# Using Wing Molt to Age Passerines[1]

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## INTRODUCTION

The discovery that the plumages and molts of young passerine birds are frequently different from those of adults, and the first adequate description of those differences, is generally attributed to Dwight (1900). Subsequent studies have further detailed these differences for a variety of North American passerines: e.g., various corvids (Pitelka 1945, 1958; Mewaldt 1958; Bancroft and Woolfenden 1982); Phainopepla *(Phainopepla nitens)* (Miller 1933); Loggerhead Shrike *(Lanius ludovicianus)* (Miller 1928); White-eyed Vireo *(Vireo griseus)* (George 1973, Thompson 1973, Lloyd-Evans 1983); various parulines (Foster 1967, Ewart and Lanyon 1970, Phillips 1974); Northern Cardinal *(Cardinalis cardinalis)* (Scott 1967, Wiseman 1977, Yen 1989); various buntings *(Passerina* spp.*)* (Rohwer 1986, Thompson 1991, Young 1991); Dark-eyed Junco *(Junco hyemalis)* (Yunick 1981); various icterids (Baird 1958, Selander 1958, Selander and Giller 1960); and House Finch *(Carpodacus mexicanus)*(Michener and Michener 1940, Stangel 1985). However, the general usefulness of such molt information to banders for determining the age of these and many other passerine birds is not widely known (but see Yunick 1984, Pyle et al. 1987).

For field ornithologists, the likelihood of age-related differences in survivorship (e.g., Woolfenden and Fitzpatrick 1984), habitat selection (e.g., Ficken and Ficken 1967), reproductive success (e.g., Hill 1988), foraging behavior and success (e.g., Breitwisch et al. 1987), migratory behavior (e.g., Ketterson and Nolan 1985), social dominance (e.g., Ketterson 1979), and morphology (e.g., Mulvihill and Chandler 1990), should make the recognition of age classes especially desirable. In fact, age is probably an important, though underappreciated, confounding variable in many studies of birds.

This article describes in detail the use of wing molt differences between adult (older than one year) and immature (up to one year old) passerines as a means for distinguishing these two age classes from early fall through late summer. In banding terminology, known immature birds are called "hatching year" (HY) until the end of the calendar year in which they hatched, and "second year" (SY) in the following calendar year. The corresponding adult age categories are "after hatching year" (AHY) and "after second year" (ASY). More details about the age codes used in banding can be found in the North American Bird Banding Manual (Vol. 1), jointly published by the U.S. Fish and Wildlife Service and the Canadian Wildlife Service. The names for the molts and plumages discussed in this paper follow the terminology of Humphrey and Parkes (1959).

## MOLTS, PLUMAGES, AND FEATHER GENERATIONS

With few exceptions, immature songbirds undergo an incomplete first prebasic molt (=postjuvenal molt in the older literature) before migrating in the fall; adults ordinarily have a complete prebasic molt (=postnuptial molt in the older literature) that takes

[1]A version of this paper was given as a handout to participants in a molt workshop at the annual meeting of the Eastern Bird Banding Association at State College, Pennsylvania, in 1992.

place either on the breeding grounds or the wintering grounds (Dwight 1900, Svensson 1984). Since the first prebasic molt of most passerines is incomplete, the wing plumage (the entire feathering of the wing) of HY and SY birds is generally composed of two feather generations (the first basic feathers and any retained juvenal feathers), while the comparable adult plumage is made up of a single feather generation (second or definitive basic feathers).

In a few cases, the situation is a bit more complicated. In Indigo *(Passerina cyanea)*, Painted *(P. ciris)*, and Lazuli buntings *(P. amoena)*, and probably some other emberizids, an incomplete presupplemental molt may occur after the first prebasic molt; this ordinarily replaces any recently molted basic wing feathers, as well as more of the juvenal wing feathers (Rohwer 1986, Thompson 1991, Young 1991). Thus, the two wing feather generations in some immature buntings in the fall are the supplemental and the juvenal. In buntings and several other passerines, the prealternate molt (=prenuptial molt in the older literature) may add a third feather generation to the wing plumage of immatures before spring and a second generation to that plumage in adults.

Importantly, regardless of any intervening molts, immatures of most passerines will retain some juvenal wing feathers between their first (incomplete) and second (complete) prebasic molts, or roughly for their first year of life.

## RECOGNIZING RETAINED JUVENAL FEATHERS

The number of juvenal wing feathers that are retained following the first prebasic and other incomplete molts is highly variable, both among and within species. Differences in the appearance of retained juvenal and molted wing feathers are also variable, ranging from very obvious to practically indiscernible (Table 1). The molt information contained in Table 1 was drawn from published studies (such as those cited in the Introduction) and extensive unpublished data taken from birds banded at Powdermill Nature Reserve. The wing feathers and feather groups referred to in the following sections are illustrated in Figure 1.

