of these bats.

It has previously been suggested that the identity of the Camazotz might correspond to the carnivorous bat *Chrotopterus auritus*. However, it is a bat that is not abundant, with considerably larger ears, a narrow and slightly elongated face, a small leaf-shaped nose, small eyes (in relation to the face), and long, pointed wings. All of these characteristics do not align with the figure of the Camazotz.

Artibeus lituratus bat pollinating opened flowers of the Ceiba pentandra tree. Hundreds of bats appear once the buds have begun to burst open. Since the Ceiba is a sacred tree. Photo by Nicholas Hellmuth, FLAAR Photo Archive of Flora and Fauna (which is separate from the FLAAR Photo Archive now at Dumbarton Oaks and separate from the FLAAR Digital Photo Archive).

There are bat representations distinct from the figure of Camazotz in other artistic works of the Maya culture. On this, we tried to determine what the artists intended to represent. In the ceramic plate of Figure 16, we believe it could represent a molossid bat (family Molossidae), which are frequent and abundant inhabitants of caves, with entirely insectivorous feeding habits.

We consider a bat from the Molossidae family because of the round shape and thick edges of the ears, which are joined at the center of the head. These are notable characteristics in bats from this family. Another point to consider is that this bat does not have a leaf-shaped nose, which is present in all the figures of Camazotz. The leaf-shaped nose is a unique characteristic of species in the Phyllostomidae family, to which *A. lituratus* belongs.

Lake Amatitlán, probable bat from the Molossidae family, Museo Popol Vuh, Universidad Francisco Marroquín. Snapshot (through the glass) by Nicholas Hellmuth.

Another representation of a bat distinct from Camazotz in Maya art is that, which, in our opinion, represents a false vampire bat (*Vampyrum spectrum*), the largest of all bats in the Americas, capable of measuring over a meter with its wings extended. The proposal for identifying this species is based on several elements, including the elongated shape of the face with a relatively small nasal leaf, the length of the legs in relation to the body, the extent and shape of the uropatagium (elastic skin fold between the legs), the absence of a tail, relatively small ears, pointed wings, and the size relationship between the bat and the deer behind it, which could be the smallest deer species, the cabrito or huitzitzil (*Mazama temama*), found on the Pacific coast of Guatemala (the origin of this piece). The crown above the deer's head may represent the small antlers characteristic of this species, although the presence of a tail and antlers could also represent the white-tailed deer (*Odocoileus virginianus*).

Bat-like nose on the anthropomorphic animal at the right in each scene, but no bat wings (but Kerr lists them as bats). Rollout K8524. Dr. Hellmuth estimates this Late Classic vase is from the Escuintla region where Early Classic Tiquisate style cylindrical tripods abound.

The false vampire is very rare in the jungles because it is highly territorial and carnivorous. Another possibility could be the woolly false vampire (*Chrotopterus auritus*), also quite large (the third largest in the Americas), however, the shape of the ears and the length of the face do not match. Although large bats are less common compared to other species, it is almost certain that the ancient Maya observed them many times, which is why this artist might have chosen to depict it.

In conclusion, although artistic representations are often accompanied by other symbols, decorations, and modifications unique to each artist, there are elements that allow speculation about the identity of some bat species in Maya art. However, further study of these works is still necessary.

