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TERRITORIAL SONGS OF THE DRONGO CUCKOO COMPLEX (*SURNICULUS LUGUBRIS* & *S. VELUTINUS*)

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ABSTRACT. - The whistling song and the trilled song of Drongo Cuckoos (*Surniculus lugubris* and *S. velutinus*) have been recognized from the song recordings. The whistling song was selected to study the similarity among 24 individuals from Nepal, India, Malaysia, Indonesia, Thailand, Philippines and Indonesia within the Drongo Cuckoo complex. Sonograms of the forms of *dicruroides* and *brachyurus* were identical, and sonograms of *velutinus* and *musschenbroeki* were identical. The note numbers, high frequency, low frequency, frequency range and duration of all individuals by using numerical clustering analysis show that the former two subspecies were clustered in one branch, while the latter two subspecies were in the other. These song similarities suggest that *velutinus* might be a distinct species rather than conspecific with *lugubris* based on this ethological point of view.

KEY WORDS. - Taxonomy, song, subspecies, Asia.

INTRODUCTION

Some authors have recognized *S. velutinus* as conspecific with *S. lugubris* including subspecies of *dicruroides, brachyurus, velutinus, lugubris* and *musschenbroeki* (Dickinson et al., 1991; Gilliard, 1950; Ripley & Robor, 1958; duPont, 1971). Payne (1997) suggested that the form *velutinus* is a distinct species because its song and juvenile plumage are different from *S. lugubris.*

The low geographic variation and wide similarities of songs of cuckoos suggest that little song learning takes place, thus song can be used in resolving taxonomic problems (Miller, 1996; Payne, 1997). Songs of several parasitic cuckoo species have been previously studied (Becking, 1975; Wells, 1982; Wells & Becking, 1975; Payne 1986, 1997). Songs may not only be the most effective way to identify species of cuckoos in the field, but they may also assist in determining the biological limits of species (Payne, 1997).

Two Drongo cuckoo (*Surniculus lugubris* and *S. velutinus*) songs have been described in words. One is a loud whistle, and the other is a shrill or trilled crescendo, but no sonogram has been reported (Ali & Ripley, 1969; Coates & Bishop, 1997; King & Dickinson, 1975; MacKinnon & Phillipps, 1993; Payne 1997). In this paper, the territorial songs were recognized and used to study the similarity within the Drongo Cuckoo complex. And then, we used clustering analysis based on five sonagram parameters to produce the dendrograms. This should be a way to determine if the different populations are different species.

MATERIAL AND METHODS

Songs were collected from the Museum of Zoology and the National Sound Archive in the British Library of Wildlife Sounds. The sampling localities and recorders as well as the recording date are listed in Table 1. Subspecies and species in Tab. 1 follows the recorders and Payne (1997). Songs of 24 individuals

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from Nepal, India, Malaysia, Indonesia, Thailand, Philippines and Indonesia were recognized and selected for analysis. Sonograms were made by a Kay Elemetrics DSP 5500 ranging 0-8 kHz using a 256-points per second, time axis 200 ms, and frequency axis 500 Hz.

The note numbers, tempo and frequency parameters of the whistle song were counted and measured by SAS Lab Processing - Avi software (Specht, 1998). Note numbers were tested by F-test to compare sample variances, t-test to compare means between samples, and coefficient of variation to compare the extent of variability across individuals within the species complex. The tempo and frequency parameters were tested by ANOVA. All these parameters include low frequency (Fmin), high frequency (Fmax), frequency range (Fran: from the low frequency to the high frequency), and duration (Tdur) during a song. We considered each individual as a separate operating taxonomic unit (OTU), and then clustered their phylogenetic tree by UPGMA (SPSS 8.0). From these trees, we can determine similarities related to different local individuals (OTUs) and subspecies. The trilled songs were also described in sonograms in the paper but not for phylogenetic analysis because of the lack of sufficient samples. Terms used in this paper are in Fig. 1.

