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Singing patterns of the Oriental Magpie Robin *Copsychus saularis* Linn.

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Abstract

Oriental Magpie Robin is a song bird that resides in some tropical regions of Asia. The present work was attempted to provide a detailed study of the territorial singing of this species in the area of Biratnagar (Nepal). Songs of Oriental Magpie Robin was recorded by using a digital voice recorder (Olympus VN-8700PC) for one hour without break at seven selected sites in Biratnagar. Recorded songs were converted in the form of spectrogram by using avisoft. Seven Oriental Magpie Robins, belonging to seven different study sites of Biratnagar were taken as subjects and have been abbreviated as Bird A, B, C, D, E, F and G respectively. It was very surprising that there was not even a single motif which was matching among any of the birds. Out of 1782 song samples recorded from seven individuals, 328 types of songs were identified. These songs were composed of 3 to 18 types of elements.

Key words: *Copsychus saularis,* Motifs, Repertoire curve, Song structure.

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Introduction

There are about 10,000 species of birds in the world, which are categorized commonly into two groups i.e. song birds and call birds. Some 4,000 species of birds in the world fall under the category of song birds which belong to the order Passeriformes. In Nepal there are several representatives of the order Passeriformes. Song birds differ from call birds in that the former have more number of cords in their syrinx (voice box). The vibration of the cord creates sweet sound called 'song'**.** Generally, calls are genetic while songs are partly inherited and partly learned.

In the case of call birds, the number of cord is less so the sound is very simple and uncomplicated. Monotonous repeated sounds are called "calls such as A…A…A…A…B…B…B. Calls are of two types. If the call has a single element, it is known as a simple call and if the call has several elements it was categorized as a complex call (Thorpe, 1961; Obrist, 1995; Ficken and Popp, 1996; Mitchell, 1977; White *et al.,* 1970). During non-breeding season birds use calls to communicate messages and to defend food resources and during the breeding season they use songs for territory maintenance and mate acquisition (Bhatt *et al*., 2000).

When the bird produces an acoustical patterns with different varieties of sound are called "songs". Songs can be simple or very complicated example AB…AB… AB… or ABCD…ABCD….EFG… respectively. The singing behavior of birds alternates always between a stream of acoustical signals and silent intervals (pause). Doves, Myna, Sparrow, Cuckoo, Parrot, Crow, Kite, Tailor bird, Cattle Egret, Peacock, Coucal, Stork, etc. are examples of call birds. Oriental Magpie Robin, Shama, Nightingale, Bulbul, Black Drongo and all birds belonging to the order Passeriformes are song birds. Some song birds can imitate sounds of other birds or sounds of their surroundings then integrate those into their own song as well, example Brown Shrike, oriental Magpie Robin, Black Brongo, etc.

Nepal has over 875 species of bird, among which 43 families falls under oscine birds. Despite this, the study of song birds has hardly been performed in Nepal, although this field of study is very popular in Europe, US and Japan. Oriental Magpie Robin is one of the song birds of family Muscicapidae. A first inquiry into the vocal accomplishments of this bird was performed (Bhattacharya *et al.*, 2007). This study had revealed that these birds do not engage in vocal matching. Here we present the results of detailed song analysis of seven songsters, focusing on the singing pattern of each bird attempting to reveal a clearer picture of the singing structure and song repertoire of the Magpie Robin.

A perusal of literature revealed that there was no standard terminology for the songs and calls of different species (Bhatt *et al.*, 2000). In the study of singing patterns of Oriental Magpie Robin, several terms have been used to understand the bird song. Some of these terminology used in these study are elements, motifs, trills and songs. These terms have been defined as follows.

Elements
Elements are the units of motifs. Each mark on the spectrogram, no matter how small it is, is an element.

Vocalizations that compose the songs and are segregated from each other by silent intervals (= within song pauses) of < 0.5 sec.

Note: Song elements from temporally coherent sound figures that usually reoccur without conspicuous variation. In addition, also the sequential combination of such element is quite regular.

Motifs
Motifs are defined as complexes of elements (notes) that always occur in the same stereotype succession.

Trills
Trills results from a succcessive repetition of song constituents, elements or syllables. Differences in the amount of syllable or element repetitions (trill sections), however accepted for a given type and measured as a kind of song variation (Hultsch and Todt, 1998).

Song
By the combination of different motifs, a song is formed. Vocalizations (‘strophes’) that compose an episode of singing then they are segregated from each other by silent intervals (= inter-song pauses) of ≥ 0.5 sec were called songs.

Songs have been shown to serve as ‘units of vocal interactions’ and to have a limited duration (< 10 sec.). Silent intervals larger than 20 sec. are regarded to separate different episodes of singing (Hultsch and Todt, 1981; 1982; 1998)

Materials and Methods
Data collection
Songs of Oriental Magpie Robin were recorded by using a Digital Recorder (Olympus VN-8700PC and Cenix Digital Recorder VR-P1890) equipped with an external microphone. Each bird was recorded for one hour at seven different selected sites located at about a distance of 2 kms or more in Biratnagar. The birds were in their natural habitats in order to compare songs on the basis of geographical positions.

