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Noteworthy acoustic records of *Eumops ferox* (Chiroptera: Molossidae) and *Mormoops megalophylla* (Chiroptera: Mormoopidae) in Mexico

Registros acústicos notables de *Eumops ferox* (Chiroptera: Molossidae) y *Mormoops megalophylla* (Chiroptera: Mormoopidae) en México

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Eumops ferox is a molossid previously considered restricted to the Neotropical region south of the Trans-Mexican Volcanic Belt. *Mormoops megalophylla* is a widespread distributed mormoopid species but restricted in the Baja California Peninsula to Baja California Sur. This note reports notable records of these two species in northern Mexico. By employing Robust Quadratic Discriminant Analysis and Welch's ANOVA, we analyzed and identified free-flying bat echolocation calls recorded during monthly surveys from January to November 2023 in two regions: Llera de Canales, Tamaulipas, and the Volcanic Complex "Las Tres Vírgenes" in Baja California Sur. Taxonomic identities were determined using frequency and temporal acoustic parameters. A total of 52 echolocation passes from *E. ferox* were documented in Llera de Canales, Tamaulipas, situated 170 km northwest of its closest previously known record and over 450 km north of its currently recognized distribution range. Additionally, 6 passes of *M. megalophylla* were identified in "Las Tres Vírgenes", located 35 km northwest of the nearest prior record. The *E. ferox* record extends its known range into northeastern Mexico, while the *M. megalophylla* record marks the northernmost occurrence of the species on the Baja California Peninsula. These findings enhance our knowledge of the distribution of both species in Mexico.

Keywords: Baja California Peninsula; echolocation; insectivorous bats; northernmost record; Tamaulipas.

Eumops ferox es un molósido que anteriormente se consideraba restringido a la región neotropical al sur de la Faja Volcánica Transmexicana. *Mormoops megalophylla* es una especie de mormópido ampliamente distribuida, pero restringida en la Península de Baja California a Baja California Sur. Esta nota reporta registros notables de estas dos especies en la región norte de México. Mediante el uso de Análisis Discriminante Cuadrático Robusto y el ANOVA de Welch, analizamos e identificamos las llamadas de ecolocalización de murciélagos en vuelo libre, registradas durante muestreos mensuales realizados de enero a noviembre de 2023 en dos regiones: Llera de Canales, Tamaulipas, y el Complejo Volcánico "Las Tres Vírgenes" en Baja California Sur. Las identidades taxonómicas se determinaron utilizando parámetros acústicos de frecuencia y temporales. Un total de 52 secuencias de ecolocalización de *E. ferox* fueron documentadas en Llera de Canales, Tamaulipas, ubicadas a 170 km al noroeste de su registro más cercano conocido y a más de 450 km al norte de su rango de distribución actualmente reconocido. Adicionalmente, se identificaron 6 secuencias de *M. megalophylla* en "Las Tres Vírgenes", situado a 35 km al noroeste del registro previo más cercano. El registro de *E. ferox* extiende su distribución conocida al noreste de México, mientras que el registro de *M. megalophylla* corresponde al registro más septentrional de la especie en la Península de Baja California. Estos registros mejoran el conocimiento de la distribución de ambas especies en México.

Palabras clave: Ecolocalización; murciélagos insectívoros; Península de Baja California; registro más septentrional, Tamaulipas.

The effectiveness of bat surveys depends on the sampling method employed (Flaquer *et al.* 2007). Conventional techniques such as mist nets and harp traps may overlook certain species as foraging strategies, vertical stratification, and echolocation reduce capture success (Berry *et al.* 2004). Consequently, relying solely on these techniques can underestimate species diversity (MacSwiney *et al.* 2008).

Since the late 1990s, the analysis of bat echolocation calls has enhanced bat fauna inventories by detecting previously unrecorded species (*e. g.*, Leal-Sandoval *et al.* 2020; Rodríguez-San Pedro *et al.* 2022, 2023). With technological advancements and the decreasing cost of ultrasonic recording equipment, the combined use of acoustic monitoring and mist netting has become

increasingly common in bat surveys (Zamora-Gutiérrez *et al.*, 2021). Consequently, our understanding of bat diversity and species distribution has improved and continues to be regularly updated (*e.g.,* González-Terrazas *et al.* 2016; Trujillo *et al.* 2021).

