SHORT COMMUNICATIONS

J. Raptor Res. 26(3):189–191

EYE COLOR OF COOPER'S HAWKS BREEDING IN WISCONSIN

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Several authors have noted the progressive changes in eye color with age in North American accipiters (Grossman and Hamlet 1964, Meng 1951, Snyder and Snyder 1974). These changes are believed to proceed from shades of yellow in younger birds to shades of orange or red in older birds. Snyder and Snyder (1974) suggested that these changes in eye color are also associated with gender and speculated about the function of eye color. Here we use the eye color recorded during 377 captures of breeding Cooper's Hawks (*Accipiter cooperii*) in Wisconsin (1980–91) to examine eye color in relation to age and gender. We also discuss our results in relation to breeding quality in males.

STUDY AREA AND METHODS

We trapped breeding Cooper's Hawks at 105 separate nesting areas (Rosenfield and Bielefeldt 1992) throughout Wisconsin during 1980–91. We caught 253 different individuals (113 males and 140 females) and retrapped some of the same birds a total of 124 times in subsequent years. Most Cooper's Hawks were trapped near their nests in mist nets (3 × 12 m) using a live Great-Horned Owl (*Bubo virginianus*) as a decoy (Hamerstrom 1963). We also caught hawks in bow nets baited with European Starlings (*Sturnus vulgaris*) and Ring Doves (*Streptopelia risoria*).

Forty-two captures involved birds of known age: 1 yr old individuals in predominantly brown plumage (N = 17); 2 yr old individuals (all males) with two generations of gray feathers, plus a few retained brown feathers on rump and/or scapular areas (N = 4); 2 or 3 yr old individuals originally marked as nestlings (Rosenfield and Bielefeldt 1992; N = 5); and 16 recaptures of the above individuals in later years. The remaining 335 captures involved 227 individuals of unknown initial age (ASY birds ≥2 yr of age) and 108 recaptures of these individuals (A3Y, A4Y, etc.) in subsequent years.

Captures of males at a given nesting area are also divided between the initial individual trapped on an area (N = 82) and subsequent individuals (replacement males) trapped on the same area in later years (N = 31). We assumed that eye colors in our sample of initial male individuals on these 82 different nesting areas represented the actual proportion of various eye colors within the breeding population in Wisconsin.

We determined the predominant color over the major part of the iris using the following categories in the color chart in Palmer (1962): yellow, orange-yellow, orange, scarlet-orange, and scarlet. Hereafter we regard orange-yellow, scarlet-orange, and scarlet as light orange, dark orange, and red color categories, respectively. In calculat-

Table 1. Iris color of known-age Cooper's Hawks breeding in Wisconsin.

AGE IN YEARS	EYE COLOR CATEGORIES				
		LIGHT		DARK	
	YELLOW	ORANGE	ORANGE	ORANGE	RED
Males (N = 29 captures)					
1	2	8	0	0	0
2	0	3	5	0	0
3	0	2	3	1	0
4	0	0	2	2	0
5	0	0	0	0	1
Females (N = 13 captures)					
1	6	1	0	0	0
2	0	2	0	0	0
3	0	1	0	0	0
4	1	0	1	0	0
5	0	0	0	1	0

Table 2. Iris color of "relative-age" Cooper's Hawks breeding in Wisconsin. Relative-age birds are after second year birds (ASY), and recaptures of these individuals (A3Y, A4Y, etc.) in subsequent years.

	Eye Color Categories						Mean Eye Color Score
Relative Age	1 Yellow	2 Light Orange	3 Orange	4 Dark Orange	5 Red	Total	
Males (N = 155 captures)							
ASY	0	14	37	26	19	96	3.5
A3Y	0	1	13	18	4	36	3.7
A4Y	0	0	4	5	6	15	4.1
A5Y	0	0	0	1	4	5	4.8
A6Y	0	0	0	0	2	2	4.7
A7Y	0	0	0	1	0	1	
Females (N = 180 captures)							
ASY	7	43	58	21	2	131	2.8
A3Y	0	7	12	4	1	24	3.0
A4Y	0	3	4	2	1	10	3.1
A5Y	0	0	5	2	0	7	3.3
A6Y	0	0	5	1	0	6	3.3
A7Y	0	0	1	1	0	2	

ing mean eye color scores for hawks in a given age category, we assigned corresponding numerical scores of 1–5 for yellow through red eyes, respectively. Clutch size was determined in 1980–91 by climbing to nests in mid-late incubation (typically about mid-May in Wisconsin).

Results and Discussion

In both sexes eye color showed a progressive change from lighter shades of yellow in younger birds to darker shades of orange or red in older birds (Tables 1, 2). However, 1 yr old males had significantly darker eyes, usually light orange, than 1 yr old females did, which are usually yellow ($\chi^2 = 6.51$, $P < 0.05$). Although our data on females did not allow further statistical comparisons of eye color between the sexes for known-age hawks, at relative ages from ASY through A7Y males always showed a markedly higher mean eye color score than females of the same relative age (Table 2). Thus the initial gender disparity in eye color in yearling hawks not only persisted in older birds, but also increased with relative age (Table 2).

