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Behavioral response of plaintive cuckoos (*Cacomantis merulinus*) to playback of conspecific vocalizations

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Abstract. *Raiyardhi Y, Mulyani YA, Kusrini MD. 2025. Behavioral response of plaintive cuckoos* (Cacomantis merulinus) *to playback of conspecific vocalizations. Biodiversitas 26: 2021-2027.* The parasitic plaintive cuckoo (*Cacomantis merulinus* (Scopoli, 1786)) is difficult to study due to its elusive behavior. This research applied bioacoustic playback methods to explore the function of its vocalizations. The study, conducted at IPB University's Dramaga campus (267 ha) from March to August 2024, tested four different cuckoo sound patterns with varying amplitude (3-6 kU), frequency (2-4 kHz), and power (20-40 dB). Playback took place between 06:00 and 10:00 in known cuckoo territories, with each session followed by a 4-minute response observation. Spectrogram analysis and MANOVA were used to evaluate bird responses based on duration, amplitude, and frequency. Pattern A elicited communicative behavior and attracted the cuckoo to the sound source. Pattern B signaled territorial claims and competition, while pattern D functioned to repel other individuals. Pattern C had no effect, confirming that it was not a cuckoo call. MANOVA results demonstrated significant multivariate effects of playback type on the acoustic responses of the plaintive cuckoo, as shown by all four test statistics (e.g., Wilks' Lambda: $p = 0.017$; Pillai's Trace: $p = 0.040$). These results provide insight into conspecific communication within the family Cuculidae and demonstrate how vocalization types relate to behaviors such as attraction, territoriality, and defense.

Keywords: Behavioral responses, cryptic birds, semantics, sound patterns, territorial signaling

INTRODUCTION

Bird vocalization can generally be divided into two types calls and songs. Calls consist of short and simple notes. Raghuram et al. (2016) classified calls into four types such as companion calls, juvenile calls, aggression calls, and alarm calls. Each bird species has specific song patterns. Songs are longer and more complex in tone, and are used to attract mates and defend territories (Guo and Liu 2017). The complexity of bird songs can be determined from the duration, repetition size, and number of elements/ syllables detected by spectrograms (Briefer et al. 2010). For territorial birds such as species in the Cuculidae family, vocalizations especially songs, are often produced during the breeding season to attract mates, reduce competition, or defend territories (Mei et al. 2022).

The plaintive cuckoo (*Cacomantis merulinus* (Scopoli, 1786)) is a parasitic bird that lays its eggs in the nest of another bird, where they are incubated and raised by the host parent. Geographical distribution of plaintive cuckoo is around East India, South China to Southeast Asia, especially Indonesia (Sumatra, Java and Kalimantan) (Payne and Kirwan 2020). This bird inhabits residential areas, plantations, and secondary forests (Widodo and Sulistyadi 2019). Plaintive cuckoos typically select small songbirds with dome-shaped hidden nests and narrow entrances as hosts (Tunheim et al. 2019). To date, 18 host species have been recorded, including the common iora (*Aegithina tiphia* (Linnaeus, 1758)), green iora (*Aegithina viridissima* (Bonaparte, 1850)), white-flanked sunbird (*Aethopyga eximia* (Horsfield, 1821)), Javan sunbird (*Aethopyga mystacalis* (Temminck, 1822)), zitting cisticola (*Cisticola juncidis* (Rafinesque, 1810)), black-throated prinia (*Prinia atrogularis* (Moore, 1854)), grey-breasted prinia (*Prinia hodgsonii* (Blyth, 1844)), bar-winged prinia (*Prinia familiaris* (Horsfield, 1821)), yellow-bellied prinia (*Prinia flaviventris* (Delessert, 1840)), plain prinia (*Prinia inornata* (Sykes, 1832)), tawny-flanked prinia (*Prinia subflava* (Gmelin, 1789)), common tailor bird (*Orthotomus sutorius* (Pennant, 1769)), dark-necked tailor bird (*Orthotomus atrogularis* (Temminck, 1836)), olive-backed tailor bird (*Orthotomus sepium* (Horsfield, 1821)), ashy tailor bird (*Orthotomus ruficeps* (Lesson, 1830)), crimson sunbird (*Aethopyga siparaja* (Raffles, 1822)), streaky-breasted spiderhunter (*Arachnothera affinis* (Horsfield, 1821)), and little spiderhunter (*Arachnothera longirostra* (Latham, 1790)) (Widodo and Sulistyadi 2019; Praveen and Lowther 2020).

