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From forest to city: singing pattern of oriental magpie-robin (*Copsychus saularis*) in peri-urban localities of Dehradun, India

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Abstract

Bird song is essential for communication, territory defence, and mate attraction, yet it is influenced by environmental factors. This study investigates the singing patterns of the Oriental magpie-robin (*Copsychus saularis*), examining how urbanization and habitat variation affect vocalization. Systematic field recordings and acoustic analyses were conducted in both forested and urban areas of the Dehradun Forest Division, India. Spectrograms were used to identify song components, frequency ranges, and modifications. Results showed that while the overall singing patterns remained broadly similar between the two habitats—suggesting that the species maintains its core vocal structure despite environmental differences—significant variation was observed in specific acoustic features. Notably, urban populations exhibited higher maximum frequencies compared to their forest counterparts. In addition, a greater number of individuals in urban areas showed variation in song, including the addition and deletion of elements. Urban birds also demonstrated greater song plasticity, likely modifying song components to maintain effective communication in noisier environments.

Keywords: Urban Noise, Bird Song Adaptation, Acoustic Communication, Song Plasticity

Introduction

The Oriental magpie-robin, henceforth OMR, was formerly classified under the family Turdidae (Thrush family) but is now considered a member of the Old-World Flycatcher family, Muscicapidae (Sheldon, 1996). Members of this family are renowned for their melodious yet complex singing, typically producing whistling or harsh hissing calls (Jerdon, 1862). It is a passerine species found in open habitats, mangroves, forest edges, coastal regions, and humanmodified landscapes such as gardens and cultivation areas (Rasmussen & Anderton, 2012; del Hoyo, 2005). The Oriental magpie-robin is a morphologically sexually dimorphic species (Bhatt, 2014). The male has black underparts and throat, while the white is on the side of the tail. As for females, the black color in males is replaced with a grey color (Ali, 1983). A song can be simply explained as a long and complex sound that is mostly produced by males during the breeding season, while in the tropics, females of some species also sing, which is less frequent than males. In such cases, both sexes perform singing during the breeding season (Odom, 2014). Research in the field of songbirds suggests the occurrence of a sophisticated song development process, which includes skills such as hearing, practicing, and memorizing. The basic principle behind the auditory mechanism of birds is similar to mammals in terms of frequency processing. Birds use about 0.5 to 6.0 kHz of auditory space for vocal communication with about 30dB of amplitude (Dooling, 2000). The song is composed of different components, where each component has a different role in completing the song structure. The study of the singing patterns of the Oriental magpie-robin (Kumar, 2002) revealed some standard terminologies for songs, such as elements, motifs, and trills. A song is composed when the vocalizations are segregated from each other by silent intervals of < 0.5 sec. The complexes of elements that always occur in the same stereotype succession are called Motifs. Differences in the amount of syllable or trill sections are measured as a kind of song variation. Silent intervals that are larger than 20 seconds tend to separate different episodes of singing (Hultsch, 1982). The Oriental magpie-robin is known to deliver six types of calls (Manshor, 2020). This study was conducted to understand the singing patterns of the Oriental magpie-robin, its structural complexity, and ecological adaptation. Given that songbirds use vocal signals for territory defense, mate attraction, and social communication, we aimed to investigate how environmental factors (e.g., urbanization, habitat type) influence song structure and variation.

Material and methods

Study Area

The study area is located near human settlements and includes a forest patch within the Dehradun Forest Division, Lachhiwala Range, characterized by a moist deciduous forest ecosystem, interspersed with Sal (*Shorea robusta*) dominated forests and patches of mixed broadleaf vegetation. The region also includes scrublands and riverine forests along seasonal streams, providing a diverse habitat for avian species and falling under the humid subtropical category (Peel, 2007). All year long, the average temperature is mild, ranging from 15 to 25°C in the winter to 35 to 40°C in the summer. The region receives 2073 mm of rainfall on average per year, with the majority of that falling between June and September (Singh et al., 2017). The study was conducted in a total area of 1170 hectares, which included 530 ha of near forest and 640 ha of urban sampling sites (Figure 1).