RESULTS

General vocalization. - Two song types have been recognized in drongo cuckoos. Song 1 is a loud whistle "pip..." repeated 4 to 11 times in a rising scale. Notes are similar in sonogram, level, up-slurred or down-slurred but with the rising pitch

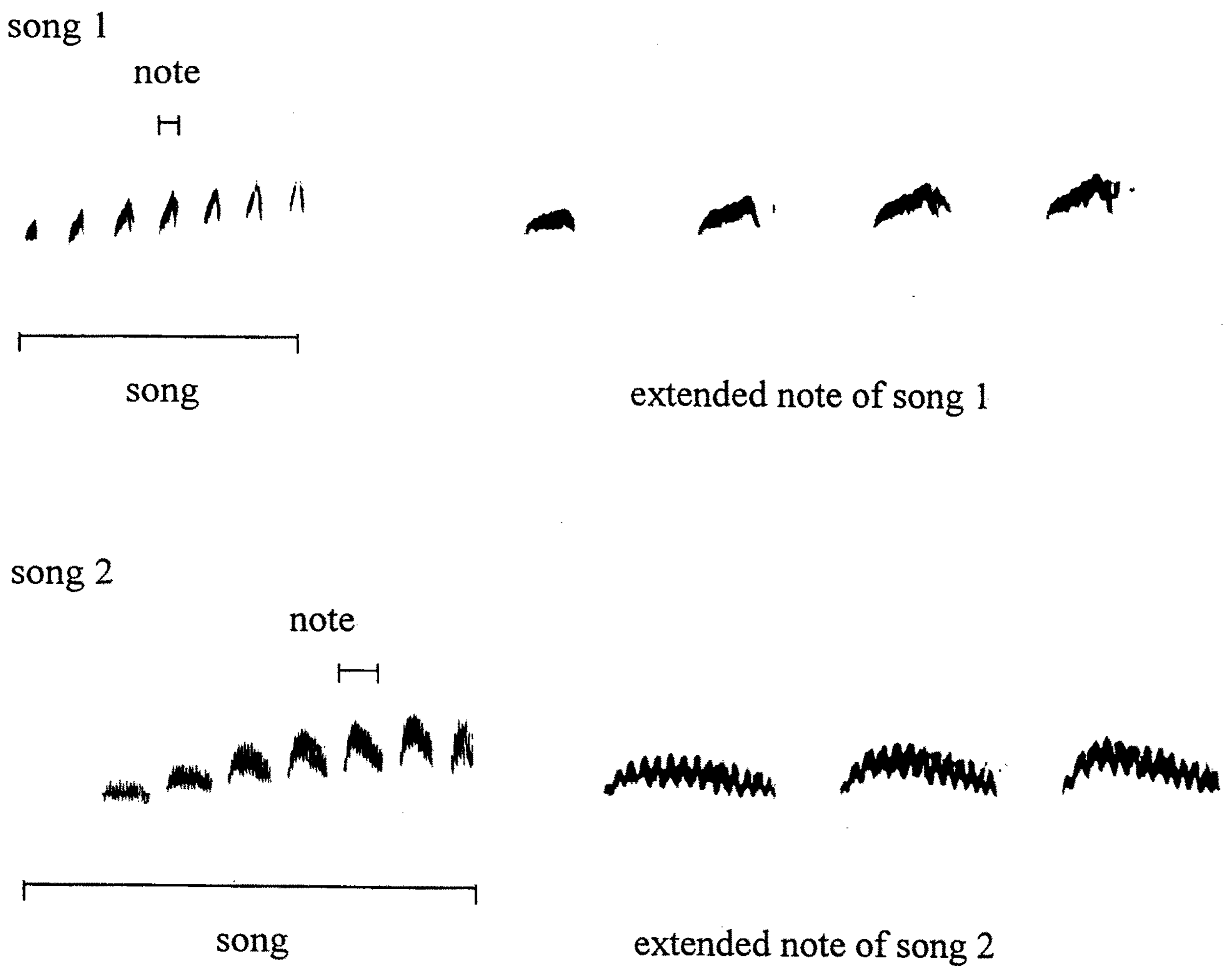

Fig. 1. Terminology used in the paper of the whistle song (song 1) and the trilled song (song 2) of Drongo Cuckoo.

within a song (Fig. 1). Song 2 is the shrill or trilled crescendo also in a rising scale, but the latter 2-3 notes are descending, followed by several similar arc-shaped or frequency modulated notes, while the 1st note is soft and lower in pitch (Fig. 3).

Song variation within individuals. - The note numbers of song 1 within an individual are very stereotyped with little variation (CV < 0.14, P < 0.05, Tables 1 & 2), and sonograms are also nearly identical (Fig. 2). One sample t test shows that there is no significant difference in note numbers within one individual (P < 0.05). Also, there are no significant differences in the maximum frequency, the minimum frequency, the frequency range, and the song duration within one individual (Table 3)(P < 0.05). Thus, these mean values of different parameters are stereotyped within one individual, and can be used to compare among all individuals.

