# Updated Manual for Ageing and Sexing Landbirds of American Samoa

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## Introduction

As part of The Institute for Bird Populations' (IBP) Tropical Monitoring of Avian Productivity and Survivorship (TMAPS) program, to monitor population dynamics of birds in tropical regions, eight long-term bird-capture stations were operated on Tutuila Island, American Samoa, during August 2012 through August 2013 (Pyle et al. 2012, 2013). As part of the goals of the overall TMAPS program in American Samoa, six of these stations on Tutuila Island and six additional stations on Ta'u Island will be operated in November - March each year from 2013 through at least 2016. This accords with the peak breeding season for most Samoan landbirds (Pyle et al. 2013).

In order to affectively monitor the population dynamics of landbirds captured at TMAPS stations, age and sex of resident species must be determined as accurately as possible. In this manual we provide criteria for ageing and sexing resident landbird species of American Samoa, based on examination of specimens and captures during August 2012 through August 2013. Accounts for 15 species are provided in a format that will enable field referencing at the TMAPS stations in American Samoa. Accounts are provided for all landbird species captured at the TMAPS stations as well as a few other species that may show few or no captures, including three species found on Ta'u but not Tutuila. Additional reference is made to species of the same genera studied in Sapain, Commonwealth of the Northern Marianas Islands (CNMI), as part of a separate TMAPS project there (Pyle et al., 2008, Radley et al. 2011). This document will be prepared to be submitted to a scientific journal in 2014.

## Methods

Pyle examined 172 specimens of 13 indigenous and two introduced bird species collected in American Samoa and (of conspecific or congeneric species) elsewhere in the southwestern Pacific. These included 66 specimens housed at the Museum of Vertebrate Zoology (MVZ), Berkeley, California; 37 specimens at the Western Foundation of Vertebrate Zoology (WFVZ), Camarillo, California; 31 specimens at the Museum of Comparative Zoology (MCZ), Cambridge, Massachusetts; 29 specimens at the California Academy of Sciences (CAS), San Francisco; 5 specimens at the Louisiana State University Museum of Natural Science (LSUMNS), Baton Rouge; 2 specimens at the Museum of Wildlife and Fish Biology (MWFB), Davis, California; 1 specimen at the

Field Museum of Natural History, Chicago, Illinois; and 1 specimen at the Yale-Peabody Museum (YPM), New Haven, Connecticut. Specimens were generally collected year-round (although fewer in June-September) and some were labeled as "adult" or "immature" but the method of age determination was usually not recorded. Most specimens were also sexed, presumably by gonadal examination, although a small proportion of apparent errors in sexing were encountered. Each specimen was carefully examined for active molt, state of feather wear indicating timing and extent of previous molts, and plumage and feather-shape criteria that could relate to age and/or sex. Measurements of wing, tail, and bill were obtained from specimens at MVZ, WFVZ, and CAS.

During August 2012 to August 2013 IBP biologists handled 837 captures of 10 resident landbird species at the eight TMAPS stations on Tutuila (Pyle et al. 2013). Molt status, degree of skull pnematization, reproductive condition, and plumage color and wear were used to infer age and sex of most birds. Photographs of many birds and their open wings and tails were obtained to document molt and age-sex criteria. These photographs were examined by Pyle to confirm or update initial age-sex determinations.

The following accounts include information on numbers of specimens examined and birds captured; number of flight feathers as based on specimen examination and measurements, information on timing and extents of molts, and age/sex criteria based on both specimen and banding data. Molt and plumage terminology follow Humphrey and Parkes (1959) as revised by Howell et al. (2003). Staffelmauser refers to a pattern of multiple molt waves that can be found in some larger birds (Pyle 2006, 2008) including Samoan doves and pigeons. Feather-tract terminology, flight-feather numbering, age terminology, and some abbreviations follow those of Pyle (1997, 2008). Common abbreviations include: juvenile - **Juv**; juvenal - **juv**; primary and primaries - **p** and **pp**; secondaries - **ss**; tertials - **terts**; rectrices - **rects**; coverts - **covs**; preformative molt - **PF**; definitive prebasic molt - **PB**; brood patch - **BP**; and cloacal protuberance - **CP**.

Age categorization follows the molt-cycle-based system devised by Wolfe et al. (2010) and Johnson et al. (2011) for tropical species ("WRP codes"). Categories used for Samoan birds include: **FCJ**, a bird in its first molt cycle and entirely in juvenal plumage; **FPF** a bird undergoing its preformative molt; **FCF**, a bird in its first molt cycle and in formative plumage; **SPB**, a bird undergoing its second prebasic molt; **SCB**, a bird in its second molt cycle and in basic plumage; **FAJ** a bird in either formative (e.g., after a complete PF) or basic plumage; **DPB** a bird undergoing its definitive prebasic molt (including its second prebasic molt after a complete PF); **DCB**, a bird in its definitive molt cycle and in basic plumage; **SAB**, a bird in at least its third molt cycle (or after its second cycle) and in basic plumage; **UPU**, an individual undergoing either the preformative or prebasic molt; **UPB**, an individual undergoing either the second or later prebasic molt; and **UCU**, an individual in unknown plumage (as distinct from FAJ above). Depending on the molting strategy, especially the extent of the preformative molt (absent, partial, or complete), some but not all of these codes are acceptable for each species. In addition, to account for birds of different cohort groups that may overlap in plumage (Wolfe et al. 2010), individuals given WRP codes FCF, UCB, and UCU were estimated from skull condition and/or flight-feather wear to be either more or less than six months old (FCFs) or six months since the previous complete molt (DCBs and UCUs).

Month ranges, e.g., "FCJ (Nov-May)" indicating that birds in that plumage (juvenal in this case, prior to the preformative molt) can be expected to occur primarily during those months; ranges of, e.g., "Feb-Jan," typical of formative and basic plumages, indicate that molt into the plumage should be peaking in Feb and that birds will be worn in Jan. All measurements are given in mm and, where enough data or information is available, metric ranges are presented as ~95% confidence intervals, as calculated as the mean $\pm$ 2*S.D (see Pyle 1997). The accompanying Powerpoint presentation contains images and captions, as referenced by figure numbers in the accounts. Captions in blue are given for specimens collected in Samoa and those in red for specimens collected outside of Samoa.

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## **Friendly Ground Dove** (FRGD) *Gallicolumba stairi*

**Individuals examined:** 3 specimens (MVZ 2, MCZ 1), collected on Fiji (MVZ) and Samoa (MCZ; Fig. 1); 0 captures during TMAPS on Tutuila.

**Structure and Measurements:** 10 pp, 10 ss, 12 rects; p10 full-length. Wing chord: ♀ (n1) 140 (Banks 1984), ♂ (n2) 149,149; Tail: ♀ none, ♂ (n2) 97,92.

**Breeding Seasonality:** No information for American Samoa.

**Molt:** One DCB male collected 23 Oct in Fiji not in molt but with apparent retained basic s4 (Fig. 3). One unknown-age female collected 3 Jun on Ofu not in molt (Banks 1984). One FPF labeled female collected 20 Aug in Fiji molting body feathers and ss, may be a male by body plumage. Undated MCZ specimen from Samoa (Fig. 1) in typical primary molt (p5 dropped) and terts dropped. Timing could be protracted and year-round as in other Pacific island doves (Pyle et al. 2008).

Molt could be similar to that of *G. xanthonura* of CMNI (Pyle et al. 2008, Radley et al. 2011) and most other Columbiformes (Pyle 1997), in which both the PF and PB are incomplete to complete, with some ss often retained (Fig. 3, 4). In *G. xanthonura* both the PF and the PB can be either incomplete or suspended, with both juv and basic ss among s1-s7 retained, secondary replacement proceeding distally from s1 and proximally from the terts, and Staffelmauser patterns among the pp (cf. Fig. 15) also possible or likely.