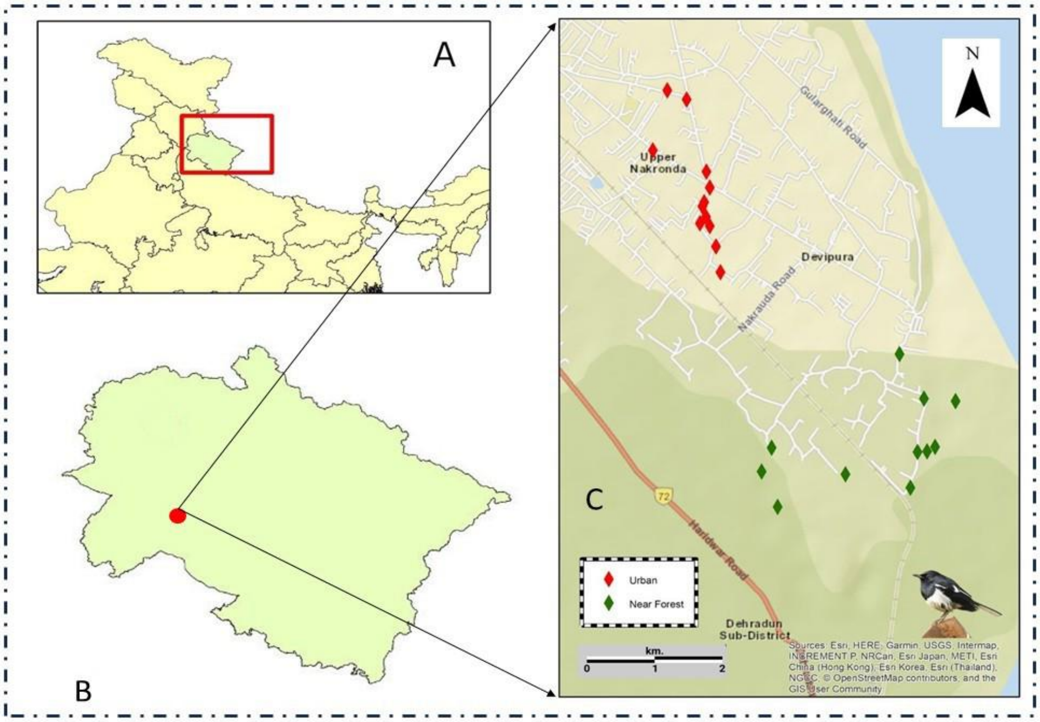


Figure 1. A: India, B: Uttarakhand, C: Study area with sampling points

The study was conducted from March to May 2022, during the breeding season of the Oriental magpie-robin (*Copsychus saularis*). A total of 24 adult males were observed, including 12 individuals each from forest and urban habitats within the Dehradun Forest Division, Uttarakhand, India. Each bird was recorded once per observation day to ensure data independence. Recordings were made between 05:30 and 08:30 hours, avoiding periods of rain or strong wind to maintain acoustic clarity. Songs were recorded using a Zoom H1n unidirectional handheld recorder at a sampling rate of 44.1 kHz and 16-bit resolution. The microphone was positioned approximately 10–15 meters from each bird to avoid behavioral disturbance. All recordings were saved in WAV format and analyzed using Raven Pro 1.6 (Bioacoustics Research Program, 2022). Spectrograms were produced using a Hann window, 512-point FFT, and 50% overlap following established avian bioacoustic procedures (Brumm & Slabbekoorn, 2005). Songs were divided into elements, motifs, and phrases following the description of Kumar and Bhatt (2002). The measured acoustic parameters included minimum frequency (kHz), maximum frequency (kHz), dominant frequency (kHz), and song duration (seconds). Song variation was determined based on the presence or absence of added or deleted elements within a phrase (Halfwerk et al., 2011). Recordings were made from distinct territorial males to ensure independence among samples. Each session lasted three to five minutes, yielding approximately 10–15 usable song phrases per bird. In total, about 240 song phrases were analyzed across both habitats. Statistical analyses were conducted using IBM SPSS Statistics 26. Descriptive statistics (mean ± SD) were calculated for each parameter across habitats. Data were tested for normality using the Shapiro–Wilk test. Normally distributed variables were compared using independent-samples *t*-tests, while non-normal data were analyzed using Mann–Whitney *U* tests. Differences in the frequency of song variation between habitats were evaluated using the Chi-square test. Statistical significance was accepted at $p < 0.05$, and all results are presented in Table 1. The analytical approach followed standard procedures outlined in Zar (2010).

Results

A total of 24 adult male Copsychus saularis (12 from forest and 12 from urban habitats) were analyzed. The songs of the recorded individuals were analyzed using spectrograms. Figures 2-8 show the spectrograms of songs from all the individuals (1–24), recorded at two sites: the forest area and an urban area. Both the forest and urban sites exhibited examples of songs with variation as well as songs without variation.

