North American Bird Bander

Volume 25 | Issue 4 Article 1

2000

A Field Test of the Use of Rectrix Shape As an Indicator of Age in Some Species of Thrushes and Warblers

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ABSTRACT

Traditionally, the age of passerines has been determined in the field by the degree of skull pneumatization or, in a few special cases, by differences in overall plumage. Current age keys recommend using tail feather shape to help age many species of passerines. We examined the rectrix shape and the degree of skull pneumatization of 1987 birds during fall migration over a four-year period at Appledore Island, Maine, to investigate the ability of experienced banders to use rectrix shape in aging passerines in the field. Tail feather shape was recorded and then age was determined by the traditional means of skulling for four species of thrushes (family Turdidae) and 19 species of wood warblers (family Parulidae). When results of the two techniques were compared, 98.3% of the hatching-year birds and 86.9% of the after-hatching-year birds exhibited correspondence between the two methods; however, exact percentages varied among species. Our results indicate that rectrix shape is useful in determining age of some species of warblers and thrushes, but this method should be used with caution.

INTRODUCTION

In field research, knowing the age of a bird can be important for a variety of reasons. Birds of differing age classes may vary in survivorship, reproductive success (Lozano et al. 1996), migration rate or timing (Francis and Cooke 1990, Ellegren 1991, Woodrey and Chandler 1997), stopover time (Ellegren 1991, Morris et al. 1994, Yong et al. 1998), and relative condition such as fat load during migration (Ellegren 1991, Woodrey and Moore 1997, Yong et al. 1998). Traditionally, the age of perching birds (order Passeriformes) has been determined by the degree of skull pneumatization or by differences in plumage; for example, the color of the alula edging in Black-throated Blue Warblers (scientific names given in Table 1). Recent keys include the addition of molt limits, wear, and feather shape (e.g., Pyle 1997).

In the fall, skull pneumatization is a reliable indicator of age in many species of birds (Stewart 1972, Svensson 1984). Pneumatization is the development of bone columns between the two skull layers in a passerine, and complete pneumatization generally takes four to six months but may take up to 12 months in some species (Pyle et al. 1987, Pyle 1997). In the fall, hatching-year (HY) birds have mostly unpneumatized skulls while after-hatching-year (AHY) birds generally have completely pneumatized skulls. Skulling is less useful in the spring because in many species skull pneumatization is completed in the fall and winter, although a few species may retain small unpneumatized windows until spring or early summer.

Current age keys may also recommend using rectrix shape to age many species of passerines in both seasons. Such keys suggest that HY birds generally have a tapered or pointed rectrix shape, while AHY birds have more truncate or blunt rectrix shape (Pyle 1997). In many species of passerines, rectrices are not replaced in either the first prebasic or prealternate molt, resulting in the retention of juvenile rectrices until the second prebasic molt, after the breeding season (Pyle 1997). Thus, the difference in feather shape often can be used in both the spring and the fall depending on the timing and extent of molt in a species. Several studies have demonstrated significant differences in rectrix shape between birds in their first year and older birds by measuring the angle of rectrix tips (Meigs et al. 1983, Collier and Wallace 1989, Donovan and Stanley 1995) or width of rectrices

(Yunick 1992). A few field studies have reported investigating differences in rectrix shape including work with Willow and Crested tits (*Parus montanus* and *P. cristatus*, Laaksonen and Lehikoinen 1976), North American kinglets (*Regulus satrapa* and *R. calendula*, Fairfield et al. 1978), Wood Thrushes (*Hylocichla mustelina*; Weinberg and Roth 1994), Ovenbirds (Donovan and Stanley *1995),* Pine Siskins (*Carduelis pinus*, Yunick 1992, 1995), and Cassin's Finch *(Carpodacus cassinii*, Balph 1977). The goal of this project was to determine whether tail feather shape is a reliable indicator of age in a number of passerines in the field. Specifically, we compared tail feather shape and degree of skull pneumatization in warblers (family Parulidae) and thrushes (family Turdidae) in the fall to determine if banders could accurately use tail feather shape to determine the age of birds during the banding process.