Song variation among individuals. - The note numbers vary greatly among individuals, ranging from 4 to 11. We compared the mean number of note numbers in song 1. The note numbers vary from 4 to 7 in the form *dicruroides* from Nepal and India, such as NE1, NE2, NE3, ID1 and ID2. They vary from 5 to 7 in *brachyurus* from Malaysia, Indonesia and Philippines, such as MA1-9, IN1, TH1, PH1 and

Table 1. Subspecies recognized and their song recordings from different localities

OTU Codes	Localities	Recorders	Date (m/y)	Subspecies
NE1	Pakhara, Nepal(27° 43' N, 85° 51' E)	Ben B. & L. C. Coffey	4/73	*dicruroides*
NE2	Kathmanin Valley, Nepal (27° 46' N, 88°26' E)	T. C. White	2/69	*dicruroides*
NE3	Chikran, Nepal	S. Buckton	5/90	*dicruroides*
ID1	Assam, India (20° 45' N, 93° 30' E)	B. C. R. Bertram	4/67	*dicruroides*
ID2	Assam, India (20° 45' N, 93° 30' E)	B. C. R. Bertram	6/67	*dicruroides*
MA1	Sabah (Borneo), Malaysia (5° N, 117' E)	N. Redman	7/91	*brachyurus*
MA2	Taman Negara National Park, Malaysia (4.7° N, 102.5° E)	R. Kersley	2/72	*brachyurus*
MA3	Negri Sembilan, Malaysia (102° 30' N, 2° 55' E)	R. Kersley	3/72	*brachyurus*
MA4	Taman Negara National Park, Pahang, Malaysia (4.7° N, 102.5° E)	R. Kersley	2/73	*brachyurus*
MA5	Taman Negara (Pahang Prov.), Malaysia (4.7° N, 102.5° E)	Tropic Asian Birds		*brachyurus*
MA6	Hinteng Highlands Road, Malaysia	G. Uadge	2/?	*brachyurus*
MA7	Paroh, Malaysia	C. Hails	3/79	*brachyurus*
MA8	Ampang, Malaysia (3° 08'N, 101° 46' E)	C. Hails	3/82	*brachyurus*
MA9	Gombak, Malaysia	C. Hails	3/81	*brachyurus*
IN1	Lampung Rrov. South Somatra, Indonesia (4.5°S, 105.1°E)	D. A. Holmes	8/76	*brachyurus*
TH1	Bangkok, Thailand (13° 44' N, 100° 30' E)	S. Harrap	4/93	*brachyurus*
PH1	Palawan, Philippines (10.5° N, 119° E)	A. Wassink	3/85	*brachyurus*
PH2	Palawan, Philippines(10.5° N, 119° E)	Tropica Asian Birds		*brachyurus*
IN2	Sulawesi, Indonesia(1.5° S, 121° E)	A. B. Van den Berg	8/84	*musschenbroeki*
IN3	Sulawesi, Indonesia(1.5° S, 121° E)	A. B. Van den Berg	8/84	*musschenbroeki*
IN4	Sulawesi, Indonesia(1.5° S, 121° E)	R. Watling	?/80	*musschenbroeki*
IN5	Halmahera, Indonesia(1.5° S, 121° E)	A. Greensmith	1-2/91	*velutinus*
PH3	Mindanao, Philippines (7° N, 125° E)	S. Harrap	2/93	*velutinus*
PH4	Luzon, Philippines (14° N, 121° E)	A. Wassink	3/85	*velutinus*

Table 2. Stereotyped song note number within individuals

Individuals	T	df	Sig (2-tailed)	Mean	SD	C. V.(N>10)
NE1	28.169	9	< 0.001	4.6000	0.5164	0.089
NE2	42.270	16	< 0.001	5.7647	0.5623	0.097
NE3	14.000	2	0.005	4.6667	0.5774	
ID1	34.395	7	< 0.001	6.5000	0.5345	
MA1	9.500	2	0.011	6.3333	1.1547	
MA2	42.177	29	< 0.001	6.2000	0.8052	0.130
MA3	66.697	25	< 0.001	6.3462	0.4852	0.077
MA4	57.161	21	< 0.001	5.2273	0.4289	0.083
MA5*		2		6.0000	<0.0001	
MA6*		2		7.0000	<0.0001	
MA7*		8		7.0000	<0.0000	
MA8*		4		7.0000	.0000	
MA9	80.498	30	< 0.001	5.8065	0.4016	0.069
IN1	48.500	14	< 0.001	6.4667	0.5164	0.079
TH1	37.000	11	< 0.001	6.1667	0.5774	0.093
PH1*		3		6.0000	<0.0001	
PH2*		9		6.0000	<0.0001	
IN2	27.398	10	< 0.001	7.6364	0.9244	0.122
IN3	66.950	23	< 0.001	10.1250	0.7409	0.073
IN4	37.000	3	< 0.001	9.2500	0.5000	
IN5	44.808	11	< 0.001	9.7500	0.7538	0.077
PH3	21.000	1	0.030	10.5000	0.7071	

