

Big eyes on the Island: First record of *Chiroderma villosum* of Cozumel Island, México and bat species richness in the Caribbean islands

Grandes ojos en la Isla: Primer registro de *Chiroderma villosum* para Isla Cozumel, México y riqueza de especies de murciélagos en las Islas del Caribe

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The closest record of *Chiroderma villosum* to Isla Cozumel is documented in the city of Playa del Carmen, Quintana Roo. Here we report the first record of *C. villosum* for Cozumel Island, and compile information on the richness of bat species in the Caribbean Islands. Mist nets were deployed on May 5, 2021 at ground level to capture bats in the forest. Each individual was processed as follows: forearm length taken with a caliper to the closest mm, and body mass was taken with a digital scale with 1g precision. Bats were identified following the bat field key of México. In one evening we captured 8 individuals of *Artibeus jamaicensis*. In addition, 1 non-reproductive, adult male of *C. villosum* was captured at 21:45 hr in a mist net crossing a trail in the semideciduous rainforest in the northwest of the San Gervasio archaeological site. So far, 19 species of bats corresponding to 5 families have been documented in Cozumel Island, the record of this specimen increases the number of species of bats present on the island to 20 species and 16 genera. More studies are still needed, but it is very likely that this species is widespread in all forested areas in Cozumel.

Key words: Bats; mist netting; monitoring; semideciduous rainforest; species diversity.

El registro más cercano de *Chiroderma villosum* a Isla Cozumel, está documentado en la ciudad de Playa del Carmen, Quintana Roo. En este trabajo documentamos el primer registro del murciélago *C. villosum* para Isla Cozumel y compilamos la información sobre la riqueza de especies de murciélagos en las Islas del Caribe. El 5 de mayo de 2021 se realizó una salida de campo, se instalaron redes de niebla a nivel del suelo. Posteriormente se tomaron los siguientes datos de cada individuo capturado: medidas del antebrazo con un vernier con una precisión de 1 mm, se tomó el peso con una báscula digital con precisión de 1 g, y se identificó la especie siguiendo la clave de murciélagos de México. Durante la noche de trabajo se capturaron 8 individuos de *Artibeus jamaicensis* y un ejemplar macho adulto no reproductivo de *C. villosum* a las 21:45 hr en una red de niebla colocada cruzando una brecha dentro de la selva mediana en el noroeste de la zona arqueológica de San Gervasio. En Isla Cozumel se han documentado 19 especies de murciélagos correspondientes a 5 familias y 15 géneros. Con el registro de este espécimen, se incrementa a 20 el número de especies y a 16 géneros de quirópteros presentes en la isla. Aunque todavía faltan más estudios, es muy probable que esta especie tenga una distribución amplia en todas las áreas de bosque en Cozumel.

Palabras clave: Diversidad de especies; monitoreos; quirópteros; red de niebla; selva mediana.

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Islands are excellent places to study biodiversity, since many of them allow us to examine entire communities of plants and animals where the different factors that shape these groups can be determined. Archipelagos are dynamically affected by climatic, ecological and geological processes showing a variety of habitats and topographic variability, and, in more recent times, the influence of human actions ([Fernández-Palacios et al. 2021](#)). The Caribbean islands are one of the most significant centers of endemic biodiversity in the world ([CienciaPR 2006](#)). In this archipelago, 44 dif-

ferent species of bats are recognized, corresponding to 5 families (6 Mormoopidae, 7 Natalidae, 17 Phyllostomidae, 3 Molossidae and 11 Vespertilionidae). The most bat diverse countries are Cuba and Jamaica, the first with 6 endemics and the second with 5 ([Díaz et al. 2021](#)).

The genus *Chiroderma* comprises 7 species of bats that live from western and northern México to southern Brazil and west to the Lesser Antilles ([da Rocha et al. 2015](#)). These bats are characterized by having proportionally very large eyes and the absence of a nasal bone ([Medellín et](#)

[al. 2008](#); [Garbino 2019](#)). In México, 3 of these species are found: *C. salvini* (Dobson, 1878), distributed from México to Bolivia ([Garbino et al. 2020](#)); *C. scopaeum* (Handley, 1966), a species endemic to western México previously considered as a subspecies of *C. salvini*; and *C. villosum* (Peters, 1860), distributed in the eastern and southeastern region of the country ([Medellín et al. 2008](#)).

