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Contributed Paper

Persistence and Alteration of the Song Structure of the Oriental Magpie Robin (*Copsychus saularis*) in Some Areas of Northern Thailand

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ABSTRACT

In some areas of northern Thailand, the song heritage of the oriental magpie robin will either be maintained or change when transferred from adults to the next generation. The songs of birds in the breeding season of 2014 were compared to the songs of birds from the same study area in 2001. We found that the song frequency ranges, strophe structures, and song syntax patterns were not significantly different between the two years. This shows that the birds have maintained some form of the song structure over time for species recognition. In contrast, the mean strophe length, the number of elements per strophe, the mean length of the terminal part of the strophe, and the number of elements in the terminal part of the strophe were completely different between the two years. These results suggest that the influences of time and the song learning process have allowed theses birds to develop some form of their own song, resulting in song variation and unique song patterns.

Keywords: oriental magpie robin, song syntax, sonogram, species recognition

1. INTRODUCTION

Song is widely used in the communication of oscine passerine birds and is generally controlled by song repertoires in the brain [1, 2]. The size and composition of a song repertoire can allow the recognition of individuals. The song repertoire is of prime importance for vocal perception, song formation, and song development. Several previous studies have suggested that the size of a song repertoire can serve to distinguish between individuals, populations, and species [3]. These differences correlated with age, social factors, and the process of learning; for example the song element repertoire size can increase in male whitethroats (*Sylvia communis*) between their first and second year [4], the influence of various social conditions can allow adult canaries (*Serinus canaria*) to develop their songs differently than other individuals [5], and the degree of change in the song repertoire of the Asian Pallas's warbler complex (*Phylloscopus proregulus* s. l.) likely resulted from the process of learning and interactions with neighbours [6]. Males generally create unique song characteristics with variable elements and

patterns of song syntax for the successful establishment of territorial boundaries [7]. The size and complexity of song repertoires can influence mate choice [8], territorial defence decisions, and the survival rate of male birds [9].

Our previous study of the song dialect of oriental magpie robins conducted in Phayao province, Thailand in 2001 showed that this bird species has a large song repertoire with a complicated structure. We found that each male bird could sing more than two different songs and that some of the songs were different from those of other male birds. The strophe structure and song syntax pattern of this bird species were investigated thoroughly by Aniroot and Sitasuwan [10], but because of the influences of time and learning process for survival in the bird's territory in the same study area, it is necessary to know if the song structure of this bird remains the same or has changed from the original song version. Thus, this study was developed. The structure and syntax of the song of the magpie robin in 2014 were compared to the song structure of this species in 2001. The part of the song structure that is maintained is used in species recognition, and the part that changes creates a unique identity for the song. The degree of acoustic similarity and differences in song structure between the 2001 and 2014 breeding seasons (November to March) were characterized and compared by analysing song elements, strophes and syntax structure. Song playback experiments were used to determine the ability of the birds to recognize songs produced by members of the same species.

2. MATERIALS AND METHODS

2.1 Study Site

This study was carried out in the Chiang Kham district in the north-eastern part of Phayao province, northern Thailand. The Chiang Kham basin is 390 m a.s.l. Moving in a clockwise direction, the neighbouring district to the north is Thoeng district of Chiang Rai province (19°4′8″N 100°1′37″E), to the east is Xaignabouli province of Laos (19°25′N 101°75′E), to the south is the Pong district of Phayao province (19°8′54″N 100°16′30″E) and to the west is the Chun district of Phayao province (19°20′14″N 100°8′6″E). The Phi Pan Nam Range runs across the district from north to south. This central plain is incised by a series of rivers, including the Ing and Lao, which flow northwards through the plain and join the Mekong river in Chiang Rai province [11]. Chiang Kham has an average annual temperature of 25.9°C. Most of the study areas for this field study were rice fields and garden houses. Male birds in eleven study areas were investigated in both years (Figure 1).