Through acoustic monitoring, this note reports two notable records in Mexico: *Eumops ferox*, a molossid bat previously thought to occur only in the Neotropical region south of the Trans-Mexican Volcanic Belt (Solari 2019), and *Mormoops megalophylla*, a widespread distributed mormoopid bat but restricted in the Baja California Peninsula to Baja California Sur (Álvarez-Castañeda 1999; Dávalos *et al.* 2019).

Acoustic recordings resembling *E. ferox* and *M. megalophylla* were obtained in 2023 from monthly surveys (January through November) at Llera de Canales, Tamaulipas, and Mulegé, Baja California Sur, respectively. In Tamaulipas, surveys were carried out near the Guayalejo River (23° 19′ 39.881″ N, 99° 1′ 0.469″ W) in a Tamaulipan Thorny Scrub with riparian vegetation and crops, under a hot semi-arid climate with summer rains (INEGI 2021). In Baja California Sur, surveys took place around the Las Tres Vírgenes Volcanic Complex (27° 31′ 59.263″ N, 112° 33′ 38.372″ W) in xerophilous scrubland, featuring a hot desert climate with temperatures of 14–24 °C and annual rainfall below 500 mm (INEGI 2010).

Acoustic surveys were conducted to assess local spatial and temporal patterns of bat activity. At each site, four transects, each 4-6 km in length, were surveyed. Bat activity was recorded for 90 minutes per transect immediately after sunset using an Echo Meter Touch 2 Pro ultrasonic detector (Wildlife Acoustics Inc., Maynard, MA) set to a 256 kHz sampling rate and connected to a Motorola G60S smartphone running Android v11. No frequency or amplitude filters were applied.

Bat echolocation calls were recorded in WAV format and analyzed in BatSound Pro v.3.31 (Pettersson Elektronik AB, Uppsala, Sweden) using a 1024-point FFT, Hamming window, and 95 % overlap, parameters chosen for analytical consistency and user convenience. The shape and structural characteristics of pulses were examined directly in the spectrogram using these settings, along with threshold = 1 and contrast = 2. For some recordings, however, these visualization settings were adjusted up to threshold = 5 and contrast = 4, to improve the clarity of pulse structure. We measured five acoustic parameters commonly used in bat species identification, call duration (Dur), maximum frequency (Fmax), minimum frequency (Fmin), peak frequency (Pkf), and bandwidth (Bw) (Orozco-Lugo *et al.* 2013; Leal-Sandoval *et al.* 2020; Ayala-Berdon *et al.* 2021; Rodríguez-San Pedro *et al.* 2022). Duration was measured in the oscillogram, beginning at the point where the signal amplitude rose abruptly above the background noise and ending when the amplitude returned to a level comparable to the noise floor, with no subsequent immediate increase (i.e., in signals exhibiting multimodal amplitude peaks resembling a "violin" shape). To visualize the oscillogram, we used the cursor selection tool to define a time window with a width approximately twice the duration of the pulse as displayed in the sonogram. Fmax, Fmin, and Pkf were extracted from the power spectrum (using the same 1024-point FFT, Hamming window, and 95 % overlap). Both Fmax and Fmin were measured at - 10 dB below the peak intensity in the power spectrum (Jensen and Miller 1999), and considering the background noise level present during the specific pulse duration. Pulses were discarded when external noise sources (e.g., insect calls, human noises) interfered with reliable measurement. Bandwidth was defined as the frequency range over which the echolocation pulse occurred and was calculated as the arithmetic difference between Fmax and Fmin.

To identify species recorded in Tamaulipas, we applied Robust Quadratic Discriminant Analysis (rQDA; Todorov and Filzmoser 2009; Tharwat 2016) using the R package rrcov (Todorov and Pires 2007) to build a discriminant model from a training dataset and to assign species identities. The rQDA extends classical QDA by using robust estimators for means and covariances, reducing sensitivity to outliers and assumption violations (Todorov and Filzmoser 2009). The training dataset comprised search-phase echolocation parameters of *Eumops ferox* recorded in 2020-2023 in La Venta, Oaxaca, Mexico (n = 24, unpublished data), supplemented with mean values from Cuban populations (n = 1, Mora and Torres 2008), and included parameters of sympatric species with similar calls previously recorded in the area: *Eumops perotis*, *Nyctinomops macrotis*, *Tadarida brasiliensis*, and *Lasiurus cinereus* (Ayala-Berdon *et al.* 2021; Szewczak 2018; Jung *et al.* 2014; Guzmán-Soriano *et al.* 2009; Mora and Torres 2008).