METHODS

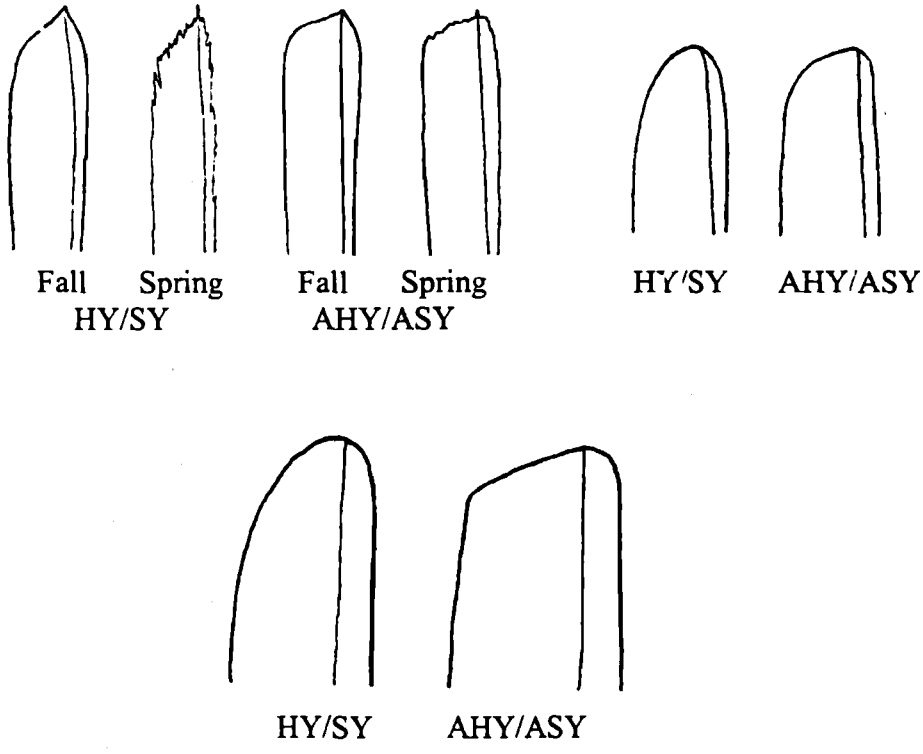
Migrant passerines were captured in mist nets during the fall migratory season on Appledore Island, Maine. For further information on the field site see Morris et al. (1994). Data were collected between mid-August and late September from 1994 to 1997. Six to ten mist nets (12 x 2.6m, 4 shelves, 30 mm mesh) were operated daily, weather permitting. The nets were opened before sunrise, closed around sunset, and checked approximately every 30 minutes during the day. Birds were brought to a central location where they were banded with a standard U.S. Fish and Wildlife Service aluminum band, and measurements and observations were recorded.

Warblers and thrushes were the focus of this study because they are common migrants on Appledore Island and because the age keys for these groups often include tail feather shape as an indicator of age (Fig. 1). Some species of warblers that were captured regularly were not included because the banders did not feel comfortable with classifying the rectrix shape for these species. Species that were not included in this study for this reason include Yellow-rumped Warbler (*Dendroica coronata*), Blackpoll Warbler (*D. striata*), Canada Warbler *(Wilsonia canadensis)*, and American Redstart *(Setophaga ruticilla).*

During the banding process, the shape of each bird's outer rectrices (generally R5 and R6) was observed and a subjective shape recorded. Tail feathers that appeared to be tapered at the tip were classified as pointed while tail feathers that appeared to be blunt were classified as such (Fig. 1). Birds that were examined but had tail feathers that could not be placed precisely into either classification by the bander were recorded as intermediate. Birds that were skulled prior to examination of tail feather shape or were not examined because of time constraints were not included in this study. After the tail feather shape was recorded, the degree of skull pneumatization was observed and recorded. The degree of pneumatization was determined on a scale of "0" to "3," with "0" indicating no pneumatization and "3" indicating complete pneumatization. Birds with a skull pneumatization score of "0," "1," or "2" were classified as HY, while birds with a score of "3" were classified as AHY. Only data from experienced banders were collected.

We determined the percentage of birds for which tail feather shape designation corresponded to the age based on skull pneumatization. We also determined the percentage of birds that were classified as intermediate; e.g., birds that we did not attempt to age by tail feather shape (Table 1). Although we did not try to have each bander observe all of the same birds, we did compare how useful this technique is with different banders. In addition to analyzing the data as a whole, we also analyzed the data for three individual banders (Table 2), thus investigating variation in the ability to use this technique in the field. To test the correspondence of skull pneumatization and feather shape, we performed Fisher's exact test (two-tailed). The Fisher's exact test tests the null hypothesis that rectrix shape is independent of skull pneumatization. Thus, if the null is rejected, we accept the alternate hypothesis that rectrix shape and skull pneumatization are associated in these species. The *P*-values we present are after sequential Bonferroni correction.

