

Notes on morphological differences exhibited by Royal Flycatcher *Onychorhynchus coronatus* taxa

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Onychorhynchus coronatus es reconocida actualmente como una especie que incluye cinco subespecies. La literatura reciente sugiere que el complejo puede comprender varios taxa de nivel específico. Se presentan datos sobre caracteres morfológicos (pico, ala, cuerpo y plumaje) extraídos de 90 especímenes de las cinco formas. Se encontraron diferencias claras y consistentes entre las formas para algunos de los caracteres medidos. La forma nominal resultó ser en promedio más pequeña en las medidas de ala, cola, cuerpo y ancho del pico que todas las otras formas. Las dos formas norteañas, *fraterculus* y *mexicanus*, resultaron ser muy similares en las medidas. El dorsal de *occidentalis* y *swainsonii*, y el ventral de *occidentalis*, son levemente más pálidos que en otras subespecies. Los hallazgos de este estudio son preliminares y no se propone un nuevo tratamiento a nivel específico para el complejo *Onychorhynchus coronatus*.

Introduction

Royal Flycatcher *Onychorhynchus coronatus* is widely distributed, from Mexico south through Central America and South America, where it occurs in the Pacific lowlands of Ecuador, the Amazon basin, and Atlantic forests of south-east Brazil. Five subspecies are recognised: *mexicanus* from Mexico to Honduras; *fraterculus* from Honduras to north Colombia; nominate *coronatus* in much of the low-lying Amazon basin (including the form *castelnaui* from the Peruvian Amazon⁶); and two isolated populations, *occidentalis* in west Ecuador and *swainsonii* in south-east Brazil.

It has been recently suggested that several of these subspecies groups deserve specific recognition: *mexicanus*, the Mexican (or Northern) Royal Flycatcher⁴; *swainsonii*, the Atlantic Royal Flycatcher²; and *occidentalis*, the Pacific Royal Flycatcher^{3,7,12}. The two forms found at the eastern (Atlantic Royal Flycatcher) and western (Pacific Royal Flycatcher) limits of the species' range in South America are considered threatened^{2,3}. Sibley & Monroe^{9,10} list four distinct forms: *coronatus*, *mexicanus*, *occidentalis* and *swainsonii*. This note presents morphological data from specimens of the five different subspecies and reviews the current status of this group. Our aim is to present findings using small sample sizes in order to stimulate further ecological and museum work on this group. It does not seek to provide categorical evidence that Royal Flycatcher should be considered a complex of several specific taxa.

Methods

Specimens

Ninety skins at the British Museum of Natural History, Tring, UK were included in this analysis. Six structural measurements (to the nearest 0.1 mm) from each specimen were taken using a wing rule and callipers. They were as follows:

1. Overall body length—from bill tip to tail tip.
2. Head and bill—from the furthest point at the back of the skull to the tip of the bill.
3. Bill width—width of bill at the widest point.
4. Wing length—unflattened (right) wing chord.
5. Bill length—from bill tip to the beginning of the feathering.
6. Tail length—between central rectrices to when the rule is pressed against the abdomen.

In addition, the plumage coloration of the underparts and upperparts were scored using the following system: (1) sandy, (2) sandy/rufous, (3) rufous-buff, (4) ruddy-brown, (5) plain brown, (6) dark brown. All plumage scores were taken before reading the label on each specimen to try and eliminate sampling bias.

Analysis

Principal Components Analysis (PCA) was used as a tool for preliminary examination of the morphological data. General Linear Models (GLM) were used to investigate specific differences between separate morphological and plumage characters of the groups. If a characteristic was found to differ significantly between subspecies and we wished to carry out further tests of significance between subspecies, then contrasting was used. Contrasting involves lumping subspecies with similar scores (i.e. means) for a given characteristic, and then repeating the GLM or undertaking t-tests. All statistical tests were undertaken using Minitab 12.1.

