# Taxonomy of the Pacific Swift *Apus pacificus* Latham, 1802, complex

*by Paul J. Leader*

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SUMMARY.—This paper considers the taxonomic implications of morphological differences within the Pacific Swift *Apus pacificus* complex. Specimens of the four currently recognised subspecies (nominate, *kanoi*, *cooki* and *leuconyx*) were examined, plus *kurodae* (currently treated as a synonym of *pacificus*) and *saliunali* (currently treated as a synonym of *kanoi*). Consistent plumage and structural differences indicate that the current taxonomy of the complex is untenable. It is proposed that *salimali* is a valid taxon but that *kanoi* is not (and should be treated as a junior synonym of *kurodae*) and that *pacificus*, *saliunali*, *leuconyx* and *cooki* merit species status.

Pacific Swift *Apus pacificus* is widely distributed, breeding from Siberia east to Kamchatka and Japan, south through China to Vietnam, Thailand and Myanmar, and Tibet, the outer Himalayas and Assam Hills (Chantler 1999). Four subspecies are generally recognised (Chantler & Driessens 1995, Chantler 1999, Dickinson 2003): *A. p. pacificus* Latham, 1802, *A. p. kanoi* Yamashina, 1942, *A. p. cooki* Harington, 1913, and *A. p. leuconyx* Blyth, 1845. This paper reviews structural and plumage differences between these taxa (the '*pacificus* complex') based on an examination of specimen material and considers the taxonomic implications of these differences. Comparison is made with Dark-rumped Swift *A. acuticauda* where relevant.

## Material and Methods

A total of 146 *Apus pacificus* specimens was examined at the Natural History Museum, Tring, UK (BMNH), Museum für Naturkunde, Berlin, Germany (ZMB), the Yamashina Institute for Ornithology, Tokyo, Japan (YIO), and the Institute for Zoology, Chinese Academy of Science, Beijing, People's Republic of China (IOZ). These specimens included 44 nominate, 47 *kanoi*, 24 *cooki* and 13 *leuconyx*. Twelve *A. p. kurodae* Domaniewski, 1933, and six *A. p. salimali* Lack, 1958, specimens were also examined. The former is generally treated as a synonym of *pacificus* and *saliunali* as a synonym of *kanoi* (Vaurie 1965, Chantler & Driessens 1995, Chantler 1999, Dickinson 2003). The holotypes of *kanoi*, *cooki* and *saliunali* were included in my analyses. One specimen of *A. acuticauda* was examined and to supplement this, data and photographs pertaining to 18 *A. acuticauda* specimens were also provided (J. Hinshaw pers. comm.).

The following measurements were taken: wing length (maximum chord), length of the longest and shortest tail feathers measured from the tail base (from which depth of tail fork was calculated) and distance between the tips of the two longest primaries (measured on the closed wing). All measurements were recorded to the nearest 0.5 mm. Plumage differences were assessed in detail, with consideration given to those attributable to age class (adult or juvenile), specimen condition and wear. Primaries are numbered from the outermost (p1) inwards.

## Results

*Plumage differences.*—The key plumage differences proved to be the size of the rump patch, extent of pale fringes on the underparts, the depth and width of the throat patch, the ground colour of the underparts and upperparts, and the colour of the underwing-coverts. I found these to vary between taxa more than is generally indicated in most of the literature (though see Rasmussen & Anderton 2005), and I found consistent plumage differences between most of the taxa examined. These differences are summarised in Table 1.

*Structural differences.*—I found that size and structure varied between taxa and consider that for most taxa there exist consistent differences from other taxa for one or more of the parameters measured (see Table 2). There was little difference with regard to the distance between the two longest primaries, except in the case of *cooki*, which is discussed below. When combined, structural and plumage differences permitted most taxa examined to be readily differentiated.