* t cannot be computed because the standard deviation is 0.0000; One sample T test (two-tailed).

Table 3. Stereotypy of song in tempo and frequency parameters within individuals

		Fmax			Fmin			Fran			Tdur		
OUT	N	Mean	SD	Sig.	Mean	SD	Sig	Mean	SD	Sig.	Mean	SD	Sig.
NE1	9	3.44	0.05	<.001	2.72	0.04	<.001	0.72	0.04	<.001	1.15	0.07	<.001
NE2	17	3.42	0.06	<.001	2.61	0.05	<.001	0.81	0.07	<.001	1.36	0.11	<.001
NE3	3	3.46	0.02	<.001	2.77	0.04	<.001	0.69	0.03	.001	1.20	0.09	<.001
ID1	8	3.59	0.08	<.001	2.66	0.01	<.001	0.92	0.09	<.001	1.46	0.13	<.001
MA1	2	3.17	0.11	.016	2.39	0.02	.004	0.78	0.13	.076	1.36	0.18	.060
MA2	29	3.19	0.08	<.001	2.37	0.11	<.001	0.82	0.08	<.001	1.32	0.19	<.001
MA3	7	3.01	0.03	<.001	2.32	0.02	<.001	0.69	0.04	<.001	1.19	0.01	<.001
MA4	22	3.26	0.06	<.001	2.49	0.03	<.001	0.76	0.07	<.001	1.12	0.10	<.001
MA5	3	3.42	0.07	<.001	2.47	0.05	<.001	0.95	0.07	.002	1.33	0.02	<.001
MA6	2	3.17	0.02	.003	2.34	0.04	.008	0.83	0.02	.012	1.53	0.01	.003
MA7	9	3.21	0.03	<.001	2.34	0.05	<.001	0.87	0.06	<.001	1.42	0.01	<.001
MA8	5	3.48	0.05	<.001	2.50	0.06	<.001	0.98	0.08	<.001	1.55	0.01	<.001
MA9	32	3.29	0.07	<.001	2.54	0.03	<.001	0.75	0.07	<.001	1.27	0.10	<.001
IN1	10	3.04	0.05	<.001	2.21	0.03	<.001	0.82	0.05	<.001	1.57	0.12	<.001
TH1	12	3.25	0.11	<.001	2.42	0.01	<.001	0.83	0.11	<.001	1.50	0.12	<.001
PH1	22	3.62	0.05	<.001	2.48	0.03	<.001	1.14	0.07	<.001	1.45	0.01	<.001
PH2	10	3.63	0.03	<.001	2.56	0.02	<.001	1.08	0.02	<.001	1.37	0.02	<.001
IN2	11	3.07	0.05	<.001	2.59	0.04	<.001	0.48	0.06	<.001	1.90	0.14	<.001
IN3	23	2.96	0.04	<.001	2.43	0.02	<.001	0.53	0.04	<.001	2.37	0.13	<.001
IN4	2	3.16	0.04	.006	2.44	0.00	<.001	0.72	0.04	.028	2.17	0.19	.040
IN5	12	2.79	0.06	<.001	2.29	0.02	<.001	0.50	0.07	<.001	2.42	0.21	<.001
PH3	2	3.14	0.01	.001	2.19	0.03	.007	0.95	0.02	.010	3.47	0.05	.006
PH4	12	3.13	0.04	<.001	2.19	0.05	<.001	0.93	0.06	<.001	3.11	0.20	<.001

One sample T test (two-tailed)

