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Identification of Oriental Cuckoo and Common Cuckoo based on primary pattern

Petteri Lehikoinen & Roni Väisänen

Identification of Oriental Cuckoo *Cuculus optatus* has always been a topic of lively discussions among birders in Europe. As an extremely rare vagrant to Europe (outside Russia), the species has gained an almost mythical reputation. The currently known plumage differences between Oriental and Common Cuckoo *C canorus* overlap considerably and are difficult to assess in the field (Cramp 1985). The lack of reliable identification features for Oriental, besides vocalisation, is surprising. This lack of knowledge might result in a vagrant Oriental being overlooked in Europe, especially during migration periods when records are more probable. During migration, birds usually remain silent, unlike in the breeding season when they are actively advertising territory through vocalizations.

The aim of this paper is to shed some light on the plumage features of Oriental Cuckoo and on separating it from the different subspecies of Common Cuckoo by studying museum specimes. Nowadays, a substantial proportion of birders are equipped with cameras, and the features presented in this paper can be interpreted even from flight photographs of lower quality.

Range and geographical variation

Oriental Cuckoo has a more eastern breeding range than Common Cuckoo. Oriental breeds in Russia from west of the Ural mountains all the way east to Kamchatka and winters south from south-eastern Asia to Australia (figure 1). The related more southern species Himalayan Cuckoo *C saturatus* was formerly considered conspecific with Oriental (Erritzøe et al 2012) but is nowadays often treated as a full species (eg, Dickinson & Remsen 2013, Gill et al 2020). Himalayan is widely distributed in south-eastern Asia and a shorter-distance migrant than Oriental, wintering south to New Guinea. It is remarkably smaller in size than Oriental (Erritzøe et al 2012), although there is some overlap (Payne 2005). Oriental and Himalayan are very similar in plumage. Literature presents differences in the fringes of juvenile contour feathers between the two but the information is slightly contradicting. Payne (2005) describes juvenile Himalayan as having broader white fringes on crown, back, and wing-coverts and tips of inner secondaries than Oriental, whereas Erritzøe et al (2012) report these being buffish in juvenile Himalayan and white in juvenile Oriental. A hepatic morph occurs in both Oriental and Himalayan (Erritzøe et al 2012). The songs of these two species differ from each other, which is the most important feature to identify the two (Lindholm & Lindén 2007, Xia et al 2016).

The precise distribution ranges of Oriental Cuckoo and Himalayan Cuckoo in China are unclear (Payne 2005, Xia et al 2016). Based on song differences, Himalayan occurs north to Shanxi and north-east to Hebei and Oriental south to Liaoning (Xia et al 2016). According to Payne (2005) and Erritzøe et al (2012), birds in Taiwan belong to Himalayan based on their small size. However, Xia et al (2016) found that their song is more like Oriental.

Common Cuckoo is more widespread than Oriental Cuckoo and most authors recognize four subspecies: *C c canorus* (hereafter nominate *canorus*), *C c bangsi* (hereafter *bangsi*), *C c subtelephonus* (hereafter *subtelephonus*) and *C c bakeri* (hereafter *bakeri*) (eg, Payne 2005, Erritzøe et al 2012, Gill et al 2020). Nominate *canorus* breeds in Europe and across Russia, Kazakhstan, Mongolia and northern China, as far east as Kamchatka (figure 1). The breeding range of *bangsi* is restricted to the Iberian peninsula and extreme north-western parts of the Maghreb. *Bakeri* breeds from north-eastern India, Bhutan and northern Vietnam to south-eastern China. *Subtelephonus* has a breeding range from the southern Caspian Sea to southern Mongolia and the extreme north-western parts of China. *Bangsi* and most nominate *canorus* winter in Africa, south of the Sahara. *Subtelephonus* winters in India and eastern parts of Africa, whereas *bakeri* and eastern populations of nominate *canorus* winter in south-eastern Asia (Cramp 1985, Erritzøe et al 2012). However, there

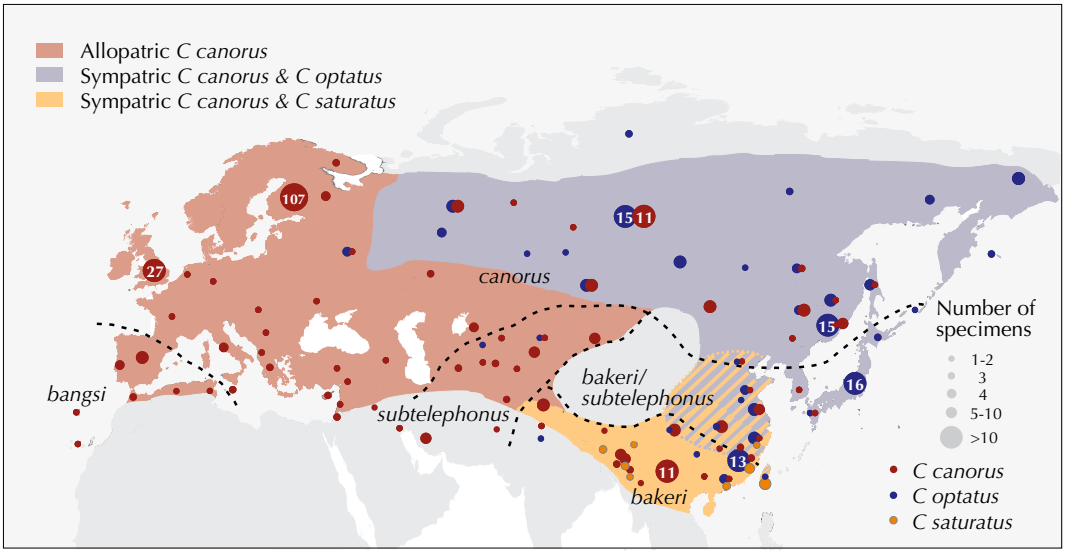

FIGURE 1 Map showing rough distributions of Common Cuckoo *Cuculus canorus* subspecies, Oriental Cuckoo *C optatus* and Himalayan Cuckoo *C saturatus* (Payne 2005, Erritzøe et al 2012, Xia et al 2016) together with collection localities of studied museum specimens. Pale red: allopatric occurrence of Common; pale violet: sympatric occurrence of Common and Oriental; pale orange: sympatric occurrence of Common and Himalayan. Dashed area: uncertain situation of distributions of Oriental and Himalayan (see text). Literature is inconsistent regarding subspecies of Common occurring in central China and maybe both *C c bakeri* and *C c subtelephonus* occur (see text). Collection localities shown in dots, where colours represent taxon collected (see legend). Size of dots represents number of samples collected on each site. Number of samples indicated in dots for localities with sample sizes >10.

is recent evidence that birds breeding in north-eastern Mongolia and Beijing, China, also migrate to winter in eastern Africa (Beijing Cuckoo Project 2019). Literature is not consistent with the subspecific status of birds in central China, which might be due to phenotypic variation (Payne 2005). According to Cramp (1985), the distribution of *subtelephonus* continues east through Mongolia and northern and central China as far as Japan, and due to their intermediate size, the eastern birds could be separated as their own subspecies, *C c telephonus*. However, currently *telephonus* is not usually considered a valid subspecies (eg, Gill et al 2020, Payne et al 2020).

The variation in phenotype of these apparently clinal subspecies has not been extensively described (eg, Cramp 1985, Erritzøe et al 2012). *Bangsi* differs from the other subspecies by its small size. The hepatic morph is unknown in *bangsi* (Erritzøe et al 2012) but some females are said to have extensive rufous on the breast (Cramp 1985). *Subtelephonus* has whiter underparts and thinner black bars on the breast than nominate *canorus*. It is also paler on the upperparts than nominate *canorus*. *Subtelephonus* is similar in size as nominate *canorus*, although Cramp (1985) mentions that typical individuals in Central Asia are as small as *bangsi*. The underwing-coverts and axillaries of *subtelephonus* are said to be less barred (Erritzøe et al 2012). In contrast, *bakeri* is darker on the upperparts than nominate *canorus* and has denser barring on the underparts. Similar to *bangsi*, *bakeri* is not known to have a hepatic morph (Erritzøe et al 2012). In size, *bakeri* is described as slightly smaller than nominate *canorus* and *subtelephonus* (Payne 2005).