**Age Determination:** Tentative acceptable age coding: FCJ (?-?), FPF (?-?), FCF (?-?), FAJ (?-?), SPB (?-?), SCB (?-?), DPB (?-?), DCB (?-?), SAB (?-?); also UPU (year-round), UPB (year-round) and UCU (year-round) for birds of undeterminable age. FCJs possibly differentiated by their broader cinnamon edging to upperpart feathers (especially greater covs) and cinnamon-washed ss, as in *G. xanthonura* (Fig. 2). FCJ male and female *Gallicolumba* doves are usually similarly plumaged. Non-FCJs with uniformly replaced pp and ss are aged FAJ as they could be either FCF or DCB after a complete molt. Birds with retained ss (Fig. 6) can be aged FCF or SAB depending on whether or not unmolted or retained feathers are juv or basic, respectively (cf. Figs. 3, 4). Look also for SAB birds with two waves of Staffelmauser (e.g., Figs. 15, 22). Basic rects (Fig. 5) are likely broader and more truncate than juvenal rects. Confirmed FCFs (by retained juv ss) that have initiated the next molt can be aged SPB, FAJs that have initiated the next molt can be aged DPB, and SABs that have initiated the next molt can be aged TAB.

**Sex Determination:** Differences in plumage between FCF/DCB female and male unknown. One FPF specimen (MVZ 51347) labeled a female but may be a male by incoming plumage but only if Friendly Ground-Dove sexually dimorphic as in other *Gallicolumba* (Fig. 6). Pratt et al. (1987) indicates that females may be similar to males or have reddish-brown breast and iridescent brown upperparts. Other *Gallicolumba* doves (including *xanthonura*) are strongly dimorphic (Fig. 6) so some sexual dimoprhism should be expected in *G. stairi*. Measurements appear promising (see above; for *G. xanthonura* wing chord is ♀ 128-141, ♂ 141-152).

**Further Study:** Nearly everything: timing and sequence of molt and age criteria; incidence of retained ss and Staffelmauser; appearance of FCJ and all subsequent plumages by sex.

## **Many-colored Fruit-Dove** (MCFD) *Ptilinopus perousii*

**Individuals examined:** 21 specimens (MVZ 6, WFVZ 1, CAS 4, MCZ 10); Samoa -12, Fiji - 9; 0 captures during TMAPS on Tutuila.

**Structure and Measurements:** 10 pp, 10-11 ss, 12 rects. The outermost p (p10) is highly modified (Fig. 8). Specimens from Samoa had wing chord: DCB ♀ (n3) 125-129, DCB ♂ (n6) 129-138. DCBs from Fiji: ♀ (n1) 128, ♂ (n1) 133.

**Breeding Seasonality:** Banks (1984) examined 74 specimens from Samoa including half-grown Juvs collected Nov-May and birds with enlarged gonads indicating breeding were collected primarily in Nov, with a few others taken in Dec-Jun. This and molt evidence suggests year-round breeding but with a peak in the austral spring and summer (Oct-Jan). This sort of breeding seasonality is typical of subtropical Columbiformes.

**Molt:** Five DCB specimens on Samoa in Nov-Mar were in active primary molt whereas four taken in Mar-Nov were not molting; similar seasonality appears to occur with Fiji specimens. One FCF from Fiji had suspended primary molt at p6 when collected on 23 Oct (Fig. 9). Banks (1984) found that 60% of 74 specimens were in active molt and these were collected in nearly every month. This suggests peak molt in non-breeding birds, probably commencing shortly after the breeding season (Dec-Mar in most), but that both breeding and molting can occur year round. Sequence appears to be typical of Columbids, distally among the pp (p1-p10) and both distally and proximally from the ss (s10-11 out and s1 in), perhaps with an additional center at s5. About half the DCB specimens had retained basic ss indicating SAB; no FCF individuals with retained juv ss found (see also Purple-capped Fruit Dove) but this should be looked for as in other *Ptilinopus* doves (Pyle et al. 2008, Radley et al. 2011). Banks (1984) records one individual with p2 and p7 in molt, indicating that Staffelmauser (cf. Fig. 15) can occur.

**Age Determination:** Tentative acceptable age coding: FCJ (year-round; primarily Dec-Mar?), FPF (year-round; primarily Jan-Jul?), FCF (year-round; all >6 months old if in this plumage), FAJ (year-round), SPB (year-round; primarily Dec-Nov?), DPB (year-round; primarily Jan-Apr?), SAB (year-round); also UPB (year-round) and UCU (year-round) for birds of undeterminable age. FCJs have pale fringes to the back feathers (Fig. 7) and a broader tip to the notched p10 (Fig. 8). FPFs in molt can be identified by p10 until it is dropped. FCF males appear to have duller rects and plumages than SAB males (Fig. 9); study needed to see if all FCF and SAB males are identifiable, precluding age code FAJ for males. Some FCFs and SABs can be identified by retained juv and basic ss, respectively (Fig. 11). Females and males with uniformly basic ss and pp should be aged FAJ (not DCB). FCFs (by retained juv ss) that have initiated the next molt can be aged SPB; FAJs and SABs that have initiated molt should be aged DPB.

**Sex Determination:** FCFs and DCBs highly dichromatic in plumage (Pratt et al. 1987, Plate 26; Fig. 7) and easily sexed. The notch of p10 in DCBs may also be shorter in males than females (Fig. 8). Wing length also appears to be diagnostically smaller in females than in males (see above). FCJ males appear to be distinguished by color of the rects, especially the central rects (Fig. 9) but study needed on variation in both sexes. Check also for differences in amount of white and green to the juv flight feathers (Figs. 7, 10) and in shape of the juv p10 (Figs. 8, 10), as compared to wing length (once it is fully grown). FCF males acquire DCB-like male plumage males so should be easily sexed once the PF has begun. Both sexes may develop BPs so the reliability of this and CPs for sexing needs to be determined.

**Further Study:** Timing for molt and age criteria. Reliability in ageing and sexing FCJ males and in ageing FCF vs. SAB males (all males, or do some have to be aged FAJ?). BP/CP for sexing?

## **Purple-capped Fruit-Dove** (PCFD) *Ptilinopus poryphyraceus*

**Individuals examined:** 19 specimens (MVZ 2, WFVZ 7, MCZ 6, CAS 4); all from Samoa. 19 captures during TMAPS on Tutuila.

**Structure and Measurements:** 10 pp, 10 ss, 12 rects. The outermost p (p10) is highly modified (Fig. 14). Specimens from American Samoa had wing chord: FCF ♀ (n4) 124-125, DCB ♀ (n14) 127-137, FCF ♂ (n2) 132, DCB ♂ (n11) 135-146.

**Breeding Seasonality:** Based on an unreported number of specimens, Banks (1984) concluded that breeding took place largely in Jun-Jan, with juvs present Aug-Feb. TMAPS banding data, however, show peak reproductive condition in Dec-Feb and one fresh juvenile captured in Jan, indicating a peak breeding season in Nov-Mar, as expected. Some other evidence suggests limited year-round breeding as typical of subtropical Columbiformes but this may occur in Western Samoa more than American Samoa.

**Molt:** Banks (1984) concluded that the PB took place primarily in Sep-Jan following breeding and that no FCFs showed juv p10s (e.g., that the FCF was complete with respect to pp). Specimens and captures undergoing DPB primary replacement were in Jan (1), May (1), Oct (2), and Nov (1) and those undergoing primary molt during the FPF were in Jun (1) and Jul (2). This evidence suggests more year-round molting than indicated by Banks (1984). Sequence is typical of Columbiformes (see Many-colored Fruit-Dove). SABs with mixed basic ss were encountered as well as Staffelmauser and primary molt suspension (Fig. 15), but no FCFs with mixed juv and basic ss were found, supporting Banks' (1984) conclusion that this molt is typically complete.

