

Biodiversity Record: Glossy horseshoe bats along the Rail Corridor

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Subjects: Glossy horseshoe bat, *Rhinolophus refulgens* (Mammalia: Chiroptera: Rhinolophidae).

Subjects identified by: Emma Chao.

Location, date and time: Singapore Island, Rail Corridor (Central), various point locations (Fig. 3) on 16, 29 & 30 July 2024, and 2 & 10 August 2024; 1945–2145 hrs.

Habitat: Urban greenery and edge of secondary forest.

Observers: Law Ing Sind, Shanyl Ong and Emma Chao.

Observations: Glossy horseshoe bats were initially seen and detected along a section of the Rail Corridor adjacent to Bukit Timah Nature Reserve (BTNR). Subsequent surveys from Hillview through Buona Vista offered bioacoustic evidence of bat activity beyond BTNR's extent, and particularly around Clementi Forest (see Fig. 3). Flight was characteristically fast and linear along the unlit path, with occasional darting into surrounding forest fringe. No sightings were made past Holland Road, where bats were only detected in passing on heterodyne.

Of note were two overhead crossings above busy main roads, which bats navigated by flying closely beside the top beams of truss bridges. Structures present along the corridor also appeared to provide temporary night roosts for individuals or pairs. On a few occasions, bats would fly in circuitous paths above cultivated shrubs, presumably feeding, although no distinct feeding buzzes or approach calls were recorded from the Corridor trail.

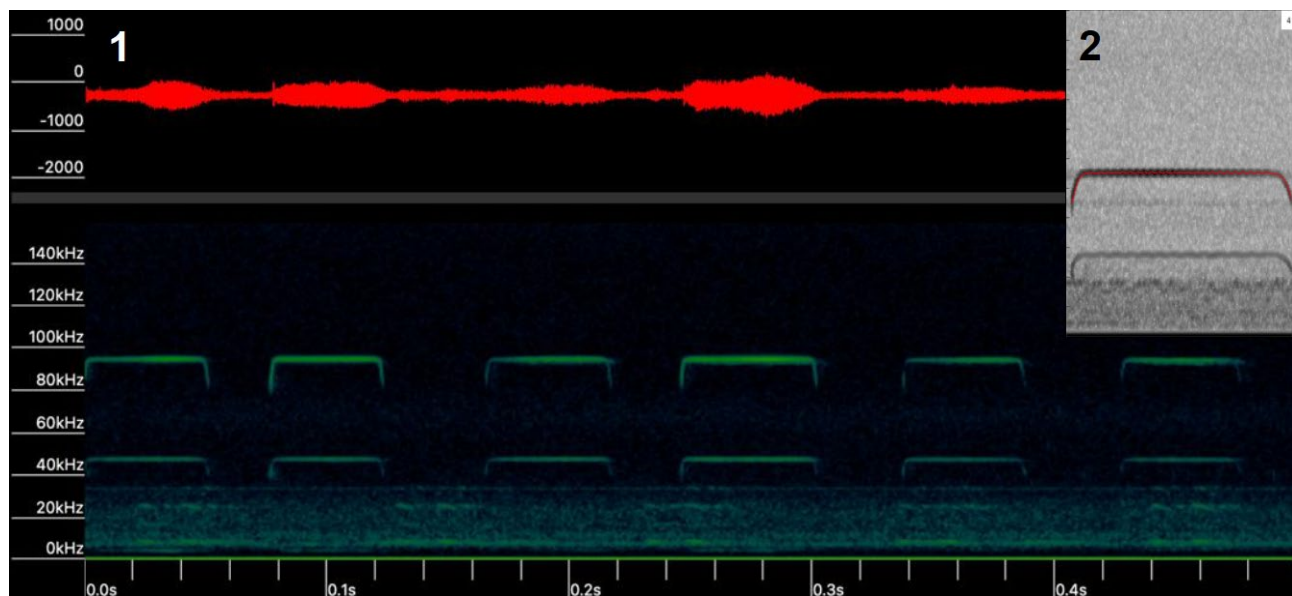


Fig. 1. Spectrogram of *Rhinolophus refulgens* search-phase call sequence in Kaleidoscope Viewer with an average peak frequency of 94.22 kHz. Fig. 2. Example call selected for measurement by the `threshold_detection` function in R package 'bioacoustics'.

Across five nights, recordings were obtained with an Echo Meter Touch 2 Pro (Wildlife Acoustics, Maynard, MA, USA) pointed directly at bats upon each sighting, following Chua & Aziz (2018, as *Rhinolophus lepidus*). A heterodyne Batbox III was also used to pick up on approaching bats. Recordings were processed and opened in Kaleidoscope Viewer (Fig. 1). Duration, frequency of maximum energy or amplitude (FMaxAmp), and centre frequency (Freq.Center) were

measured for the subset of search-phase calls with high signal-to-noise ratios by the threshold_detection function from R package ‘bioacoustics’ (Marchal et al., 2022).

