Mathews, G. M. 1912a. Additions and corrections to my Reference List to the birds of Australia. *Austral Avian Record* 1: 25–52.
Mathews, G. M. 1912b. Editorial notice. *Austral Avian Record* 1: 65.
Mayr, E. 1986. Monarchidae. *In* Watson, G. E., Traylor, M. A. & Mayr, E. (eds.) *Check-list of birds of the world*, vol. 11. Mus. Comp. Zool., Cambridge, MA.
Mees, G. F. 1982. Birds from the lowlands of southern New Guinea (Merauke and Koembe). *Zool. Verhand., Leiden* 191.
Schodde, R. & Mason, I. J. 1999. *The directory of Australian birds passerines*. CSIRO Publishing, Melbourne.

Addresses: Richard Schodde, Australian Biological Resources Study, GPO Box 787, Canberra City, ACT 2601, Australia, e-mail: Richard.Schodde@deh.gov.au. Edward Dickinson, The Trust for Oriental Ornithology, Flat 3, Bolsover Court, 19 Bolsover Road, Eastbourne BN20 7JG, UK.

The taxonomic status of the three subspecies of *Cuculus saturatus*

by Ben King

Received 3 January 2004

Cuculus horsfieldi Moore 1857, *Cuculus saturatus* 'Hodgson' Blyth 1843, and *Cuculus lepidus* S. Müller 1845, were all originally described as species. However, Peters (1940) placed *C. horsfieldi* as a subspecies of *C. saturatus* and *C. lepidus* as a subspecies of *C. poliocephalus* Latham 1790. Wells & Becking (1975) demonstrated that *lepidus* was more closely related to *C. saturatus*, based on its song, which they described and illustrated with sonograms. A classification of *C. saturatus* consisting of three subspecies was generally followed into the 1990s, e.g., by Sibley & Monroe (1990), Howard & Moore (1991) and Wells (1999). However Payne (1997) considered *C. horsfieldi* a species separate from *C. saturatus*, based on differences in their songs, which he described. Clements (2000) followed this split.

The breeding ranges of the three forms of *Cuculus saturatus* are allopatric. *C.* (*s.*) *horsfieldi* breeds across northern Eurasia from north-east Europe to Japan and north-east China. *C.* (*s.*) *saturatus* breeds across the Himalayas, southern China, Taiwan and the extreme northern part of south-east Asia. *C.* (*s.*) *lepidus* is resident in Malaya, and the Greater and Lesser Sunda Islands. *C.* (*s.*) *horsfieldi* and *C.* (*s.*) *saturatus* winter from southern India east and south to New Guinea and Australia. Recent field work and museum study suggests that the taxonomic status of these forms should be revisited.

