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Echolocation sounds of the painted bat *Kerivoula picta* (Vespertilionidae)

So far nine species of insectivorous bats have been reported in Madurai (9°58'N, 78°10'E) and their field ethology, neurophysiology and chronobiology have been studied extensively¹. These bats use species-specific echolocation calls of various frequencies while hunting and are classified as surface gleaners, within foliage foragers and open-air foragers². The ultrasonic calls emitted by bats may be of constant frequency (CF) or frequency modulated (FM) or both (CF/FM)^{2,3}.

One of the most attractive among bats, especially in the family Vespertilionidae is the painted bat, *Kerivoula picta* (Microchiroptera: Kerivoulinae). This species, captured at the Madurai Kamaraj University (MKU) campus is a new addition to the list of bats in Madurai. Apart from taxonomy, distribution, roosting and scanty reports on reproduction, no other information is available on this species^{4–6}. Here we present the structure and characteristics

of the echolocation calls of this little known species *K. picta*.

On 22 January 2006, around 2100 h while monitoring the activity patterns of fruit bats in the MKU quarters garden, a female *K. picta* (Figure 1a and b) was found trapped in the mist net that was erected to capture fruit bats. We carefully transported the individual to the laboratory and released it into a free-flight room (3.1 mL × 2.4 mW × 4.0 mH) around 2146 h. The flight room was provided with several perches made of wooden pieces fixed permanently to the walls on all sides for the bats to roost. The echolocation calls of the bat were recorded during flight as well as at rest using the method described below. We took photographs using a digital camera (Nikon Coolpix E2500) and released the individual in the university garden around 0050 h on the next day.

Echolocation calls emitted by *K. picta* were recorded using a SM2 microphone

(Ultra Sound Advice, UK) and filtered using a SP2 Pre-amplifier (cut-off frequency 25 kHz) and fed into the Portable Ultra-sound Signal Processor (PUSP: Ultra Sound Advice, UK) which time-expanded 2 s of sound by 10X at a sampling rate of 448 kHz. The calls were recorded onto Sony HF90 cassettes using a Sony WM-D6C Professional Walkman cassette recorder (Sony Corporation, Japan).

The time-expanded sounds from the Sony Walkman were digitized and analysed using BatSound v 2.00 (Pettersson Elektronik AB, Uppsala, Sweden) with a 16 bit A: D converter at a sampling rate of 44.1 kHz. The threshold level was set at 16 in BatSound and the FFT size was 512 points. Interpulse interval (onset of first call to the onset of the next call) and call duration were measured from oscillograms. From the sonagrams, the maximum and minimum frequencies of each call were measured. The peak frequency of the

Table 1. Comparison of acoustic parameters of echolocation calls of the painted bat *Kerivoula picta* recorded during rest and flight

Echolocation call parameter	At rest (n = 197)				In flight (n = 74)				Flight calls vs rest calls	
	Range	Median	Mean	SD	Range	Median	Mean	SD	Z	P
Duration (ms)	5.60–0.32	1.70	1.93	1.14	0.90–0.30	0.60	0.58	0.18	–7.55	0.0001
Interpulse interval (ms)	520.00–3.90	24.00	46.96	64.30	592.00–10.20	13.20	41.11	106.73	–4.16	0.0001
Starting frequency (kHz)	156.90–72.70	131.00	126.58	19.22	156.90–98.70	144.00	140.21	14.13	–2.34	0.0190
End frequency (kHz)	135.50–41.50	77.80	77.52	12.08	134.00–81.00	99.00	103.57	14.86	–7.48	0.0001
Peak frequency (kHz)	145–63.40	101.75	103.66	17.76	144.80–66.00	114.50	115.81	14.81	–0.36	0.7100

P, Probability; Z, Wilcoxon Signed-Ranks Nonparametric test. Significance of the test was assessed at an alpha of 0.05.

