

## Short Communication

# Vocalization of Western Tarsier (*Cephalopachus bancanus* Horsfield, 1821) in Bangka Island, Indonesia

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### ABSTRACT

Every tarsier species performs different vocalization behaviour. *Cephalopachus bancanus* as one of the tarsier species listed as vulnerable in the IUCN red list has limited and different information about their vocalization. This research was designed to explore the species vocalization in the vicinity of Petaling Village, District of Bangka, Bangka Island, Indonesia. Tarsier vocalization inside temporary enclosures was recorded using a handy recorder and analysed using bioacoustics software Audacity 2.3.3 and Raven Pro 1.6.1. We described seven vocalization types with different functions and spectrogram patterns. One type of vocalization, squeak, is produced only by the infant. Two types of vocalizations (whistle and cheeps) were produced by the infant and adult, and four vocalization types were performed by adults. Those types of vocalizations can be heard within human hearing. Some types of vocalizations have peak frequencies at the ultrasonic level, i.e.: agonistic scream, alarm call, distress call, and hysteresis.

**Keywords:** Bangka, *Cephalopachus bancanus*, vocalization, western tarsier

Primates are social creatures, which communicate in several ways such as agonistic (Perreira & Kappeler 1997), grooming (Dunbar 1991), scent marking (Heyman 2006), and vocalization (Waser & Brown 1984; Cheney & Seyfrath 1996). Primates, especially nocturnal primates, use vocalization to interact with the conspecific, announce territorial boundaries or potential threats, spacing, and group coordination (Bearder 1999; Braune et al. 2005; McComb & Semple 2005; Rasoloharijaona et al. 2006; Zuberbuehler 2005). The knowledge of primate vocal behavior can be used for primate populations survey, one of which is tarsiers (Nietsch 1999; Rehakova-Petru et al. 2012).

Tarsiers are small nocturnal faunivorous native to the south-eastern part of Asia. Currently, there are three genera of tarsiers (Groves & Shekelle 2010; Shekelle et al. 2017, 2019), which was distributed in different biogeographic region. Eastern tarsier or *Tarsius* spp. inhabit Sulawesi and its surrounding small islands, the Philippine Tarsier *Carlito* in the Mindanao Shelf, and Western tarsier *Cephalopachus* in the Sunda Shelf (Borneo, Natuna, Belitung, Bangka, and southern part of Sumatra) (Groves & Shekelle 2010).

Western tarsier *Cephalopachus bancanus* is categorized as vulnerable by the IUCN. *Cephalopachus bancanus* has four subspecies, *C.b. saltator* in Belitung Island, *C.b. borneanus* in Borneo, *C.b. natumensis* in Natuna island, and *C.b. bancanus* which inhabit Bangka Island and southern part of Sumatra. The last subspecies are categorized as endangered by IUCN (Shekelle & Yustian 2008). This intriguing nocturnal primate, including all species and subspecies, is also protected by the Indonesian Minister of Environment and Forestry Regulation No. P.106/2018, strengthening the Indonesia Government Regulatory No. 7 of 1999.

