CHAPTER 4
RESULTS

The survey of study site

Northern Thailand (17°-20° N, 97°-101°E) is characterized by multiple mountain ranges, and drainage basins. The Northern plains called Lanna are isolated by parallel mountain ranges extending from the western border to the eastern border; Thanon Thong Chai Range, Khun Tan Range, Daen Lao Range, Phi Pan Nam Range, Luang Prabang Range, and Phetchabun Range including a series of the rivers, the Ping, Wang, Yom and Nan (Gardner *et al,* 2000). Northern Thailand has a tropical savanna climate relating to high altitude and latitude contributing to more seasonal temperature variation which decreases the temperature than the other regions. Eleven study sites in northern Thailand are composted of Chiang Mai (1), Chiang Rai (2), Lampang (3), Lamphun (4), Mae Hong Son (5), Nan (6), Phayao (7), Phetchabun (8), Phitsanulok (9), Phrae (10), and Tak (11) provinces (Figure 1). Fifteen male birds in each site had investigated. Their territories are revealed by the location of singing that marked on a territorial song map (Figure 2).

1. Mueang Chiang Mai city (18°47′25″N, 98°59′4″E) is located in the ping river basin. Surrounded by the high mountain ranges, it covers an area of approximately 152.4 km^2. Mueang Chiang Mai is situated on the Mae Ping river basin and is 300 metres above sea level. The mountainous terrain of the Daen Lao Range in the northern end of the province, the Thanon Thong Chai Range stretching in a north-south direction, and the Khun Tan Range in the east of the province. The temperature average yearly is at 26.36 °C. The most of study areas are the rice field and orchard.

2. Phan District (19°33′14″N, 99°44′26″E) is total area 1,023.0 km^2. The district is between the Daen Lao Range in the north and the Phi Pan Nam I Range in the west and the south that covered by rain forest. The Lao River runs along the plain of Phan district. The average elevation of the district is 416 metres. The most of plain area of Phan distrisct is composed of rice field and orchard. Phan district has the temperature

average yearly at 34.9 °C. The most of study areas are the rice field and garden house.

3. The district of Mueang Lampang (18°17′31″N, 99°30′16″E) is situated in the valley of the Wang River in the heart of Northern Thailand, bordered by the Khun Tan Range on the north and the west and the Phi Pan Nam II Range on the east. There is total area 1,156.6 km^2 and Lampang basin is 268.80 meters above sea level. Lampang has the temperature average yearly at 26.6°C. The most of study areas are the rice field and urban area.

4. Mueang Lamphun (18°34′41″N, 99°1′4″E) is the one of district of Lamphun province which has a total area 479.8 km^2 and Lamphun basin is 290.29 meters above sea level. Lamphun is located in the river valley of the Ping River. It is surrounded by mountain chains, with the Thanon Thong Chai Range in the west and the Khun Tan Range in the east of the province which covered with rain forest. Lamphun has the temperature average yearly at 26.85°C. The most of study areas are the rice field and garden house.

5. Mae Sariang (18°9′34″N, 97°56′1″E) is a small town and the one of district of Mae Hong Son province. Mae Sariang is located in the Yuam river basin which has total area about 2,587.4 km^2 and elevation is 600 meters. Most of the areas of Mae Sariang are surrounded with the Daen Lao Range which located on the northern most portion of the district marks the northern boundary between Thailand and Burma. The Thanon Thongchai Range in the east of the district serves as the boundary between the provinces of Mae Hong Son and Chiang Mai. The temperature average yearly is at 26.36°C. The most of study areas are the rice field and orchard.

6. Mueang Nan (18°47′37″N, 100°43′46″E) is the district of Nan province which located in the remote valley of the Nan River. Nan is surrounded by mountains which covered with rain forests, the Phlueng Range in the western part and the Luang Prabang Range in the east. Mueang Nan is total area 813.126 km^2 and Nan basin is 300 meters above sea level. The temperature average yearly is at 36.5 °C. The most of study areas are the rice field and orchard.

7. Chiang kham (19°31′24″N, 100°18′6″E) is located in the northeast of Phayao province that has total area 784.061 km^2 and Chiang kham basin is 390 meters above sea level. The Phi Pan Nam II Range runs across the district from north to south and the Luang Prabang is in the east. Chiang kham has a temperature average yearly at 25.9°C .The most of study areas are the rice field and garden house.

8. Phetchabun (16°26′35″N, 101°8′57″E) is located in the lower northern region of Thailand, in the area between the northern and the central region. The Pa Sak River runs through the eastern side of Phetchabun and the Phetchabun mountain range to the east and west. Mueang Phetchabun is total area 2,281.0 km^2 and Petchabun basin is 114 meters above sea level. Phetchabun has the temperature average yearly at 37.2 °C. The study site of Mueang Petchabun has focused on the rice field and orchard.

9. Mueang Phitsanulok (16°49′29″N, 100°15′34″E) lies within the boundary between the Nan Basin and the Yom Basin. The Nan River and the Khwae Noi River are the important water resource for agriculture. Muenag Phitsanulok district is total area 750.810 km^2 and Pitsanulok basin is 44 meters above sea level. Phitsanulok has a temperature average yearly at 37.4 °C. The most of study areas are the rice field and orchard.

10. The district of Mueang Phare (18°8′44″N, 100°8′29″E) is located in the valley of the river Yom of Phare province. Mueang Phare is total area 756.1 km^2 and elevation of 159 metres. There are hills both to the east and west of the town, the Phlueng Range in the east and the Phi Pan Nam II Range runs across the province from North to south in the west. Phrae Province has a temperature average yearly at 37.3 °C. The most of study areas are the rice field and garden house.

11. The district of Mueang Tak (16°52′54″N, 99°7′25″E) is a total area 1,599.356 km^2 and is located in the Ping River basin which has elevation 116.2 meters. Thanonthongchai, Luang and Phamuan mountains are main mountains. Tak has a temperature average yearly at 27.69°C. The most of study areas are the rice field and orchard.

Song syntax and descriptive statistic of song variables

One hundred and sixty five song types were compared and characterized for the degree of acoustic similarity and differences of song structure by Avisoft SASLab Pro (v. 4.40; Avisoft Bioacoustic, Berlin) and descriptive of SPSS. Sonagrams showed that all song types ranged in frequency from 1.99 (±0.01 SE) to 5.74 (±0.03) kHz. The mean song length was 79.88 (±3.24) seconds that consisted of 11.95 (±0.43) strophes. Two or more strophes were repeatedly used to synthesize a single song. The result showed that the minimum of repeatedly of strophes in the song was 5.00 (±0.43) strophes that used a mean length 17.00 (±3.24) seconds and the maximum of strophe repeatedly was 30.00 (±0.43) strophes that used a mean length 190.00 (±3.24) seconds.

A strophe is composed of two parts, initial and terminal parts. The initial part of a strophe is a group of core elements that is used to share among the males of this species (Figure 6). The initial part of the strophe, the first second, contains one or more core elements (Figure 6) that consists of 3.98 (±0.05) elements. The terminal part of the strophe is a the fine structure of specific elements (Table 1.) that differs in each bird population and has a mean length 0.26 (±0.001) seconds and contained 3.80 (±0.15) specific elements. The initial part of a strophe always starts with the core element, the introductory element, that appears within the first element of each strophe. Introductory core elements are classified to 3 types: horizontal, harmony, and descending element. The strophe structure can be showed in several types of syntax. One strophe syntax is the orientation of the first introductory core element in all songs with a mean of degree of 166.88 (±1.46) and the width of the first introductory core element which was 0.97 (±0.05) kHz. The results showed that the overlapping between the first element and the second, the harmony element, had a mean length of overlapping of 0.04 (±0.001) seconds that had a gap distance between of the first and second element of 0.42 (±0.04) kHz. (Figures 4 and 5). The last element of the core element, marking element, is located 3.98 (±0.05) element and was followed by a the fine structure group of specific elements.