Observing the activities of the plaintive cuckoo is challenging, so its presence is often first detected by its song. Kim et al. (2018) explain that species have brown upper body feathers with black stripes and white lower bodies with fine black stripes, which enhance their camouflage. The bioacoustic approach is particularly appropriate for studying this species, as it emphasizes vocalizations and their functional significance (Penar et al. 2020).

Research on plaintive cuckoo vocalization activities is currently limited to the identification and classification of sound patterns. Lei et al. (2003) identified six vocalization patterns, consisting of two song patterns and four call patterns. Mackinnon et al. (2010) corroborated this by noting that two sound patterns were commonly heard during plaintive cuckoo observations. In contrast, Raiyardhi (2023) documented four distinct vocalization patterns, highlighting variation likely due to differences in sampling locations. Further studies are required to validate these patterns and elucidate the functional roles of plaintive cuckoo vocalizations.

The acoustic playback method is appropriate for studying the vocal behavior of the plaintive cuckoo. Acoustic playback is part of a bioacoustic approach that is commonly used to study bird behavior, confirm the presence of rare, and attract individuals to a location (De Rosa et al. 2021). Its growing popularity is attributed to its ease of use, cost-effectiveness, and proven efficacy. Acoustic playback is widely used in research on intraspecific interactions, sexual selection, competition, interspecific interactions, predation, brood parasitism, multispecies research, flocking behavior, and community monitoring (Miao and Canwei 2023).

In brood parasitism, vocalizations play a key role in determining whether calls are used for communication with conspecifics or heterospecifics. For example, the common cuckoo (*Cuculus canorus* (Linnaeus, 1758)) produces aberrant calls for conspecific interaction (Moskát and Hauber 2021), while females may vocalize to deter heterospecific hosts from their nests (Wang et al. 2022). There are no studies that have specifically addressed the use of plaintive cuckoo vocalizations for interindividual or interspecies communication. However, the vocal functions of the plaintive cuckoo remain unexplored. This study aims to describe the behavioral response of plaintive cuckoos to conspecific vocalizations using the acoustic playback method.

MATERIALS AND METHODS

Study area

This research was conducted at IPB University's Dramaga Campus (6°32'41"S - 6°33'58"S, 106°42'47"E - 106°44'07"E), Bogor District, West Java Province, Indonesia. The study area covers 267 hectares and includes wetlands, agricultural land, residential areas, secondary forest and parks. The study area is located in a tropical region with an average daily rainfall of 8 mm/day and an average daily temperature of 25.5°C (Hidayat and Farihah 2020). Data collection was conducted from March to August 2024.

Preparation of sound samples

The research samples of plaintive cuckoo vocalizations were obtained with Passive Acoustic Monitoring (PAM), from using a SwiftOne, from September 2022 to May 2023. A total of 108 hours of passive acoustic monitoring recordings from six sites at the IPB Dramaga campus were analyzed to identify plaintive cuckoo vocalizations. The recorded sounds were compared with spectrogram data from Lei et al. (2003) and reference databases such as Xeno-canto and eBird. The selected sound samples were clear and noise-free and were edited using Raven Pro 1.6 (Cornell Lab of Ornithology 2024) and Audacity.

The selected sound patterns were then cut and duplicated using RavenPro with a playback sample duration criterion of 2 minutes, consisting of repetitions of a sound pattern with an interval of 1-2.5 seconds between sections, based on Wang et al. (2022) and Moskát et al. (2023). The sampled sound patterns were exported in WAV format to preserve the sound quality. The sampled sound patterns were processed using Audacity's Noise Reduction feature before field testing. During the test, some samples still sounded unclear due to the noise of the urban environment at the research site. Therefore, the dB value of the sound pattern samples was increased to match the field test results. Four plaintive cuckoo sound patterns were selected based on Raiyardhi's (2023) study, characterized by amplitude range (3-6 kU), frequency range (2-4 kHz), and power (20-40 dB). Sound patterns A, B, and D are song patterns (Figure 1), while sound pattern C is a call pattern.

Testing of acoustic playback methods

Playback response testing was conducted at the predetermined territorial sample locations between 6:00 am and 10:00 am on days without rain or high winds. Observers played the playback only once per territorial sample site per day. A total of 40 playback repetitions were required, with each of the four sample vocalizations played 10 times.

