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Vocalizations and species limits of the plaintive cuckoo (*Cacomantis merulinus*) and the brush cuckoo (*C. variolosus*)

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A b s t r a c t . Vocalizations of the plaintive cuckoo (*Cacomantis merulinus*) and brush cuckoo (*C. variolosus*) were compared. Six major sound types were identified in the plaintive cuckoo, and four in the brush cuckoo. On the basis of song similarity as assessed by sonogram qualitatively and quantitatively, the grey-bellied cuckoo (*C. passerinus*) was considered conspecific with *C. merulinus* and the rusty-breasted cuckoo *C. sepulcralis* was considered conspecific with *C. variolosus*. The song similarities between *C. merulinus* and *C. variolosus* were considered homologous and derived from common ancestry.

Key words: plaintive cuckoo, brush cuckoo, vocalization

Introduction

The species limits of the plaintive cuckoo (*Cacomantis merulinus*) and the brush cuckoo (*C.variolosus*) are uncertain with both species having allopatric subspecies of questionable affinity. The grey-bellied Indian form of the plaintive cuckoo *C. passerinus* is replaced by rusty-breasted forms of *C. merulinus querulus* in Southeast Asia, *threnodes* on the Malay Peninsula and *merulinus* in Indonesia and the Philippines. North Asian and Indonesian populations of the brush cuckoo are rusty-breasted while those in South Asia, the Molucca, New Guinea and Australia are gray-breasted.

In the case of *C. merulinus*, the primary question is whether *passerinus* is the same species as *C. merulinus*. B i s w a s (1951) suggested *C. passerinus* was a distinct species because *passerinus* and *querulus* have different call notes: "*Passerinus* has a plaintive call of two syllables, the last one lengthened, while *querulus* has a loud-toned whistle, repeated four times and terminating with a shake". The form *passerinus* is sometimes regarded as a distinct species (B i s w a s 1951, M a r t e n s & E c k 1995, S i b l e y & A h l q u i s t 1990) and sometimes as conspecific with *C. merulinus* (A l i & R i p l e y 1969, P a y n e 1997, S m y t h i e s 1960, W h i t e & B r u c e 1986).

In the case of *C. variolosus*, the question is whether *sepulcralis* (and other forms north and west of New Guinea) are in fact a single species. The form *sepulcralis* is sometimes regarded as a distinct species; the Indonesian cuckoo (W h i t e & B r u c e 1986, M a c K i n n o n & P h i l l i p p s 1993, C o a t e s & B i s h o p 1997), and sometimes as conspecific with *C. variolosus* (P a y n e 1997, S m y t h i e s 1986). The form *sepulcralis* has also been considered a sibling species of *C. merulinus* and sympatric with it from the Malay Peninsula to the Philippines (W h i t e & B r u c e 1986).

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In some cases, song can be a better indicator of species boundaries than morphology and has proven useful in testing species identity and limits in other birds (Payne 1986). We suggest that this approach might provide a way to examine relationships between *Cacomantis* populations.

Several plaintive cuckoo vocalizations have been reported (Ali & Ripley 1969, MacKinnon & Phillipps 1993, Payne 1997), including a 3-note phrase rising song, "tay-ta-tee", a trill cadence song with 4 slow notes followed by 4 rapid notes, "tee-tee-tee-tee-tita-tita-tita-tita-tee" and a repeated simple song (Table 1). The brush cuckoo is also reported to give several songs and calls (Watling 1983, MacKinnon & Phillipps 1993, Pizzey & Doyle 1980, Coates & Bishop 1997). For example, a 2-note call "tee-too", a 4-note "Where's the tea" or a descending whistles "peeyu peeyu peeyu..." (Table 1).

So far as we know, these onomatopoeic descriptions (Watling 1983, Cheng et al. 1991, Coates & Bishop 1997, Payne 1997) plus a few objective analyses (see the simple song sketches in MacKinnon & Phillipps (1993) and simple audiogram figures in Martens & Eck (1995)) are the only available information on the vocalizations of these species.

Table 1. Song and call descriptions of the plaintive cuckoo and brush cuckoo.

Species	Sound description	Locality	Literature
C. merulinus	8-note "ka.....pie"	China	Cheng et al 1991
C. merulinus	"piteer" , "kiveer", "weeti-teeti", "peter-peter" repeated; "pee-pipee-pee, pipee-pee ?" or "pee-pipee-peepi, pipee-peepi ?"	India	Ali & Ripley 1969
C. merulinus	3-note "tay-ta-tee, tay-ta-tee"; "pwee, pwee, pwee, pee-pee-pee-pee"	Borneo, Sumatra, Java and Bali	MacKinnon & Phillipps 1993
C. merulinus	3-note "ti-ter-wi", "pee-to-peet"	Indonesia	Coates & Bishop 1997
C. sepulcralis	"weet", "peeweet" repeated 10–25 times	Borneo, Sumatra, Java and Bali	MacKinnon & Phillipps 1993
C. sepulcralis	2-note "tee-too", "tee-toe", "tee-tee-tee"	Sulawesi	Watling 1983
C. variolosus	"peeyu peeyu peeyu……" repeated 3–16 times 4 more notes "where's the TEA"	Indonesia	Coates & Bishop 1997
C. sepulcralis	2-note "tee-too"; 2-7 notes "fiew"; 3-note "pee, peei, peeit, peeit, pee-to-weeit"; "fear" repeated; "fear-a-fear" repeated; "hiet" repeated 10–25 times; "peewieiet" repeated	Indonesia	Coates & Bishop 1997

Table 1 shows that song and calls descriptions follow the published references.

