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The case for splitting the Square-tailed Drongo *Dicrurus ludwigii*: a review of the phenetic evidence

by Lincoln D. C. Fishpool, Françoise Dowsett-Lemaire & Robert J. Dowsett

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SUMMARY.—The validity of recent changes in the taxonomic treatment of the Square-tailed Drongo *Dicrurus ludwigii* is assessed via analyses of morphological, morphometric, acoustic and distributional evidence. In addition to confirming the characters already recognised to distinguish West and Central African *sharpei* from the *ludwigii* group, we report previously undocumented but notable differences in voice and tail morphology. The occurrence of a hitherto unrecognised population of *sharpei* in south-east DR Congo, inferred from recent molecular studies, is confirmed, whilst evidence of the close approach of the two taxa in north-west Angola, within c.60 km of each other, further supports their distinctiveness. The proposal to separate *sharpei* itself into two species—with populations west of the Niger River recognised as *occidentalis*—is, however, not supported by vocal data, whilst differences in bill size, the sole known physical discriminant, are here found to be much more modest than previously reported, perhaps attributable to the larger sample sizes used in this study. Thus, on phenetic evidence, *occidentalis* merits no more than subspecific status.

In his revision of the taxonomy of Square-tailed Drongo *Dicrurus ludwigii* (A. Smith, 1834), Clancey (1976) recognised five subspecies, which he divided into two ‘broad groupings’. The first, his *ludwigii* group, comprised four subspecies: nominate, *muenzneri* Reichenow, 1915, *tephrogaster* Clancey, 1975, and *saturnus* Clancey, 1976. His accompanying map showed that the first three were distributed—almost parapatrically—along the East African coast, from the Eastern Cape of South Africa to the Limpopo River (nominate), with *tephrogaster* north of the Limpopo, penetrating inland as far west as southern Malawi and eastern Zimbabwe, and reaching northern Mozambique, where it was replaced northwards by *muenzneri*, ranging from the Ruvuma River in southern Tanzania via coastal Kenya to southern Somalia. The distribution of *saturnus*, disjunct from the other three, was mapped as extending across southern DR Congo west to central Angola. Here it approached the sole member of Clancey’s second lineage: *sharpei* Oustalet, 1879, of north-west Angola to Cameroon, thence east to western Kenya and west to Senegambia (Clancey 1976). This treatment subsequently found wide acceptance in global and regional handbooks and checklists, including Pearson (2000), Hockey *et al.* (2005), Rocamora & Yeatman-Berthelot (2009), Dickinson & Christidis (2014) and del Hoyo & Collar (2016).

As Clancey (1976) pointed out, *ludwigii* and *sharpei* had previously been treated as separate species: Sclater (1930) had considered them to be distinct as, by implication, did Bates (1930) and Bannerman (1939). The decision to reduce *sharpei* to a subspecies of *ludwigii* was made by MacDonald (1946), on the basis that they were ‘clearly very closely related’ and as they were ‘contiguous in distribution, [*sharpei*] should be regarded as a race’. The only comparative information given was that *sharpei* was ‘generally duller than the nominate race’ (MacDonald 1946). In his revision of the family Dicruridae, Vaurie (1949) endorsed this view and it is the one that has, until recently, prevailed.

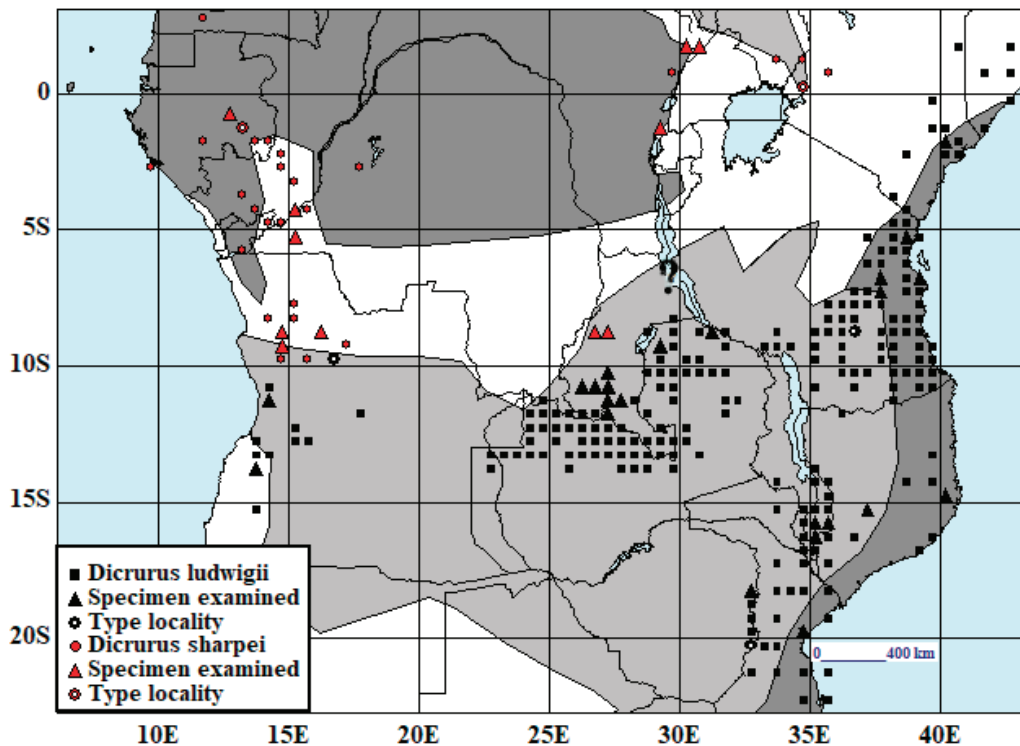


Figure 1. Map showing the distribution in south-central Africa of the Square-tailed Drongo taxa *Dicrurus ludwigii* and *D. sharpei*. For the area of contact in Angola, triangles represent both specimens checked by LDCF and sound-recordings (by M. S. L. Mills) whose identities have been confirmed by FD-L. Shading represents: the Guineo-Congolian and East Coast regions (dark grey), Zambezian region and tip of the Sudanian (medium grey) with transition zones and parts of other regions in white. See text for explanation of '?' on Lake Tanganyika.

The characters by which Clancey (1976) distinguished the two groups are listed in Table 1. While some had, as shown, previously been reported by Vaurie (1949), others Clancey (1976) recorded for the first time and were sufficient to prompt him to speculate that 'this form [i.e. *sharpei*] may in fact not be conspecific with the taxa of the *D. ludwigii* group'. This possibility has since been echoed by Pearson (2000), Rocamora & Yeatman-Berthelot (2009) and del Hoyo & Collar (2016).

As indicated in Table 1, Clancey (1976) reported sexual dimorphism in size in *ludwigii* and for the three characters measured—wing, culmen and tail lengths—he presented the supporting data separately for males and females; however, for *sharpei* they were combined, as he considered the sexes to be of similar size (Table 2). His measurements also suggested that, at least for wing length, *sharpei* averaged larger than *ludwigii* (Table 2). By contrast, with the exception of wing length in male *muenzneri* (on the basis of just four specimens), size differences between taxa in the *ludwigii* group were, at most, modest (Table 2).

The same adjective is applicable to the other differences described by Clancey (1976) between members of the *ludwigii* group, which consisted mainly of the degree of saturation and distribution of glossiness on the body plumage, with *tephrogaster* the palest overall and somewhat greener, less blue-black than the others, and in which the difference in male and female plumage was most obvious. This may explain why, in contrast to wide acceptance of Clancey (1976) by subsequent global and continental treatments, a number of contemporary, geographically more focused studies recognised only *ludwigii* and *sharpei*.

TABLE 1
Differences between *Dicrurus (ludwigii) sharpei* and other taxa included within *D. ludwigii*, as reported in previous studies and found in this study.

Character	Condition		Source			
	<i>D. ludwigii</i> group ¹	<i>D. (l.) sharpei</i>	Vaurie (1949)	Clancey (1976)	Fuchs <i>et al.</i> (2017, 2018)	This study
Intensity of colour of overall plumage	less saturated, paler	more saturated, darker	-	yes	-	yes
Metallic sheen of upper- and underparts	more intense and greenish or steely blue	less intense and purplish or violaceous	yes	yes	yes	yes
Colour of tips of axillaries and underwing-coverts	white in females and subadult males; black in adult males	black in all cases	yes	yes	yes	yes ³
Sexual dimorphism in plumage	belly black in males, sooty or lead grey in females	none	yes	yes	-	yes
Sexual dimorphism in size	males average larger than females	none	(yes) ²	yes	-	no ⁴
Shape of tail	more furcate or lyrate	more parallel-sided and square-ended	-	yes	-	yes
Shape of outer vane of outermost rectrix (r5)	narrows subterminally, broader at the tip	+/- uniform width throughout	-	-	-	yes
Shape of tip of r5	outer and inner vanes meet at an acute or subacute angle	outer and inner vanes meet at an obtuse angle	-	-	-	yes
Width of r5	averages larger	averages smaller	-	-	-	yes
Main song type	jumble of 'whipped' notes, with V-shaped structure	rolled <i>tchre</i> notes, often alternating with various sharp notes	-	-	-	yes

¹Includes the nominate subspecies, *muenzneri*, *tephrogaster* and *saturnus*—see text.