The following will help banders recognize retained juvenal wing feathers in many HY/SY birds:

1. To begin with, start with a bird known to be immature based on incomplete skull pneumatization or other criteria, and with a species characterized by fairly obvious differences between juvenal and molted feathers (i.e., species/sex with a detectability score of 0 or 1 in Table 1). Except in the most obvious cases, a bander's ability to see the differences between molted and retained wing feathers is largely determined by available light. Whenever possible, examine the bird's spread wing in very good light, even if that means getting up and moving from your banding table to a place with more light (e.g., outdoors or by a window). Direct sunlight or bright indirect light is usually the best. Artificial light sources may be helpful or not, depending on their brightness and wavelength and on the color of the feathers being examined (R. Yunick, pers. comm.). Try holding the wing horizontally, with the primaries and secondaries pointing away from you, and look at the wing feathers from above. Make sure that all the relevant feather groups are visible and reasonably well-preened. Tilt the wing up and down as needed according to the angle of your light source.

It is often helpful to examine both wings, since the incomplete molt of immature birds is frequently asymmetrical, and this asymmetry can serve to highlight the contrast between molted and retained feathers. Try to identify the exact wing feathers or feather groups that have molted and those that are retained from the juvenal plumage.

2. In general, retained juvenal feathers will appear differently or less richly colored, less lustrous, more worn and faded, and often shorter and less blunt than comparable molted wing feathers. Occasionally, retained juvenal feathers will have a different pattern than molted feathers, such as a terminal spot (e.g., the "tear drops" on some juvenal wing coverts of immature *Catharus* thrushes). Retained juvenal feathers are particularly easy to distinguish when they are mixed in with molted feathers in the same feather group, as in the case of one or more retained outer greater secondary coverts.

3. Differences in color, lustre, and wear are usually much less obvious in species with brown, greenish or light grayish wing feathers, and more obvious in species with black, dark gray or blue feathers (Table 1). Also, differences between retained juvenal and molted wing feathers generally are more difficult to see when these feathers are barred, vermiculated, or otherwise strongly patterned.

4. The areas of the wing that are most likely to show a contrast between juvenal and molted feathers are the greater secondary coverts (including the carpal covert), alula, tertials, secondaries, and primaries, in approximately decreasing order of occurrence (Table 1). This is because, at its maximum, the prebasic wing molt of most immature passerines is usually limited to the lesser coverts, the middle (or median) coverts, some number of greater secondary coverts, the carpal covert and, less often, the alula covert. A first prebasic molt that typically includes one or more tertials (the collective name for secondaries 7-9 -- see Fig. 1) and additional alula feathers occurs in fewer species. And, in fewer still, the molt may include additional inner secondaries and outer primaries (but usually not the accompanying greater primary coverts). While a small percentage of individuals in this last group may undergo a complete molt of wing feathers, only a very few species are characterized by a complete first prebasic molt (e.g., swallows [Hirundinidae], Horned Lark *[Eremophila alpestris]*, Bushtit *[Psaltriparus minimus]*, Wrentit *[Chamea fasciata]*, European Starling *[Sturnus vulgaris]*, meadowlarks *[Sturnella* spp.*]*, some *Ammodramus* sparrows, and House Sparrow *[Passer domesticus]* -- from Pyle et al. 1987).

5. For many species, birds that are observed to have retained juvenal wing feathers may be aged HY/SY, and individuals that do not show any retained juvenal wing feather may be safely aged AHY/ASY. However, in some other species, the difficulty of seeing a contrast between retained juvenal and molted feathers, the occasional occurrence (in >5% of immatures) of a complete prebasic molt, or other complications (see below) means that only well-marked HY/SY birds can be distinguished, while birds showing no obvious contrast cannot certainly be identified as adults on that basis (see Table 1).

6. In general, differences between retained juvenal feathers and those replaced during the first prebasic molt will be increasingly obvious from fall through spring, due to the comparatively much more rapid wear of the more loosely structured and less well-pigmented retained juvenal feathers.