In this paper, we visually compare sound spectrograms of different vocalizations of the plaintive cuckoo and brush cuckoo. We then compare the spectrograms of *passerinus* with those of other forms of the plaintive cuckoo, and *sepulcralis* with other forms of the brush cuckoo. On the basis of this analysis we discuss the taxonomic status of the two forms with reference to the hypothesis that "Geographic populations of cuckoos which have apparently identical songs appear to be conspecific" (P a y n e 1997).

Material and Methods

Vocalizations were obtained from the collection of the National Sound Archive of the British Library of Wildlife Sounds, Library of Natural Sounds of Cornell University, and from available cassettes (S m i t h 1993). The locality of each recording, recorder and date are listed in figures of the text. Sounds were identified from spectrograms produced using the computer program Avisoft-SAS Lab Processing (S p e c h t 1998). Frequency resolution was 21 Hz, time resolution was 11.61 ms, FFT length 1024 pts. Spectrograms were also made using a Kay Elemetrics DSP 5500 Sonagraph from 0–8 kHz. Recordings of 38 individuals from 32 localities were available for comparison. Five subspecies have currently been recognized in the plaintive cuckoo, and eleven subspecies in the brush cuckoo (P a y n e 1997).

We identify the song type in every individual and every subspecies from the sound recorded (Table 2). From the table, we can find cadence song and rising song are common in 5 subspecies.To show the relationship between subspecies and between species, we measured some characters of cadence song for cluster analysis (M a h l e r & T u b a r o 2001). The characters include: the duration of song (D), the frequency range of song (FR), the number of note, the duration of 1st note (D1), the range of 1st note (FR1), the dominant frequency of 1st note (MPF1), the duration of 2nd note (D2), the range of 2nd note (FR2), the dominant frequency of 2nd note (MPF2) and the interval between 1st and 2nd (INT). Because the duration of song and the number of note change so much even in one individual, we eliminate them in the analysis. We also measured some characters of rising song (the number of note is 2 or 3): the duration of song (Dr), the duration of 1st note (Dr1), the range of 1st note (FRr1), the dominant frequency (MPFr1), the duration of 2nd note (Dr2), the dominant frequency of 2nd note (MPFr2). Because in some sonograms, the interval between 1st and 2nd note and the range of 2nd note is too small to measure accurately, we selected 6 parameters for cluster analysis. Every individual we measure two or seven songs which

Table 2. Song type in every subspecies identified from the sound recorded.

	Song Type							
	Cadence song	Rising song	Call "tchree"	Call "pier"	Call "ji-jiu"	Call "schee-jiu"	Call "fee"	Call "fea"
C. m. lanceolatus	+	+						
C. m. threnodes	+	+	+					
C. m. merulinus	+			+				
C. m. passerinus					+			
C. m. querulus	+	+			+	+		
C. v. sepulcralis	+	+					+	
C. v. virescens	+	+					+	+
C. v. variolosus							+	

depend on songs recorded, and the average number is used for analysis. We used "Squared Euclidean distance" and "Ward Method" to cluster.

All the characters of songs are measured by Avisoft-SASLab software. All procedures were carried out in SPSS Package (10.0 version).

Results

The plantive cuckoo

Song 1. Rising song "tay-ta-tee"

This song consists of three notes (Fig.1). The 1st and the 3rd notes are higher in pitch with longer duration; the middle note is lower in pitch with shorter duration. The 1st note shows