Strophes can be classified to two types. A basic strophe is the initial part and the climax strophe contains initial and terminal parts (Figure 7). The song syntax is

synthesized from strophes to form complete song. Songs are always introduced with a basic strophe that has repeatedly 2.15(±0.07) strophes and a mean length of 8.83 (±0.37) seconds, followed by the climax strophe with 8.32(±0.34) strophes and a mean length of 64.56(±2.87) seconds, it is terminated with a basic strophe that is repeated many times 1.69(±0.04) and a mean length of 7.16(±0.27) seconds. The time interval of strophes was 4.85(±0.07) seconds. The strophe generally consisted of 7.72(±0.17) elements and a mean length of 1.93(±0.03) seconds (Table 1).

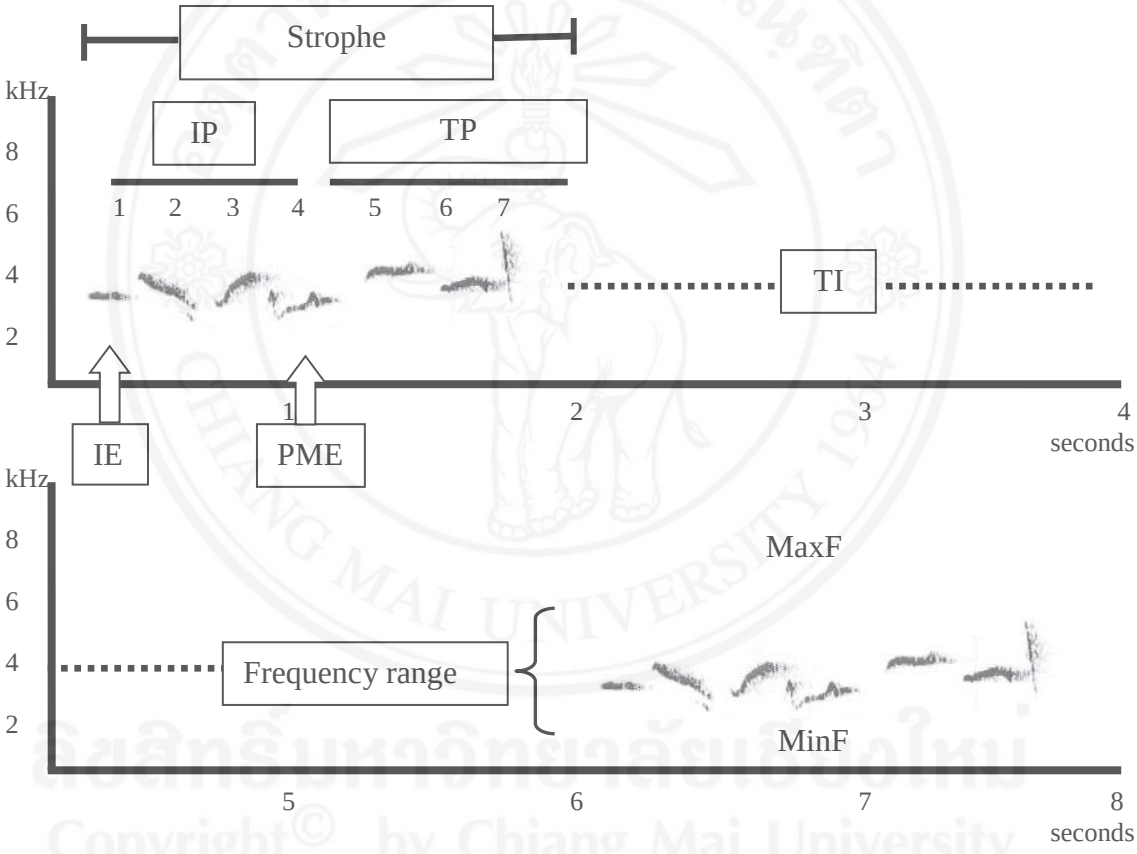

Figure 7. Sonagram of a typical male oriental magpie robin song. Details of the strophe of the songs were used to calculate acoustic variables. IP = initial part of strophe, TP = terminal part of strophe, TI = time interval of strophe, IE = introductory element, PME = position of marking element.

Table 1. Variables measured of the fine structural features of 11 populations of oriental magpie robin song in northern Thailand.

21 song variables (15 male birds in 11 populations)	(n = 165) Mean	SE	SD
Mean length of strophe (MLSt, seconds)	1.93	0.03	0.49
Number of elements per strophe (NESt)	7.72	0.17	2.27
Number of elements in the first strophe second (EFSt)	3.98	0.05	0.71
Number of elements in the terminal part of each strophe (NETP)	3.80	0.15	2.01
Time interval between strophes (TI, seconds)	4.85	0.07	0.99
Position of marking element (PME)	3.98	0.05	0.69
Maximum frequencies (MaxF, kHz)	5.74	0.03	0.39
Minimum frequencies (MinF, kHz)	1.99	0.01	0.02
Number of strophes per song (NSSo)	11.95	0.43	5.56
Mean length of song (MLSo, seconds)	79.88	3.24	41.61
Number of basic strophes in song introduction (NBSIn)	2.15	0.07	0.98
Number of basic strophes in terminating song (NBSTe)	1.69	0.04	0.62
Mean length of basic strophes in song introduction (TBSIn)	8.83	0.37	4.78
Mean length of basic strophes in terminating song (TBSTe, seconds)	7.16	0.27	3.49
Number of climax strophes of song (NCS)	8.32	0.34	4.49
Mean length of climax strophe of each song (TCS, seconds)	64.56	2.87	36.97
Mean length of the terminal part of strophe (MLTP, seconds)	0.26	0.00	0.05
Degree of orientation of the first core element (DOFE)	166.88	1.46	18.87
Overlapping of the first and second core elements (OFSE, seconds)	0.04	0.00	0.02
Gap distance between of the first and second core elements (GFSE, kHz)	0.42	0.04	0.33
Width of first core element (WFE, kHz)	0.97	0.05	0.60

Factor analysis of song variables

The correlation of 21 variables are examined by Factor analysis. Computationally this technique can be described the correlation among variables by the correlation matrix. The results showed that the correlation matrix was indicated the correlation among the 21 variables between 0 to 1. From the Table 2, the correlation matrix between 2 variables were the strongest negative and positive relationships when the correlations were more than 0.60. The value of correlation matrix between variable 1:2, variable 1:4, variable 2:4, variable 3:6, variable 9:10, variable 9:11, variable 9:12, variable 9:13, variable 9:15, variable 9:16, variable 10:11, variable 10:13, variable 10:15, variable 10:16, variable 11:13, variable 11:15, variable 11:16, variable 12:14, variable 15:16, variable 18:21, variable 19:20 were 0.85, 0.87, 0.93, 0.97, 0.86, 0.74, 0.63, 0.61, 0.94, 0.83, 0.67, 0.67, 0.83, 0.98, 0.86, 0.62, 0.61, 0.76, 0.82, -0.96, and 0.91, respectively.

Kaiser-Meyer-Olkin (KMO) KMO and Barlett's Test was 0.637 and then Bartlett's Test of Sphericity, Chi-Square test was 4.543E3 that has a the degree of freedom 210. The value of the Chi-Square test was 0.00 (sig <0.01) which indicates the strongest relationship of song variables, The result of confirm hypothesis H1 and rejects H0. This song data was used for the PCA test.