Vagrancy of Oriental Cuckoo in Europe

Despite the potential for vagrancy of Oriental Cuckoo into Europe as a Wetsren Palearctic (WP) breeder and long-distance migrant, a recent record in Finland is the only one outside Russia we are aware of. Furthermore, in the (greater) WP and outside breeding range, Oriental has occurred as a vagrant only in Israel (a juvenile ringed and photographed at Eilat on 17 August 1985; Shirihai 1999) and Iran (two records in 1898: on 20 April (collected) and 28 September; Khaleghizadeh et al 2017). The observations (n=35) in New Zealand, c 2000 km from the nearest winter-

ing grounds in eastern Australia (Miskelly et al 2017) represent the vagrancy potential of the species. Therefore, the small number of observations in the (greater) WP outside breeding range is somewhat surprising.

The Finnish record concerned a territorial male at Sotkamo in the eastern part of the country. The bird was found singing in the summer of 2015 and returned to the same location in 2016 (Väisänen et al 2016, 2017; cf Dutch Birding 37: 272, plate 422-423, 2015; plate 304, 308). Following this record, there were some suggestions that Oriental Cuckoo may have been overlooked in Finland and that it could be a more frequent visitor. Finland has a breeding bird monitoring scheme consisting of a grid of transect lines in every 25 km, and, in addition, a different scheme concentrating on protected areas. If the species occurred annually in Finland with several singing individuals, we would presume it to be encountered in either of these monitoring schemes, or accidentally by birders more often than once. It is noteworthy that there are three earlier reports of singing birds from Finland which were initially believed to be Oriental (Vasamies 1998, Lindroos & Luoto 2000; plate 305-306). However, closer examination of these birds revealed that their songs differed from what is typical for Oriental and they also showed partly intermediate plumage features between Oriental and Common Cuckoo (Lindholm & Lindén 2003). These reports have been rejected by the Finnish rarities committee (Luoto et al 2005; see below). Due to the intermediate song and appearance, these birds could have been hybrids but there is no hard evidence for this assumption. Because of these birds, however, erroneous information on the species' breeding occurrence in Finland has crept into the literature (eg, Payne 2005).

Material and methods

The previous identification problems in this species meant that the Sotkamo bird got special attention by the Finnish rarities committee. In June 2015, long recordings of song and calls were obtained and it was captured for close examination. Thanks to widely available reference material, it was concluded that the vocalisations of the Sotkamo bird corresponded with typical Oriental Cuckoo. However, reference material for measurements and plumage details were scarce. Therefore, in 2016-18, we studied the collections of the Natural History Museum, Tring, England; the Zoological Institute of the Russian Academy of Sciences, St Petersburg, Russia; and the Finnish Museum of Natural History, Helsinki, Finland. Altogether, we investigated 314 specimens of the four subspecies of Common Cuckoo, 153 of Oriental and 19 of Himalayan Cuckoo (table 1, figure 1). Only specimens collected roughly in the breeding season (mainly May-August) were considered, although this does not safely exclude individuals on migration. We excluded specimens from wintering grounds, since the taxa apparently mix in winter and collection locality does not provide as good support for (sub)specific identification as in the breeding season. We classified specimens to the taxon as on the original labels. Birds labelled as a taxon that is no longer recognized were attributed to the taxon in which it is subsumed nowadays; it means that specimens labelled as Common Cuckoo *C c 'telephonus'* from central China were included in *bakeri*, based mainly on the distribution of *'telephonus'* given in the literature (eg, Erritzøe et al 2012). Likewise, specimens labelled as Common *C c 'johanseni'* were included in nominate *canorus* (cf Gill et al 2020, Payne et al 2020). The original identification to species level appeared to be almost always correct and we found only one specimen labelled

TABLE 1 Wing lengths (maximum chord; mm) of museum specimens of Common Cuckoo *Cuculus canorus*, Oriental Cuckoo *C optatus* and Himalayan Cuckoo *C saturatus*. Given are: range, average and sample size. 'Adult' includes both sexed and unsexed specimens. Specimens from collections of Natural History Museum, Tring, England; Zoological Institute of the Russian Academy of Sciences, St Petersburg, Russia; and Finnish Museum of Natural History, Helsinki, Finland.

Taxon	male	female	adult	juvenile
C canorus bangsi	207-220; 213.2 (7)	188-219; 206.0 (6)	188-222; 210.9 (15)	199 (1)
C c canorus	199-246; 225.3 (85)	191-244; 213.7 (50)	191-246; 220.9 (146)	181-228; 207.8 (86)
C c bakeri	207-235; 218.8 (17)	197-217; 208.6 (5)	197-235; 214.7 (52)	182-204; 193.6 (3)
C c subtelephonus	–	–	207-232; 218.0 (11)	–
C optatus	194-225; 205.5 (55)	182-213; 195.0 (39)	182-225; 201.5 (109)	169-210; 193.5 (44)
C saturatus	176-190; 181.0 (3)	169-192; 181.2 (10)	169-195; 182.3 (18)	181 (1)

as Oriental for which we had a firm reason to believe that it actually was a nominate *canorus* due to its long wing, thin barring on belly, completely barred underwing-coverts and paler upperparts compared with the majority of Oriental specimens. Also, the primary pattern of this individual was distinctively different from the rest of Oriental specimens. Due to obvious mismatch between label and appearance, this specimen was discarded from the study.

Identification

Oriental Cuckoo and Himalayan Cuckoo are smaller in size than Common Cuckoo, which can be seen in wing lengths (table 1). The size difference might even be useful in the field but there is overlap in size between the species. It is also worth noting that the geographical variation among Common is extensive, including clear differences in size between subspecies. In addition to size, also other plumage characters separating the species are overlapping (eg, Payne 2005, Erritzøe et al 2012). Oriental has on average wider and darker bars on the underparts than Common. Bars are also on average fewer in Oriental, being sparser and more well defined. The pattern and colour of undertail-coverts and vent are also described to differ between the species, with Oriental more often having weaker markings as well as some rusty-buff tones on vent and undertail-coverts. The underwing-coverts of Oriental normally have the same rusty-buff tone. The colour of the upperparts also differs on average, Oriental being usually darker and more bluish than the paler and greyish Common. The mentioned characters however seem to show considerable variation between the two species (plate 302-303) and are not very helpful for field identification (Kennerley & Leader 1991). Eye colour should also differ between Oriental and Common (Bengtsson 2002). Lindholm & Lindén (2003) concluded that females normally have darker eyes than males and second calendar-year birds have darker eyes than adults. The most marked difference in eye colour is seen in adult males, as Oriental has a dark brownish-toned iris while in Common the iris is paler and yellow. However, ageing is not always straightforward, since second calendar-year birds returning to the breeding grounds in spring may have had a complete moult during winter and only birds with unmoulted feathers can be reliably aged (Demongin 2016).

Differences in the underwing pattern have been emphasized only quite recently, and especially the pattern of underwing-coverts seems to be, at least, a strongly indicative identification criterium (Kennerley & Leader 1991, Lindholm & Lindén 2003, Mann 2014). In Common Cuckoo, the leading edge of the underwing is clearly barred and the background colour is close to pure white, while Oriental Cuckoo shows a plain or very lightly barred leading edge with a warm buff wash. Lindholm & Lindén (2003) concentrated on analysing the differences in vocalizations of the two species but also presented some of the first insights to quantify differences in underwing pattern. These differences overlapped between the two species but indicated marked differences in the pattern of primaries. We concentrated on this feature in our study of museum specimens, as it appeared to us one of the clearest measurable differences between the two species and yet, as far as we know, still unpublished.