**Age Determination:** Acceptable age coding: FCJ (year-round; primarily Dec-May), FPF (year-round; primarily Jan-Jul), FCF (year-round, primarily Feb-Jan; all should be at least 6 months old), FAJ (year-round; primarily May-Apr), SPB (year-round; primarily Sep-Jan), DPB (year-round; primarily Sep-Jan), SAB (year-round, primarily Dec-Nov); also UPB (year-round) and UCU (year-round) for birds of undeterminable age. FCJs have pale fringes to the back and other feathers (Figs. 12, 14), a broader tip to the notched p10 (Fig. 14), and a duller tail pattern, with less yellow to the central rects (r1) and little to no yellow to the outer rects (Fig. 17). FPFs in molt can be identified by p10 until it is dropped. Some SABs can be identified by retained basic ss (cf. Figs. 15, 16; see also Fig. 11), and probably a small proportion of FCFs may retain juv ss (cf. Fig. 11). Individuals with uniformly basic ss and pp should be aged FAJ (not DCB). FCFs (by retained juv ss) that have initiated the next molt can be aged SPB and FAJs and SABs that have initiated the next molt can should aged DPB. Individuals with 2-3 waves of Staffelmauser and basic (non-juv) p10 (Fig. 15) probably can be aged DCB (or TAB indicating at least third cycle), but we are not accepting these codes for this species at this time.

**Sex Determination:** Most individuals can be sexed by wing chord (see above) once age is determined. FCJs probably not separable to sex by plumage. DCB/SAB females average less orange and maroon coloration to the belly and duller and grayer napes than in males (Fig. 12-13) but study is needed on range of variation within each sex. Back color and tail pattern may also average slightly duller in female than male (Figs. 12, 17). FCF males may overlap SAB females and so FAJ individuals are probably best not sexed by plumage; only SABs (with retained basic ss or Staffelmauser) should probably be sexed female by plumage alone. Both sexes may develop BPs so the reliability of this and CPs for sexing needs to be determined.

## **Pacific Pigeon** (PPIG) *Ducula pacifica*

**Individuals examined:** 24 specimens (MVZ 12, WFVZ 6, MCZ 3, CAS 1, MWFB 2); 15 from Samoa and 9 from elsewhere in sw. Pacific; 3 birds photographed apart from TMAPS stations.

**Structure and Measurements:** 10 pp, 13 ss, 12 rects. Specimens from Samoa had wing chord: DCB ♀ (n1) 215, DCB ♂ (n3) 233-240; tail DCB ♀ (n1) 135, DCB ♂ (n3) 144-176. Amadon (1943a) records mean flattened wing lenghts from Samoa as follows: wing chord: ♀ (n12) 237.6, DCB ♂ (n10) 251.5; tail ♀ (n8) 147.9, ♂ (n10) 153.5.

**Breeding Seasonality:** Banks (1984) noted a female specimen from Tutuila with ovaries "approaching readiness" in Apr and one in Oct with minute ovaries; this and molt data suggested to Banks that peak breeding may occur in May-Sep, but molting birds found during this period here (see below) suggests it can at least be variable, probably year-round as in other Columbids.

**Molt:** Banks (1984) found most of 21 Pacific Pigeons collected in Samoa Oct-Jan showed body molt and that 8 of 21 showed primary molt. DCB specimens examined from Samoa in primary molt were collected in Apr (1 completing), Jun (1 commencing), and Oct (completing) while those not molting pp or ss were collected in Jan (2), Feb (1), Apr (2), May (2), Jun (1), and Nov (1). This suggests more molting in Jun-Oct and breeding in Jan-May but both breeding and molting probably occur year round to some extent. Suspensions and Staffelmauser both recorded (Figs. 21-22): these included FCFs that had suspended the PF after p2 and p7 replaced (MVZ 65411 and 65410); DPBs that had suspended molt after p6 and p8 had been replaced (CAS 24493, WFVZ 22089); and TAB individuals showed Stafffelmauser, both with sets at p1-p2, p3-p8, and p9-p10 (MWFB 8982, WFVZ 22087; Fig. 21) and another TAB with sets at p1, p2-p6, and p7-p10 (MCZ). Two FAJ specimens had also undergone a complete molt. Sequence typical of Columbiformes (see Many-colored Fruit-Dove) and without molt center at s5 (two specimens show proximal replacement from s1, distal from the terts, and s6 replaced last). Specimen that had suspended the PF had replaced r1-r4 and retained juv r5-r6 (Fig. 20).

**Age Determination:** Tentative acceptable age coding: FCJ (?-?), FPF (?-?), FCF (?-?), FAJ (?-?), SPB (?-?), DPB (?-?), DCB (?-?), SAB (?-?); also UPU (year-round), UPB (year-round) and UCU (year-round) for birds of undeterminable age. FCJs likely have pale fringes to the back and other feathers as in other *Duculus* pigeons (Fig. 18) and shower paler and duller upperparts and underparts (Fig. 19). FCJs and FPFs also show uniformly brownish and dull green flight feathers without molt clines, limits, or Staffelmauser patterns (Figs. 18), and narrower and browner outer rects (Fig. 20). FPFs in molt and FCFs after suspended molt can be identified by outer rect, ss, and pp criteria until all feathers are dropped (Figs. 20-21) and some SPB/SABs can be identified by retained juv ss (Fig. 21). Individuals with basic pp and ss of single generation should be aged FAJ. Many SABs and TABs can be identified by retained basic ss and/or Staffelmauser patterns (Fig. 22). FAJs that have initiated the next molt can be aged DPB, and SABs that have initiated the next molt can be aged TAB.

**Sex Determination:** SAB females appear to average slightly duller green upperparts and duller gray head and breast than SAB males but plumage appears unreliable for separating individuals. Measurements (see above) appear useful for sexing, females being smaller, but more samples needed to determine ranges. Both sexes may develop BPs so the reliability of this and CPs for sexing needs to be determined. The bill knob (cf. Fig. 23) may average larger on males than females but this may also vary by age and season; study needed.

**Further Study:** Timing for molt and age criteria. Reliability of bill knob size for ageing and sexing (relative to breeding season). Reliability of measurements and BP/CP for sexing.

## **Blue-crowned Lory** (BCLO) *Vini australis*

**Individuals examined:** 15 specimens (CAS 5, FMNH 1, MCZ 8, YPM 1); all from Samoa. 0 captures during TMAPS on Tutuila.

**Structure and Measurements:** 10 pp, 10 ss, 12 rects. Measurements from Samoa including those of Amadon (1942): Wing chord: ♀ (n15+) 102-113, ♂ (n15+) 104-117; tail ♀ (n15+) 61-67, ♂ (n15+) 61-69; 0 captures at TMAPS stations.

**Breeding Seasonality:** Banks (1984) noted an adult male collected in Jun with enlarged testes and that only four of 64 taken in Dec-Jan were in breeding condition, suggesting more-active breeding sometime in Feb-Nov, perhaps with a peak in Jun.

**Molt:** Banks (1984) noted two adult specimens from Jun and Oct showing light body molt but no or suspended primary molt (and worn feathers), and that 30% of the Dec-Jan sample were molting pp while many others showed fresh pp. Of specimens I examined primary molt was noted on two specimens in Aug (molt starting) and Oct (near completed), and no primary molt was noted on DCBs in Aug (2) and FCFs in Aug, Oct, and Dec. This suggests peak flight-feather molt in Aug-Jan or so. The FCFs appeared to have molted body feathers but no flight feathers (possibly terts) or wing covs during the PF. Sequence of flight-feather molt as in most other parrots, bi-directionally within pp and ss tracts from p5/p6 and s5 (Pyle 2013). Tail molt in one specimen appeared to proceed as r6-r2-r3-r4-r1-r5 and in another it generally proceeded from r1 to r6. Molt suspensions appeared frequently in DCBs (e.g., Fig. 25D) but no Staffelmauser-like waves were noted as is found in some larger parrots (Pyle 2013).

