Manual for Ageing and Sexing Birds of Saipan, with notes on Breeding Seasonality

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Introduction

The Institute for Bird Populations (IBP) is initiating its Tropical Monitoring of Avian Productivity and Survivorship (TMAPS) program to monitor population dynamics of birds in tropical regions. Protocols for TMAPS will generally follow those of the MAPS Program in North America; however, because of extended and non-synchronous breeding seasons for many species in the tropics, protocols related to seasonality will vary some from those of MAPS. Several experimental TMAPS stations are currently in operation in Mexico to investigate various protocols, and six TMAPS stations were established on the island of Saipan, Commonwealth of the Northern Marianas Islands (CNMI), Micronesia, in April-July 2008 (Saracco et al. 2008).

The impetus for both MoSI and TMAPS arose from The Institute's Avian Survivorship Project at Naval Station Guantanamo Bay, Cuba, which was begun in October 1998. The purpose of this 5-year study was to determine annual and over-wintering survival of both migratory and resident landbirds in three major habitat types on the installation, and to monitor the reproductive success of the resident species by mist netting and direct nest monitoring. 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. Accordingly, through extensive specimen examination and by use of data collected in the field, IBP developed aging and sexing criteria for 15 landbird species that were frequently captured at Guantanamo Bay (Pyle et al. 2004).

In this manual we provide similar, preliminary criteria for ageing and sexing resident species captured at the Saipan TMAPS stations, based on examination of specimens and data collected at Saipan TMAPS stations in 2008. Accounts for 13 species are provided in a format that will enable field referencing during future years at the TMAPS stations on Saipan. We anticipate that this document will evolve as more data are collected, especially on between-year recaptures of birds known to be over a year in age.

Methods

Specimens of 12 indigenous and one introduced bird species collected in the CMNI (and occasionally elsewhere in Micronesia) were examined by PP at the Museum of Vertebrate Zoology (MVZ), Berkeley, California (204 specimens); the Brigham-Young University at Hawaii (BYUH), Laie, Hawaii (52 specimens); and the B.P. Bishop Museum (BPBM), Honolulu, Hawaii (53 specimens). Many specimens at MVZ were collected on Saipan in 1945 by Joseph T. Marshall, who was stationed in Micronesia during WWII (Marshall 1949). These specimens were collected year-round (although fewer in June-September) and were labeled as "adult" or "immature" but the method of age determination was not recorded (perhaps gonadal size). Most specimens at all three museums were also sexed, presumably by gonads, although a small proportion of apparent errors in sexing were encountered. Further information (including collection dates) is available on-line for individual specimens from Saipan at MVZ and BPBM. Specimens of many species resident to Saipan were also collected on Tinian, Guam, and Palau; specimens from these islands were checked if the subspecies was the same as that found on Saipan. Each specimen was carefully examined for active molt, state of feather wear indicating timing and number (within the first and definitive cycles) of previous molts, and plumage and feather-shape criteria that could relate to age and sex.

Six TMAPS stations were set up on Saipan by PR, JB, and CC and were operated primarily by JB and CC from 13 April - 17 July 2008, during which 1,270 captures were recorded. Standard MAPS banding data (according to the MAPS Manual) were collected, including those on breeding characters (BP and/or CP), wing chord, molt, plumage, and characteristics of feather tracts in the wing. Particular attention was paid to aging and sexing criteria, based on preliminary evidence from specimen examination along with criteria presented for North American landbirds by Pyle (1997). Over 1000 images were also obtained, primarily of open wings, to help document molt and age/sex-determination criteria.

There were few or no specimens or captures of two introduced species occurring on Saipan, Orange-cheeked Waxbill (*Estrilda melpoda*; introduced to Saipan between 2001 and 2002) and Eurasian Tree Sparrow (*Passer montanus*), the latter of which was previously treated by Pyle (1997). Consequently, they are not currently included in this text.

The following accounts include information on numbers of specimens examined (by island) and numbers of captures recorded at TMAPS stations on Saipan, for which the information present in the account was based; structure as based on specimen examination; measurements from specimens and captures; tentative results on breeding and molting patterns based on specimen and capture data as well as the published literature; preliminary age-sex criteria; and suggestions for further research. Molt and plumage terminology follow Humphrey and Parkes (1959) as revised by Howell et al. (2003). 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 diagnostics by season are given for each species in format, e.g., "Juv-HY/SY (Aug-Jul)", indicating that Juvs and HYs (birds in their first calendar year) can be aged in August-December and SYs (birds in their second calendar year) can be aged in January-July. These ranges are conservative based on just one year of data, and could be expanded in future years. All measurements are given in mm and 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.

Acknowledgments

We thank the U.S. Fish and Wildlife Service (USFWS) for the necessary funds (via the State Wildlife Grant) to establish TMAPS on Saipan. Sylvan Igisomar, Gayle Martin, and Laura Williams, all of Commonwealth of the Northern Marianas (CNMI) Department of Fish & Wildlife (DFW), were instrumental in securing these funds for TMAPS program initiation on Saipan. Julie Duenas and Kathy Yuknavage of the CNMI Coastal Resource Management Office (CRMO) assisted us by digitally (via GIS) parsing out private from public lands on Saipan. Daniel Lamar and Leno Olopai allowed entry to their lands and also assisted us in gaining access to lands adjacent to their properties for the purpose of data collection. We thank Stephen Mosher, Thalia Sachtleben, and Curt Kessler for unpublished data and information. At the Institute for Bird Populations (IBP) we thank Amy Finfera and Ron Taylor for helping to train CC and JB, and Jim Saracco, David DeSante, and Rodney Siegel for logistical and administrative support. This is contribution number 350 of IBP.