²Vaurie (1949) published measurements which indicated some sexual dimorphism in *ludwigii* but did not discuss this.

³One specimen of *sharpei* found for which this was not true—see text.

⁴Sexual dimorphism occurs in *sharpei* but only in wing length *cf. ludwigii*—see text and Tables 3–4.

These include Zimmerman *et al.* (2001), Stevenson & Fanshawe (2002), Dowsett-Lemaire & Dowsett (2006), Dowsett *et al.* (2008) and Chittenden *et al.* (2016).

Understanding of this complex has, with the publications of Fuchs *et al.* (2017, 2018), changed significantly. The principal taxonomic implications of their findings, which were based largely on molecular evidence, involved the reinstatement of species status to *sharpei* on the basis of substantial genetic divergence between it and the *ludwigii* lineage, a case reinforced by the finding that *sharpei* is in fact more closely related to Shining Drongo *D. atripennis* than to *ludwigii*. In corroboration, Fuchs *et al.* (2017, 2018) simply referred to, and confirmed, the morphological differences between *sharpei* and *ludwigii* reported by Vaurie (1949)—not those by Clancey (1976). In addition, their studies demonstrated an unexpected but marked genetic difference between samples of *sharpei* from either side of the Niger River in Nigeria. These results were supported by hitherto unrecognised differences in bill morphology, whereby culmen length and the width and depth of the bill of the western populations proved to be significantly larger than in those to the east (Table 2). Although based on small sample sizes, these differences were considered sufficient to merit splitting *sharpei* at species level. Thus, those populations west of the Niger River to Senegambia, and also including, tentatively, those north of the Benue River in Nigeria, were separated as a

TABLE 2
 Selected mensural data for Square-tailed Drongo *Dicrurus ludwigii sensu lato* and Shining Drongo *D. atripennis* from previous studies. Measurements in mm.
 Taxonomy follows named source.

Taxon	Clancey (1976)				Fuchs <i>et al.</i> (2018)							
	Sex	Statistic	Wing	Tail	Culmen	Taxon	Sex	Statistic	Wing	Culmen	Bill width	Bill depth
<i>D. l. sharpei</i>	M+F	Mean	108	88.8	21.6	<i>D. sharpei</i>	M+F	Mean	106.1	20.9	6.4	5.8
		Range	105.5–111.0	86–91	20.5–23.5			Range	103–108	20.0–21.8	5.8–7.1	5.3–6.6
		SD	2.24	1.6	0.9			SD	1.2	0.5	0.5	0.4
<i>D. l. ludwigii</i>	M	Mean	103.5	89.1	21.4	<i>D. occidentalis</i>	M+F	Mean	106.6	22	7.1	6.4
		Range	101.5–107.5	86.0–93.5	20–22			Range	104–110	21.8–23.9	6.5–7.4	6.2–6.7
		SD	2.02	2.54	0.63			SD	1.7	0.7	0.3	0.1
<i>D. l. tephrogaster</i>	F	Mean	99	85.7	20.7	<i>D. l. ludwigii</i>	M+F	Mean	100.6	22.3	6.5	6.5
		Range	96.0–101.5	82–90	20–22			Range	99–102	21.6–22.7	6.3–6.8	6.4–6.7
		SD	1.66	2.56	0.72			SD	1.1	0.4	0.2	0.1
<i>D. l. muenzneri</i>	M	Mean	103.2	89.9	22.2	<i>D. l. muenzneri</i>	M+F	Mean	103.9	21.8	6.5	6.3
		Range	100–107	87.5–93.0	20–24			Range	95–115	20.7–23.5	6.1–6.9	5.7–6.8
		SD	2.01	1.79	1.05			SD	5.3	0.6	0.2	0.2
		Mean	103.2	89.9	22.2			Mean	103.9	21.8	6.5	6.3
		Range	100–107	87.5–93.0	20–24			Range	95–115	20.7–23.5	6.1–6.9	5.7–6.8
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		SD	2.01	1.79	1.05			SD	5.			

TABLE 2 CONTINUED
 Selected mensural data for Square-tailed Drongo *Dicrurus ludwigii sensu lato* and Shining Drongo *D. atripennis* from previous studies. Measurements in mm.
 Taxonomy follows named source.

		Clancey (1976)				Fuchs <i>et al.</i> (2018)			
F	Mean	98.7	85.8	21.1					
	Range	95.0–103.5	82.0–88.5	20–22					
	SD	3.16	2.11	0.62					
	<i>n</i>	12	12	12					
M	Mean	109	88.5	21.5					
	Range	104–112	86–91	21–22					
	SD	3.46	2.38	0.58					
	<i>n</i>	4	4	4					
F	Mean	99.8	83.5	20.5					
	Range	96–105	80.0–87.5	19.0–21.5					
	SD	3.02	2.62	0.87					
	<i>n</i>	7	7	7					
M	Mean	106.2	89.7	21.6					
	Range	103.5–110.0	85.5–93.0	20.5–23.0					
	SD	2.18	2.88	0.78					
	<i>n</i>	10	10	10					
F	Mean	99.9	85.9	21.1					
	Range	98.0–104.5	82.0–91.5	20–22					
	SD	2.14	2.36	0.78					
	<i>n</i>	10	10	10					
<i>D. l. saturnus</i>	M+F								
	Mean					106.5	21	6.8	6.6
	<i>n</i>					1	1	1	1
<i>D. atripennis</i> ¹	M+F								
	Mean					112.6	23.6	7	7.1
	Range					106.5–118.5	22.2–24.8	6.3–7.4	6.7–7.5
	SD					2.3	0.7	0.3	0.2
	<i>n</i>					22	22	18	16

¹Data shown only for populations from Nigeria eastwards



new species, *D. occidentalis* (Fuchs *et al.* 2018: 115), with use of the name *sharpei* restricted to populations east and south of the Niger River (Fuchs *et al.* 2018). An additional conclusion, that *saturnus* (DR Congo to Angola and Zambia) should be considered a subspecies of *sharpei* rather than *ludwigii* (Fuchs *et al.* 2017), was subsequently reversed after more samples were analysed (Fuchs *et al.* 2018). Finally, with some minor qualification, Fuchs *et al.* (2018) advocated the recognition and retention of the four subspecies that comprise the *ludwigii* group *sensu* Clancey (1976). These findings have been adopted by Clements *et al.* (2019), Gill & Donsker (2019) and Winkler *et al.* (2020).

Prompted by the fact that justification for separating *sharpei* from *ludwigii* by Fuchs *et al.* (2017) relied almost exclusively on molecular data and because of the arresting assertion in Fuchs *et al.* (2018) that the new taxon *occidentalis* was the most distinct morphologically of any 'in the *D. ludwigii*-*D. atripennis* complex', we present a study of the morphological basis for these interpretations, based on examination and measurement of specimens of *ludwigii*, *sharpei* and *atripennis*. We also include an analysis of vocal data, a potential source of information not mentioned by Fuchs *et al.* (2017) and mentioned but not explored by Fuchs *et al.* (2018). We also note that Fuchs *et al.* (2018: 127) included mensural data for a specimen of *sharpei* from Ogooué, Gabon (MNHN ZO 1878-90), without recognising it to be the holotype—collected at Doumé on the Ogooué River in November 1876 by Alfred Marche (Oustalet 1879: 97; see also Marche 1882 for details of his travels).

We do not comment on the genetic results of Fuchs *et al.* (2017, 2018). Neither do we attempt a re-assessment of the validity of races of the *ludwigii* group; we accept the status quo but, given the small differences between these taxa, they are here treated collectively except where, because of their geographical proximity in parts of their ranges and the findings of Fuchs *et al.* (2017, 2018), it is necessary to consider the relationship between *saturnus* and *sharpei*.

In the following, unless indicated otherwise, '*ludwigii*' refers to the *ludwigii* group *sensu* Clancey (1976), i.e. comprising *muenzneri*, *tephrogaster*, *saturnus* and the nominate subspecies. We use *sharpei sensu stricto* for those populations of *sharpei* east of the Niger River, and *occidentalis* for those west and north of it; when meaning the form as a whole, i.e. prior to the work of Fuchs *et al.* (2018), *sharpei* is used unqualified. Use of *ludwigii sensu lato* indicates *ludwigii* plus *sharpei*.

Methods

In all, 197 specimens were assessed and measured: 86 *sharpei*, 66 *ludwigii* and 45 *atripennis* held in NHMUK, Tring, and RMCA and RBINS, Brussels (acronyms explained in Acknowledgements). The *sharpei* material comprised 60 specimens of *sharpei sensu stricto* from east of the Niger (11 from Nigeria, 14 Cameroon, one Republic of Congo, 29 DR Congo, three Sudan, two Angola) and 26 *occidentalis* (nine Nigeria including one from north of the Benue River, three Ghana, two Liberia, eight Sierra Leone, one Guinea, two Guinea-Bissau, one The Gambia); the *ludwigii* skins included 14 identified as nominate (one Mozambique, 13 South Africa), 14 *tephrogaster* (five Malawi, five Mozambique, four Zimbabwe), 12 *muenzneri* (one Kenya, 11 Tanzania) and 26 *saturnus* (two Angola, 22 DR Congo, two Zambia). The *atripennis* material came from Liberia (18), Nigeria (15) and Cameroon (12).