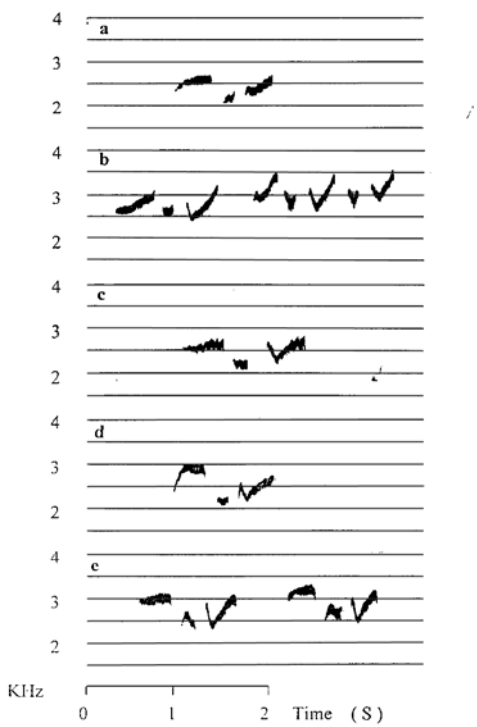

Fig. 1

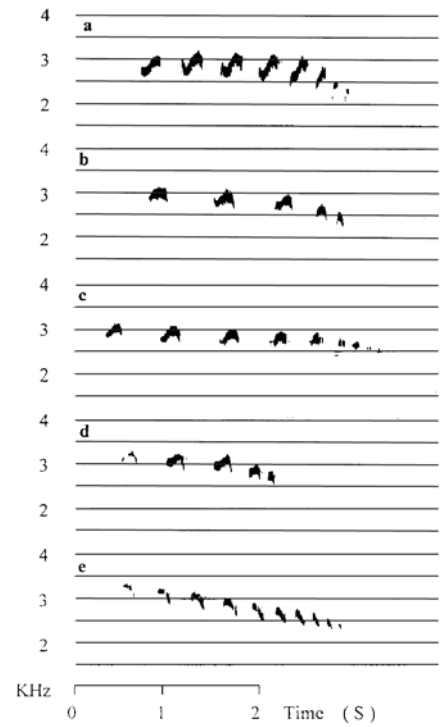

Fig. 2

Fig. 1. Rising song "tay-ta-tee" and its variations in the plaintive cuckoo *Cacomantis merulinus* (a: *C. m. lanceolatus* in Sulawesi, Indonesia, recorded by S. W. Smith in 1991; b: complex type of *C. m. lanceolatus* in Sulawesi, Indonesia, recorded by R. Watting in 1980; c: *C. m. threnodes* in Jahore, Malay Peninsula, recorded by T. C. White in 1964; d: *C. m. threnodes* in Krav Game Reserve, Malay Peninsula recorded by C. Hails in 1981; e: *C. m. querulus* in Assam, India, recorded by B. B. & L. C. Coffey in 1973).

Fig. 2. Cadence song "pwee, pee-" of *C. merulinus* (a: *C. m. lanceolatus* in Lore Lindu, Sulawesi, Indonesia, recorded by S. W. Smith in 1991); (b: *C. m. threnodes* in Jahore, Malay Peninsula, recorded by T. C. White in 1964; (c: *C. m. querulus* in Naratiwat, Thailand, recorded by D. A. Holmes in 1974); (d: *C. m. querulus* in Assam, India, recorded by B. B. & L. C. Coffey in 1973); (e: *C. m. merulinus* in Mindanao, Philippines, recorded by N. Redman in 1991).

slight or gradual upward frequency modulation, and the 3rd note is frequency modulated, being first down-slurred, then up-slurred. The song can be longer (Fig. 1 a-c-d), and "tay-ta-tee", or part of this phrase, may be repeated, for example , "tay-ta-tee, tay-ta-tee, ta-tee", "tay-ta-tee, tay-ta-tee, ta", "tay-ta-tee, tay-ta-tee, tay-ta-tee", "tay-ta-tee, tay-ta-tee, tay-ta-tee, ta, tay-ta-tee" and so on (Fig. 1 b–e). These complex songs with different note-sequences were recognized from the rising scale. Forms from Java, the Malay Peninsula and India have similar, rising 3-note songs. Among individuals, songs show little variation within an area (Table 3), for example, S1 a, b from 2 individuals in Sulawesi and S1 c, d from 3 individuals in the Malay Peninsula. But songs from different areas are slightly more variable; S1 in Sulawesi is slightly different from S1 in the Malay Peninsula and S1 e in India.

Table 3. Song and call diversity of the plaintive cuckoo.

Sound type and variations	Locality
S1 a, b; S2 a; S3 a	Lore Lindu, Sulawesi, Indonesia
S1 a, b; S2 a	Palu Valley, Sulawesi, Indonesia
S2 c	South Tapanuli, North Sumatra, Indonesia (N 1° 15', E 99° 10')
S1 c; S2 b, d; S4 b	Buket Kumming Estate, Malay Peninsula
S2 b, c	Dusan Game Reserve, Malay Peninsula
S1 c; S2 b, d; S3 a	Johare State, Malay Peninsula (N 1° 50', E 102° 22')
S1 d; S2 b; S3 b	Krav Game Reserve, Malaya
S2 c	Prinyor, Naratiwat Prov. S. Thailand (N 6° 30', E 101° 15')
S5	Thekkady, Rajapalaiyam, India (N9° 30', E 77°)
S5	Manas Sanctuary, Assam, India (N 26° 45', E 91°)
S1 e; S2 b	Kohora, Assam, India
S6	Kohora, Assam, India
S2 e	Palawan, Philippines (NB 10.5°, EL 119°)
S2 e	Bislig, Mindanao, Philippiness
S2 e	Qeszon N. P. Luzon, Philippines
S4 a	Mt. Makiling, Luzon, Philippines

Table 3 shows song types and their variants in the plaintive cuckoo.

Song 2. Cadence song "pwee, pee-"

This song is in a descending scale. Of 79 songs analyzed, of 9 notes accounting for 20% of the total song(average = 9.5 ±2.6, rang = 4 to 16). The first several notes are higher in pitch, "/⁀\" – shaped with a longer duration and time intervals, later notes are lower in pitch and of shorter duration with shorter time intervals. Near the end of the song, the notes are the faster and lower in pitch and are delivered with shorter inter-note intervals (Fig. 2).