There are several steps in the playback response test for the plaintive cuckoo. First, the researchers conducted a survey at the territorial sample sites according to the observation route planned for that day. The researchers had to confirm the presence of the plaintive cuckoo within the sample site. Before the playback test could be conducted, certain conditions had to be met: The plaintive cuckoo had to be detectable by the observer, the distance between the observer and the bird had to be accurately estimated, the playback sound had to be audible to the bird, and the bird had to remain in the same location prior to the playback test (Bibby et al. 1998).

In the second step, the researchers prepared the equipment. A SONY PX470 voice recorder mounted on a telescopic pole was placed as close as possible to the tree where the plaintive cuckoo was perched to clearly record the response sounds. The ROBOT Bluetooth Speaker RB120 was connected to a smartphone and ready to play the plaintive cuckoo's vocalization patterns. During the playback response test, observers hid to ensure that the plaintive cuckoo was not disturbed by their presence (Wang et al. 2022). Researchers were also required to wear non-bright clothing to avoid frightening the bird.

In the third step, we observed the behavior of plaintive cuckoos using the continuous focal animal sampling method, which records the behavior of a single individual over a specific period of time (Bosholn and Anciães 2018). Observations lasted 4 min: 1 minute before playback, 2 minutes during playback, and 1 minute after playback.

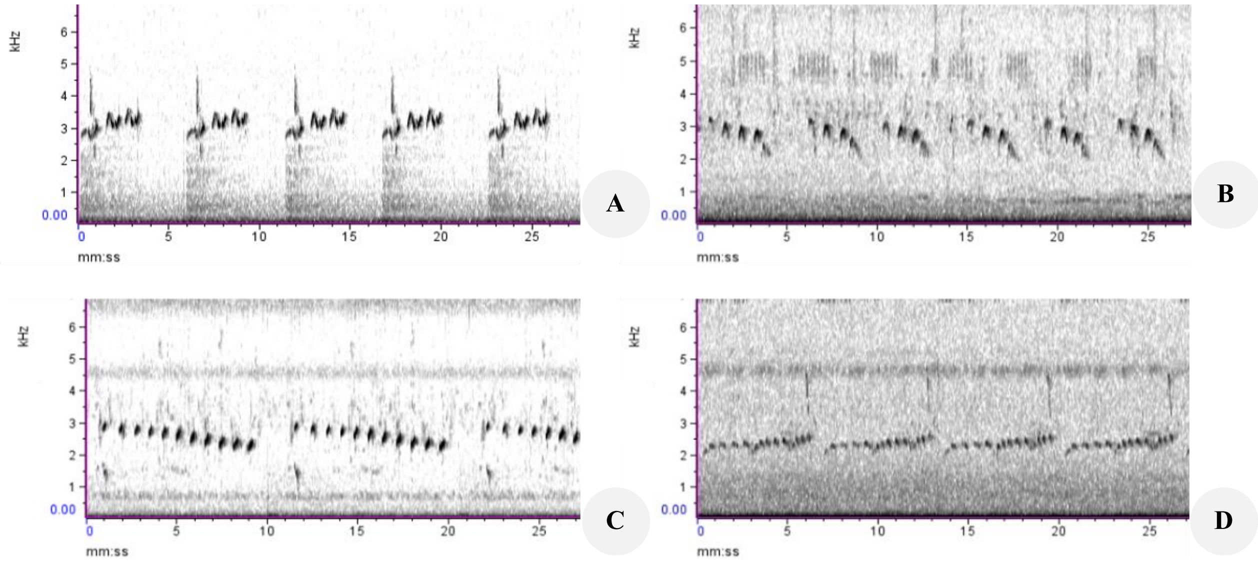

Figure 1. Sample of plaintive cuckoo sound patterns playback tested

Researchers recorded data on the tree where the plaintive cuckoo sang, the bird's response before and after the playback, and any responses from other plaintive cuckoos. If the observed plaintive cuckoo moved to a new location during the observation period, the researcher followed the bird and continued to record its responses as long as it remained within the sample area.

Data analysis

Territorial mapping analysis was performed using ArcMap 10.8.2 to determine the boundaries of the research sample sites. Data from the recorded responses of the plaintive cuckoo were processed using Raven Pro 1.6 to generate spectrograms. Spectrogram analysis provided values for duration (s), amplitude (u), and frequency (Hz) for each playback response. These sound pattern criteria values were then analyzed using MANOVA to understand the relationship between the dependent variable (response sounds) and the independent variable (type of playback sound pattern) of plaintive cuckoo (Kleindorfer et al. 2013).

