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## MOLT PATTERNS, AGE, AND SEX CRITERIA FOR SELECTED HIGHLAND COSTA RICAN RESIDENT LANDBIRDS

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**Patrones de muda, edad, y criterios de sexado para algunas aves terrestres de las partes altas de Costa Rica.**

**Key words:** Costa Rica, Cordillera de Tilarán, highland birds, age-related plumage, sex-related plumage, molt.

Demographic studies within temperate latitudes often use molt and plumage-based criteria to differentiate age and sex classes (Bayne & Hobson 2002, Brown *et al.* 2002, Jones *et al.* 2004). Despite their critical nature (Pyle *et al.* 2004, DuVal 2005, Doucet *et al.* 2007), molt and plumage data derived from resident tropical species remain scarce (Dickey & van Rossem 1938, Diamond 1974, Foster 1975, Prys-Jones 1982, Pyle *et al.* 2004, Ryder & Wolfe 2009, Wolfe *et al.* in press). To advance our understanding of resident tropical avifauna molt, we studied molt patterns and plumage-based age characteristics for ten resident highland species commonly found in the northern cordilleras of Costa Rica.

The following accounts summarize our findings on molt, aging, and sexing criteria. They are based on skin specimens obtained from museum collections and banding data from a study of bird ecology in coffee plantations and forest habitats in the Cordillera de Tilarán, Costa Rica (winter and spring of 2006/07 and 2007/08).

### METHODS

Museum specimens from Mexico through northern Colombia were examined at the California Academy of Sciences, San Francisco (September 2007) and at the U.S. National Museum (Smithsonian), Washington, DC

(December 2007). The ages of birds in the collections were commonly inferred; however, the prevalence of partial to incomplete preformative molt patterns among resident Neotropical landbirds presumably facilitated preliminary age-class differentiation, as in temperate and other tropical species (Pyle 1997, Pyle *et al.* 2004, DuVal 2005, Doucet *et al.* 2007, Ryder & Wolfe 2009, Wolfe *et al.* in press). Birds captured in the northern cordilleras of Costa Rica were processed in a standardized fashion where body molt, wing molt, molt-limits, and breeding characteristics were documented. Importantly, juvenile feathers often wear more rapidly in relation to formative or definitive feathers, thereby aiding in differentiating age classes. Temporal patterns of molt and breeding seasonality were considered when using feather 'wear,' 'contrast in wear,' and 'molt limits' to infer age classification. Molt terminology follows those of Pyle (1997) and Howell *et al.* (2003). The first basic plumage is referred to as juvenile plumage, followed by the preformative molt. Subsequent molts include prealternate and definitive prebasic molts.

The calendar-year aging system is commonly used to categorize age in temperate latitudes by placing individuals into age classes based on their hatching date in relation to January 1<sup>st</sup> (Pyle 1997). However, tropical breeding seasonality is often not well described or overlaps January 1<sup>st</sup> (see Wolfe *et al.* 2009); such hindrances are not conducive to categorizing age by the juxtaposition of a hatching date and January 1<sup>st</sup>. In order to provide repeatable and accurate age classes, we categorize age in the form of plumage classes (e.g. 'juvenile [unknown],' 'formative [male],' 'definitive [female],' etc.).

Primaries and primary coverts are generally referred to as "inner" and "outer" depending on their juxtaposition to the body of the bird; greater coverts and rectrices are referred to in a similar fashion. For molt

extent, "partial" indicates that no flight feathers were replaced (except the tertials or central rectrices in some individuals). "Limited" indicates that some, but not all body feathers and no flight feathers were replaced, and "complete" refers to the entire replacement of all feathers (Pyle 1997). Sample sizes, morphological measurements, and molt patterns are summarized in Tables 1 and 2.

## SPECIES ACCOUNTS

### Plain Antvireo (*Dysithamnus mentalis*)

The preformative molt includes only the lesser and median coverts but no greater coverts, primary coverts, tertials, or rectrices. Juvenile (male and female) individuals resemble adults but are more mottled below, with a whitish throat, yellowish chest, and yellowish belly (Stiles & Skutch 1989).

Formative (female) plumage can be characterized by retained primary and greater coverts that are washed brown, typically with a tawny edging, and tipped buff. Formative (male) plumaged individuals have dusky-brownish primary coverts, and greater coverts which are often washed brown, and tipped white. Formative (male and female) plumage can also be characterized by retained rectrices which are often washed brown, tapered, and relatively worn. Formative plumaged individuals (male and female) also have an alula washed brown to gray, and edged white.