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Micronesian Megapode *Megapodius laperouse*

Individuals examined: 3 specimens (MVZ 2, BPBM 1; Saipan 1, Palau 2); no captures.

Structure and Measurements: 10 primaries (wing morphology not recorded). Number of ss and rects not noted (rects very short). Adult male at MVZ (95071; Fig. 1) had wing chord 174, exposed culmen 17, tarsus 52. For 15 birds (likely adults, sex unknown) captured on Aguiguan in Jun-Aug 2008 (C. Kessler, USFWS, pers. comm.): wing chord 160-192, tail 53-72, exposed culmen 17-24, tarsus 52-65.

Breeding Seasonality: Baker (1951) reported eggs collected on 17 Feb, 15 May, and 24 Jun in the CNMI in 1931, and a chick taken on 17 Jul in an unspecified year in the late 1800s. Craig (1996) suspected peak calling (and perhaps breeding activity) in Jan, but also noted courtship activity in Jul. During a DWF trip to Asuncion 17-23 May many juveniles (considerably smaller in size than adults) were recorded and photographed. This suggests a spring-summer breeding season, but study needed to confirm that it is not year-round.

Molt: Six adults observed on Aguiguan in Jun-Aug 2008 were undergoin complete molt in conjunction with breeding (C. Kessler, USFWS, pers. comm.). Adult male at MVZ (95071) collected 19 Nov is in molt and is exhibiting Staffelmauser (Pyle 2006) with three sets of pp including p1-p3, p4-p8 (p7g and p8x), and p9-p10. Among ss, s1 was growing (50%), there were proximal sets at s2-s4 and s5 inward, and a distal set from the terts outward. There was moderate body molt on back and breast. Adult male at BPBM (6577) collected 3 Feb had p10/p10 and s3/s3 growing but uniform pp and ss otherwise, indicating a complete molt terminating with these feathers. So molt may be protracted over winter. Molt strategies in megapodes are largely unknown (Stresemann and Stresemann 1966) but they presumably lack prealternate molts.

Age Determination: Acceptable age coding: Tentatively, Juv-HY/SY (Jun-May), AHY/ASY (Jun-May), ASY/ATY (Jun-May), ATY/A4Y (Jun-May). These dates subject to revision once timing of breeding and molt better understood. A Juv at MVZ (95072) and those photographed by DFW on Asuncion had brown-and-buff bars to upperparts and buff and dull-brown underparts, very different from the plumage of definitive-cycle adults (Fig. 1). Progression of plumages from juv to definitive aspect unknown. Staffelmauser patterns in the specimen indicate the potential to age adults to AHY/ASY (one set of pp), ASY/ATY (2 sets of pp), or ATY/A4Y (3 sets of pp), as found on the ATY specimen (see Pyle 2006, 2008).

Sex Determination: Sexes appear to be alike in all plumages and CP and BP are apparently not developed. Measurements also need to be checked for sexual dimorphism.

Further Study: Wing morphology, secondary count and measurements needed from specimens. Molts and plumage succession needs determination. Staffelmauser patterns need to be fully documented. Age determination according to season and sex-determination criteria need to be investigated.

Island Collared-Dove (Philippine Turtle-Dove) *Streptopelia bitorquata*

Individuals examined: 10 specimens (MVZ 7, BYU-H 1, BPBM -2; Saipan 2, Tinian 1, Guam 7); 4 captures.

Structure and Measurements: 10 pp, 10 ss, 12 rects. P10 full-length. Adult specimens had wing chord: ♀ (n4) 149-158, ♂ (n3) 150-159; one Juv ♂ had wing chord 147. Four captured adults (unknown sex) had wing chords of 153-155.

Breeding Seasonality: Baker (1951) reports evidence of nesting by Island Collard Doves on Guam in Feb-Jun, and notes one carrying nesting material on 13 Nov. Baker (1951) also reports two eggs collected from a nest on Rota on 31 Oct. Three of four captures from 1 May-8 Jul showed evidence of BPs. This perhaps suggests prolonged or year-round breeding with a peak in spring, as is common in subtropical Columbiformes.

Molt: Patterns of wear and molt (*cf.* Figs. 2-3) indicate that pp molt distally from p1 to p10, ss molt distally from s1 and s5 and proximally from the terts (as expected in dyastataxic taxa such as *Streptopelia*; Bostwick and Brady 2002, Pyle 2008), and rects are replaced distally (r1-r6) on each side of the tail. Thus the last feathers replaced are among p10, s3-s4, s6-s8, and r5-r6. A Juv at MVZ (115696) collected 27 Mar had begun preformative (PF) body molt but not flight-feather molt. An HY at BPBM (1293) was replacing p6 on 7 Jun. Thus, the PF may occur over summer. Among AHYs, p molt during the PB was noted 3 Jun-3 Jul (p5x-p6x - 3 specimens), and 12 Mar (p9x - 2 specimens), while birds collected in Oct-Dec lacked molt. Among captured birds, active PB molt was noted 1 May-26 Jun (e.g., Fig. 2) while one captured 8 Jul had completed molt (Fig. 3). Thus the PB may occur primarily over summer, but the 12 Mar specimens indicate variation - that some birds may molt year-round or suspend molt over winter. In one of these the older feathers appeared juv (indicating SY; MVZ 30951) and in the other they appeared basic (indicating ASY; MVZ 30952) (Figs. 6-7). Otherwise, most specimens had uniform pp and ss of a single generation, although the individual captured on 8 Jul (Fig. 3) and at least one adult (MVZ95120) collected in Oct had retained definitive ss, as can occur occasionally in Mourning Dove *Zenaida macroura* (Pyle 1997).