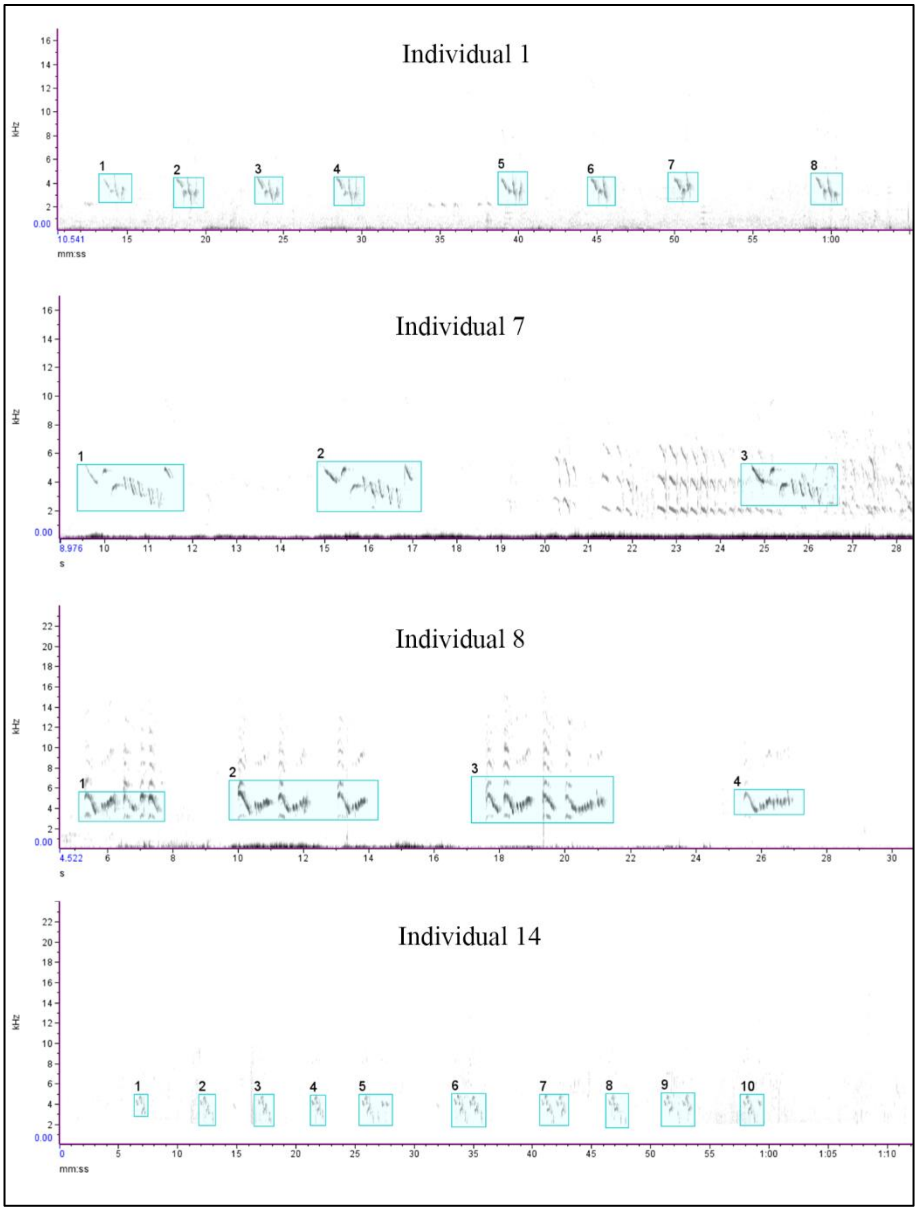


Figure 2. Spectrograms of Individuals in the forest with no variation (1/2)

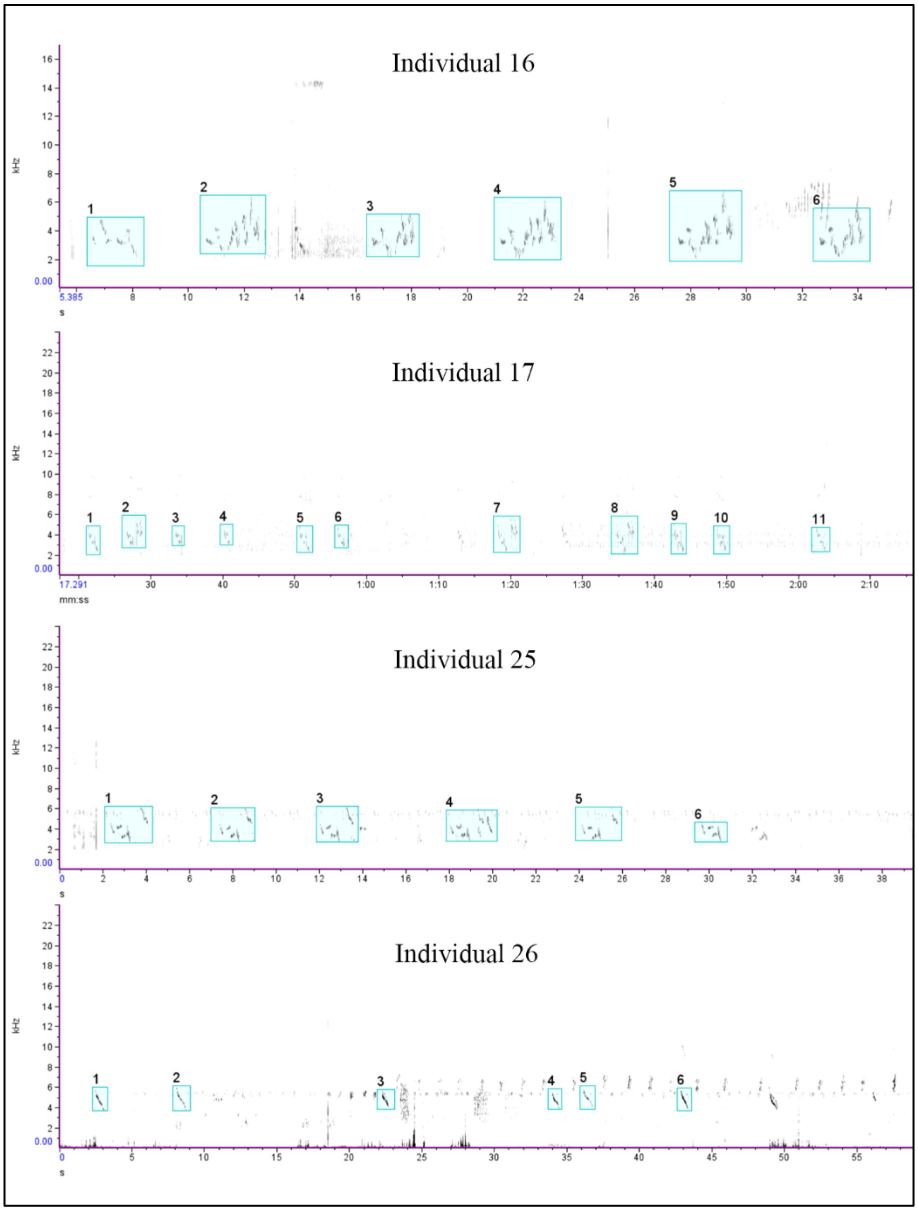


Figure 3. Spectrograms of Individuals in the forest with no variation (2/2)