Mensural data, all collected by LDCF, comprised length of folded wing (unflattened chord, using a metal wing rule with a perpendicular stop at zero), length of tail (from point of insertion to tip of r5, the outermost rectrix), culmen length (from point of insertion on the skull to tip), bill width and depth at the distal end of the nares (all measured using Vernier callipers accurate to 0.1 mm) and max. width of the outer rectrix, r5, which was measured,

with the specimen placed ventral side up, by reading from a piece of graph paper (1 mm scale) positioned beneath the distal portion of the feather.

Tarsus length was not measured as neither Vaurie (1949) nor Clancey (1976) assessed it and because Fuchs *et al.* (2018) did not find it informative. Depth of the tail fork (the distance between the tips of r1 and r5), which has sometimes been used to assess differences in tail shape and proportion, was also excluded. Although Vaurie (1949) measured it, he noted that ‘...there is no character that shows so much variation’; nor was it used by Clancey (1976) or Fuchs *et al.* (2018). Unsexed individuals were excluded from the analyses (see below), as were immatures with pointed tips to their rectrices, such that the structure of r5 was unmodified (see below), as both Vaurie (1949) and Clancey (1976) cautioned that this age group averaged smaller in wing and tail measurements than their respective adults. However, those with pale margins to the feathers of the breast, belly and / or undertail-coverts (other indicators of immaturity) were retained if tail shape was adult in form.

The data were analysed for statistically significant differences using Student’s *t* tests and, for those results which were significant, the effect size or magnitude of the differences were assessed using Cohen’s *d*.

The material used for the voice analysis came from published sources (Stjernstedt 1989, Gibbon 1991, Chappuis 2000), xeno-canto.org (XC) and unpubl. recordings by FD-L and M. S. L. Mills (deposited at the British Library). Sonograms were prepared by N. K. Krabbe using CoolEditPro. The distribution map was prepared using DMAP (<http://www.dmap.co.uk>).

Results

Morphology.—This study confirmed all of the plumage differences between *ludwigii* and *sharpei* (Table 1) reported by Clancey (1976), although one of the 86 specimens of *sharpei* (NHMUK 1911.5.31.455, a female from Bitye, Dja River, Cameroon) does possess white tips to the underwing-coverts. This individual is not in adult plumage as the undertail-coverts and some belly feathers are also white-tipped and it is greyish, not black, ventrally, although the tail is adult in structure.

In addition, the difference in tail shape proved to be attributable to a number of structural modifications not hitherto documented. These are that in *sharpei* the outer vane of r5 is mostly either of uniform width throughout its length or widens only slightly towards the tip, whilst the inner and outer vanes meet at the apex, allowing for the blunt or rounded tip, at an obtuse angle. In many (not all) specimens, the angle is sufficiently wide as to make it appear square-tipped. By contrast, in *ludwigii* the outer vane of r5 is, in most cases, perceptibly narrower over much of its length than it is distally, and the tip is more sharply angled, such that it is acute or almost so (Figs. 2a,b, 6a,b). These features, coupled with the fact that the rachis of r5 in *sharpei* is straight or curves outwards to only a limited degree—in *ludwigii* it is more conspicuously outcurved (Fig. 3)—explain the contrast in overall tail shape. Consequently, the tail of *ludwigii* has been variously described as being more forked, fishtail-shaped, furcate, lyrate or lyre-shaped than that of *sharpei* (Clancey 1976, Pearson 2000, Rocamora & Yeatman-Berthelot 2009), such that only the latter can really merit the vernacular epithet ‘Square-tailed’ (Fig. 3).

We also confirm the statement by Fuchs *et al.* (2018) that *sharpei sensu stricto* and *occidentalis* cannot be distinguished using plumage: we were unable to find any diagnostic characters.

Mensural data and the results of our statistical tests are summarised in Tables 3–5. These support Clancey’s (1976) finding that male *ludwigii* average larger than females: wing, tail and culmen lengths were all greater in males ($p < 0.01$) (Tables 3 and 5). By contrast, our data

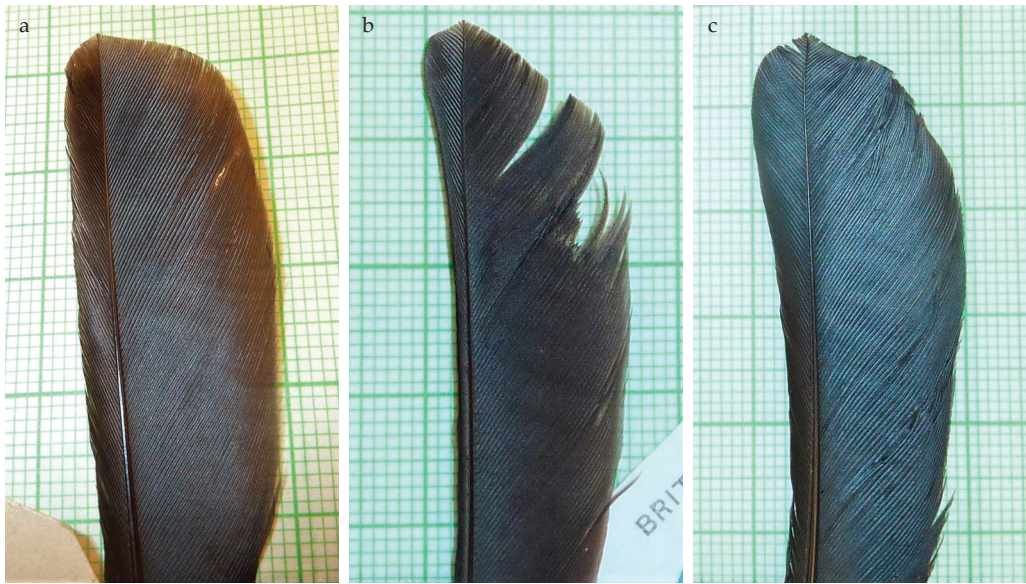


Figure 2. Ventral views of the distal portion of outermost rectrix (r5) of Square-tailed Drongo *Dicrurus ludwigii* taxa and Shining Drongo *D. atripennis*: (a) *sharpei* (NHMUK 1966.16.5812, Bamenda, Cameroon); (b) *ludwigii saturnus* (NHMUK 1957.37.453, Chingoroi, Angola); (c) *atripennis* (NHMUK 1977.20.3042, Mt Nimba, Liberia). See text for discussion of details of structure. Scale in mm (L. D. C. Fishpool, © Natural History Museum, London)

do not fully support his view that the sexes of *sharpei* are ‘virtually alike’ in size; we found male wing length to be greater ($p < 0.01$). No such differences were, however, recorded for the other parameters. Moreover, power tests indicated that for the differences in mean tail and culmen lengths (Table 3) to be assessed (80% chance) as statistically significant ($p < 0.05$), sample sizes of 2,536 and 547, respectively, would be required. This suggests that, unlike *ludwigii*, there is indeed no difference between the sexes in these parameters in *sharpei*. For *atripennis*, the only significant difference ($p < 0.05$) found was in the width of r5 (Table 5). Power analysis in this case found that sample sizes of 80, 14,819 and 131, respectively, would be needed for differences in mean wing, tail and culmen lengths (Table 3) to qualify (80% chance) as significant ($p < 0.05$), indicating that for wing length there is perhaps some uncertainty over this result.

Comparisons of male *sharpei* and *ludwigii* revealed highly significant differences ($p < 0.00001$) in wing length and width of r5, with *sharpei* having longer wings (mean 105.9 versus 101.2 mm) but narrower outer tail feathers (mean 14.86 vs. 16.06 mm). There was also a difference ($p < 0.05$) in culmen length (mean 20.86 [*sharpei*] vs. 21.27 mm) (Tables 3 and 5). Comparable differences in wing length and width of r5 were found for females, but not in culmen length; females, however, showed a difference ($p < 0.05$) in tail length (mean 91.57 [*sharpei*] vs. 89.71 mm). The effect sizes of the differences in wing length and width of r5 were broadly comparable between the sexes and mostly larger than those within the sexes of either taxon (Table 5); in all cases, however, Cohen’s d was < 2 (i.e. with a difference in mean of less than two standard deviations) and, on the basis of the scale used by Tobias *et al.* (2010), the magnitude of these differences therefore qualify as ‘minor’ (see Discussion).