Number of birds
Seven Oriental Magpie Robins, belonging to seven different study sites in Biratnagar were taken as subjects and have been abbreviated as follows:

Location A- Bird A, Location B- Bird B, Location C- Bird C, Location D- Bird D, Location E- Bird E, Location F- Bird F and Location G- Bird G.

Data analysis
Recorded sound was converted in the form of spectrogram (i.e. the graphic representation of sound also known as sonogram) by using commercial software program called Avisoft (R. Specht, Berlin). The sound spectrogram technique is a well established method to characterize acoustic signals on the basis of their frequency, duration and amplitude. Data was obtained from the measurement of their amplitude and frequency from spectrogram.

Data were transferred to a computer where all recordings were digitalized for analysis. Hard copies of spectrogram were made at 8 KHz in order to compare and sort out the different types of song pattern. Sound patterns were sampled and printed in the form of frequency spectrograms (sonograms). A total of 1 hour singing duration for each individual bird was then sampled out. All further steps of data analysis followed conventional procedures of avian sound research (Todt, 1970; 2004; Hultsch and Todt, 1981; 1989; 2004)

Statistical tools were not used for analyses because the data of song available for the various species were extremely variable. This procedure followed suggestions of (Mundry and Fischer, 1998) that are appropriate if samples are too small for asymptotic tests (Siegel and Castellan, 1988).

Results

The results of data analysis of songs of seven Oriental Magpie Robins from Biratnagar have been described bird wise below:

Bird A

Bird A sang 6 types of motifs (Fig. 3) in 1 hour recording. The motifs of Bird A were composed of 3 to 6 elements with an average of 5 elements.

There were altogether 19 types of song with various combinations of motifs and the total number of vocalizations of the bird A in 1 hour was 330. Shape of a 'repertoire curve' (Fig. 6), showed the composition of song types in 1 hour period of Bird A. It was seen that Bird A had sung 4 to 9 songs per minute which were made up of 2 to 5 motifs.

Out of these 19 songs, the most repeated song was 71 times while 2 songs were not repeated at all in this one hour of recording.

Silent intervals segregating the songs of Bird A were preferentially around 4.5 sec. (Fig. 2b). Interestingly most song lasted for about 4 sec. (Fig. 2a), which pointed out their interactive role. Peak intervals measured between the starts of two successive songs were found at 7 sec. (Fig. 5) in Bird A.

Bird B

Bird B sang 15 types of motifs (Fig. 3) in 1 hour recording. The motifs of Bird B were composed of 3 to 8 elements with an average of 5 and 7 elements.

There were altogether 120 types of motif combinations or songs and the total number of vocalizations of the Bird B in 1 hour was 321. Shape of a 'repertoire curve' (Fig. 6), showed the composition of song types in 1 hour period of Bird B. It was seen that Bird B had sung 4 to 8 songs per minute which were made by the combination of 2 to 8 motifs.

Out of 120 types of songs, the most repeated song was 27 times while 63 songs were not repeated at all in this one hour of recording. In this case it was seen that although the songs were made up by the combination of 2 to 8 motifs, the most repeated songs were made up of only 2 motifs.

Silent intervals segregating the songs of Bird B were preferentially around 1.5 sec. (Fig. 2b). Interestingly most song lasted for about 3 sec. (Fig. 2a), which pointed out their interactive role. Peak intervals measured between the starts of two successive songs were found at 5 sec. (Fig. 5) in Bird B.

Bird C

Bird C sang only two types of motif (Fig. 3) in one hour recording. The motifs of Bird C were composed of 4 and 6 elements. Motifs were made up of 4 and 6 elements respectively.

There were altogether 12 types of songs and the total number of songs sung by Bird C was 411 in 1 hour long song. Shape of a 'repertoire curve' (Fig. 6), showed the composition of song types in 1 hour period of Bird C. It was seen that Bird C had sung 3 to 8 songs per minute which were made up of 2 to 9 motifs.

Out of these 12 types of song, the most repeated song was 197 times while 5 songs were not repeated at all in this one hour of recording.

In Bird C, it was seen that as there were altogether only two motifs, most of the songs were comprised of motif 2 and 1 which were used repeatedly in songs.

Silent intervals segregating the songs of Bird C were preferentially around 2 sec. (Fig. 2b). Interestingly most song lasted for about 4 sec. (Fig. 2a), which pointed out their interactive role. Peak intervals measured between the starts of two successive songs were found at 6 sec. (Fig. 5) in Bird C.

Bird D

Bird D sang 4 types of motifs (Fig. 3) in 1 hour recording. The motifs of Bird D were composed of 5 to 8 elements.

There were altogether 36 types of song formed by various combinations of motifs and the total number of vocalizations of the Bird D in one hour period was 169. Shape of a 'repertoire curve' (Fig. 6), showed the composition of song types in 1 hour period of Bird D. It was seen that sometimes Bird D had sung 4 to 8 songs per minute which were made by the combination of 2 to 7 motifs.

Out of 36 types of song, the most repeated song was 39 times while 15 songs were not repeated at all in this one hour of recording.