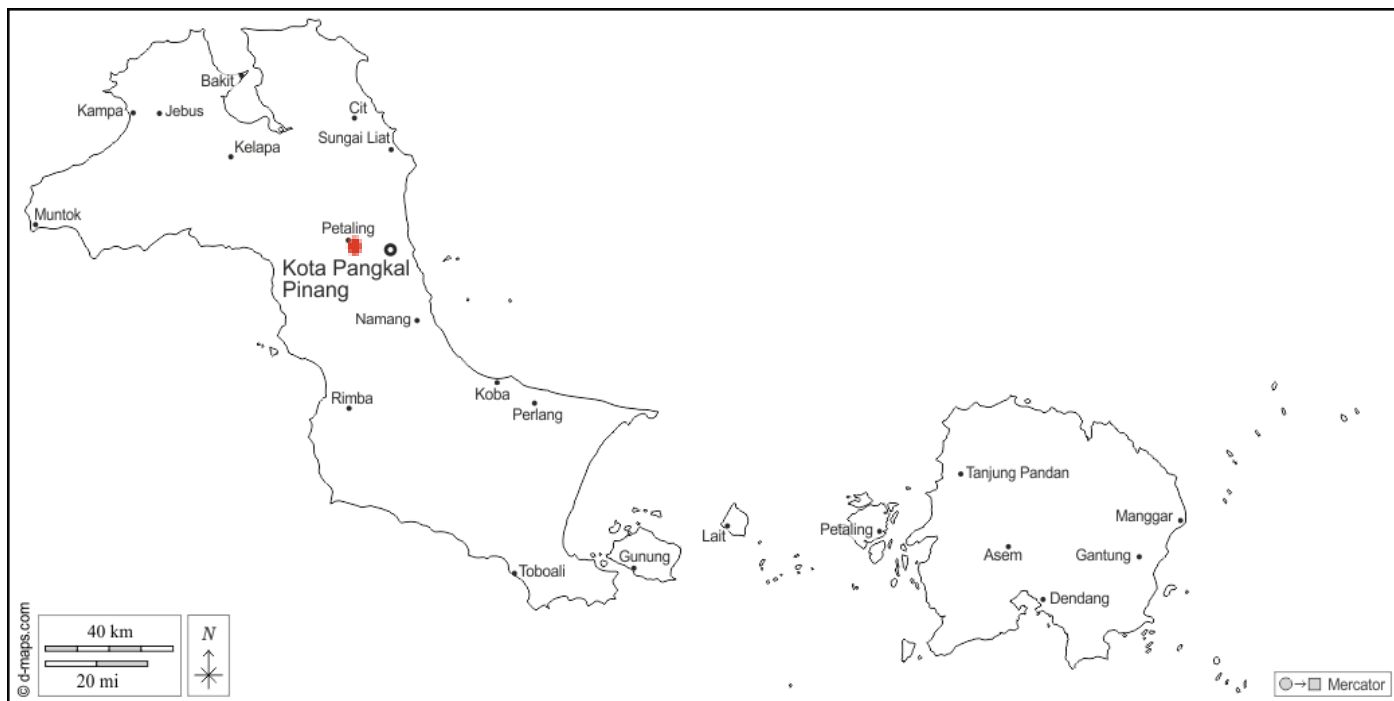
The difference in vocalization characteristics and behavior can be used as a basis for confirming the taxonomy of tarsier species (Nietsch & Kopp 1998; Burton & Nietsch 2010; Shekelle et al. 2017, 2019). Tarsiers in Sulawesi perform duet calls behavior, with each species exhibits different duet calls behavior (MacKinnon & MacKinnon 1980; Nietsch 1999; Nietsch 2003; Merker & Groves 2006; Shekelle et al. 2008). In contrast to Eastern tarsier, neither Philippine tarsier *Carlito syrichta* nor Western tarsier *Cephalopachus bancanus* show a duet calls behavior (Yustian 2007; Rehakova-Petru et al. 2012). The acoustic characterization of ultrasonic vocalization of *Tarsius syrichta* and *Tarsius spectrum* has been described by Gursky (2013, 2015). In addition, Rehakova-Petru et al. (2012) also explained the acoustic behavior and individual variation of long-distance calls of the Philippine tarsier.

So far, there are no data of Western tarsier vocalization in Sumatra or Bangka Island. Crompton and Andau (1987) heard numerous clear vocalization of Western tarsier at Sepilok Forest Reserve, Sabah, Borneo (*C. b. borneanus*). They proposed that, even though the sound frequency is high, three types of *C. b. borneanus* vocalizations are relatively easy to be distinguished. Niemitz (1979) described at least seven different types of sounds produced by *C.b. borneanus* in Semongok Forest Reserve, Sarawak, Borneo. Nevertheless, Niemitz (1979) also reported that Western tarsier is “ordinarily silent” and cannot often be heard in the wild. Yustian (2007) did not obtain any audible vocalization from *C. b. saltator* in Belitung Island. Niemitz (1979) and Gursky (2015) proposed that Western tarsier might also communicate via ultrasonic sound. This study was designed to explore the vocalization and determine the spectrographic description of Western tarsier *C. b. bancanus* in Bangka Island.

### Study Site and Animals

The research was conducted in the agroforest area of Petaling Village in Bangka Regency, Province of Bangka Belitung Islands (2°16' S, 105°57' E), located about 22 km west of Pangkal Pinang, the capital city of the province (Figure 1). The area consists of secondary forests and plantations such as rubber, pepper, banana, and palm oil. The rubber plantations are more than 10 years old, and other vegetation grows around the plantation, forming dense secondary vegetation.