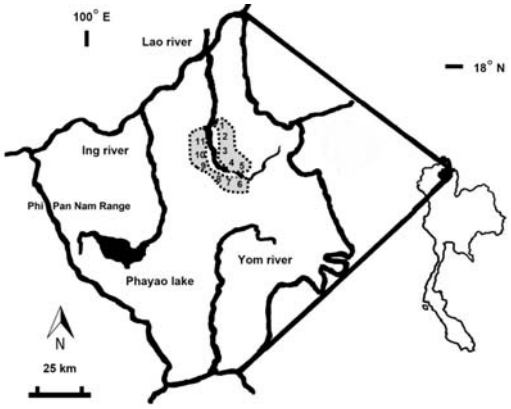

Figure 1. Map of the study area in Chiang Kham, Phayao province, northern Thailand. Oriental magpie robin songs were extensively studied in the eleven study areas outlined above.

2.2 Study Species

The oriental magpie robin (*Copsychus saularis* Linnaeus, 1758) is classified within the Passeriformes order and the Muscicapidae

family [12]. This species is distributed across most of India, China, southeast Asia, and the East Indies archipelago. Their territories are defended by monogamous pairs and range from 1 to 2 km^2. The average breeding age of this species is more than 2 years [13]. This bird is a resident that is born, breeds, and dies in cultivated areas that are often close to human habitations, parks, gardens and open woodlands. In addition, it remains in its initial habitat and displays aggressive behaviour towards intruders. Calls and songs are used as a form of communication in this bird species. Males sing their songs loudly from the top of trees or other high perches during the breeding season, which mainly between occurs November and March in Thailand [14]. Their territories are revealed by the location of their singing. Males often perch in exposed places. Singing occurs from dawn to dusk, and the location of each singing male was marked on a territorial song map (Figure 2).

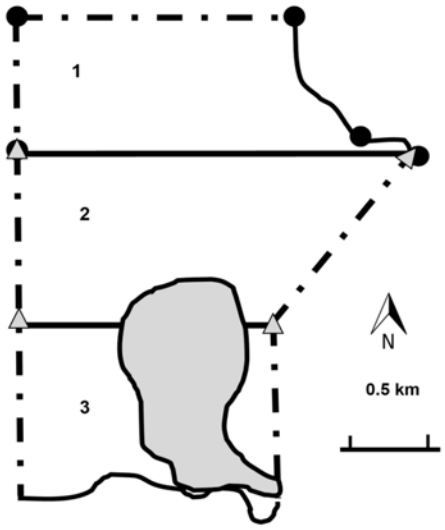

Figure 2. The location where each male sings was marked on a territorial song map. Territorial maps can show the probable territory of this species, i.e., a black circle for the first territory and a shaded triangle for the second territory.

2.3 Recording and Observing Song Behaviour

Recording was carried out during the breeding season, November to March, for 2 days on average per month in each study area. The song data were analysed using the SASLab Pro (v. 4.40; Avisoft Bioacoustic, Berlin) and SPSS programs (v 16.0). The sound recording equipment included a condenser microphone (RODE, model), which connected to a digital recorder (ZOOM Handy Recorder H4N). The sound was recorded digitally and saved on an SD memory card. The sound data were analysed using a computer program.

2.4 Bioacoustic Analysis

The acoustic characteristics measured included the mean length of the song (MLSo, sec), the average number of strophes per song (ANSSo), the maximum and minimum frequencies (MaxF and MinF, kHz), frequency range (FR, kHz), the mean length of strophes (MLSt, sec), the number of elements per strophe (NESt), the number of elements in the first second of each strophe (NEFSt), the mean length of the terminal part of each strophe (MLTPSt, sec), the number of elements in the terminal part of each strophe (NETPSt), the time interval between strophes (TISt, sec), the position of marking elements (PME), and the characteristics of specific elements at the terminal part of each strophe [15, 16] (Figure 3). The degree of acoustic differentiation among the characteristics of song structure was compared between the two years by using paired-samples t-tests.

2.5 Playback Protocol

We chose a common territorial song type that is generally used to communicate in each study area as the representative song in the playback trails. Male birds in each study

area heard three playback trials of eleven song types in both 2014 and 2001 at 5 min intervals, using the acoustics of the Eurasian tree sparrow (*Passer montanus*) as the control group. An acoustic loud-speaker was placed on top of a 1 metre high stand near the edge of each male's territory.

The loudspeaker was turned on while the subject was singing spontaneously in its territory, and we then observed his behaviour. The reaction of males to sound from the loud-speaker was classified according to [17]: 1 = the subject stands more than 15 m away from the loudspeaker, 2 = the subject stands 10 to 15 m away, 3 = the subject stands 5 to 10 m away and performs a counter song, 4 = the subject stands less than 5 m away and performs a counter song, and 5 = the subject shows extreme aggressive behavior, performs a counter song and then pecks the loud-speaker. The results of the song response data for each trial were analysed by one-way ANOVA (randomized complete block design (RCBD)).