Bats of the genus *Chiroderma* act more as seed predators than as seed dispersers. After extracting juice from the fruit pulp, they chew the seeds thoroughly and spit out small fragments or swallow and digest the seed fragments, excreting four times fewer intact seeds than *Artibeus watsoni* (Thomas, 1901; [Wagner et al. 2015](#)). Its reproductive cycle corresponds to a bimodal pattern with 2 birth peaks, 1 at the beginning of the rainy season and another towards the end of the season, which is typical of the *Stenoderma* subfamily ([Garbino 2019](#); [Fleming et al. 2020](#)).

Species of the genus *Chiroderma* are small to medium-sized bats (forearm length = 38–54 mm; weight = 12–26 g). The color of the back varies from pale reddish brown to olive and olive brown on the belly. They have white facial stripes that vary in intensity depending on the species, and some species have a faint white line on their back ([Gardner 2007](#); [Díaz et al. 2016](#)).

Chiroderma villosum, commonly known as the “hairy eyed bat,” can be differentiated from other species of the genus *Chiroderma* by the faint or imperceptible facial and dorsal lines, the tricolor dorsal fur, and the presence of long guard hairs that protrude noticeably from the rest of the fur on the back. The upper central incisors of *C. villosum* are thin and parallel to each other, not convergent as in *C. salvini* ([Gardner 2007](#); [Medellín et al. 2008](#); [Garbino 2019](#); [York et al. 2019](#)).

Chiroderma villosum has been documented in the Dzilam State Reserve located northwest of Yucatán ([Sosa-Escalante et al. 2001](#)) and in the city of Playa del Carmen, Quintana Roo ([Birney et al. 1974](#)), being the closest point of land to Cozumel Island, at a distance of ~ 20 km ([Orellana et al. 2007](#)). In Quintana Roo, on the islands of Holbox and Isla Mujeres there are no published records on the presence of bat species and in Banco Chinchorro there is the only record of a *Rhogeessa aeneus* ([Charruau et al. 2021](#)). Cozumel Island is the third largest island in México after Tiburón Island and Ángel de la Guarda Island, both in the Sea of Cortés. So far, 19 species of bats corresponding to 5 families have been recorded on Cozumel Island (8 Phyllostomidae, 1 Mormoopidae, 1 Natalidae, 4 Molossidae and 5 Vespertilionidae; [Rivas-Camo et al. 2020](#)). In this work: 1) we document the first record of the bat *C. villosum* for Isla Cozumel, 2) we update the number of bat species present on the island, and 3) we compile information on the diversity of bat species in the islands of the Caribbean and the area surface that each island has.

Cozumel Island is located 20 km southeast of Playa del Carmen, off the coast of Quintana Roo (20° 26' N, 86° 55' W).

It is an oceanic island of coral origin and is the largest in the Mexican Caribbean with an area of almost 480 km² ([Morales-Contreras et al. 2020](#)). The average annual temperature is 25.5 °C, maximum 39 °C and minimum 20 °C. The average annual precipitation is 1,570 mm. The vegetation presents a well-defined gradient, starting from the eastern coastal strip with halophyte vegetation of coastal dunes followed by the savannah, the mangrove, the low deciduous forest and culminates with the medium sub-deciduous forest from the central portion of the island to the west coast, where patches of mangrove forest also persist. The low deciduous and medium sub-deciduous forest cover almost 70 % of the island's surface ([CONANP 2007](#); [Duran et al. 2010](#)).

In the last 6 years monitoring work under the Directorate of Conservation and Environmental Education of the Foundation of Parks and Museums of Cozumel, which aims to promote development of scientific studies and environmental culture, has been carried out to document the bat fauna in the archaeological area of San Gervasio (20° 30' 0.82" N, 86° 50' 47.89" W; Figure 1). The forest is composed primarily of 2 arboreal strata between 8 and 20 m in height, and there is a sparse shrub-herbaceous stratum ([Reynoso-Campos et al. 2015](#)). In this subdeciduous medium forest, there is a predominance of *Manilkara zapota* (zapote), *Esenbeckia pentaphylla* (hoocop), *Cedrela odorata* (red cedar), *Psidium sartorianum* (pichiche), *Bursera simaruba* (chacah), *Metopium brownei* (chechem), *Lysiloma latisiliqua* (tzuk-te), *Pithecellobium platylobum* (chacojo), *Piscidia piscipula* (yellow), *Picramnia andicola* (light yellow), *Pithecellobium* sp. (common name unknown), *Lysiloma latisiliqua* (tsalam), and *Ceiba aesculifolia* (ceiba).