Primary pattern

We focused our study on the amount of barring of the three outermost primaries (hereafter: p10 = outermost, p9 = second outermost and p8 = third outermost). These primaries showed the most pronounced differences between the species and are clearly visible in flight and sometimes even on a perched bird. We counted the number of white bars on each of the primaries (hereafter bars) on the right wing only. In general, the primary pattern seemed to be consistent on both wings and to avoid pseudoreplication arising from repeated counts on same individuals, we ignored the pattern of primaries on the left wing. However, in some cases we counted the barring on the left wing, when the primaries of the right wing had either been lost or damaged in a way that counting the bars was not possible. Also, some second calendar-year birds had left some primaries unmoulted on the right wing. Since the patterns of juvenile and adult primaries differ from each other, the juvenile primaries were also ignored, and the left wing was used instead for counting the bars. If the outermost primaries were lost, broken or unmoulted on both wings, the specimen was not included in the data. In some cases the definition of a bar was not straightforward. To account for this, only a clearly white marking with well-defined edges was classified as a bar (figure 2). This classification was done to increase the comparability between low quality field photographs and specimens studied in hand. Unclear bars might be difficult to detect from low quality photographs and thus lead to different results in different observation situations. An exception was made in assessing the bars of the hepatic morph,

302 Pattern of underparts of five Common Cuckoos / Koekoeken *Cuculus canorus canorus* (left) and five Oriental Cuckoos / Boskoekoeken *C optatus* (right) *(Petteri Lehikoinen/Natural History Museum, Tring, England)*. Although barring on breast and belly is in general thinner in Common than in Oriental, due to large variation this feature is of rather limited use in field identification of single individual. Undertail-coverts of Oriental supposedly more rusty-buff and less marked (eg, Svensson et al 2015) but largely overlapping between both species as seen here.

303 Colouration of upperparts of five Common Cuckoos / Koekoeken *Cuculus canorus canorus* (left) and five Oriental Cuckoos / Boskoekoeken *C optatus* (right) *(Petteri Lehikoinen/Natural History Museum, Tring, England)*. Same individuals and order as in plate 302. Common is generally paler on mantle and upperparts, and showing less bluish tone on mantle, rump and uppertail-coverts. However, also this feature shows large variation in both species (cf rightmost Common and leftmost Oriental) and assessing this character in field is challenging.

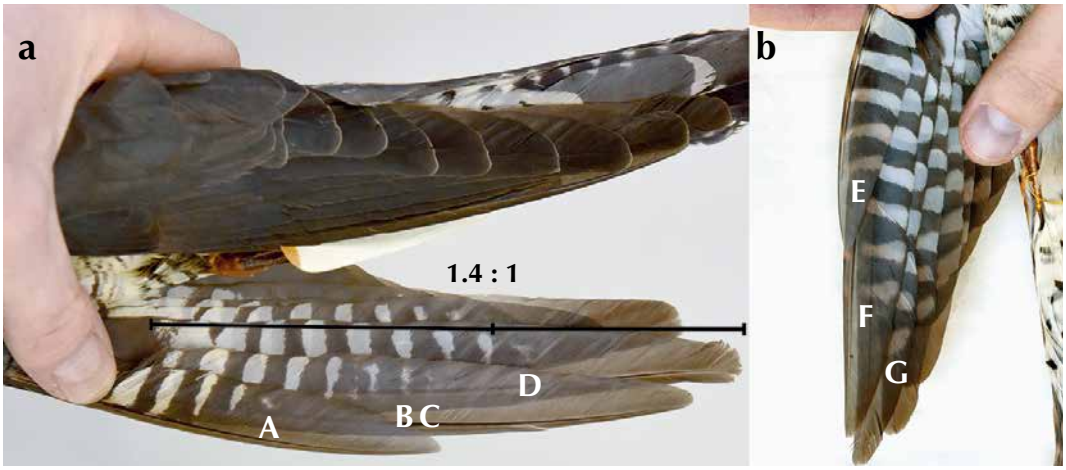

FIGURE 2 Classifications of bars and ratio between barred area and unbarred primary tip *(Petteri Lehikoinen/Natural History Museum, Tring, England & Zoological Institute of the Russian Academy of Sciences, St Petersburg)*. We counted only pure white bars as they are easy to detect in even poor-quality field photographs, despite small size. In figure 2a, markings A and B on p10 and p9, respectively, were classified as bars, whereas markings C and D on p9 and p8, respectively, were not due to blurry appearance deriving from dirty pale colouration. This Common Cuckoo *Cuculus canorus canorus* shows five bars on p10, seven on p9 and eight on p8 (sum 20 bars) and primaries of this specimen are very weakly patterned for this species. Barred area was considered to start from edge of first bar (closest to base of primary) continuing to furthest edge of last bar (closest to primary tip); in turn, dark tip was measured continuing from that point outwards to primary tip. Ratio is 1.4 on p8 and 0.9 on p9. On hepatic morph (figure 2b), markings closest to primary tip are always brownish and in this morph these markings (E, F and G, on p10, p9 and p8, respectively) were also considered as bars due to their large size. This hepatic morph of Oriental Cuckoo *C optatus* shows five bars on p10 and seven bars on both p9 and p8 (sum 19 bars). Ratios are 1.8 on p9 and 2.5 on p8.

in which the pale markings closest to the primary tip are always at least partly buffish or sandy in colour (figure 2b). However, these markings are usually large and unlikely to be overlooked from field photographs and therefore they were classified as bars. This was also the case for some juveniles which showed large buffish outermost bars, an underwing pattern similar to the hepatic morph. Most juveniles showed whitish outermost bars with only a hint of buff colour.

In some cases, the number of bars on the primaries can be difficult to count in the field. These cases include especially the photographs where the underwing is out of focus. To be able to assess such cases, we also measured, from the specimens, the length of the barred area and the unbarred feather tip on p8-9. The ratio between the barred area and unbarred feather tip (hereafter ratio) can be used as a supportive identification feature. It can be obtained from any field photograph where the underwing is visible, and acquiring the ratio does not require exact measurements, which are only possible to obtain in hand.

Results

Grey morph adults

In general, Oriental Cuckoo had fewer bars on the three outermost primaries (figure 3-5) than Common Cuckoo. Himalayan Cuckoo had very similar numbers of bars as Oriental. Subspecies of Common showed variation in the number of bars, and some individuals of the smallest subspecies *bangsi* and *bakeri* had less bars and thus resembled more of Oriental than Common subspecies *canorus* and *telephonus* (figure 4-5). Overlap in the number of bars between Oriental and Common Cuckoo was smallest on p8 and p9 (figure 4).

On p10, the overlap between species ranged between four and seven bars. Highest overlap was in six bars and the numbers below or above this could be useful in separating the species: 45% of Common Cuckoos had more than six bars on p10, whereas this was the case only for 2% of Oriental Cuckoo and 7% of Himalayan Cuckoo. For subspecies of Common, the number of bars below six was twice as common for *bangsi* (15%) than for *bakeri* (8%) and nominate *canorus* (7%).

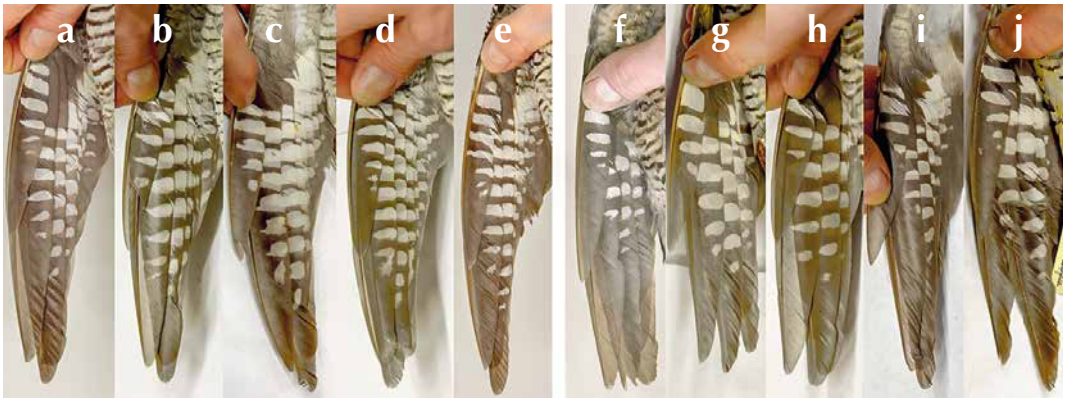

FIGURE 3 Variation in primary pattern of Common Cuckoo / Koekoek *Cuculus canorus canorus* (**a-e**) and Oriental Cuckoo / Boskoekoek *C optatus* (**f-j**) *(Petteri Lehikoinen/Natural History Museum, Tring, England & Zoological Institute of the Russian Academy of Sciences, St Petersburg)*. In general, Oriental had fewer white bars on primaries and bars were larger and more rounded. However, shape of bars varied remarkably. Common in **a** (collected in Brighton, England) was only specimen of this subspecies showing seven bars on p8. Such individual is probably impossible to distinguish from Oriental solely based on primary pattern.