The study took place from February to April 2020 and was initiated by conducting a preliminary survey to confirm the presence of tarsiers at the research site through their movement, vocalization, and recent urine marks on the bark of trees. Once we located the animal, followed by attempts to hand-capture the tarsiers. We captured one female and two males, which were then used for the first recording process. After the first recording was completed and all the individuals were released, we conducted other attempts to capture tarsiers in other parts of the forest. Again, we managed to catch three individuals (one pregnant female and two males). In total, we captured six individuals, i.e. four adult males and two adult females. The adult females gave birth during the study, bringing the total to seven individuals. Two temporary wire-net enclosures of 2'2'2 m<sup>3</sup> size, with natural vegetation



**Figure 1.** Site location (shown in red dot) in Petaling Village, Bangka Regency. (Map source: d-maps.com).

inside, were made within their habitat of captured, each with a distance of  $\pm$  30 m apart. In each of the enclosures, the tarsiers were fed twice daily with live crickets or grasshoppers. The difficulties in finding, capturing, and maintaining tarsiers in the enclosures had been a limitation in this research. After data collection, all tarsiers were released right or to close the place when they are being captured. The study was carried out with the permission of the Indonesian Government through Bangka Regency Government Permit No. 070/04/Bankesbangpol/2020.

### Data collection and processing

The recording process was conducted after the animals were habituated for five days. We conducted two periods of recording. In the First period of recording, one enclosure consists of one adult male and one female, whilst in other enclosures is consists of only one male. A period of recording was done in three consecutive nights. In the second period of recording, as mentioned above, one of the females gave birth on the second night of the recording process.

Tarsier vocalizations were recorded from 17.00 PM to 07.00 AM using Zoom H1 Handy Recorder (Zoom Co. Japan), built-in microphone, with 96 kHz sample rate and 16-bit recording quality (Gursky 2015; Rehakova-Petru et al. 2012). The recorder device is placed two meters outside the enclosure. Replacement of the recorder battery was carried out every 10 hours. Additionally, animals were recorded using a handphone (Redmi 7, Xiaomi Co.) microphone with a 44,1 kHz capacity while being handled for release. The use of this handphone device is not standardized and validated method.

During the recording process, the time and the animal activities were also observed to explain the context of the produced vocalization. We refer to Niemitz (1979, 1984), Crompton and Andau (1987), Nietsch (2003), and Rehakova-Petru et al. (2012) to interpreting the acoustic structure and the context of each type of vocalization.

Recorded vocalizations were extracted and analysed using Audacity 2.3.3 (Audacity(R): Free Audio Editor and Recorder from <https://audacityteam.org/>) and spectrogram visualization produced by Raven Pro

1.6.1 Bioacoustics Analysis Software (The Cornell Lab Center for Conservation Bioacoustic) (Rehakova-Petru et al. 2012; Kulander 2018). The spectrogram was made with FFT parameters 512, Hann window, and overlap of 87.5% (Gursky 2013).

**Data Analysis**

The analysis was carried out to determine the initial frequency (start frequency of the selection in kHz), lowest frequency (the lowest frequency within a selection in kHz), highest frequency (the highest frequency within a selection in kHz), duration of one vocalization, and the number of vocalization (adapted from Charif et al. 2010; Kulander 2018). Only samples with the good recording quality and low background noise were analyzed. The small number of the vocalization produced by the observed animals, as well as the small number of good recording quality, became the limitations in this study. Data were discussed with a descriptive analysis approach.

**Cephalopachus bancanus Vocalization Types and Characteristics**

We identified seven types of Western tarsier vocalizations with different patterns (Table 1). One type of vocalization, squeak, is produced only by the infant. Two types of vocalizations (whistle and cheep) were produced by both infants and adults, and four vocalization types were performed only by adults.