To detect and capture bats we used the direct capture method 1 night a month in the archaeological zone of San Gervasio, where we installed 3 mist nets of 2 m x 2 m, 6 m x 2 and 12 m x 2. The nets were opened at 18:00 hr and

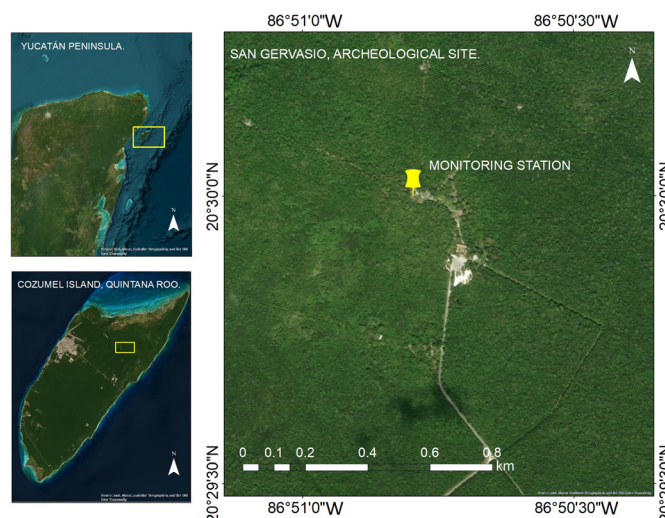


Figure 1. Study area in the San Gervasio Archaeological Zone in the northwest of Isla Cozumel, Quintana Roo, México, where the individual of *Chiroderma villosum* was captured.

closed at 24:00 hr coinciding with the peak of bat activity at the beginning of the night (Turcios-Casco et al. 2021). The nets were checked approximately every 10 to 15 min to avoid stress on the captured animals. Subsequently, measurements of the forearm were taken with a Truper CAL-6MP analog vernier caliper and the weight was taken with a digital scale with a precision of 1 g. The captured bats were identified following Medellín et al. (2008).

To prepare the list of Caribbean islands and their diversity of bat species, a literature review containing recent information on the bats present on these islands was carried out following Díaz et al. (2021) and Caribbean Atlas (2024).

On May 5, 2021, during the monthly monitoring of the Cozumel Island Bat Species Diversity project, 8 individuals of *Artibeus jamaicensis* (Leach, 1821) and a non-reproductive adult male specimen of *C. villosum* were captured (Figure 2) at 21:45 hr in a 12 m mist net placed over a gap within the semideciduous rainforest in the northwest of the San Gervasio archaeological zone (Figure 1). The *C. villosum*'s forearm measurement was 47 mm and the weight was 24.3 g. The identification of the species was carried out through the morphometric characteristics of the genus *Chiroderma* by the absence of the nasal bone, the proportionally larger eyes and the measurement of the forearm (Medellín et al. 2008; Garbino 2019).

The record of this specimen increases the number of bat species present on the island to 20 and the number of genera to 16 (Table 1; SEMARNAT 2010; Simmons and Cirranello 2024). Biogeographic characteristics, such as different types of habitats, are closely related to the relief, climate, soil, flora and fauna characteristics of the region and, in the case of Cozumel, its proximity to the Yucatán Peninsula and the Antilles, place Cozumel as one of the Mexican islands with the greatest diversity of bat species and the Caribbean islands with the most bat species (Table 1). With 20 species, Cozumel Island has the 4th most bat diversity, following Trinidad and Tobago with 67, Cuba with 26 and Jamaica with 22 (Table 2).

In this study, 20 species of bats corresponding to 16 genera organized into 5 families have been recorded in Cozumel. Among them, 6 species of the Stenodermatinae subfamily are reported, including *Phyllops falcatus* (Gray, 1839) that lives in the Greater Antilles (Rivas-Camo et al. 2020) and the new record of *Chiroderma villosum*.