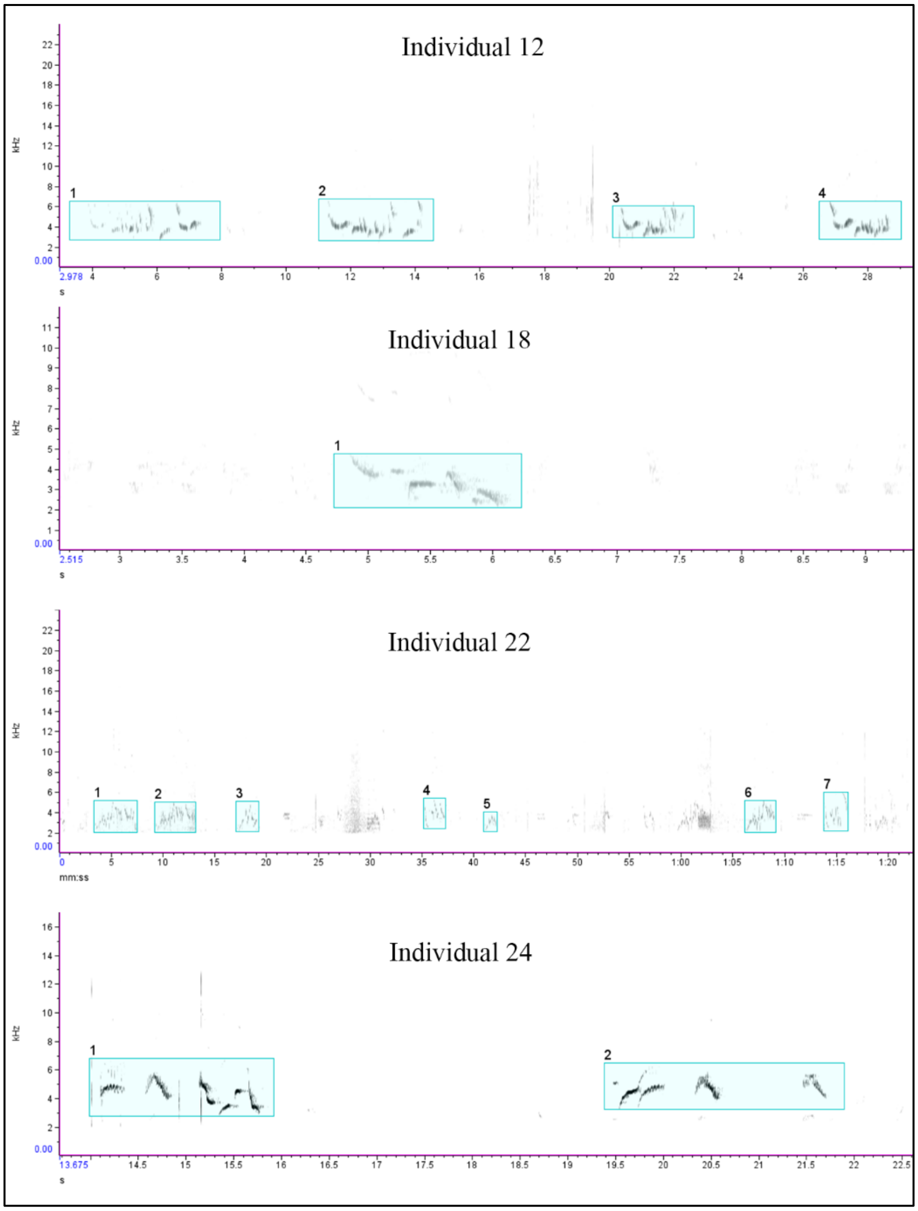
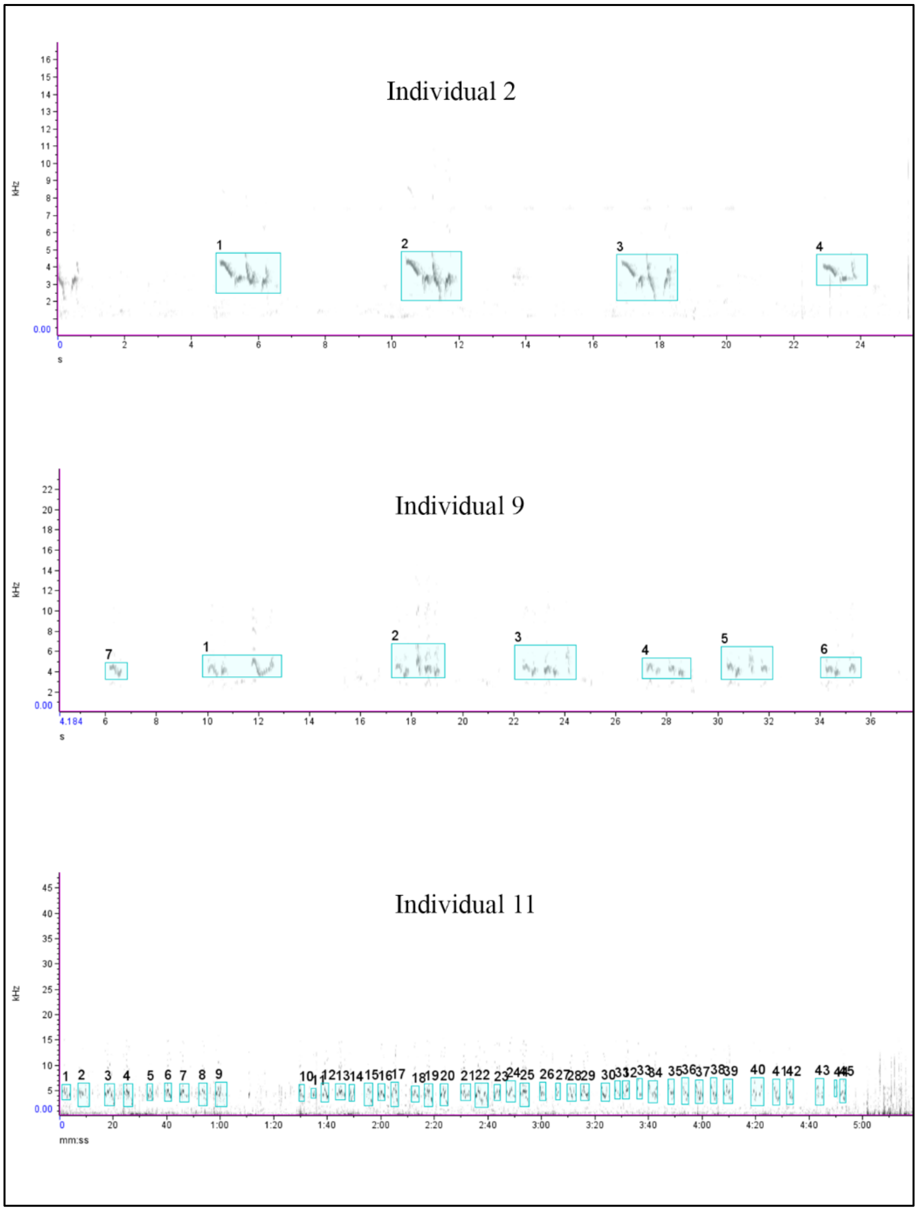