The sonogram shows that the 1st note is up-slurred with lower pitch (2.6–3 kHz) in the Indonesian form (Fig. 2 a); while it is slightly more level with higher frequency (3–3.5 kHz) in the Malay Peninsula, Thailand and Indian forms (Fig. 2 b–d). In forms from the Philippines, it is more down-slurred (Fig 2 e). The sonograms of cuckoos from the Malay Peninsula, Thailand and India are very similar, and intermediate between those from Indonesia and the Philippines. Among individuals, 2 from Sulawesi had the similar

sonogram form of S2 a, but one from North Sumatra had S2 c; 3 from Malay Peninsula had S2 b, c or d; and 3 from the Philippines had S2 e (Table 3).

Call 3. "tchree" or "piteer"
This whistle consists of one up-slurred note (Fig. 3). The note in Indonesia is lower in pitch (2.5 kHz) than in the Malay Peninsula (2.9 kHz). This song is quite similar to the 1st note of the "tay-ta-tee" song; it is possibly a variant of this.

Call 4. "pier"
This is also a repeated note ranging from 2 to 13. The note is "^" – shaped and up-slurred continuously in a gradual descending scale (Fig. 4).

Call 5. "ji-jiu-ji-jiu"
This song consists of 4 notes in a descending scale, the 2nd and 4th notes being repeated (Fig. 5). The 1st and 3rd notes are slightly down-slurred and higher in pitch, the 2nd and 4th are sharply down-slurred and lower pitched. Forms from Tekkady and Assam have near identical S5 sonograms (Table 3).

Call 6. "schee-jiu"
Consists of two notes, "/ \" – shaped (Fig. 6). The 1st note is up-slurred, the 2nd is down-slurred. The mean frequency of the 1st note is slightly higher than that of the 2nd.

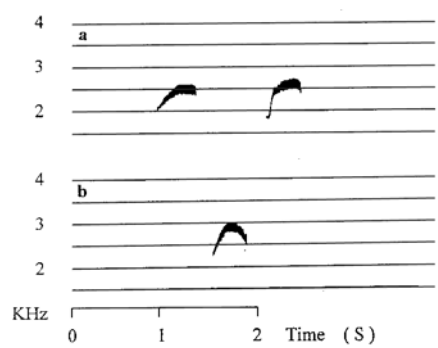

Fig. 3

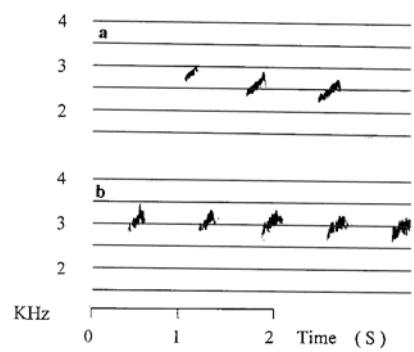

Fig. 4

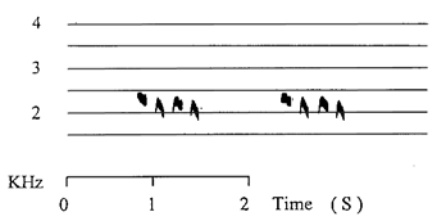

Fig. 5

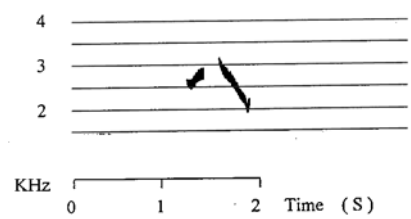

Fig. 6

Fig. 3. Calls "tchree" of *C. m. lanceolatus* (a: in Lindu, Sulawesi, Indonesia, recorded by S. W. S m i t h in 1991); and *C. m. threnodes* (b: in Krav Game Reserve, Malay Peninsula, recorded by C. H a i l s in 1981).
Fig. 4. Calls "pier" of *C. m. merulinus* (a: in Mt. Makiling, Luzon, Philippines, recorded by A. G r e e n s m i t h in 1990; b: in Kumming Estate, Malay Peninsula, recorded by R. K e r s l e y in 1973).
Fig. 5. Call "ji-jiu..." of *C. m. passerinus* in Thekkady, India, recorded by B. C. R. B e r t r a m in 1996.
Fig. 6. Call "schee-jiu" of *C. m. querulus* in Kohora, Assam, India, recorded by B. B. & L. C. C o f f e y in 1973.

Song 1. Rising song "where's the tea"
This song is a mournful whistle consisting of 3 (sometimes 2) notes. The 1st and the 3rd notes are higher in pitch and longer in duration; the middle note is lower in pitch, of shorter duration, lower amplitude and difficult to detect (Fig. 7 d,e,f). This song can also repeat several times in a rising scale (Fig. 7 d,e,f). Frequency and temporal features vary among different forms from Indonesia, Papua New Guinea, the Malay Peninsula, Singapore and the Philippines, and even within individuall birds, but the geographic forms have identical song patterns with 2 or 3 notes in a phrase (Fig. 7). Among individuals, individuals have S1 b, d note types in Sulawesi; S1 a in North Sumatra; S1 c in Papua New Guinea; S1 e, g in the Malay Peninsula; S1 f, g in Singapore and S1 g in the Philippines (Table 4).