**Age Determination:** Tentative acceptable age coding: FCJ (year-round; primarily Mar-Jul?), FPF (year-round; primarily Jun-Jan?), FCF (year-round; < 6 mo-old primarily Jun-Nov and > 6 mo-old primarily Dec-May?), SPB (year-round; primarily Aug-Jan?), DCB (year-round), DPB (year-round, primarily Aug-Jan?); also UPB (year-round, primarily Aug-Jan?) and UCU (year-round) for birds of undeterminable age. FCJs, FPFs, and FCFs appear to retain juv pp and rects and can be identified by relatively worn, narrow, and pointed feathers and un-notched outer pp (Figs. 24-26). These age groups also average less red to the underparts and weaker blue crown feathers by sex (Fig. 24); study needed on how FCJ and FCF differ, e.g., whether or not FCJs have red to the underparts and blue to the crowns. SPB should be assigned to FCFs that have begun the next (PB2) complete molt. DCBs and DPBs have relatively fresh and broad pp and rects, un-notched outer pp, and more red and blue to the plumage by sex (Figs. 24-26). DPB should be assigned to molting DCBs (with older basic feathers). Birds may suspend molt and can be assigned SCB if still showing juv feathers (e.g., worn and pointed rects or frayed and un-notched outer pp) or SAB if showing older basic feathers (e.g., older broader rects or notched outer pp, as in Fig. 25D) but these age codes are not assignable to this species at this time.

**Sex Determination:** Females appear to average slightly duller green, with smaller red patches to the underparts and duller blue crowns, but differences by age appear to be greater than those of sex (Fig. 24). It may also be that males have larger notches to the outer pp by age (Fig. 25) but study needed. It is possible that some birds of known age (FCF or DCB) can be sexed. Males average larger than females (see above) but not enough to enable reliable sexing of most individuals. Occurrence and reliability of CP and BP for sexing unknown.

**Further Study:** Timing for molt and age criteria. Appearance of FCJs. Reliability of sexing known-aged birds. Reliability of BP and CP.

## **Long-tailed Cuckoo** (LTCU) *Eudynamis taitensis*

**Individuals examined:** 2 specimens (MVZ 2); from Samoa and Wake Is.; 0 captures in TMAPS.

**Structure and Measurements:** 10 pp, 10 ss, 10 rects. Measurmensts from Higgins (1999): wing (flat) DCB M 182-196, DCB F 177-193, FCJ M 162-182, FCJ F 164-184; tail DCB M 213-239, DCB F 206-234, FCJ M 160-207, FCJ F 162-208.

**Breeding Seasonality:** This species breeds in New Zealand during Oct-Mar, most migrating north into Polynesia and elsewhere in Feb-Mar and returning in Oct-Nov (Bogert 1937, Higgins 1999). Bogert (1937) lists 19 specimens from the Samoan Islands including dated specimens collected in Mar (1), May (1), Jun (2) , Aug (1), Nov (3), Dec (2), and Jan (3). Banks (1984) mentions specimens from Oct and May. Bogert (1937) mentioned that some first-cycle birds remain on winter grounds for their first summer and the Dec-Jan specimens above support this idea; Stresemann and Stresemann (1961) suggest that all first-year birds remain north for their first breeding season.

**Molt:** Stresemann and Stresemann (1966) and Higgins (1999) indicate that all molting occurs away from breeding grounds and that it probably begins in May and is well advanced in Jul. Banks (1984) noted one specimen from Samoa taken 7 Oct not showing molt and one from 10 May molting head and neck feathers. Banks also indicates that all 8 specimens collected in Samoa in Nov-Jan (Bogert 1937) were in molt, one of which was molting pp. Unusual molt sequence appears typical of other cuckoos (Stresemann and Stresemann 1961), in which all odd-numbered pp are replaced first followed by all even-numbered pp, though p1 and p2 can fall outside this sequence. Molt can begin with any of odd-numbered pp or p2, typically beginning with p2, p3, p7 or p9, ending with p6, p8, or p10, and with the replacement of p1, p4 and p5 often occurring at irregular times. Higgins (1999) indicates the PF to follow the same sequence as the PB and be complete, beginning Nov and completing Mar-Apr, suggesting that one-year-old birds stay on the winter grounds for their first breeding season. Auckland Museum (2012) indicates an additional first-cycle body molt on the breeding grounds from a white juv plumage to a buff formative plumage (Fig. 27) but it seems just as likely (if not more so) that it could be a morph or plumage anomaly (since the rects also appear white and it is very doubtful that these are replaced before migration).

**Age Determination:** Acceptable age coding in Samoa: FCJ (Apr-Nov?), FPF (Jun-Mar?), DPB (May-Sep), FAJ (Mar-Oct); assumes no PF before leaving New Zealand and that the first complete molt is the PF (cf. **Molt** and Fig. 27); also UPU (year-round) and UCU (year-round) for birds of undeterminable age. FCJs in Samoa are rich buffy underneath and have bold white spots to the upperparts whereas FAJs are whitish underneath and have rufous bars to the upperparts (Figs. 27-28), but beware some FCJs that may be whitish (Fig. 27). Higgins (1999) indicates no other plumage differences between age groups. Measurements smaller in FCJ/FPFs than in FAJs by sex (see above). Individuals molting out of FCJ (old feathers juv) should be coded FPF and those molting out of later plumages (old feathers formative or basic) should be coded DPB.

**Sex Determination:** Bogert (1937) suggests that females may average duller, darker, and with more white spots to upperparts than males but that considerable variation precludes sexing some individuals. Bogert (1937) and Higgins (1999) indicates sexes are alike in plumage and are only slightly smaller than males on average (see above); thus sexes are probably not reliably separated.

**Further Study:** Molt strategies and plumage criteria for ageing birds in Samoa need confirmation. Check if rect and pp shape could help as in North American cuckoos (Pyle 1997).

## **White-rumped Swiftlet** (WRSW) *Aerodramus spodiopygia*

**Individuals examined:** 6 specimen (MVZ 1, WFVZ 5) from Tutuila (MVZ) and Western Samoa (WFVZ); 11 captures during TMAPS on Tutuila.

**Structure and Measurements:** 10 pp, 7 ss, 10 rects. No measurements by sex available. Eleven captures of unknown sex had wg chord 108-117 and tail 48-52.

**Breeding Seasonality:** Banks (1984) notes that only one of 21 specimens collected in Nov-Feb in Samoa was in full breeding condition (several appeared to be commencing and one was a recent fledgling) but also noted that Beck had observed active nests in a cave in December. Three juveniles were captured during TMAPS in Aug. Dhondt's (1976) suggestion that they breed year-round in Western Samoa seems a likely possibility on Tutuila, although there may be a peak breeding season in Mar-Sep (see also Molt). In Australia this species breeds in Nov-Mar (Higgins 1999). None of 8 captures of non-juveniles on Tutuila were not showing breeding condition in Feb-Sep.

**Molt:** Banks (1984) noted that 13 of 21 specimens collected in Nov-Feb in Samoa were molting pp and that the others seemed to be fresh first-cycle birds without primary molt. Two specimens collected in Western Samoa were completing molt 27 Mar. Banks noted specimens in Jun and Oct that were not molting, as was the case with specimens in Apr and May (fresh) and Jul and Nov (worn). Three of 8 captures of non-juveniles on Tutuila were showing flight-feather molt, in May, Aug, and Sep; one of these captured 19 Sep had suspended or arrested molt, possibly the PB2, between p7 and p8 (Fig. 29) and at least two of these had narrow and evenly worn primaries (no cline) suggesting juvenal feathers (Fig. 31). The remaining 5 without molt were captured in Feb-Jul. Overall this suggests peak molting in Aug-Mar and a complete (possibly incomplete) PB but partial PF (not including flight feathers), a strategy common to other small swifts (Pyle 1997). However the molting bird in May may be evidence of year-round breeding and molting. Higgins (1999) noted that Australian subspecies show extensive breeding overlap between breeding and molting and this could also occur for Samoan populations.