Table 2. Correlation matrix of 21 variables showing the degree of correlation between variable.

	Variable (V)																				
V	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**
1	1	0.85	0.20	0.87	-0.15	0.23	0.49	-0.12	0.19	0.26	0.02	0.08	0.21	0.14	0.22	0.26	-0.01	-0.09	0.23	**0.25**	**0.06**
2	0.85	1	0.44	0.93	-0.09	0.42	0.39	-0.01	0.10	0.20	0.01	-0.02	0.14	-0.01	0.13	0.22	0.01	-0.10	0.17	**0.20**	**0.07**
3	0.20	0.44	1	0.14	0.01	0.97	0.11	-0.01	0.03	0.10	0.01	-0.06	0.01	-0.16	0.10	0.13	0.06	-0.10	-0.07	**-0.08**	**0.09**
4	0.87	0.93	0.14	1	-0.08	0.13	0.39	-0.01	0.10	0.21	0.01	-0.01	0.17	0.04	0.10	0.22	0.01	-0.07	0.22	**0.26**	**0.04**
5	-0.15	-0.09	0.01	-0.08	1	0.01	-0.15	-0.01	-0.04	0.22	0.03	0.03	0.13	0.22	-0.04	0.20	0.05	0.05	-0.10	**-0.09**	**-0.05**
6	0.23	0.42	0.97	0.13	0.01	1	0.15	-0.01	0.01	0.07	-0.02	-0.09	0.00	-0.17	0.09	0.11	0.03	-0.11	-0.03	**-0.04**	**0.10**
7	0.49	0.39	0.11	0.39	-0.15	0.15	1	0.12	0.09	0.18	0.03	0.14	0.02	0.06	0.09	0.20	0.05	-0.14	0.12	**0.11**	**0.15**
8	-0.12	-0.01	-0.01	-0.01	-0.01	-0.02	0.12	1	-0.14	-0.14	-0.09	-0.05	-0.21	-0.15	-0.14	-0.12	-0.06	0.05	-0.01	**-0.03**	**-0.05**
9	0.19	0.10	0.03	0.010	-0.04	0.01	0.09	-0.14	1	0.86	0.74	0.63	0.61	0.45	0.94	0.83	0.02	-0.09	-0.08	**-0.05**	**0.03**
10	0.26	0.20	0.10	0.21	0.22	0.07	0.18	-0.14	0.86	1	0.67	0.50	0.67	0.46	0.83	0.98	0.01	-0.13	-0.10	**-0.07**	**0.06**
11	0.02	0.01	0.01	0.01	0.03	-0.02	0.03	-0.09	0.74	0.67	1	0.54	0.86	0.37	0.62	0.61	0.14	-0.06	-0.17	**-0.16**	**0.02**
12	0.08	-0.02	-0.06	-0.01	0.03	-0.09	0.14	-0.05	0.63	0.50	0.54	1	0.42	0.76	0.49	0.44	0.07	0.08	0.07	**0.05**	**-0.12**
13	0.21	0.14	0.01	0.17	0.13	0.00	0.02	-0.21	0.61	0.67	0.86	0.42	1	0.51	0.50	0.56	0.10	-0.02	-0.06	**-0.03**	**-0.01**
14	0.14	-0.01	-0.16	0.04	0.22	-0.17	0.06	-0.15	0.45	0.46	0.37	0.75	0.51	1	0.35	0.35	-0.01	0.12	0.11	**0.11**	**-0.17**
15	0.22	0.13	0.10	0.10	-0.04	0.09	0.09	-0.14	0.94	0.83	0.61	0.49	0.50	0.35	1	0.82	-0.01	-0.11	-0.09	**-0.06**	**0.05**
16	0.26	0.22	0.13	0.22	0.20	0.11	0.20	-0.12	0.84	0.98	0.61	0.44	0.56	0.35	0.82	1	0.01	-0.15	-0.10	**-0.07**	**0.08**
17	-0.01	0.01	0.06	0.01	0.05	0.03	0.05	-0.06	0.02	0.01	0.14	0.07	0.10	-0.01	-0.01	0.01	1	-0.03	0.04	**-0.11**	**0.06**
18	-0.09	-0.10	-0.10	-0.07	0.05	-0.11	-0.14	0.05	-0.09	-0.13	-0.06	0.08	-0.02	0.12	-0.11	-0.15	-0.03	1	0.45	**0.47**	**-0.96**
19	0.23	0.17	-0.07	0.22	-0.10	-0.03	0.12	-0.01	-0.08	-0.10	-0.17	0.07	-0.06	0.11	-0.09	-0.10	0.04	0.45	1	**0.91**	**-0.43**
20	0.25	0.20	-0.08	0.26	-0.09	-0.04	0.11	-0.03	-0.05	-0.07	-0.16	0.05	-0.03	0.11	-0.06	-0.07	-0.11	0.47	0.91	**1**	**-0.46**
21	0.06	0.07	0.09	0.04	-0.05	0.01	0.15	-0.05	0.03	0.06	0.02	-0.12	-0.01	-0.17	0.05	0.08	0.06	-0.96	-0.43	**-0.46**	**1**

KMO and Barlett's Test

Kaiser-Meyer-Olkin measure of sampling adequacy = 0.637

Bartlett's Test of Sphericity , Approx. Chi-Square = 4.543E3, df. =210, Sig. = 0.00

Principle component analysis (PCA) of song variables

Each principle component was extracted by an eigenvalue that shows the proportion of variance to each principle component. From the principle component analysis results (Table 3), twenty-one variables are classified into 7 distinct groups (components, PCs).

The first component was song structure that has 8 variables compose of (9) number of strophes per song (NSSo), (10) mean length of song (MLSo, seconds), (11) number of basic strophes in the song introduction (NBSIn), (12) number of basic strophes terminating the song (NBSTe), (13) mean length of the basic strophe in song introduction (TBSIn), (14) mean length of the basic strophe terminating the song (TBSTe), (15) number of climax strophes per song (NCS), (16) mean length of the climax strophe of each song (TCS).

The second component was strophe structure and maximum of frequency that has 4 variables compose of (1) mean length of each strophe (MLSt), (2) number of elements per strophe (NESt), (4) number of elements in the terminal part of each strophe (NETP), (7) maximum frequencies (MaxF, kHz).

The third component was fine structure of introductory element that has 4 variables composed of (18) the degree of orientation of the first core elements (DOFE), (19) overlapping time of the first and second core element (OFSE), (20) the gap distance between of the first and second core elements (GFSE), (21) the width of the first core element (WFE).

The fourth component was number and position of element that has 2 variables compose of (3) number of elements in the first strophe second (EFSt) and (6) position of marking elements (PME) and the fifth, sixth, and seventh has one component : (5) time interval between strophes (TI), (8) minimum frequencies (MinF), and (17) mean length of the element in the terminal part of each strophe (MLTP), respectively.

The basic loading factor found after varimax rotation (eigenvalue > 1.0) that can be shown in the scree plot (Figure 7). The rotated eigenvalues of the seven PCs were 5.73, 3.44, 3.04, 1.70, 1.17, 1.08, and 1.06, respectively. These PCs explained 82.17% of total variance, accounting for 26.05%, 15.56%, 14.00%, 10.13%, 5.84%, 5.29%, and 5.28%, respectively (Table 3). The component plot in rotated space showed the correlation of 21 song variables. Three-dimentional graph can be shown obviously the distribution of 21 variables that organized into 7 components (Figure 8).

Table 3. Principle component analysis of 21 song variables of the oriental magpie robin produced seven factors summarizing the fine structural features of songs, represented here as correlation coefficients. Variables with the strongest relationships (correlations > 0.60) are in bold and underline.