RESULTS AND DISCUSSION

Testing of acoustic playback methods

Playback with the A pattern produces a different response each time it is repeated. The plaintive cuckoo responds to the A Pattern playback pattern with responses such as A Pattern, B Pattern, D Pattern, and new call notes (Figure 2). The results show that 39% of the responses were A Pattern, 44% B Pattern, 6% D Pattern, and 11% were call responses. The individual plaintive cuckoo also tends to approach the sound source during playback. It is thought that the A pattern is used by the plaintive cuckoo to communicate with other plaintive cuckoo individuals.

The B-pattern is the most dominant sound produced by the plaintive cuckoo during observation. When the plaintive cuckoo sings for a long time, it combines this pattern with the A and D patterns. When a loudspeaker is placed near the plaintive cuckoo's perch and the sound is played, the bird responds with the B pattern or a combination of the A pattern (Figure 3). If the B-pattern sound is played at a higher volume than the cuckoo's song and close to its perch, the bird will move and sing again. It is thought that the B-pattern is used by the plaintive cuckoo to mark its territory, indicating territorial competition.

An interesting phenomenon occurred during data collection, such as an interaction between the plaintive cuckoo (*C. merulinus*) and the square-tailed drongo-cuckoo (*Surniculus lugubris* (Horsfield, 1821)) (Figure 4). This is noteworthy because territorial interactions between the plaintive cuckoo and the square-tailed drongo-cuckoo are rarely observed. The plaintive cuckoo continuously produced the B-pattern sound, which was immediately answered by the song of the drongo cuckoo. This territorial song competition lasted continuously for 3-5 minutes.

The results of the playback experiment showed that the C pattern was not produced naturally by the plaintive cuckoo nor in response to the playback. Based on the reactions of the plaintive cuckoo during the playback, there was no significant change between before and after the treatment (Figure 5). Initially, the plaintive cuckoo marked its territory by producing the B-pattern. After the treatment, it continued to sing with the B pattern without showing any change in response.

Another form of response that occurred after playing the C pattern of the plaintive cuckoo was the production of the B and A patterns (Figure 6). These responses occurred only once in several repetitions of the playback of the C pattern. It was observed that before the playback test, the plaintive cuckoo first marked its territory with the B pattern. The plaintive cuckoo responded to the C-pattern playback by showing territorial defense behavior.