It is very likely that *C. villosum* has a wide distribution in all semideciduous rainforest areas in Cozumel, since 40 % of the flora reported in the state of Quintana Roo is represented on the island (Télez-Valdez et al. 1989). In addition, monitoring efforts have focused solely on the archaeological site of San Gervasio because it is an area managed by the Cozumel Parks and Museums Foundation and because current resources limit study expansion to other points on the island.

Hurricanes appear to have a severe negative effect on bat and bird populations (Pedersen et al. 1996; Rodríguez-

Durán and Kunz 2001), but for *P. falcatus*, hurricanes have allowed this species to reach and colonize a new area (Rivas-Camo et al. 2020). The influence of hurricanes on the dispersion of bat species on other Caribbean islands among other dispersion factors over the sea could suggest that with greater sampling effort and a permanent study program it is likely to continue recording additional species. There is a pattern of increasing richness with proximity to the continent, as is the case with Trinidad and Tobago, which despite being less than half the land area of Cuba, has more than twice as many bat species, presumably related to its proximity to Venezuela.

Bat monitoring in Cozumel is a program that contributes to understanding the functioning of the island's ecosystem and seeing how this large island is linked to the mainland and to other Caribbean Islands. Only by continuing with the research and monitoring projects can we be in a position to prepare a management and conservation plan that is consistent, complete, and with a robust and deep knowledge of the island's biodiversity.

Table 1. Richness of bat species on Cozumel Island, Quintana Roo, México and risk category according to the official Mexican Standard NOM-059-SEMARNAT-2010.

List of Species	NOM-059-SEMARNAT-2010 Status
FAMILY PHYLLOSTOMIDAE	
<i>Artibeus jamaicensis</i>	
<i>Artibeus lituratus</i>	
<i>Artibeus phaeotis</i>	
<i>Centurio senex</i>	
<i>Glossophaga mutica</i>	
<i>Micronycteris microtis</i>	
<i>Mimon cozumelae</i>	Threatened
<i>Phyllops falcatus</i>	
<i>Chiroderma villosum</i>	
FAMILY MORMOOPIDAE	
<i>Pteronotus mesoamericanus</i>	
FAMILY NATALIDAE	
<i>Natalus mexicanus</i>	
FAMILY MOLOSSIDAE	
<i>Eumops bonariensis</i>	
<i>Molossus alvarezii</i>	
<i>Molossus nigricans</i>	
<i>Nyctinomops laticaudatus</i>	
FAMILY VESPERTILIONIDAE	
<i>Eptesicus furalis</i>	
<i>Lasiurus frantzii</i>	
<i>Lasiurus ega</i>	
<i>Myotis pilosatibialis</i>	
<i>Rhogeessa aeneus</i>	

Table 2. Number of bat species and territorial extension of Caribbean Islands.

Island	Bat species registered	Extension (km ²)	Reference
Trinidad and Tobago	67	5,128	Díaz <i>et al.</i> 2021
Cuba	26	110,860	Mancina <i>et al.</i> 2007
Jamaica	22	10,991	McFarlene 1986; Díaz <i>et al.</i> 2021
Cozumel	20	647	This study
Haiti	17	27,750	Díaz <i>et al.</i> 2021
Dominican Republic	18	48,670	Díaz <i>et al.</i> 2021
Grenada	15	344	Díaz <i>et al.</i> 2021
Guadeloupe	13	1,631	Díaz <i>et al.</i> 2021
Puerto Rico	13	8,959	Gannon <i>et al.</i> 2006
Dominica	12	751	Díaz <i>et al.</i> 2021
Martinique	11	1,128	Díaz <i>et al.</i> 2021
Montserrat	11	102	Díaz <i>et al.</i> 2021
Saint Vincent and the Grenadines	11	389	Díaz <i>et al.</i> 2021
Bahamas	10	13,939	Speer <i>et al.</i> 2015
Barbados	10	430	Díaz <i>et al.</i> 2021
Bonaire	10	288	Díaz <i>et al.</i> 2021
Saint Kitts and Nevis	10	269	Díaz <i>et al.</i> 2021
Saba	9	13	Díaz <i>et al.</i> 2021
Saint Lucia	9	616	Díaz <i>et al.</i> 2021
Saint Eustatius	8	21	Díaz <i>et al.</i> 2021
Aruba	7	193	Díaz <i>et al.</i> 2021
Antigua and Barbuda	7	442	Díaz <i>et al.</i> 2021
Curacao	6	444	Díaz <i>et al.</i> 2021
Cayman Island	6	250	Díaz <i>et al.</i> 2021
Anguilla	5	91	Díaz <i>et al.</i> 2021
British Virgin Islands	4	153	Díaz <i>et al.</i> 2021
United States Virgin Islands	4	347	Díaz <i>et al.</i> 2021
Saint Maarten	4	53	Díaz <i>et al.</i> 2021
Bermudas	3	56	Díaz <i>et al.</i> 2021
Saint Barth	2	21	Díaz <i>et al.</i> 2021
Turks and Caicos Islands	2	430	Díaz <i>et al.</i> 2021