**Age Determination:** Acceptable age coding: FCJ (year-round; primarily May-Sep?), FPF (year-round; primarily Aug-Mar?), FCF (year-round, < 6 mo-old primarily Sep-Feb and > 6 mo-old primarily Mar-Aug?), SPB (year-round, primarily Aug-Mar?), DCB (year-round), DPB (year-round, primarily Aug-Mar?); also UPB (year-round, primarily Aug-Mar?) and UCU (year-round) for birds of undeterminable age. This coding assumes above molt strategies and that FCF can be separated from DCB by primary and rectrix shape. FCJs of Australian subspecies have narrow buff fringes to upperparts feathers, ss, and p1-p6 when fresh (Higgins 1999), as is common in Juvenile swifts (Pyle 1997). Assuming flight feathers are retained, some or most FPFs and FCFs should show narrow and worn vs. DPBs and DCBs with broad and fresh outer rects and outer pp, as in other swifts (Figs. 86, 89, and 91 in Pyle 1997). See Figures 29, 30, 31, and 32. Many birds will likely be intermediate and should be aged UCU. Birds molting outer pp can be aged SPB if outer pp and rects juv (cf. Fig. 29) or DPB if outer pp and rects basic.

**Sex Determination:** Sexes likely monochromatic and similar in size, as in Australian subspecies (Higgins 1999) and most swifts. Reliability of BP and CP needs to be assessed.

**Further Study:** Molt timing and strategies. Reliability of feather shapes for ageing. Do FCJs have pale fringing to feathers when fresh?

## **Collard Kingfisher** (COLK) *Todiramphus chloris*

**Individuals examined:** 20 specimens collected in Samoa (MVZ 4, WFVZ 9, MCZ 2, CAS 4, LSU 1); also 17 specimens at MVZ and 91 captures as part of Saipan TMAPS program (Pyle et al. 2008, Radley et al. 2011). 94 captures during TMAPS on Tutuila.

**Structure and Measurements:** 10 pp, 11 ss, 12 rects. P10 full-length. Specimens and captures from Samoa had wing chord: FCJ/FCF ♀ (n9) 90-93, DCB ♀ (n27) 93-100, FCJ/FCF ♂ (n19) 88-92; DCB ♂ (n35) 91-99; exposed culmen: FCF ♀ (n3) 35-40, DCB ♀ (n6) 41-43, DCB ♂ (n9) 38-42. Mayr (1941) gives measurements for Manu'a group: wing DCB ♀ (n17) 97-103, FCF ♂ (n11) 91-96, DCB ♂ (n29) 95-101; culmen (presumably from nares) DCB ♀ (n17) 32-39, FCF ♂ (n11) 32-40, DCB ♂ (n29) 33-39.

**Breeding Seasonality:** Banks (1984) based on extensive specimen evidence noted that none showed breeding conditions in Mar-Jun (at which time molt was completing) but a high proportion were in breeding condition in Oct-Nov, suggesting an austral spring and summer breeding season; nests were also noted in Jan-Mar indicating some late or year-round breeding as well. Few of 94 captures on Tutuila showed breeding condition indicating CP/BP may be difficult to detect on live birds.

**Molt:** Banks (1984) suggests peak molting season in around Jan-May and few specimens in molt collected in Jun-Dec. Seven of eight DCB specimens collected Feb-Apr had completed molt whereas one was completing molt (p7 growing) on 3 Mar (WFVZ 22117). Twenty captures were showing symmetrical flight-feather molt with a clear peak in Feb-Jun. Banks indicates the "post-Juv" molt (indicating PF) possibly to be complete but this is doubtful, unless he was referring to the PB2. On Saipan the PF appears to be absent and the PB complete (Pyle et al 2008, Radley et al. 2011) and Higgins (1999) stated that no flight feathers are replaced at the PF in Australian populations. Sequence according to these studies and specimen examination is typical: p1 to p10, s1 inward, and the terts outward, and rects in ~order r1-r6-r5-r2-r4-r3. Little or no evidence of suspended molt or retained flight feathers observed in Saipan (Pyle et al. 2008) or Samoa.

**Age Determination:** Acceptable age coding: FCJ (year-round, primarily May-Jan), SPB (Dec-Jun), DCB (year-round), DPB (Jan-Jun); also UPB (Dec-Jun) and UCU (year-round) for birds of undeterminable age. FCJs have white-fringed lesser wing covs (Fig. 33), and indistinct dusky mottling to breast (Fig. 34) which may wear off before the first molt commences. Shape and condition of the outer pp (Fig. 35) and rects (Fig. 36) helpful with separation of FCJ from DCB. Back color appears to average more greenish in FCJs than DCBs, sex for sex. Individuals molting out of FCJ (old feathers juv) should be coded SPB and those molting out of DCB plumage (old feathers basic) should be coded DPB.

**Sex Determination:** As in Mircronesia (Pyle et al. 2008, Radley et al. 2011) females show olive backs and turquoise wings and tails, and males showing turquoise backs and blue wings and tails (Figs. 35-38); beware FCJs may average greener than DCBs in each sex. In DCBs from Samoa there was also a pattern where males showed deep buff in the crown lacking in females (Fig. 37) and females showed more white to the outer rects (including some with a patch at the base of the outer web) than males (Fig. 38) but the reliability of these features for sexing requires further study. Extent of the blue patch in the crown averages more in the Manu'a Group (*T. c. Manu'ae*) than on Tutuila (*T. c. pealei*) but does not appear related to sex (Banks 1984). In Saipan BPs were recorded in females and probably some males whereas no CPs were detected (Radley et al. 2011). Measurements (see above) and BP/CP seem unhelpful for sexing this species in Samoa.

**Further Study:** Does this species have a PF? Confirm reliability of age-sex criteria in Samoa.

## **Red-vented Bulbul** (RVBU) *Pycnonotus cafer*

**Individuals examined:** 2 specimens not collected in Samoa (MVZ 2); also 20+ specimens collected in Hawaii and elsewhere examined in the past; 18 captures during TMAPS on Tutuila.

**Structure and Measurements:** 10 pp, 9 ss, 12 rects. P10 about half length of longest p. Measurements of *P. c. bengalensis* (subspecies in Samoa) from Islam and Williams (2000): wing chord: ♀ (n596) 92-101, ♂ (n514) 97-108 (Fiji); tail: ♀ (n?) 85-95, ♂ (n?) 90-103 (India). Dhondt (1977) found bimodal distribution in unsexed adults from Samoa, indicating wing lengths of 93 or less were females, lengths of 96 or more were males, and lengths of 94-95 could be either. This suggests that Samoan birds might be smaller than in Fiji, but confirmation of this is needed. Six captures of females on Tutuila had wg chords 90-92 and tw males had wing chords 99-100, supporting the above measures.

**Breeding Seasonality:** Dhondt (1977) indicates peak breeding in Samoa during Nov-Jan, in accordance with Watling's (1983) findings of Oct-Feb in Fiji. Only two of 18 captures on Tutuila showed breeding characters, female with a BPs in Nov and Dec. In Hawaii this species has protracted breeding season in Jan-Oct, peaking in Mar-Aug (boreal summer) (Islam and Williams 2000). The equivalent at about the same austral latitude in Samoa would be a protracted breeding season in Jul-Apr with peak in Sep-Feb. Banks (1984) noted specimens of young collected in primary molt in Dec, which suggests more-protracted breeding than found by Dhondt.

**Molt:** Evidence from Samoa, Fiji, and Hawaii, indicate that molt follows breeding and that it is complete in both first-cycle and older birds (Dhondt 1977, Watling 1986, Islam and Williams 2000). In Samoa it begins in adults and Juvs in mid-Jan and extends through Apr or May (Dhondt 1977). All 5 captures on Tutuila in Feb-Mar showed flight-feather molt and none outside of these months did. Banks (1984) recorded a DCB (FAJ) not molting in Jun and FPFs molting inner pp in Dec, perhaps from an early or a-seasonal fledging. Higgins et al. (2006) indicates that the PF can be partial in some birds but this requires confirmation. Sequence is typical of passerines: p1 to p10, s1 to s6 and bi-directionally from s8, and generally r1 to r6 (Dhondt 1977).