*Diagnoses.*—*A. p. pacificus*: in plumage and structure, *pacificus* is very similar to both *kurodae* and *kanoi* (Figs. 1–4). There is extensive overlap in wing length between these three taxa, although in *pacificus* the tail is longer than in *kurodae* or *kanoi* (mean 75.1 mm for *pacificus* vs. 71.1 mm and 72.4 mm for *kurodae* and *kanoi*, respectively), although values for tail fork depth were similar (mean 32.8 mm for *pacificus* vs. 29.8 mm and 30.4 mm for *kurodae* and *kanoi*, respectively), as was relative depth of the tail fork expressed as a percentage of tail length (mean 43.3% for *pacificus* vs. 42.0% and 41.8% for *kurodae* and *kanoi*, respectively).

Plumage differences from *kurodae* and *kanoi* are limited to a tendency for *pacificus* to exhibit a cleaner, whiter throat patch and a slightly broader rump patch than *kurodae* and *kanoi*, although many *kurodae* and *kanoi* possess a rump patch comparable to that of typical *pacificus*.

*Kurodae*: for separation from *pacificus*, see that taxon. I found this taxon inseparable in terms of both plumage and structure from *kanoi*, even when comparing the holotype of *kanoi* to a series from Japan (Figs. 3–4) (see Discussion concerning the type locality of *kurodae*).

*Kanoi*: for separation from *pacificus*, see that taxon. As discussed above, I found *kanoi* and *kurodae* inseparable.

*Salimali*: whilst wing length of *salimali* is similar to that of *pacificus*, *kurodae* and *kanoi* (179.8 mm vs. 179.9 mm, 182.3 mm and 181.4 for *pacificus*, *kurodae* and *kanoi*, respectively), it is distinctly longer tailed (mean 79.0 mm vs. 75.1 mm, 71.1 mm and 72.4 mm for *pacificus*, *kurodae* and *kanoi*, respectively). Tail fork depth is similar in all four taxa, and as a consequence the relative depth of the tail fork expressed as a percentage of tail length is notably different, averaging 37.4% for *salimali* vs. 43.3%, 42.0 % and 42.0 % for *pacificus*, *kurodae* and *kanoi*, respectively. The similar wing length yet longer tail results in a lower wing-tail ratio for *salimali*, 2.28 vs. 2.40, 2.57 and 2.51 for *pacificus*, *kurodae* and *kanoi*, respectively.

In plumage, *salimali* differs notably from all taxa examined in the pattern of the throat patch, which forms a narrow pale strip on the centre of throat and is narrowest at the base of the bill, where it tapers to a neat point (Fig. 5). (One *leuconyx* specimen was examined which had been over-stretched during preparation. As a result the throat patch was rather elongated and superficially similar to that of *salimali* but this specimen was otherwise typical of *leuconyx*.) The throat patch is less than half the width of other taxa. The rump patch is consistently narrow (*c.*10 mm wide) and the crown and nape are mid brown, contrasting conspicuously with the mantle which is glossy black (Fig. 6). The pale tips to the underparts are much reduced compared to *pacificus*, *kurodae* and *kanoi*, and more comparable to *leuconyx* in this character.

TABLE 1
Key plumage differences in adult plumage of members of the *Apus pacificus* complex and closely related taxa.