Age Determination: Acceptable age coding: Juv-HY (Feb-Aug), HY/SY (Sep-Aug), U/AHY (Sep-Aug), AHY/ASY (Sep-Aug); likely very similar to Mourning Dove (Pyle 1997). Juvs have rusty fringing to back feathers and wing covs (lacking in adults), smaller and weaker dark hind-collars, and narrower and more tapered rects (Figs. 4-5). These should be expected in Feb-Aug. The PF is usually complete in Mourning Dove and this seems a reasonable assumption for *Streptoptila*. Thus birds in Sep-Aug without retained ss should be aged U/AHY. In Sep-Jul, some birds will still be molting or will have retained ss and can be aged HY/SY (with retained outer pp and/or ss; Fig. 6) or AHY/ASY (with retained basic outer pp or ss; Figs. 3 & 7).

Sex Determination: Sexes seemed alike in all plumages, with males perhaps having a stronger hind collar. Measurements need to be checked but do not look useful for sex determination so far. BPs likely occur in both sexes while CPs are not developed.

Further Study: Molt timing. Look for retained feathers. See if females are duller than males (in future museum visits where birds have been sexed).

White-throated Ground Dove *Gallicolumba xanthonura*

Individuals examined: 21 specimens (MVZ 15, BYU-H 4, BPBM 2; Sarigan - 1, Saipan 10, Tinian 3, Rota - 2, Guam 5); 22 captures.

Structure and Measurements: 10 pp, 10 ss, 12 rects. P10 full-length. Wing chord: specimens: ♀ (n8) 128-141, ♂ (n10) 141-152. Captures had ♀ (n8) 128-141, ♂ (n7) 135-148.

Breeding Seasonality: Baker (1951) reported adult White-throated Ground Doves with enlarged gonads and other evidence of nesting in Feb-Jul. Craig (1996) suspected peak breeding during Apr-Jul and all 14 nests observed by Stinson (1993) were located in Apr-Sep. Thirteen of 18 captures during the TMAPS season showed evidence of BPs. Recently fledged males have been documented on Guam in Sep and Nov (Baker 1951, Jenkins 1983). This perhaps suggests peak breeding in spring, but year-round breeding may also be expected, as is common in subtropical Columbiformes and was suspected by Jenkins (1983) for the extinct Guam population.

Molt: Three of four HYs captured 5 May - 25 Jun were undergoing flight-feather molt, suggesting an incomplete to complete PF, as found in most Columbiformes (Pyle 1997). Seven of 14 adults collected 1 Apr-27 Jun and 7 of 13 adults captured 18 Apr-28 Jun were in flight-feather molt, without any patterns noted relative to timing. The remaining 7 specimens (collected year-round) were not in molt. These patterns suggest an extended molting season from at least Feb-Aug, and possible year-round molting. Assuming an incomplete to complete PF, it looks like both the PF and the PB can be either incomplete or suspended, with both juv and basic ss among s1-s7 retained (Fig. 10). Sequence of secondary replacement could not be inferred from specimens (*Gallicolumba* was not treated by Bostwick and Brady 2002 and Columbiformes can show either eutaxy or diastataxy) but replacement generally appeared to be distally from s1 and proximally from the terts. Also, one specimen collected 8 Apr and one bird captured 26 Apr (Fig. 10) appeared to be showing Staffelmauser patterns.

Sex Determination: Adults are strongly dichromatic (Fig. 11). Juvs resemble females (Fig. 8; see below) and it is unknown if males and females differ in juv plumage. Wing length (see above) would appear to separate many individuals to sex, including Juvs when fully grown; Juvs should show wing chords in the bottom portions of the ranges for each sex. BPs were observed in both sexes and no CPs were detected.

Age Determination: Acceptable age coding: Juv-HY (Jan-Aug?), HY/SY (Aug-Jul), U/AHY (Jul-Jun), AHY/ASY (Aug-Jul). Juvs are differentiated from adult females by their broader cinnamon edging to upperpart feathers (especially greater covs) and cinnamon-washed ss (Figs. 8-10). It is unknown what Juv males look like but if they resemble Juv females, birds in transitional juv-to-male plumage can probably be aged HY/SY (Aug-Jul). Non-Juvs with uniformly replaced pp and ss are best aged U/AHY (Jul-Jun). Birds in molt (Figs. 9-10) or with retained ss (Fig. 12) can be aged HY/SY (Aug-Jul) or AHY/ASY (Aug-Jul) depending on whether or not unmolted or retained feathers are juv or adult, respectively. Crown and lower back color varies extensively in males (Fig. 13) and study is needed to determine if this is related to age. Birds with two waves of Staffelmauser (e.g., Fig. 10) may be aged ASY later in the season but study is needed.

Further Study: What do Juv males look like? Does molt occur year-round or are there molting seasons? How does head and lower back color compare with age in males? Figure 13 can be used to score birds, including recaptures. How prevalent is Staffelmauser and can this be used to age ASYs later in the year than Jul?

Mariana Fruit Dove *Ptilinopus roseicapilla*

Individuals examined: 33 specimens (MVZ 10, BYU-H 8, BPBM 15; Saipan 15, Tinian 2, Rota 7, Guam 9); 2 captures.

Structure and Measurements: 10 pp, 10 ss, 12 rects. The outermost p (p10) is highly modified (images). Adult specimens had wing chord: ♀ (n13) 118-128, ♂ (n16) 124-133. Two captured birds (a female and unknown sex) had wing chords of 125-126.

Breeding Seasonality: Baker (1951) reports adult Mariana Fruit Doves with enlarged gonads and other evidence of breeding in Mar-Jul; Craig (1996) detected increased calling rates in Apr-Jul and recorded nest building in Feb, eggs in May, and fledglings in Jul; 35 of 38 nests observed by Stinson (1993) were located in Apr-Sep. A female captured 14 Apr showed a developing BP. This suggests a spring-summer breeding peak, corresponding with peak fruiting on Saipan (Craig 1996), but low-level year-round breeding could occur, as is in other subtropical Columbiformes.