Figure 2. Adult male of *Chiroderma villosum* captured in the San Gervasio Archaeological Zone, Cozumel Island, Quintana Roo, México (Photograph: P. Sabido). Image available at rivas1988@hotmail.com.

Literature cited

BIRNEY, E. C., *ET AL.* 1974. Mammalian distributional records in Yucatan and Quintana Roo, with comments and reproduction, structure, and status of peninsular populations. Occasional Papers, Bell Museum of Natural History, University of Minnesota 13:1-25.

CARIBBEAN ATLAS. 2024. The Caribbean Islands. Campus de Martinique Schoelcher. www.caribbean-atlas.com. Accessed on February 28, 2024.

CHARRUAU, P., *ET AL.* 2021. The Yucatan Yellow Bat (*Vespertilionidae*, *Rhogeessa aeneus*): a New Record for Banco Chinchorro Atoll, Mexico. *Caribbean Journal of Science* 51:101-103.

CIENCIA PUERTO RICO (CIENCIAPR). 2006. Reconocida la biodiversidad del Caribe. www.cienciapr.org. Accessed on February 26, 2024.

COMISIÓN NACIONAL DE ÁREAS NATURALES PROTEGIDAS (CONANP). 2007. Estudio previo justificativo para el establecimiento del Área de Protección de Flora y Fauna Isla de Cozumel, Quintana Roo, México. Comisión Nacional de Áreas Naturales Protegidas. México City, México.

DA ROCHA, P. A., *ET AL.* 2015. First record of Salvin's big-eyed bat *Chiroderma salvini* Dobson, 1878 for Brazil. *Mammalia* 80:1-6.

DÍAZ, M. M., *ET AL.* 2016. Clave de identificación de los murciélagos de Sudamérica. Programa de Conservación de los Murciélagos de Argentina. Magna Publicaciones. Tucumán, Argentina.

DÍAZ, M. M., *ET AL.* 2021. Clave de identificación de Murciélagos Neotropicales. Programa de Conservación de los Murciélagos de Argentina. Publicación especial N°4 Programa de Conservación de los Murciélagos de Argentina (PCMA). Tucumán, Argentina.