Males that were 2–5 yr old were very unlikely to have yellow eyes, while males that were 4–5 yr old were not likely to have light orange eyes. Conversely, it seemed that most males did not attain their red eyes until ≥5 yr of age.

In both sexes, detectable changes in eye color appeared to cease once the birds were about 5 yr old (Table 2). Asymptotes seem to occur at the same relative age for both sexes, but females reached their asymptote at markedly lower scores than did males (3.3 vs. 4.7; Table 2). Evidently, some females did not achieve red eyes, at least at ages up to A7Y.

Our data on male ages and eye colors were also useful in examining the possibility that preferential mating occurs on the basis of eye color in males, as suggested by Snyder and Snyder (1974). Our information from ASY captures suggests that about 20% of breeding male Cooper's Hawks in Wisconsin had red eyes (Table 2). However, this sample of ASY birds may have been skewed toward males with lighter eyes because it included replacement males at some nesting areas; such replacements could predominantly have been younger males with lighter eyes. We thus compared eye color in individual males initially captured on 82 nesting areas with eye color in

Table 3. Iris color of initial and replacement male Cooper's Hawks at 82 nesting areas in Wisconsin.

	Eye Color Categories						Mean Eye Color Score
	1 Yellow	2 Light Orange	3 Orange	4 Dark Orange	5 Red	Total	
Initial	1	18	24	21	18	82	3.5
Replacement	1	7	17	5	1	31	2.9

Table 4. Clutch size by eye color category for breeding male Cooper's Hawks in Wisconsin.

COLOR CATEGORY	N	$\bar{x}$	RANGE
Yellow	1	4.0	NA
Light Orange	12	4.25	3–6
Orange	45	4.40	2–5
Dark Orange	28	4.28	2–6
Red	19	4.68	4–5

replacement males at 31 of these areas. Initial males did show a greater proportion of red eyes than replacement males (22% vs. 3%) and initial males had higher mean eye color scores than their replacements (Table 3). Therefore, we regard the 22% figure as the actual proportion of red-eyed males in the breeding population.

Snyder and Snyder (1974) hypothesized that red eyes "could be a good indicator" of the age and quality of a male and that "hunting skills may improve progressively over the lifetime of a bird." They postulated that birds with the darkest red eyes might have the greatest success in obtaining mates. If older, darker-eyed males are indeed higher quality mates and more proficient hunters than younger, lighter-eyed males, there should be fitness differences related to eye color.

We suggest that a revealing test of male quality should be clutch size. Males provide virtually all the food to their mates in the pre-incubation period (Rosenfield et al. 1991), a time in which both prey abundance and vulnerability are presumably at their lowest levels during the breeding cycle. This role as principal supplier of prey, as well as the males' relative hunting skills in the pre-incubation period, should be manifest in the pair's clutch size. Although males with red eyes had the largest mean clutch size (Table 4), there was no statistically significant difference in clutch size among the eye color categories (median test $\chi^2 = 5.02$, df = 3, $P > 0.05$). Therefore we found no support for the premise that male fitness is associated with male eye color. Finally, if the darkest red eyes were associated with male quality, we could expect selection for a proportion of red-eyed males much higher than the 22% we found in the Wisconsin breeding population.

RESUMEN.—Hemos examinado las relaciones entre edad, sexo, vigor de los machos (i.e., número de huevos en el nido), y el color de los ojos, en 253 gavilanes de la especie *Accipiter cooperii*, durante el ciclo de reproducción, en Wisconsin, desde 1980 a 1991. En ambos sexos el color de los ojos mostró un cambio progresivo que va del amarillo claro, en gavilanes jóvenes, al anaranjado obscuro ó al rojo, en aves de más edad. Los machos tuvieron ojos más obscuros que las hembras de la misma edad. No hemos encontrado justificación a la hipótesis que sostiene que el vigor de los machos está asociado con el color de los ojos. No hubo diferencias en los tamaños de las nidadas que estuvieran en relación con categorías en el color de los ojos.

[Traducción de Eudoxio Paredes-Ruiz]

ACKNOWLEDGMENTS

It is with great pleasure that we acknowledge the guidance and support of Frances and Frederick Hamerstrom, for it was primarily because of their strong urging that we began trapping breeding Cooper's Hawks 12 yr ago. We thus regard results herein as a tribute to their foresight. Many organizations and individuals have helped in financial and other ways with our research. We especially thank the Wisconsin Department of Natural Resources, the University of Wisconsin at Stevens Point, the Madison, Milwaukee and Lakeland Audubon Societies, and C. and M. Nelson. R.K. Anderson and R. Jurewicz have provided long-term support for our study. This manuscript was improved by the comments of K. Bildstein and D. Evans, and the statistical advice of E. Anderson. D. Snyder typed various drafts of this manuscript. The Personnel Development Committee at the University of Wisconsin–Stevens Point provided support for publication.

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Received 23 March 1992; accepted 26 May 1992