Molt: Adult specimens in molt were collected 30 May (p7 growing), 20 Jul (p1-3 growing or missing), 19-24 Jul (5 specimens, p3-p8 growing), 6 Sep (p1 missing), and 18 Oct (p10 in pin). One adult captured 14 Apr had p3 growing (Fig. 14) and another adult captured that date had suspended molt after p1-p3 had been replaced (Fig. 15). Two adult captures 14 Apr did not show flight-feather molt but showed moderately heavy body molt. A specimen collected 7 Jan had suspended molt after p9 (Fig. 16). All other specimens were not in molt, including many collected in Oct-Apr and some collected May-Sep. This indicates a protracted molt that typically occurs from Apr-Oct but may only take half the period or so, such that some birds are not in molt during this period. Sequence appears to be typical of Columbids, distally among the pp (p1-p10) and both distally and proximally from the ss (s10 out and s1 in), perhaps with an additional center at s5. Based on Jul specimens in molt with juv p10 the PF is presumed complete on nearly-so; the 7 Jan specimen had apparently either suspended or arrested the PF after p9 had been replaced. Several other specimens had retained some ss (Figs. 14 & 17).

Age Determination: Acceptable age coding: Juv-HY (Feb-Aug), HY/SY (Aug-Mar), U/AHY (Jul-Jun), AHY/ASY (Aug-Jul). One Juv at BYU-H (4395) had an entirely green head, as indicated for Pacific *Ptilinopus* in general by Pratt et al. (1987). This and other HYs had a modified p10 that was thicker and blunter than those of adults (Fig. 16), and narrower green rects with just a hint of a yellow tail band. So HYs can be identified in Feb-Aug by these features. Some HYs may suspend or arrest molt until at least Jan (Fig. 16), and can be aged HY/SY through at least Mar, perhaps later. Care would be needed to separate these from HYs in Apr-Aug. Adults (at least) can also occasionally retain basic or formative ss through the cycle and can be aged AHY/ASY by the presence of retained basic outer pp or ss in Aug-Jul. The retained outer p will be highly modified (Fig. 16), and retained ss on AHY/ASYs will be the same size and shape as newer ss, just more worn (Figs. 14 & 18) whereas retained juv ss would be narrower and much more worn.

Sex Determination: Birds in formative and definitive basic plumage can be sexed by plumage patterns to the nape and central rects (Fig. 18). Wing chord (see above) should also separate most or all birds, including Juvs when fully grown. One BP was recorded in a female; BPs likely occur in both sexes while CPs are not developed.

Further Study: Is there a molt center at s5 or not? What do Juvs of each sex look like? Can they be sexed by the pattern to the band on the rects?

Mariana Swiftlet *Aerodramus bartschi*

Individuals examined: 24 specimens (MVZ 22, BPBM 2; Saipan 5, Guam 19); no captures.

Structure and Measurements: 10 pp, 7 ss, 10 rects. P10 full-length. Known-sex specimens had wing chord: ♀ (n7) 106-112, ♂ (n11) 106-112.

Breeding Seasonality: On Saipan, Rice (1993) and Reichel et al. (2007) documented peak nesting activity for Mariana Swiftlets starting in May and continuing through Sep, with reduced activity from Oct to Apr. Jenkins (1983) reported clutches of single eggs that were laid on Guam between Jan and Jul, but indicated no records of nesting from Jul through Dec.

Molt: One adult collected 3 Dec (MVZ 95146) was just completing molt, with p10 about 80% grown. Two specimens at BPBM (1323-1324) had dropped p1-p3 on 1-6 Jun. This and wear patterns of remaining specimens suggest a protracted molt in summer and fall. Individuals collected 24 Dec (MVZ 95145) and 1 Jun (BPBM 1323) had very pointed and worn outer pp and rects, indicating that the PF is incomplete, as reported for small North American swifts (Pyle 1997).

Age Determination: Acceptable age coding: Juv-HY/SY (Jul-Jun), U/AHY (Jul-Jun), AHY/ASY (Jul-Jun). Look for Juvs to have pale fringing to upperpart feathers, as found in other swifts (Pyle 1997). Some HY/SYs and AHY/ASYs can be reliably aged in Jul-Jun by the presence of, respectively, narrow and worn vs. broad and fresh outer rects and outer pp (Figs. 86, 89, and 91 in Pyle 1997). Many birds will be intermediate, however, and should be aged U/AHY.

Sex Determination: Sexes appeared monochromatic in plumage aspect. Wing chord appears not to differ either. All live birds should be sexed U unless BP proves reliable for sexing females; it is listed as probably reliable in North American species (Pyle 1997).

Further Study: Might Juvs have pale-fringed feathers as in other swifts? Look for molt limits among wing covs in HY/SYs after partial PFs. Can BP be used to sex females?

Collard Kingfisher *Todiramphus chloris*

Individuals examined: 17 specimens (MVZ 17; Saipan 8, Tinian 9); 57 captures.

Structure and Measurements: 10 pp, 11 ss, 12 rects. P10 full-length. Specimens had wing chord: ♀ (n8) 112-120, ♂ (n9) 112-118; exposed culmen: adult ♀ (n7) 47-52, adult ♂ (n8) 50-53. Wing chords for captured adults: ♀ (n11) 111-123, ♂ (n2) 116-118, Unknown sex (n43) 111-122. One HY had chord 109.