To ensure predictor independence, one pulse per date and site was used in the training data, and Tamaulipas recordings were averaged per pass, treating passes separated by silent gaps or different dates as independent. Principal Component Analysis was applied to reduce multicollinearity, and rQDA was conducted using the first three components of call signatures from *E. perotis*, *N. macrotis*, *T. brasiliensis*, *L. cinereus* and *E. ferox* (Oaxaca and Cuba) as training data, excluding PCA-scores of *E. ferox* from Tamaulipas. Model performance was assessed using accuracy and ROC AUC using the pROC package (Robin *et al.* 2011) in R (R Core Team, 2025). Species identity for Tamaulipas recordings was then inferred by applying the rQDA model's posterior probabilities to their PCA-scores.

We assessed each principal component's contribution to group discrimination using an index based on standardized mean differences. PCA loadings identified the acoustic parameters most linked to the discriminant component, which were then compared between Tamaulipas recordings and other reference species using Welch's ANOVA with Games-Howell post hoc tests for

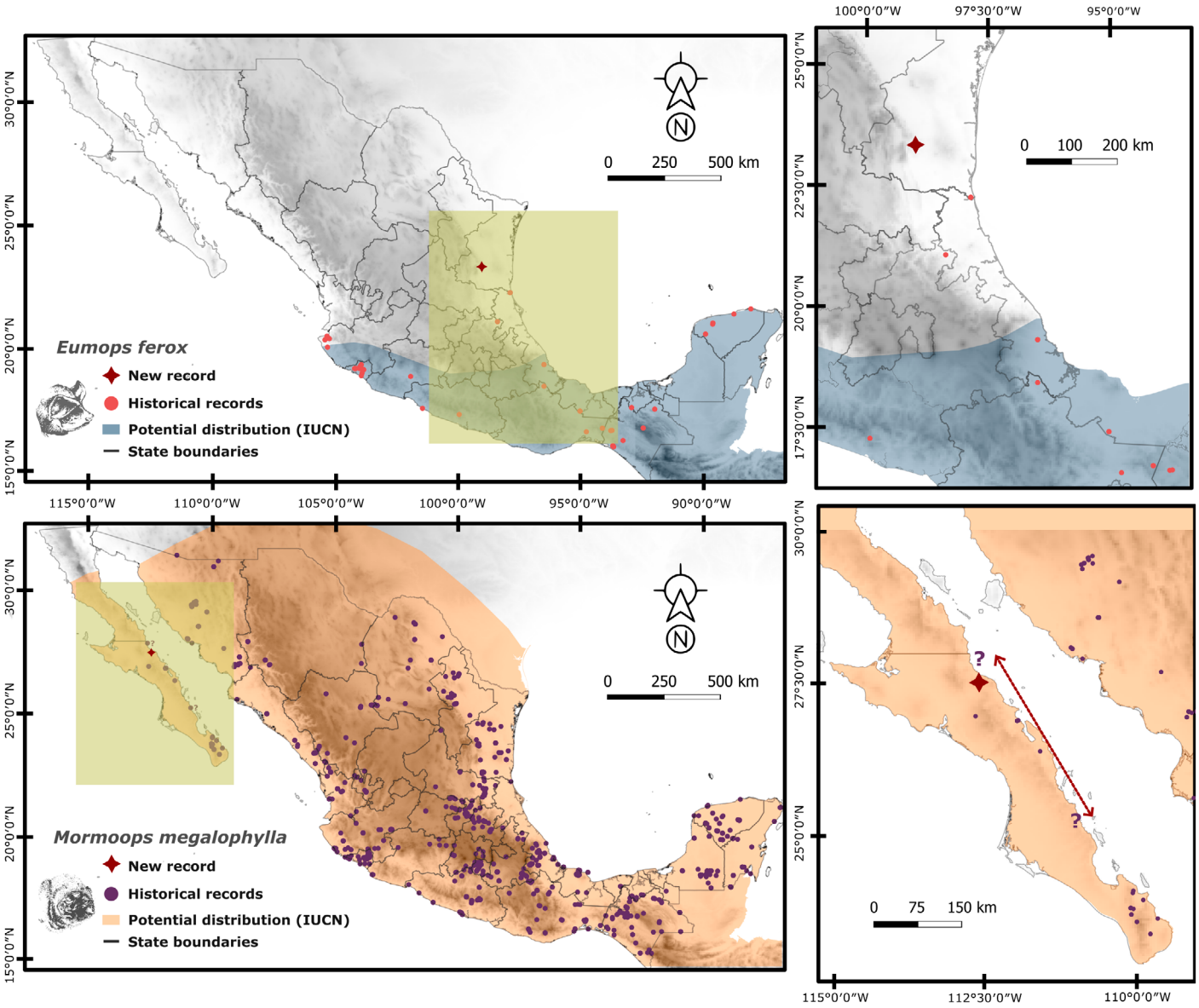

Figure 1. Norteworthy records of *Eumops ferox* (above) and *Mormoops megalophylla* (below) from Llera de Canales, Tamaulipas, and the Volcanic Complex Las Tres Vírgenes, Baja California, respectively. Circles represent historical records up to the current study (GBIF.org 2024 a,b,c), while red stars denote new records. The colored areas (blue or orange) indicate the geographic distribution ranges according to the IUCN for *E. ferox* (Solari 2019) and *M. megalophylla* (Dávalos *et al.* 2019). For *M. megalophylla*, the two potential locations for the previously debated record from Bahía San Carlos, Costa Este (see main text) are marked with question marks and the red arrow indicate the distance between them.

unequal variances and non-normal data (Delacre *et al.* 2019; Shingala and Rajyaguru 2015).