**Infant squeak**

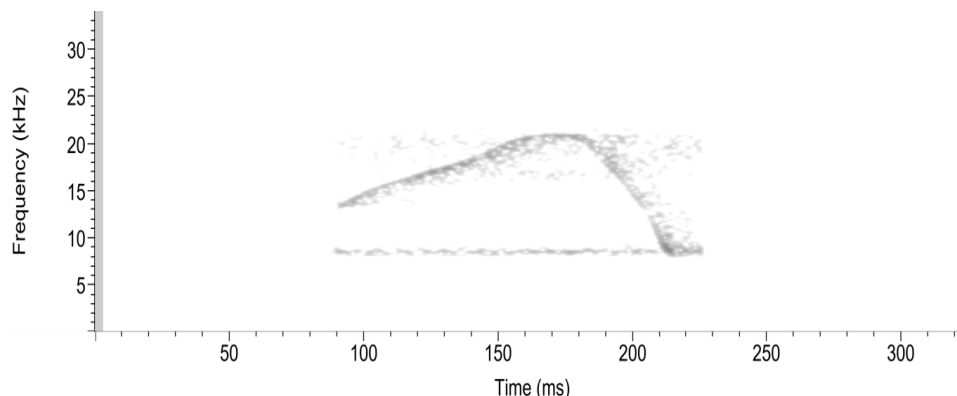
Infant squeaks (Figure 2) are types of single-beat tone vocalization produced by an infant. This type of vocalization was audible, starting from 11.1 kHz to 18 kHz, but could reach the lowest frequency at 9.6 kHz. Infant squeak is thought to be a form of summons to the mother. Infant squeak sounds more

**Table 1.** *Cephalopachus bancanus* vocalization characteristics in Bangka Island (mean ± SD).

Type of Vocalization	Initial Frequency (kHz)	Lowest Frequency (kHz)	Highest Frequency (kHz)	Range of Frequency (kHz)	Duration (ms)	Number of vocalizations
<b>Squeak (Infant)</b>	11.1 ± 3.4	9.6 ± 3.4	18 ± 1.8	8.4	102 ± 30	83
<b>Whistle</b>						
Infant	11.7 ± 0.95	9.1 ± 0.73	12.1 ± 0.84	3	104 ± 30	51
Adult	13.5 ± 1.8	9.5 ± 0.3	14.7 ± 0.88	5.2	96 ± 6	3
<b>Cheep</b>						
Infant	16.8 ± 1	16.1 ± 1.2	18.2 ± 0.8	2.1	138 ± 40	15
Adult	12.8 ± 1.3	12.1 ± 1.4	13.5 ± 2.0	1.4	102 ± 20	5
<b>Agonistic Scream</b>						
Adult	4.8 ± 0.56	4.4 ± 0.46	22.7 ± 2.7*	18.3	654 ± 276	27
<b>Alarm Call</b>						
Adult	6.0 ± 1.6	5.5 ± 1.4	22.8 ± 3.6*	17.3	163 ± 98	23
<b>Distress Call</b>						
Adult	5.9 ± 0.83	3.2 ± 0.79	20.4 ± 1.7*	17.0	82 ± 21	5
<b>Hysteresis</b>						
Adult	5.3 ± 0.3	0.22 ± 0.2	22.0 ± 0*	16.7	384 ± 151	5

\* reached ultrasonic level

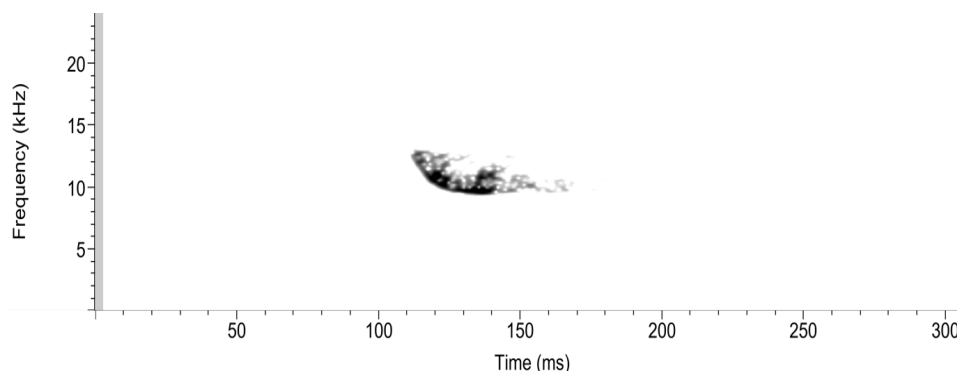
evident and has a higher frequency range in comparison to infant whistle. This vocalization is presumed to have the function which is related to communication with the mother. Infant tarsiers make a sound when they have a feeling of loneliness, anxious, feel sick, hungry, or cold (Niemitz 1979; Nietsch 2003).