Results

The primary and secondary axis of the PCA together accounted for 73% of the original variation. Fig. 1 shows the primary axis plotted against the secondary axis. The first principal component axis (PC1) separated *coronatus* and *swainsonii* from

mexicanus and *fraterculus*. Character loadings (Table 1) suggested that birds from the *coronatus* and *swainsonii* groups (with higher PC1 scores) tended to have smaller body lengths and head and bill measurements than those with lower PC1 scores (i.e. *mexicanus* and *fraterculus*). The second principal components axis (PC2) provided poor resolution between subspecies but one—*swainsonii*—could perhaps be separated from the others on this axis. This suggests that birds with higher PC2 scores tend to have longer bills than those with lower scores (i.e. birds belonging to the *swainsonii* group).

Table 1. Character loadings on principal component axes (PC1 and PC2) for a Principal Component Analysis of six morphological measurements taken from Royal Flycatcher *Onychorhynchus coronatus*.

| Variable | Principal Component | |
|-----------------------|---------------------|--------|
| | Axis 1 | Axis 2 |
| Body length | -0.45 | 0.14 |
| Head and bill | -0.45 | +0.22 |
| Bill width | -0.37 | +0.24 |
| Wing length | -0.41 | -0.36 |
| Bill length | -0.35 | +0.68 |
| Tail length | -0.41 | -0.53 |
| Eigen value | 3.52 | 0.86 |
| % variation explained | 58.6 | 14.4 |

Significant differences between the five groups were found when each morphological characteristic was compared separately (Table 2): *coronatus* had smaller measurements for five morphological characteristics (the exception being bill length). The *fraterculus* and *mexicanus* groups tended to be very similar in all measurements. These two groups had larger bill width, and larger bill and wing length than *occidentalis*. They also had larger bodies and longer head and bill measurements than *swainsonii*. Our findings from the PCA were supported by significant differences when comparing subspecies

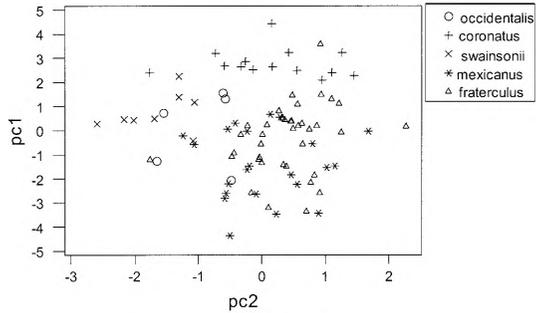


Figure 1. Plot of first (PC1) and second (PC2) principal components for a Principal Components Analysis of six morphometric measurements from five subspecies of Royal Flycatcher *Onychorhynchus coronatus*.

with smaller body sizes and head and bill measurements (*swainsonii* and *coronatus*) with the remaining subspecies ($t = 7.11$, d.f. = 88, $p < 0.001$ & $t = 5.55$, d.f. = 88, $p < 0.001$ respectively). In addition, the bill length of *swainsonii* was significantly smaller than all the other groups combined ($t = 18.6$, d.f. = 88, $p < 0.001$).

Contrasting between groups demonstrated that underpart coloration was significantly darker in *coronatus* and *swainsonii* specimens than in *fraterculus* and *mexicanus*. Birds from the *occidentalis* group were significantly paler than any others ($F = 50.9$, d.f. = 2, $p < 0.001$). There were no significant differences for the scores given to the upperparts of *fraterculus*, *coronatus* and *mexicanus*, but all three proved significantly darker than *swainsonii*, which was in turn scored as significantly darker than *occidentalis* ($F = 105.0$, d.f. = 2, $p < 0.001$).