| | *pacificus* | *kurodae* | *kanoi* | *salimali* | *cooki* | *leuconyx* | *acuticauda* |
|---|---|---|---|---|---|---|---|
| Rump patch | Broad (*c.*20 mm wide) with few or no darker shaft-streaks | Broad to medium (*c.*15–20 mm wide) with few or no darker shaft-streaks | Broad to medium (*c.*15–20 mm wide) with few or no darker shaft-streaks | Narrow (*c.*10 mm wide) with indistinct dark shaft-streaks | Narrow (*c.*10 mm wide) with conspicuous dark shaft-streaks; these often broaden near the feather tip to form dark club-shaped marks | Narrow (*c.*10 mm wide) with fine but distinct dark shaft-streaks | None, rump and uppertail-coverts concolourous with mantle and tail |
| Throat patch | Very pale whitish, very well defined and not extending onto upper breast, dark shaft-streaks fine | Greyish, moderately well defined and not extending onto upper breast, dark shaft-streaks fine | Greyish, moderately well defined and not extending onto upper breast, dark shaft-streaks fine | Well-defined narrow off-white strip on centre of throat; narrowest at base of bill where tapers to a neat point; does not extend onto upper breast; dark shaft-streaks either extremely fine or lacking. | Off-white with well-defined black shaft-streaks, lower border ill-defined and extending onto upper breast | Off-white with fine dark shaft-streaks, lower border ill-defined typically extending onto upper breast and some mottling on throat patch, especially at sides and towards lower border | None, feathers black with very well-defined pure white fringes (i.e. same as rest of underparts) |
| Upperparts | Uniform dark brown, sometimes slightly darker on mantle | Uniform dark brown, sometimes slightly darker on mantle | Uniform dark brown, sometimes slightly darker on mantle | Crown and nape mid brown, contrasting with glossy black mantle | Entire upperparts including crown and nape black with extensive green iridescence, often with narrow white fringes to scapulars | Crown and nape mid brown, contrasting with glossy black mantle | Crown and nape blackish, contrasting with glossy black mantle |
| Underparts | Uniform dark brown with well defined but narrow off-white fringes | Uniform dark brown with well defined but narrow off-white fringes | Uniform dark brown with well defined but narrow off-white fringes | Uniform dark brown with greatly reduced pale fringes to feathers | Black with broad, well-defined pure white fringes | Upper breast mid brown, becoming darker over lower breast and rest of underparts; poorly defined pale tips to feathers | Black with broad, very well-defined pure white fringes |
| Underwing-coverts | Dark brown and similar in colour to rest of underwing | Dark brown and similar in colour to rest of underwing | Dark brown and similar in colour to rest of underwing | Dark brown and similar in colour to rest of underwing | Black and contrasting with the rest of underwing | Dark brown and similar in colour to rest of underwing | Black and contrasting with rest of the underwing |

TABLE 2
Summary of key structural differences between members of the *Apus pacificus* complex and closely related taxa.

| | | Wing length (mm) | Tail length (mm) | Tail fork depth (mm) | Wing/tail ratio | Tail fork as % of tail length |
|---|---|---|---|---|---|---|
| *pacificus* | Max. | 190.0 | 83. | 42.0 | 2.80 | 51.6 |
| | Min. | 170.0 | 64.0 | 25.5 | 2.20 | 37.28 |
| | Mean | 179.9 | 75.1 | 32.7 | 2.40 | 43.3 |
| | SD | 4.63 | 4.47 | 3.6 | 0.13 | 3.89 |
| | *n* | 43 | 42 | 42 | 42 | 42 |
| *kurodae* | Max. | 188.0 | 77.0 | 34.0 | 2.79 | 49.2 |
| | Min. | 174.0 | 66.0 | 24.5 | 2.40 | 34.0 |
| | Mean | 182.3 | 71.1 | 29.8 | 2.57 | 42.0 |
| | SD | 4.54 | 3.4 | 3.3 | 0.12 | 4.86 |
| | *n* | 12 | 12 | 11 | 11 | 11 |
| *kanoi* | Max. | 191.5 | 78.5 | 37.5 | 2.85 | 52.3 |
| | Min. | 171.5 | 63.50 | 21.0 | 2.34 | 33.1 |
| | Mean | 181.4 | 72.4 | 30.4 | 2.51 | 42.0 |
| | SD | 4.07 | 3.25 | 3.25 | 0.11 | 3.50 |
| | *n* | 46 | 47 | 47 | 46 | 46 |
| *salimali* | Max. | 183.0 | 85.0 | 35.0 | 2.46 | 41.2 |
| | Min. | 177.0 | 72.0 | 24.0 | 2.14 | 31.2 |
| | Mean | 179.8 | 79.0 | 29.6 | 2.28 | 37.4 |
| | SD | 2.3 | 4.24 | 4.39 | 0.11 | 4.7 |
| | *n* | 6 | 6 | 6 | 6 | 6 |
| *leuconyx* | Max. | 170.0 | 73.0 | 27.0 | 2.66 | 39.1 |
| | Min. | 151.0 | 61.0 | 16.0 | 2.18 | 25.8 |
| | Mean | 161.1 | 67.9 | 23.5 | 2.38 | 34.6 |
| | SD | 5.43 | 3.97 | 3.44 | 0.14 | 4.40 |
| | *n* | 13 | 13 | 13 | 13 | 13 |
| *cooki* | Max. | 181.5 | 82.0 | 28.0 | 2.67 | 38.4 |
| | Min. | 162.0 | 65.0 | 15.0 | 2.17 | 21.7 |
| | Mean | 172.4 | 73.0 | 21.5 | 2.37 | 29.3 |
| | SD | 5.05 | 3.99 | 3.32 | 0.12 | 3.7 |
| | *n* | 18 | 16 | 17 | 16 | 16 |
| *acuticauda** | Max. | 181.6 | 75.1 | 27.2 | 2.79 | 37.8 |
| | Min. | 166.3 | 60.2 | 16.2 | 2.27 | 26.9 |
| | Mean | 173.4 | 69.1 | 22.2 | 2.57 | 32.2 |
| | SD | 4.55 | 4.98 | 3.72 | 0.17 | 3.53 |
| | *n* | 16 | 15 | 16 | 16 | 15 |