## SOME OF THE COMPLICATIONS

1. Early-hatched juveniles frequently have a more extensive molt than later-hatched birds. Among the later-hatched birds (or in species characterized by a very late breeding season; e.g., American Goldfinch, *Carduelis tristis* -- Middleton 1977) may be individuals that failed to molt any of their juvenal wing feathers or that molted only the lesser and middle coverts (resulting in little or no contrast among wing feathers, see Table 1). Furthermore, as a consequence of their late hatching, those juvenal wing feathers may not appear very worn when the bird is examined. However, such birds will often strike the bander as being immature based on characteristics such as plumage color (e.g., House Finch, Yunick 1987), tail feather shape, or eye color. Check the skulls of such questionable birds. Because they are late-hatched, they may exhibit delayed skull pneumatization.

2. Conversely, contrast among wing feathers is not always due to the retention of juvenal feathers. Because of differences in patterns of feather pigmentation and wear, adults will sometimes show a contrast between or within feather groups sufficient for them to be mistaken as immatures. After an adult bird has worn its definitive basic plumage for several months, its greater primary coverts often appear much more worn than the adjacent greater secondary coverts, and the lower alula feather(s) may appear to be more worn than the upper one(s). It is usually in late winter or early spring when normal wear differences within and among the feather groups of adult birds can begin to create contrast like that seen in immature birds. Recognizing these birds as adults showing normal wear of their feathers will require experience. However, despite the appearance of contrast among feathers, banders will have difficulty in

determining where the apparently incomplete molt began and left off in such adult birds. This is because the wear differences are graded or continuous, rather than marked or "stepped." Furthermore, other characteristics, such as eye color or tail feather shape, will often make the bander suspicious of this sort of contrast among the worn wing feathers of adult birds.

3. Adults of some species may normally retain feathers during an otherwise complete prebasic molt. In species with such an "arrested" or "interrupted" definitive prebasic molt (e.g., Rose-breasted Grosbeak, *Pheucticus ludovicianus*; Cannnell et al. 1983) some inner secondaries or outer primaries may not be molted until the bird reaches its wintering grounds. In the meantime, there will be a marked contrast between the molted and unmolted wing feathers. Remember, though, that immature birds with an extensive prebasic molt that includes wing feathers other than the tertials typically will replace *inner* secondaries and *outer* primaries, which would give the reverse contrast between molted and unmolted wing feathers compared to an adult that has had an interrupted molt. Apparently, unique among passerines is the molt of adult Red-eyed Vireos *(Vireo olivaceus)*. In this species, adults usually do not molt all of their greater secondary coverts, nor any remiges (the collective term for primaries and secondaries) other than the tertials; thus, in the fall the wing of immature birds appears more or less fresh and even-aged (contrast between molted and retained juvenal wing feathers is practically indiscernible, Table 1), while that of the adults shows a marked contrast. Details of the unusual molt by adults of this species will be published shortly (Mulvihill and C. Rimmer, in prep.).

4. Adults of many other species may abnormally retain stray wing feathers following a definitive prebasic molt (e.g., Yunick 1976). Usually this retention is limited to one or a few feathers (often greater primary coverts or one or more feathers of the alula) and asymmetrical between wings (Mulvihill, pers. obs.). Such abnormally retained feathers (which have been worn since the previous prebasic molt, or for over a year) are extremely worn and contrast even more with the molted plumage than would a retained juvenal feather.

5. With regard to contrast among feathers on the wing of adult passerines, the greatest complication stems from the extensive prealternate molt of some species, particularly *Dendroica* warblers. In several of these species, both adults and immatures may molt inner greater secondary coverts and tertials on the wintering grounds, so that both age classes show a marked contrast between molted and unmolted wing feathers in the spring. In fact, this often makes it impossible to separate the age classes confidently. However, with practice, banders can learn to distinguish retained juvenal wing feathers from the molted basic feathers of adults, even though both may show contrast with feathers recently replaced during the prealternate molt.

Furthermore, the prealternate molt of immature birds frequently does not obscure differences between retained juvenal feathers and the feathers replaced during the first prebasic molt. This is because the prealternate molt typically replaces some but not all of the feathers that were replaced during the first prebasic molt. Those basic feathers not replaced will still show a marked contrast with adjacent juvenal feathers; in this case, banders may be able to see three distinct feather generations (for example: alternate feathers--some inner greater secondary coverts and possibly some tertials; basic feathers--outer greater secondary coverts, carpal covert, and alula covert; and retained juvenal feathers--greater primary coverts, lower alula feathers, and remiges other than any molted tertials).

## SUMMARY

Because most immature passerines have an incomplete first prebasic molt, they retain juvenal wing feathers until their definitive (complete) prebasic molt about a year later. During this time, immature birds can be distinguished as HY/SY by the contrasting appearance of their retained juvenal wing feathers with any molted wing feathers, and AHY/ASY birds can often be distinguished by the lack of such contrast. Differences between juvenal and nonjuvenal wing feathers range from obvious to practically indiscernible, depending on the species.