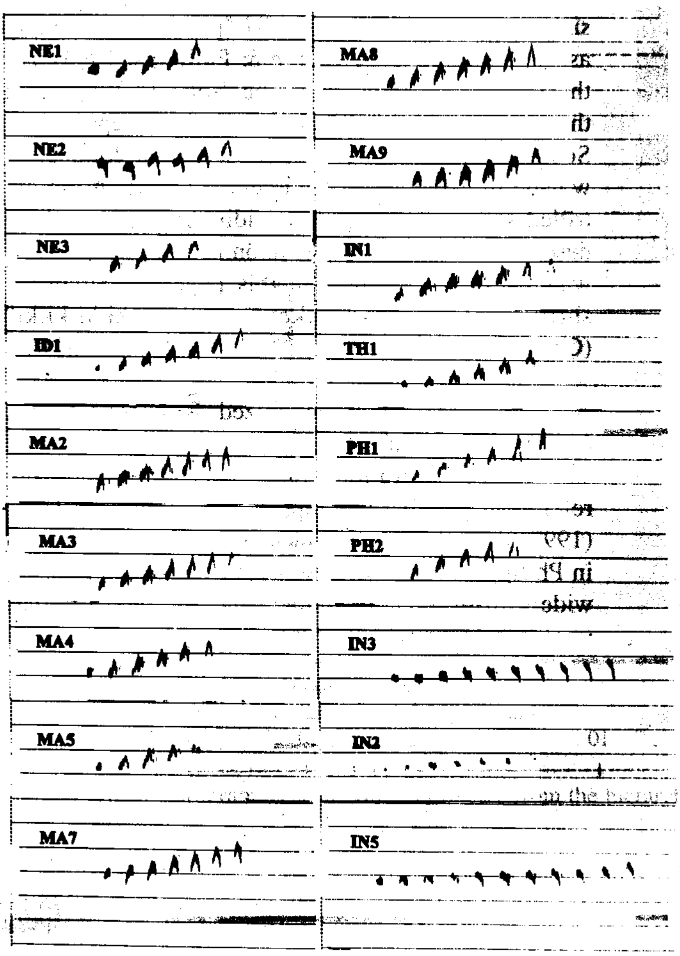

Fig. 2. Catalogue of the Whistle song of Drongo Cuckoo.

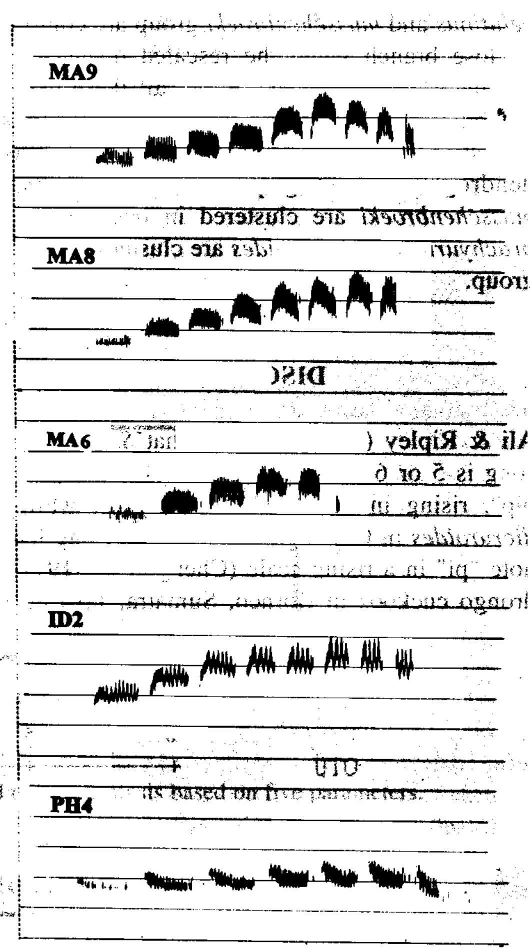

Fig. 3. Sonogram of the trilled crescendo of Drongo Cuckoo.

PH2, and vary from 8 to 10 in *musschenbroeki* from Sulawesi of Indonesia, such as IN2, IN3 and IN4. While *velutinus* from Indonesia and Philippines, such as IN5, PH3 and PH4 is from 9 to 11.

The sonogram of *velutinus* is similar to that of *musschenbroeki* in that they all have more notes and with longer duration (1.9-3.5s). The form *dicruroides* is similar to the form *brachyurus*, in that they have fewer notes and with shorter duration (1.1-1.6s).

Of song 2, the sonagram of ID2 of the form *dicruroides* is similar to those of MA6 and MA8 of *brachyurus*. Also different notes' shape was recognized in the form *dicruroides* among individuals at the same locality. The note numbers are also varied among individuals. Sonagram of *velutinus* is more level and with small frequency range.