Table 2. Biometric data (mean \pm 1 S.D.) for the five subspecies. General Linear Models were used to test for differences between groups and, in all cases, Kruskal-Wallis tests yielded results significant to $p < 0.001$. Sample sizes are in parentheses.

| | <i>coronatus</i> (16) | <i>fraterculus</i> (38) | <i>occidentalis</i> (5) | <i>mexicanus</i> (23) | <i>swainsonii</i> (8) |
|--------------------|--------------------------|----------------------------|----------------------------|--------------------------|--------------------------|
| MORPHOLOGY | | | | | |
| Body size (mm) | 143.12 \pm 5.41 | 160.89 \pm 12.8 | 163.0 \pm 14.85 | 165.87 \pm 10.43 | 153.88 \pm 5.30 |
| Head and bill (mm) | 40.44 \pm 2.01 | 43.71 \pm 2.00 | 43.90 \pm 3.02 | 45.71 \pm 2.09 | 41.79 \pm 3.1 |
| Bill width (mm) | 8.48 \pm 0.51 | 9.31 \pm 0.46 | 8.76 \pm 0.29 | 9.50 \pm 0.59 | 9.39 \pm 0.16 |
| Wing length (mm) | 75.19 \pm 3.47 | 81.97 \pm 4.18 | 78.8 \pm 2.17 | 84.57 \pm 4.27 | 83.25 \pm 2.92 |
| Bill length (mm) | 17.61 \pm 1.31 | 21.34 \pm 1.41 | 18.4 \pm 2.03 | 21.05 \pm 1.82 | 14.79 \pm 0.51 |
| Tail length (mm) | 60.57 \pm 4.11 | 68.00 \pm 4.83 | 75.00 \pm 6.29 | 71.05 \pm 4.66 | 70.25 \pm 3.99 |
| COLORATION | | | | | |
| Underparts | 1.59 \pm 0.27 | 1.03 \pm 0.16 | 0.70 \pm 0.27 | 1.07 \pm 0.23 | 1.56 \pm 0.42 |
| Upperparts | 3.97 \pm 0.13 | 3.70 \pm 0.27 | 2.10 \pm 0.22 | 3.65 \pm 0.32 | 2.88 \pm 0.23 |

Discussion

The morphological and plumage differences described here provide the first analysis of its type of the five subspecies of Royal Flycatcher. PC1, in a Principal Components Analysis of morphometric measurements, approximates to an axis of body size and PC2 to a shape axis^{5,8}. In this study, PC1 highlighted the smaller size of *coronatus* and *swainsonii* from *mexicanus* and *fraterculus*, and PC2 the shorter bill of *swainsonii*. The general linear models supported the results from the Principal Components Analysis: *swainsonii* and *occidentalis* had consistently paler upperparts, and *occidentalis* on the underparts as well, than the other subspecies, even given the small samples used in this study. These differences are intriguing but alone cannot be considered sufficient to draw firm conclusions concerning the taxonomic status of any members of the complex.

The behaviour and vocalisations of the different taxa have been noted as similar⁶. All five subspecies are often found alone or in pairs, in mature secondary forest and its borders^{2,6}. The nesting preferences—overhanging vegetation, often near water—are similar for *occidentalis*, *coronatus* and *mexicanus*^{1,11}. Royal Flycatchers rarely vocalise⁶. Published recordings of *mexicanus* and *coronatus* exist, but we were unable to uncover recordings of the other taxa in a limited search.

An assumption with these data is that the museum specimens were labelled correctly. The error caused by this is unknown in this study as the museum labels were used unquestioningly. A way to improve the analysis would be to incorporate the origin of each specimen into the analysis to investigate further patterns within each subspecies. This would also enable the source of outliers from each subspecies to be investigated (e.g. was the outlier from *fraterculus* that fell within the range of *coronatus* within the ordination in Fig. 1 a result of incorrect labelling or was it located very close to *coronatus* populations?).

Considering the potential threats to *swainsonii* and *occidentalis*, priority should be given to further research to clarify the taxonomic position of the Royal Flycatcher complex. Further analyses of museum specimens are recommended to reinforce our findings. Furthermore, birders visiting South America can assist by recording vocalisations and collecting ecological information on Royal Flycatchers they may encounter.

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