Breeding Seasonality: Baker (1951) reports an egg from Saipan on 31 Jul, and Craig (1996) observed recently fledged young in Jan, and active nests in May and Jun. Eleven individuals were captured with BPs including 7 in Apr and only 4 in May-Jul. Two Juvs were captured on 10 Jun and 10 Jul. This and molt patterns perhaps suggest a spring-summer peak to the breeding season, although the Jan fledglings detected by Craig (1996) suggest lower-level breeding at other times.

Molt: Adult specimens undergoing flight-feather molt were collected 22 Oct (p5-p6 growing, terts new), 28 Oct (p6 growing, terts growing), 6 Dec (p9 growing, s1 new, s2 growing, s3-s5 old, s6 growing, s7-s11 new), 3 Feb (MVZ 95172; p7 growing, ss and rects new?), and 16 Feb (MVZ 95170; pp and ss new, r1 new, r2-r4 missing, r5-r6 growing) but some winter-collected birds were not in molt. Only 2 of 43 captures in Apr-Jul were undergoing flight-feather molt, adults on 26 May and 10 Jun; light body molt was recorded on a few individuals scattered through the season. This suggests molting primarily in Oct-Feb but perhaps not with all individuals. Molt and wear clines and observations of captured birds indicate typical sequence (p1 to p10, s1 inward, and the terts outward, and rects in ~order r1-r6-r5-r2-r4-r3). Lack of observed SYs in Apr-Jul capture data indicates that first winter birds undergo a complete molt, perhaps best termed an early 2nd PB (there may be no PF in this species). During definitive PBs, p covs appeared generally to be replaced with pp, although two specimens had what appeared to be mixed generations of p covs (image) as found in North American kingfishers (Pyle 1997). Otherwise, no evidence of suspended molt or retained flight feathers was found.

Sex Determination: Both adults and Juvs appear from specimen evidence to be sexually dichromatic, females showing olive backs and turquoise wings and tails, and males showing turquoise backs and blue wings and tails (Figs. 19 & 21-22). Some intermediates were captured, however, and further study is needed to determine reliability of sexing based on upperpart color. Wing length appears similar but exposed culmen length may average greater in males than females. BPs were recorded (primarily in Apr-May) on 3 females and 8 birds of unknown sex; these likely occur in both sexes. No CPs were detected.

Age Determination: Acceptable age coding: Juv-HY/SY (May-Apr), AHY/ASY (Mar-Feb), ASY/ATY (Mar-Feb). **However, using the following, TMAPS banders recorded 49 ASYs and no SYs in 2008 (all ages changed to AHY) so this may not be reliable.** Juvs have white-fringed lesser wing covs (Fig. 19), and indistinct dusky mottling to breast (Fig. 20) which may wear off before the first molt commences. The wing and tail feathers appear to be retained until the first winter/spring, allowing ageing of HY/SYs through Feb-Apr and AHY/ASYs through Mar by the shape and condition of the outer pp (Fig. 21) and rects (Fig. 22). Occasional individuals with mixed basic p covs (indicating two previous PBs) can be aged ASY/ATY in Mar-Feb. Look for some SY/TYs with retained juv p covs, as in North American kingfishers (Pyle 1997). The extent of dusky in the crown may indicate immaturity but exceptions occur and reliable ageing unlikely.

Further Study: Does this species have a PF? Can sexing criteria by upperpart color be refined? Can ageing per the above be refined?

Micronesian Honeyeater *Myzomela rubratra*

Individuals examined: 32 specimens (MVZ 13, BYU-H 9, BPBM 10; Saipan 16, Tinian 2, Rota 3, Guam 7); 72 captures.

Structure and Measurements: 10 pp (p10 short), 9 ss, 12 rects. Specimens at MVZ had wing chord: ♀ (n4) 62-64, ♂ (n9) 71-76; exposed culmen: ♀ (n4) 9.8-11.0, ♂ (n9) 10.7-12.4. Captures had ♀ (n19) 61-68, ♂ (n29) 66-77.

Breeding Seasonality: On Guam, Baker (1951) reports adults with enlarged gonads and eggs of Micronesian Honeyeaters collected from May to Jul, an individual with enlarged gonads taken on 26 Jan, and a pair with two young 9 Oct, and Jenkins (1983) reported year-round breeding but was unsure if one or more peaks occurred. Craig (1996) recorded nest-building in Feb and courtship in May, and Japanese collectors reported nests with eggs in Jan, Feb, and Mar (Sachtleben et al. 2006). Capture data indicate that over 50% of adults had BPs or CPs in Apr-May, but that this proportion tailed off during Jun and Jul, coincident with an increase in the proportion of young captured. This perhaps suggests peak breeding in Mar-Jun, with sporadic low-level breeding the rest of the year.

Molt: Juvs undergoing the PF were collected and captured in May-Jul and were primarily replacing body feathers before Jun 1st but had begun flight-feather molt in Jun-Jul. Lack of molt limits in non-molting spring AHYs (Fig. 24) indicates that the PF may be complete and include wing feathers following flight feathers, but study is needed. One apparent SY captured 23 Apr was finishing wing molt (Fig. 25) indicating that it can be protracted or suspended in some (perhaps late-hatching) individuals. Capture data and 10 specimens in wing molt indicate an extended period for the PB (Mar-Oct) but not all birds are in molt during this period. Molt can be variable and protracted (Figs. 26-27); e.g., one recaptured bird proceeded only from p3 to p10 in 10 weeks. Sequence appears typical of North American passerines (Pyle 1997). Some birds could also retain feathers and/or undergo suspended PBs (Figs. 27-28) further adding variability to the molt strategies in this species.