**Age Determination:** Acceptable age coding: FCJ (Dec-Apr), FPF (Dec-May), FAJ (year-round, primarily Apr-Jan), DPB (Jan-May); also UPU (Jan-May) and UCU (year-round) for birds of undeterminable age. FCJs are similar in plumage to DCBs (FAJs) but should be distinguishable by more filamentous plumage, paler (pinker) undertail covs, and probably browner head plumage (Fig. 39). Outer pp, primary covs, and rects may average narrower and more pointed than in post-Juv feathers (cf. Fig. 40). Because the PF and PB occur at about the same time (after breeding) look for juv flight feathers in FCJs and FPFs to average fresher than basic feathers in FAJs and DPBs (primarily in Nov-Feb). Skull information should also help separate these age groups and incomplete skulls after the PF (in an FAJ) may allow ageing to FCF and DCB in Apr-Oct (study needed).

**Sex Determination:** Males and females are similar in plumage (Islam and Williams 2000). Females are smaller than males and measurements appear useful in separating most birds in Samoa: Wing chord < 94 = female; wing chord > 95 = M. Breeding condition (BP/CP) should also be useful for sexing in Nov-Feb.

## **Samoan Shrikebill** (SASH) ***Clytorhynchus* [*vitiensis*] *powelli***

**Individuals examined:** 10 specimens from Ta'u at WFVZ. Five specimens of *C. pachycephaloides* from New Hebrides examined at MVZ. 0 captures during TMAPS on Tutuila.

**Structure and Measurements:** 10 pp, 9 ss, 12 rects. P10 reduced and p9 short, about equal to p6. Measurements of specimens wing chord: ♀ (n4) 88-90, ♂ (n4) 93-94; tail: ♀ (n4) 72-76, ♂ (n4) 74-76. Measurements of Samoan birds (*C. v. powellli*) from Mayr (1933): wing chord: ♀ (n?) 87-90, ♂ (n?) 88-93; tail: ♀ (n?) 71-75, ♂ (n?) 73-77; exposed culmen: ♀ (n?) 23.1-24.2, ♂ (n?) 22.8-24.8.

**Breeding Seasonality:** Banks (1984) indicated that four active nests were found and collected by Beck in the first half of Jan. Mayr (1933) noted that birds collected in Dec-Jan were all worn or in early molt. This suggests peak breeding in Nov-Feb.

**Molt:** Mayr (1933) noted that birds collected in Dec-Jan were worn or in early molt, suggesting a peak molting season of Jan-Apr or so. Eight of 10 specimens at WFVZ collected Mar-Apr not in molt (DCBs fresh) whereas two were completing molt (WFVZ 22159, 22165). Extent of PF appears to be partial based on specimen evidence, as in other Monarch flycatchers including *C. pachycephaloides* and fantails (Monarchidae or Rhipiduridae) (Radley et al. 2011). Three FCF specimens at WFVZ appeared to have replaced 0, 2, and 6 inner greater coverts but no terts or other flight feathers. Three FCF specimens of *C. pachycephaloides* at MVZ had replaced some but not all med covs and 0-4 inner greater covs but no terts or central rects. In most birds including fantail the PF occurs within the first few months after fledging, concurrent with PBs of adults.

**Age Determination:** Tentative acceptable age coding: FCJ (year-round, primarily Jan-Apr?), FPF (year-round, primarily Mar-May?), FCF (year-round, < 6 mo-old primarily Mar-Aug, > 6 mo-old primarily Sep-Feb), SPB (year-round, primarily Jan-May), DCB (year-round), DPB (year-round, primarily Jan-May); also UPB (year-round, primarily Jan-May) and UCU (year-round) for birds of undeterminable age. FCJs likely have weak plumage and swollen gapes as in other Monarch flycatchers, and show rufous-fringed wing covs (Fig. 41). FCFs after the PF show molt limits in the wing (Fig. 41), with 0-6 inner greater coverts replaced and probably limits among the outer median coverts when 0-2 greater coverts replaced. FCFs also show tapered and pointed rects and outer pp as is typical of passerines (Figs. 42, 43). Watling (2001) indicates that FCJs have completely dark bills whereas older birds have white or gray edges to the lower mandibles; timing of such changes needs study. FCFs in molt (with older juv flight feathers) should be assigned SPB and DCBs in molt (with older basic feathers) could be assigned DPB.

**Sex Determination:** According to Watling (2001) sexes are similar in plumage, though females may average slightly duller. Females average smaller than males but measurements indicate some to extensive overlap (see above); more data needed.

**Further Study:** Confirmation of breeding and molt timing. Extent of molt and ageing and sexing criteria. Confirm bill color change in first cycle and timing of change. More data on wing chord ranges for sexing.

## **Wattled Honeyeater** (WAHO) *Foulehaio carunculata*

**Individuals examined:** 11 specimens collected in Samoa (MVZ 6, MCZ 1, CAS 4); all from Samoa. 463 captures during TMAPS on Tutuila.

**Structure and Measurements:** 10 pp, 9 ss, 12 rects. P10 about 40% and p9 about 80% of longest p (p8). Measurements (specimens here and from Mayr 1932): wing chord: ♀ (n14+) 87-98, ♂ (n18+) 98-109; tail: ♀ (n14+) 72-78, ♂ (n18+) 80-90. Wing chord in TMAPS data for known-sex birds (with full BP or CP) appear to show bimodal distribution: ♀ (n54) 85-97, ♂ (n69) 97-106.

**Breeding Seasonality:** Based on substantial specimen evidence, Banks (1984) concluded that they breed year-round, perhaps with peaks in Dec-Feb and Jun-Aug. Specimens with enlarged gonads were collected in almost every month. Capture data indicate similar findings, with low-levels of full CPs and BPs in Jan-Jul and higher numbers in Aug-Dec.

**Molt:** Mayr (1932) noted that birds collected in Nov were worn and those collected in Feb-May were fresh. Banks (1984) indicated specimens collected in body molt during Mar-Jul and Oct-Mar with not all birds in molt during any month. Flight-feather molt was restricted to Dec-Mar, according with Banks' observations; however, one specimen (MVZ 65428) was completing molt (p10 sheathed) in Jun and two others (CAS 24476 and 24481) had just begun molt in Oct, so perhaps it can occur year-round or nearly so as well. All 67 birds capture undergoing flight-feather molt and/or heavy body molt were in Nov-Apr; light body molt was recorded throughout the year. It is possible that both a DPB and a DPA occur based on this information but confirmation of this would be required; it seems equally possible that body molts (especially the PF) are protracted, as can occur in the similar genus *Meliphaga* of Australia (Higgins et al. 2001). The PF is partial, with no to all secondary covs and no flight feathers replaced (cf. Fig. 50). Partial PF is also found in *Meliphaga* (Higgins et al. 2001). Primary molt sequence during PBs appears typical of p1 to p10, and the rects may generally be replaced distally on each side of the tail. One captured individual showed s3-s6 being molted synchronously, perhaps in distal sequence, but after s1-s2 and the tertials were replaced (Fig. 48).

**Age Determination:** Acceptable age coding: FCJ (year-round, primarily Jan-Mar), FPF (year-round, primarily Oct-Apr), FCF (year-round, < 6 mo-old primarily Mar-Aug, > 6 mo-old primarily Sep-Feb), SPB (Nov-May), DCB (year-round), DPB (Nov-May); also UPB (Dec-May) and UCU (year-round) for birds of undeterminable age. FCJs are similar in plumage to older birds but are paler, have more filamentous feathers, more-swollen yellow gapes, and lack or have rudimentary red wattles (Figs. 44-45). FCJs and FCFs may show more dusky mottling to breast than DCBs but this also may relate to population (Manu'a group vs. Tutuila; Mayr 1932) so study needed. The juv greater covs appear paler and average stronger yellowish tips than formative and basic covs (Figs. 46-47); molt limits good for FCFs (Fig. 46). Juv primary covs, outer rects, and outer pp are also more narrow and tapered in juv feathers than in basic feathers (Figs. 46-52). A Contrastingly fresh block of secondaries may follow a suspended molt and indicate DCB (Fig. 49). FCFs in molt (with older juv flight feathers) should be assigned SPB and DCBs in molt (with older basic feathers) should be assigned DPB.