Fig.1. Variations in the shape of outer rectrices (r4 - r6) by age, indicating the difference in shape between birds in their first year and older birds (from Figure 139 in Pyle 1997, used by permission). The three pairs show some of the variation among species.



RESULTS

We examined the degree of skull pneumatization and the tail feather shape of 1987 birds, encompassing four species of thrushes and 19 species of warblers (Table 1). Overall, 98.3% of HY birds were classified as having pointed rectrices, and thus aged as hatching-year based on tail feather shape alone. When analyzed by species, we found 90% or greater correspondence in all species and among 16 species we observed 100% correspondence between recorded tail shape and skull pneumatization score (Table 1). Overall, 86.9% of the AHY birds were classified as having blunt rectrices, and thus our age designation was the same based on tail feather shape and skull pneumatization. We recorded an intermediate tail feather shape in only 1.5% of the HY birds and 4.6% of the AHY birds observed in our focal species (Table 1). Fisher's exact tests indicate that there is a strong relationship between tail feather shape and skull pneumatization among all birds ($P<0.0001$). Likewise, data collected by each of the three banders also supported a strong relationship between tail feather shape and skull pneumatization (Table 2, $P<0.001$ for each bander).

The correspondence of the two techniques in aging birds was strong in all species (Table 1), although percentages varied among species. Data from each of the three individual banders also indicate a correspondence between tail feather shape and skull pneumatization in our focal species. All of the focal species with at least five adults exhibited a significant relationship between tail feather shape

Table 1. The percent of birds aged correctly by rectrix shape. Total aged includes only those birds assigned to the pointed or blunt categories. Percent aged correctly compares these rectrix shape categories to the level of skull pneumatization (completely or partially pneumatized). Total intermediate indicates the number of birds examined that were not assigned to the pointed or blunt rectrix categories, but does not include those birds not examined.

Species	Hatching Year			After Hatching Year		
	Total Aged	% Aged Correctly	Total Intermediate	Total Aged	% Aged Correctly	Total Intermediate
Veery *(Catharus fuscescens)*	20	100.0	0	1	100.0	0
Gray-cheeked Thrush *(C. minimus)*	2	100.0	0			
Swainson's Thrush *(C. ustulatus)*	27	100.0	2	3	100.0	2
Hermit Thrush *(C. guttatus)*	28	100.0	0	1	100.0	1
Blue-winged Warbler *(Vermivora pinus)*	34	100.0	0	1	0.0	0
Golden-winged Warbler *(V. chrysoptera)*	5	100.0	0			
Tennessee Warbler *(V. peregrina)*	11	90.9	0	7	85.7	2
Nashville Warbler *(V. ruficapilla)*	77	100.0	1	3	100.0	0
Northern Parula *(Parula americana)*	21	100.0	0	3	100.0	0
Yellow Warbler *(Dendroica petechia)*	194	99.5	1	2	100.0	0
Chestnut-sided Warbler *(D. pensylvanica)*	33	100.0	1	1	0.0	1
Magnolia Warbler *(D. magnolia)*	119	96.6	3	20	85.0	1
Cape May Warbler *(D. tigrina)*	39	100.0	1	4	75.0	0
Black-throated Blue Warbler *(D. caerulescens)*	145	100.0	1	10	80.0	0
Black-throated Green Warbler *(D. virens)*	48	100.0	0	2	100.0	0
Blackburnian Warbler *(D. fusca)*	10	90.0	0			
Pine Warbler *(D. pinus)*	3	100.0	0			
Ovenbird *(Seiurus aurocapillus)*	127	99.2	0	2	100.0	0
Northern Waterthrush *(S. noveboracensis)*	471	96.8	13	77	88.3	1
Connecticut Warbler *(Oporonis agilis)*	8	100.0	0			
Mourning Warbler *(O. philadelphia)*	34	100.0	0			
Common Yellowthroat *(Geothlypis trichas)*	240	97.1	3	8	87.5	0
Wilson's Warbler *(Wilsonia pusilla)*	111	100.0	1			
TOTAL	**1807**	**98.3**	**27**	**145**	**86.9**	**8**

Table 2. The percent of birds aged correctly by rectrix shape for three individual banders. (number attempted)