Age and Sex Determination: Acceptable age coding: Juv-HY (Mar-Jun), HY/SY (May-Apr), U/AHY (Oct-Sep), AHY/ASY (Mar-Feb). Males and females appear to be reliably separated by wing and exposed culmen lengths (see above), and plumage appears to allow separation of four age/sex classes (Fig. 23): Juv-HY females were primarily brown, AHY females were brown washed dull to medium-bright red; Juv-HY males were brown mottled medium-bright to bright red, and AHY males were black and bright red (Figs. 23 & 30). Thus, measurements combined with plumage should allow ageing and sexing of birds in Mar-Aug and probably later in the season. The gapes of young birds were also yellowish (Fig. 30) and this appears to be useful in determining HY/SYs through the first six months or more of life. Some molting birds with juv outer pp, middle ss, or rects can be aged SY through Apr or later (Figs. 25 & 29). Some molting birds with older basic flight feathers or birds with retained basic feathers or suspended molts can be aged ASY through Feb or later (Figs. 27-29). Otherwise, birds with dark gapes and uniform basic-like wings and tails should be aged U/AHY in Oct-Sep. In addition, males and females appear to be reliably separated by wing and exposed culmen lengths and CP/BP (see above).

Further Study: Confirm complexities of PFs and PBs. How can this be better applied to timing of ageing criteria?

Rufous Fantail *Rhipidura rufifrons*

Individuals examined: 41 specimens (MVZ 24, BYU-H 14, BPBM 3; Saipan 17, Tinian 16, Aguijan 3, Rota 5); 649 captures.

Structure and Measurements: 10 pp (p10 short), 9 ss, 12 rects. Specimens had wing chord: ♀ (n11) 63-67, ♂ (n12) 65-70 and captures had wing chord: ♀ (n79) 62-68, ♂ (n22) 64-69.

Breeding Seasonality: On Guam, Baker (1951) reported Rufous Fantail nests taken in Feb and Mar, and Jenkins (1983) reported breeding in Jan-Apr, Jun, and Nov. Craig (1996) found active nests in Feb-Apr and Oct-Nov. Capture data shows proportions of adults with breeding condition moderate in Apr (~40%) and trailing off to few or none by the end of May. HYs were captured throughout the Apr-Jul period. This evidence suggests perhaps bimodal breeding, with peaks in Feb-May and Sep-Nov.

Molt: About half of the captures in Apr-Jul were of birds undergoing molt. Specimens undergoing p molt were collected year-round (including about half the specimens from Oct-Apr) and assessment of feather wear on non-molting birds indicated no strong seasonality to molt, but there may also be biomodal molting seasons following breeding (see above). Capture data also indicate that the PF is complete and apparently can occur as early as 6-8 weeks after fledging; few Juvs were captured that had not begun molt. PFs and PBs can be protracted and suspended (Fig. 34), but no evidence of retained feathers was found. Thus it appears that molt (and breeding?) occurs year-round (or is perhaps bimodal), with suspensions of molt for breeding. Capture and specimen data indicate that replacement sequence is typical of passerines (Pyle 1997), with pp replaced distally (p1-p10), terts replaced in order s8-s9-s7, and the remainder of the ss being replaced proximally (s1-s6).

Age Determination: Acceptable age coding: Juv-HY (Jan-Dec), HY/SY (Mar-Feb), U/AHY (Aug-Jul for molting birds; Jun-May for non-molting birds). Juvs are fluffier and slightly duller in plumage aspect overall than older birds, and have broad rusty tips to the greater covs (Fig. 31), which wear to buff within a few weeks (Fig. 32). HY/SYs in molt can be identified year-round (molting SYs through Feb) by having retained Juv outer pp, medial ss, and/or rects (Figs. 32 & 35). Birds with uniformly definitive (formative/basic) flight feathers (Figs. 33 and 35) should be aged U/AHY in Jun-May, and molting birds with older definitive flight feathers (Figs. 34-35) can be aged U/AHY in Aug-Jul.

Sex Determination: No plumage differences found and measurements show only slight dimorphism, so most birds cannot be sexed based on size or plumage. BPs and CPs appear reliable for sexing females and males, respectively, in Apr-May, with some BPs recorded in Jun-Jul.

Further Study: Are there seasonal peaks to breeding and molting or does it simply occur year-round? Is the PF always complete, and how soon does it occur after fledging? HYs reported with BPs and CPs in 2008; confirm that HYs can breed.

Nightingale Reed-Warbler *Acrocephalus luscinius*

Individuals examined: 8 specimens (MVZ 5, BYU-H 1, BPBM - 2; Saipan 5, Guam 3); 4 captures.

Structure and Measurements: 10 pp (p10 short.), 9 ss, 12 rects. Specimens had wing chord: ♀ (n3) 79-86, ♂ (n5) 85-91; exposed culmen: ♀ (n3) 28-34, ♂ (n5) 28-33; and bill depth at distal end of nares ♀ (n3) 4.5-4.8, ♂ (n5) 4.8-6.0. Four captures (1 male and 3 of unknown sex) had wing chord 85-87. Ranges (95% CI) based on data presented by Craig (1992) are as follow: wing chord: ♀ (n10) 78-86, ♂ (n19) 83-91; tail length ♀(n10) 72-84, ♂ (n19) 79-87; bill length from distal end of nares: ♀ (n10) 20.8-24.4, ♂ (n19) 21.0-25.0; and tarsus ♀ (n10) 31.8-34.6, ♂ (n19) 32.8-36.8.

Breeding Seasonality: For Guam, Baker (1951) reported nests or adults in breeding condition in Jun. Two of three birds captured in early May had CPs. In a detailed year-round survey, Mosher and Fancy (2002) and S. Mosher (in litt.) found nests nearly year-round, with a possible hiatus in Oct-Nov. Craig (1996) also found little seasonality to breeding behavior although suggested (Craig 1992a) a drop in territoriality during the wet season in Sep-Nov.