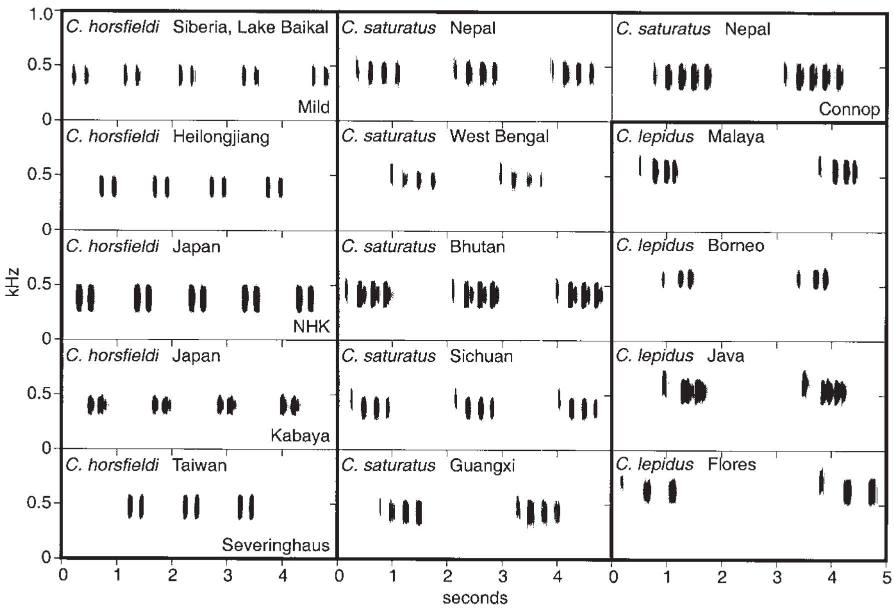

Figure 1. Samples of the territorial songs of *Cuculus* (*s.*) *horsfieldi*, *C.* (*s.*) *saturatus* and *C.* (*s.*) *lepidus* from different parts of their ranges. Note that the song of *horsfieldi* consists of only two equal notes whilst that of *saturatus* has 3–4 equal notes with a higher pitched introductory note. *C.* (*s.*) *lepidus* song differs from *saturatus* song by its higher pitch, with only 2–3 equal notes.

Songs

Wells & Becking (1975) presented a single sonogram for each of the three *C. saturatus* forms (with two for *lepidus*: one from Java and one from peninsular Malaysia), as well as *C. poliocephalus*. They relied on published descriptions to establish the universality of each form's song and concluded that the songs of the three forms of *saturatus* they recognised were sufficiently similar to indicate conspecificity, whilst the song of *C. poliocephalus* was quite distinct.

Herein are presented sonograms (Figs. 1–2) of recently recorded and previously unpublished (mostly) tape-recordings of all four of these forms from different parts of their wide ranges, indicating that the song of each is indeed universal. The much higher pitched song of *C. poliocephalus* is so different that further comparison with the three *C. saturatus* forms is considered unnecessary.

The song of *horsfieldi* is a deep booming couplet *hoop hoop* (occasionally 3–4 notes), the two notes 0.3–0.5 kHz in frequency, *c*.0.14 seconds apart. The call of *saturatus* is composed of 3–4 similar *hoop* notes similarly spaced and pitched, with a shorter introductory *huk* note on a higher frequency (0.35–0.58 kHz). The song of *lepidus* is similar in structure to *saturatus* but the entire song is higher pitched, with only 2–3 *hoop* notes. Most of the energy of the *hoop* notes is above 0.5 kHz (i.e. 0.45–0.70 kHz).

The number of *hoop* notes varies among as well as between individuals in all three forms. David Wells (pers. comm.) states that *lepidus* in peninsular Malaysia produces songs similar to those of *saturatus* and *horsfieldi*, albeit in the *lepidus* pitch range and subordinate to its normal song. Lindholm & Lindén (2003), in a study of *horsfieldi* songs from north-east Europe and across Siberia state that the basic rhythm of its song 'could be described as invariably having bisyllabic phrases', and described several variants. My own field experience with all three forms suggests that, whilst there is variability in the numbers of *hoop* notes and presence or absence of the introductory *huk* note, usage of the 'normal' song as presented in the sonograms and the description above is well over 99%. Thus, each of the three forms of *Cuculus saturatus* has a distinct song, which readily identifies the individual.

Playback experiments *per se* were not carried out. However, in the course of tape-recording, I normally playback the voices of the birds I record to visually ensure the correct identity of the vocalist. Response of *Cuculus* cuckoos varies immensely from none to approaching closely and calling more. In the course of these playbacks, I have never observed a response by a *Cuculus* cuckoo other than the species whose vocalisations were played. This experience indicates that the main function of *Cuculus* songs is intraspecific communication and bolsters the notion of their usefulness as a taxonomic character. It also suggests that playback experiments might be helpful in elucidating *Cuculus* systematics.

The recording of *horsfieldi* from Taiwan by Severinghaus on 29 April is interesting in that *horsfieldi* is not known to breed that far south, yet it was made during the breeding season on that island, and although the date is not too late in spring for the bird to have been en route further north, *Cuculus* cuckoos rarely call away from their breeding areas. This suggests that a reassessment of the taxonomic status of the birds breeding on Taiwan is needed.

Sonograms were made using Canary 1.2.4, the Bioacoustics Workstation of the Bioacoustics Research Program at the Macaulay Library of Natural Sounds at the Cornell Laboratory of Ornithology.

Morphology

The plumage of females is identical to that of males in each of the three forms, except for the brown 'hepatic' plumage phase of some females. The respective plumages of *horsfieldi* and *saturatus* are identical, including the brown 'hepatic'

TABLE 1

Comparison of wing length of adults (presumed accurately sexed) of *Cuculus* (*s.*) *horsfieldi*, *C.* (*s.*) *saturatus* and *C.* (*s.*) *lepidus*. Note that there was no overlap in the sample measured. However, with a larger sample, Robert Payne (pers. comm.) found slight overlap in wing measurements of adult *C.* (*s.*) *horsfieldi* and *C.* (*s.*) *saturatus* of *c*.5%. Measurements in mm; s.d. = standard deviation.