**Figure 2.** Spectrogram of infant squeak of *Cephalopachus bancanus* in Bangka Island.

### **Infant whistle**

Infant whistles (Figure 3) are also types of single-beat tone vocalization produced by tarsier's infant and can be heard by humans. Infant whistle is often encountered just before dawn, or when the tarsier is going back to the sleeping site. As the second frequent call observed, this whistle was also thought to be a form of summons to the mother tarsier. These types of vocalizations are presumed to have the same function as infant squeak, which is related to communicate with the mother.



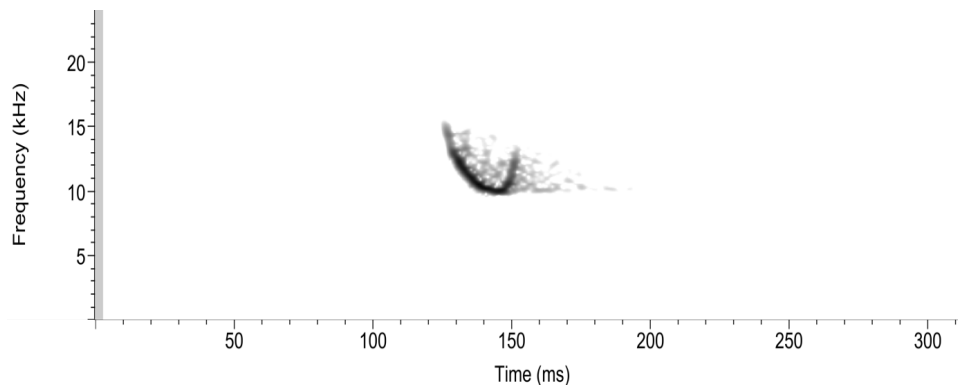
**Figure 3.** Spectrogram of infant whistle of *Cephalopachus bancanus*.

### **Adult Whistle**

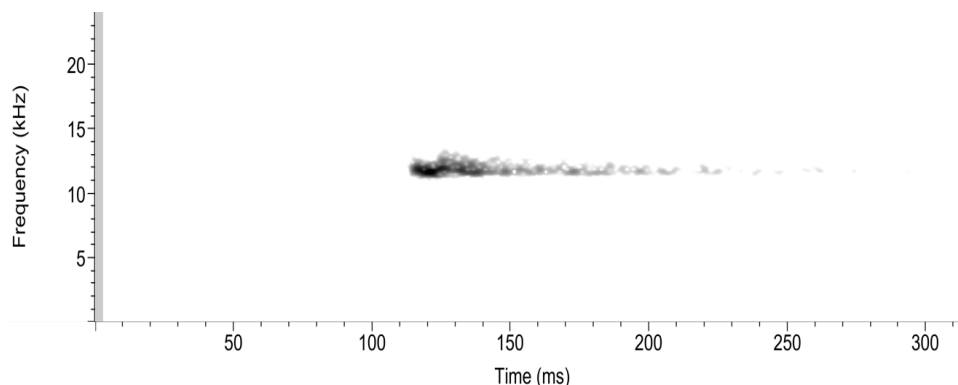
The whistle is thought to provide information on the presence of nearby tarsiers related to territorial function in the adult. Whilst in the infant the vocalization intensity was the second act after squeak, this audible single-beat tone vocalization is the fewest vocalization type. The Western tarsier whistle has the same visual spectrogram form as *Carlito syrichta's* whistle (forming the letter U, Figure 4), which is associated with territorial functions and attracting the attention of the opposite sex (Rehakova-Petru et al. 2012).

### **Infant Cheep**

Infant cheeps (Figure 5) is a type of audible vocalization performed by the infant. This type of vocalization can be heard clearly. In comparison to the other types of vocalizations produced by the infant, this type is the fewest number. Nevertheless, infant cheeps are also presumed to have the same function as infant squeak and whistle, to communicate with the mother.