Species	Hatching Year			After Hatching Year		
	% Correct Bander 1	% Correct Bander 2	% Correct Bander 3	% Correct Bander 1	% Correct Bander 2	% Correct Bander 3
Veery	100.0 (15)		100.0 (5)		100.0 (1)	
Gray-cheeked Thrush	100.0 (1)		100.0 (1)			
Swainson's Thrush	100.0 (23)		100.0 (4)	100.0 (3)		
Hermit Thrush	100.0 (28)			100.0 (1)		
Blue-winged Warbler	100.0 (9)	100.0 (21)	100.0 (4)			0.0 (1)
Golden-winged Warbler	100.0 (1)	100.0 (4)				
Tennessee Warbler	85.7 (7)	100.0 (4)		100.0 (5)	0.0 (1)	100.0 (1)
Nashville Warbler	100.0 (49)	100.0 (15)	100.0 (13)	100.0 (3)		
Northern Parula	100.0 (18)	100.0 (3)		100.0 (3)		
Yellow Warbler	97.8 (46)	100.0 (144)	100.0 (5)	100.0 (2)		
Chestnut-sided Warbler	100.0 (11)	100.0 (20)	100.0 (2)	0.0 (1)		
Magnolia Warbler	97.0 (67)	100.0 (35)	88.2 (17)	83.3 (18)		100.0 (2)
Cape May Warbler	100.0 (25)	100.0 (12)	100.0 (2)	100.0 (3)	0.0 (1)	
Black-throated Blue Warbler	100.0 (105)	100.0 (23)	100.0 (17)	87.5 (8)	0.0 (1)	100.0 (1)
Black-throated Green Warbler	100.0 (31)	100.0 (7)	100.0 (10)	100.0 (2)		
Blackburnian Warbler	100.0 (2)	85.7 (7)	100.0 (1)			
Pine Warbler	100.0 (30					
Ovenbird	100.0 (73)	98.0 (49)	100.0 (5)	100.0 (1)	100.0 (1)	
Northern Waterthrush	97.5 (197)	96.5 (259)	93.3 (15)	91.2 (34)	85.7 (42)	100.0 (1)
Connecticut Warbler	100.0 (1)	100.0 (7)				
Mourning Warbler	100.0 (9)	100.0 (23)	100.0 (2)			
Common Yellowthroat	94.1 (68)	98.1 (157)	100.0 (15)	66.7 (3)	100.0 (4)	100.0 (1)
Wilson's Warbler	100.0 (52)	100.0 (50)	100.0 (9)			

and skull pneumatization (Tennessee Warbler: $P<0.05$; Magnolia Warbler: $P<0.001$; Black-throated Blue Warbler: $P<0.001$; Northern Waterthrush: $P<0.001$; and Common Yellowthroat: $P<0.001$).

DISCUSSION

In HY birds, we found that 98.3% of the 1835 birds aged with both tail feather shape and skull pneumatization corresponded. We assumed that age was determined correctly using skull pneumatization and, therefore, that more than 98% of HY birds were aged reliably using tail feather shape. In AHY birds, 86.9% of the 152 birds captured showed correspondence between tail feather shape and skull pneumatization. This suggests that we are able to age reliably more than 86% of AHY birds in the field using tail feather shape. These results from banders in the field (> 85% concordance between using tail feather shape and skulling) are similar to the results of Weinberg and Roth (1994), who found that experienced banders could age 80-95% of Wood Thrushes, and Collier and Wallace (1989), who found that reliability of rectrix shape in *Catharus* thrushes was supported strongly by other accepted aging criteria. Likewise, Donovan and Stanley (1995) used image analysis software to determine rectrix shape of Ovenbirds and had 90% correct classification.

Several authors caution against the use of tail feather shape as the sole method of aging passerines (Svensson 1984, Pyle et at. 1987, Jackson 1992, Pyle 1997). This caution is consistent with the Bird Banding Laboratory's policy that any age and sex criterion must be at least 95% reliable to be acceptable. In some species, rectrix shape may be difficult to determine. For example, Jackson (1992) reports pointed rectrices in an after-second-year (ASY) Firecrest *(Regulus ignicapilis)* and Balph (1977) cautions against aging Cassin's Finches with intermediate rectrix shapes. Yunick (1995) found that after birds with intermediate shapes were excluded, rectrix shape (pointed or rounded) was consistent with other aging criteria for over 98% of both second-year (SY) and ASY Pine Siskins. Our results indicate that although tail feather shape is not a totally accurate method of determining age, it certainly is a potentially useful one in both warblers and thrushes, and in some species meets the 95% reliability standard. These results are similar to the study by Fairfield et at. (1978) on North American kinglets. Knowing that banders can use this method reliably in the field is particularly valuable when some other methods are unavailable (e.g., species with complete pneumatization early in the fall).