Figure 4. Spectrograms of Individuals in the forest with variation (1/1)

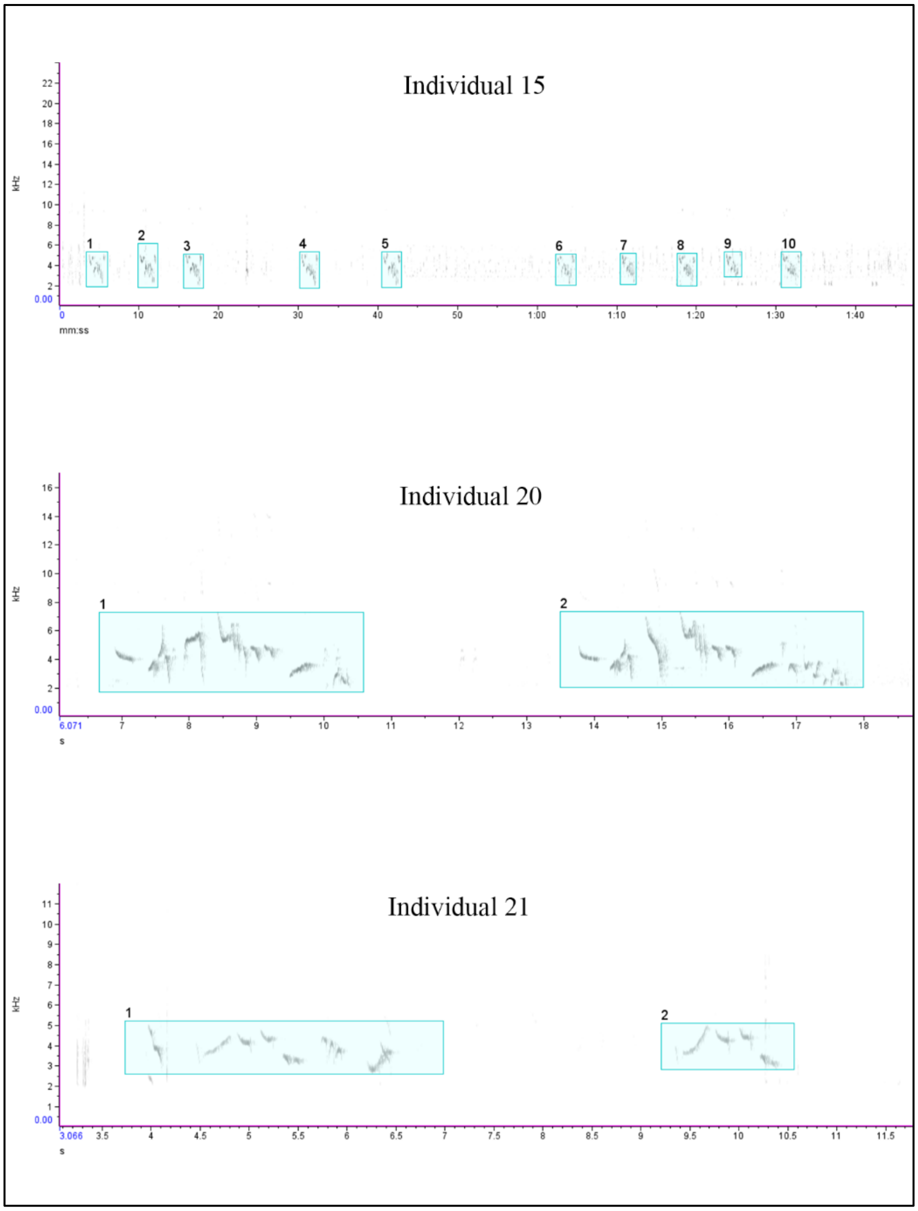


Individual 2

Individual 9

Individual 11

Figure 5. Spectrograms of Individuals in the urban areas with no variation (1/2)