Silent intervals segregating the songs of Bird D were preferentially around 4.5 sec. (Fig. 2b). Interestingly most songs lasted for about 6 sec. (Fig. 2a), which pointed out their interactive role. Peak intervals measured between the starts of two successive songs were found at 12 sec. (Fig. 5) in Bird D.

Bird E

Bird E sang 5 types of motif (Fig. 3) in 1 hour recording. The motifs of Bird E were composed of 2 to 5 elements with an average of 5 elements.

There were altogether 51 types of songs which the bird composed by the variations in combination of motifs and the total number of vocalizations by Bird E in one hour were 226. Shape of a 'repertoire curve' (Fig. 6), showed the composition of song types in 1 hour period of Bird E. It was seen that Bird E has sung 4 to 9 songs per minute which were made up of 3 to 8 motifs.

Out of 51 songs, the most repeated song was 38 times while 2 songs were not repeated at all in this one hour of recording.

Silent intervals segregating the songs of Bird E were preferentially around 1.5 sec. (Fig. 2b). Interestingly most song lasted for about 5 sec. (Fig. 2a), which pointed out their interactive role. Peak intervals measured between the starts of two successive songs were found at 6 sec. (Fig. 5) in Bird E.

Bird F

Bird F sang 8 types of motif (Fig. 3) in 1 hour recording. The motifs of Bird F were composed of 2 to 6 elements with an average of 5 elements.

There were altogether 65 types of song sung by Bird F in 1 hour and the total number of song was 292. Shape of a 'repertoire curve' (Fig. 6), showed the composition of song types in 1 hour period of Bird F. It was seen that Bird F had sung 4 to 8 songs per minute which were made up of 3 to 12 motifs.

Out of 65 types of song, there were 2 most repeated songs and both of them were repeated for 35 times while 25 songs were not repeated at all in this one hour of recording.

Silent intervals segregating the songs of Bird F were preferentially around 1.5 sec. (Fig. 2b). Interestingly most song lasted for about 3 sec. (Fig. 2a), which pointed out their interactive role. Peak intervals measured between the starts of two successive songs were found at 5 sec. (Fig. 5) in Bird F.

Bird G

Bird G sang 8 types of motifs (Fig. 3) in 1 hour recording. The motifs of Bird G were composed of 4 to 10 elements.

There were altogether 25 types of song and total number of songs sung by Bird G in one hour was 33. Shape of a 'repertoire curve' (Fig. 6), showed the composition of song types in that 1 hour period. It was seen that Bird G had sung 3 to 6 songs per minute which were made up of 2 to 7 motifs.

Singing pattern of Oriental Magpie Robin

In the case of Bird G, no absolute favorite motif combinations were recognized. Out of 25 songs, 8 songs were repeated ones and the remaining 17 were just sung only once during 1 hour long period.

Silent intervals segregating the songs of Bird G were preferentially around 4.5 sec. (Fig. 2b). Interestingly most song lasted for about 4 sec. (Fig. 2a), which pointed out their interactive role. Peak intervals measured between the starts of two successive songs were found at 9 sec. (Fig. 5) in Bird G.

The songs of these Oriental Magpie Robins were found to be highly varied and complex which were composed of different types of motifs. Out of 1782 song samples recorded from seven individuals, 328 types of songs were identified. These songs were composed of 3 to 18 types of elements. Trills (successive repetition of the same element) were found in the songs of only one individual i.e. Bird C (Fig: 4).

Singing (=bouts of songs) --

Songs --------------- ---------------- --------------

Elements -

Figure 1**.** Structural hierarchy of song organization (for details see Todt 2004).