The differences between both sexes of *atripennis* and *sharpei* in all parameters measured, except bill width, were both highly significant ($p < 0.00001$) and with effect sizes that mostly qualify under the Tobias *et al.* (2010) criteria as ‘medium’, whilst for width of r5 it is ‘major’ (Tables 3 and 5). Given how much larger *atripennis* was found to be than *sharpei*, it was not



Figure 3. Ventral views of tails of Square-tailed Drongo *Dicrurus ludwigii* taxa to show differences in structure. Left: *sharpei* (NHMUK 1954.59.179 [top] and 1966.16.5802, Okposi and Abeokuta, Nigeria). Right: nominate *ludwigii* (NHMUK 94.8.16.117 [top] and 94.8.16.114, both Durban, South Africa) (L. D. C. Fishpool, © Natural History Museum, London)

considered necessary to test for differences between *atripennis* and *ludwigii* since the latter, as shown, averages smaller than *sharpei*.

Summary morphometric data for *sharpei sensu stricto* and *occidentalis* are shown in Table 4. Tests between the sexes demonstrated that in *sharpei sensu stricto* there were differences ($p < 0.05$) in wing length and width of r5, and although no corresponding differences were found for *occidentalis* (Table 5), this may be attributable to insufficient sample sizes, at least for wing length. Power tests indicated that sample sizes of 39 and 139, respectively, would be required for the differences in recorded mean wing length and width of r5 in *occidentalis* (Table 4) to be detected (80% chance) as statistically significant ($p < 0.05$). Because, however, no significant differences were found in bill dimensions, the sole reported morphological discriminant between the two, data for the sexes were pooled in subsequent analysis—Fuchs *et al.* (2018) did not separate the sexes. Tests between *occidentalis* and *sharpei sensu stricto* showed that, using the full dataset of the latter, *occidentalis* is larger in bill width and depth ($p < 0.01$) and in culmen length ($p < 0.05$) (Tables 4–5); for each, however, the effect size of these differences was < 2 or ‘minor’. Moreover, because the Niger River in Nigeria forms the boundary between the two taxa, it was considered more informative to restrict analysis of the *sharpei sensu stricto* dataset to those specimens from eastern Nigeria and Cameroon, and thus closest geographically to *occidentalis*. So constrained, the difference between the

TABLE 3
Summarised mensural data for *Dicrurus ludwigii*, *D. (l.) sharpei* and *D. atripennis* from this study.
Measurements in mm.

Taxon	Sex	Statistic	Wing	Tail	R5 width ³	Culmen	Bill width	Bill depth
<i>D. ludwigii</i> ¹	M	Mean	101.17	93.15	16.06	21.27	7.2	6.37
		SD	2.79	3.02	0.91	0.77	0.34	0.28
		Max.	107	100.9	18	22.8	7.9	7.0
		Min.	95	88.8	15	19.9	6.4	5.8
		<i>n</i>	36	31	35	36	35	32
	F	Mean	98.36	89.71	15.68	20.57	7.27	6.4
		SD	2.32	3.95	0.89	0.44	0.36	0.31
		Max.	102	100.2	18	21.5	7.9	7.3
		Min.	94	83.1	15	19.6	6.5	5.9
		<i>n</i>	22	22	22	22	22	22
<i>D. (l.) sharpei</i> ²	M	Mean	105.89	91.77	14.86	20.86	7.22	6.29
		SD	2.92	2.87	0.80	0.78	0.46	0.36
		Max.	112	98.3	17	22.0	8.2	7.1
		Min.	100	86.5	14	18.4	6.2	5.5
		<i>n</i>	44	41	43	43	43	41
	F	Mean	103.87	91.57	14.62	20.73	7.33	6.34
		SD	3.24	2.05	1.05	0.76	0.41	0.27
		Max.	109	95.8	17	22.4	8.1	7.0
		Min.	97	86.7	13	19.4	6.6	5.8
		<i>n</i>	31	30	29	27	29	28
<i>D. atripennis</i>	M	Mean	111.36	101.3	20.82	23.3	7.28	7.24
		SD	3.86	3.69	1.4	0.79	0.38	0.29
		Max.	121	109.8	23	25.3	7.9	7.7
		Min.	105	94.5	19	21.9	6.5	6.6
		<i>n</i>	22	22	22	22	22	22
	F	Mean	109.64	101.19	19.5	22.97	7.45	7.34
		SD	3.23	3.08	1.76	1.09	0.35	0.32
		Max.	116	106	22	24.6	8.2	8.0
		Min.	104	95.3	16	21.1	6.8	6.7
		<i>n</i>	22	20	20	22	22	21

¹Includes the nominate subspecies, *muenzneri*, *tephrogaster* and *saturnus*—see text

²Includes *D. occidentalis*

³Max. width of the outermost rectrix, r5

two populations is limited to bill depth ($p < 0.01$) (Tables 4–5), with *occidentalis* again larger. The effect size remains minor, whilst in all cases the extent of overlap in bill measurements in the two populations is considerable.

TABLE 4

Summarised mensural data for *Dicrurus sharpei* and *D. occidentalis* from this study. Taxonomic treatment follows Fuchs *et al.* (2018). Measurements in mm.

4a. Sexes separated								
Taxon	Sex	Statistic	Wing	Tail	R5 width ¹	Culmen	Bill width	Bill depth
<i>D. occidentalis</i>	M	Mean	106.09	90.76	14.64	21.24	7.51	6.55
		SD	3.01	2.45	0.92	0.50	0.27	0.39
		Max.	110	93.5	17	22	7.9	7.1
		Min.	101	86.6	14	20.5	7.0	5.7
		<i>n</i>	11	11	11	11	11	11
	F	Mean	104.00	91.06	15.00	20.90	7.40	6.37
		SD	3.50	2.57	1.25	0.86	0.33	0.18
		Max.	108	94	17	22.4	7.9	6.6
		Min.	99	86.7	13	19.4	7.0	6.0
		<i>n</i>	10	10	10	9	10	10
<i>D. sharpei</i>	M	Mean	105.82	92.14	14.94	20.73	7.12	6.19
		SD	2.93	2.96	0.76	0.82	0.47	0.31
		Max.	112.00	98.30	17.00	21.80	8.20	6.80
		Min.	100	86.5	14	18.4	6.2	5.5
		<i>n</i>	33	30	32	32	32	30
	F	Mean	104.05	91.96	14.39	20.55	7.27	6.31
		SD	3.09	1.69	0.92	0.59	0.45	0.33
		Max.	109	95.8	17	21.5	8.1	7.0
		Min.	97	89.6	13	19.7	6.6	5.8
		<i>n</i>	20	19	18	17	18	17
4b. Sexes combined								
<i>D. occidentalis</i>	M + F	Mean	105.09	90.86	14.77	21.07	7.47	6.47
		SD	3.26	2.39	1.07	0.67	0.3	0.31
		Max.	110	94	17	22.4	7.9	7.1
		Min.	99	86.6	13	19.4	7.0	5.7
		<i>n</i>	22	22	22	21	22	21
<i>D. sharpei</i>	M + F	Mean	105.04	91.96	14.72	20.64	7.18	6.24
		SD	3.17	2.62	0.85	0.76	0.46	0.31
		Max.	112	98.3	17	21.8	8.2	7.0
		Min.	97	86.5	13	18.4	6.2	5.5
		<i>n</i>	54	50	51	50	51	48
All material	M + F	Mean	104.91	91.34	14.52	20.93	7.41	6.19
		SD	3.33	1.66	0.84	0.6	0.44	0.31
		Max.	112	94.6	17	21.8	8.2	6.9
		Min.	97	89	13	19.8	6.6	5.7
		<i>n</i>	23	20	23	22	23	22

¹Max. width of the outermost rectrix, r5



TABLE 5

Results of Student's *t*-test comparisons and effect size statistics for mensural data between samples of *D. ludwigii*, *D. (l.) sharpei* and *D. atripennis*. **Emboldened, italicised *p*-values indicate the result is significant at *p*<0.01.** *Italicised *p*-values indicate the result is significant at *p*<0.05.* Remainder not significant. Effect size statistic (Cohen's *d*) given only for comparisons with a significant *p*-value.