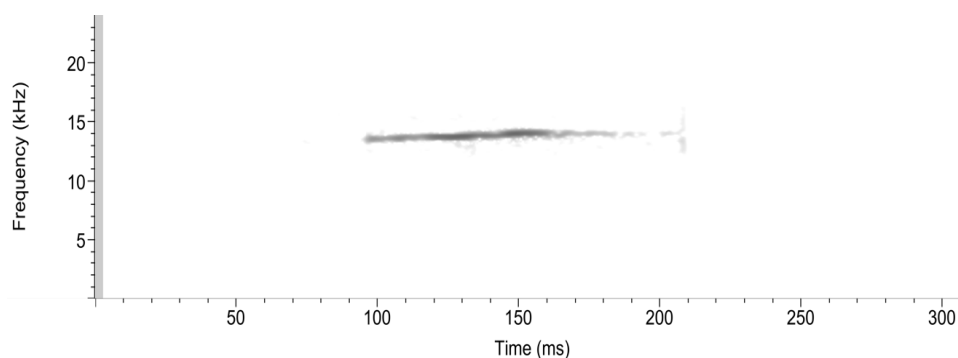
**Figure 4.** Spectrogram of whistle vocalization of *Cephalopachus bancanus*.



**Figure 5.** Spectrogram of infant cheep vocalization of *Cephalopachus bancanus*.

#### **Adult Cheep**

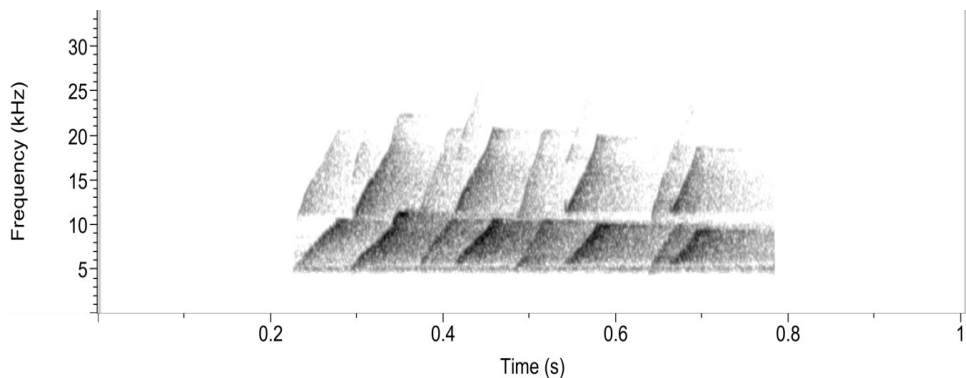
Adult cheeps (Figure 6) is a type of audible one-beat vocalization found in mothers with her infant. The same type of vocalization is also found in *Carlito syrichta* (Rehakova-Petru et al. 2012). In *Cephalopachus bancanus*, this type of vocalization can appear along with other types of vocalizations, such as agonistic scream, whistle, infant squeak, and mother call.