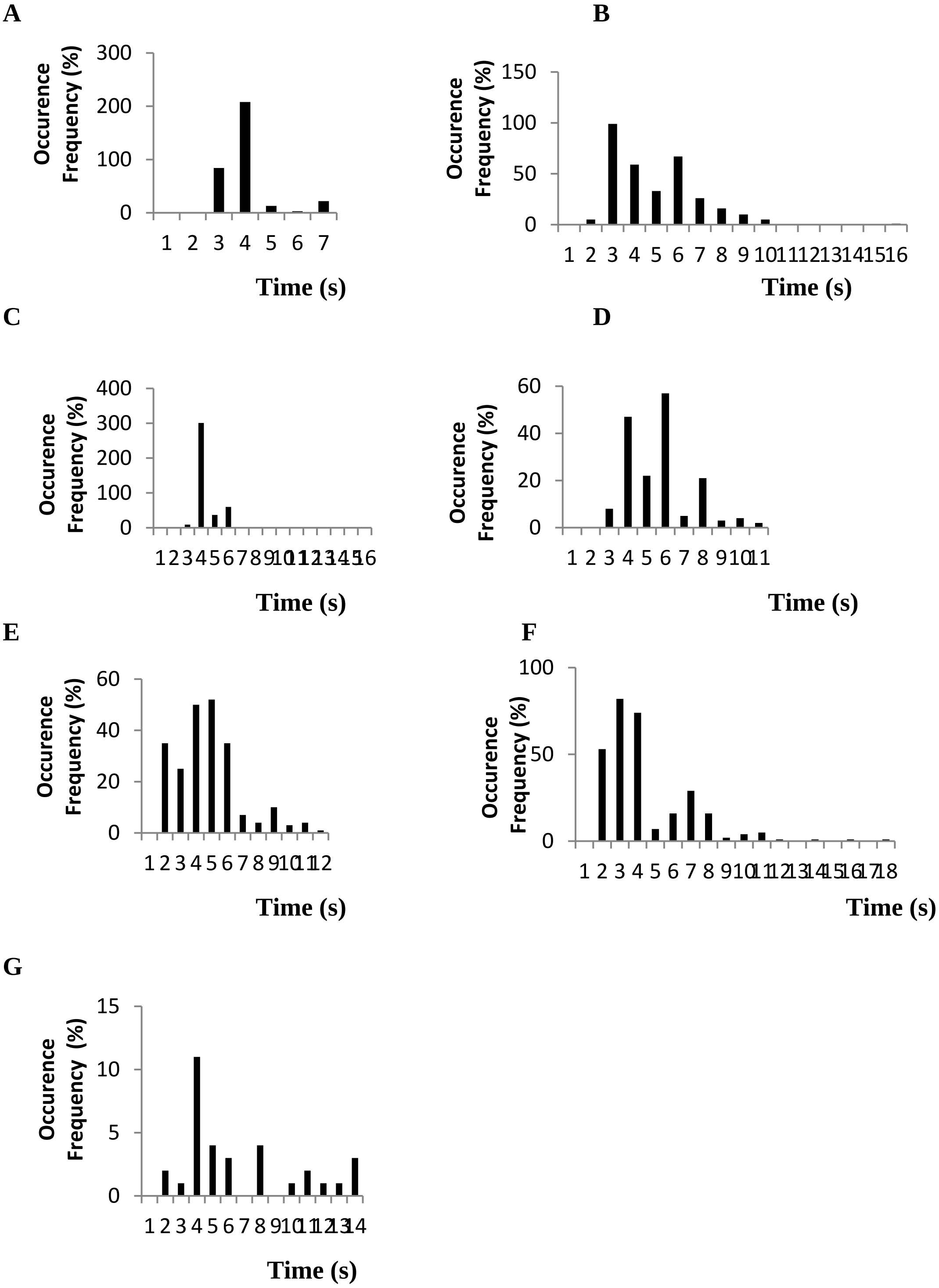


Figure 2a. Frequency distribution (histogram) of song lengths.