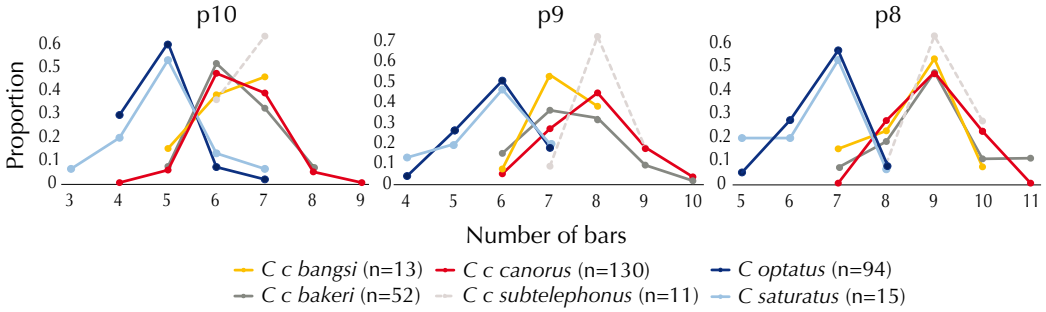

FIGURE 4 Number of bars in three outermost primaries (p8-10) and their share in studied specimens of adult grey morph Common Cuckoo *Cuculus canorus* and subspecies, Oriental Cuckoo *C optatus* and Himalayan Cuckoo *C saturatus*

On p9, species overlapped in six to seven bars. 18% of Oriental Cuckoo and 20% of Himalayan Cuckoo had seven bars, whereas 8% of Common Cuckoo had six bars on p9. However, subspecies of Common differed in this aspect and six bars was more common in *bakeri* (15%) than in *bangsi* (8%) and nominate *canorus* (6%) (figure 4).

The pattern on p8 was similar to p9, except that the species overlapped in seven to eight bars and differences between species were slightly more emphasized (figure 4). Percentage of Oriental Cuckoos having seven bars on p8 was 10%, and of Himalayan Cuckoos 7%. Only 3% of all Common Cuckoos had six bars on p8 but again, this differed between the subspecies and was most common for *bangsi* (15%) and *bakeri* (8%) but quite rare for nominate *canorus* (1%).

Within an individual, the number of bars on the three outermost primaries showed marked collinearity (r=0.8). This means that an individual having few bars on one of the three outermost primaries is likely to have few bars also on the other two primaries. Therefore, when summing all the bars on three outermost primaries the overlap between the species was reduced compared with a single primary (figure 5). The main overlap ranged between 19 and 22 bars. 78% of Oriental Cuckoo and 73% of Himalayan Cuckoo had bars fewer than 19, whereas this was observed in only one specimen of Common Cuckoo (17 bars on *bangsi*; 7% of the studied specimens of this subspecies). In contrast, 90% of all Common had more than 20 bars on p8-10, which was seen in only one specimen of both Oriental (21 bars) and Himalayan

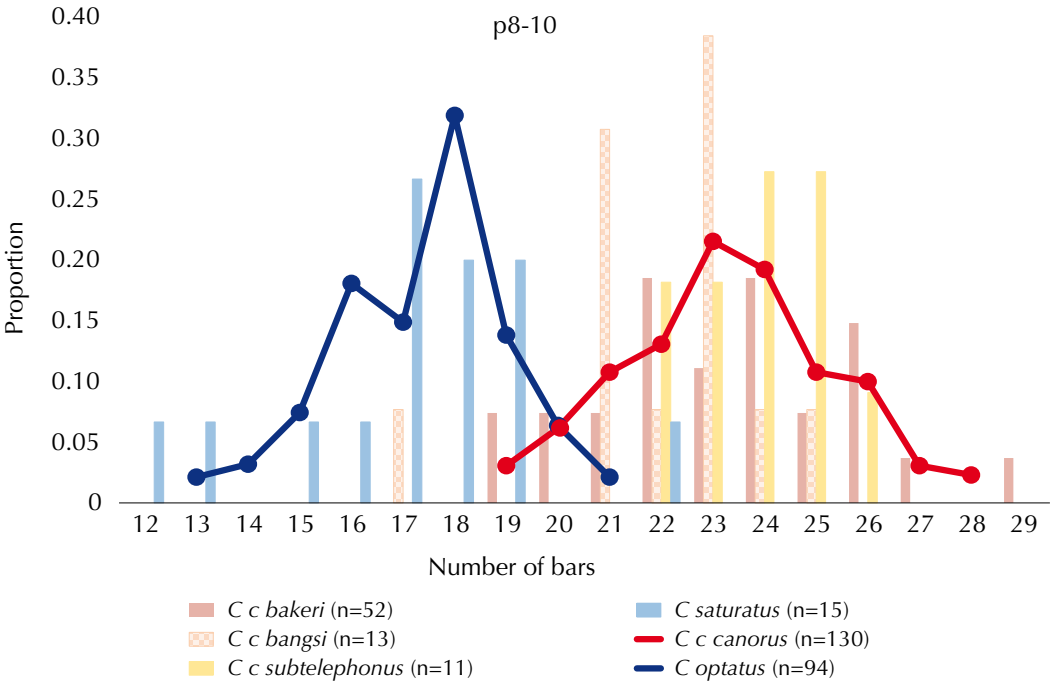

FIGURE 5 Sums of bars on three outermost primaries (p8-10) and their share in studied specimens of adult grey morph Common Cuckoo *Cuculus canorus* and subspecies, Oriental Cuckoo *C optatus* and Himalayan Cuckoo *C saturatus*. *C c canorus* and *C optatus* shown as dots and with connecting lines, while other subspecies shown as bars due to their low sample sizes.

(22), representing 2% and 7% of the studied specimens of these taxa, respectively.

Since Oriental Cuckoo and Himalayan Cuckoo had fewer bars on the outermost primaries, also the barred area was shorter in length than in Common Cuckoo (figure 6-7). Although the overlap between the species reduced the role of this feature as an identification criterion, the high or low ratio values could indicate the species at least when separating Oriental and Himalyan from Common. Values lower than the median value of Oriental Cuckoo on p9 (1.0) were seen in 53% of Himalayan and subspecies of Common as follows: 3% of nominate *canorus*, 8% of *bangsi*, 18% of *bakeri* and none for *subtelephonus* (figure 6). Correspondingly on p8, 40% of Himalyan, 5% of nominate *canorus*, 23% of *bangsi*, 14% of *bakeri* and again none of *subtelephonus* had values lower than the median value of Oriental (1.4) (figure 7). The situation was reverse above the median values of nominate *canorus*. These were 1.5 on p9 and 2.0 on p8, above which only 7% and 4% of Oriental specimens had values, respectively.

Hepatic morph adults

Adult females of all studied taxa, except *bangsi* and *bakeri*, have a hepatic morph (Erritzøe et al 2012). Within specimens of adults (including both sexes), the hepatic morph covered 13% of both Oriental Cuckoo (n=114) and nominate Common Cuckoo (n=153). These would comprise 40% of the specimens labelled as females in Common and 38% in Oriental. However, sexing of the grey morph is not straightforward, and the true share of hepatic morph among females is difficult to interpret from these figures. We did not find hepatic morphs among the adult specimens of *subtelephonus*, probably caused by the small sample size (n=11).