Song similarity by numerical clustering. - From the dendrogram of the note numbers of all individuals (Fig. 4), we find that IN5, IN4, IN2 and IN3 are clustered together with PH3 in a branch. The others clustered together in the other. These results suggest that all these individuals can be divided into two distinct groups.

If all the five song parameters being considered collectively (Fig. 6), PH3 and PH4 are clustered in a terminal branch; IN3 and IN5 are in a terminal branch and then clustered with IN4. These two branches are then clustered with IN2. The others are in the same branch. These suggest that all these individuals can also be divided into two groups. Furthermore, NE1 with NE3; MA6, MA7 with MA8; MA2, MA3 with MA9; PH3 with PH4; IN3 with IN5, all these individuals in the same terminal branch are mostly distributed at the same or near localities.

All OTUs from *brachyurus* and *dicruroides* group are embed in the close branch when the rescaled distance cluster combine value is under 7. OTUs from *velutinus* and *musschenbroeki* group are combined in a close branch when the rescaled distance cluster combine value is under 10, but all these OTUs are combined when the value is over 25. By comparing the subspecies with all OTUs as well as the dendrogram of song parameters, *velutinus* and *musschenbroeki* are clustered in one group, while *brachyurus* and *dicruroides* are clustered in the other group.

DISCUSSION

Ali & Ripley (1969) reported that *S. l. dicruroides* song is 5 or 6 whistling notes "pip-pip-pip-pip-pip-pip", rising in pitch with each "pip", while *S. l. dicruroides* in China gave a whistling song like a 6-note "pi" in a rising scale (Cheng et al., 1991). The drongo cuckoos in Borneo, Sumatra, Java and Bali sing a loud clear song with 4-7 "pi" note on steadily ascending scale (MacKinnon & Phillipps, 1993). All these described songs might be "song 1" reported in this paper. King & Dickinson (1975) reported in Southeast Asia drongo cuckoos with a loud clear whistle of 4-6 notes in an ascending scale. A rapidly trilled series of rising notes ending with about three descending notes in MacKinnon & Phillipps (1993), which might be song 2 in this paper. In Sulawesi, shrill whistled notes like "ki.ki.ki.ki.ki.ki.ki.ki" (Coates & Bishop, 1997).

All these OTUs are recognized with four forms, *brachyurus*, *dicruroides*, *velutinus* and *musschenbroeki* from the recorders's report and from referencing to the geographic distribution of Payne (1997) as bellow: subspecies *velutinus* is distributed in Philippines and Sulu Is., subspecies *dicruroides* is widely distributed in Punjab and lower Himalayas