**Sex Determination:** Sexes are similar in plumage. Females average smaller than males and, for now, wing chord < 96 can be sexed F and wing chord > 100 can be sexed M. Factor age into these ranges as first-cycle birds (with juvenal primaries) will fall primarily into the lower halves of the ranges; older birds (with basic primaries) in the upper halves.

**Further Study:** Does dusky mottling to breast indicate FCJ or FCF in both island groups?

## **Cardinal Honeyeater** (CAHO) *Myzomela cardinalis*

**Individuals examined:** 16 specimens (MVZ 5, WFVZ 4, CAS 5, LSU 2). 12 (all but WFVZ) from Tutuila, all labeled males, 10 adults and two first-cycle birds, one of which (CAS 24468) is probably a female by measurements. Mayr (1932) also mentions preponderance of males in collections. Two females at WFVZ. 105 captures during TMAPS on Tutuila.

**Structure and Measurements:** 10 pp (p10 short), 9 ss, 12 rects. Specimens (here and from Mayr 1932): wing chord: ♀ (n29) 55-64, ♂ (n80) 62-72; tail ♀ (n13) 37-42, ♂ (n16+) 40-46; culmen from nares: DCB ♀ and ♂ (n14+) 15.5-17.0; FCJ/FCF ♀ and ♂ 15.0-16.0; exposed culmen DCB ♂ (n10) 17.8-20.0. Wing chord measurements of Micronesian Honeyeater (*M. rubratra*, considered conspecific with *cardinalis* by Mayr 1932) are ♀ 61-73, ♂ 62-79, indicating much less sex-specific dimorphism.

**Breeding Seasonality:** Banks (1984) indicates that males in breeding condition were taken Mar-Jul and possibly Oct-Nov, females in non-breeding condition taken Jun-Jul, and one recently fledged young in Nov. This and molt information (below) may suggest peak breeding in Oct-Dec but possible year-round breeding at lower levels. Capture data indicate breeding activity (full BPs or CPs) in Oct-Jan and Apr-May, perhaps indicating a double breeding season.

**Molt:** Mayr (1932) mentioned that most specimens collected in Oct-Feb were worn whereas those collected in Mar-May were fresh. Banks (1984) indicated that birds molting pp were collected only in Feb but that some (but not all) birds collected in Apr-Nov were undergoing body molt. Capture data indicates symmetrical flight-feather molt by most birds in Dec-May but few birds in Jun-Nov. Birds with light to heavy body molt were captured year-round but primarily during Dec-May as well. The PF appears to vary from partial or incomplete to complete in *Myzomela* elsewhere in the Pacific (Higgins et al. 2001, Radley et al. 2011; Figs. 53-57) and this appears to be the case in for Cardinal Honeyeater in Samoa. The innermost 2-6 primary coverts are either retained during the PF or are replaced with browner feathers than in basic plumage, and this appears to be reliable for ageing most or all FCFs. The tertials seem often to show limits (cf. Fig. 58) indicating a partial PF or perhaps a PA. DPBs can also be suspended or arrested (cf. Fig. 59).

**Age and Sex Determination:** Acceptable age coding: FCJ (year-round), FPF (year-round), FCF (year-round for both < and > 6 mo-old), SPB (year-round, primarily Dec-May), DCB (year-round), DPB (year-round, primarily Dec-May); also UPB (year-round, primarily Dec-May) and UCU (year-round) for birds of undeterminable age. Mayr (1932) describes all age/sex groups of *M. cardinalis* from Samoa: plumage differences appear to parallel those of Micronesian Honeyeater (*M. rubratra*) and other *Myzomela*, in which FCJs are primarily pale olive and gray, FCF females dull olive and gray with some scarlet, DCB females are darker olive and gray with scattered scarlet coloration on crown, throat, and back, and a scarlet rump, FCF males are mixed blackish and grayish (especially on underparts) with scarlet to bright red, and DCB males are black and bright red (Figs. 53-57). Capture data in TMAPs supports this and also indicates that all FCFs are reliably aged by retention of some to all wing feathers. Many appear to have a complete PF but retain juvenal brown inner primary coverts. Retained juv pp and rects are narrower and browner or paler (sex for sex) than replaced formative and basic feathers (Fig. 60). Wing chord should separate the sexes in most individuals, with < 62 indicating females and > 64 indicating males. Once age of outer primaries and plumage are factored in (birds with juvenal primaries will have shorter wings than those with basic primaries, sex for sex), all birds should be reliably sexed..

## **Polynesian Starling** (POST) *Aplonis tabuensis*

**Individuals examined:** 21 specimens (MVZ 2 from Fiji, WFVZ 19 from throughout Samoa, mostly Manua group). 32 captures during TMAPS on Tutuila.

**Structure and Measurements:** 10 pp (p10 short), 9 ss, 12 rects. Measurements of Samoan birds from Mayr (1942), WFVZ, and capture data: from Tutuila (*A. t. tutuilae*), wing chord: ♀ (n23) 99-106, ♂ (n20) 107-115; tail ♀ (n9) 52-58, ♂ (n10) 58-66; from Manu'a group (*A. t. manu'ae*) wing chord: ♀ (n20) 101-107, ♂ (n23) 105-112; tail ♀ (n20) 51-58, ♂ (n23) 57-62; bill lengths appear equal but bill depths may be sex-specific (see Age/Sex).

**Breeding Seasonality:** Banks (1984) reports a male collected in Jul in breeding condition but that most specimens collected Oct-Jan were molting and not in breeding condition. This suggests peak breeding in the austral winter, perhaps May-Sep or so. TMAPS capture data from Tutuila coincides, birds in peak breeding condition being recorded in Jun-Oct, FPFs in Nov, and birds in Dec-May not in breeding condition.

**Molt:** Banks (1984) reports that many birds from the Manu'a group collected in Dec-Jan were molting and that a complete molt was taking place on specimens from Tutuila in Oct-Nov whereas Jan birds were fresh. TMAPS capture data indicates symmetrical molt in Nov-Jan but DCBs without molt in Feb-Oct. Molt sequence appears typical of passerines, p1 to p10, s1 to s6 preceded by the terts in sequence s8-s9-s7, and the rects generally replaced distally on each side of the tail. Capture data indicate the PF to be partial, including some but not all wing covs but no ss, pp, or rects, as in other *Aplonis* starlings (Higgins et al. 2006, Radley et al. 2011).

**Age/Sex Determination:** Acceptable age coding: FCJ (Aug-Dec), FPF (Sep-Feb), FCF (year-round, < 6 mo-old primarily Oct-Mar, > 6 mo-old primarily Apr-Feb), SPB (Oct-Jan), DCB (year-round), DPB (Oct-Jan); also UPB (Oct-Jan) and UCU (year-round) for birds of undeterminable age. Age determination easier in Manua Islands, where DCBs are sooty underneath and FCJs and FCFs are streaked (Fig. 61). On Tutuila all age groups appear to be variably streaked underneath (Pratt et al. 1987). In both age groups (but more importantly on Tutuila) ageing can be accomplished by molt limits among wing feathers (cf. Fig. 4) and shape and condition of the outer pp and rects (cf. Fig. 62). Check also for bare-part color changes (adults have yellow bills and irises and younger birds may have darker colors; cf. Fig. 63). Adult males may have glossier and more attenuated crown and nape feathers than adult females (Fig. 63), a sex-specific pattern generally true of *Aplonis* (e.g., Figs. 64, 67), and this likely will be of use in sexing and possibly ageing, FCFs showing less gloss than DCBs, sex for sex. FCFs undergoing flight-feather molt (with older juv flight feathers) should be assigned SPB and DCBs in molt (with older basic feathers) should be assigned DPB. Measurements (see above) appear to be useful for sexing most Polynesian Starlings; for wing chord, < 105 indicates female and > 107 indicates male; accounting for age (birds with juvenal primaries < those with basic primaries) and tail measures (see above) most or all should be sexed. CP and BP are reliable for sexing in other *Aplonis* (Radley et al. 2011) and appear to be so for Polynesian Starling in Jun-Oct.