Individual 15

Individual 20

Individual 21

Figure 6. Spectrograms of Individuals in the urban areas with no variation (2/2)

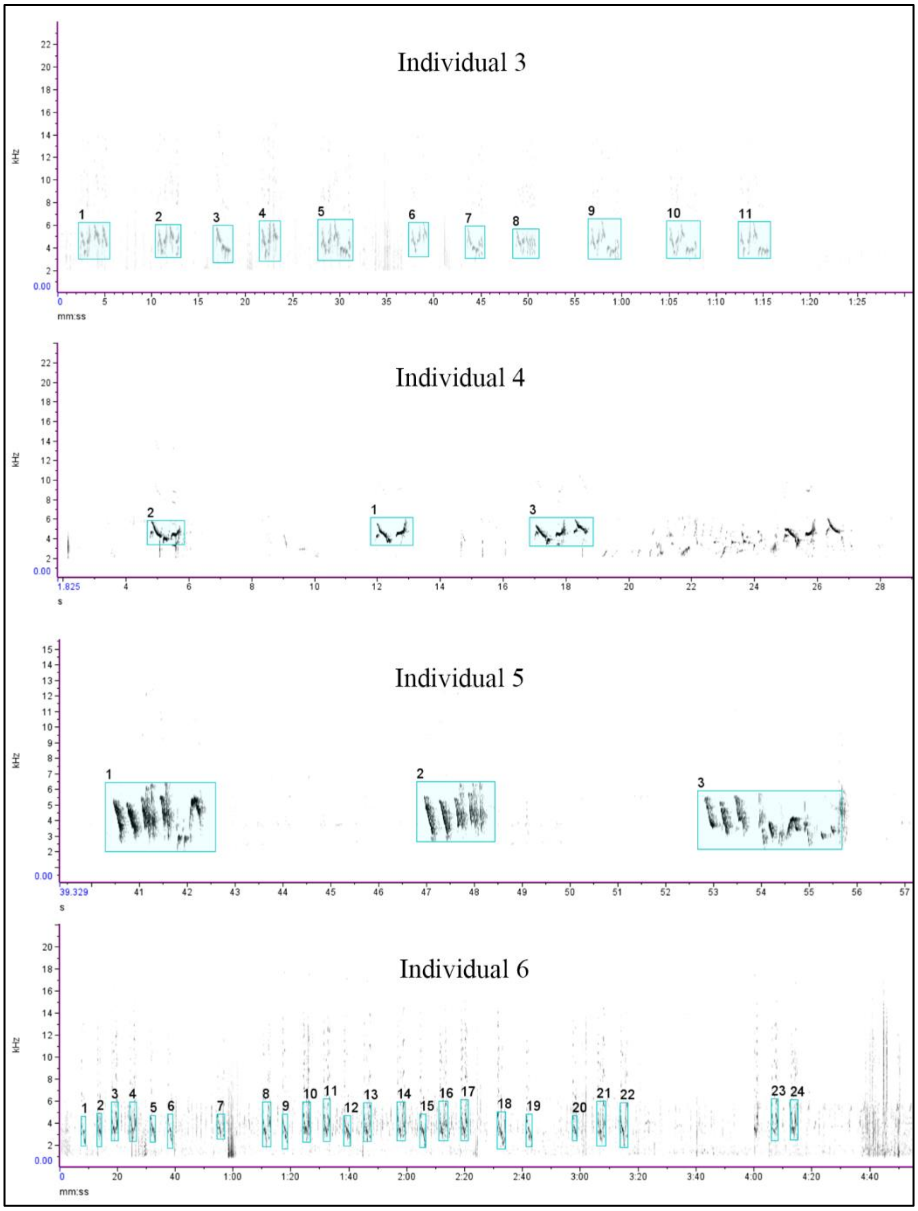


Figure 7. Spectrograms of Individuals in the urban areas with variation (1/2)