Comparison	Statistic	Wing	Tail	R5 width ¹	Culmen	Bill width	Bill depth
<i>D. ludwigii</i> ²							
Males vs. females	<i>t</i> -value	3.945	3.596	1.531	3.838	-0.712	-0.385
	<i>p</i> -value	0.0002	0.0007	0.1315	0.0003	0.4793	0.7019
	Cohen's <i>d</i>	0.705	0.978		1.116		
<i>D. (l.) sharpei</i> ³							
Males vs. females	<i>t</i> -value	2.812	0.331	1.096	0.672	-1.02	-0.603
	<i>p</i> -value	0.0063	0.742	0.2767	0.5036	0.3113	0.5488
	Cohen's <i>d</i>	0.655					
<i>D. atripennis</i>							
Males vs. females	<i>t</i> -value	1.61	0.104	2.695	1.153	-1.614	-1.131
	<i>p</i> -value	0.115	0.9178	0.0102	0.2555	0.114	0.2643
	Cohen's <i>d</i>			0.83			
<i>D. (l.) sharpei</i> vs. <i>D. ludwigii</i>							
Males	<i>t</i> -value	7.335	-1.973	-6.176	-2.334	0.248	-1.005
	<i>p</i> -value	<0.00001	0.5247	<0.00001	0.0222	0.8048	0.3183
	Cohen's <i>d</i>	1.653		1.336	0.529		
Females	<i>t</i> -value	6.815	2.21	-3.808	0.875	0.57	-0.732
	<i>p</i> -value	<0.00001	0.0317	0.0004	0.386	0.5712	0.4676
	Cohen's <i>d</i>	1.955	0.591	1.089			
<i>D. atripennis</i> vs. <i>D. (l.) sharpei</i>							
Males	<i>t</i> -value	6.437	11.353	21.807	11.922	0.475	10.488
	<i>p</i> -value	<0.00001	<0.00001	<0.00001	<0.00001	0.6361	<0.00001
	Cohen's <i>d</i>	1.598	2.883	5.227	3.108		2.906
Females	<i>t</i> -value	6.388	13.297	10.038	8.445	1.134	11.857
	<i>p</i> -value	<0.00001	<0.00001	<0.00001	<0.00001	0.2625	<0.00001
	Cohen's <i>d</i>	1.784	3.677	3.367	2.384		3.378
<i>D. sharpei</i> ⁴							
Males vs. females	<i>t</i> -value	2.087	0.241	2.275	0.821	-1.076	-1.234
	<i>p</i> -value	0.0419	0.8107	0.0274	0.4155	0.2874	0.2235
	Cohen's <i>d</i>	0.588		0.652			
<i>D. occidentalis</i> ⁴							
Males vs. females	<i>t</i> -value	1.471	-0.271	-0.764	1.096	0.828	1.377
	<i>p</i> -value	0.1575	0.7894	0.4542	0.2873	0.4181	0.1846
<i>D. sharpei</i> vs. <i>D. occidentalis</i>							
Males and females	<i>t</i> -value	-0.0667	1.685	-0.201	-2.225	-2.712	-2.787
	<i>p</i> -value	0.947	0.9642	0.8409	0.0294	0.0084	0.0069
	Cohen's <i>d</i>				0.6	0.747	0.742
<i>D. sharpei</i> (Nigeria and Cameroon only) vs. <i>D. occidentalis</i>							
Males and females	<i>t</i> -value	-0.181	0.663	-0.99	-0.769	-0.4222	-2.907
	<i>p</i> -value	0.8573	0.5113	0.328	0.4462	0.675	0.0059
	Cohen's <i>d</i>						0.886

¹Max. width of the outermost rectrix, r5²Includes the nominate subspecies, *muenzneri*, *tephrogaster* and *saturnus*—see text.³Includes *D. occidentalis*⁴*Sensu* Fuchs *et al.* (2018)

Vocalisations.—Drongo vocalisations are rather varied and include some soft babbling whistles that can be produced by both sexes in all African species; these presumably have no territorial context. By contrast, the louder calls or songs used in territorial advertisement or defence are more species-specific.

The most frequent song types of *ludwigii* consist of a rapid jumble of ‘whipping’ notes, V-shaped in structure, throughout the distribution of the group (Fig. 4a, H, J and K). These songs can be preceded, or alternated, with typical hard downward *kjiup* notes (Fig. 4a, I) or double *kji-tup*, or other similar hard whistles, also given when leading a mixed-species flock. The sonogram of *ludwigii* in Maclean (1985: 476) illustrated a similar song type. Another, less frequent motif consists of a short, fast jumble of grating notes: a good example can be heard on XC 365934 from southern Malawi, or XC 516540 from Tanzania.

By contrast, in both *sharpei sensu stricto* and *occidentalis* the most frequent song motifs are noticeably different and consist of some hard, slightly rolled *tchre* notes repeated 2–3 times, either given without other notes or, very often, alternating with a sharp note of rather different structure (Fig. 4a, A–F), a loud *kiup* (Fig. 4a, A), or *ueerr* (B), *peek* (C–D), rolled *prurr* (E) or double *kjup*, *kjup* (F). It is striking how similar these songs are either side of the Niger River—they are common to both *sharpei sensu stricto* and *occidentalis* (Fig. 4a, C–D, from Benin and Cameroon, respectively). These sharp notes and also liquid trills *tu-lu-lu-lu-lu* (not illustrated but part of the same recording from Benin, and heard in a recording from northern Angola made by M. S. L. Mills) can also be given in isolation. One motif of both *sharpei* and *ludwigii* is shown in Fig. 4b at a slower timescale to illustrate more clearly the differences in structure.

Both *sharpei* and *ludwigii* can also produce a more complex motif of contrasting notes (that is, with different frequencies in alternation), an example of which is shown for the former in Fig. 4a, G (Togo, by the same bird that produced B), and for the latter in Fig. 4a, L, from South Africa. The latter includes a few *tchre* notes, of a structure slightly different from similar notes in *sharpei*, showing harmonic overtones. Another example of this type of motif in *ludwigii* can be heard on XC 280252, also from South Africa. We have yet to find a motif with *tchre* notes from further north in its range.

A further important difference between the two taxa is the occasional incorporation of imitations of other species in the vocal repertoire of *ludwigii*, whereas to our knowledge this does not occur in *sharpei* (pers. obs.; N. Borrow & R. Demy in litt. 2020). The most frequent extra-specific motif reproduced by *ludwigii* is the *kwip* call of African Goshawk *Accipiter tachiro*. Vernon (1973) also mentioned imitations of Common Bulbul *Pycnonotus barbatus*, but these must be infrequent and we have not identified any other extra-specific renditions in the songs of *ludwigii*. The goshawk calls have been heard or tape-recorded at least in Zambia, Malawi (pers. obs.; see also XC 365934, with one ‘goshawk’ note at the end), Tanzania (e.g. XC 26822, plus several recent recordings by L. A. Hansen, including XC 516540) and South Africa (XC 280256). S. Keith (in Fry et al. 2000) wrote of a recording from Tanzania that *ludwigii* produced a ‘brief ‘twit’ extremely like the ... ‘chit’ made by African Goshawk ... possibly an imitation’. A comparison of sonograms shows these, in fact, to be perfect imitations, with, as in the original motif, many harmonic overtones (FDL pers. obs.).

Commercially published recordings of *sharpei* are limited to those on Chappuis (2000). Unfortunately, most of the cuts therein were of misidentified *atripennis*: thus all five sequences from southern Ivory Coast are typical of the varied repertoire of *atripennis*, as also are two from north-east Gabon (from Makokou: C. Érad in litt. 2020). Aside from the soft babbling whistles (cut 9), which could be given by any of these drongo species, all these motifs are outside our experience of *sharpei*, especially the monotonous repetitions of *fu* or *fee* notes, reminiscent of a malaconotid bush-shrike. Cut 3, from south-west Senegal