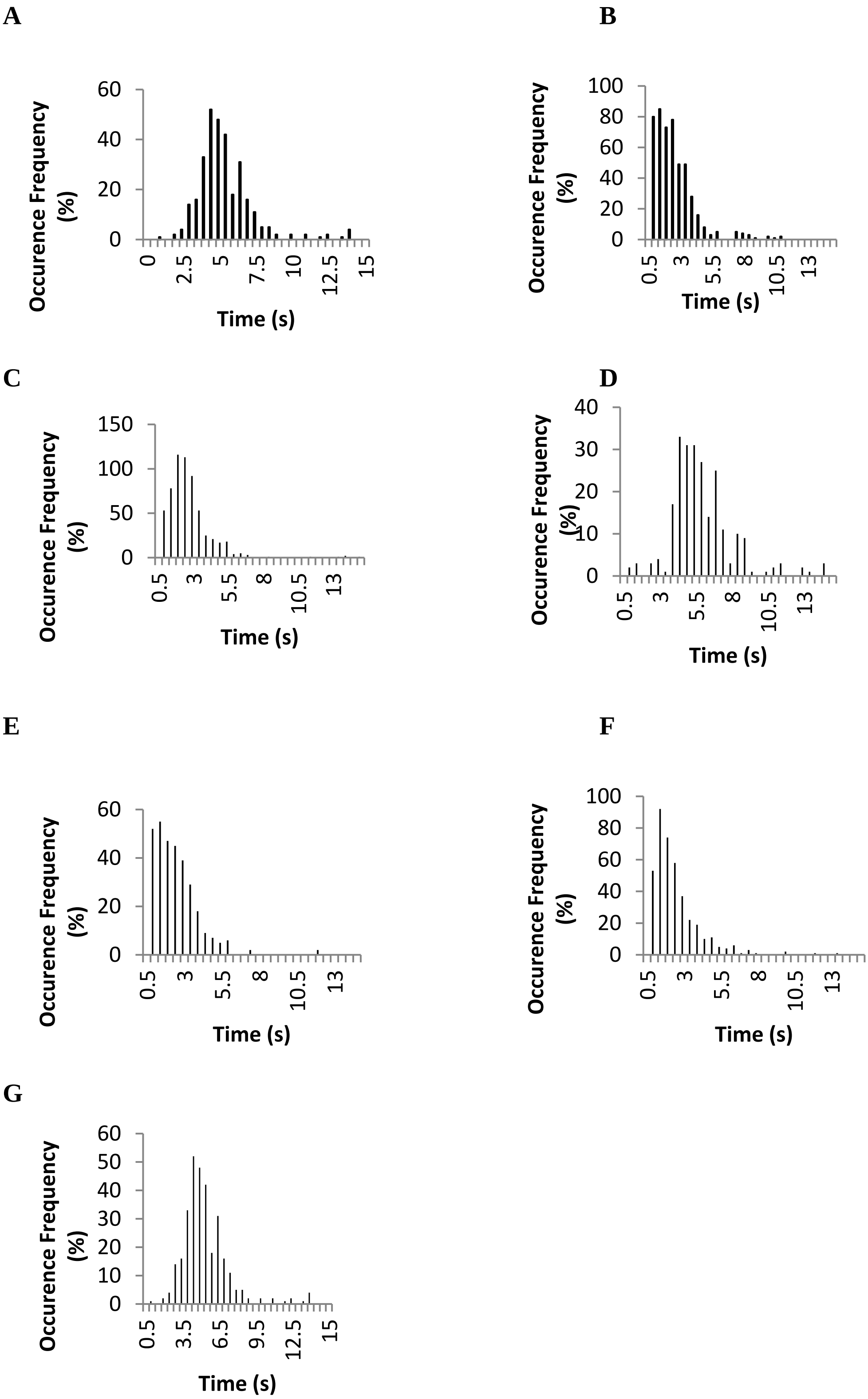


Figure 2b. Frequency distribution (histogram) of durations measured between songs.

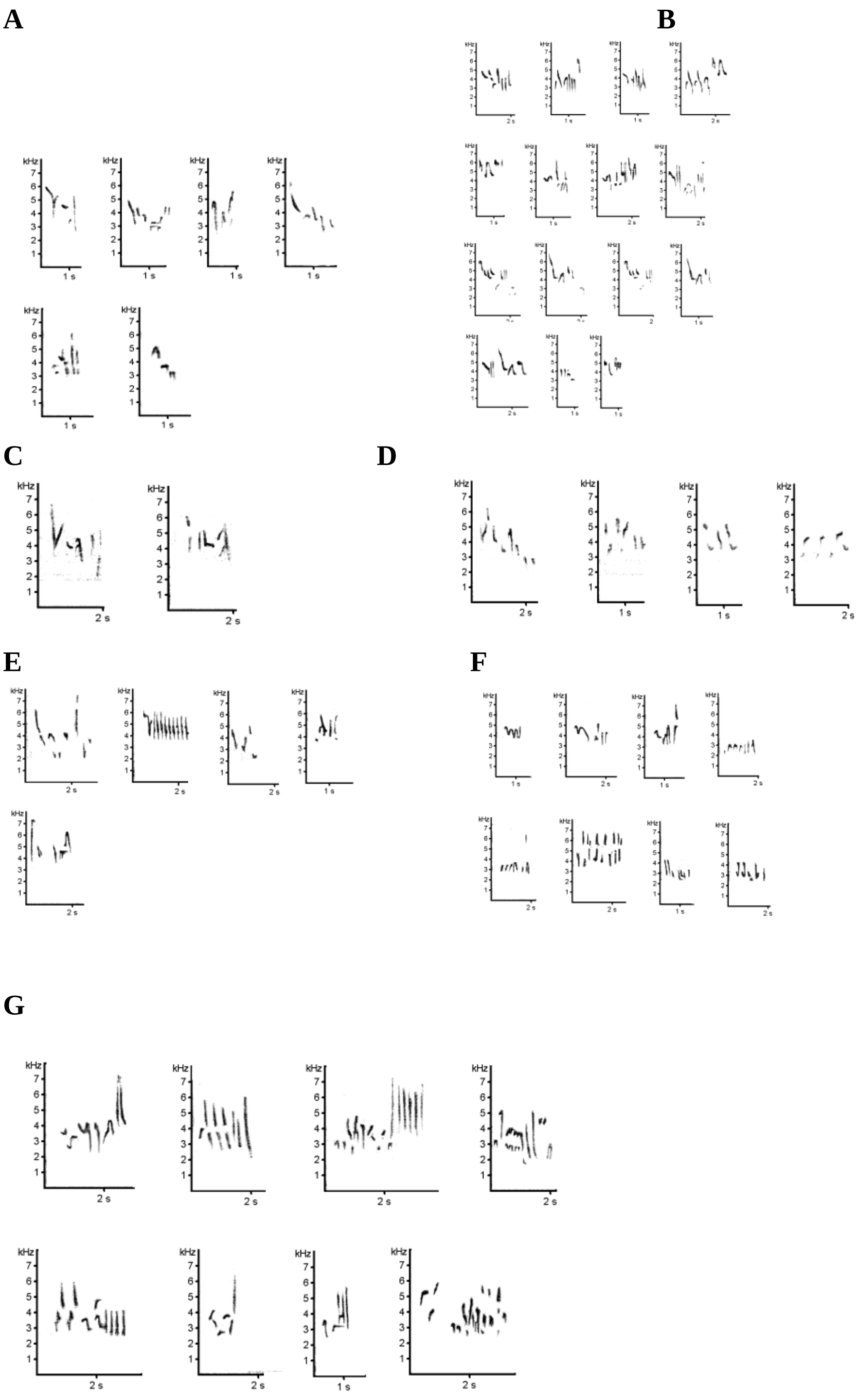


Figure 3. Frequency spectrograms (sonograms) of motif types composing the vocal repertoire of 7 male Oriental Magpie Robins. Capital (A, B, C, D, E, F, Z) refer to the birds. The songsters did not share parts of their repertoires (see text).