One problem using tail feather shape is variation between species in general rectrix shape. For example, Yellow-rumped Warblers and Blackpoll Warblers appear to have naturally blunt tail feathers and neither species was included in this study for this reason. On the other hand, some passerines naturally have more pointed tail feathers than others. This could result in the misclassification of an AHY bird as a HY bird, especially among banders with little experience with these species. On Appledore Island, the banders have noticed that Blue-winged Warblers appear to have highly pointed tail feathers. We only had a sample size of 1 for AHY Blue-winged Warblers and further study is needed to determine if the highly pointed tail resulted in the misclassification. Additionally, feather shape is not useful in birds with replaced tails. Juveniles that have lost tail feathers will grow replacement feathers that are likely to be blunt in shape (Pyle 1997). The presence of replacement tail feathers could also result in a misclassification of HY birds as AHY birds.

The birds used in this study were all banded by experienced banders. This attempted to control for the misclassification of tail feather shape and skull pneumatization, by attempting to remove inexperience as a confounding factor in our data. However, inexperience with a particular species may be a confounding factor for species that were not encountered regularly on Appledore Island. Although each of the banders in this study was experienced in skulling, mistakes in skull designation could also confound our results. Likewise, because most banders were working with recorders, mistakes in recording particular details could have resulted in some of the misclassifications. These two problems of skulling and recording accurately may have been

responsible for some of the differences between the two methods, and thus the rectrix-shape method may be even more reliable than indicated.

The percent correctly aged of AHY birds was 86.9% compared to 98.3% of the HY birds. This may have resulted from the much smaller sample size of AHY birds. The data collected were substantially biased toward juvenile birds with 1835 juvenile and only 152 adult birds banded. In many of the species, relatively few or no AHY birds were captured and examined. For the species with only a few birds banded, further study could help determine if AHY birds of these species can be aged reliably by rectrix shape.

Ageing passerines with tail feather shape is not 100% accurate and should be used with caution, particularly with species encountered infrequently or in low numbers. This ageing technique is best used in conjunction with other techniques such as skull pneumatization, molt limits, and overall plumage colors and patterns. By combining multiple methods of age designation, it is likely that banders can have confidence in their age categorization, even in the absence of skulling in the spring.

ACKNOWLEDGMENTS

Canisius College supported this research with faculty development grants and fellowships to SRM, as well as funding student travel for MTB. This manuscript benefitted greatly from the review and comments of Charles M. Francis, Robert P. Yunick, and two anonymous reviewers. The Shoals Marine Lab generously provided transportation to the island, logistical support on the island, and financial support to the Appledore Island Migration Station. We are very grateful to Mary Wright and David Holmes who were two of the banders who ran the banding station and contributed rectrix shape data to this project. We would also like to thank the many people who assisted at the Appledore Island Migration Station during this study, especially Carol Cushing, Dorothy Fitch, Anthony Hill, Rozzie Holt, Mac McKenna, John Munier, and Becky and Mark Suomala. Finally, we are grateful to the staff of the Shoals Marine Laboratory who made the many weeks on Appledore Island possible and very enjoyable. This is contribution #102 of the Shoals Marine Lab and contribution #5 of the Appledore Island Migration Station.

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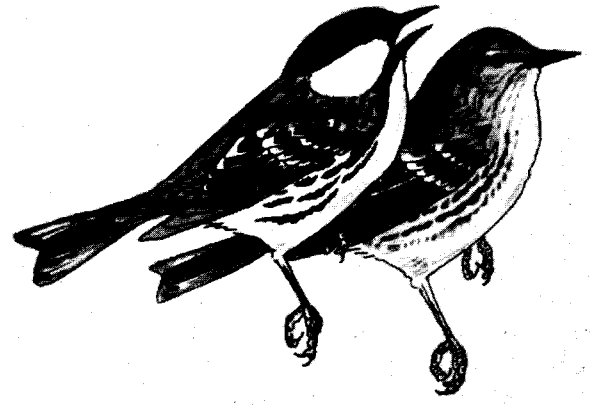

Blackpoll warblers by George West