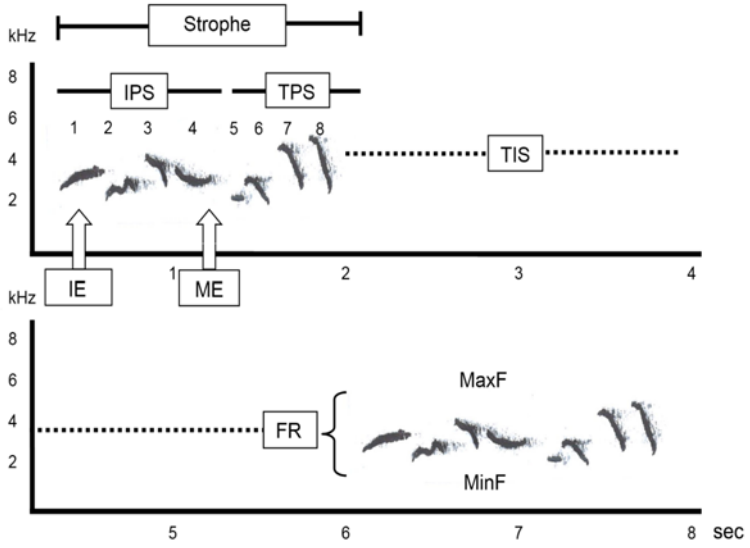

Figure 3. Spectrogram of a typical male oriental magpie robin song. Details of the strophe of the songs were used as the method of calculation of the acoustic variables noted in Table 1. IE = introductory element, ME = marking element, TIS = time interval of strophe, IPS = initial part of strophe, TPS = terminal part of strophe, FR = frequency range, MaxF = maximum frequency, MinF = minimum frequency.

3. RESULTS AND DISCUSSION

The song types ranged in frequency from 2 to 5.97 kHz and there was no significant difference between 2001 and 2014. Two or more strophes were repeatedly used to produce a single song that conformed to all the song types in 2001 and 2014. The mean song length of the different song types in 2001 and 2014 was 70.72 and 72.63 seconds and consisted of 10.18 and 10.54 strophes, respectively. The time intervals of the strophes in the songs of 2001 and 2014 were 3.72 and 4.00 seconds, respectively. A strophe is composed of two parts starting with the initial part and followed by a terminal part.

We found that the mean strophe length of the 2001 song type was 1.57 seconds and the strophes consisted of 5.81 elements on average. The mean length and number of strophes of the 2014 song type were 1.90

seconds and 6.84 elements, respectively. There were significant differences in the mean strophe length (correlation=0.517, p=0.021) and number of strophes (correlation=0.227, p=0.024) among the song types of 2001 and 2014 (Table 1). In the initial part of the strophe, the first second contains one or more core elements (Figure 3). The mean number of elements in the first second of the strophe of the song type of 2001 was 3.72, and for 2014, it was 3.63 elements. The first core element is called the introductory element, while the last part is the marking element. The positions of the marking elements were approximately 3.72 and 3.63 on the strophe, and there were no significant differences between the song types of the two years (Table 1). The terminal part has a group of specific elements that contain one or more elements. The mean length of the terminal part of the strophe (correlation=0.454, p=0.039) and the number of specific elements in the terminal part of the strophe (correlation=0.323, p=0.021) showed significant differences between the song types of 2001 and 2014 (Table 1 and Figure 4). The 2014 song type demonstrated a higher mean length and number of specific elements at the terminal part than that exhibited in 2001. The mean length of the terminal part for 2014 was 0.87 seconds and contained approximately 2.98 specific elements. The mean length and the number of specific elements for 2001 were 0.56 seconds and 1.92 elements, respectively (Table 1).

Table 1. Variation in the oriental magpie robin song characters recorded in Phayao province, northern Thailand during the 2001 and 2014 breeding seasons.