*data for all but one specimen provided by Janet Hinshaw (Museum of Zoology, University of Michigan, Ann Arbor)

Figure 1. Ventral view of specimens of Pacific Swift *Apus p. pacificus* (Paul J. Leader / Yamashina Institute for Ornithology)

Figure 2. Dorsal view of specimens of Pacific Swift *Apus p. pacificus* (Paul J. Leader / Yamashina Institute for Ornithology)

Figure 3. Ventral view of five specimens of Pacific Swift *Apus pacificus kanoi* on left and type specimen of *'kurodae'* on right (Paul J. Leader / Yamashina Institute for Ornithology)

Figure 4. Dorsal view of five specimens of Pacific Swift *Apus pacificus kanoi* on left and type specimen of *'kurodae'* on right (Paul J. Leader / Yamashina Institute for Ornithology)

*Cooki*: at 172.4 mm, *cooki* has the second shortest mean wing length after *leuconyx* (161.1 mm) and a tail length similar to that of *kurodae* and *kanoi* (73.0 mm vs. 71.1 mm and 72.4 mm). It has the shallowest tail fork (mean 21.5 mm vs. 23.5 mm for *leuconyx* and 29.6–32.7 mm for all other taxa), and the shortest relative depth of the tail fork expressed as a percentage of tail length (mean 29.3% vs. 34.6% for *leuconyx* and 37.4–43.3% for all other taxa).

Perhaps most importantly, whilst in all other taxa the longest primary was p2 in all individuals: *pacificus* (p2 1.1–8.5 mm longer than p1; $n$ = 19), *kurodae* (2.1–6.1 mm longer; $n$ = 11), *kanoi* (1.0–7.4 mm longer; $n$ = 32), *salimali* (0.6–4.9 mm longer; $n$ = 6) and *leuconyx* (1.3–4.8 mm longer; $n$ = 9), of 18 *cooki* the longest primary is p1 on 13 (72%) being 1.0–4.0 mm longer than p2, the other five have p2 longest by 0.7–2.3 mm, which is at the lower end of the range for the other taxa.

I found *cooki* to be distinctive in plumage and readily separable from all other taxa using a number of criteria. The rump patch is narrow (*c*.10 mm wide) with conspicuous dark shaft-streaks which typically broaden near the feather tip to form broad, club-shaped dark marks (Fig. 8), rather than the, at most, narrow, dark shaft-streaks (usually none) of all other taxa. The upperparts and underparts are black and very different from all other taxa, which have dark brown upper- and underparts (or in the case of *salimali* and *leuconyx* black on the upperparts is restricted to the mantle). The underparts have broad, well-defined white fringes that approach those of *A. acuticauda* rather than any of the taxa in the *pacificus* complex (Fig. 8). The throat patch is off-white with well-defined black shaft-streaks (more pronounced than in other taxa) and extends onto the upper breast (Fig. 9). The upperparts possess an extensive green iridescence and often show narrow white fringes to the scapulars in fresh plumage. Finally, the underwing-coverts are black and contrast with the rest of the underwing, whereas in all other taxa the underwing-coverts are dark brown and hence similar to the rest of the underwing.