Song 2. Cadence song "fear-fear-fear..."
This song is a loud frequency modulated whistle, "Λ" – shaped that appears very slightly downscale (Fig. 8)with a repeated range from 1 to 17. 130 songs analysed mostly consisted of 5 notes accounting for 24 % of this song (average 5.8 ±2.6).. The inter-note intervals become shorter from phrase to phrase.

The peak frequency is higher in *C. v. sepulcralis* in Sulawesi (3 kHz) than that in *C. v. sepulcralis* from Mindanao (2.3 kHz), but the notes have a similar sonogram shape. Among

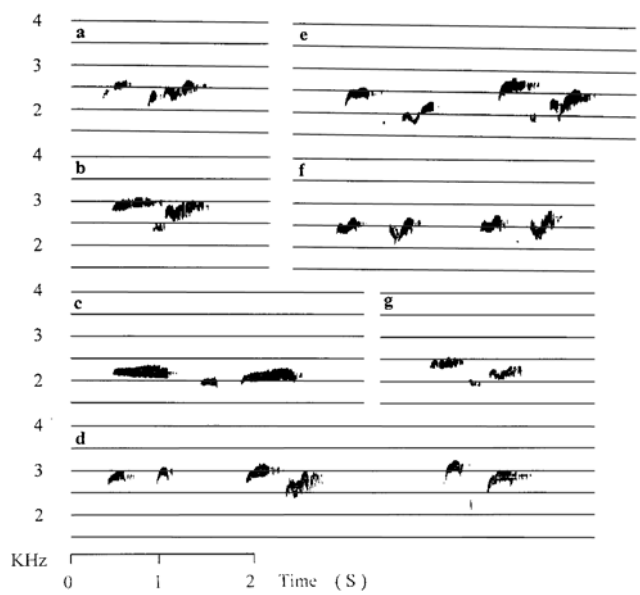

Fig. 7

Fig. 7. Rising song and its geographic variations in the brush cuckoo *Cacomantis variolosus* (a: *C. v. virescens* in South Tapanvli, North Sumatra, Indonesia, recorded by D. A. Holmes in 1974; b: in Sulawesi, Tengah, Indonesia, recorded by A. B. van den Berg in 1984; c: in Mt. Hagen, Papua, New Guinea in 1974; d: *C. v. sepulcralis* in Lore Lindu, Sulawesi, Indonesia, recorded by S. W. Smith in 1991, and by R. Watting in 1980; e: in Gombak, Malay Peninsula, recorded by C. Hails in 1980; f: in Upper Pierce Reserve, Singapore, recorded by C. Halls; g: *C. v. sepulcralis* in Mt. Katanglad, Mindanao, Philippines, recorded by A. Greensmith in 1990).

Table 4. Song and call diversity of the brush cuckoo.

Sound type and variations	Locality
S1 a; S2 b	South Tapanvli, North Sumatra, Indonesia
S1 b, d; S2 e; S4 a	Tengah, Sulawesi, Indonesia
S1 b; S2 a	Tengah, Sulawesi, Indonesia
S1 d; S2 e; S3 c	Lore Lindu, Sulawesi, Indonesia
S2 b	Teluk Bara, Boru, Indonesia
S2 a	Dumogo-Bone, Sulawesi, Indonesia
S4 b	Cavira, Java, Indonesia
S2 e	Anaso, Sulawesi, Indonesia
S1 g; S2 c; S2 f; S3 c	Mt. Katanglad, Mindanao, Philippines
S1 e, g; S2 d	Gombak, Malay Penninsula
S1 f, g; S2 d	Upper Pierce Reserve, Singapore
S2 c	Mt. Mahiling, Central Luzon, Philippines
S2 c, S2 f	Mt. Poles Pass, Northern Luzon, Philippines
S3 a	Moroee Prov., Papua New Guinea
S1 c	Mt. Hagen, Papua New Guinea
S3 a	WAU Morobe, New Guinea (S 7° 30, E 146° 30)
S3 a	Jimmi Valley, Western Highland, New Guinea (S 6°, E 144°)
S3 b	Queensland, Lamington, Australia
S4 b	Gubatten, Queensland, Australia
S4 b	Queensland, ME, Tanbonier, Palm Grove, Australia

Table 4 shows song types and their variants in the brush cuckoo.

individuals, S2 a, e song forms from Sulawesi have nearly identical sonograms; while S2 b, c, d and f song forms from North Sumatra, the Malay Peninsula, Singapore and the Philippine have similar sonograms; especially individuals in Northern Luzon which have not only S2 c but also S2 f; S2 f seems intermediate in song pattern between S2 a, e and S2 b, c, d (Fig. 8, Table 4).

Call 3. "fee-fee-fee..."
This is a quiet mournful whistle, '/⁀\' – shaped in nearly the same scale (Fig. 9), and repeated from 5 to 16 times. The inter-note interval seems relatively short.

The note "fee" of *sepulcralis* is repeated as many as 55 to 57 times in a song. The frequency and temporal traits are varying among forms and individuals but have a similar sonogram shape. The S3 b form in Australia has a longer note duration and shorter inter-note intervals than the S3 c form of Sulawesi and the Philippines; the S3 a form in Papua New Guinea is intermediate between S3 b and S3 c in note duration and inter-note intervals (Fig. 9, Table 4).