Date	Time	Call Duration / ms	FMaxAmp. / kHz	Freq. Center / kHz	Signal:Noise	Calls	Latitude	Longitude
16/07/2024	20:45:22	44.17	89.80	95.84	16.63	4	1.3572283	103.767490
29/07/2024	21:13:49	49.83	96.51	96.63	15.51	4	1.3365983	103.781095
29/07/2024	21:14:02	48.74	96.15	96.22	15.84	7	1.3365983	103.781095
02/08/2024	21:15:37	44.08	95.52	95.22	14.09	2	1.3364751	103.780796
02/08/2024	19:54:26	42.83	96.13	95.96	11.84	4	1.3365883	103.781088
02/08/2024	20:07:28	44.17	90.52	95.74	11.07	2	1.3349483	103.781352
02/08/2024	19:56:31	46.75	96.27	96.31	14.23	2	1.3365633	103.781083
02/08/2024	19:56:25	41.92	94.18	94.52	11.49	2	1.3365633	103.781083
10/08/2024	20:30:22	52.83	98.97	98.55	14.72	2	1.3470029	103.773793
Average		46.15	94.89	96.11	13.93	3.22		

Table 1. Call measurements averaged by file with the corresponding recording details. Default parameter settings of the threshold_detection function were adjusted to capture Rhinolophid call structure.



Fig. 3. Map of a central part of Singapore Island showing all recorded bat passes across 5 nights, identified in Kaleidoscope. The location of the southernmost detection on heterodyne is indicated (pink square) and the Rail Corridor highlighted grey (stretch of about 7.3 km). Surrounding areas of unmanaged vegetation in dark green (sourced from Gaw et al., 2019) include Bukit Timah Nature Reserve (A) and Clementi Forest (B). Fig. 4. Ventral view of a *Rhinolophus refulgens* in flight along the Corridor (Photograph by: Emma Chao). Fig. 5. Close-up of one individual bat’s profile and noseleaf (Photograph by: Shanyl Ong).

Remarks: *Rhinolophus refulgens* is a small horseshoe bat of uniform colouration which varies from blackish-grey to brown and reddish, with light-tipped or frosted underparts, and a dark to pinkish brown noseleaf that lacks lateral lappets. The connecting process is distinctively triangular and notched (visible in Fig. 5), the lancet bluntly-pointed, and the

anterior noseleaf narrower than the muzzle (Kingston et al., 2006, as *Rhinolophus lepidus*). Locally, CF calls average about 97.8 kHz (Pottie et al., 2005, as *Rhinolophus lepidus*) yet in other localities may just surpass 100 kHz (Francis, 2019). The recorded mean CF frequencies of about 95–96 kHz (see Table 1.) are slightly lower than expected but still within range for this species. Lower averages may also be the result of bats in flight using doppler shift compensation on objects in their surroundings, since none were recorded while stationary.

The Rail Corridor's horseshoe bats likely originate from known BTNR roosts, where the species has historically been found to be abundant (Teo & Rajathurai, 1997; Teo & Thomas, 2019; as *Rhinolophus lepidus*). Although long-distance flight and vagility are characteristic of such cave-roosting species as *Rhinolophus refulgens*, this record finds them capable of accessing secondary forest a distance away from roost sites, across heterogeneous urban greenery and variable light and noise conditions. This is somewhat consistent with the habit of cavernicolous bats, which do utilise uneven resource distributions in fragmented landscapes (Struebig et al., 2009). This species' activity at novel sites in the urban matrix moreover builds upon observations of *Rhinolophus refulgens* by Lee (2016, as *Rhinolophus lepidus*) outside Nature Reserve boundaries, namely at Zhenghua Nature Park.

Although bats were only observed up to a certain point of the Corridor, the presence of some vegetation and low-light conditions could be sufficient to facilitate movements farther south. Rhinolophids are easily exposed to predation in well-lit spaces due to constrained flight speeds and morphology suited for manoeuvring forest clutter (Rowse et al., 2016). Photosensitivity is, therefore, adaptive, and *Rhinolophus refulgens* may only be tolerant of artificial light up to a certain limit. Hence, urban sources of excessive light, additional noise, and disturbance of utilised structures could potentially reduce the species' foraging activity and range. On another note, the comparative value bats glean from feeding within exotic-dominated, secondary forest clutter may present an interesting avenue for study.

Rhinolophus refulgens has been treated as a synonym of the Blyth's horseshoe bat, *Rhinolophus lepidus*, in many of the publications referenced herein. Both species are very similar in appearance, but unique DNA barcodes and craniodental morphology in Peninsular Malaysian populations are considered distinct enough from *Rhinolophus lepidus* of mainland south and south-east Asia (see Soisook et al., 2016) to support the recognition of *Rhinolophus refulgens*, as a separate species inhabiting the Thai-Malay peninsula (see Francis, 2019; Simmons & Cirranello, 2024).

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