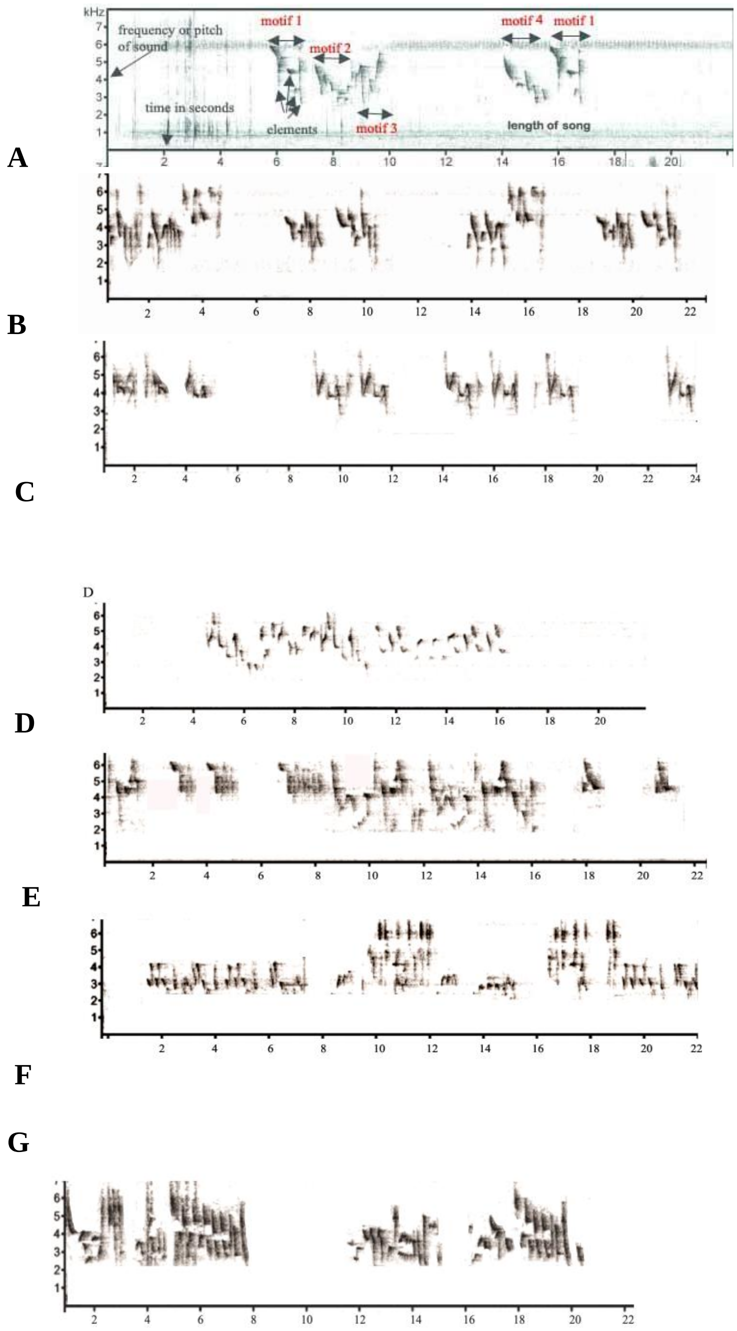


Figure 4. Frequency spectrograms illustrating how motif types can compose successive songs.