It should be noted that the holotype is a very worn breeding adult (collected 2 June 1912) and that the rest of a series at BMNH from the type locality (Gokteik Caves, eastern Myanmar) are juveniles lacking fully grown wings. As such they appear, superficially at least, smaller, duller and browner (especially the juveniles) than specimens of *cooki* from elsewhere. However, they all share a comparable rump patch size and patterning with other *cooki* specimens, and the adult, once the effects of wear are considered, is comparable with other *cooki* specimens I have examined.

*Leuconyx*: much the smallest of the taxa examined; mean wing length is 161.1 mm vs. 172.4 mm to 182.3 for all other taxa. Mean wing length is closest to that of *cooki*, from which it differs notably in other respects, especially plumage (see *cooki* for details). Mean tail length is also shortest; 67.9 mm vs. 72.4–79.0 mm in all other taxa.

In plumage *leuconyx* is most similar to *salimali* in that the rump patch is consistently narrow (*c*.10 mm wide) and the crown and nape are mid brown and contrast conspicuously with the mantle, which is glossy black (Fig. 10). However, the throat patch pattern is distinctly different, being broad (covering the entire throat), off-white with fine dark shaft streaks, while the lower border is ill-defined and typically extends onto the upper breast with some mottling within the throat patch, especially at the sides and towards the lower border (Fig. 9). The upper breast is mid brown, paler than in other taxa, becoming darker over the lower breast and the rest of the underparts.

## Distribution and breeding ecology

*Pacificus* breeds from Siberia east to Kamchatka and northern Japan, south to northern China. It breeds from sea level to 3,000 m in Japan and nests on cliff faces and in caves, and on buildings. It is primarily a long to very long-distance migrant, with birds wintering

Right, top to bottom:

Figure 5. Ventral view of specimens of Sálim Ali's Swift *Apus salimali* (Paul J. Leader / © The Natural History Museum, Tring)

Figure 6. Dorsal view of specimens of Sálim Ali's Swift *Apus salimali* (Paul J. Leader / © The Natural History Museum, Tring)

Figure 7. Ventral view of specimens of Cook's Swift *Apus cooki* (Paul J. Leader / © The Natural History Museum, Tring)

in Indonesia, Melanesia, Australia and Tasmania.

*Kurodae* and its junior synonym *kanoi* (see below) breed across much of eastern China, southern Japan and Taiwan. In China, it breeds commonly in eastern Guangdong province, but its status further west is unclear and demands additional research (particularly in western Guangdong and eastern Guangxi with regard to the distribution of *cooki*). I have examined one *kanoi* specimen at ZMB collected on 15 May 1929 at Yao Shan, Guangxi, which was perhaps a local breeder. It nests on cliff faces, including sea cliffs (Lack 1956a) and in caves, and winters in Malaysia, the Philippines and Indonesia.

*Salimali* breeds at very high altitudes (above 3,400 m) and is restricted to the east Tibetan Plateau and adjacent high-altitude western Sichuan. It habitually nests on buildings, perhaps most famously in the Potala Palace, Lhasa. Its winter distribution is apparently unknown but, at the very least, it must be an altitudinal migrant.

*Cooki* is restricted to lowland Myanmar, northern Thailand, Vietnam and Guangxi province, China. Based on the available information, the taxon is restricted as a breeder to limestone caves (Smythies 1986, Wells 1999, Ngonjun & Sitasuwan 2001; P. D. Round *in litt.* 2009) and it appears that this is the only member of the *pacificus* complex that habitually breeds in limestone habitats, although this requires confirmation. It is

Right, top to bottom:

Figure 8. Dorsal view of specimens of Cook's Swift *Apus cooki* (Paul J. Leader / © The Natural History Museum, Tring)

Figure 9. Ventral view of specimens of Blyth's Swift *Apus leuconyx* (Paul J. Leader / © The Natural History Museum, Tring)

Figure 10. Dorsal view of specimens of Blyth's Swift *Apus leuconyx* (Paul J. Leader / © The Natural History Museum, Tring)

a short-distance migrant or near-resident and I have examined winter-collected specimens from Laos (November—YIO), Vietnam (January—BMNH), Cambodia (January—BMNH), the northern Shan States, Myanmar (January—BMNH), and there are two February Thai specimens (P. D. Round *in litt.* 2009).