On average, hepatic morphs of both Oriental Cuckoo and nominate Common Cuckoo had more bars on the three outermost primaries than grey morph adults but the maximum number of bars on a single primary was very similar to that of grey morph (figure 8-9). The difference between the two species was most marked on p8 but compared with grey morph, the hepatic Oriental showed more often eight bars on this primary

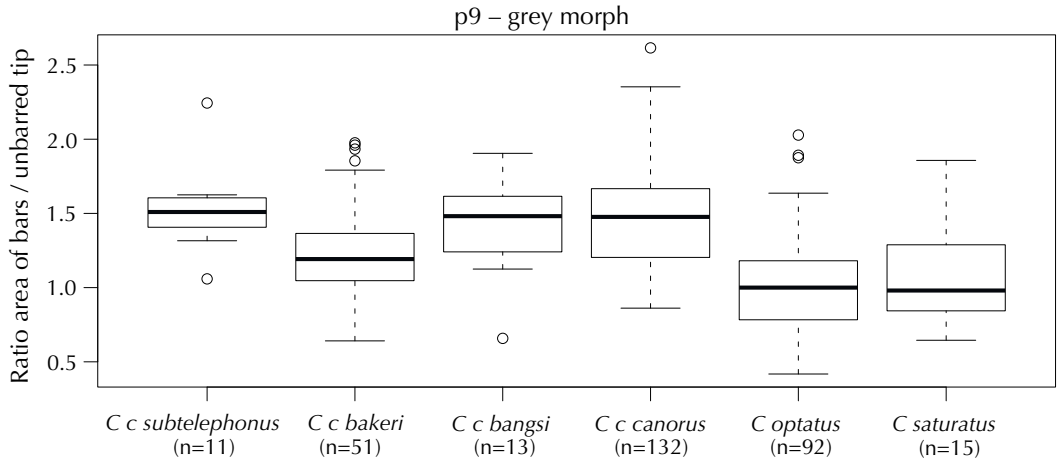

FIGURE 6 Ratios of lengths of barred area and unbarred feather tip on second outermost primary (p9) in grey morph adults of Common Cuckoo *Cuculus canorus* and subspecies, Oriental Cuckoo *C optatus* and Himalayan Cuckoo *C saturatus*. Box: values between first and third quartile; midline: median value; whiskers: lowest and highest values within range of 1.5 times interquartile range from box, and values farther than this are represented individually as outliers (circles).

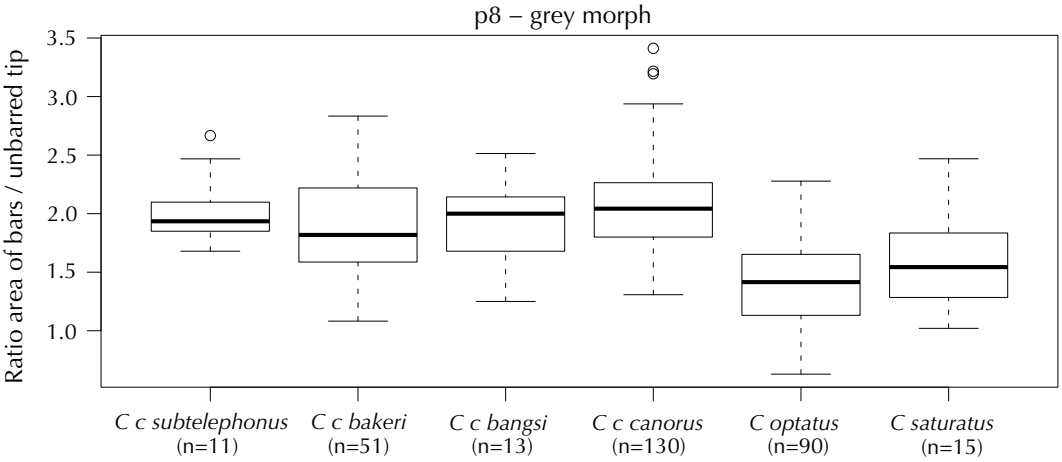

FIGURE 7 Ratios of lengths of barred area and unbarred feather tip on third outermost primary (p8) in grey morph adults of Common Cuckoo *Cuculus canorus* and subspecies, Oriental Cuckoo *C optatus* and Himalayan Cuckoo *C saturatus*. Box: values between first and third quartile; midline: median value; whiskers: lowest and highest values within range of 1.5 times the interquartile range from the box, and values farther than this are represented individually as outliers (circles).

(27% of the specimens; figure 9). The sum of bars on p8-10 overlapped only at 21 bars, and 80% of Oriental had fewer and 95% of nominate Common had more than this (figure 10).

The ratios on p8 and p9 were higher on hepatic than on grey morph adults but may similarly aid separating the Oriental Cuckoo and nominate Common Cuckoo (figure 11). On p9, 10% of nominate Common had ratios lower than the median value of Oriental (1.8) and 55% of nominate Common had higher values than the maximum observed value of Oriental (2.2). On p8, 5% of nominate Common ratios fell under the median value of Oriental (2.3), and 45% of nominate Common ratios were higher than the highest of Oriental (2.8).

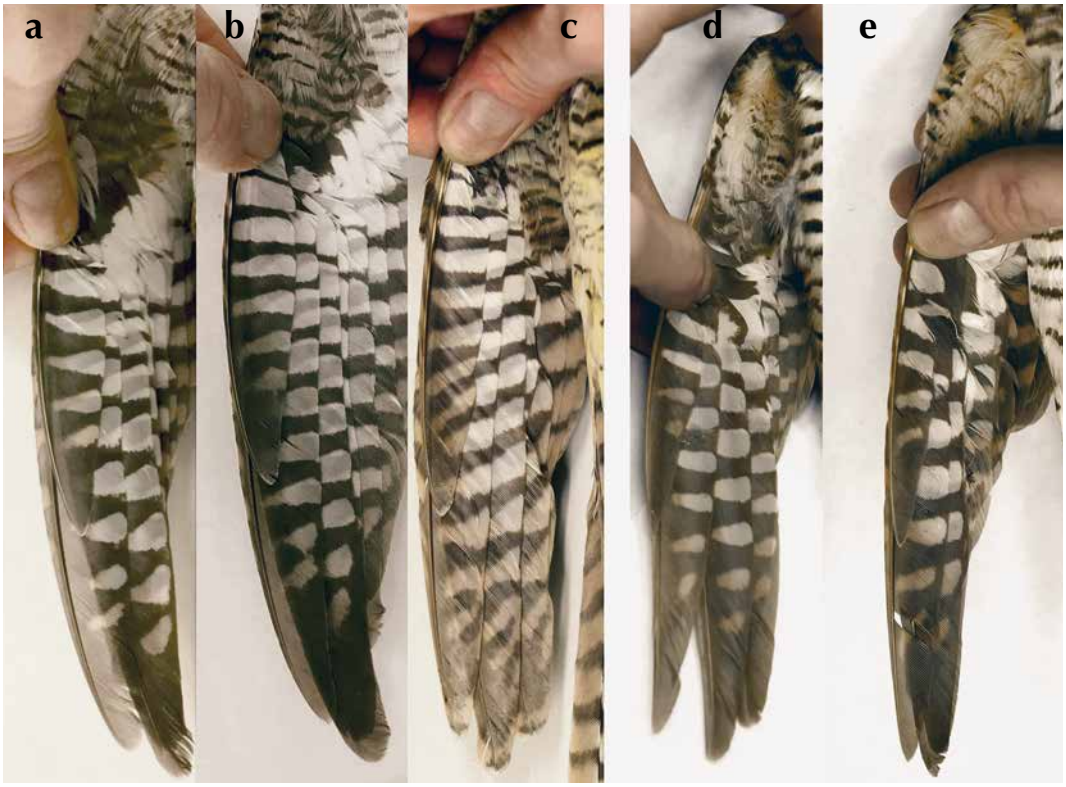

FIGURE 8 Variation in primary pattern of adult hepatic morph Common Cuckoo / Koekoek *Cuculus canorus canorus* (**a-c**) and Oriental Cuckoo / Boskoekoek *C optatus* (**d-e**) *(Petteri Lehikoinen/Natural History Museum, Tring, England & Zoological Institute of the Russian Academy of Sciences, St Petersburg & Finnish Museum of Natural History, Helsinki)*. Primaries more barred than on grey morph but still showing similar differences between both species. Our data did not contain any nominate *canorus* with seven bars on p8, while this was most frequent number in Oriental. Barred area was also on average longer in Common than in Oriental on p8-9 (see also figure 11-12). Lesser underwing-coverts were more often less patterned in Oriental than in Common, which instead showed more barring. Extensive barring of primaries in **c** is somewhat aberrant and this individual is shown as extreme outlier in figure 11.