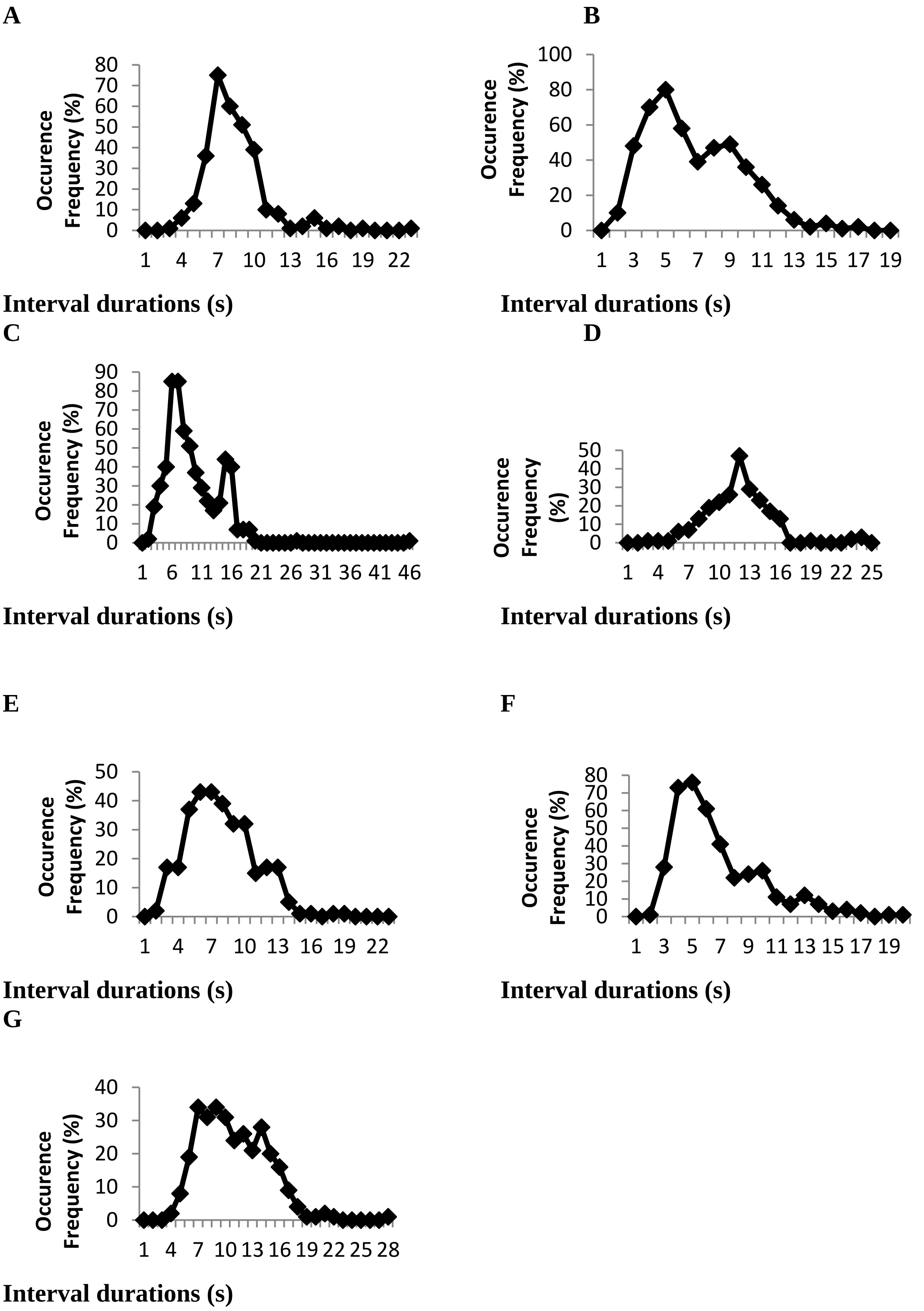
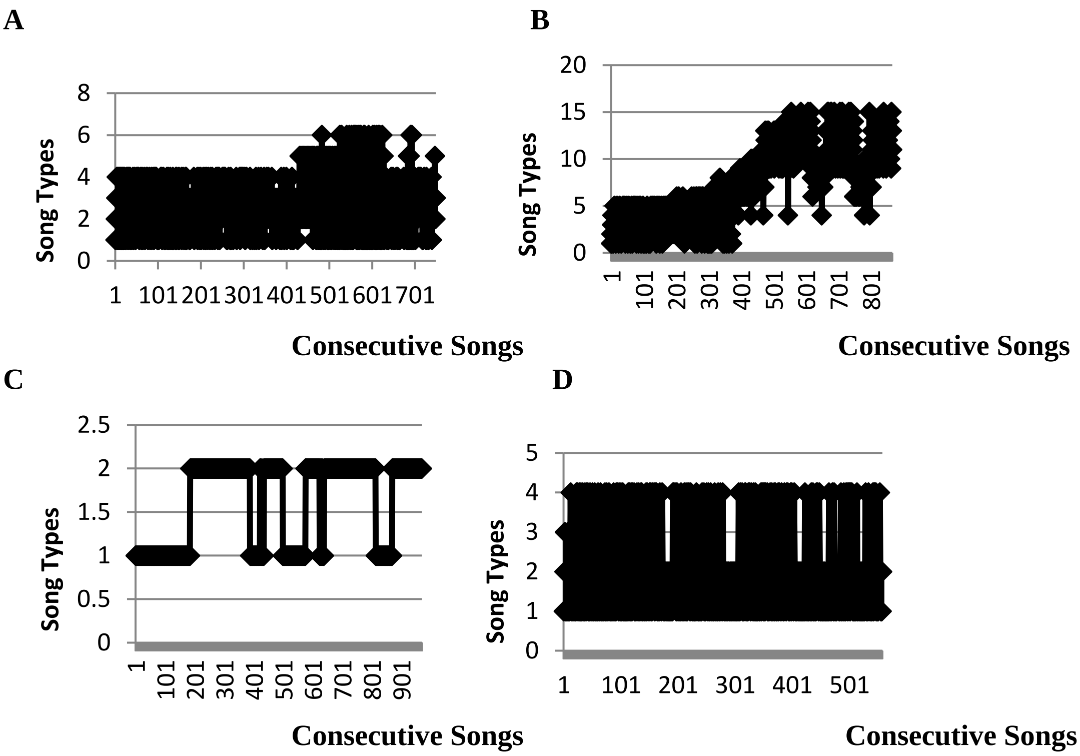


Figure 5. Frequency distribution of intervals measured between the start of two successive songs.