	Male	Female
Cuculus (*s.*) *horsfieldi*		
flattened wing length		
sample size	13	8
mean (range)	203.5 (194–212)	196.9 (186–212)
s.d.	5.7	7.8
Cuculus (*s.*) *saturatus*		
flattened wing length		
sample size	14	5
mean (range)	186.7 (174–192)	177.0 (172–185)
s.d.	4.8	6.4
Cuculus (*s.*) *lepidus*		
flattened wing length		
sample size	14	15
mean (range)	156.2 (147–169)	147.5 (143–152)
s.d.	6.2	3.5

phase females, and there appears to be no way to differentiate them by plumage alone, either in the field or in the hand (Robert Payne, pers. comm.).

Most accurately sexed specimens of *horsfieldi* and *saturatus* can be distinguished by *horsfieldi*'s larger size (i.e. wing length); see Table 1 and Fig. 3. From a larger sample, Robert Payne (pers. comm.) found that 95% of accurately sexed adult specimens could be differentiated.

However, grey phase *lepidus* can readily be differentiated from the grey phase of both *horsfieldi* and *saturatus* by both plumage characters (Table 3) and measurements (Table 1 and Fig. 3). *C.* (*s.*) *lepidus* is overall darker with broader dark bands on the lower breast and belly, and darker, more rusty-buff, undertail-coverts. None of the *lepidus* in the sample overlapped with *saturatus* or *horsfieldi* in wing length, and only a few in culmen length.

'Hepatic' phase female *C.* (*s.*) *lepidus* can be distinguished from 'hepatic' phase female *saturatus* and *horsfieldi* by darker rufous upperparts with broader black barring, and broader black barring on the underparts.

C. (*s.*) *lepidus* also shows a difference in wing formula (see Table 2), with p7 (numbered from the outermost secondary) being second longest and p9 being third longest (usually reversed in *horsfieldi* and *saturatus*), and has a slightly more rounded wing. As both *horsfieldi* and *saturatus* are migratory, a more pointed wing than in resident *lepidus* could be expected and this difference is not presented as having taxonomic significance.

Discussion

The genus *Cuculus* comprises a group of species very much alike in plumage, so much so that they are normally difficult or impossible to differentiate by sight alone, and often difficult to identify even in the hand. They are, however, highly vocal during the breeding season, often seeming to call all day and all night. Each species has a distinctive song that is stereotyped and much the same over its entire range. These species-specific songs enable identification and are an excellent key to their taxonomic status (Payne 1997).

With the larger number of tape-recordings of the three *Cuculus saturatus* forms from a broad sample of their wide ranges now available, it can be demonstrated that, whilst the songs of all three forms are variable, each has a consistent and different 'normal' song, which is that usually heard in the field.

TABLE 2

Comparison of wing formula of *Cuculus* (*s.*) *horsfieldi*, *C.* (*s.*) *saturatus* and *C.* (*s.*) *lepidus*. Note somewhat different wing shape of *lepidus*. Measurements in mm.

	horsfieldi 12 specimens (8 males, 3 females, 1?)	*saturatus* 11 specimens (8 males, 3 females)	*lepidus* 13 specimens (9 males, 3 females, 1?)
Longest primary	8	8	8
Second-longest primary—mean distance from tip (range)	9 (7 once) 9 = 7 (four times) 6.6 (0.0–8.8)	9 (7 twice) 9 = 7 (three times) 8.0 (0.0–10.2)	7 5.3 (3.2–8.0)
Third-longest primary—mean distance from tip (range)	7 (9 once) 7 = 9 (four times) 9.2 (0–11.1)	7 (9 twice) 7 = 9 (three times) 9.5 (0.0–13.3)	9 9.7 (7.1–12.2)
Fourth-longest primary—mean distance from tip (range)	6 24.2 (18.4–29.1)	6 21.7 (19.0–24.0)	6 16.5 (13.1–19.8)
Fifth-longest primary—mean distance from tip (range)	5 40.1 (32.8–46.8)	5 36.6 (25.5–38.9)	5 27.0 (23.3–31.4)