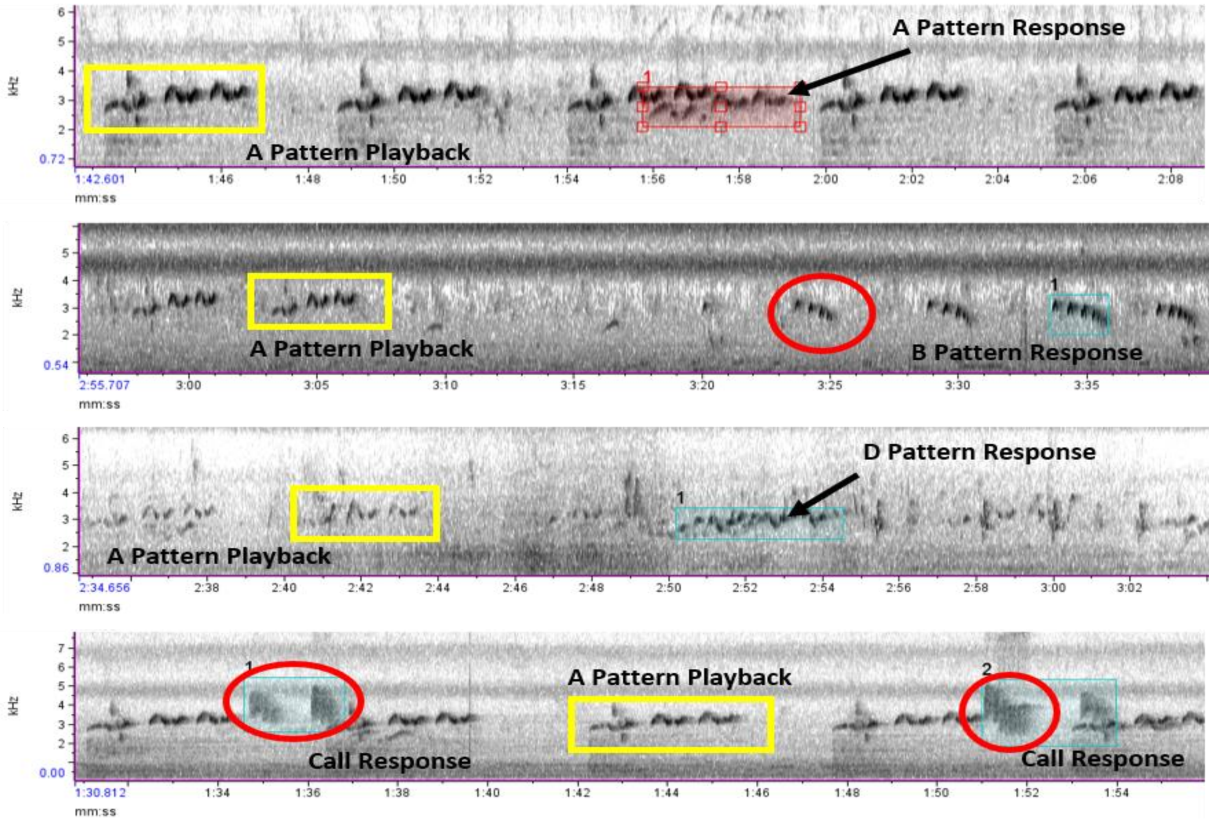

Figure 2. Response of plaintive cuckoo to the A pattern playback

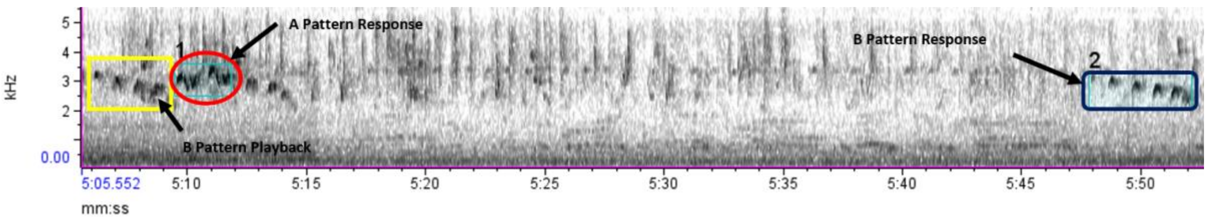

Figure 3. Response of plaintive cuckoo to the B pattern playback

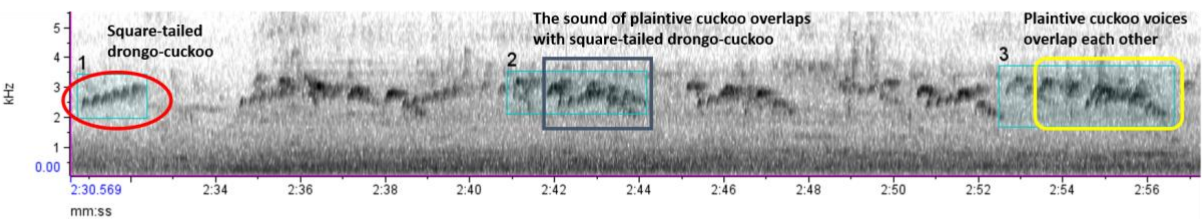

Figure 4. Interaction of territory competition between plaintive cuckoo and square-tailed drongo-cuckoo