For *M. megalophylla*, we applied the same methodology used for *E. ferox* in Tamaulipas. The rQDA training dataset included echolocation calls of *M. megalophylla* (n = 23) and *Pteronotus fulvus* (n = 40) recorded in La Mancha, Veracruz in 2022 (Echo Meter Touch 2 Pro, unpublished data). *Pteronotus fulvus* was included because it occurs in Baja California's Cape Region and its multi-harmonic, quasi-constant, modulated calls resemble those of *M. megalophylla* (Álvarez-Castañeda 1999; Arnaud-Franco *et al.* 2012; Orozco-Lugo *et al.* 2013).

We recorded 52 passes (268 calls) of free-flying *Eumops cf. ferox* in Llera de Canales, Tamaulipas, ~ 170 km northwest of the nearest previous record (Figure 1). Calls were single-harmonic, quasi-constant frequency (Figure 2a), averaging 16.23 ± 1.06 ms in duration, a minimum frequency of 13.57 ± 0.33 kHz, and 15.69 ± 0.39 kHz peak frequency (Table 1). Recordings occurred multiple times in January, February, July, and August 2023, and activity peaked shortly after sunset and 2-3 h later.

The training dataset violated assumptions of multivariate normality ($E = 6.423$, $P < 0.001$) and covariance homogeneity ($X^2 = 396.21$, $d.f. = 30$, $P < 0.001$), justifying the use of rQDA. The model achieved 93.02 % overall accuracy, with ROC AUC > 0.96 for most species except *T. brasiliensis* (AUC = 0.68); *E. ferox* reached 88 % accuracy (AUC = 0.97). Posterior classification assigned 51 passes (98.1 %) from Tamaulipas to *E. ferox* with high posterior probability (> 0.93) (Figure 3a). The first PC, primarily influenced by Fmin, Fmax, and Pkf, was the most effective for separating *E. ferox* from other species (Figure 3b,c). Welch's ANOVA with Games-Howell

Table 1. Acoustics parameters of echolocation calls for *Eumops ferox* (Llera de Canales, Tamaulipas) and *Mormoops megalophylla* (Las Tres Vírgenes Volcanic Complex, Baja California) are highlighted in bold. Calls included in both rQDAs, as well as those from the training dataset, are presented with sample size (n) -indicating the number of calls and the number of passes in parentheses- along with the mean (X), standard deviation (SD), and coefficient of variation (CV). Abbreviation: *Eumops ferox* (Eufe), *Eumops perotis* (Eupe), *Lasiurus cinereus* (Laci), *Nyctinomops macrotis* (Nyma), *Tadarida brasiliensis* (Tabra), *Mormoops megalophylla* (Mome), *Pteronotus fulvus* (Pteful).