The percentage of hepatic morph among adult specimens of Himalayan Cuckoo was 17% (n=13) but due to the small sample size this taxon is not presented in figure 9-11. The primary patterns of the three specimens were similar to that of Oriental Cuckoo. One of them had five bars on p10, whereas two others had six. Two of them had six bars on p9 while one had seven, and all three had seven bars on p8. The sum of bars in p8-10 of these three specimens was 18, 19 and 20. The ratios of hepatic Himalyan were 1.8, 2.1 and 2.8 for p9 and 2.4, 2.5 and 2.6 for p8. These were similar to Oriental, except for a single high value of 2.8 on p9, which was far higher than in any Oriental (cf figure 11).

Juveniles

The primary pattern of juvenile Oriental Cuckoo and nominate Common Cuckoo resembled the pattern of hepatic morph adults (figure 12-13). They had more bars on the three outermost primaries than grey morph adults, and juvenile Oriental had fewer bars than juvenile nominate Common. The differences between the two species were most emphasized again on p8, where 51% of Oriental had fewer than eight bars, which was the lowest number observed in nominate Common with 14% of all juvenile specimens. More than eight bars were found in 86% of nominate Common but in only 2% of Oriental.

The overlap in the sum of bars on p8-10 ranged between 20-22 (figure 14). Fewer than 21 bars

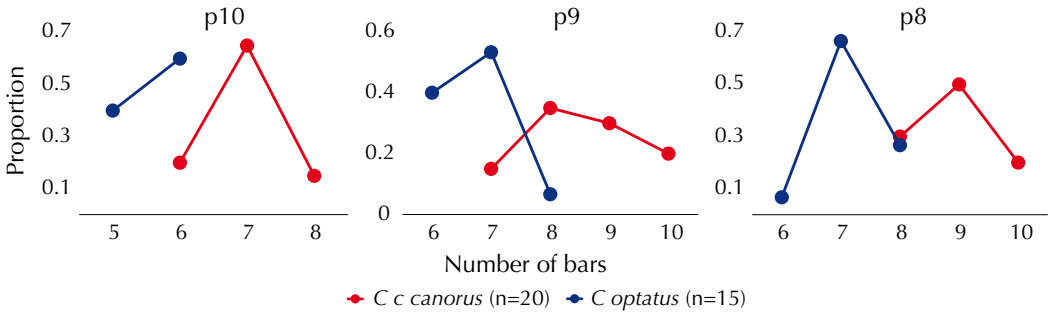

FIGURE 9 Number of bars on three outermost primaries (p8-10) and their share in studied specimens of adult hepatic morph Common Cuckoo *Cuculus canorus canorus* and Oriental Cuckoo *C optatus*

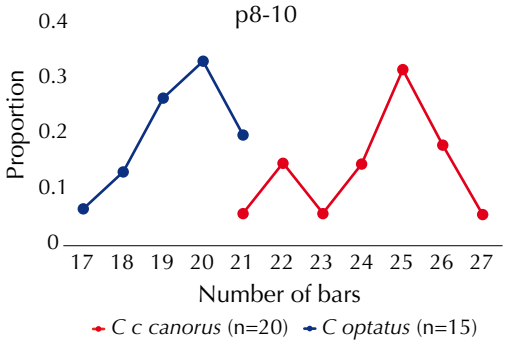

FIGURE 10 Sums of bars on three outermost primaries (p8-10) and their share in studied specimens of adult hepatic morph Common Cuckoo *Cuculus canorus canorus* and Oriental Cuckoo *C optatus*

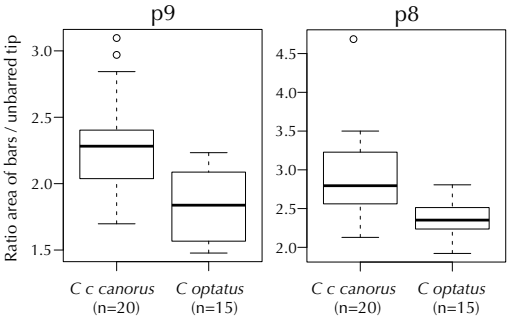

FIGURE 11 Ratios of lengths of barred area and unbarred feather tip on second (p9) and third outermost primary (p8) in hepatic morph adults Common Cuckoo *Cuculus canorus canorus* and Oriental Cuckoo *C optatus*. Box: values between first and third quartile; midline: median value; whiskers: lowest and highest values within range of 1.5 times interquartile range from box, and values farther than this are represented individually as outliers (circles).

were observed in 71% of Oriental Cuckoo and 1% of nominate Common Cuckoo. More than 21 were seen in 91% of nominate Common and 4% of Oriental juveniles.

The ratios of p9 and p8 were also very similar to those of hepatic morph adults. On p9, only 1% of nominate Common Cuckoo had values lower than the median of Oriental Cuckoo (1.5) and furthermore, 60% of nominate Common had values higher than the maximum of Oriental (2.2) (figure 15). A similar but more pronounced pattern was witnessed on p8, where none of the nominate *canorus* samples had values lower than the median of Oriental (1.8), and only 3% were below the value of 2.1, below which 75% of ratio values of Oriental were observed. Both species had outliers on the high end of the scale, thus making higher values slightly less usable for indicative identification (figure 15).

In addition, we studied three juveniles of *bakeri* and one *bangsi* of Common Cuckoo, and one Himalayan Cuckoo. The variation of the number of bars and ratios on the outermost primaries of these taxa are presented in table 2.

Assessing features in field photographs

Cuckoos are rather visible both on territory and during migration, and obtaining a photograph of a cuckoo in flight showing the underwing pattern is not particularly difficult. Especially the pattern of the outermost primaries can often be interpreted well from the photographs and a reliable identification for many individuals can be achieved solely based on the number of white bars on the three

FIGURE 12 Variation in primary pattern of juvenile Common Cuckoo / Koekoek *Cuculus canorus canorus* (**a-b**) and Oriental Cuckoo / Boskoekoek *C optatus* (**c-d**) *(Petteri Lehikoinen/Natural History Museum, Tring, England & Zoological Institute of the Russian Academy of Sciences, St Petersburg & Finnish Museum of Natural History, Helsinki)*. In general, primary pattern of juvenile Oriental and Common looks superficially similar but we did not find any nominate *canorus* with seven bars on p8. Although difficult to see in museum specimens, note also underwing-coverts which show more extensive and stronger barring in Common than in Oriental.

outermost primaries. There are, however, occasions when the exact number of bars can be difficult to count. Most of these relate to the low quality of the photograph caused by, eg, long distance or the target being out of focus. The classification of a bar is not always straightforward, not even from a high-quality photograph (plate 307-308). These occasions concern usually small pale markings on primaries and the line when a marking is classified as a bar is artificial. A rule of thumb for assessing was reached by squinting the eyes, which reflects the situation of an unfocused photograph. When a primary marking on a specimen fulfilled the criteria of size, sharpness and white colour to be classified as a bar, it most often was also visible when squinting the eyes. Our experience is that squinting gives corresponding results between high-quality photographs (in field and in hand) and when those are blurred artificially with image processing tools. The problematic small markings are in general uncommon and classification of such does not usually have much impact on the eventual outcome. Moreover, in a high-quality photograph it should be possible to see the other supporting identification features from underwing and underparts and use the combination of all these to reach a solid identification. Interpreting the number of bars on a poor-quality photograph may, however, be less safe and the possibility of missing some of them increases.