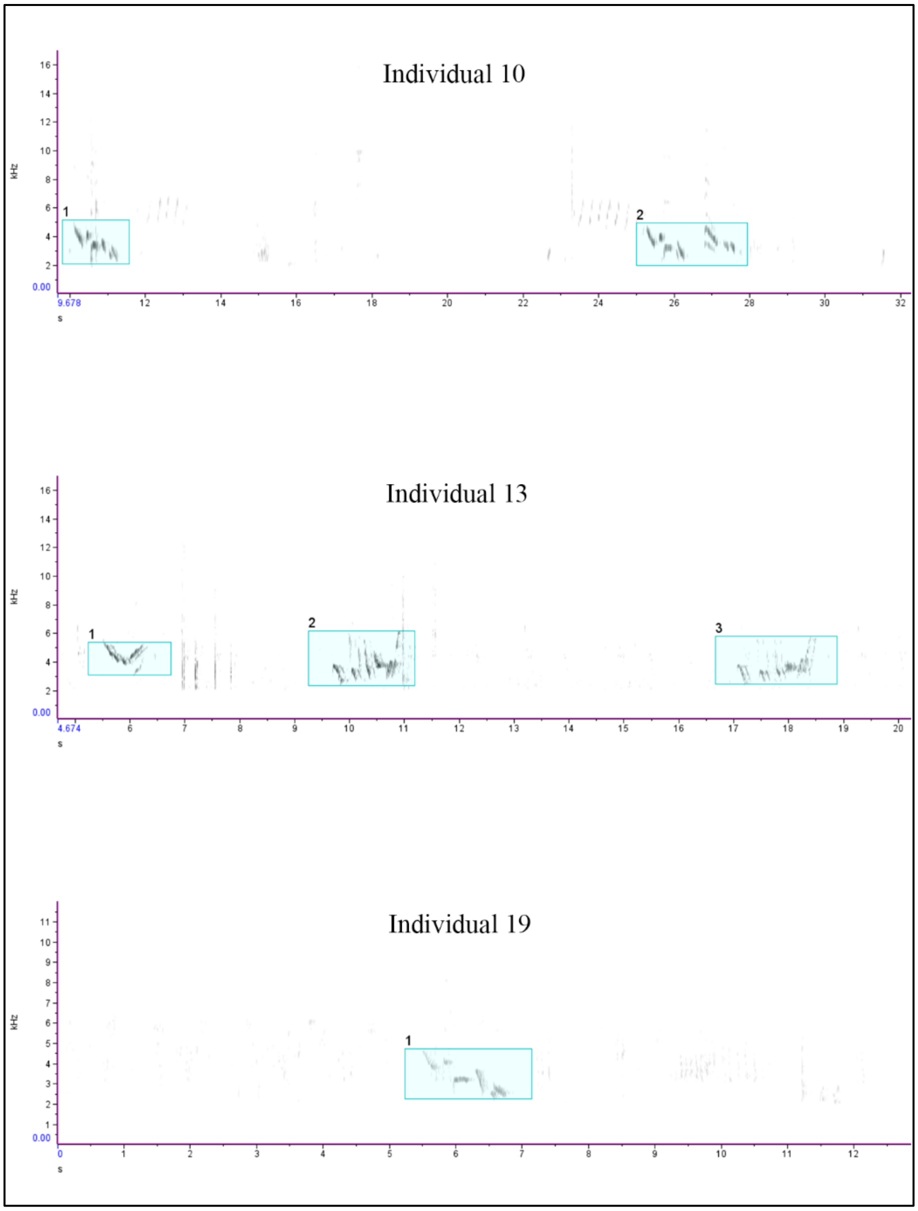


Figure 8. Spectrograms of Individuals in the urban areas with no variation (2/2)

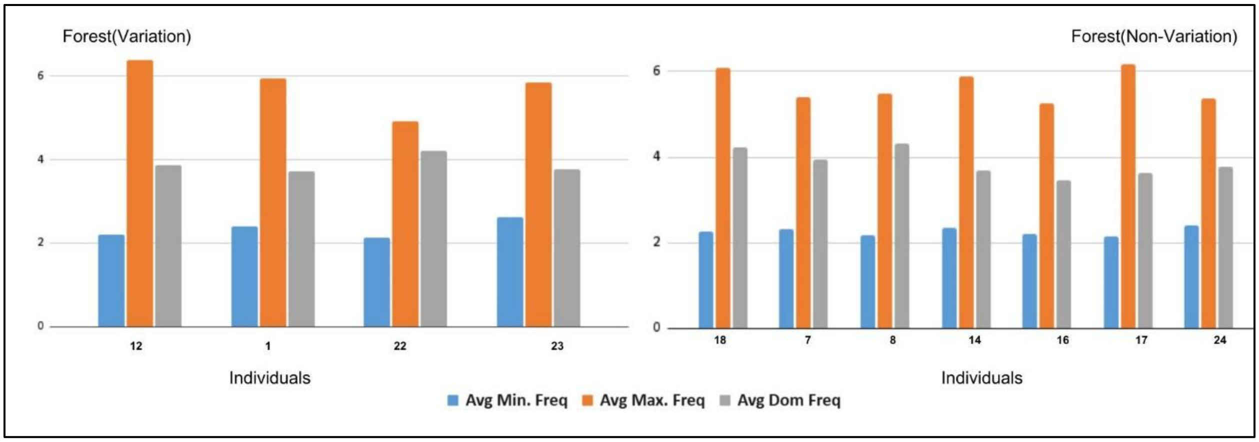


Figure 9. Graphical representation of the Average Maximum, Average Minimum, and Average Dominant Frequencies of recorded male individuals from the Forest sites