*Leuconyx* is a mid to high-altitude breeder, occurring at 1,300–3,800 m in Pakistan, Nepal, Bhutan and north-east India. Presumably facilitated by its smaller size, this is the only member of the *pacificus* complex recorded utilising the nests of other birds, including those of hirundines (Lack 1956b). It is resident or partially migratory, wintering at lower altitudes in Nepal (Inskipp & Inskipp 1985) and peninsular India (Vaurie 1965).

There is much variation in the timing of the breeding between the various taxa, which is unsurprising given the large range of the *pacificus* complex and the marked differences in migratory behaviour. The southernmost taxon *cooki* is generally on eggs in Myanmar in May (Smythies 1986) or even early March in northern Thailand (Ngonjun & Sitasuwan 2001) while *leuconyx* breeds March–May in Nepal (Chantler 1999). However, most *pacificus* are just returning to the breeding grounds in May, with breeding in some areas commencing in June (Brazil 1991, Chantler & Driessens 1995).

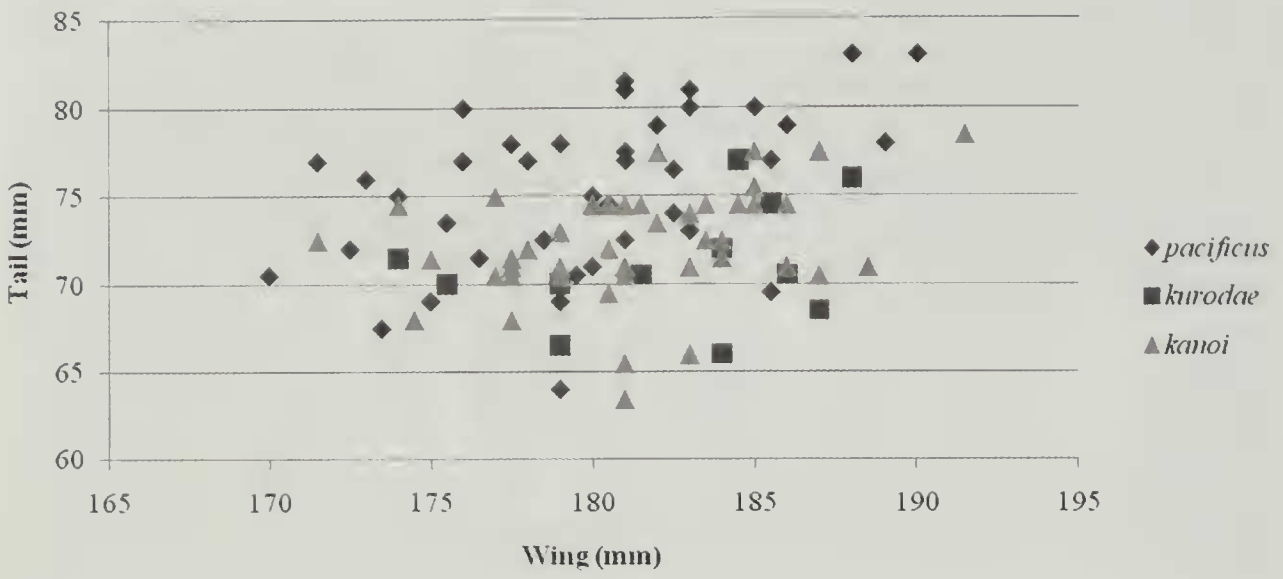


Figure 11. Scatter plot of wing and tail lengths (in mm) of *pacificus*, *kurodae* and *kanoi*.