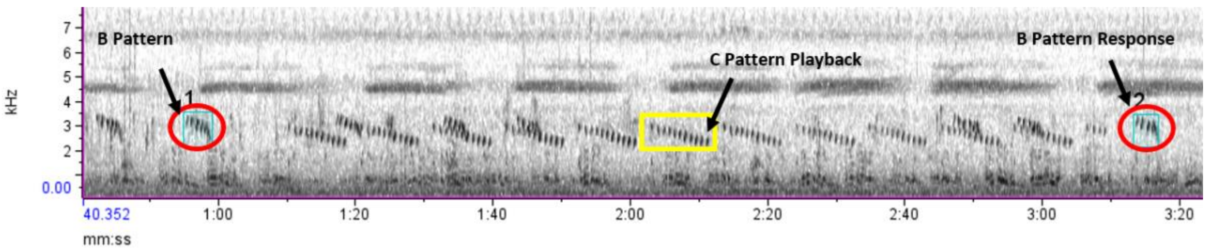

Figure 5. No effect on playback response from C pattern

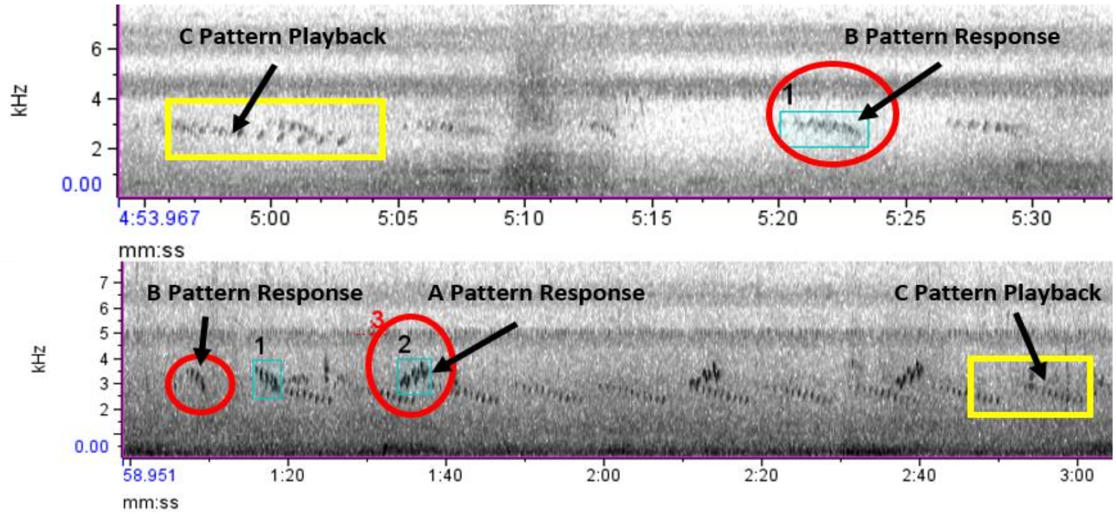

Figure 6. Plaintive cuckoo response to playback of C pattern

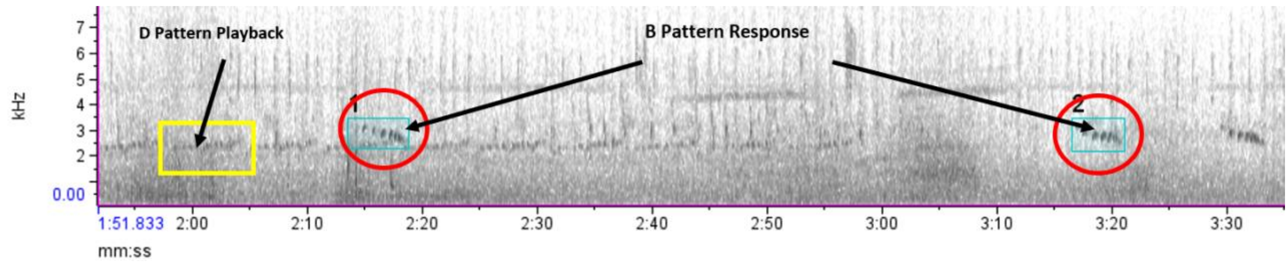

Figure 7. Plaintive cuckoo response to playback of D pattern

Based on the playback experiment of the D pattern, the plaintive cuckoo responded by vocalizing briefly with the B pattern before fleeing and leaving its territory (Figure 7). It is suggested that the D pattern is used by the plaintive cuckoo to scare away competitors. This pattern is often used in conjunction with the B pattern to mark the plaintive cuckoo's territory.

Doubts that each playback pattern tested on the plaintive cuckoo has no effect or produces the same response can be resolved with a MANOVA test. The responses of the plaintive cuckoo to each playback sound pattern can be confirmed to be different. MANOVA results demonstrated significant multivariate effects of playback type on the acoustic responses of the plaintive cuckoo, as shown by all four test statistics (e.g., Wilks' Lambda: $p = 0.017$; Pillai's Trace: $p = 0.040$). This indicates that the bird responds differently to each sound pattern.