**Further Study:** Assess bill and iris color in FCJs and FCFs and see how it can be used in ageing (and maybe sexing as well).

## **Samoan Starling** (SAST) *Aplonis atrifusca*

**Individuals examined:** 17 specimens (MVZ 2, WFVZ 11, CAS 2, LSU 2) from American and Western Samoa; 59 captures during TMAPS on Tutuila.

**Structure and Measurements:** 10 pp (p10 short, about length of p covs, contra indications in Amadon 1943b, but variable; see below), 9 ss, 12 rects. Measurements of American Samoan birds (Mayr 1942, Banks 1984, specimens, captures): from Manu'a group: wing chord: ♀ (n20) 139-154, ♂ (n42) 147-162; tail ♀ (n20) 94-107, ♂ (n42) 99-115; from Tutuila: wing chord: ♀ (n14) 131-150, ♂ (n25) 140-160; tail ♀ (n13) 88-104, ♂ (n24) 96-117. So birds of Tutuila may average smaller but with more variation than birds of Manu'a group, though beware mis-sexed specimens may have contributed to above ranges. Bill from nostril from Tutuila measured ♀ (n12) 19.9-22.0, ♂ (n22) 21.0-23.6 (Banks 1984). Exposed culmen from specimens throughout Samoa: ♀ (n6) 27-33, ♂ (n4) 32-39.

**Breeding Seasonality:** Banks (1984) summarizes specimen and other information indicating a peak breeding season in Jun-Dec. In the TMAPS data reproduction was present in birds captured in May-Oct and lacking in DCBs in Nov-Apr, supporting this.

**Molt:** Banks (1984) reports that none of many specimens collected in Feb-Jul were undergoing primary molt and that a small proportion were undergoing body molt in Jun-Jul. Seven specimens collected Mar-Apr were not in molt, four specimens collected Jun and early Jul were worn and not molting, and four collected in Aug (2) and Nov (2) were undergoing primary molt (replacing p5, p6, or p7). Seventeen captures in the TMAPS data were in symmetrical molt in Jun-Dec (peaking in Aug-Oct) whereas those collected outside these months were not in molt. This all suggests a season to the PB of Jun-Dec. Molt sequence appears typical of passerines, p1 to p10, s1 to s6 preceded by the terts in sequence s8-s9-s7, and the rects generally replaced distally on each side of the tail. Capture data indicate the PF to be partial, including some but not all wing covs but no ss, pp, or rects, as in other *Aplonis* starlings (Higgins et al. 2006, Radley et al. 2011).

**Age/Sex Determination:** Acceptable age coding: FCJ (Jul-Nov), FPF (Aug-Feb), FCF (year-round, , < 6 mo-old primarily Oct-Mar, > 6 mo-old primarily Apr-Feb), SPB (Jun-Dec), DCB (year-round), DPB (Jun-Dec); also UPB (Jun-Dec) and UCU (year-round) for birds of undeterminable age. There is no indication of streaked underparts in FCJ or FCF Samoan Starlings, as in other *Aplonis* species (Fig 61; Mayr 1942, Pratt et al. 1987). Watling (2001) indicates that younger birds are brown than adults and this appears to be the case but it may be subtle. Ageing best accomplished by molt limits among wing feathers (Fig. 66) and shape and condition of the outer pp and rects (cf. Fig. 65). DCB males appear to have glossier and more attenuated crown, nape, back, neck, and breast feathers than adult females (Fig. 67), a sex-specific pattern generally true of *Aplonis* (Amadon 1943b, Higgins et al. 2006, Radley et al. 2011), and this likely will be of use in sexing and possibly ageing, FCFs showing less gloss than DCBs, sex for sex. FCFs undergoing flight-feather molt (with older juv flight feathers) should be assigned SPB and DCBs in molt (with older basic feathers) should be assigned DPB. Measurements (see above) may be useful for sexing about half of Samoan Starlings; for wing chord, on Tutuila < 140 indicates female and > 150 indicates male and in the Manua Islands < 147 indicates female and > 154 indicates male. Accounting for age (birds with juvenal primaries < those with basic primaries) and tail measures (see above) most or all should be sexed. CP and BP are reliable for sexing in other *Aplonis* (Radley et al. 2011) and appear to be so for Samoan Starling in May-Oct. Bill size also appears useful for sexing but measurement ranges need to be confirmed.

**Common Myna** (COMY) *Acridotheres tristis*
**Jungle Myna** (JUMY) *Acridotheres fuscus*

**Individuals examined:** COMY: 14 specimens (MVZ 14); also 40+ specimens collected in Hawaii and elsewhere examined in the past; six captures during TMAPS on Tutuila. JUMY: no speicmens, six captures during TMAPS on Tutuila.

**Structure and Measurements:** 10 pp (p10 short), 9 ss, 12 rects. Measurements of same COMY (nominate *tristis*) subspecies from Hawaii (Kannan and James 2001): wing chord: ♀ (n39) 120-139, ♂ (n19) 134-142. For JUMY, no published measurements found; from capture data: wing chord: ♀ (n2) 112-115, ♂ (n2) 115-120.

**Breeding Seasonality:** No information for either species in Samoan Islands. In Hawaii most breeding of COMY occurs in Mar-Jul (Kannan and James 2001), the equivalent of Sep-Jan in Samoa. Captures of JUMY on Tutuila were in breeding condition in Nov-Feb.

**Molt:** In Hawaii most molting of COMY occurs in Sep-Dec following breeding (Kannan and James 2001), the equivalent of Mar-Jun in Samoa. TMAPS Capture data indicate symmetrical molt for both species in Jan-Mar (2 COMY, 4 JUMY). In COMY the PF is complete and occurs at the same time as the PB (Kannan and James 2001) and the same appears true of JUMY. Molt sequence is typical of passerines, p1 to p10, s1 to s6 preceded by the terts in sequence s8-s9-s7, and the rects generally replaced distally on each side of the tail.

**Age/Sex Determination:** Acceptable age coding: FCJ (Nov-Feb), FPF (Dec-May), FAJ (year-round), DPB (Dec-May); also UPU (Dec-May) and UCU (year-round) for birds of undeterminable age. In both species FCJs resemble later plumages but are paler and have pale fringing to some of the body feathers and ss (cf. Kannan and James 2001); body feathers may also be more loosely textured. Ageing birds following the PF not possible; all birds lacking molt and juv feathers should be assigned FAJ. Shape and condition of pp and rects useful in distinguishing juv from post-juv feathers, and check also the distinctness of the white in rects and pp and presence/absence of black marks to the primary covs (in COMY, Fig. 69). FCJs in molt (with older juv flight feathers) should be assigned FPF and FAJs in molt (with older basic feathers) should be assigned DPB. Measurements (see above) may be helpful for sexing some individuals but metrics in Samoa need to be determined. In both species there is variation in distinctness of head and back plumage, and females may have shorter and duller modified crown feathers than males (cf. Fig. 68), but details and reliability of this for sexing needs to be worked out. CP and BP are reliable for sexing other starlings (Pyle 1997, Radley et al. 2011) Male COMY may occasionally incubate eggs (Kannan and James 2001) so it may be possible that full BPs indicate females whereas partial BPs are found in both sexes; CPs should be reliable for sexing males.