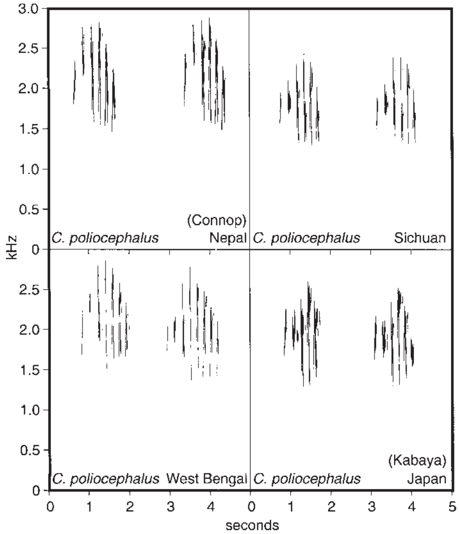

Figure 2. Samples of the territorial song of *Cuculus poliocephalus* from different parts of its range.

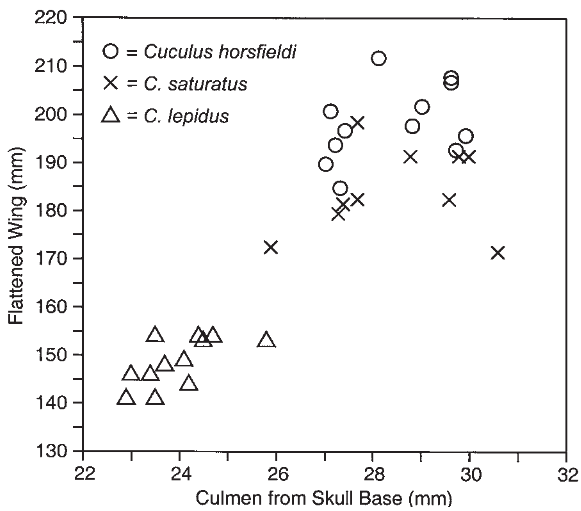

Figure 3. Scatter plot of wing length against culmen length for respective sexes of *Cuculus* (*s.*) *horsfieldi*, *C.* (*s.*) *saturatus* and *C.* (*s.*) *lepidus*. Note that there is no overlap in this sample in wing length between respective sexes of the three forms. However, with a much larger sample, Robert Payne (pers. comm.) found *c.*5% overlap in wing length of respective sexes of *horsfieldi* and *saturatus*. Note also that there is no overlap in culmen length between *horsfieldi* and *lepidus*, but some overlap between *saturatus* and *lepidus*, and nearly complete overlap between *horsfieldi* and *saturatus*.

TABLE 3
Comparison of grey-phase adult *Cuculus* (*s.*) *saturatus* and *C.* (*s.*) *horsfieldi* with grey-phase adult *C.* (*s.*) *lepidus*.

Cuculus (*s.*) *saturatus* *Cuculus* (*s.*) *horsfieldi*	body area	*Cuculus* (*s.*) *lepidus*
dark grey	upperparts of body	dark slaty grey
more, because neck paler	contrast between sides of neck and dark upperwing-coverts	little, because neck darker
pale grey	throat and upper breast	grey
white, often with buffy tinge	base colour of lower breast and belly	pale buffy
*c.*60% of width of pale bands	dark bars on lower breast and belly	almost equal in width to pale bands
buffy	undertail-coverts	rusty buff

Morphologically, *horsfieldi* and *saturatus* differ only in size, with much overlap. However most (*c.*95%) accurately sexed adult specimens can be differentiated by wing length.

C. lepidus differs markedly from *saturatus*/*horsfieldi* in plumage and size, its plumage differing sufficiently to permit field identification of *lepidus* by sight alone, whilst measurements will easily distinguish most, if not all, *lepidus* specimens. In a genus wherein most species are morphologically very close, *lepidus* is conspicuous in its differences from *saturatus*/*horsfieldi*.