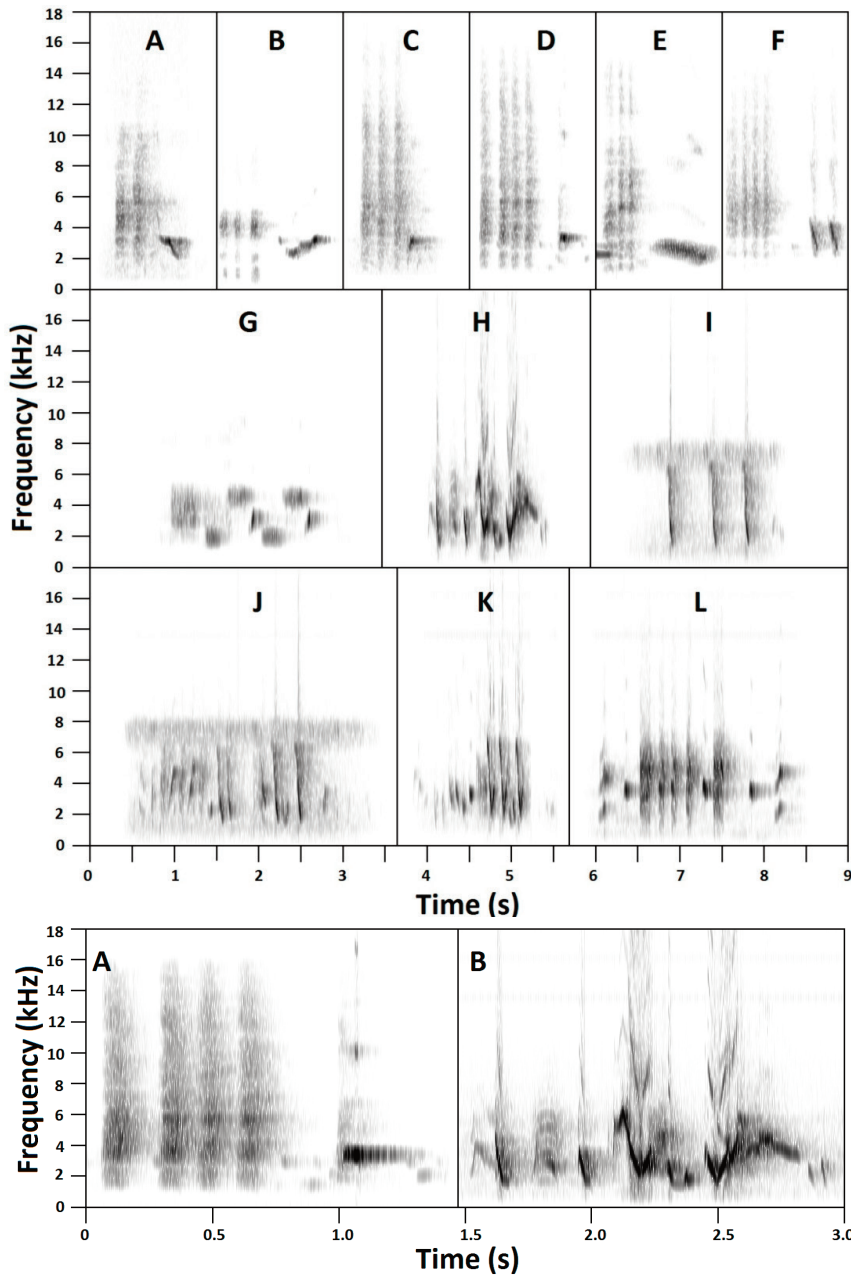


Figure 4a (upper three rows). Sonograms of characteristic vocalisations of Square-tailed Drongo *Dicrurus ludwigii* taxa. A–G: *sharpei* (A–C, *G occidentalis*, D–F *sharpei sensu stricto*—see text). A = Zinguichor, Casamance, Senegal (B. Piot, XC 453789, xeno-canto.org); B = Assoukoko, Togo (F. Dowsett-Lemaire, unpubl.); C = Gbèba, Benin (F. Dowsett-Lemaire, unpubl.); D = Mankon Forest near Bamenda, Cameroon (M. Nelson, XC 99707); E–F = Kakamega, Kenya (E by J. Bradley, XC 101207, F by M. S. L. Mills, 104-003, unpubl.). G = Assoukoko, Togo (F. Dowsett-Lemaire, unpubl.). H–L: *ludwigii*. H = *saturnus*, Ndola, Zambia (Stjernstedt 1989); I–J = *muenzneri*, Witu Forest, Kenya coast (F. Dowsett-Lemaire, unpubl.); K–L = nominate, Mapelane in KwaZulu-Natal and Dweza in Transkei, South Africa (Gibbon 1991).

Figure 4b (bottom row). Sonograms of vocalisations of Square-tailed Drongo *Dicrurus ludwigii* taxa at a slower timescale to illustrate structure more clearly. A (= D in Fig. 4a): *sharpei sensu stricto*—four hard *tchre* notes followed by a sharp *peek*; B (= H in Fig. 4a): *ludwigii saturnus*—jumbled V-shaped, ‘whipping’ notes (see text).



Figure 5. Ventral views of Square-tailed Drongo *Dicrurus ludwigii tephrogaster* to show sexual dimorphism in colour of the underparts. Male above, female below. (NHMUK 1911.5.30.500 [top] and 1911.5.30.499, both Chirinda Forest, Zimbabwe) (L. D. C. Fishpool, © Natural History Museum, London)

(Casamance)—i.e. *occidentalis*—is, on the other hand, typical of *sharpei*, with hard repeated *tchre* notes alternating with loud, rolled *ruee* notes. Cut 1 (unknown locality in Gabon, a recording by Chappuis) is also rather typical of *sharpei*.

Distribution.—The range of *ludwigii sensu lato* in south-central Africa is shown in Fig. 1 and includes all records traced by the authors that could confidently be attributed to either *sharpei* or *ludwigii*, with provenances of specimens examined by LDCF indicated. Records are mapped at the scale of half-degree (30 × 30 minute) squares (localities and supporting references available from the authors on request). The ‘?’ on Lake Tanganyika refers to the Mpala specimen discussed below.

It is apparent that in the area shown *ludwigii* is essentially confined to the Zambezan and East Coast regions, whilst *sharpei* is found on the margin of the Guineo-Congolian region and in its transition zones with the Sudanian and Zambezan regions. The two approach each other closely in south-east DR Congo and, especially, northern Angola.

Examination of material in RBINS revealed that the series of 20 specimens from Upemba National Park (c.08°45’S, 26°45’E), Katanga, DR Congo, collected by de Witte and attributed by Verheyen (1953) to nominate *ludwigii*, are in fact all *sharpei* (Fig. 6a); morphologically and mensurally they are entirely consistent with other *sharpei* specimens examined. This discovery considerably extends the known range of *sharpei* in DR Congo to the south-east of the country (Fig. 1) and, as discussed below, explains some results of the molecular study of Fuchs *et al.* (2017, 2018). In the same collection there is, moreover, a female specimen (RBINS 51078) of *sharpei*, correctly labelled by Verheyen, collected, also by de Witte, on 26 July 1954 in Virunga (=Albert) National Park, DR Congo, which appears hitherto not to have been reported. The precise locality is given as ‘Ababiba, riv. Affl. Malibonge s/af Lue, altitude 1,420 m’. Ababiba is near Buhima, itself close to Rumangabo at 01°20’S, 29°22’E (Fig. 1).

A specimen, attributed to nominate *ludwigii*, reputedly from Mpala (06°45’S, 29°31’E) (Schouteden 1971: 186), shown by a ‘?’ on Fig. 1, was collected by Emile Storms, but its provenance may be doubted. Dubois (1886: 148) listed two *Dicrurus* in the Storms collection,

'*atripennis*' and '*divaricatus*' (i.e. a form of *adsimilis*). Schouteden indicated that he had not seen the specimen, although Hartlaub (1886: 146) had stated that Storms' specimens were deposited at RMCA. No such specimen that might be *ludwigii sensu lato* has been traced in either of the Belgian collections (RMCA, RBINS). Chapin (1954: 4) wrote that *ludwigii* was reported as far north as north-east Marungu, but Dowsett & Prigogine (1974: 30) were unable to find details. It is possible this was in reference to the Storms specimen. It is known that Storms met Richard Böhm and Paul Reichard at Mpala (Schouteden 1971: 3), but there is no reason to suppose there was confusion over who collected this specimen, and it is not mentioned in the Böhm collection detailed by Matschie (1887). It is apparent from Fig. 1 that *ludwigii sensu lato* is not known in this region of south-east DR Congo, although it does occur in northern Zambia as close as the Lofu River, Lake Tanganyika (NHMUK; Neave 1910: 260).

That Fuchs *et al.* (2018) reported haplotypes of both *sharpei* and *saturnus* from north-west Angola is, however, not surprising since, as they said, Clancey's type of *saturnus* came from Cangandala, Malanje Province, and 'Clancey (1976) considered *sharpei* to occur' in N'Dalatando, Cuanza Norte. We confirm that there are two *bona fide* specimens of *sharpei* (NHMUK 1910.5.6.1546–1547) from N'Dalatando (09°18'S, 14°54'E), collected by William Ansoorge, which form part of this study. The holotype of *saturnus* (type locality: Maubi River, Cangandala, Malanje: 09°47'S, 16°41'E, Clancey 1976) remains in Durban Natural Science Museum (D. Allan *in litt.* 2021) together with a second specimen, clearly *saturnus*, which Clancey would have also examined. This originates from the rio Cacongo (= Cacungun), Cangandala, Malanje (09°25'S, 16°21'E). The latter is little more than 60 km south of the nearest *sharpei*, from 40 km north of Calandula (08°54'S, 16°05'E)—a confirmed sound recording by M. S. L. Mills—and a series of specimens labelled Calandula (09°06'S, 15°53'E) in the Field Museum of Natural History (FMNH), Chicago. Additional nearby *sharpei* are from Luhanda, 5 km north of Quela (09°16'S, 17°02'E; FMNH 220969, a G. Heinrich specimen), the rio Lutete (09°31'S, 15°45'E)—named Pungo Andongo in Dean (2000)—whence a specimen identified by Stresemann (1937: 53) was collected by Rudolf Braun (Fig. 1) and 10 km south of Quibaxe (08°34'S, 14°35'E). The last, together with a record of *saturnus* from Kumbira forest (11°08'S, 14°17'E), derives from acoustic evidence provided by M. S. L. Mills.

Thus, in both south-east DR Congo and north-west Angola, the ranges of *sharpei* and *saturnus* approach each other closely (Fig. 1). This is consistent with the statement by Fuchs *et al.* (2018) that the two 'appear to be parapatrically distributed' in Angola and south-east DR Congo, although we have no evidence that this is also the case in Zambia, as they suggested.