		Eufe (training dataset)	**Eufe Tamaulipas**	**Eupe**	**Laci**	**Nyma**	**Tabra**	**Mome (training dataset)**	**Mome Baja California**	**Pteful**
n		25	268(52)	64	23	83	20	23	29(6)	40
	$\bar{X}$	17.79	19.20	12.67	30.56	23.51	30.19	55.64	59.05	71.68
Fmax	*SD*	1.91	0.95	1.47	5.30	3.48	3.35	3.14	0.93	1.85
	CV	10.76	4.96	11.59	17.36	14.79	11.11	5.64	1.57	2.58
	$\bar{X}$	13.97	13.57	10.42	22.47	18.30	23.29	42.64	38.96	57.04
Fmin	*SD*	0.79	0.33	1.39	1.51	0.96	1.53	5.10	0.69	1.66
	CV	5.63	2.41	13.36	6.72	5.26	6.57	11.95	1.76	2.91
	$\bar{X}$	3.71	5.63	2.24	8.09	5.21	6.90	13.00	20.10	14.63
Bw	*SD*	1.09	1.01	1.34	4.72	3.32	2.98	7.36	1.47	1.99
	CV	29.26	17.89	59.83	58.33	63.79	43.23	56.63	7.31	13.61
	$\bar{X}$	15.56	15.69	11.60	24.51	20.51	25.48	52.92	54.48	63.53
Pkf	*SD*	1.26	0.39	1.28	1.65	1.29	1.75	1.35	0.32	5.02
	CV	8.08	2.46	11.03	6.74	6.26	6.86	2.54	0.59	7.89
	$\bar{X}$	15.00	16.23	21.06	11.09	12.24	12.04	6.94	5.69	5.88
Dur	*SD*	1.95	1.06	3.59	1.53	2.55	5.60	1.50	0.45	1.50
	CV	13.03	6.55	17.06	13.82	20.80	46.51	21.62	7.89	25.43

Table 2. Results of the Games-Howell post-hoc test comparing *E. ferox* from Tamaulipas with *E. ferox* from training dataset, and sympatric open-space aerial hawking species presented in Tamaulipas.

		Pkf		**Fmin**		**Fmax**	
	n	*q*	*P*	*q*	*P*	*q*	*P*
Eumops ferox (training dataset)	*25*	0.732	0.995	-3.46	0.1748	4.92	0.017
Eumops perotis	*64*	34.35	< 0.001	24.73	< 0.001	40.84	< 0.001
Lasiurus cinerus	*23*	-35.77	< 0.001	-39.55	< 0.001	-14.42	< 0.001
Nyctinomops macrotis	*83*	-45.24	< 0.001	- 58.18	< 0.001	-15.11	< 0.001
Tadarida brasiliensis	*20*	-35.11	< 0.001	- 39.82	< 0.001	-20.41	< 0.001

tests revealed significant differences in these parameters (F = 580.66, *d.f.* = 5/73.70, $P < 0.001$ for Pkf; F = 686.41, *d.f.* = 5/74.25, $P < 0.001$ for Fmin; F = 294.52, *d.f.* = 5/75.51, $P < 0.001$ for Fmax) relative to other aerial-hawking bats, but not compared to *E. ferox* from the training dataset (Table 2).

For *M. megalophylla*, we recorded 6 echolocation passes (29 calls) about 55 km north of a previous record in Santa Ana and 35 km northwest of another in Santa Rosalía, Baja California (Figure 1). Calls consisted of a quasi-constant segment followed by a steeply modulated portion; in some cases, a brief initial FM component was present. Up to three harmonics were usually visible, with the second harmonic being the most energetic (Figure 2b). The calls had an average duration of 5.69 ± 0.45 ms, a maximum frequency of 59.05 ± 0.93 kHz, and a peak frequency at 54.4 ± 0.32 kHz (Table 1). Recordings occurred in July, September, and November 2023, 90 min to 2 h after sunset.

The rQDA was applied as the training dataset violated normality (E = 3.351, $P < 0.001$) and covariance homogeneity (X^2 = 96.41, *d.f.* = 12, $P < 0.001$). The model achieved 100 % classification accuracy and AUC = 1 for both *M. megalophylla* and *P. fulvus*. Posterior classification assigned all Baja California passes to *M. megalophylla* with probability 1. The first PC, primarily influenced by Fmin, Fmax, and Pkf, was the most effective for separating *M. megalophylla* from *Pteronotus fulvus* (Figure 3d,e). Welch's ANOVA (F = 79.251, *d.f.* = 2/42.18, $P < 0.001$ for Pkf; F = 1091.9, *d.f.* = 2/24.57, $P < 0.001$ for Fmin; F = 467.04, *d.f.* = 2/20.52, $P < 0.001$ for Fmax) with Games-Howell post hoc tests confirmed significant differences between Baja California *M. megalophylla* and *P. fulvus* (Pkf q = -15.933, $P < 0.001$; Fmin q = -66.525, $P < 0.001$; Fmax q = -37.391, $P < 0.001$), and also with Veracruz *M. megalophylla* for Pkf, Fmin, and Fmax (Pkf q = 7.148, $P < 0.001$; Fmin q = -4.737, $P < 0.001$; Fmax q = 6.39, $P < 0.01$).