Definitive (female) plumaged individuals often have a steely-gray alula with buff tipping. Definitive (female) primary coverts are dark-gray to steely-gray and edged olive to rufous. Definitive (female) plumage can also be characterized by buff-tipping in the outer greater coverts. Definitive (female) plumaged rectrices are relatively fresh, truncate, and washed olive-brown. Definitive (male) plumaged birds have a steely-gray alula with white edging. The primary coverts in definitive (male) individuals are steely-gray, with white

TABLE 1. Wing-chord and tail measurements (in mm) for ten species of resident landbirds commonly found in the Cordillera de Tilarán, Costa Rica. Values within parentheses indicate sample sizes.

Species	Wing chord		Tail	
	Male	Female	Male	Female
Plain Antvireo	110–128 (14)	96–117 (11)	78–112 (14)	71–85 (11)
Olive-striped Flycatcher	60–78 (25)	59–67 (24)	45–63 (25)	40–50 (24)
Rufous-and-white Wren	62–75 (14)	61–74 (16)	36–57 (14)	42–57 (16)
Black-faced Solitaire	62–67 (13)	58–65 (6)	58–79 (13)	56–62 (6)
Orange-billed Nightingale-Thrush	73–90 (15)	71–88 (12)	60–72 (15)	59–70 (12)
Slaty-backed Nightingale-Thrush	80–93 (13)	77–89 (12)	59–75 (13)	55–71 (12)
Pale-vented Thrush	110–128 (14)	96–117 (11)	78–112 (14)	71–85 (11)
Tawny-capped Euphonia	59–71 (13)	53–62 (14)	35–42 (13)	29–35 (14)
Slate-throated Whitestart	62–75 (23)	56–67 (19)	36–61 (23)	50–65 (19)
Chestnut-capped Brush-Finch	74–88 (17)	75–85 (16)	69–95 (17)	71–85 (16)

tipping, and often edged greenish, with relatively fresh rectrices that are truncate, steely-gray, and sometimes tipped white.

#### Olive-striped Flycatcher (*Mionectes olivaceus*)

The preformative molt appears to include all greater coverts, but not the tertials or rectrices. Juvenile (unknown) individuals have less distinct streaking on the breast, and the wing-bars appear ochraceous. Juveniles often have all-black bills, with the base turning orange with age.

Formative (female) individuals can be characterized by retained primary coverts which lack greenish edging, contrasting slightly with the replaced greater coverts. Formative (female) individuals have retained rectrices which are often washed brownish, worn, and tapered; primary nine is typically not notched. Formative (male) plumage criteria are the same as formative (female), except that primary nine has slight or no notching.

Definitive (female) individuals can be characterized by relatively fresh primary coverts, and rectrices that appear more fresh and truncate relative to formative plumaged birds; primary nine is typically not notched. Definitive (male) individuals have similar criteria as definitive (female), except primary

nine is often deeply notched (Fig. 1).

#### Rufous-and-white Wren (*Tbryothorus rufalbus*)

The preformative molt is variable, with replacement of three to six inner greater coverts and the complete replacement of tertials. Rectrices are also retained during the preformative molt. Juvenile (unknown) individuals are darker plumaged above, with a dull-black and scaled crown, a buff-tinged breast that is mottled blackish, and undertail coverts barred black and brown (Stiles & Skutch 1989).

Formative (unknown) plumaged individuals have replaced inner greater coverts and tertials that are bright rufous (often tipped-white when fresh), more densely barred black (2:1 difference in the amount of black barring between replaced and retained coverts), which contrast with retained juvenile outer greater coverts and flight feathers (Fig. 2). Formative (unknown) individuals can also be characterized by a brown iris and retained rectrices which are often tapered and worn.

Definitive (unknown) plumaged individuals show no contrast between uniform, bright-rufous coverts, and flight feathers. Definitive rectrices are bright, lustrous, relatively fresh, and truncate. Definitive iris is typ-

TABLE 2. Documented molt patterns and sample sizes for ten species of resident landbirds commonly found in the Cordillera de Tilarán, Costa Rica.

Species	Sample size (n)		Molt pattern		
	Field captures	Museum specimens	Preformative molt	Definitive prebasic molt	Prealternate molt
Plain Antvireo	3	25	partial	complete	absent (?)
Olive-striped Flycatcher	37	36	partial	complete	absent
Rufous-and-white Wren	11	30	partial	complete	absent
Black-faced Solitaire	14	18	partial	complete	absent(?)
Orange-billed Nightingale-Thrush	25	27	partial	complete	absent(?)
Slaty-backed Nightingale-Thrush	9	25	partial	complete	absent
Pale-vented Thrush	16	25	partial	complete	absent
Tawny-capped Euphonia	5	26	partial	complete	partial-limited-absent
Slate-throated Whitestart	17	40	partial	complete	absent
Chestnut-capped Brush-Finch	12	32	partial	complete	limited-absent

ically reddish-brown. Sexes are similar in all plumages.