Discussion

Our study confirms all of the differences between *ludwigii* and *sharpei* documented by Clancey (1976), with the partial exception of the lack of sexual dimorphism in size within *sharpei*, a discrepancy which may be attributable to the larger sample size here (86) vs. his 11 (Tables 2–3). Although this dimorphism in *sharpei* is restricted to wing length, the scale of the difference, as measured by Cohen's *d*, was comparable to that of *ludwigii* (Table 5). That *sharpei* does show such dimorphism brings it into line with almost all other members of the Dicruridae, wherein males average larger than females (Vaurie 1949, Rocamora & Yeatman-Berthelot 2009); our finding that there was little mensural difference between the sexes in *atripennis*, including wing length, is therefore notable (Table 5) although, as indicated above, larger sample sizes are desirable to confirm this. However, the occurrence of sexual dimorphism in plumage colour in *ludwigii* (Fig. 5) appears exceptional, if not

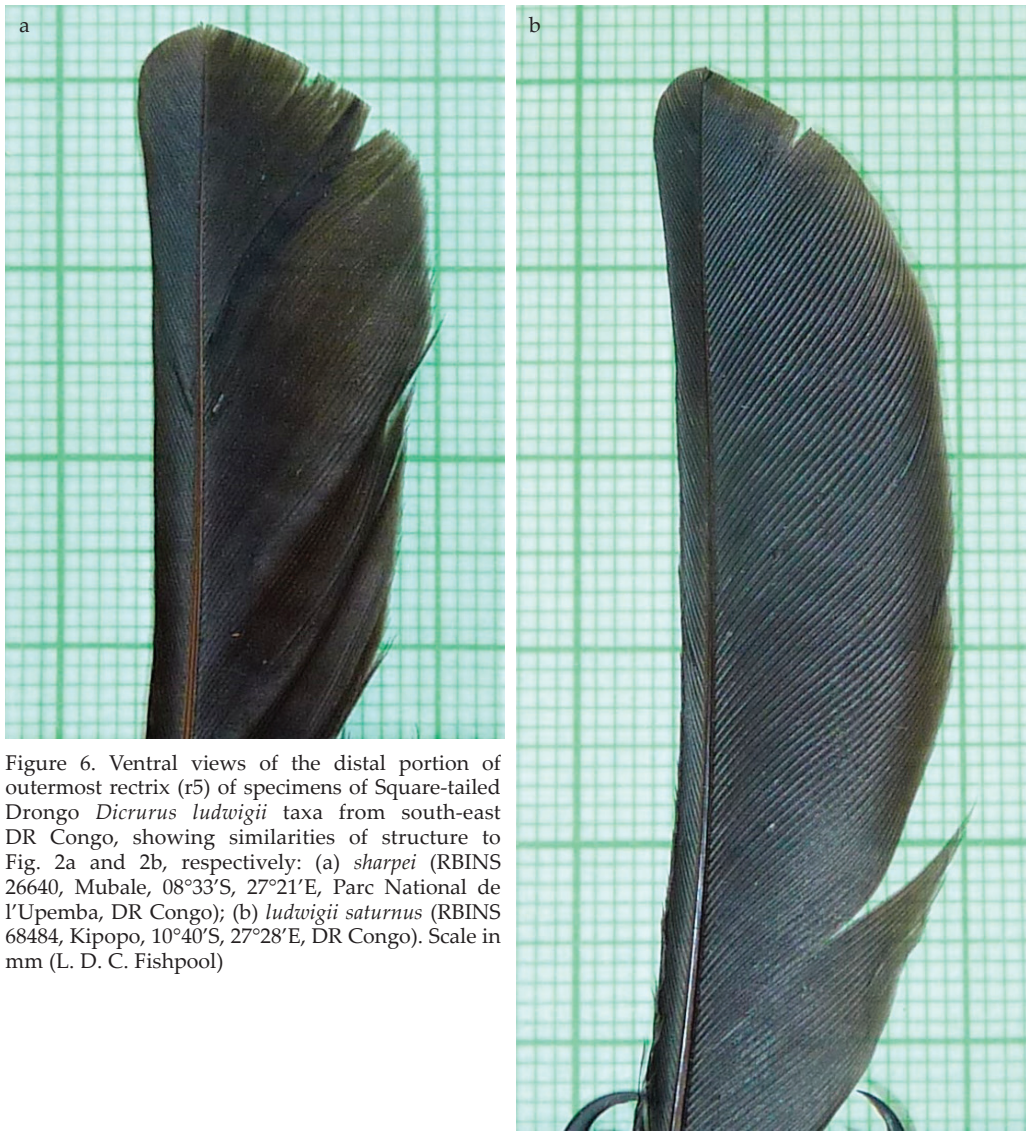


Figure 6. Ventral views of the distal portion of outermost rectrix (r_5) of specimens of Square-tailed Drongo *Dicrurus ludwigii* taxa from south-east DR Congo, showing similarities of structure to Fig. 2a and 2b, respectively: (a) *sharpei* (RBINS 26640, Mubale, 08°33'S, 27°21'E, Parc National de l'Upemba, DR Congo); (b) *ludwigii saturnus* (RBINS 68484, Kipopo, 10°40'S, 27°28'E, DR Congo). Scale in mm (L. D. C. Fishpool)

unique, in the family (Rocamora & Yeatman-Berthelot 2009), although female *atripennis* are less extensively glossed below than males (Pearson 2000, Rocamora & Yeatman-Berthelot 2009; pers. obs.).

The contrast in overall tail shape between *ludwigii* and *sharpei*—more or less parallel-sided and square-ended in *sharpei* vs. increasingly divergent distally and with a notch at the tip in *ludwigii* (Fig. 3)—is a consequence of a combination of characters. These include the fact that the outermost rectrix of *ludwigii* shows a greater degree of outward curvature, a wider tip, a sharper angle where the inner and outer vanes meet, and by the subterminal reduction in the width of the outer vane. Each character is inconspicuous and/or subtle but, in sum, they amount to a significant divergence in tail structure. Indeed, in structure—if not dimensions (Tables 3, 5)—the tail feathers of *sharpei* are closer to those of *atripennis* than they are to *ludwigii* (Fig. 2a–c), which is consistent with the finding of Fuchs *et al.* (2017, 2018) that *sharpei* and *atripennis* are sister taxa.

Analysis of vocal repertoires of the various taxa shows that *ludwigii* is clearly distinct from *sharpei*—not only in the structure of motifs and notes, but also in the occasional presence of imitations of calls of African Goshawk, whereas *sharpei* never imitates. In contrast, *sharpei sensu stricto* and *occidentalis* have very similar, even identical, motifs either side of the Niger River.

As mentioned above, Fuchs *et al.* (2017), in making their case to re-elevate *sharpei* to species level, used Vaurie (1949) as authority for the characters which distinguish it morphologically from *ludwigii*; it is unclear why the additional points (Table 1) noted by Clancey (1976), and repeated in the subsequent literature, were ignored. Moreover, Fuchs *et al.* (2017) misquoted Vaurie (1949) by saying ‘...individuals of the subspecies *saturnus* and *sharpei* have white tips (or at least some traces) on the axillaries and on the small feathers along the ventral edge of the metacarpus, whereas they are generally absent in the subspecies *ludwigii*, *muenznerii* [sic] and *tephrogaster* (Vaurie 1949)’. In fact, Vaurie (1949) said the converse: ‘In *sharpei*, according to my specimens, the white is completely absent in both immature and adult plumage.’ Our results support Vaurie’s interpretation, while the presence (confirmed here) of white tips to the axillaries in specimens of *saturnus*—undescribed at the time of Vaurie’s study—is indicative of its affinities with the *ludwigii* group, rather than *sharpei*.

As also previously noted, placement of *saturnus* was revised between the two studies by Fuchs *et al.* (2017, 2018). In the former, analysis of a single sample of the taxon, from south-east DR Congo, placed it in a clade with *sharpei*, whereas the later study included samples from seven *saturnus* specimens, two from DR Congo, two from Zambia and three (including the type) from Angola. Whilst genetic analysis recovered the Zambian and Angolan material in the *ludwigii* clade, the two DR Congo samples again aligned with *sharpei*. Their decision to revert to treating *saturnus* as a subspecies of *ludwigii* was influenced by placement of the sample from the type specimen.

The novel implication remained meanwhile that *sharpei* was, on molecular evidence, present in south-east DR Congo. Fuchs *et al.* (2017, 2018) did not, however, draw any explicit inferences from the plumages of specimens concerned. The finding here that the population in Upemba, south-east DR Congo is, on morphological grounds, indeed *sharpei*, *contra* Verheyen (1953), confirms their suspicion (Fig. 1, 6a). The two specimens sampled by Fuchs *et al.* (2018) in fact form part of the de Witte series documented by Verheyen (1953), one of which appears as Fig. 6a (Mubale, 08°33’S, 27°21’E). However, Clancey (1976) was also correct in stating that the range of *saturnus* included DR Congo. He examined material from Kambove (10°52’S, 26°37’E), which is in far south-east Katanga, near Lubumbashi, but it is unclear how many specimens were involved, possibly only one, as there is just one from DR Congo in NHMUK, and that is from Kambove. We confirm that this specimen is indeed *saturnus*, not *sharpei*, as is a series of some 20 specimens in RMCA and RBINS from the general area of Lubumbashi (Fig. 1, 6b). Other localities in Schouteden (1971: 186–187), away from the Upemba area (*sharpei*), and considered to represent *saturnus*, range from Tenke (10°36’S, 26°07’E) east to St Hubert (11°29’S, 27°36’E). The nearest known locality of *saturnus* to Upemba seems to be Lukonzolwa (08°47’S, 28°38’E), on Lake Mweru, to the east of the easternmost *sharpei* specimens at Mubale. Although mentioned by Schouteden (1971), this specimen is not housed in Belgium. It was collected by Michele Ascenso (Salvadori 1907) and it is implied that his specimens were identified by Ogilvie-Grant & Reichenow. Elter (1986: 183) showed it to be in the Museo Regionale di Scienze Naturale, Turin, under the name *luwigi* (*sic*), with coding that indicates it is indeed the Ascenso specimen. The distance between the two localities is 140 km.