Discussion

The sound patterns of plaintive cuckoo were found to have one call pattern and three song patterns. The song pattern response of the plaintive cuckoo is similar to the spectrogram of A pattern, B pattern, and D pattern samples. The call pattern of the plaintive cuckoo was observed less frequently than its song pattern behavior. There are very few encounters of calls behavior because calls are used for short-term communication in channel information, unlike to songs which can be used for long-distance communication such as mate attraction, territorial defense, and other social interactions (Sandoval and Graham 2024).

The call pattern found in this study were different. In terms of pronunciation, the written form of the calls of the plaintive cuckoo is similar to the calls "*tehree*" or "*piteer*" found in the study by Lei et al. (2003). When examining the spectrogram of the calls from this study, the frequency shows a decrease from high to low, while the spectrogram of Lei et al. (2003) shows an increase from low to high frequency. The publication of the calls of the plaintive cuckoo that match the results of this study can be found in a recording with the code XC862053 on the website xeno-canto.org.

The song pattern A is suspected to be used by the plaintive cuckoo to communicate with its conspecifics. The responses generated during playback tests with this pattern are quite varied, including responses of A, B, D, and call. When this sound pattern is played, the plaintive cuckoo tends to approach the sound source. The researchers have not yet been able to clearly distinguish whether the approaching plaintive cuckoo is male or female in the field. Specifically, this study does not yet provide a clear answer as to the function of the A-song pattern, whether it is produced by males to attract females or whether it is a sound produced by females in response to males' songs (Riebel et al. 2019). The natural combination of plaintive cuckoo songs, particularly the B and A patterns, is often heard during the breeding season to attract mates. This behavior is similar to the repetitive "*cu-coo*" songs of the common cuckoo during the mating season (Moskát and Hauber 2021).

The results of the playback test with the B-song pattern indicate that this vocalization is used by the plaintive cuckoo to defend its territory. When the B song is played, the plaintive cuckoo responds with the same pattern and appears to be competing to see which bird has the stronger call. The square-tailed drongo also shows a strong response when competing for territory with the plaintive cuckoo during the playback of the B song. According to the concept of acoustic space territoriality, birds are more likely to vocalize and produce songs when they hear different song patterns from other species. In addition to demonstrating territorial responses, competition between calls of different species indicates an environment free from predation risk (Rossetto and Laiolo 2024).

According to Raiyardhi (2023), the C vocalization pattern was neither observed nor elicited as a response from the plaintive cuckoo during field studies, indicating that this pattern is not part of the plaintive cuckoo's repertoire. Publications on plaintive cuckoo vocalizations by Lei et al. (2003) did not match the spectrograms obtained in this study. The C-pattern used in the plaintive cuckoo playback tests was more similar to the songs of the rusty-breasted cuckoo (*Cacomantis sepulcralis* (S.Muller, 1843)), as evidenced by a recording published on the xeno-canto.org website with the code XC737842.

The D-pattern is suspected to be used to drive other plaintive cuckoos away from its territory. This song is often heard along with the B pattern as the plaintive cuckoo marks its territory. In terms of the spectrogram, this vocal pattern is similar to the songs of the banded bay cuckoo (*Cacomantis sonneratii* (Latham, 1790)), as seen in recording XC809917 on the xeno-canto.org website. There is a possibility of vocal mimicry between the plaintive cuckoo and the banded bay cuckoo as a strategy to fend off competition from each other. The ability for vocal mimicry is also present in common cuckoos (*C. canorus*) to threaten other birds and for communication between mates (Moskát and Hauber 2021).

The results of the MANOVA test further strengthen the evidence that each playback vocal pattern tested elicits different responses. A total of 47 observation data points of the plaintive cuckoo's responses were obtained, consisting of vocal patterns A, B, C, and call. According to a bioacoustics study of songbirds such as the rock thrush conducted by Putranto et al. (2023), factors such as duration, amplitude, and frequency can influence the characteristics of bird song patterns.

In conclusion, the playback experiments revealed that the A pattern elicited a communicative response, with the plaintive cuckoo tending to approach the sound source. The B pattern served as a territorial marker and was associated with competition between individuals. The D pattern was used by the plaintive cuckoo to expel other individuals from its territory. Playback of the C pattern showed no change in response, indicating that it is not a plaintive cuckoo call. According to MANOVA calculations with 95% confidence level, there are significant differences in the responses of the plaintive cuckoo to the playback patterns in terms of duration (s), peak amplitude (u), and peak frequency (Hz).

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