**Figure 6.** Spectrogram of cheeps vocalization of *Cephalopachus bancanus*.

#### **Agonistic Scream**

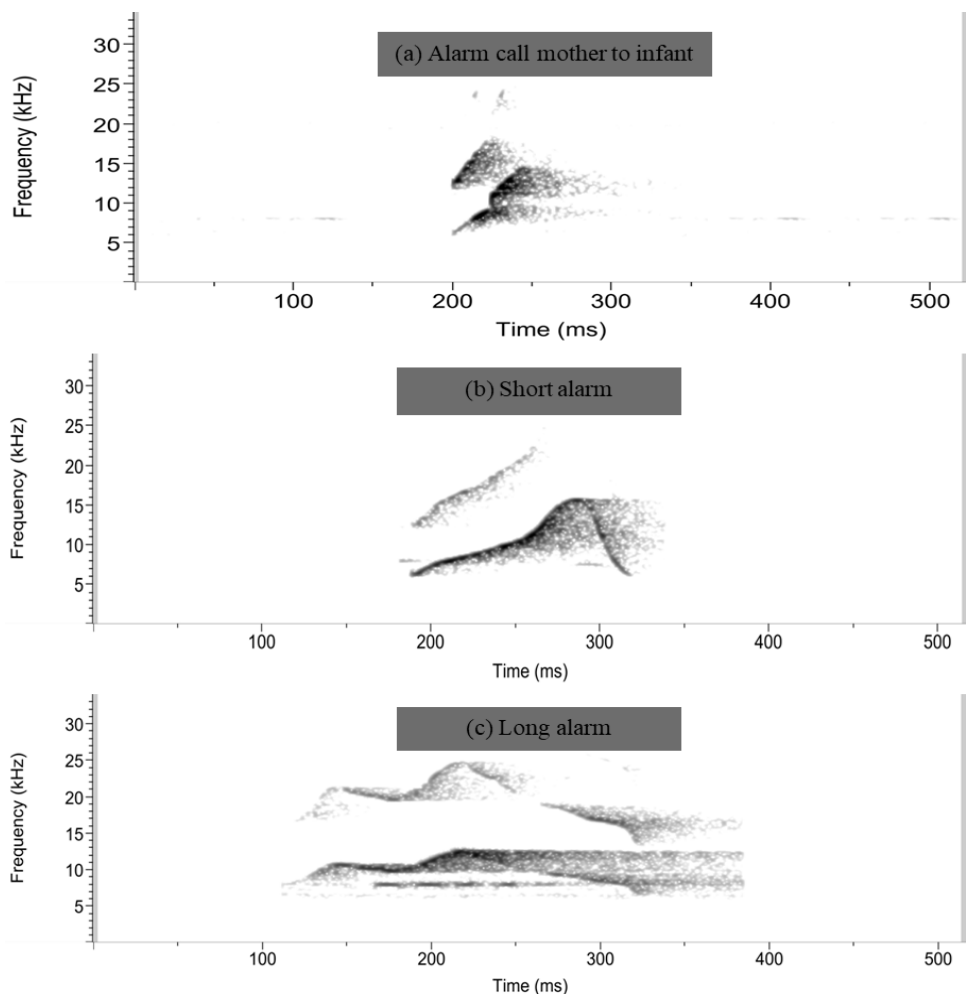
This vocalization pattern (Figure 7) appears when there was accidental nearly physical contact between two adult male tarsiers. One individual or both will make sounds related to agonistic functions or pressure other individuals to move away. After making this sound, which could reach an ultrasonic level (more than 20 kHz), the two individuals would stay apart from each other. This is related to the tarsier's solitary nature who feels disturbed when there are other individuals at the territory. This type of vocalization was performed by tarsier in Borneo (Niemitz 1979), however, there is no report from the Philippine tarsier group (Rehakova-Petru et al. 2012).



**Figure 7.** Spectrogram of agonistic scream vocalization of *Cephalopachus bancanus*.

**Alarm Call**

Alarm vocalization (Figure 8 a, b & c) were generated as a response to the threats around. This type of vocalization is followed by a very active movement behaviour. Nietsch (2003) states that when they sense a threat, tarsier (*Tarsius spectrum*) will produce a loud vocalization, which is called a whistle alarm and alarm call. In Western tarsier, there are two other types of alarm: short alarm call (Figure 8b) and long alarm call (Figure 8c). Short alarm and long alarm calls have a nearly similar frequency, but they are different in the length of the vocalization duration as well as the visual form of the spectrogram. These types of vocalizations have the highest peak frequency, more than 22 kHz (Table 1), which indicates that *Cephalopachus bancanus* can also communicate at the ultrasonic level, although no pure ultrasound sounds were found.



**Figure 8.** Spectrogram of alarm calls of *Cephalopachus bancanus*. Alarm call mother to infant (a), short alarm (b), and long alarm (c).

### Distress call and Hysteresis

*Cephalopachus bancanus* can produce very loud, shrill, repetitive sounds, followed by rebellious behaviour during the capture and handling process. This behaviour occurs because the tarsier feels depressed and panic. These types of vocalizations (Figure 9a & b) may also appear when tarsiers become prey for predators. In spectrogram visualization, these two types of vocalizations appeared complexly and difficult to be analysed. This vocalization appears when we handled the animals to release, and the recording process is only done using a handphone microphone with a sample rate of 44.1 kHz. If a higher sample rate is used, it is possible that the frequency of this type of vocalization exceeds the frequency seen in the current spectrogram. Distress calls and hysteresis are often encountered simultaneously at one vocalization. However, distress calls can also appear without hysteresis being followed. Distress calls always appear in one beat, while hysteresis occurs in several beats.