In this note, we report noteworthy records of *E. ferox* and *M. megalophylla* in Mexico based on acoustic evidence, extending their known distribution. These findings underscore the importance of ongoing acoustic surveys to document bat diversity in Mexico, particularly in

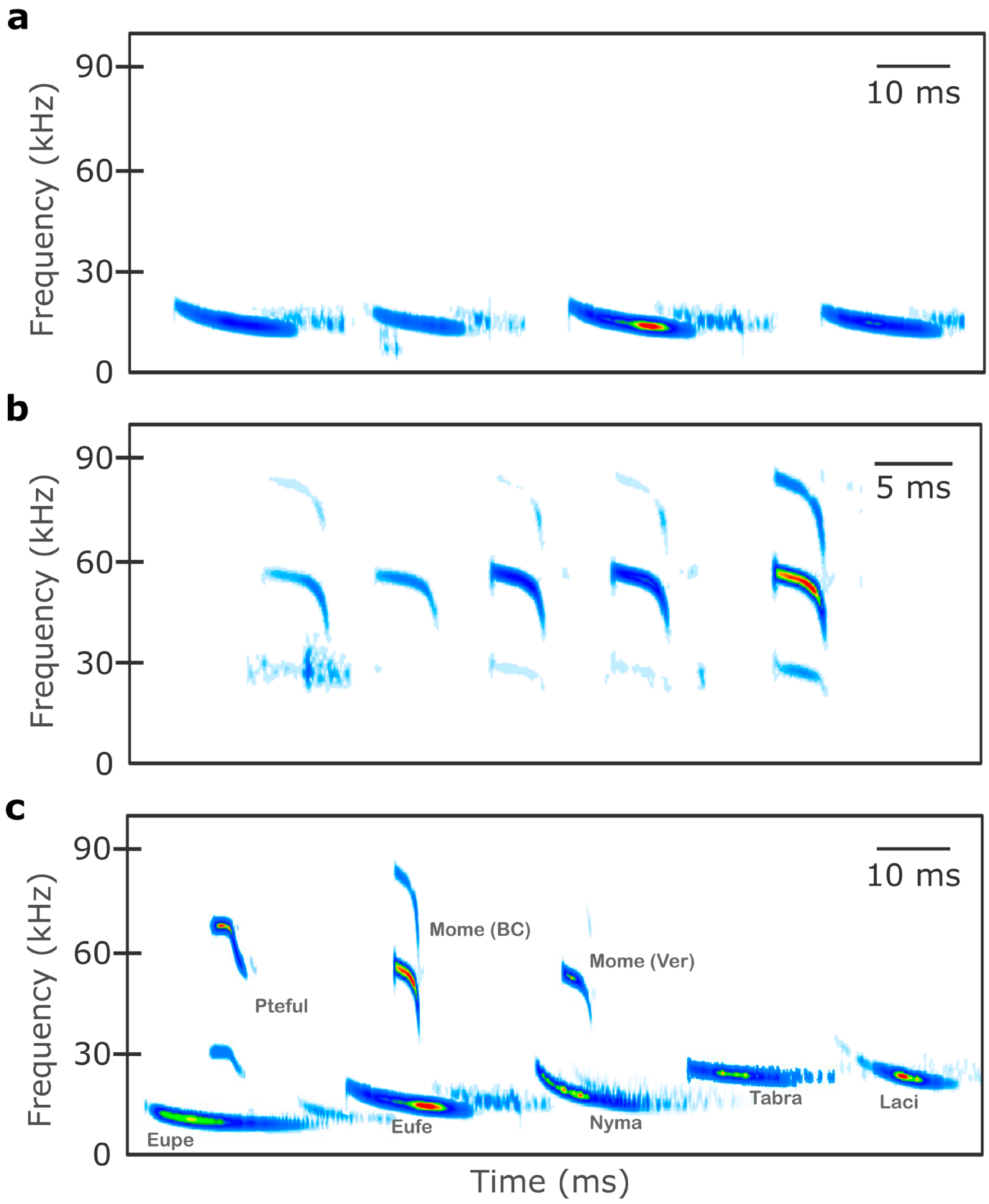

Figure 2. Sonograms of echolocation calls of (a) *Eumops ferox* recorded in Llera de Canales, Tamaulipas, and (b) *Mormoops megalophylla* recorded in the Las Tres Vírgenes Volcanic Complex, Baja California Sur. Panel (c) is a composition illustrating sonograms of echolocation calls from various species used as reference for species discrimination analysis based on acoustic parameters. The time between pulses in all panels is compressed and does not represent the actual interval separating them. Abbreviations: Mome (Ver): *M. megalophylla* from Veracruz; Mome (BC): *M. megalophylla* from Baja California; Pteful: *P. fulvus*; Eupe: *E. perotis*; Eufe: *E. ferox*; Laci: *L. cinereus*; Nycma: *N. macrotis*; Tabra: *T. brasiliensis*. Sonograms were generated using SonoBat Viewer (free version) with blue contrast settings.

Figure 3. (a) Posterior probability of identity assigned to *E. ferox* from Tamaulipas based on the rQDA model. Each bar represents a pass. (b) Variable importance, calculated through the mean standard distance of class, for discriminating *E. ferox* from other open-space aerial hawking species. (c) Scatter plot of the PCA-scores of PC1 and PC3 for *E. ferox* and other sympatric aerial hawking bat species analyzed in the rQDA. The plot is constructed based on variable importance. (d) Variable importance, calculated through the mean standard distance of class, for discriminating *M. megalophylla* from *P. fulvus*. (e) Scatter plot of the PCA-scores of PC1 and PC32for *M. megalophylla* and *P. fulvus* analyzed in the rQDA. Similar to *E. ferox*, the scatterplot is based on variable importance according to the rQDA. In both cases, training and empirical data for *E. ferox* from Tamaulipas and Oaxaca, as well as *M. megalophylla* from Baja California Sur and Veracruz, are included.