Black-faced Solitaire (*Myadestes melanops*)

The preformative molt is variable, with zero to six inner greater coverts replaced, and the primary coverts and rectrices retained. Occasionally juvenile body plumage is also retained during the preformative molt. Juvenile (unknown) individuals have heavy buff-spotting, body washed sooty-gray to grayish-olive above, and wing coverts are tipped buff (Stiles & Skutch 1989).

Formative (unknown) plumaged birds retain primary and outer greater coverts which often contrast distinctly with replaced inner greater coverts (sometimes tipped buff). The retained rectrices are narrow, often worn, with limited amounts of white on the outer rectrices (relative shape is often hard to differentiate between age classes, therefore, wing coverts are best aging criteria). If present, patches of retained juvenile body feathers are buffy and usually located on the back and flanks.

Definitive (unknown) individuals can be characterized by uniform-gray body plumage,

and wing coverts that are uniform in wear. Definitive (unknown) rectrices are typically broad and truncate, with an extensive amount of white on the outer rectrices. Sexes are similar in all plumages.

Orange-billed Nightingale-Thrush (*Catbarus aurantirostris*)

The preformative molt is variable, with one to seven inner greater coverts replaced. Rectrices and tertials are also probably retained during the preformative molt. Juvenile (unknown) individuals have buffy-edged back feathers, dull-olive breasts, and a mostly black bill.

Formative (female) plumaged birds retain a variable number of outer greater coverts (often hard to determine). Formative (female) plumaged birds can also be characterized by retained rectrices which are often noticeably more worn, tapered, and washed brownish. The culmen of formative plumaged (female) birds is mostly-dusky (rarely mostly-orange). Formative (male) plumaged birds have similar criteria to formative (female) birds, except the male culmen is mostly bright orange.



FIG. 1. Definitive-plumaged male *Mionectes olivaceus*. Note lack of contrast between visible primary coverts and greater coverts and deeply notched 9<sup>th</sup> primary.

Definitive (female) plumaged individuals can be characterized by having no contrast within the greater coverts, and truncate rectrices. The base of the culmen in definitive (female) birds is mostly dusky. Definitive (male) plumaged birds are similar to definitive (female) except the culmen is mostly bright orange.

Slaty-backed Nightingale-Thrush (*Catbarus fuscater*)

The preformative molt is variable, with replacement of one to four inner greater coverts. The alula and central rectrices are also retained during the preformative molt. Juvenile (unknown) birds are extensively-washed brownish in the chest and throat.

Formative (unknown) individuals have several retained outer greater coverts which are dull-black contrasting with jet-black

replaced inner greater coverts; primary coverts dull black. Rectrices are tapered, often worn, and sometimes with a slight brownish wash; retained remiges are often with slight brownish wash.

Definitive (unknown) individuals have lustrous-black coverts that do not contrast in wear; rectrices are broad and truncate. Sexes are similar in all plumages.

Pale-vented Thrush (*Turdus obsoletus*)

The preformative molt is variable, with one to all inner greater coverts replaced. Tertials and rectrices are retained during the preformative molt. Juvenile (unknown) individuals have buffy spotting on the breast and extensive buffy-tipping in the wing coverts.

Formative (unknown) plumaged individuals typically have retained outer greater coverts which are shorter and often tipped



FIG. 2. Formative-plumaged *Thryothorus rufalbus*. Note replaced tertials and inner-greater coverts contrast with retained and 'less-densely' barred juvenile feathers (photo by P. Pyle).

buff. Some retained median and lesser coverts are often tipped buff. Retained rectrices are often narrow and relatively worn.

Definitive (unknown) plumaged individuals have greater coverts uniform in wear, color, and length. Definitive rectrices are broad and truncate, with an extensive amount of white on outer rectrices. Sexes are similar in all plumages.

#### Tawny-capped Euphonia (*Euphonia anneae*)

The preformative molt includes greater coverts but no rectrices. Museum specimens suggest a limited to partial prealternate molt. Juvenile (unknown) birds are dull olive-green above, washed with dark gray on the crown and nape. Juvenile flanks are dull olive, with the throat grayish olive and the belly grayish-buff (Stiles & Skutch 1989).