Variable	F1	F2	F3	F4	F5	F6	F7
MLSt (seconds)	0.15	**0.92**	0.05	0.08	-0.07	-0.06	-0.00
NESt	0.05	**0.90**	0.02	0.32	0.01	-0.01	-0.03
EFSt	0.02	0.15	-0.05	**0.96**	0.02	0.01	0.05
NETP	0.06	**0.94**	0.04	0.02	0.03	-0.02	-0.04
TI (seconds)	0.07	-0.06	-0.01	0.01	**0.91**	-0.01	0.01
PME	0.00	0.16	-0.04	**0.95**	-0.01	0.02	0.03
MaxF (kHz)	0.11	**0.61**	-0.06	0.01	-0.20	0.46	0.18
MinF (kHz)	-0.14	-0.05	0.01	0.02	0.03	**0.87**	-0.11
NSSo	**0.95**	0.03	-0.04	0.02	-0.16	-0.02	-0.08
MLSo (seconds)	**0.91**	0.18	-0.09	0.06	0.14	-0.03	-0.11
NBSIn	**0.82**	-0.09	-0.09	-0.00	0.00	-0.05	0.17
NBSTe	**0.71**	-0.02	0.18	-0.16	0.00	0.21	0.28
TBSIn	**0.75**	0.10	-0.01	-0.03	0.17	-0.21	0.18
TBSTe	**0.60**	0.06	0.23	-0.29	0.28	0.05	0.23
NCS	**0.88**	0.05	-0.07	0.11	-0.17	-0.04	-0.17
TCS	**0.86**	0.19	-0.11	0.11	0.10	-0.01	-0.16
MLTP	0.02	-0.01	-0.06	0.08	0.01	-0.07	**0.86**
DOFE	-0.03	-0.18	**0.88**	0.00	0.15	0.05	-0.04
OFSE (seconds)	-0.09	0.28	**0.78**	-0.08	-0.21	-0.05	0.12
GFSE (kHz)	-0.06	0.31	**0.79**	-0.10	-0.18	-0.07	-0.03
WFE (kHz)	-0.02	0.16	**0.87**	-0.01	-0.16	-0.05	0.08
Eigenvalue	5.73	3.44	3.04	1.70	1.17	1.08	1.06
% of variance explained	26.05	15.56	14.00	10.13	5.84	5.29	5.28

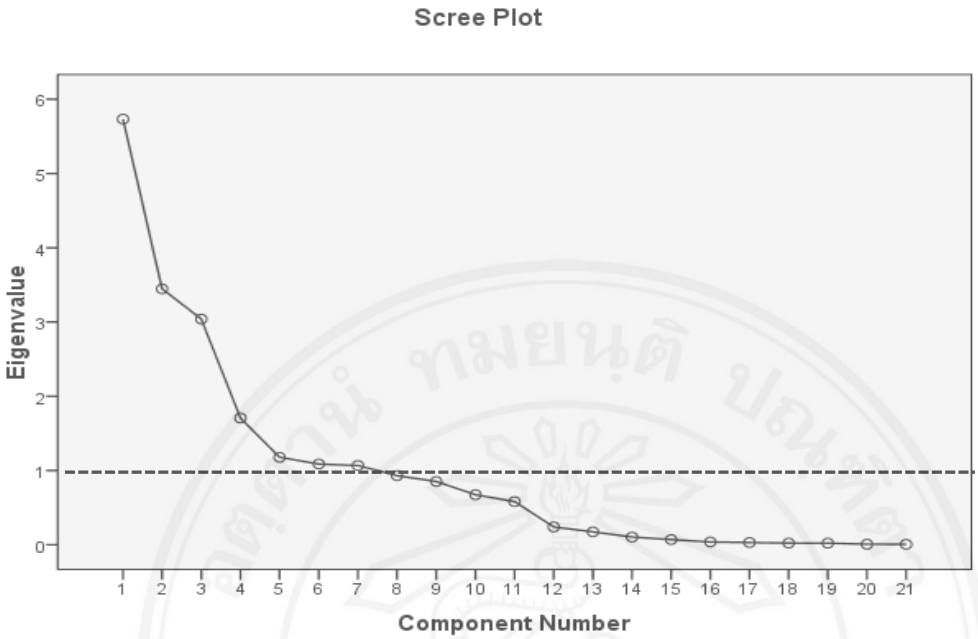

Figure 8. Scree plot showing the loading factor found after varimax rotation when eigenvalue is > 1.0.

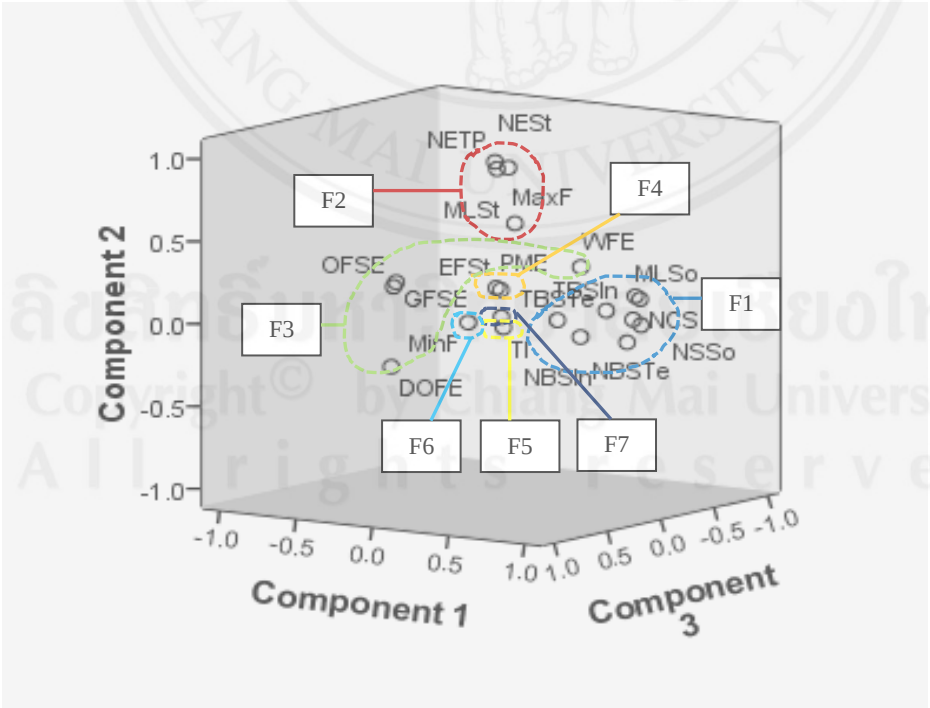

Figure 9. Component plot in rotated space showing the correlation of 21 song variables.

Frequency distribution of song types

The similarity of qualitative and quantitative song structures are organized into the same group of song type. A total of 165 song types of 11 populations indicated a regular distributuion of song types. Songs can be classified in three types which is based on the introductory element. Song type A starts with introductory horizontal element, type B with an introductory harmony element, and type C with an introductory descending element. The most common song type of all populations was type A, followed by B, and C with frequency numbers of 91, 50, and 24, respectively (Table 4). The histogram of the frequency number of song types indicated a mean of song type (A) was 8.27 with a standard deviation of 1.19, song type (B) 4.55 and 0.93, and song type (C) 2.18 and 0.98 (Figure 9, 10, and 11).

Table 4. Frequency distribution of song types.