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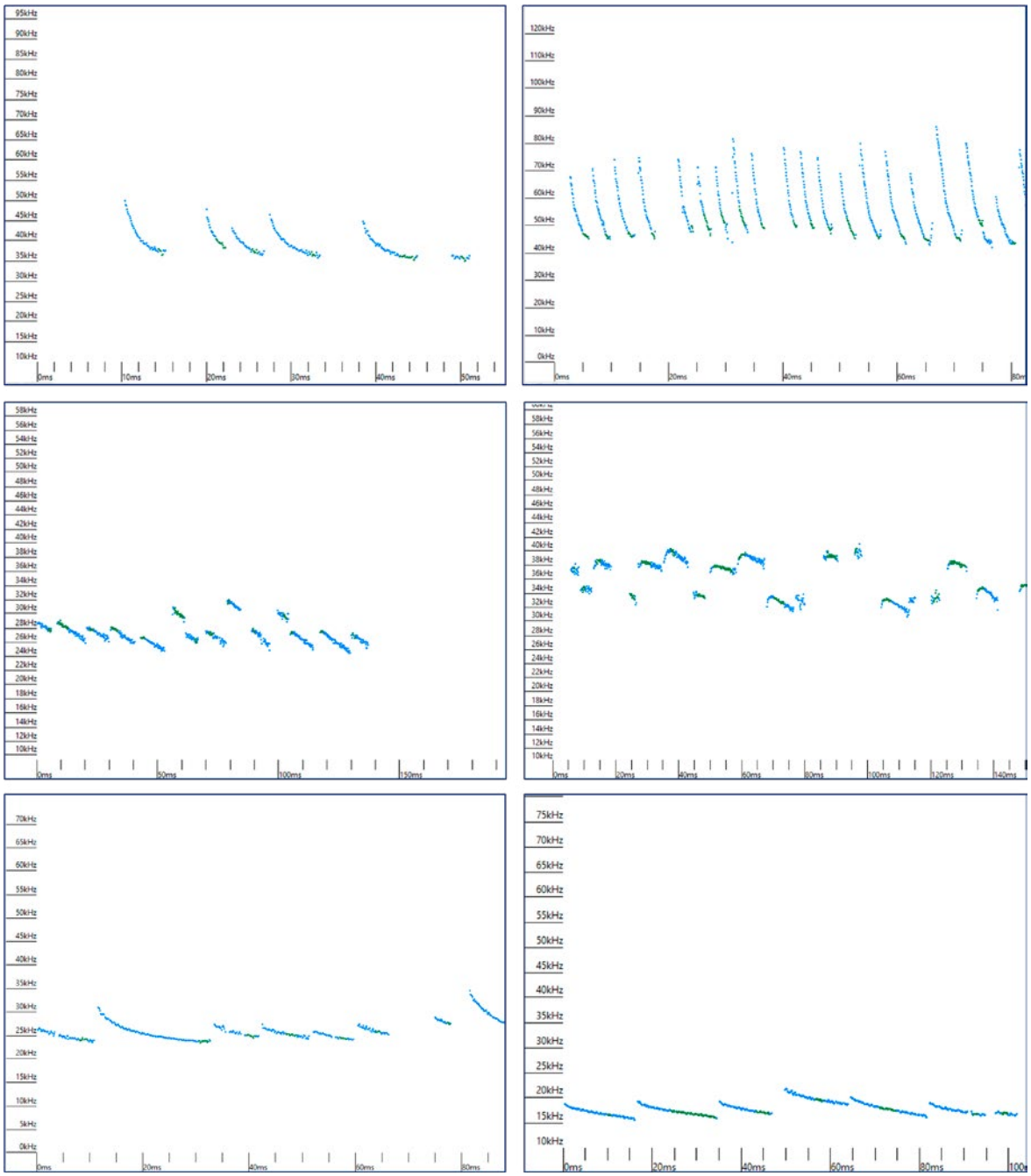
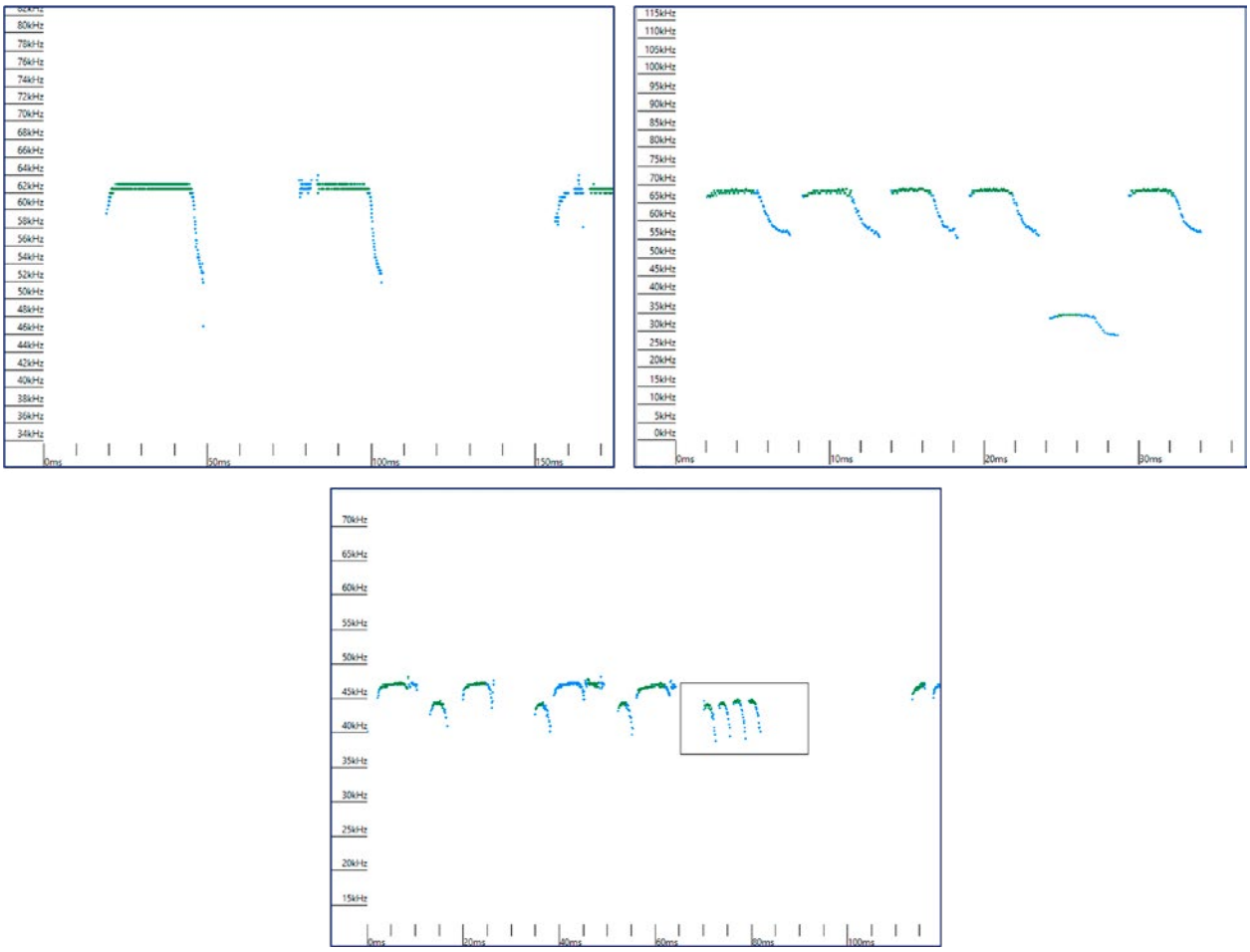
ANNEX 1:
Soundgrams of species recorded by high frecuency recordings in Uaxactún