Formative (female) plumaged individuals have primary coverts thinly edged greenish, often worn and tapered. The retained rectrices are often worn, tapered with greenish extending to the rachis (on center rectrix) and the forehead patch is often yellow to rarely orange. Formative (male) plumaged birds rarely have mixed (blotchy) female-type and male plumage. Typical plumage includes definitive male-like body plumage with retained primary coverts edged greenish-yellow, and relatively worn. Formative (male) plumaged individuals have retained rectrices which are tapered, often worn, and thinly edged blue. Sometimes two to three outer greater coverts are retained.

Definitive (female) plumaged individuals have primary coverts with green lining. Definitive (female) rectrices are steely-gray with a

green-wash that rarely reaches the rachis (on center rectrix); outer rectrices are steely-blue with distinct green edging. Definitive (female) forehead patch is deep orange. Definitive (male) plumaged individuals have deep-blue edging on primary coverts, which do not contrast in wear with the greater coverts. Definitive (male) rectrices are broad, and distinctly edged blue.

Slate-throated Whitestart (*Myioborus miniatus*)

The preformative molt is similar to temperate Redstart counterparts; it includes all lesser coverts, median coverts, and a variable number of greater coverts and tertials. The central rectrices are retained during the preformative molt. Juvenile (unknown) plumaged birds are washed brown with spotting on back, crown, and throat. Juvenile greater coverts are tipped brown to buff, the crown lacks red. Juvenile head patterns can be characterized by having no or a limited amount of black in the face, throat, and crown.

Formative (unknown) plumaged birds have retained primary coverts, with no distinct edging or slightly edged bluish gray, often contrasting in wear with replaced greater coverts. Several outer greater coverts are often retained (sometimes tipped brown), contrasting with replaced greater coverts (often lined gray with no tipping or occasionally tipped white to gray). Some tertials are often retained and washed brownish. Formative (unknown) individuals have retained rectrices which are tapered and often relatively worn.

Definitive (unknown) plumaged birds show no contrast between uniform, lined blue-gray primary coverts, and greater coverts (often tipped white). Definitive (unknown) rectrices are fresh and truncate relative to formative plumaged individuals. On average, definitive (unknown) plumaged individuals have more black in throat, auriculars, and margin of crown patch. The orange breast patch is often brighter in definitive (unknown)

plumaged individuals relative to formative (unknown) plumaged birds.

Chestnut-capped Brush-Finch (*Arremon brunneinucha*)

The preformative molt includes some to all greater coverts, with the tertials and rectrices being retained. Banding data suggests that a prealternate molt may occur in some individuals. Juvenile (unknown) individuals have body feathers washed brownish, with brown streaking on chest, and no strong contrast between crown and back. Juvenile (unknown) individuals can also be characterized by a brownish throat and buff-tipped greater coverts.

Formative (unknown) birds retain juvenile primary coverts which appear brownish and often worn, with little or no greenish edging, thereby contrasting indistinctly with replaced inner greater coverts. Retained outer greater coverts in formative (unknown) plumaged birds are often tipped buff.

Definitive (unknown) individuals have uniform primary and greater coverts which appear dusky and often fresh, with greenish-yellow edging. Definitive rectrices appear broad and truncate relative to formative plumaged birds. Sexes are similar in all plumages.

## DISCUSSION

Our species accounts and subsequent results indicate that ten resident highland tropical species adhere to molt sequences commonly found in temperate landbird species (Pyle 1997, Howell *et al.* 2003) and other resident tropical avifauna (Dickey & van Rossem 1938, Pyle *et al.* 2004, DuVal 2005, Doucet *et al.* 2007, Ryder & Wolfe 2009, Wolfe *et al.* in press). Due to the ubiquitous nature of a partial preformative molt among our study species, each species treated in this study can be accurately placed into discreet age and plumage classes using age-related molt-based crite-

ria. Complete preformative molts were not found among the ten study species, while prealternate molts appear to be rare (possibly occurring in two species), and presupplemental molts remained undetected.

Although our data provide initial age-related plumage characteristics for ten resident Neotropical species, our results remain preliminary and tentative in nature. Due to low sample sizes and temporally restricted field seasons, our results and subsequent inferences serve two limited functions: 1) the formation of a basis for studying molt ecology and gender-specific differences among resident highland species, and 2) providing a tool for field ornithologists to accurately place birds into discreet age and plumage classes. We encourage the publication of similar efforts in order to further our understanding of molt ecology and promote a synthesis of data pertaining to age and sex criteria of resident tropical bird species.

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