Number of male birds in each population (n=15)	Frequency number of song types		
	A	B	C
Site 1 of Chiang Mai	8	6	1
Site 2 of Chiang Rai	7	5	3
Site 3 of Lampang	8	4	3
Site 4 of Lamphun	8	5	2
Site 5 of Mae Hong Son	8	5	2
Site 6 of Nan	10	3	2
Site 7 of Phayao	6	5	4
Site 8 of Phetchabun	8	5	2
Site 9 of Phitsanulok	10	4	1
Site 10 of Phrae	9	5	1
Site 11 of Tak	9	3	3
Total of song types (165)	91	50	24

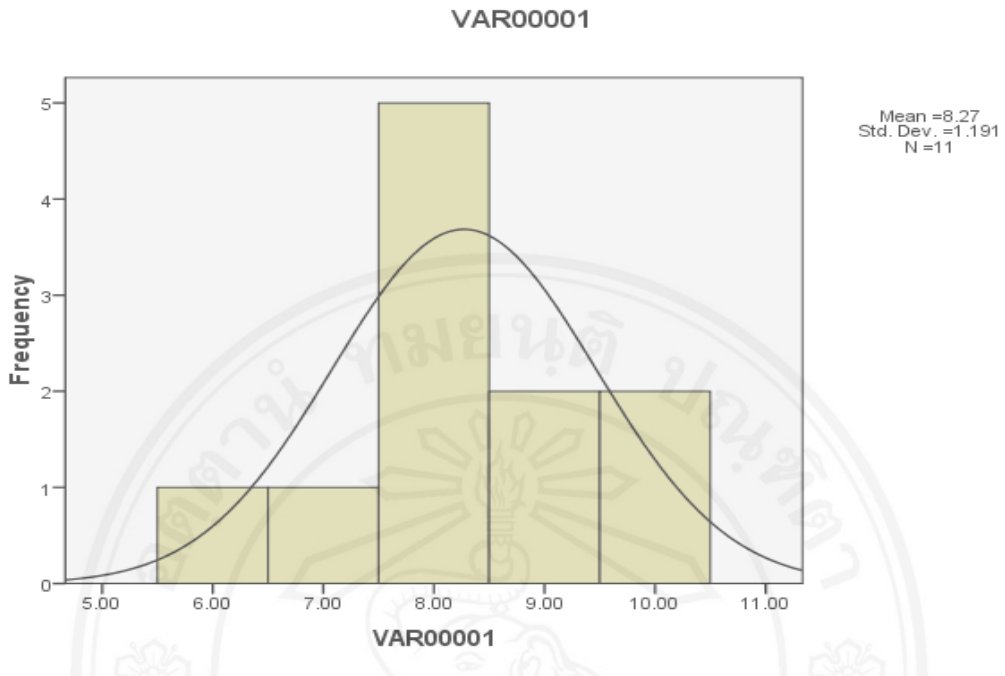

Figure 10. Histogram showed the frequency distribution of song type A.

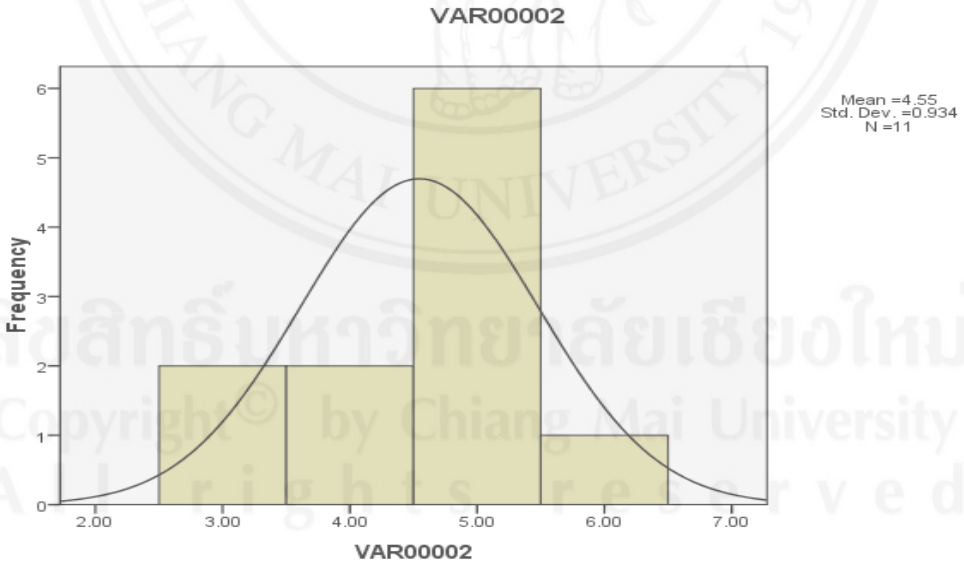

Figure 11. Histogram showed the frequency distribution of song type B.

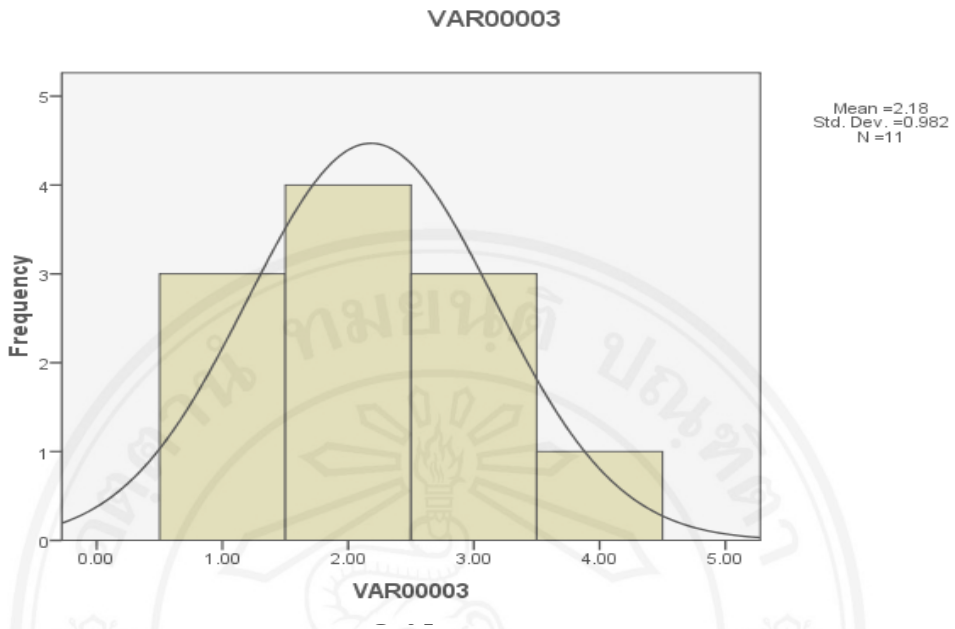

Figure 12. Histogram showed the frequency distribution of song type C.

Hierarchical cluster analyses

I selected song variables which were related to qualitative and quantitative fine structures of the strophe. Thirteen song variables are composted of (1) mean length of each strophe (MLSt, seconds); (2) number of elements per strophe (NESt); (3) number of elements in the first strophe second (EFSt); (4) number of elements in the terminal part of each strophe (NETP); (5) time interval between strophes (TI, seconds); (6) position of marking elements (PME); (7) maximum frequencies (MaxF, kHz); (8) minimum frequencies (MinF, kHz); (17) mean length of the element in the terminal part of each strophe (MLTP); (18) the degree of orientation of the first core elements (DOFE); (19) overlapping time of the first and second core element (OFSE, seconds); (20) the gap distance between of the first and second core elements (GFSE, kHz); (21) the width of the first core element (WFE, kHz) which are shown in cluster analysis dendrogram (Figure 12).