It is important to point out that other ageing techniques than the examination of wing molt are frequently more practical or useful (e.g., skulling, particularly in the fall), and that it is usually best to determine age based on a suite of characteristics (skull condition, molt, eye color, feather shape, etc.). Age determinations based on molt differences may not be acceptable to the Bird Banding Laboratory in all cases, particularly the identification of SY and ASY birds in the spring. More published studies of the timing, pattern, and extent of molt of immature and adult birds are needed. Banders are in a particularly good position to make such contributions to the literature.

Banders who want to learn more about the molts of the specific passerines that they handle should obtain copies of Dwight (1900) and Pyle et al. (1987). Both of these comprehensive works contain much useful information, but they also contain some inaccuracies and should be used with caution (see Mulvihill and Leberman 1988; Parkes 1975, 1988). A bander's own careful observations will be the best guide of all.

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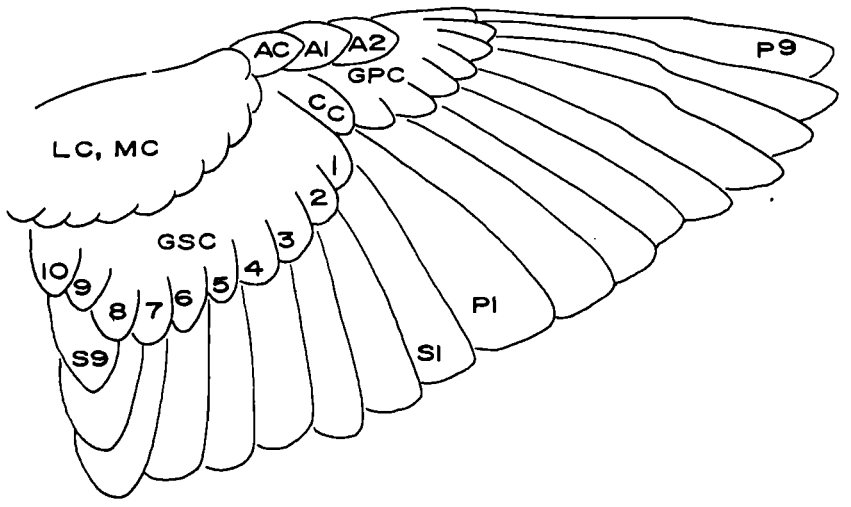


**Figure 1.** The feathers and feather groups of a representative passerine wing. Abbreviations are as follows: AC (alula covert), A1 (first alular feather), A2 (second alular feather), CC (carpal covert), GPC (greater primary coverts; usually nine in number, not seven as shown), GSC (greater secondary coverts), LC (lesser coverts), MC (middle or median coverts), P1-P9 (primaries one through nine); some passerines have a tenth primary), S1-S9 (secondaries one through nine). Secondaries 7-9 are collectively called tertials. The primaries and secondaries are collectively called the remiges.

**Table 1.** Areas of contrast (including differences in color, wear, shape and/or size) between retained juvenal feathers and molted feathers in the first basic and first alternate wing plumage of selected passerines. An "X" indicates contrast between molted feathers of that group and the unmolted feathers of adjacent groups or between molted and unmolted feathers within that group. Lower case "x" indicates that feathers are molted only rarely in that feather group. "( )" indicates contrast only for some species in a listed genus.

| Species | SC[1] | AL[2] | TT[3] | SS[4] | PP[5] | Detectability[6] | Comments |
|---|---|---|---|---|---|---|---|
| *Empidonax* flycatchers | X | X | X | X[7] | X[7] | 2-3 | |
| Eastern Phoebe | X | X | X | | | 2 | Also look for molted cent. rectrices in HY/SY birds. |
| Black-cp. Chickadee | X | X | x | | | 3 | |
| Tufted Titmouse | X | X | X | | | 2 | |
| Carolina Wren | X | X | X | X | X | 2-3 | |
| House Wren | X | X | x | | | 3 | |
| Kinglet spp. | x | | | | | 3 | |
| Blue-gray Gnatcatcher | X | X | | | | 1-2 | |
| Eastern Bluebird | X | X | X | | | 0(1-2) | |
| *Catharus* thrushes | X | X | | | | 2 | Often retains many/all SC; these do not always have"teardrop"pattern. |
| Wood Thrush | X | | | | | 2 | Often retains many/all SC.Molted SC in this species often have buffy tips, like ret. juv. SC. |
| American Robin | X | X | X | | | 1-2 | |
| Gray Catbird | X | X | X | | | 1-2 | Often retains many/all SC. |
| White-eyed Vireo | X | X | X | X | X | 2 | |
| Other vireos | X | X | | | | 2-3 | Adult Red-eyed Vireos also have an incomplete prebasic molt before leaving their breeding grounds (see text). |
| *Vermivora* warblers | X | X | (x) | | | 1-2 | |
| Yellow Warbler | X | X | X[7] | x[7] | | 1-2 | TT and some inner SC may be replaced by both AHY/ASY and HY/SY over winter. (see text). |
| *Dendroica* warblers | X | X | (X[7]) | (x[7]) | | 0-2 | |
| Bl.-and-Wh. Warbler | X | X | | | | 0-1(1-2) | |
| American Redstart | X | X | | | | 2-3 | |
| *Seiurus* warblers | X | X | | | | 2-3 | |