historically underexplored regions with insectivorous bat species. Our models, constructed using Robust Quadratic Discriminant Analysis, successfully distinguished their calls from those of closely related species, strongly suggesting the presence of *E. ferox* in Tamaulipas and *M. megalophylla* in northern Baja California Sur.

Echolocation calls of *E. ferox* from Tamaulipas were clearly distinguished from sympatric aerial-hawking bats (Table 1). While *N. macrotis*, *L. cinereus*, and *T. brasiliensis* emitted higher frequencies (Ayala Berdon *et al.* 2021; Szewczak 2018), the congener *E. perotis* produced lower ones (Szewczak 2018; Rodríguez-San Pedro *et al.* 2023). These differences likely reflect negative allometry between body size and call frequency (Jones 1999; López-Cuamatzi *et al.* 2020), as *E. ferox* (Forearm [FA]: 55-63 mm; Body mass [BM]: 34-42 g; Lim 2019a) is larger than *L. cinereus* (FA: 50-57 mm; BM: 20-35 g; Cláudio 2019) and *T. brasiliensis* (FA: 36-47 mm; BM: 8-15 g; Lim 2019d), but smaller than *E. perotis* (FA: 72-83 mm; BM: 52-76 g; Lim 2019b). Interestingly, in comparison with *N. macrotis*, *E. ferox* has a similar forearm length but greater body mass (*N. macrotis* FA: 54-65 mm; BM: 17-34 g; Lim 2019c). Thus, allometry could be a contributing factor; however, it is important to note that this relationship may not apply uniformly across all comparisons, particularly among molossid bats (see Jung *et al.* 2014), and other factors may also influence the divergence in echolocation call frequencies within our dataset.

The acoustic traits of *E. ferox* in this study resemble those from Campeche (Guzmán-Soriano *et al.* 2009), though at slightly lower frequencies. Intraspecific variation in echolocation call parameters is well-documented and often linked to environmental factors (Jiang *et al.* 2015). For instance, higher frequencies are more prone to atmospheric attenuation under high humidity or wind (Gillam *et al.* 2009), while lower frequencies are more resilient (Goerlitz 2018). Lower call frequencies of *E. ferox* in Llera de Canales may reflect the impact of stronger winds (INEGI 2021), similar to observations from La Venta, Oaxaca, another windy site used for training data. Further studies are needed to verify this pattern and its driving factors.