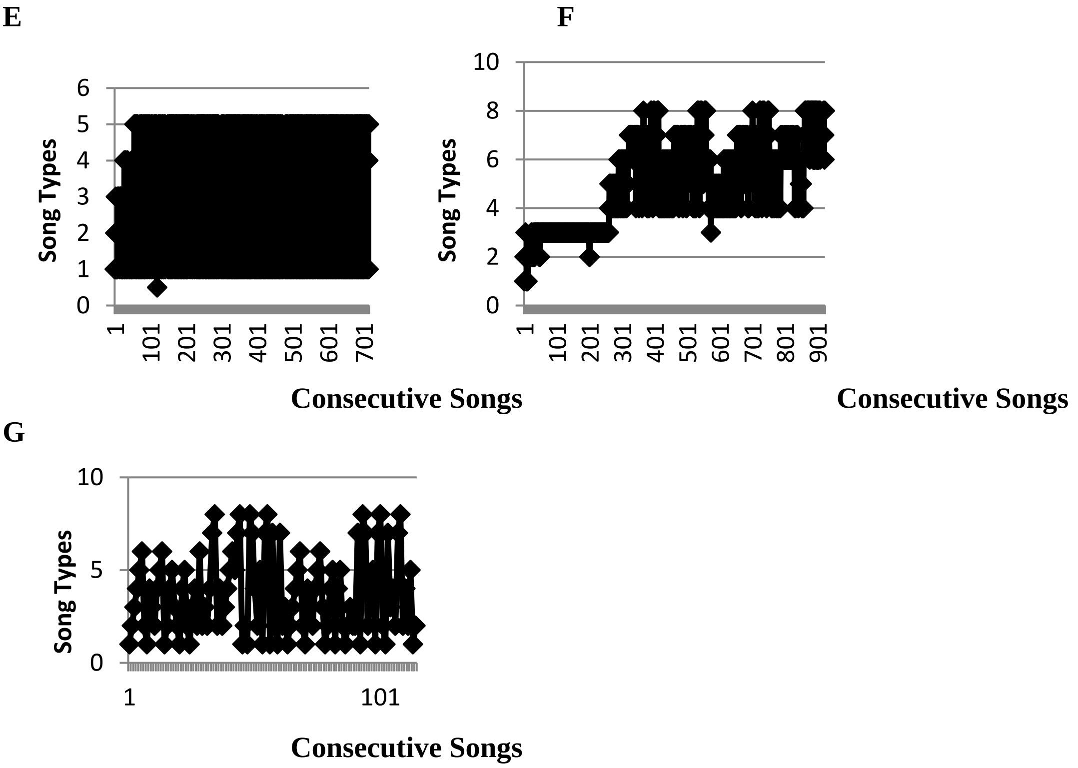


Figure 6. Shape of a "repertoire curve"

Discussion

This detailed study of Oriental Magpie Robin supports the first fundamental study of this bird in terms of song length, song repetition and non-vocal matching (Bhattacharya *et al.,* 2007). Some other birds such as great tits (Falls *et al.,* 1982; Mc Gregor *et al.*, 1992) and song sparrows (Kramer and Lemon, 1983; Kramer *et al.,*1985; Nielson and Vehrencamp, 1995) also have similar singing properties with small repertoire and repetitive performance. Where vocal matching is a common pattern in vocal interaction (Todt, 1971a, 1975, 1981; Falls *et al.,* 1982; Krebs *et al.,* 1978; Kramer and Lemon, 1983; Hultsch and Todt, 1986), too many species of song birds show this remarkable behavior of "vocal non-matching". A basic study of Shama thrushes, also a native of South East Asia (Bhattacharya *et al.,* 2008) showed a similar behavior of vocal non-matching.

The hypotheses for vocal matching ranges from very straight forward ones like addressing an opponent (Todt, 1975) or 'sending keep out signal' (Falls, 1985; Shackleton and Ratcliffe, 1994), to more controversial ones like 'distance estimation' (Falls *et al.,* 1982; Morton, 1982; Naguib 1997) or attracting the attention of the third party like females or other males (Todt, 1981). On the other hand, the "working hypotheses" presented (Bhattacharya *et al.,* 2007) for birds who do not engage in non-vocal matching suggested a non-philapatric behavior where birds leave their native areas and invade into other habitats.

Since bird song is a learned behaviour (reviews in Catchpole & Slater, 1995; Hultsch & Todt, 2004), it is a kind of vocal imitation, which begins with a memorization of auditory stimuli, usually con-specific song patterns, and continues with a development of vocalizations often matches the pattern of the perceived originals. Although the Magpie Robins do not share their repertoire, it would be interesting to expose nestlings of this bird to songs of an adult in order to explore whether the nestlings would then integrate the learned songs into their repertoire as an adult, and further to what extent the learned song would be modified to give it an individual touch. This bird is well known for its ability of vocal imitations of sounds of its surroundings. The above inquiry could also shed some light on whether such imitations then make the learned songs of our youngsters diverse when they turn adults.

Our studied birds were all non-neighbors far away from hearing distance of each other. The findings of the song structure of neighboring birds (Bhattacharya *et al.,* 2007) and ours on non-neighboring birds strongly calls for a study on the ecological aspects i.e. dispersal of youngsters before or/and after the sensitive phases where auditory learning occurs. Looking into the distance of dispersal of youngsters could also help in answering a number of opened questions in the song performance of the Oriental Magpie Robins.

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