Call 4. "fea"
This is a loud whistle, repeated as many as 19 to 38 times in a series (Fig. 10). It resembles the "fear-fear-fear..." song type but with a longer time interval (Fig. 8 b–d). Sonograms of this song are similar among individuals from Indonesia and Australia (S4 a, b Table 4).

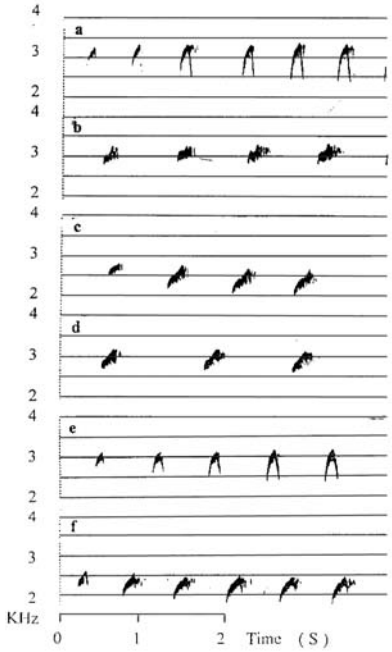

Fig. 8

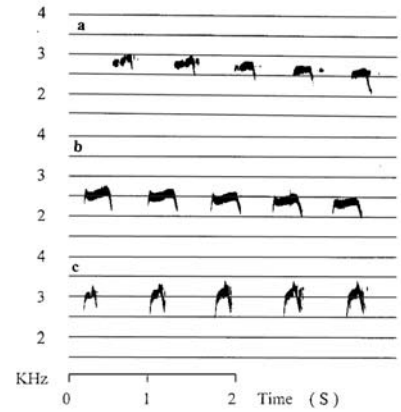

Fig. 9

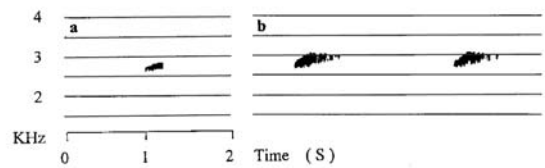

Fig. 10

Fig. 8. Cadence song of *C. variolosus* (a: *C. v. virescens* in Sulawesi, Tengah, Indonesia, recorded by A. B. van den B e r g in 1984; b: in South Tapanvli, North Somatra, Indonesia, recorded by D. A. H o l m e s in 1974; c: in Mt. Poles Pass, Northern Luzon, Philippines, recorded by A. W a s s i n k in 1985; d: in Gombak, Malay Peninsula, recorded by C. H a i l s in 1980; e: *C. v. sepulcralis* in Lore, Lindu Reserve, Sulawesi, Indonesia, recorded by N. G a r s n e r in 1992; f: *C. v. sepulcralis* in Mt. Katanglad, Mindanao, Philippines, recorded by S. H a r r a p in 1931).
Fig. 9. Call "fee..." of *C. variolosus* (a: in WAU Morobe, New Guinea, recorded by Z i m m e r m a n D. & M. E d w a r d s in 1979; b: in Queensland, Lamington, N. P.. Australia, recorded by J. F i s h e r in 1982; c: in Lore, Lindu Reserve, Sulawesi, Indonesia, recorded by N. G a r s n e r in 1992).
Fig. 10. Call "fea" of *C. variolosus* (a: *C. v. virescens* in Tengah of central Sulawesi, Indonesia, recorded by A. B. van d e n B e r g in 1984; b: Queensland, ME, Tanbonier, Palm Gpooe, Australia, recorded by T. C. W h i t e in 1979).

The cluster analysis

From the Fig. 11a, three individuals of *C. v. sepulcralis* from Philippine are clustered in a terminal branch; 6 individuals of *C. v. sepulcralis* from Indonesia and Singapore are clustered in a branch; 8 individuals of 4 subspecies of *C. merulinus* are clustered together, while 2 individuals of *C. v. virescens* are clustered in a terminal branch.

However, *C. v. sepulcralis* from Philippine and *C. v. sepulcralis* from Indonesia and Singapore are not gathered in a near branch. The possible reason is their cadence song is so varied in tempo, as shown in figure 8 (eg. e in Indonesia, f in Philippine). *C. v. sepulcralis* and *C. v. virescens* are not clustered in a near branch. The possible reason is the number of cadence song is not enough, or maybe they are so varied, which more studies are required to confirm. Obviously, their rising songs are clustered in a near branch, which suggests that they are closely related.