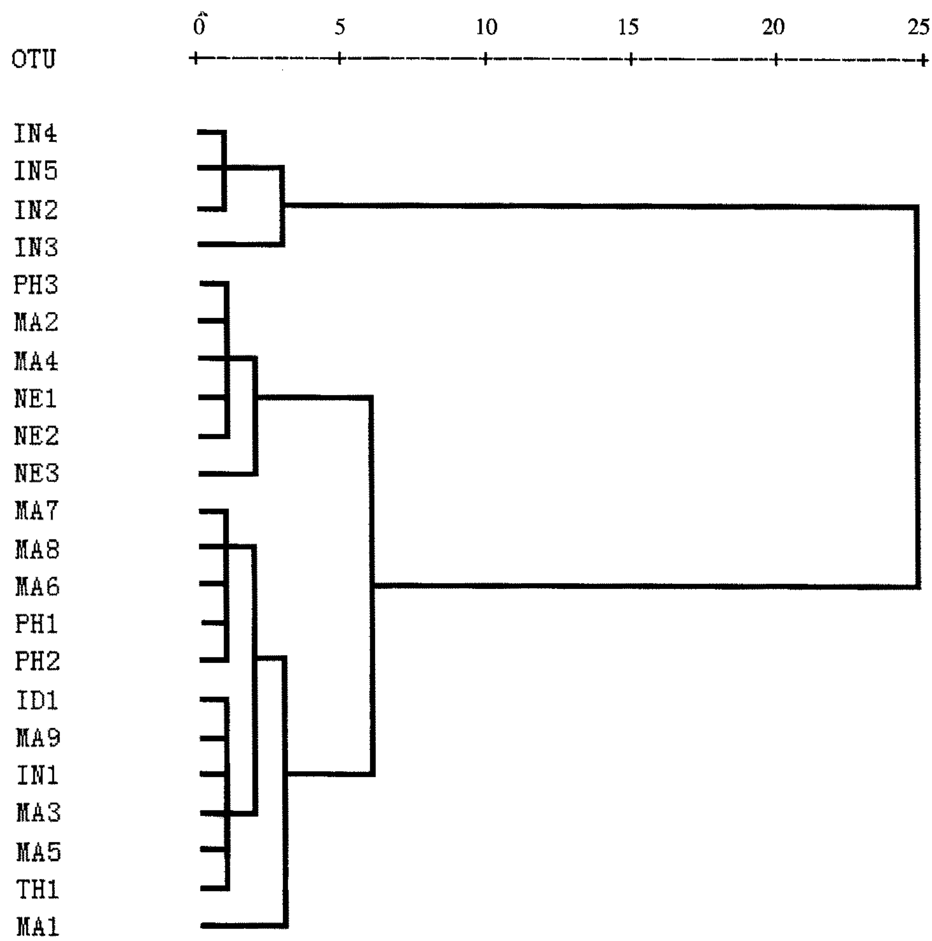

Fig. 4. Dendrogram using Average Linkage of note numbers of drongo cuckoo complex.

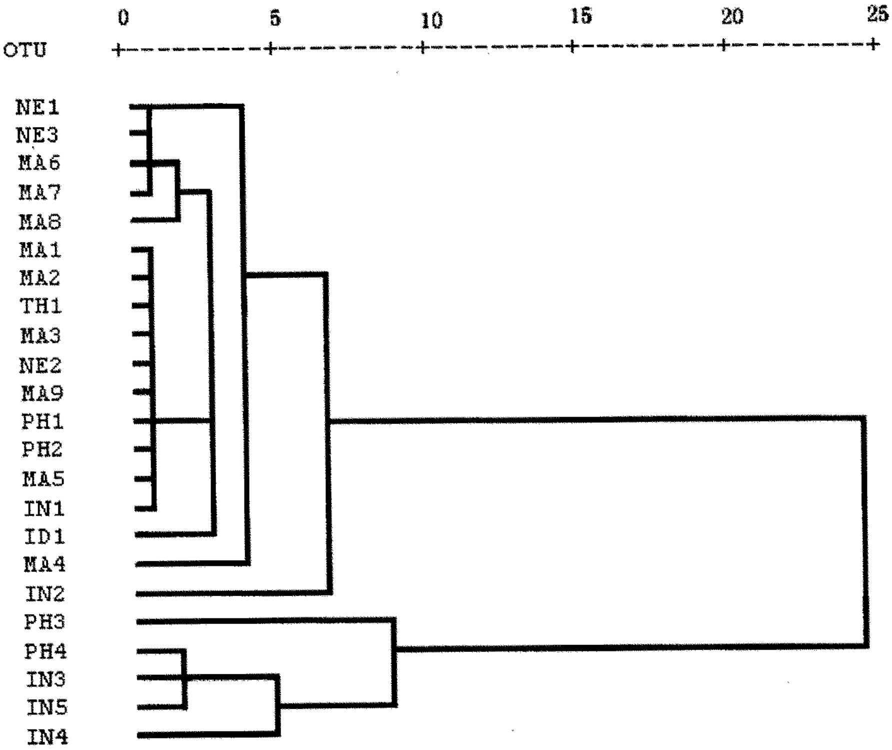

Fig. 5. The dendrogram by using Single Linkage from the hierarchical cluster analysis based on five parameters.