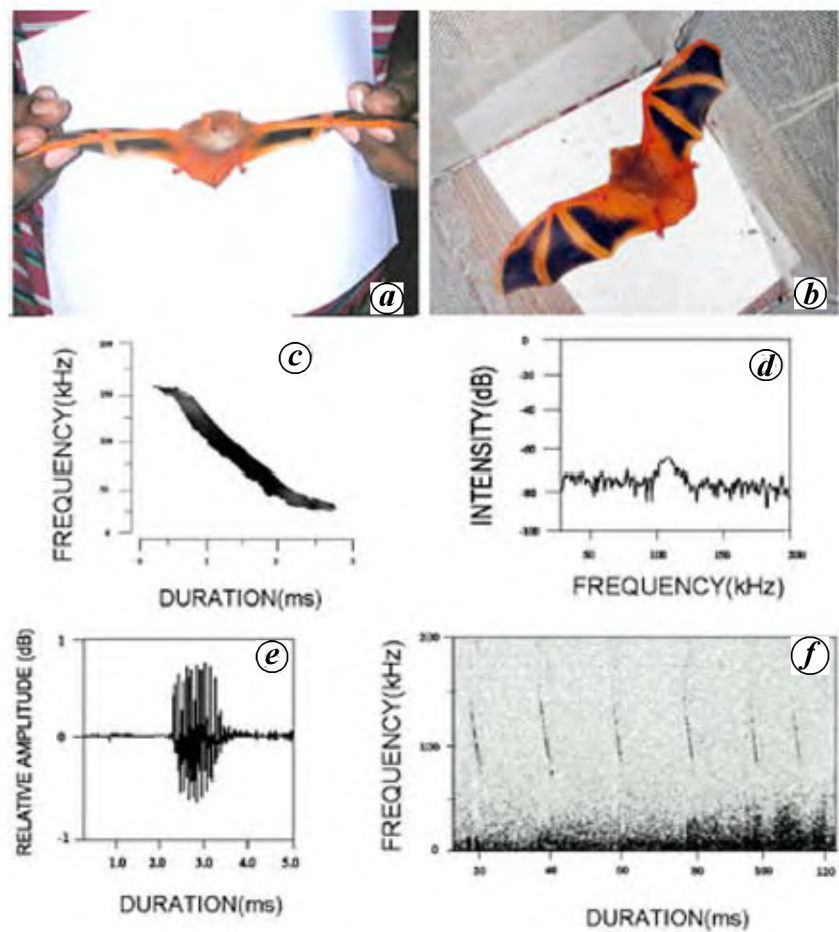


Figure 1. *a*, *Kerivoula picta* – front view. *b*, *K. picta* – dorsal view (photograph taken when the bat was kept inside a cage). *c*, Sonogram representing a single echolocation call of *K. picta*; *d*, Power spectrum; *e*, Oscillogram; *f*, Sonogram of approach calls when the bat approaches the obstacle inside a flight room.

harmonic of all the calls was noted from the power spectra. We used Wilcoxon signed-ranks nonparametric test to compare the acoustic parameters of calls between flight and at rest.

We analysed a total of 271 echolocation calls which included 197 calls during rest and 74 calls from six approach flights towards obstacles (walls) in the flight

room. Echolocation calls were broadband, steep frequency modulated sounds starting from 156.9 kHz and ending at 41.5 kHz (Figure 1 *c*). The duration ranged from 5.6 to 0.3 ms (Figure 1 *c*, *e*) and the power spectrum is shown in the Figure 1 *d*. Table 1 summarizes the echolocation call details recorded when the bat was at rest and during flight. The acoustic parameters

of calls between flight and at rest differed in duration, IPI, starting and end frequencies but not peak frequency (Table 1). We observed a characteristic phase change with a decrease in interpulse interval and duration when the bat approaches obstacles (Figure 1 *f*), similar to other vespertilionids.

Our analysis shows that the echolocation calls of *K. picta* are close to the range of

frequencies reported in other Kerivoula species found in Malaysia⁷ such as *K. intermedia*, *K. pellucida*, *K. minuta* and *K. papillosa*, with starting frequency ranging from 152 to 180 kHz and end frequency between 43 to 86 kHz. The broadband, short duration and low intensity features in the echolocation calls of bats belonging to Kerivoulinae suggest an adaptive strategy for foraging in cluttered environments such as banana plantations, sugarcane fields, etc.⁷. It has been proved among vespertilionids, that bats with higher starting frequencies and bandwidths and shorter pulse intervals were able to capture prey closer to clutter than those with lower starting frequencies and bandwidths and higher pulse intervals⁸. Thus we suggest that *K. picta* may be adapted to forage in complex forest understoreys and agricultural fields. Furthermore, broadband, low intensity, short duration characters in their echolocation calls also imply that they can glean insects from surfaces^{9,10}.

The echolocation characteristics and the presence of a large interfemoral membrane (see Figure 1a), a characteristic feature of family Vespertilionidae, suggest that *K. picta* is an aerial hawker, i.e. capturing insects during flight using the interfemoral membrane as a net. The tip of the interfemoral membrane of *K. picta* has a conspicuous fringe of hairs and it has

been hypothesized in *Myotis nattereri* another vespertilionid bat species, that this membrane may have a sensory function¹¹.

We observed the bat roosting in a dry leaf of the banana plant located inside the university campus. Further studies are in progress to assess the population status of the bat in and around Madurai. The foraging areas of *K. picta* are monitored at night using bat detectors in different areas. This rare and beautiful bat could be serve as flagship species for bat conservation.

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