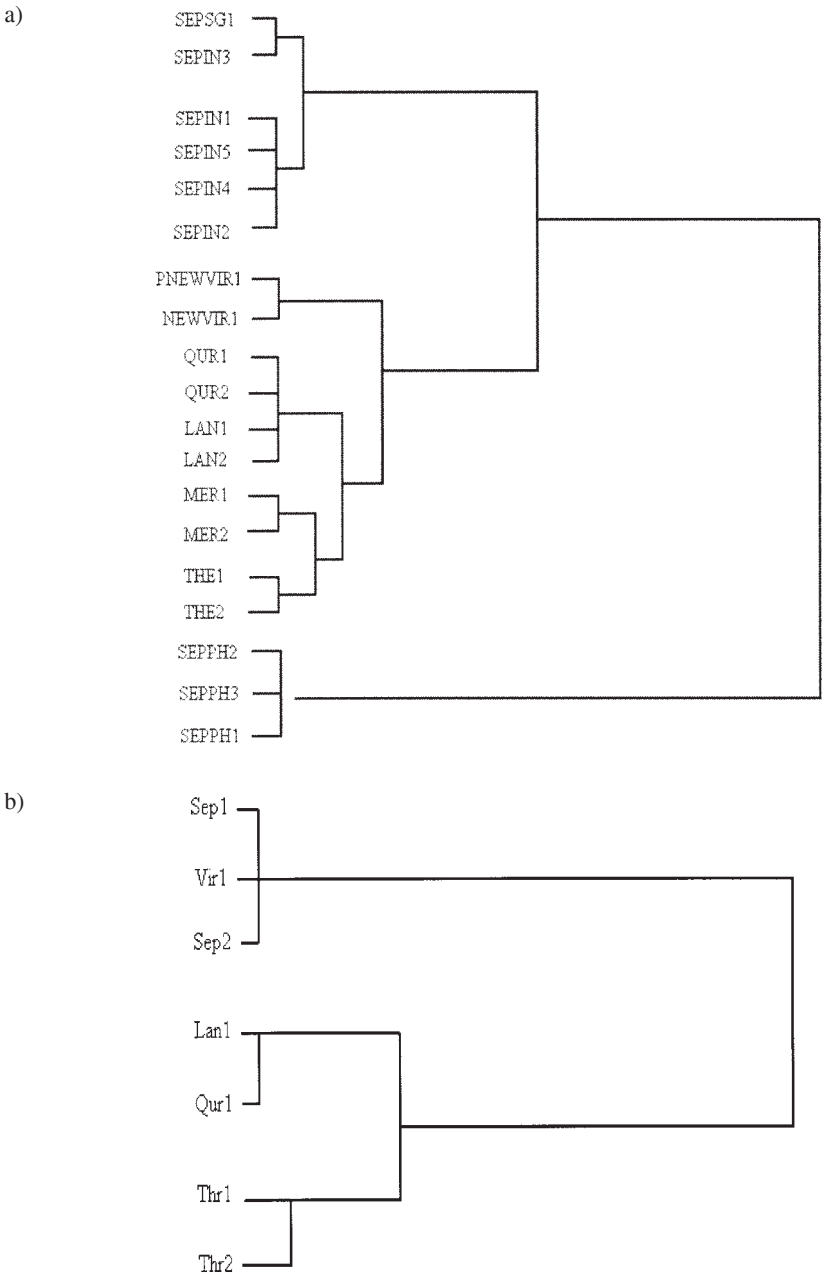

Fig.11. Two dendrograms of some individuals based on parameters of cadence song a) and rising song b) respectively.

From the Fig. 11b, we can find two main branches: 3 individuals of *C. variolosus* are clustered together, while 4 individuals of *C. merulinus* are clustered together. Two individuals of *C. m. threnodess* are clustered together.

Discussion

The plaintive cuckoo *C. merulinus* has 5 or 6 recognized call types: rising song "tay-ta-tee", cadence song "pwee, pee-", "tchree" or "piteer" call, "pier" call, "ji-jiu-ji-jiu" call and "schee-jiu" call. In addition, there is the "pee-pipee-pee, pipee-pee ?" call or its variant "pee-pipee-peepi, pipee-peepi ?" described by Ali & Ripley (1969), the "keveeear-keveear-keveear" call and its variant "wheeeh-whooh-pe-ti-weear pe-ti-weear" described by Roberts (1991), and the "ti-ter-wi" or "pee-to-peet" call described by Coates & Bishop (1997). However, all these descriptions might be the same as the rising song "tay-ta-tee" and its variants described in this paper. The 3-note song "tay-ta-tee" is the basic syntax of the rising song. The plaintive cuckoo can utter a complex song with different note-sequences in a phrase. In Indonesia, India, and the Malay Peninsula, different forms have the same song pattern although with variations in frequency and tempo. The call "pwee, pwee, pwee, pee-pee-pee-pee" described by MacKinnon & Phillipps (1993) might be the same song type as the cadence call "tee-tee-tee-tee-tita-tita-tita-tiat-tee" described by Smythies (1981) and the "ka.....pie" of Cheng et al. (1991), and might be the same song as our cadence song "pwee, pee-". We described this song here to show that the numbers of notes in this song type is varied and to show different appearance in sonograms of the note "tee" between song 1 and song 2. This song has been described as 4 slow notes followed by 4 rapid notes (Ali & Ripley 1969, Cheng et al. 1991). As we observed, notes in a phrase vary in number from 1 to 16 but generally have 9 rather than 8 notes. In Indonesia, the Malay Peninsula, Thailand, the Philippines and India, different forms have similar sonogram patterns with slight differences in the shape of notes and numbers of notes in a song.