The similarity between the songs of *lepidus* and *saturatus* suggest *saturatus* is the closest relative of *lepidus*, whilst the different songs of *Cuculus canorus* Linné 1758, and *C. micropterus* Gould 1837, suggest that they are more distant genetically from *saturatus*. But, morphologically, *canorus, micropterus* and *saturatus/horsfieldi* are quite similar to each other, yet quite distinct morphologically from *lepidus*. I would argue that vocalisations are a better indicator of relatedness than morphology in this case.

It is concluded that the three forms of *Cuculus saturatus* all represent species taxa, based on their distinct songs and different measurements, the case of *lepidus* bolstered by its distinct plumage. The following English names are recommended: Oriental Cuckoo *C. horsfieldi*; Himalayan Cuckoo *C. saturatus*; and Sunda Cuckoo *C. lepidus*.

The distinct song types and measurements of each of the three forms, as well as the plumage differences between *lepidus* and *saturatus*/*horsfieldi* satisfy the diagnosibility requirement of the Phylogenetic Species Concept. Their breeding allopatry will prevent merging in the future. Satisfying the non-interbreeding requirement of the Biological Species Concept is more difficult and involves a judgment call because the three forms are allopatric in their breeding range. However, I would postulate that the distinct calls of these three forms would operate as an effective isolating mechanism if they were to meet on their breeding grounds. DNA studies and possibly playback experiments would help to resolve the taxonomic status of the three forms.

The variation in the vocalisations shown by the sonograms of *C. lepidus* cannot be understood without more data. It will take a study of vocalisations, DNA, measurements and plumage characteristics from a series of individuals from each main island group in the Greater and Lesser Sundas to determine whether *C. lepidus* is one variable species or several.

Acknowledgements

Jeff Groth, Mary LeCroy, Robert Payne, David Wells and an anonymous reviewer provided helpful commentary. Jeff Groth prepared the sonograms. John Fitzpatrick and Greg Budney of the Macaulay Library of Natural Sounds at the Cornell Laboratory of Ornithology provided support and the use of tape-recording equipment. The Taiwan *C. horsfieldi* recording by Sheldon Severinghaus is on deposit at the Macaulay Library of Natural Sounds at the Cornell Laboratory of Ornithology; the Nepal *C. saturatus* tape-recording by Scott Connop is on his single cassette *Birdsongs of Nepal*, published by the Cornell Laboratory of Ornithology in 1993; the first Japanese *C. horsfieldi* tape-recording is from a three-cassette collection, entitled *Japanese birds in sound, 100 well-known species*, published in 1971 by NHK TV in Japan; the second Japanese *C. horsfieldi* tape-recording is on a six-CD set by Tsuruhiko Kabaya, *The songs and calls of 420 birds in Japan*, published by Shogakukan, Tokyo, in 2001; the Siberian *C. horsfieldi* by Krister Mild is on his self-published two-cassette *Soviet bird songs* (1987), Stockholm. All of the recordings without a parenthetical recordist were made by Ben King and will eventually be deposited at the Macaulay Library of Natural Sounds at the Cornell Laboratory of Ornithology. All measured specimens are housed at the American Museum of Natural History, New York.

References:

Clements, J. F. 2000. *Birds of the world: a checklist*. Ibis Publishing, Vista, CA.

Howard, R. & Moore, A. 1991. *A complete checklist of the birds of the world.* Second edn. Academic Press, London.

Lindholm, A. & Lindén, A. 2003. Oriental Cuckoo in Finland. *Alula* 9: 122–133.

Payne, R. B. 1997. Cuckoos (Cuculidae). Pp. 508–607 *in* del Hoyo, J., Elliott, A. & Sargatal, J. (eds.) *Handbook of the birds of the world*, vol. 4. Lynx Edicions, Barcelona.

Peters, J. L. 1940. *Check-list of the birds of the world*, vol. 4. Harvard Univ. Press, Cambridge, MA.

Sibley, C. G. & Monroe, B. L. 1990. *Distribution and taxonomy of birds of the world.* Yale Univ. Press, New Haven & London.

Wells, D. R. 1999. *The birds of the Thai-Malay Peninsula.* Academic Press, London.

Wells, D. R. & Becking, J. H. 1975. Vocalizations and status of Little and Himalayan Cuckoos, *Cuculus poliocephalus* and *C. saturatus* in Southeast Asia. *Ibis* 117: 366–371.

Address: Ornithology Department, American Museum of Natural History, Central Park West at 79th Street, New York, NY 10024, USA.