By means of sonographic diagrams, Niemitz (1979) described at least seven different types of sounds produced by *Cephalopachus bancanus*. This study also described seven types of vocalizations, although perhaps in a slightly different designation and context. For example, one twittering type of vocalization produced by an infant, Niemitz designated as “patches”, and we defined it as “squeak” and “infant whistle”. While Niemitz also described the distress call of a tarsier infant when left alone as “colon and apostrophe”, we assumed that was a “cheep” call. In another example, Niemitz designated “hysteresis” as vocalization with agonistic correlation, while we could distinguishably two types of vocalizations as “agonistic scream” and “hysteresis”. We agree with Niemitz, that vocalization in this species is much more complex than previously described.

Through this research, we concluded that all types of vocalizations of Western tarsier *Cephalopachus bancanus*, which was observed and recorded in Bangka Island, can be heard within human hearing and some of the vocalizations, such as alarm call, agonistic scream, distress call, and hysteresis have peak frequencies at the ultrasonic level (> 20 kHz). We recommend further research to compare vocalization within subspecies (Western tarsier in Bangka and southern Sumatra) to prove at least the ultrasonic vocalization of this species.

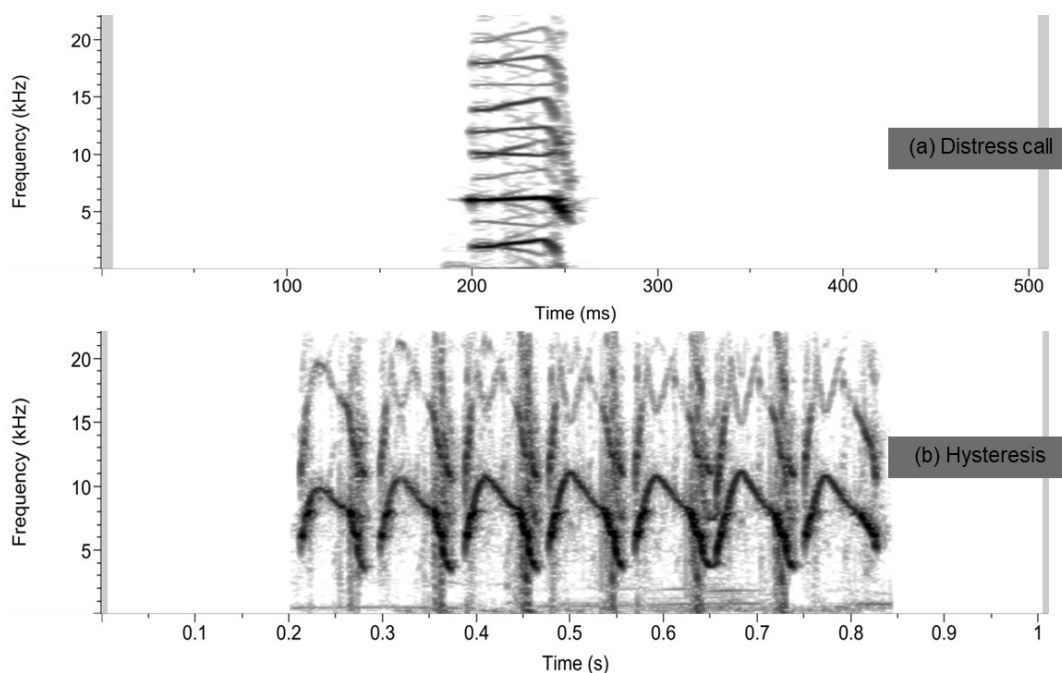


Figure 9. Spectrogram of distress call and hysteresis of *Cephalopachus bancanus*. Distress call (a) and Hysteresis (b).



## AUTHORS CONTRIBUTION

I.Y. and A.S. designed the research and supervised all the studies. D.K. collected and analysed the data. I.Y. and D.K. wrote the initial manuscript. Z.E. contributed to data collection. D.S., E.P., and L.H. reviewed, revised, and proofread the final manuscript.

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## CONFLICT OF INTEREST

The authors confirm that there is no conflict of interest regarding the research and/or financial support for this work.

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