The rescaled distance cluster combine with 13 song variables at 15 and 20 are considered for grouping the song dialects of oriental magpie robin. The out group was of the acoustics of the Eurasian sparrow (*Passer montanus*), which was as a control group. Two clusters of song dialects are classified by 20 of rescaled distance cluster combine with 13 song variables. The large cluster is composed of two subsets of song dialect of song type A and B , The small cluster was song type C. However, three clusters of song dialects are separated obviously by 15 of rescaled distance cluster combine with 13 song variables. Three clusters of song dialect are consisted of song type A, B, and C. Each cluster of song type A started with an introductory horizontal element in the first second of the strophe ( ) . Song type B started with an introductory harmony element in the first strophe second ( ). Song type C started with an introductory descending element in the first strophe second ( ). The dendrogram shows that each cluster of songs has the persistence of the song pattern all of 11 populations. Each dialect song type can be described in the degree of similarity and difference of song structure by the number of element in the strophe, the number of the fine structure in the terminal part of the strophe, the arrangement of the specific element, and the character of specific element in the terminal part of the strophe.

Three subgroups of song type A are separated by 8 of rescaled distance cluster combine with 13 song variables. The first subgroup is composed of songs from Phetchabun (8), Tak (11), Lampang (3), Phrae (10), and Phayao (7). The second subgroup was Chiang Mai (1), Lamphun (4), Chiang Rai (2), Phitsanulok (9), and Mae Hong Son (5). The last subgroup that isolated from the other was song type of Nan (6) (Figure 13).

The character of the overlapping pattern of the first and second introductory element of song type B can be shown the degree of song similarity as song type A but the dendrogram of song type B, also has four subgroups at 8 of rescaled distance cluster combine with 13 song variables. The first subgroup was of songs from Chiang Rai (2), Tak (11), Nan (6), and Phrae (10). The second subgroup were from Lamphun (4), Phitsanulok (9). The third subgroup is made of Phetchabun (8), Phayao (7), Lampang (3), and Chiang mai (1). The last of subgroup was from Mae Hong Son (5) (Figure 14).

For song type C there were 3 from 8 of rescaled distance cluster combine with 13 song variables. (Figure 14). The first subgroup of song is consisted of Chiang Rai (2), Lamphun (4), Nan (6), Lampang (3), Mae Hong Son (5), Phrae (10), and Chiang mai (1). The second subgroups were song of Phayao (7), Phitsanulok (9), and Tak (11), and song of Phetchabun (8) was the last of subgroups (Figure 15).

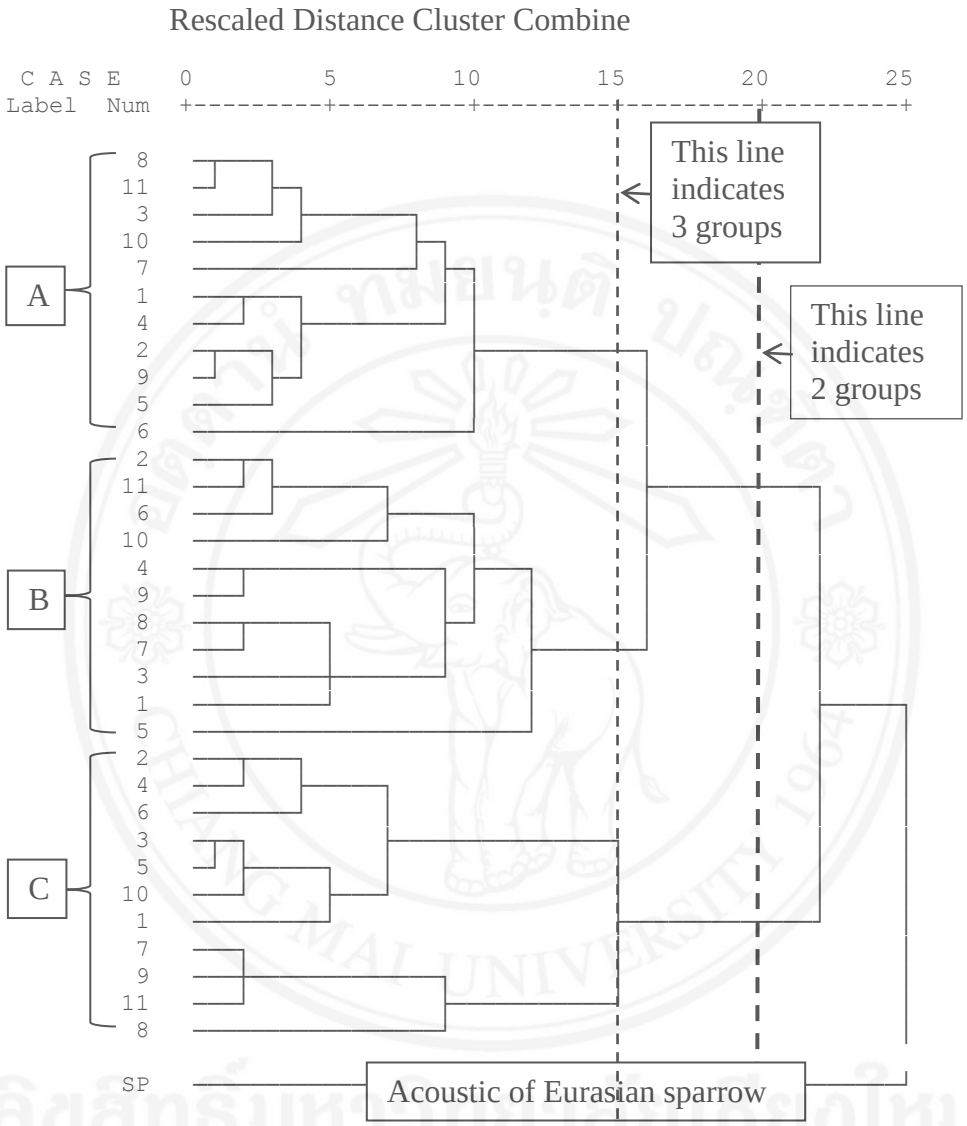

Figure 13 . Dendrogram showing three distinct groups of song dialect of the oriental magpie robin. (1) Chiang Mai, (2) Chiang Rai, (3) Lampang, (4) Lamphun, (5) Mae Hong Son, (6) Nan, (7) Phayao, (8) Phetchabun, (9) Phitsanulok, (10) Phrae, and (11) Tak.