## Discussion

Based upon a combination of plumage and structure, I found each specimen of *saliuali*, *cooki* and *leucouyx* to be readily separable, and that *pacificus*, *kauoi* and *kurodae* whilst separable from the other taxa were very similar to each other. Both *kurodae* and *kauoi* are separable from *pacificus* when compared as a series on the basis of the cleaner, white throat patch and broader rump patch of *pacificus*, but there is substantial overlap in the size of the rump patch in these three taxa. I compared the holotype of *kauoi* to a series of *kurodae* from Japan and found them to be inseparable, being unable to detect any of the differences (darker body, stronger greenish gloss, narrower throat patch and rump patch) identified by Yamashina (1942). The type locality of *kurodae* is stated to be 'Japan' although the holotype was apparently lost during World War II (Mlíkovský 2007), making a comparison of the holotypes of *kauoi* and *kurodae* impossible. In size (wing and tail length) there is overlap between all three, but with most overlap between *kurodae* and *kauoi* and a very clear tendency for larger individuals to be *pacificus* (Fig. 11). Vaurie (1959, 1965) considered *kauoi* separable from *pacificus* based on differences in the upperparts and possibly the throat ('the white area of the throat is usually more restricted and less pure'), a feature which I found differentiated *saliuali* from *pacificus* (and other taxa). However, given that Vaurie (1959, 1965) treated *saliuali* as a synonym of *kauoi* and examined specimens that included material from within the range of *saliuali* but not, apparently, the type of *kauoi* I find his diagnosis of *kauoi* and treatment of *saliuali* unconvincing.

Based upon these findings, rather than treat *kurodae* as a synonym of *pacificus* I consider *kurodae* and *kauoi* to be synonyms, and as it predates *kauoi* by nine years, *kurodae* has precedence.

Despite frequently being treated as a junior synonym of *kauoi* (Vaurie 1959, 1965, Chantler 1995, 1999, Dickinson 2003), I found *saliuali* to be a highly diagnosable taxon, with all individuals examined separable from all other taxa, including *pacificus*, in both structure and plumage. As noted above, Lack (1959, 1965) and Vaurie (1959) differed in their treatment of *saliuali*, despite considering the same five specimens at BMNH collected in south-east Tibet. I also examined these five specimens, plus a further specimen from Sichuan at IOZ.

Lack (1958), in describing *salimali*, noted that the specimens were very similar to *leuconyx* in plumage but differed in being larger, however he did not make mention of the distinctly different throat pattern. Vaurie (1959, 1965) attached greater significance to the similar size of *salimali* to *kanoi*, but as discussed above, based on an examination of the holotypes of both taxa, I find his conclusion that *salimali* and *kanoi* are similar in terms of plumage unconvincing. It should also be noted that Vaurie (1959, 1965) used only wing length to assess size, and did not consider differences in tail length or tail structure. As demonstrated above, these are also important in the diagnosis of *salimali*.

It is noteworthy that Deignan (1956) considered 17 specimens from western Sichuan collected during July, August and October inseparable from a series of nine *kanoi* collected on the Batanes Islands, in the northern Philippines, and a further specimen from Fujian province, China. These Sichuan specimens may be *salimali*, which was described in the same year and of which Deignan was probably unaware at the time (his manuscript was submitted in April 1955), or they could indeed be *kanoi*, which may breed at lower altitudes in the region, although this scenario seems unlikely given that western Sichuan is generally much higher than other parts of the province. It should be noted that his August and October specimens are almost certainly migrants. Unfortunately, Deignan (1956) does not state in which collection(s) his Sichuan specimens are housed, as they clearly merit re-examination. Ali & Ripley (1970) somewhat surprisingly and without explanation, treated birds in south-east Tibet as *kanoi*, noting breeding in the Tsango Po Valley, which is the type locality of *salimali* (Lack 1958).