The putative difference in iris colour between *sharpei* and *ludwigii* reported by Stevenson & Fanshawe (2002)—orange-red in *sharpei*, scarlet-red in nominate—is not supported by specimen label data. These describe the irides of both variously to be red, orange-red, blood-red, crimson, ruby, orange-vermilion etc. although only for *ludwigii*, in some specimens, are they said to be orange, without a modifier.

Notably, we did not find the major differences in bill measurements reported by Fuchs *et al.* (2018) between *sharpei sensu stricto* and *occidentalis* (Tables 2, 4, 5). While we found the bill dimensions of *occidentalis* averaged larger than those of *sharpei* (Table 4)—the statistical significance of which (Table 5) is discussed above—in line with the trends reported by Fuchs *et al.* (2018), the scale of these differences was much more modest. Thus, the differences between the means of culmen, bill width and depth in *occidentalis* and *sharpei sensu stricto* given by Fuchs *et al.* (2018) were, respectively, 1.1, 0.7 and 0.8 mm: the equivalent figures here, for *sharpei sensu stricto* specimens from eastern Nigeria and Cameroon alone, are 0.14, 0.06 and 0.28 mm; and while (for the same populations) the overlap in the range in culmen lengths reported here is considerable, Fuchs *et al.* (2018) found there to be almost none (Tables 2 and 4). The reason for this may be attributable to disparity in sample sizes, smaller in Fuchs *et al.* (2018)—see Tables 2 and 4.

The accurate and consistent location of the point of measurement of bill width and depth—the distal end of the nostril—proved not to be straightforward, for the reasons given by Vaurie (1949): ‘The frontal feathers in all drongos are dense and extend to a greater or lesser degree over the upper mandible, the nostril being generally well concealed’. Apart from in specimens lacking some feathering in this region, as a consequence of collection, skin preparation and subsequent handling etc., locating the leading edge of the nostril took some practice and persistence: the data used here came from re-measurement of all specimens after several ‘rehearsals’.

In seeking to explain their novel discovery of putative differences in bill size, Fuchs *et al.* (2018) wrote ‘Clancey (1976)...had access to several specimens from within the range of *D. occidentalis*, but he did not measure bill length, but instead examined variation in plumage and tail length’. This is, however, partly incorrect: Clancey (1976: 99) gave measurements of 11 specimens of *sharpei*, including bill length, and while it is not clear exactly how many of these were *occidentalis* (he reported examining 15 skins in all), the list of localities he provided made it apparent that several specimens from either side of the Niger River must have been involved. Both Clancey (1976) and Fuchs *et al.* (2018) refer to a specimen from Anara Forest, Kaduna, Nigeria (10°42'N, 07°38'E) and as this skin, in NHMUK—whose material Clancey (1976) used—was confirmed as a ‘verified specimen’ of *occidentalis* by Fuchs *et al.* (2018), it seems clear that the same specimen was involved. No differences in bill size were reported by Clancey (1976).

Fuchs *et al.* (2018) noted that Clancey (1976) examined variation in tail length—and indeed shape—which they did not, nor did they state why they did not (Fuchs *et al.* 2017, 2018). As mentioned above, Fuchs *et al.* (2018) claimed their ‘...new species of drongo was overlooked by taxonomists despite *D. occidentalis* being the morphologically most differentiated species in the *D. ludwigii*-*D. atripennis* complex’. Even if our study had confirmed the reported differences in bill morphology shown by *occidentalis*, it would be hard to sustain such an assertion, given the differences in tail structure and dimensions between *sharpei* and *ludwigii* described and illustrated here.

The assertion becomes even more untenable when *sharpei* and *atripennis* are compared. Apart from the fact that the plumage of *atripennis* is much more highly glossed than it is in *sharpei* and *ludwigii* (Pearson 2000, Rocamora & Yeatman-Berthelot 2009; pers. obs.), it is clear from Tables 3 and 5 that for all parameters measured, except bill width, the magnitude

of the differences between *atripennis* and *sharpei* dwarfs those between *occidentalis* and *sharpei sensu stricto*. The statement that ‘the most reliable biometric measurements to discriminate *D. atripennis* from any *D. ludwigii* population are bill depth and wing length’ (Fuchs *et al.* 2018) also demands reconsideration in light of the differences in tail dimensions reported here (Tables 3 and 5).

Nor can we agree with the claim that their ‘... data ... clearly enable diagnosis of a discret (*sic*) set of characters that render *D. occidentalis* distinct from other drongo specimens collected throughout the geographical range of each of the other taxa’ (Fuchs *et al.* 2018). The only ‘character’ by which *occidentalis* can safely be distinguished from *sharpei sensu stricto* in the field, or indeed in the hand, is geographical location.

Del Hoyo & Collar (2016) assessed the case for species status of *sharpei* using the system of scoring proposed by Tobias *et al.* (2010). They gave it—together with *saturnus*, on the basis of the results published by Fuchs *et al.* (2017), subsequently reversed in Fuchs *et al.* (2018)—a total of five points. They also noted that ‘vocal differences not apparent in limited samples available’, an observation which the larger number of samples available to our study has contradicted.

To achieve species status using the system of Tobias *et al.* (2010) a threshold of seven is required. Scores are awarded for differences in plumage, size and voice (but not genetic composition), in which an exceptional character (radically different coloration, pattern, size or sound) scores 4, a major character (pronounced difference in body part colour or pattern, measurement or sound) 3, medium character (clear difference, e.g. a distinct hue rather than different colour) 2, and minor character (weak difference, e.g. a change in shade) 1. Species status cannot be triggered by minor characters alone, and only three plumage characters, two vocal characters, two biometric characters (assessed for effect size using Cohen’s *d* where 0.2–2.0 is minor, 2–5 medium, 5–10 major and >10 exceptional) and one behavioural or ecological character (allowed 1) may be counted (hence ‘ns’ with a number in square brackets is used where a difference is identified and judged for its strength, but ‘no score’ is allowed).

On the basis of the revised morphological differences reported here (Table 1), we score *sharpei* as differing from *ludwigii* as follows. Rachis of r5 only weakly outcurved, its outer vane of +/- uniform width throughout or only slightly widened distally, the tip with an obtuse angle vs. rachis more strongly outcurved, outer vane conspicuously narrower subterminally than distally, tip sharply angled (+/- acute) (3); breast and belly black in both sexes vs. breast and belly black in males, sooty or lead grey in females (1); violet-purplish vs. bluish-green gloss (1); all dark (both sexes and immatures) vs. white-tipped underwing-coverts and axillaries in females and subadult males (1) [ns]; longer vs. shorter winged in both sexes (effect size males 1.65, females 1.95) (1); narrower vs. wider tip to outermost tail feather (effect size males 1.34, females 1.09) (1). Total eight.

On plumage and mensural characters alone therefore, the score passes the threshold for species status. If acoustic differences are included (not scored formally but at least 2), together with the possibility that the two forms approach parapatry (a max. separation of 60 km in north-west Angola), which would attract a further score of 3, then the threshold is far exceeded. On the other hand, using the same system the differences between *occidentalis* and *sharpei sensu stricto* (Nigeria and Cameroon only) score no more than 1 for a deeper vs. shallower bill (effect size 0.89) (Table 5), with a possible further 3 for claimed parapatric separation at the Niger River: sample sizes in Fuchs *et al.* (2018) are, however, too small to confirm or refute the existence of such a divide.

Thus, the range and extent of the plumage, morphometric and vocal differences between *sharpei* and *ludwigii* described here, combined with the molecular evidence

provided by Fuchs *et al.* (2017), are, we consider, easily sufficient to justify species status for *sharpei*. On the other hand, judged solely on the phenetic evidence, which boils down to differences in bill size from *sharpei sensu stricto*—there being none in plumage or voice—*occidentalis* should be considered no more than a weakly defined subspecies of *sharpei*.

Fuchs *et al.* (2018) used the phrase ‘... areas where the Western Square-tailed Drongo and Shining Drongo co-occur ...’ In our experience however, *atripennis* is never found syntopically with *occidentalis* or indeed *sharpei sensu stricto*, since they have different habitat requirements, a point made briefly in Fishpool *et al.* (2010) and one which we hope to explore more fully in a forthcoming publication, taking the opportunity to rectify a number of misidentifications in the literature revealed as a result of mapping their respective distributions, part of which appears as Fig. 1.

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