Usability of features in identification

Due to the considerable sample size, we are quite confident that the pattern of three outermost primaries can be used to identify the majority of Oriental Cuckoos and Common Cuckoos. The third outermost primary (p8) seems to be the most practical with the smallest overlap between the species. Seven or fewer bars on this primary is a strong indication for Oriental in all ages and colour morphs. Our data show that the variation in the number of bars on p10 is much more diverse than reported in a previous study (Balatsky 2016). According to that paper, Common shows six to seven bars on p10 in all ages and colour morphs, while Oriental shows only four to five. However, we collected more data which show that there is

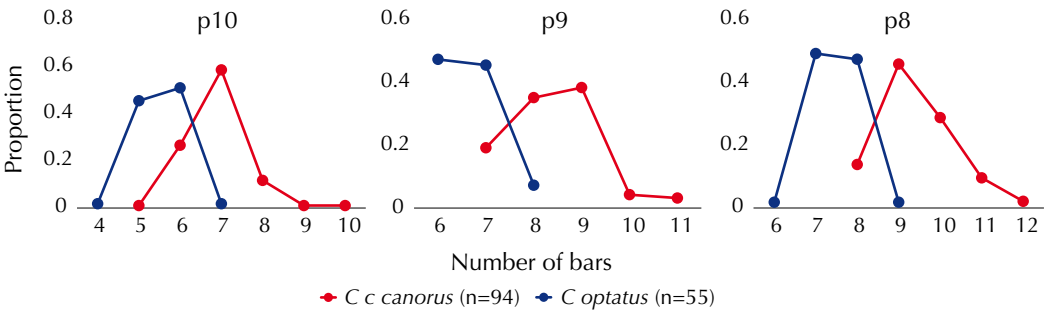

FIGURE 13 Number of bars on three outermost primaries (p8-10) and their share in studied specimens of juvenile Common Cuckoo *Cuculus canorus canorus* and Oriental Cuckoo *C optatus*

TABLE 2 Number of bars and ratios on outermost primaries of specimens of juvenile Common Cuckoo *Cuculus canorus* of subspecies *C c bangsi* and *C c bakeri* and Himalayan Cuckoo *C saturatus*. For *bakeri* values given are: range and average.

Taxon	Number of bars			Ratios	
	p10	p9	p8	p9	p8
C c bangsi (n=1)	7	9	10	2.1	2.8
C c bakeri (n=3)	7	7-9; 8	8-10; 9	1.9-2.1; 2.0	2.2-2.9; 2.6
C saturatus (n=1)	5	6	7	1.5	2.1

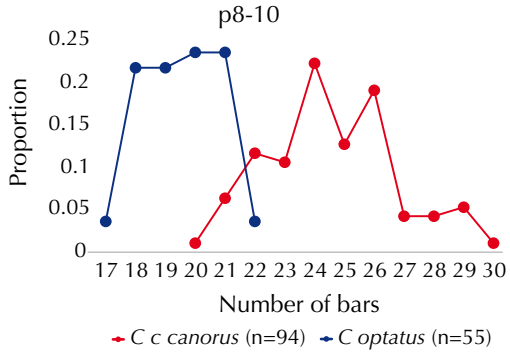

FIGURE 14 Sums of bars on three outermost primaries (p8-10) and their share in studied specimens of juvenile Common Cuckoo *Cuculus canorus canorus* and Oriental Cuckoo *C optatus*

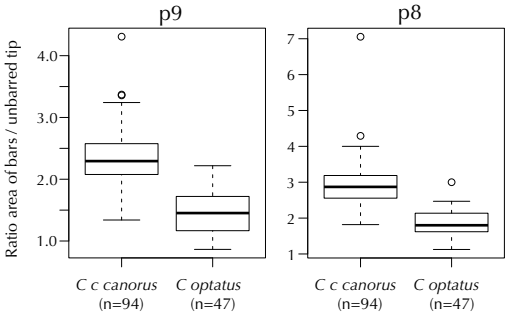

FIGURE 15 Ratios of lengths of barred area and unbarred feather tip on second (p9) and third outermost primary (p8) in juvenile Common Cuckoo *Cuculus canorus canorus* and Oriental Cuckoo *C optatus*. Box: values between first and third quartile; midline: median value; whiskers: lowest and highest values within range of 1.5 times interquartile range from box, and values farther than this are represented individually as outliers (circles).

variation between both ages and colour morphs in the primary pattern but also that p10 seems to be the least reliable of the three outermost primaries in identification of the two species.

The presented features appear to be especially useful when separating Oriental Cuckoo and nominate *canorus*, which occur largely in sympatry. However, the identification may be more complicated in south-western Europe and south-eastern Asia, where the *bangsi* and *bakeri* subspecies of Common Cuckoo occur, respectively. These subspecies showed a larger proportion of individuals with fewer bars on the primaries than nominate *canorus*, and as they are also smaller in size than nominate *canorus*, their resemblance to Oriental is emphasized (figure 16). The number of bars on the primaries may be related to wing length, as higher proportions of less barred Common are found in the smallest subspecies. Furthermore, this could be supported by the detail that the smallest nominate Common are found in Britain (Cramp 1985), where we also found the only individual of nominate *canorus* with seven bars on p8. These small individuals resembling Oriental have also caused confusion in Britain before (Kennerley & Leader 1991). However, *bangsi* and *bakeri* have, similarly to nominate *canorus,* more barring on the underwing-coverts. This feature, if present, might be sufficient to rule out a vagrant Oriental.

The individuals of Common Cuckoo with fewer bars on the primaries seem to be concentrated in eastern-central China (from Yunnan and Sichuan to the east coast). A considerably large proportion of adult grey-morph individuals in this geographic region seems to have very finely barred underparts and slightly paler upperparts compared with nominate *canorus* and also *bakeri* from Himalayas (plate 309). This would fit well with the phenotype of *subtelephonus* of Common, of which the distribution in most recent literature is considered to be restricted to Central Asia west from southern Mongolia (Gill et al 2020, Payne et al 2020). However, Cramp (1985) mentions the range of this subspecies to cover also central China and Japan, and the appearance of these individuals would also corre-

FIGURE 16 Common Cuckoo / Koekoek *Cuculus canorus bangsi (Petteri Lehikoinen/Natural History Museum, Tring, England)*. One of two specimens of this subspecies with only seven bars on p8. Primary pattern basically identical to average Oriental Cuckoo *C optatus*. Underwing-coverts of this specimen were completely barred, which is not visible in figure, but is uncommon in Oriental. The other specimen with seven bars on p8 had also seven bars on both p9-10, which would be exceptional for Oriental according to our data. Nevertheless, such individuals may cause headache in western Europe.

spond better with this subspecies, or currently unrecognized *'telephonus'*, rather than *bakeri*. Payne (2005) also mentions individuals resembling *subtelephonus* being reported as far east as coastal plains of southern China, which is rather far from the described eastern range edge of *subtelephonus*. It is worth mentioning that the majority of the specimens studied are more than a century old. Although the phenotype of the taxa should hardly show any changes in this time, the ranges might

304 Oriental Cuckoo / Boskoekoek *Cuculus optatus*, adult male, Sotkamo, Finland, 22 June 2015 *(Petteri Lehikoinen)*. This individual held territory at Sotkamo in summers of 2015-16. This bird showed four bars on p10, eight (peculiarly small) on p9, and six on p8 (sum 18 bars), which is good for *optatus*. Ratios were 0.9 on p9 and 1.0 on p8, which are low for any Common Cuckoo *C canorus* subspecies. In addition, features supporting *optatus* are warm buffish wash on underwing-coverts, barring only on greater underwing-coverts and axillaries, and plain lesser, median and carpal coverts. Such dark and brownish eye would also be very uncommon for adult male Common.

305 Cuckoo / koekoek *Cuculus*, adult male, Lieksa, Finland, 6 June 2001 *(Osmo Huupponen & Antero Lindholm)*. This bird held territory in summers of 1998-2001, and then was considered Oriental Cuckoo *C optatus*. However, further studies showed that its song did not quite fit this species (cf Lindholm & Lindén 2003). Its appearance was, however, very similar to *optatus*, with five bars on p10, six on p9 and seven on p8 (sum 18 bars). Ratios were 1.4 on p9 and 1.8 on p8, which are rather high for *optatus* but within median 50% of Common Cuckoo *C canorus canorus*. Underwing-coverts had warm wash, good for *optatus*. Lesser underwing-coverts very faintly barred, suggesting *optatus*, although there was quite extensive barring on carpal coverts. Eye rather dark for Common. Despite being very similar to *optatus* in many aspects, it showed some characters intermediate between Common and Oriental, including song, and thus could very well be hybrid of these two species.

have altered. The three subspecies *canorus*, *subtelephonus* and *bakeri* might also meet and interact in eastern-central China leading to a population with mixed features. Nevertheless, the very thin barring on the underparts could be an additional feature to identify the individuals with fewer bars on the primaries in the Far East.

Although the identification of the smaller Common Cuckoo taxa and Oriental Cuckoo can be difficult, the biggest challenges in identification might be, especially in a rarity context, to recognise possible hybrids. Hybridisation between these species has apparently not been reported (Lindholm & Lindén 2003, Payne 2005) but would be a reasonable explanation for the intermediate Finnish birds. Recent hybridisation might also explain the lack of consistent differences in mtDNA between the two species but is not the only possible explanation (Payne 2005). Regarding the possibility of hybridisation, a silent bird outside the breeding range should be perfectly documented and all the available criteria used for a firm identification.