In the plaintive cuckoo, the rising song and cadence songs of *passerinus* are similar to those in other forms of *C. merulinus*. The S5 song type sonograms from *paserinus* of Peninsular India are apparently identical to *C. m. querulus* in Assam. Those of *C. m. threnodes* in the Malay Peninsula, *C. m. querulus* in Thailand and *C. m. merulinus* in Sulawesi and the Philippines are similar (see Table 3), while *passerinus, querulus* and *merulinus* also have similar songs. In addition, their host species are the same, indicating that all these cuckoos have a similar ecological role (Payne 1997). Also, Smythies (1960) suggested that *passerinus* in Burma was broadly similar to the form *threnodes* in Borneo, and listed them as two different subspecies of *C. merulinus*. The songs are consistent with the suggestion that the grey-breasted Indian form of *passerinus* is a subspecies of *C. merulinus*. However, the territorial song of *passerinus* in Nepal (Martens & Eck 1995: Fig. 48 a–d) seems to differ in having a short angular introductory part connected with a long whistle by a short loop. The songs "ji-jiu-ji-jiu" and "schee-jiu" currently found in India have not so far been identified in current recordings from other localities. These apparent discrepancies require further investigation.

The low geographic variation and wide similarities of cuckoos' song suggest that song similarity in sonogram morph and tempo can be used in resolving taxonomic problem (Miller 1996, Payne 1997, Lei 2002, Lei & Payne 2002).

The brush cuckoo *C. variolosus* has 4 recognized sound types: rising song "where's the tea", cadence song "fear-fear-fear…", "fee-fee-fee…" call and "fea" call. Shrill rising song is a 3-note song type, which might be the same as the "pee-to-weeit" described by Coates & Bishop (1997). It also has a uniform song type with variation in frequency, tempo and note sequences (2-note) among different forms and also has diverse verbal descriptions

(Coates & Bishop 1997). The songs of *sepulcralis* in Sulawesi, Java, the Malay Penninsula, Singapore and the Philippines are apparently identical to those of other forms else where in Sulawesi and Papua New Guinea. The cadence song "fear-fear-fear..." (Fig. 8) might be the same as "wee" or "peeweet" (MacKinnon & Phillipps 1993) since it is repeated many times, slowing and descending by semitones, as is the "chu-ii, chu-ii" of Lekagul & Round (1991) and the "fear" call recorded by Coates & Bishop (1997). This song is similar to the "pier" of the plaintive cuckoo documented in this paper (Fig. 4). These *sepulcralis* song from Lore Lindu, Sulawesi, and Mindanao in the Philippines, are also apparently identical to those of *virescens* in South Sumatra and Tengah, Indonesia, and other forms in the Malay Peninsula (Fig. 4). Sonograms of the song "fee-fee-fee" are more level in shape than those of "fear-fear-fear". This song in *sepulcralis* from Sulawesi and Mindanao is apparently similar to that of *C. v. variolosus* from Queensland, Australia and the form in New Guinea, but with longer time repetition. The sonogram shape of *sepulcralis* seems to be more intermediate between Song type 2 and 3. Thus we suggest that these two songs of *sepulcralis* are apparently identical to those of other forms (see Table 4), which supports the hypothesis that the rusty-breasted or Indonesian cuckoos of the form *sepulcralis* are the same species as *C. variolosus*.

Comparing the plaintive cuckoo with the brush cuckoo, we found that the rising songs of the Plaintive Cuckoo and Brush Cuckoo are similar in structure and that the "pier" call of the former species is similar to the "fea" call of the latter one. So, at least two songs are nearly identical between these two species. The form *sepulcralis* has been considered probably more closely related with *C. merulinus* than with *C. variolosus* (White & Bruce 1986). In Java, it was also considered to have a rising call similar to that of the plaintive cuckoo but more rapid and jumbled (Coates & Bishop 1997). However, from the sonograms, the rising song of *sepulcralis* is much more similar to that of other forms of *C. variolosus* than to that of *C. merulinus* with its more complicated note-sequences in the rising song. The dendrogram b (Fig. 11b) also shows that. The cadence song "fear..." of *sepulcralis* is similar to that of other forms of *C. variolosus* rather than *C. merulinus*.. On the other hand, the cadence song "pwee, pee" in *C. merulinus* was not found in *sepulcralis*. The "fee..." and "fea" call types are also similar to those of other forms of *C. variolosus.* The dendrogram a (Fig. 11a) also shows that *sepulcralis* is more different from *C. merulinus* than *C. v. virescens* from *C. merulinus.* Thus we suggest that *sepulcralis* is conspecific with *C. variolosus* rather than *C. merulinus*. However, more song recordings are needed to measure and confirm the generality of the observed similarities. The young of brood parasitic cuckoos may never hear their parents, so it seems unlikely that songs are learned in these species. The song similarities of the plaintive cuckoo and the brush cuckoo are homologous. They have also been given corresponding terms between species. As there is no evidence for song learning in cuckoos, we suggest that the plaintive cuckoo and brush cuckoo share these songs as a result of common ancestry (homology) rather than learning. The song similarity of these 3 species and maybe with other closely related species, and their song evolution, remains to be determined.

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