Molt: Specimens in molt included two on 1 Feb and one on 26 Jun that were finishing molt with p10 in pin and molt among the ss, and one on 9 Jul that was worn and just beginning molt. Three other AHYs collected in 8 Feb-2 Jun, and two captured 1-2 May were not in molt and appeared relatively fresh, and one collected 26 Jun was not in molt and was worn. During extensive year-round banding, S. Mosher (in litt) also found peaks flight-feather and body molt in Apr-Jun and Oct-Jan, although not all captures during these periods were undergoing molt. No molt limits were observed in specimens or TMAPS captures to assess extent of PF. Svensson (1992) indicates that other *Acrocephalus* species have complete PFs so perhaps this is the case here. There was no evidence for protracted, suspended, or arrested molts. The two 1 Feb birds finishing molt at MVZ were labeled "imm" and "ad", perhaps indicating a complete PF in the former bird. A bird captured for TMAPS 1 Jul appeared to be a Juv just commencing body molt at the PF (Fig. 37) and the 9 Jul bird appeared to have juv flight feathers and so may also have been commencing the PF. This indicates a bimodal molting season, despite year-round or near year-round breeding, but how this differs between first-cycle and adult birds requires further study. Sequence of secondary molt was distal from s1 and proximal from the terts, with s5 the last replaced (Fig. 36).

Age Determination: Acceptable age coding: Juv-HY (Jan-Sep), HY/SY (Mar-Feb), U/AHY (Aug-Jul for molting birds; Jun-May for non-molting birds). Juvs appear to be like other *Acrocephalus* (Svensson 1992) in being similar to adults but having indistinct fringing to wing covs, darker eyes, and narrower pp and rects (Figs. 37-38). Definitive (formative/basic) plumage lacks this fringing and has broader (and probably sturdier) outer pp and rects (Figs. 39-40) and adults appear to have warmer brownish to reddish-brown eyes (Fig. 39). Timing of the use of these criteria is tentative and no other criteria are known.

Sex Determination: No plumage differences found. The measurement samples are small but suggest a fair degree of sexual dimorphism, perhaps enabling the sexing of some individuals. S. Mosher (in litt) indicated that the best variables for sexing included wing chord, weight, and number of rectrices, and he will be working on a discriminant function analysis for sexing this species. One individual with a CP in May was assumed to be a male.

Further Study: How do HYs and AHYs differ in molt patterns? Can BP and CP be used for sexing? Need to confirm usefulness and timing of skull ossification for ageing (this may turn out to be the best criterion).

Bridled White-eye *Zosterops conspicillatus*

Individuals examined: 53 specimens (MVZ 47, BYU-H 3, BPBM - 3; Saipan 28, Tinian 24, Aguijan 1); 190 captures.

Structure and Measurements: 9 pp (p9 full-length), 9 ss, 12 rects. Individuals at MVZ from Saipan had wing chord: ♀ (10) 49-55, ♂ (n12) 50-54. Captures had wing chord: ♀ (29) 49-54, ♂ (n17) 51-54.

Breeding Seasonality: Nesting was recorded for the Bridled White-eye on Saipan from May to Jul, and of 18 birds taken in Sep on Tinian, half (*n*9) had enlarged gonads (Baker 1951). Baker also reported three nests containing eggs taken on Tinian on 8 Jan. Capture data indicate birds in reproductive condition throughout the season, with a slight peak early (Apr-15 May) and perhaps a second peak later (Jul). Craig (1996) recorded little to no seasonality in breeding behaviors of Bridled White-eyes on Saipan. This information indicates year-round breeding.

Molt: Fifteen specimens collected in molt all occurred in Jan-Apr. The remainder of the specimens did not show molt and were collected year-round. Banding data indicate that most HYs but a smaller proportion of adults were undergoing flight-feather molt throughout the Apr-Jul season. Both specimen and capture data indicated that the PF could be partial to incomplete, with all or some ss, rects, and pp retained. Variation in these birds suggests that some may have a complete PF as well. Odd patterns of molt were observed in both capture data and specimens; e.g., MVZ 95376 collected 19 Jan had p5 old, p6 new, and p7 old, and p8-p9 new on the R wing and p5 old, p6 new, p7 old, and p8-p10 new on the left wing (Fig. 41). Whether this represents a molt pattern of some sort or simply an anomaly awaits further study.

Age Determination: Acceptable age coding: Juv-HY (Sep-Dec), HY/SY (Oct-Sep), U/AHY (Nov-Oct). No Juv specimens or captures were observed. Presumed differences between HY/SYs and AHYs could be seen in the shape and color of the pp and rects - browner, more pointed, and more worn in juv feathers than in adult feathers (Fig. 42). Because the PF may sometimes be complete, birds with uniformly definitive rects must be aged U/AHY in Nov-Oct. It is possible that these or others with mixed definitive flight-feathers (cf. Fig. 41) may be reliably aged AHY/ASY but more study is needed. The p covs seemed pretty similar between the two age groups, each having green-edged feathers as are generally found in AHYs.

Sex Determination: No plumage differences found. Measurements indicate little to no ability for sex determination. BPs and CPs appear reliable for sexing females and males, respectively, in Apr-Jul and probably year-round.

Further Study: Look for additional individuals with unusual molt patterns and figure out how this relates to age-determination. What do Juvs look like? Confirm that PF can be complete. Can BP be used for sexing?

Golden White-eye *Cleptornis marchei*

Individuals examined: 16 specimens (MVZ 10, BPBM 6; Saipan - 11, Aguijan 5); 251 captures.