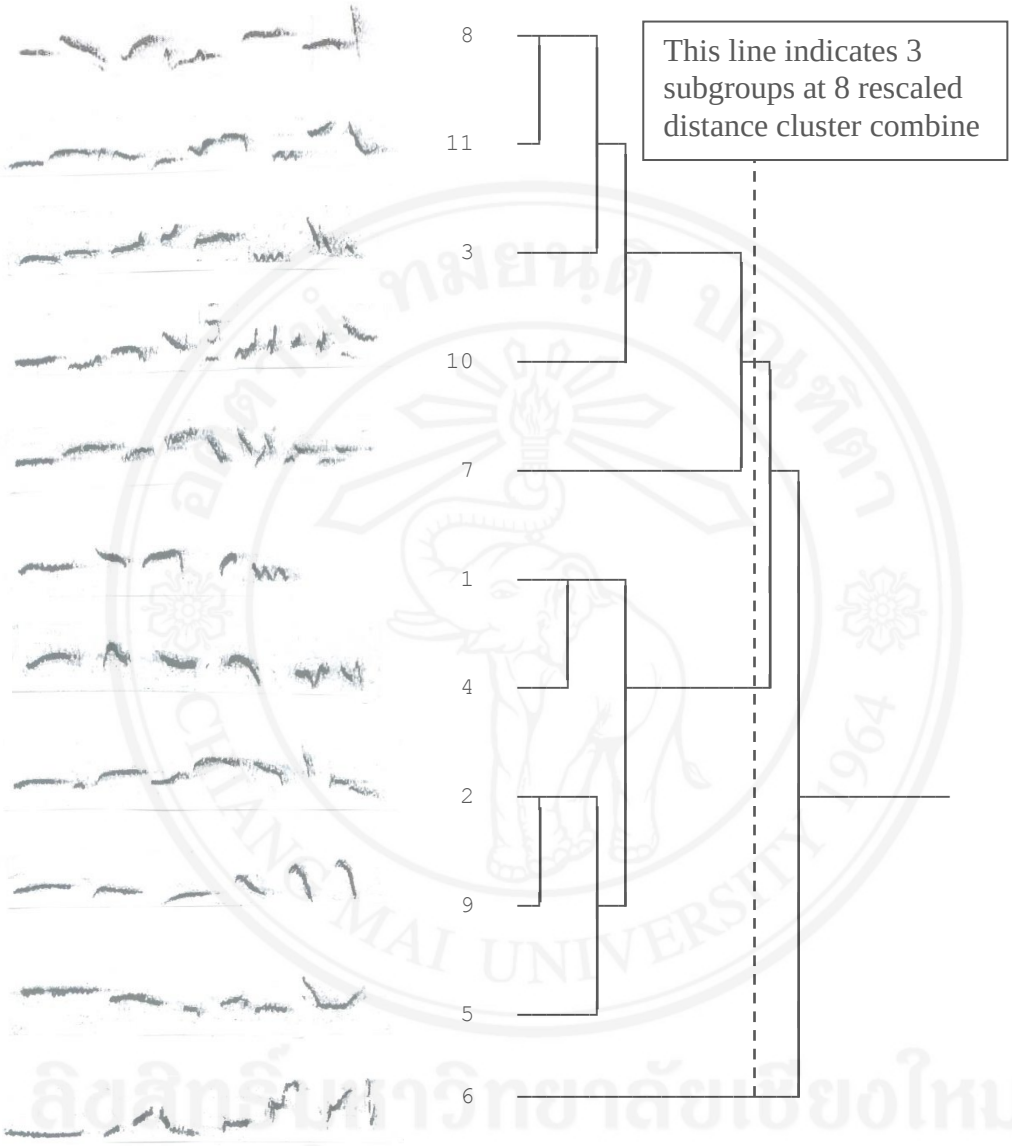

Figure 14. Dendrogram showing song variation of song type A. (1) Chiang Mai, (2) Chiang Rai, (3) Lampang, (4) Lamphun, (5) Mae Hong Son, (6) Nan, (7) Phayao, (8) Phetchabun, (9) Phitsanulok, (10) Phrae, and (11) Tak.

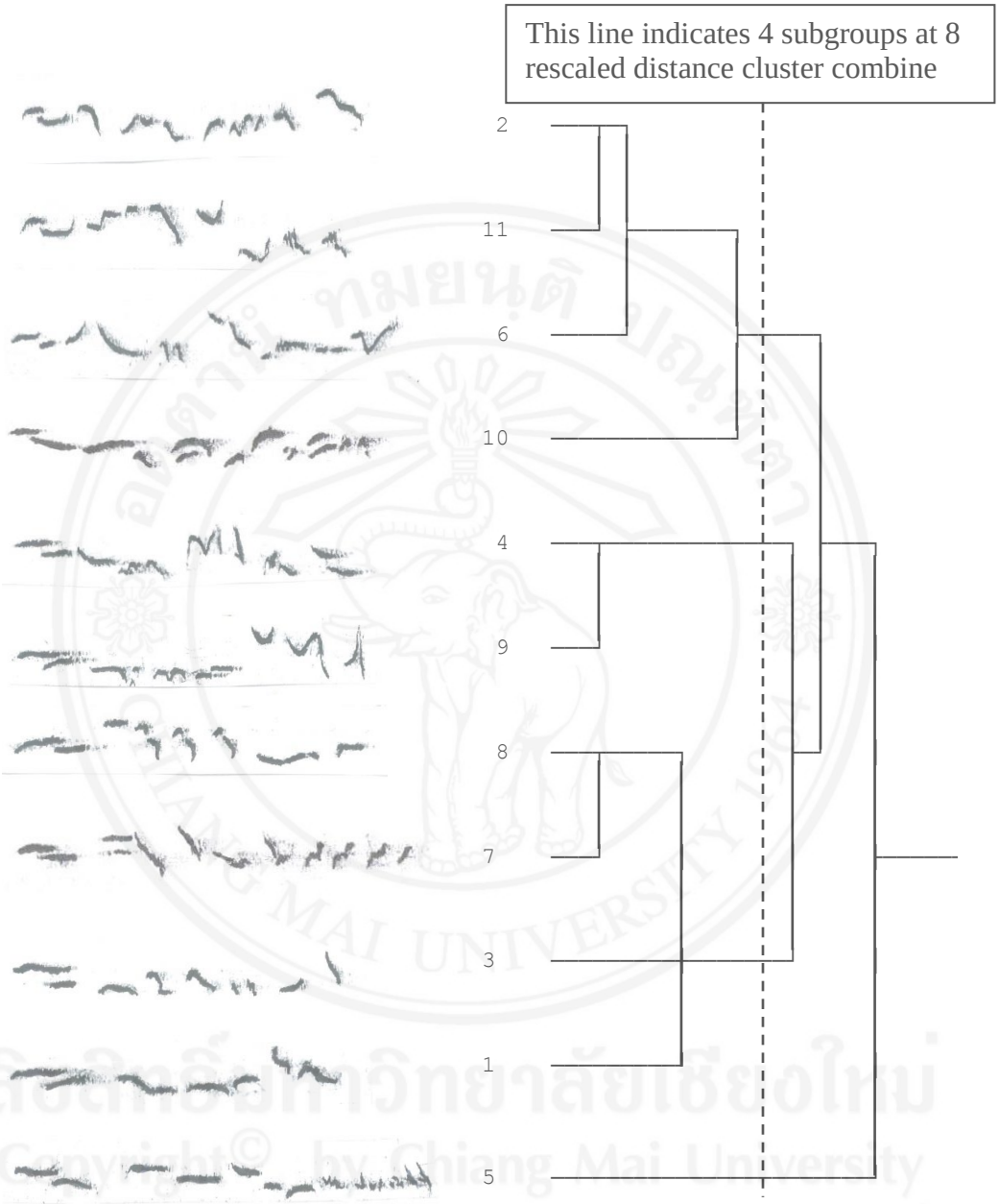

Figure 15. Dendrogram showing song variation of song type B. (1) Chiang Mai, (2) Chiang Rai, (3) Lampang, (4) Lamphun, (5) Mae Hong Son, (6) Nan, (7) Phayao, (8) Phetchabun, (9) Phitsanulok, (10) Phrae, and (11) Tak.