Variables	2001 (n = 11) Mean±SD	2014 (n = 11) Mean±SD	Correlation	*p-value*
1. MLSo	70.72±10.62	72.63±12.41	0.967	0.592
2. ANSSo	10.18±1.78	10.54±2.08	0.911	0.684
3. MaxF	5.97±0.07	6.00±0.05	0.800	0.167
4. MinF	2.05±0.05	2.08±0.07	0.812	0.830
5. FR	2.05-5.97	2.08-6.00	-	-
6. MLSt	1.57±0.36	1.90±0.44*	0.517	0.021
7. NESt	5.81±1.07	6.84±1.05*	0.227	0.024
8. NEFSt	3.72±0.64	3.63±0.67	0.897	0.341
9. MLPTSt	0.56±0.35	0.87±0.43*	0.454	0.039
10. NETPSt	1.92±1.09	2.98±1.09*	0.323	0.021
11. TISt	3.72±0.33	4.00±0.50	0.194	0.094
12. PME	3.72±0.64	3.63±0.67	0.897	0.341

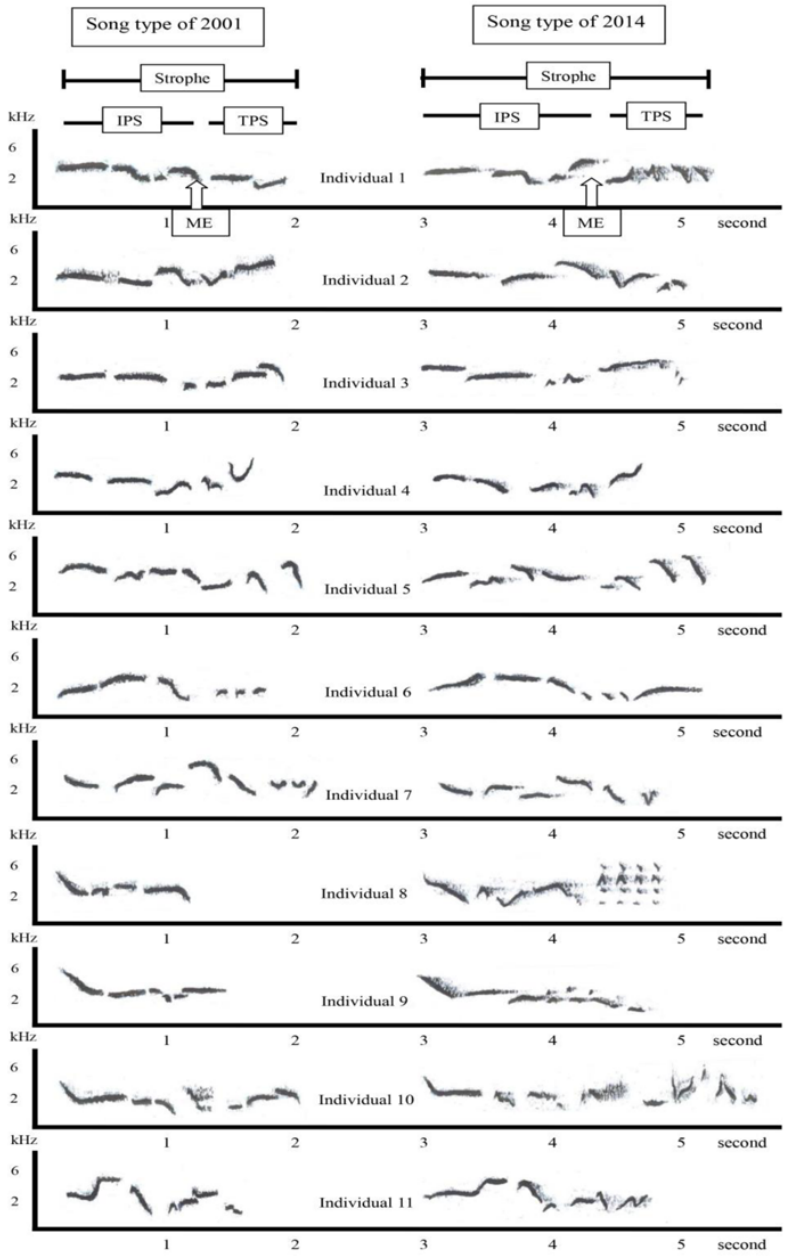

Figure 4. Comparison of the sonograms of the 11 song types from 2001 and 2014. IPS = initial part of strophe, TPS =terminal part of strophe, ME = marking element.