Structure and Measurements: 10 pp (p10 short), 9 ss, 12 rects. Specimens had wing chord: ♀(n8) 64-76, ♂ (n8) 72-82; exposed culmen: ♀(n8) 12.7-14.0, ♂ (n8) 13.9-15.5, bill from nares ♀(n8) 8.3-11.8, ♂ (n8) 9.3-12.2; tarsus ♀(n8) 22-28, ♂ (n8) 24.5-29.0. Captured birds had wing chord ♀(n64) 67-75, ♂ (n93) 70-82. Plumage much laxer than in Bridled White-eye and wing morphology also very different. See Slikas et al. (2000) for relationships in Golden and other white-eyes.

Breeding Seasonality: Baker (1951) reports one nest of a Golden White-eye on 7 Jul; Stinson and Stinson (1994) observed three active nests in May-Jun. Capture data indicate active BPs and CPs observed throughout Apr-mid Jul, with a slight tapering off in Jun-Jul. HYs were also not identified until mid-May, with most being captured after mid-Jun. Craig (1996) recorded active nests in most months between and including Jan and Oct, and singing year-round, but suggested that breeding was curtailed during prolong dry periods in certain years. This suggests year-round breeding but that a fairly well-defined, spring-summer breeding season occurred in 2008.

Molt: Specimens collected in Dec (1), Jan (5), Feb (3), and Apr (1) were not in molt. Capture data indicates low proportions undergoing flight-feather molt in Apr-May, with higher proportions (> half) undergoing molt observed after 20 Jun. Wear patterns on adult feathers (fresher in Dec wearing by Apr) support a late summer/fall molting period, after breeding, perhaps primarily in Jul-Oct. Molt limits between back and wings on specimens and captured birds (Figs. 43-45) suggest that the PF includes body feathers only. But confirmation needed: four of six HYs were recorded with symmetrical flight-feather molt (but details lacking) and the majority of adults appeared to have fresh flight-feathers and were aged ASY in 2008 (poor breeding in 2007?). Wear clines suggest flight-feather replacement sequences in typical patterns but confirmation is needed. No evidence for suspended PB or retained feathers during this molt was encountered.

Age Determination: Acceptable age coding presumably: Juv-HY (Aug-Nov), HY/SY (Sep-Aug), U/AHY (Nov-Oct), AHY/ASY (Nov-Oct). Juvs not described (should occur in Jun-Sep). HY/SYs should show molt limits between wing and back (Figs. 43-44) and narrow, worn and tapered outer pp and rects (Figs. 44 & 46); these presumably can be aged as such in at least Sep-Aug. AHY/ASYs show uniform wing covs and back feathers (Figs. 43 & 45) and broader and fresher outer pp and rects (Figs. 45-46) and presumably can be aged as such in Sep-Aug. However, confirmation is needed that the PF is always partial. Also, some intermediates may be difficult to age by these criteria and should be age U/AHY (Sep-Aug). Skulling was difficult due to thick skin over the head.

Sex Determination: No sex-specific plumage differences were found among specimens. BPs were observed in both sexes but CPs presumably were reliable for sexing males. Measurements indicate moderate to strong sexual dimorphism, with both wing length and (especially) bill length being useful or reliable for sexing (see above). Bill length proved reliable against CP for sexing males.

Further Study: Molt timing and confirm extent of PF, ageing criteria, and timing. Do males have less-full BPs than females?

Micronesian Starling *Aplonis opaca*

Individuals examined: 46 specimens (MVZ 32, BYU-H 10, BPBM 4; Saipan 10, Tinian 14, Rota 1, Guam 18, Palau 3); 10 captures.

Structure and Measurements: 9 pp (p9 full-length), 9 ss, 12 rects. Specimens at MVZ had wing chord: ♀ (11)115-124, ♂ (n14) 124-137; exposed culmen: ♀ (11) 19.0-21.0, ♂ (n14) 20.0-22.5; bill depth at distal end of nares ♀ (11) 7.9-9.2, ♂ (n14) 8.9-10.3. See **Age/Sex** regarding wing chord measures.

Breeding Seasonality: Baker (1951) reports six active nests and/or eggs collected on Guam and Saipan in Mar-Jun. However, only one of nine captures during Apr-Jun showed breeding condition, a male with a CP captured 22 Apr. Craig (1996) reported little seasonality to breeding behaviors of Micronesian Starlings.We thus do not have enough information to assess whether or not a distinct breeding season exists (but see Molt).

Molt: Twelve AHY specimens and five captured birds were undergoing flight-feather molt during 12 Apr-16 Oct, although 6 specimens and 4 captured birds during this period were not in molt. No molt was observed among 11 specimens collected in Nov-Mar. This indicates a molting season that spans the summer, but may be protracted, perhaps depending on breeding, which may occur predominantly in spring. HY/SYs with molt limits indicated that the PF often includes the body feathers and some lesser and median covs; one specimen (MVZ 95321) from Palau had replaced two inner greater covs and s8-s9 (Fig. 47).

Age/Sex Determination: Acceptable age coding: Juv-HY (May-Aug), HY/SY (Sep-Aug), AHY/ASY (Sep-Aug). Juvs and HY/SYs are olive and streaked and AHY/ASYs have entirely blackish plumage aspect (Fig. 48). Adult males seemed a bit glossier than females and immature males a bit darker than females (Fig. 48). SYs in molt (Fig. 49) likely can be identified through at least Aug and possibly later. For wing chord HY/SYs were smaller than AHY/ASYs, sex for sex, such that those with wing 122-126 were either AHY/ASY females or HY/SY males, and all birds should be reliably sexed by this metric, once aged. Bill length and depth also seemed useful (see above).

Further Study: Confirm timing of molt and ageing criteria. Confirm that both BP and CP are reliable for sexing.