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- DURAN, R., W. TORRES, AND I. ESPEJEL (EDS.). 2010. Biodiversidad y Desarrollo Humano en Yucatán, primera edición. Centro de Investigación Científica de Yucatán (CICY). Mérida, México.
- FERNÁNDEZ-PALACIOS, P. J., ET AL. 2021. Scientists' Warning- The Outstanding Biodiversity of Islands is in Peril. Global Ecology and Conservation. Biodiversidad y Desarrollo Humano en Yucatán, first edition. Centro de Investigación Científica de Yucatán (CICY). Mérida, México.
- FLEMING, T. H., ET AL. (EDS.). 2020. Reproduction and life histories. Phyllostomid bats: A unique mammalian radiation, first edition. The University Chicago Press. Chicago, U.S.A.
- GANNON, M. R., ET AL. 2006. Bats of Puerto Rico: an island focus and a Caribbean perspective. Texas Tech University Press. Kingston, Jamaica.
- GARBINO, G. S. 2019. *Chiroderma villosum*. Pp. 554 in Handbook of the Mammals of the World (Wilson, D. E., and R. A. Mittermeier, eds.). Lynx Edicions. Barcelona, Spain.
- GARBINO, G. S. T., ET AL. 2020. Systematics of big-eyed bats, genus *Chiroderma* Peters, 1860 (Chiroptera: Phyllostomidae). *Zootaxa* 4846:1-93.
- GARDNER, A. L. 2007. Mammals of South America. Marsupials, Xenarthrans, Shrews and Bats. The University of Chicago Press. Chicago, U.S.A.
- MANCINA, A. C., ET AL. 2007. Endemics under threat: an assessment of the conservation status of Cuban bats. *The Italian Journal of Mammalogy* 18:3-15.
- McFARLENE, D. A. 1986. Cave bats in Jamaica. *Oryx* 20:27-30.
- MEDELLÍN, R. A., ET AL. 2008. Identificación de los Murciélagos de México Clave de Campo. Instituto de Ecología, Universidad Nacional Autónoma de México. México City, México.
- MORALES-CONTRERAS, J., ET AL. 2020. Recursos florales usados por el colibrí esmeralda de Cozumel (*Chlorostilbon forficatus*). Huitzil. *Revista Mexicana de Ornitología* 21:1-12.
- ORELLANA, R., ET AL. 2007. El clima de Cozumel y la Riviera Maya. Pp. 23-32 in Biodiversidad acuática de la Isla de Cozumel (Mejía-Ortíz, L. M., eds.). Universidad de Quintana Roo. México City, México.
- PEDERSEN, S. C., ET AL. 1996. Notes on bats from Montserrat (Lesser Antilles) with comments concerning the effects of Hurricane Hugo. *Caribbean Journal of Science* 32:206-213.
- REYNOSO-CAMPOS, J. J., ET AL. 2015. Hormigas (Hymenoptera: Formicidae) de la Isla Cozumel, Quintana Roo, México. Pp. 27-39 in Avances de Formicidae en México (Castaño-Meneses G., et al., eds.). Centro de estudios en Zoología. Guadalajara, México.
- RIVAS-CAMO, N. A., ET AL. 2020. Cuba in Mexico: first record of *Phyllops falcatus* (Gray, 1839) (Chiroptera, Phyllostomidae) for Mexico and other new records of bats from Cozumel, Quintana Roo. *Zookeys* 973:153-162.
- RODRÍGUEZ-DURÁN, A., AND T. H. KUNZ. 2001. Biogeography of West Indian bats: an ecological perspective. Pp. 335-368 in Biogeography of the West Indies: Patterns and Perspectives (Woods, C. A., and F. E. Sergile, eds.). CRC Press, second edition. Boca Raton, U.S.A.
- SECRETARÍA DE MEDIO AMBIENTE Y RECURSOS NATURALES (SEMARNAT). 2010. Norma Oficial Mexicana NOM-059-SEMARNAT-2010, Protección ambiental-Especies nativas de México de flora y fauna silvestres-Categorías de riesgo y especificaciones para su inclusión, exclusión o cambio-Lista de especies en riesgo. Secretaria de Medio Ambiente y Recursos Naturales. México, 30 de diciembre de 2010. México City, México.
- SIMMONS, N. B., AND A. L. CIRRANELO. 2024. Bat Species of the World: A taxonomic and geographic database. <http://batnames.org>. Accessed on April 10, 2024.
- SOSA-ESCALANTE, J., ET AL. 2001. *Chiroderma villosum* (Chiroptera: Phyllostomidae) en el estado de Yucatán, México. *Revista Mexicana de Mastozoología* 5:68-71.
- SPEER, K. A., ET AL. 2015. Bats of Bahamas: natural history and conservation. *Bulletin Florida Museum Natural History*. Gainesville, U.S.A.
- TÉLLEZ-VALDEZ, O., ET AL. 1989. Las Plantas de Cozumel (Guía Botánico-Turística de la Isla de Cozumel, Quintana Roo). Instituto de Biología. Universidad Nacional Autónoma de México. México City, México.
- TURCIOS-CASCO, M. Á., ET AL. 2021. Patrones de actividad de murciélagos filostómidos en un bosque seco en Honduras. *Therya Notes* 2:34-38.
- WAGNER, I., ET AL. 2015. Cheating on the mutualistic contract: nutritional gain through seed predation in the frugivorous bat *Chiroderma villosum* (Phyllostomidae). *Journal of Experimental Biology* 218:1016-1021.
- YORK, H. A., ET AL. 2019. Field key to the bats of Costa Rica and Nicaragua. *Journal of Mammalogy* 100:1726-1749.

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