Sotkamo bird and problematic Finnish individuals

As mentioned earlier, a singing male in eastern Finland represents the sole accepted record of Oriental Cuckoo in Europe outside Russia. This bird was found on 14 June 2015 in the middle of a large forested area at Sotkamo (63°59′N, 28°15′E) by Jyrki Lukkari. It was singing in its territory for almost three weeks. We caught the bird for ringing and closer examination on 22 June 2015. The following year, the bird returned to sing in the same area; it was rediscovered on 20 May and was singing for six weeks.

The song and calls of this individual were recorded and according to analyses, both were identical to that of Oriental Cuckoo. The plumage features also fitted the characteristics of Oriental

306 Cuckoo / koekoek *Cuculus*, Joutsa, Finland, 31 May 1999 *(Jari Kostet)*. This second calendar-year male (unmoulted juvenile secondaries on left wing) held territory at Joutsa in summer of 1999. It was then considered as Oriental Cuckoo *C optatus*. In contrast with individual at Lieksa (plate 305), appearance of this bird was much more similar to Common Cuckoo *C canorus*. It had six bars on p10, seven on p9 and eight on p8 (sum 21 bars), which would fit Common better but would not be totally exceptional for Oriental either. Ratios were 1.3 on p9 and 1.7 on p8, falling well within overlap zone between Oriental and nominate Common. Barring on belly rather strong and could suggest Oriental, together with hint of warm wash on underwing-coverts. However, extensively barred underwing-coverts fitting Common much better, as well as very pale iris (especially for second calendar-year male).

well (plate 304, 308). The upperparts of the Sotkamo bird were rather dark with a blue hue and it had a rather bold and blackish barring on the underparts. Due to the moult limits in the remiges, it could be aged as an adult (older than second calendar-year; EURING age 6) in the summer of 2015. For a fully adult male, the brownish iris of the Sotkamo bird fitted Oriental much better than Common Cuckoo. The underwing of the Sotkamo bird gave an overall weakly patterned impression which also matched Oriental well (plate 304, 308). The underwing-coverts were quite plain and the dark barring was concentrated to the axillaries and greater coverts. The primaries had bars on a very restricted area, leaving a long part of the feather from the tip towards the base unmarked. Most importantly, the longest primary (p8) had only six bars, which according to our data rules out Common. The maximum chord wing length of 224 mm was at the higher end of Oriental (table 1) but still inside the variation of this taxon. It must be noted that the wing lengths presented in table 1 are measured from dried specimens, which can be up to 10% shorter than on live birds due to shrinking (Vepsäläinen 1968).

The earlier problematic Finnish birds included singing males in Lieksa (1998-2001), Karstula (1998-99) and Joutsa (1999). Lindholm & Lindén (2003) analysed the sound recordings of these birds and, based chiefly on the wrong song structure, the birds were not accepted as Oriental Cuckoo by the Finnish rarities committee (Luoto et al 2005). The song of these birds had three syllables which differed in pitch from each other, in contrast with the evenly pitched bisyllabic song of Oriental (Lindholm & Lindén 2003). The song also lacked the polysyllabic start typical for Oriental. There were photographs available of the Lieksa and Joutsa birds and they both showed some plumage features which were not perfect for Oriental, which are examined in plate 305-306. The comprehensive analysis of all these problematic Finnish birds can be found in Lindholm & Lindén (2003).

Acknowledgements

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Samenvatting

DETERMINATIE VAN BOSKOEKOEK EN KOEKOEK OP BASIS VAN HANDPENPATROON De kenmerken die in de literatuur worden genoemd om Boskoekoek *Cuculus optatus* en Koekoek *C canorus* te onderscheiden zijn alle relatief, met uitzondering van de onderscheidende zang, en determinatie in het veld is daardoor moeilijk. Een zingend mannetje Boskoekoek werd in juni 2015 waargenomen in Finland en keerde terug in 2016; dit was het eerste geval in Europa buiten Rusland. Vanwege eerdere problematische individuen in Finland in de jaren 1998-2001 werd dit exemplaar in detail bestudeerd. Voor dit onderzoek zijn zoölogische collecties bezocht van de natuurhistorische musea in Tring, Engeland, St Petersburg, Rusland, en Helsinki, Finland. In totaal werden balgen van 314 Koekoeken, 153 Boskoekoeken en 19 Himalayakoekoeken *C saturatus* bestudeerd, van alle ondersoorten. DE nadruk lag op het patroon van de ondervleugel waar de meest karakteristieke en kwantificeerbare kenmerken werden gevonden. Het aantal witte banden op de drie buitenste handpennen vertoonde

307 Common Cuckoo / Koekoek *Cuculus canorus canorus*, male, Tohmajärvi, Finland, 8 June 2010 *(Markku Rantala)*. Assessing identification features from good field photograph is easy. This bird has five bars on p10, six on p9 and nine on p8 (sum 20 bars). Last small marking nearest to tip of p9 is very small (eg, compared with last markings on p10 and p8) and we would not count it as bar. Despite barred area on p8-10 seeming quite restricted and sum of bars falling in overlap zone between Common and Oriental Cuckoo *C optatus*, nine bars on p8 is clear sign for Common. Ratio on p9 is 0.9 and very close to minimum value of nominate Common (figure 6). Ratio on p8 is 1.7, which falls also in lowest 25% of nominate Common but in highest 25% of Oriental (figure 7). Other features, including completely barred underwing-coverts, thin and dense barring of underparts and pale yellow eye, all support Common.

verschillen tussen de twee soorten, met slechts een relatief kleine overlap. Hoewel er in dit kenmerk variatie was tussen ondersoorten, leeftijdsklassen en kleurvarianten, is de conclusie dat dit kan worden gebruikt voor het met zekerheid determineren van de meerderheid van de individuen. Er bestaan echter problematische vogels en deze komen vaker voor in het meest westelijke deel van Europa en het meest oostelijke deel van Azië. Bovendien vertoonden drie eerdere problematische vogels in Finland intermediaire verenkleedkenmerken en vocalisaties en bestaat de mogelijkheid dat het hybriden tussen beide soorten zijn. Het onderscheiden van dergelijke exemplaren vormt een uitdaging, vooral als deze geen geluid laat horen, en daarom moet voorzichtigheid worden betracht bij het determineren van een (mogelijke) Boskoekoek in Europa.

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308 Oriental Cuckoo / Boskoekoek *Cuculus optatus*, adult male, Sotkamo, Finland, 27 May 2016 *(Markku Rantala)*. Same bird from Sotkamo as in plate 304 but photographed year later. All diagnostic features of Oriental can be seen here. There are four bars on p10, five on p9 and six on p8 (sum 15 bars). We would not classify small and smudgy marking on base of p10 and small greyish spot nearest to tip of p8 as bars. Part of vane of p8 has been ripped away near second last marking, complicating its classification. However, this marking looking large enough to be visible even in lower quality photographs and when squinting eyes and thus considered as bar. Ratio on p9 is 0.7, below lowest value of Common Cuckoo *C canorus canorus* (figure 6). Ratio on p8 is 1.2, also near minimum value of nominate Common (figure 7). Underwing-coverts have warm wash and faint barring on underwing is concentrated on axillaries and to central underwing-coverts. Barring of underparts is blackish and rather well defined but could be wider and more typical for Oriental. Eye colour has not changed compared with previous year (cf plate 304) and remains brownish.

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309 Five Common Cuckoos / Koekoeken *Cuculus canorus* from eastern central China (left) and five Oriental Cuckoos / Boskoekoeken *C optatus* (right) *(Petteri Lehikoinen/Natural History Museum, Tring, England)*. Based on collection sites, these Common should be *C c bakeri*. However, note very thin underpart barring associated with *C c subtelephonus*. Upperparts also relatively pale, with slightly stronger contrast between paler greater coverts and darker alula and primary coverts than in Oriental. Literature describes *bakeri* being darker on upperparts than *C c canorus* and thus resembling more *optatus*, which is contradictory to these rather pale individuals and also better fitting *subtelephonus*.

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