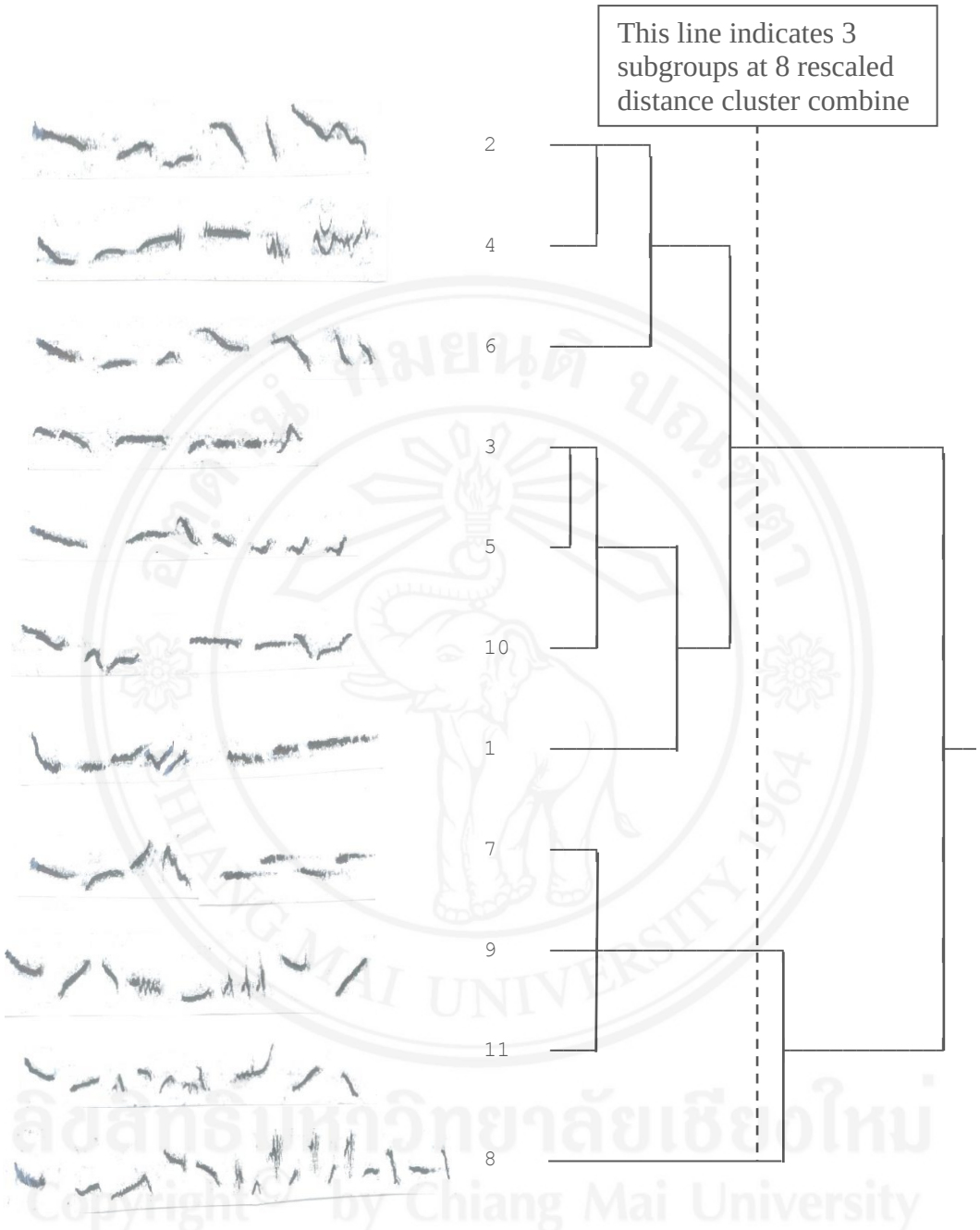

Figure 16. Dendrogram showing song variation of song type C. (1) Chiang Mai, (2) Chiang Rai, (3) Lampang, (4) Lamphun, (5) Mae Hong Son, (6) Nan, (7) Phayao, (8) Phetchabun, (9) Phitsanulok, (10) Phrae, and (11) Tak.

Song playback analysis

The territorial song playback technique has been very successful in answering questions about discrimination, especially concerning species or neighbor recognition. The reaction to territorial song playback is shown by a song score if males display aggression, rather than avoidance.

Table 5 shows that the reaction mean of 3 male birds in the Chiang Mai population to playback of 34 songs with 11 of song type A, 11 of B, 11 of C, and one of the Eurasian sparrow were 3.88 (±0.29), 3.91(±0.30), 3.96 (±0.31), and 1.33(±0.33), respectively. The reaction mean of 3 male birds in the Chiang Rai population to playback of these 34 songs were 3.91 (±0.29), 3.96(±0.34), 4.01(±0.37), and 1.66(± 0.31), respectively. The reaction mean of 3 male birds in the Lampang population to playback of the 34 songs were 3.80 (±0.35), 3.96(±0.29), 3.90(±0.25), and 1.33(±0.33), respectively. The reaction mean of 3 male birds in the Lamphun population to playback of the 34 songs were 3.76 (±0.51), 4.06(±0.38), 3.66(± 0.29), and 1.33(±0.33) respectively. The reaction mean of 3 male birds in the Mae Hong Son population to playback of the 34 songs were 3.91 (±0.29), 3.96(±0.34), 4.01(±0.37), and 1.66(± 0.33) respectively. The reaction mean of 3 male birds in the Nan population to playback of the 34 songs were 3.96 (±0.12), 4.03(±0.35), 4.06(±0.31), and 2.00(± 0.01), respectively. The reaction mean of 3 male birds in the Phayao population to playback of the 34 songs were 3.90(±0.51), 3.76(±0.14), 4.11(±0.31), 1.67(±0.30), respectively. The reaction mean of 3 male birds in the Phetchabun population to playback of the 34 songs were 3.90 (±0.30), 4.00(±0.25), 4.05(±0.30), and 1.66(±0.33), respectively. The reaction mean of 3 male birds in the Phitsanulok population to playback of the 34 songs were 4.01 (±0.44), 4.08(±0.36), 3.96(±0.16), and 1.66(±0.33), respectively. The reaction mean of 3 male birds in the of Phrae population to playback of the 34 songs were 3.64 (±0.34), 3.83(±0.16), 3.90(±0.30), and 1.33(±0.33), respectively. The reaction mean of 3 male birds in the Tak population to playback of the 34 songs were 3.73 (±0.17), 3.86(±0.23), 3.63(±0.13), and 1.00(±0.01), respectively. The reaction mean of 33 male birds of 11 populations to responses of 34 songs A, B and C were 3.85(a), 3.94(a), and 3.93(a), there was no significant different between the three groups of

song types, The mean reaction of all male birds to the acoustics of the Eurasian sparrow was 1.51(b) and had significantly different responses at the 0.05 level (Table 5).

Table 5. The reaction of males to song playback trials. Values for each mean of reaction to song playback trials are given as means ± SE.

Male birds of each population (n = 3)	Reaction mean to song playback trials			
	A	B	C	D
Chiang Mai	3.88±0.29	3.91±0.30	3.96±0.31	1.33±0.33
Chiang Rai	3.91±0.29	3.96±0.34	4.01±0.37	1.66±0.31
Lampang	3.80±0.35	3.96±0.29	3.90±0.25	1.33±0.33
Lamphun	3.76±0.51	4.06±0.38	3.66±0.29	1.33±0.33
Mae Hong Son	3.91±0.29	3.96±0.34	4.01±0.37	1.66±0.33
Nan	3.96±0.12	4.03±0.35	4.06±0.31	2.00±0.01
Phayao	3.90±0.51	3.76±0.14	4.11±0.31	1.67±0.30
Phetchabun	3.90±0.30	4.00±0.25	4.05±0.30	1.66±0.33
Phitsanulok	4.01±0.44	4.08±0.36	3.96±0.16	1.66±0.33
Phrae	3.64±0.34	3.83±0.16	3.90±0.30	1.33±0.33
Tak	3.73±0.17	3.86±0.23	3.63±0.13	1.00±0.01
Mean of reaction	3.85a	3.94a	3.93a	1.51b

The mean difference is significant at the 0.05 level.