Eptersicus furinalis (left, top), Rhogeessa tumida (right, top), Molossus rufus (middle, left), Molossus sinaloae (middle, right), Nyctinomops laticaudatus (bottom, left), Eumops ferox (bottom, right).



Pteronotus mesoamericanus (left, top), Pteronotus fulvus (right, top), Saccopteryx bilineata, and in the black box, the beginning of a feeding buzz can be observed (bottom).

ANNEX 2:
Photo credits

1. * José Octavio Cajas Castillo (BQB Biósfera). Pags: 6, 7, 9, 12,18. 19
2. ** Edwin Solares (FLAAR). Pags: 5, 7, 9, 12, 14
3. *** Photos taken by José Octavio Cajas Castillo in other areas of Guatemala are included to better illustrate the document. Pages: 12, 18, 19.

ANNEX 3:
Categories of the list of threatened species (LEA, CONAP 2022).

Usos permitidos de las especies amenazadas de fauna

Categoría 1 (PC) En peligro crítico o en vías de extinción	Categoría 2 (EP) En peligro	Categoría 3 (VU) Vulnerable
a) Investigación científica y reproducción con fines de conservación.	a) Investigación científica y reproducción con fines de conservación.	a) Investigación científica y reproducción con fines de conservación.
b) Se podrá autorizar el aprovechamiento única y exclusivamente de partes o derivados, bajo planes de manejo que incentiven la conservación de la especie, siempre y cuando no ponga en riesgo la integridad del individuo, su población silvestre y en cautiverio.	b) Aprovechamiento de especímenes reproducidos ex situ de forma sostenible, legal y trazable.	b) Aprovechamiento de especímenes reproducidos ex situ de forma sostenible, legal y trazable.
		c) Aprovechamiento y comercialización de individuos del medio silvestre por medio de planes de manejo que garanticen la sobrevivencia de la especie (el uso no debe disminuir el tamaño poblacional ni el área de distribución de la especie en 10 años o 3 generaciones).
		d) Cacería y pesca deportiva y/o de subsistencia. El calendario cinegético deberá estar acorde a lo especificado en este listado.