The result of the playback experiment showed that the reaction mean of the response of all males to the eleven different conspecific song types ranged from 3.59 to 3.95 in 2001, however, in 2014, the lowest and the highest reaction means to the eleven song types were 3.86 and 4.22, respectively. We found that the reaction means of the responses of male birds to the eleven song types in 2001 was generally lower than the reaction means to the song types of 2014. However, there was no significant difference

in the response of male birds to the songs of 2001 and 2014, but their responses to the acoustics of the Eurasian tree sparrow were significantly different (Figure 5). Each species has a certain part of its song that is shared among its members, and this contributes to species recognition. In general, territorial male birds respond strongly to familiar songs, followed by unfamiliar conspecific songs, and heterospecific songs [18, 19]. The beginning of the introductory core elements and marking elements are located in the first second of the strophe and are followed by a fine structure of specific elements that demonstrated the song syntax pattern of this species. The occurrence of a group of core elements at the initial part of the strophe may be of prime importance for the song structure of this bird species, as this structure is shared among the males. The consistent frequency range of the songs, the repeated strophes that produce a single song, the time interval of each strophe, the number of elements in the first second of each strophe, and the positions of marking elements are preserved in all instances. These patterns of song syntax may well relate to species recognition.

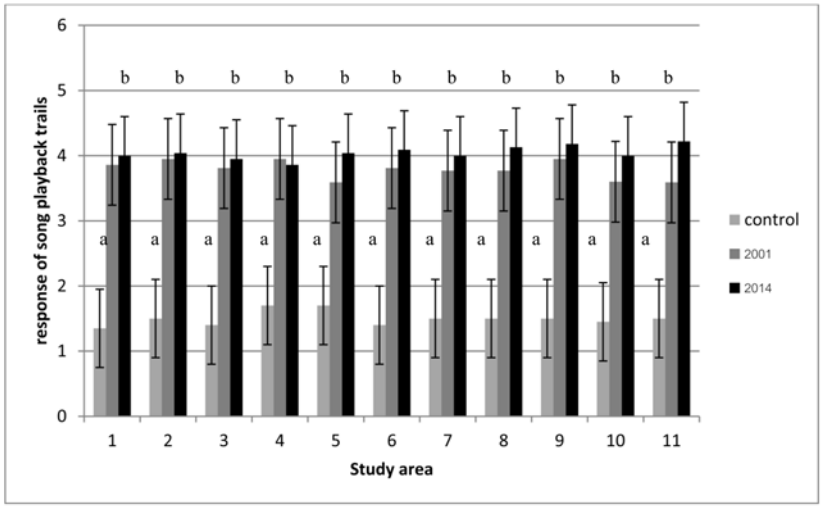

Figure 5. Response of male individuals to song playback trials in 2001 and 2014.

Members of the same species communicate and recognize their populations from any song that contains the same core elements, a consistent frequency and a particular rhythm or temporal pattern [20]. The recognition of these details of song structure in member of the same species could be used in mate choice as well as territory defence [21, 22, 23].

The mean length of the strophe, the number of elements per strophe, the mean length of the terminal part, and the number of elements in the terminal part were different between the two years, especially in terms of the quality and quantity of specific elements at the terminal part of the strophe. Specific elements that are used to create different patterns of song syntax produce a unique song. The unique features of the strophe enable birds to recognize their own species or other species and can be influenced by interspecies competition between different species that share the same habitat for territory delineation. These song syntax patterns have a direct function in territory establishment [24], male attraction, and territory defence [25].

Genetic (innate) knowledge combined with empirical knowledge (learning time) allow male birds to develop unique patterns of song structure [26]. Changes to these patterns occur after the song patterns have been recognized and learned among the males of the species, and their own unique song patterns could be transferred from adults to their progeny [27, 28, 29, 30].

4. CONCLUSION

The song frequency ranges and song syntax patterns were preserved, and may aid in the recognition of member of this species. Changes in song characteristics and increase in the fine details of specific elements in the terminal part of the strophe were caused by social interactions that influenced song development. As part of a future research plan, male birds in other areas in northern Thailand will be investigated. Song data will be record for 2 years for use in a high-grade song structure analysis that will help us to easily understand the mechanisms of the persistence and alteration of song syntax, including the function of song in a given species.

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