| Species | SC[1] | AL[2] | TT[3] | SS[4] | PP[5] | Detect-ability[6] | Comments |
|---|---|---|---|---|---|---|---|
| *Oporornis* warblers | X | X | | | | 2-3 | |
| Common Yellowthroat | X | X | X | X | X | 2-3 | |
| *Wilsonia* warblers | X | X | | | | 2-3 | |
| Yellow-breasted Chat | X | X | X | X | X | 2-3 | |
| Scarlet Tanager | X | X | X | X[7] | x[7] | 0(2-3) | |
| Rose-br. Grosbeak | X | X | X | X[7] | | 0(2-3) | |
| Indigo Bunting | X | X | X | X | X | 0(2-3) | Spring (ASY) adults may show contrast between TT and other SS. Look especially for very worn gr. prim. covs. and contrast between inner and outer PP in HY/SY birds. |
| Rufous-sided Towhee | X | X | X | x | | 0(2-3) | |
| *Spizella* sparrows | X | X | X | (X) | (X) | 2-3 | |
| *Melospiza* sparrows | X | X | X | (X) | (X) | 2-3 | |
| *Zonotrichia* sparrows | X | X | (X[7]) | | | 2-3 | |
| Dark-eyed Junco | X | X | X | | | 1-2 | |
| Blackbirds (Icterids) | X | X | X | X | X | 0-3(2-3) | Some HY of most species have a complete or nearly complete prebasic molt. Underwing covs. are often the only ret. juv. wing feathers. |
| Purple Finch | X | X | | | | 2 | |
| House Finch | X | X | X | X | X | 1-2 | Complete first prebasic molt may occur in >5% of HY in some populations (i.e., detectability may be "3" for those populations). |
| Pine Siskin | X | X | X | | | 2 | |
| American Goldfinch | x,X[7] | | | | | 1-2(2-3) | Most individuals molt only some lesser wing coverts during the first prebasic molt (but HY/SY males do not obtain an entirely bright yellow "shoulder" until the second prebasic molt). SY birds often molt some middle coverts and SC in spring. Juvenal, buffy-tipped carpal coverts apparently always retained. |

[1] **Secondary coverts** (including carpal covert): look for contrast between molted inner and retained outer greater secondary coverts or between molted greater secondary coverts and retained greater primary coverts or secondaries. The carpal covert is often molted even when several outer secondary coverts have been retained.

[2] **Alula** (alula covert and two alular feathers): look for contrast between molted upper and unmolted lower alular feathers, or between molted alula and unmolted greater primary coverts.

[3] **Tertials** (secondaries 7-9): look for contrast between molted and unmolted tertials, or between molted tertials and unmolted adjacent secondaries.

[4] **Secondaries** (other than tertials): look for contrast between molted inner and unmolted outer secondaries.

[5] **Primaries**: look for contrast between molted outer and unmolted inner primaries.

[6] **Detectability**: difficulty of distinguishing between retained juvenal and molted first basic feathers, rated on a scale of 0 (easy) to 3 (not possible in most cases). Depending on experience and available light, banders may find species more or less difficult to evaluate than the given values would indicate. Values in parentheses are for females, when these are much more difficult to evaluate than males of the same species. A rating of "0" or "1" indicates that the majority of individuals can be identified easily as either immature or adult based on wing molt; a "2" rating means that molt differences are much more difficult to see and that many birds in both age classes may not be identifiable by molt; a "3" rating means that the age class of most individuals cannot be reliably determined by molt due to the difficulty of recognizing juvenal feathers or because a large number of immatures has a complete prebasic molt (e.g., Icterids), and that typically only the most well-marked immatures can be identified.

[7] Contrast in spring birds only (i.e., after first prealternate molt).

**NOTES**