Of the taxa examined, *cooki* is by far the most distinctive in plumage, and has a distinctly different wing structure. The glossy black plumage and heavier rump patch streaking led Lack (1956b) to remark that *cooki* resembles Dark-rumped Swift *A. acuticauda* more that it resembles *pacificus*, and considered that '*cooki* completely bridges the [morphological] gap' between *pacificus* and *acuticauda*. This formed a large part of his argument that *acuticauda* should be treated as a subspecies of *pacificus*. Lack (1956b) noted the distinct wing structure of *cooki*, and commented: 'In some other species of *Apus*, as mentioned later, the difference between the first and second primary is a valuable aid in the determination of species, but in *A. pacificus* it varies within the species'. Vaurie (1959), by contrast, was unequivocal in his treatment of *acuticauda* as a valid species citing the all dark rump and distinct differences in tail feather shape (with *acuticauda* having highly attenuated outer tail feathers), and the close proximity (50 km) to breeding *acuticauda* and the nearest breeding *leuconyx* as evidence, but did not comment on differences in wing structure; his treatment of *acuticauda* has been widely adopted since.

Like Lack (1956b), I consider *cooki* to resemble *acuticauda* more than other members of the *pacificus* complex, being black above and below, and in the very broad white fringes to the underparts. It is also very similar in overall structure (Table 2) to *acuticauda*, to which it may prove to be more closely related. It should be noted that most data for *acuticauda* presented in Table 2 were not collected by the author, and as such I am reluctant to discuss the relationship between *cooki* and *acuticauda* in more detail. However, I consider it to be plausible that both taxa are not members of the *pacificus* complex (which may only comprise nominate *pacificus*, *kurodae*, *salimali* and *leuconyx*), and that the *pacificus* complex as currently recognised may be polyphyletic.

## Conclusions

Given that *Apus* swifts are profoundly adapted to an aerial existence, it has been argued elsewhere (e.g. Brooke 1971) that consistent structural differences between apparently closely related taxa are of taxonomic significance (e.g. Fry *et al.* 1988). Such an approach

has led to a substantial revision of the genus *Apus* (primarily within the dark-rumped African taxa). Of the 17 species currently recognised by Gill & Donsker (2010), Lack (1956b) recognised just seven (Lack recognised ten species in the genus, but three of these are no longer placed in *Apus* by Gill & Donsker 2010).

There has been no systematic review of the *pacificus* complex since Lack (1956b) and Vaurie (1965), and based on my findings above I consider it clear that structural differences that have subsequently led to extensive taxonomic revision of congenerics are also evident in the *pacificus* complex. The taxonomic importance of these structural differences is further supported by consistent plumage differences, as well as by differences in migration strategies and breeding ecology.

When both measurements and plumages are assessed, *pacificus*, *salimali*, *cooki* and *leuconyx* all satisfy the diagnosibility requirements of the Phylogenetic Species Concept. Satisfying the non-interbreeding requirement of the Biological Species Concept (BSC) is problematic given that all four possess allopatric breeding ranges. However, it could be argued that the marked differences in the timing and altitude of breeding, migration strategy and, in the case of *cooki*, breeding habitat are effective isolating mechanisms and that some members of the *pacificus* complex meet the requirements of the BSC (perhaps most robustly in respect of *cooki*). Molecular studies and research into potential vocal differences (a review of a small number of recordings suggests clear differences between taxa) could further the taxonomic status of these taxa. I consider the present taxonomic arrangement of the *pacificus* complex untenable and that the complex is best treated as four separate species. Accordingly, I propose the following taxonomic treatment:

**Pacific Swift** *Apus pacificus* Latham, 1801
subspecies *kurodae* Domaniewski, 1933
**Sálim Ali's Swift** *Apus salimali* Lack, 1958
**Blyth's Swift** *Apus leuconyx* Blyth, 1845
**Cook's Swift** *Apus cooki* Harington, 1913

The English names chosen recognise the predominately far easterly distribution of *pacificus* (including *kanoi*) and avoid further use of the name 'Fork-tailed Swift' which I consider to be a distinctly inappropriate name given the structural characteristics of most members of the genus. With the exception of *pacificus*, I have shied away from geographical monikers, to avoid introducing the potentially confusing name Himalayan Swift for *leuconyx* (vs. Himalayan Swiftlet *Collocalia brevirostris*) and to commemorate some 'giants' of Asian ornithology.

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*Address*: c/o Asia Ecological Consultants Ltd., 127 Commercial Centre, Palm Springs, New Territories, Hong Kong, People's Republic of China, e-mail: pjleader@asiaecol.com.hk