Rescaled Distance Cluster Combine

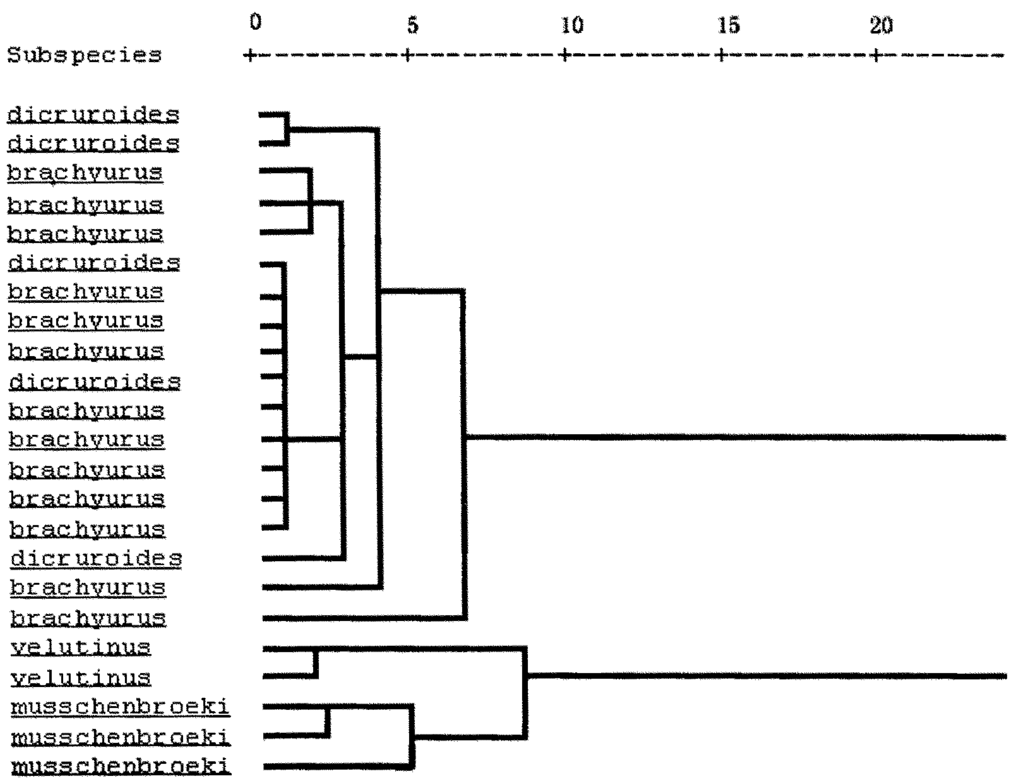

Fig. 6. The dendrogram of subspecies based on 5 parameters of song by using Single Linkage from the hierarchical cluster analysis.

eastern through Nepal to Assam and Manipur, and from South China south through Myanmar and Thailand to Indochina, but winters south to Malaysia, Sumatra and Java, subspecies *brachyurus* is distributed in Malaysia, Sumatra and Bangka, Borneo and southwestern Philippines (Palawan, Balabac, Calauit), and subspecies *musschenbroeki* is distributed in Sulawesi and Butung to Bacan and Halmahera (north Moluccas).

The note shape of forms *musschenbroeki* and *velutinus* are more level at the beginning, and then down-slurred like "¬" - shaped, while those of *dicruroides* and *brachyurus* are up-slurred and then down-slurred like "Λ" - shaped. Note numbers of both *musschenbroeki* and *velutinus* are more similar than other two forms (*dicruroides* and *brachyurus*). All five parameters, including note numbers, high frequency, low frequency, frequency range and duration of *dicruroides* and *brachyurus* are similar, while those of *velutinus* and *musschenbroeki* are similar. By clustering analysis of these parameters, the former two subspecies were clustered in the same group, *dicruroides - brachyurus* group, and the latter two subspecies were in the other group, *velutinus - musschenbroeki* group. This two groups are not closely related and with high dissimilarity (Fig. 6). At the same time in *dicruroides - brachyurus* group, individuals of *dicruroides* and *brachyurus* are closely related and some OTUs of them are clustered at the same terminal branch. In *velutinus - musschenbroeki* group, individuals of *velutinus* and *musschenbroeki* are clustered closely at the terminal branch. That is to say, of the species *S. lugubris*, songs of *dicruroides* and *brachyurus* are similar, and do not obviously sort in a geographical way, while those of *musschenbroeki* and *velutinus* are nearly identical. Some authors recognized *S. velutinus* as conspecific with *S. lugubris* including subspecies of *dicruroides, brachyurus, velutinus, lugubris* and *musschenbroeki* (Dickinson et al., 1991; Gilliard, 1950; Ripley & Robor, 1958; duPont 1971). Payne (1997) suggested that the form *velutinus* is a distinct species because its song and juvenile plumage are difference from *S. lugubris*. From our results, as for the Drongo Cuckoo complex, songs between subspecies might be similar in sonograms and should be clustered closely. Their distributions do not overlap and no paper concerning their interbreeding has been reported, so we suggest that from this vocal ethological point of view the *dicruroides* and *brachyurus* are two subspecies of *S. lugubris*, while *velutinus* and *musschenbroeki* are two subspecies of *S. velutinus*, which agrees with Payne (1997) that the form *velutinus* might be a distinct species.

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