Our multiple records of *E. ferox* in Llera de Canales, Tamaulipas, suggest its presence in northeastern Mexico. Although surveys covered nearly a full year, the species was detected only in January-February and July-August, indicating a possible seasonal pattern that warrants further year-round monitoring. Previous distribution models (Medellín *et al.* 2008) suggested the occurrence of *E. ferox* in the region based on records collected in Tampico, Tamaulipas, in 1923 (FMNH 124224-29), but no additional records existed until now. Combined with historical observations (Figure 1), our findings indicate that the range of *E. ferox* extends along the Gulf of Mexico slope beyond the limits currently recognized by the IUCN (Solari 2019) (Figure 1).

The shape, multi-harmonic structure, and frequency of *M. megalophylla* calls in our recordings match previous descriptions from Mexico and the Neotropics (i.e., Orozco-Lugo *et al.* 2013). However, Games-Howell tests revealed significant differences between Veracruz and Baja California Sur populations, likely reflecting intraspecific geographic variation rather than species-level divergence (Jiang *et al.* 2015). Despite these differences, both populations remain clearly distinct from *P. fulvus*.

Previous records of *M. megalophylla* on the Baja California Peninsula are concentrated in southern Baja California Sur (BCS), including the Cape Region near La Paz and Comondón, as well as two northern BCS locations in Mulegé municipality (Santa Ana, Santa Rosalía, and the municipal head) (Figure 1). A controversial record of *M. megalophylla* on the Baja California Peninsula concerns a female captured on July 24, 1963, by Jamie Maya and deposited at the University of Arizona Museum of Natural History (UAZ 09941). Although labeled as collected at "Bahía San Carlos, East Coast", BCS (Bucci 2024), the assigned coordinates (27° 55′ 00.0″ N 112° 43′ 00.0″ W) fall over water in the Gulf of California (Figure 1). This may represent the northernmost record of the species on the peninsula, but the exact collection site is uncertain. The assigned coordinates were taken from one of two potential locations for Bahía San Carlos in Baja California Sur (Melanie Bucci, curator of the Mammal Collection at the University of Arizona Museum of Natural History, *pers. comm.*). The second location (25° 16′ 0.001″N, 110° 57′ 0″W), provided by the curator as an alternative (but not shown in either GBIF or VertNet; Bucci, *pers. comm.*), lies 350 km south of the coordinates assigned to the specimen and 290 km south of our record from the "Las Tres Vírgenes" Volcanic Complex. Given the curator's acknowledgment of the uncertainty around the location assigned to the UAZ 09941 specimen, reflected in GBIF's "Georeference verification status" field indicating the need for verification (Bucci 2024), we consider that our record of *M. megalophylla* in the lowlands of the Volcanic Complex of "Las Tres Vírgenes" represents the most reliable northernmost record of occurrence of this species on the Baja California Peninsula.

Identifying bat species through comparative analyses of echolocation call parameters is a scientific practice that inherently involves some degree of uncertainty regarding taxonomic identity. Acknowledging this uncertainty, we consider that, although our quantitative analyses and the available ecological background on the distribution and ecology of the species discussed in this note support our inferences about these remarkable records, a thorough field exploration of the region is necessary to obtain voucher specimens. Such efforts would confirm the presence of these species and dispel any remaining skepticism. In this sense, our note emphasizes the importance of continued bat monitoring in the region to enhance our understanding of bat diversity and distribution in northern Mexico.

Based on a quantitative analysis of echolocation call parameters, this note reports noteworthy records of *E.*

ferox and *M. megalophylla* in northern Mexico. The record of *E. ferox* from Llera de Canales, Tamaulipas, represents the northernmost occurrence of this species and confirms its presence in northeastern Mexico, complementing previous records from Tampico, Tamaulipas. Regarding *M. megalophylla*, the record presented here constitutes the most reliable and northernmost occurrence of the species on the Baja California Peninsula. Furthermore, our quantitative analysis revealed significant differences in the acoustic parameters of echolocation calls between Baja California and reference data from Veracruz, suggesting the presence of geographic variation that warrants further investigation. The records presented here contribute substantially to understanding the geographic distribution of both species, extending their known ranges and adding new localities. These findings underscore the importance of continued field surveys in northern Mexico and highlight the value of acoustic monitoring for improving bat diversity inventories across the country.

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