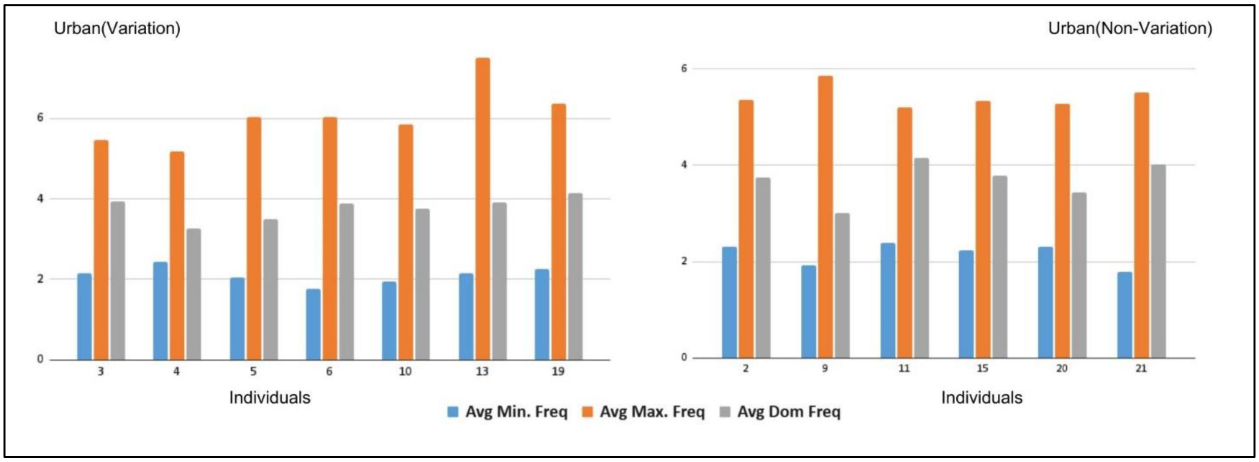


Figure 10. Graphical representation of the Average Maximum, Average Minimum, and Average Dominant Frequencies of recorded male individuals from the Urban sites

The average maximum song frequency was higher among urban individuals (6.19 ± 0.46 kHz) than forest individuals (5.72 ± 0.39 kHz). Minimum frequency values were similar between habitats, with forest birds averaging 2.31 ± 0.27 kHz and urban birds 2.23 ± 0.25 kHz. Dominant frequency averaged 4.18 ± 0.42 kHz in the forest and 3.89 ± 0.36 kHz in the urban sites (Figures 9 and 10). Song duration showed comparable values across habitats (7.1 ± 2.0 s in forest; 7.5 ± 1.7 s in urban). The proportion of songs showing variation was greater among urban individuals (75%) than forest individuals (42%). All descriptive and comparative values are summarized in Table 1.

Table 1. Mean (± SD) values of acoustic parameters of Oriental magpie-robin (Copsychus saularis) songs recorded in forest and urban habitats of Dehradun, India. Statistical significance was set at $p < 0.05$

Acoustic parameter	Forest (n = 12)	Urban (n = 12)	*p*-value	Interpretation
Maximum frequency (kHz)	5.72 ± 0.39	6.19 ± 0.46	0.031	Higher in urban habitat
Minimum frequency (kHz)	2.31 ± 0.27	2.23 ± 0.25	0.34	No significant difference
Dominant frequency (kHz)	4.18 ± 0.42	3.89 ± 0.36	0.29	No significant difference
Song duration (s)	7.1 ± 2.0	7.5 ± 1.7	0.38	No significant difference
Songs showing variation (%)	41.6	75.0	0.043	More frequent in urban habitats

Discussion

This study revealed distinct acoustic adjustments in the songs of the Oriental magpie-robin (*Copsychus saularis*) between forest and urban habitats of Dehradun. While the species retained its overall song structure, urban individuals produced songs with higher maximum frequencies and greater song variation. These modifications likely represent adaptive responses to increased ambient noise in urban environments. The elevation in maximum frequency among urban birds aligns with the Acoustic Adaptation Hypothesis, suggesting that birds shift song pitch to reduce masking by low-frequency anthropogenic noise. Similar adjustments have been reported in other passerines such as *Parus major* (Slabbekoorn & Peet, 2003), *Turdus merula* (Nemeth & Brumm, 2010), and *Passer domesticus* (Luther & Baptista, 2010). The pattern observed here indicates that *C. saularis* exhibits short-term vocal plasticity, enabling effective communication despite environmental interference. The higher frequency of song variation in urban individuals further supports this plasticity. The addition or deletion of elements within song phrases may enhance communication efficiency under variable noise conditions (Halfwerk et al., 2011). Such variability may also arise through cultural transmission, as individuals exposed to diverse soundscapes incorporate novel elements into their repertoires (Slater, 1986). Although dominant frequency and song duration did not differ significantly, both parameters showed trends consistent with adjustments to urban noise, similar to findings in other tropical songbirds (Gil & Brumm, 2014). These results indicate that the Oriental magpie-robin maintains its basic vocal identity while demonstrating flexibility in acoustic expression, reflecting its capacity to persist and communicate effectively in changing soundscapes.

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