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RED-WINGED BLACKBIRDS: II. PIGMENTATION IN EPAULETS OF FEMALES<sup>1</sup>

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*Abstract.* This study describes color changes in upper secondary coverts (epaulets) of female red-winged blackbirds (*Agelaius phoeniceus*) in successive molts. The methods used included Munsell color chips and microscopic examination of feathers. Examination of feathers collected from these upper secondary coverts showed color pigments distributed in barbs and barbules of distal feathertips. Yellow pigments predominated in juvenile and first-winter females and orange and rust in second-winter and older birds. Rust color resulted from dark hamuli on orange barbules; in the absence of melanin in hamuli the feather appeared orange. No appreciable color changes appeared after the second winter plumage. Females with pure red feathers were not found among the redwings studied. Effect of diet on pigmentation could not be ascertained by the methods used.

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Since field workers commonly use epaulet color to estimate the ages of male redwings, I proposed a similar system for aging female redwings (Miskimen 1980). In the case of females, there is some difficulty in making clear distinctions between colors. Not only are color descriptions subjective, but the feathers are refractive to light and colors seem to change with light intensity and quality as well as angles of observation. Color variations are continuous, not discrete. For example, I found difficulty in distinguishing dilute rust from rust and rusty from orange. In this paper I attempt to standardize the descriptions of colors and to relate the colors described to structures and pigments in individual feathers.

## METHODS

Newly-fledged female redwings (n=24) were caught in a decoy trap on South Bass Island, Ohio (18 in the summer of 1973, the others in 1974 and 1975). They were held in a large outdoor flight cage, described by Miskimen (1980) and caught periodically for examination and collection of feather samples. I used a set of Munsell color chips to match with the feathers (Munsell 1961). In the Munsell system, each color is given 3 descriptive dimensions: hue, determined by the wave length of the pigment reaction; value, the degree of darkening; and chroma, the concentration of pigment. Each

quality is assigned a numerical series of variation, and each color chip carries an identifying group of numbers recorded as hue/value/chroma. I matched a Munsell color chip to the extended right wing of each bird to obtain an overview impression of color. Next, I removed 5 or 6 adjacent feathers from the same area and taped them to an identifying file card. Later, I examined the feather samples with a dissecting microscope, matching the samples with color chips and recording the Munsell formula of each chip. Finally, I examined samples of barbs and barbules with a compound microscope, using incident light to determine pigment distribution. Although this study does not include male redwings, I have included data from epaulet feathers of the study skin of one adult male for comparison.

## RESULTS

The proximal part of each epaulet feather was gray, a few pale, down-like barbs succeeded by the darker web. Melanin granules appeared in pith chambers in the lightest barbs, but the darkest portions of the feathers were uniformly dark; only the distal 1 or 2 mm of the feathers were yellow or orange. Yellow and orange colors were distributed evenly through the feather medullae. Although each sample consisted of 5 or more feathers originally adjacent, all were not the same color, and colors on opposite sides of the same feather were sometimes different. The following descriptions refer to the predominant appearance of the

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TABLE 1  
*Epaulet colors of red-winged blackbird females related to molts.*

Age	Epaulet	Wing		
		Barbs	Barbules	Hamuli
Juvenile 1st winter	buff	pale yellow	pale yellow	colorless
	dilute	pale to deep yellow	pale yellow	dark
2nd winter	gold	pale or deep yellow	pale yellow	absent or colorless
	rust	orange	deep yellow	dark
3rd and 4th winter	orange	orange	orange	absent or short, orange
Adult male (n=1)	red	red	red	absent*

\*May be absent due to storage wear.

whole epaulet and to the brightest region of a sample of feathers, the two being essentially the same.

Yellow pigment appeared typically in small amounts in juvenile redwing females and increased somewhat in the first winter plumage acquired in late summer or fall (table 1). In most young birds, the hamuli acquired dark pigment (melanin) at this time, giving them a dilute rusty appearance. In a few birds, the hamuli remained colorless or were absent, resulting in a gold color. At the molt in late summer or fall of the second year, orange feathers predominated in the feather tips. If the hamuli were absent

or colorless, the epaulet appeared bright orange; if the hamuli were dark-pigmented the appearance was rusty.

The results of matching feathers with the Munsell color chips are shown numerically in table 2. In juvenile birds, colors ranged from 2.5Y to 5Y with 2.5Y the median. First-winter birds also had median hue of 2.5Y, but older birds had medians in the YR range, subjectively orange. The value, or darkness, varied little with age. Medians were 6 or 7, in the middle of the 1 to 9 range from black to white. The chroma, or color saturation, increased from juvenile 6 to first winter 10, and from first winter 10 to

TABLE 2  
*Epaulet colors of female red-winged blackbirds as expressed by the Munsell system (1961).*

Chronological age	Description	Sample size	Hue*	Value**	Chroma†
Juvenile	buff	6	2.5Y (2.5Y-5Y)	6 (6-8.5)	6 (5-12)
1st winter	dilute gold	22	2.5Y (7.5YR-5Y)	7 (5-9)	10 (4-14)
2nd winter	rust, orange	21	7.5YR (2.5YR-2.5Y)	6 (5-9)	12 (6-13)
3rd winter	rust, orange	19	5YR (7.5YR-10YR)	7 (5-8)	12 (8-16)
4th winter	rust and orange	13	7.5YR (2.5YR-10YR)	7 (5-9)	12 (6-18)
Adult male	red	1	5R	4	12

\*Hue (light wave), scale 1-18 with letter: R=red, Y=yellow, YR=yellow-red (orange), mean (range).

\*\*Value (melanin concentration), scale 1 to 9, 1=black, 9=white, mean (range).

†Chroma (pigment concentration), scale 1 to 18, 1=dilute, 18=concentrated, mean (range).

second winter 12. Thereafter, the median chroma remained at 12 through the third and fourth winters.

#### DISCUSSION

The captive redwing females used in this study were all hatched on South Bass Island. Presumably they were a small, representative sample of the Island breeding population having similar genetic make-up. Mixed wild bird seed was included in the diet of the caged birds, but after capture they had no access to insects. Their diets differed somewhat in this respect from diets of other Island redwings. The results must therefore be qualified by the fact that with respect to diet, the captives were like the general population only during the first few weeks of life.

My observations showed that small amounts of yellow pigment were present in fledglings, that the concentration of pigment increased at the molt to first winter plumage, and change from yellow to orange occurred usually at the molt to second winter plumage, in the second summer. According to Rawles (1961 p. 219) color pigments are derived from lipochromes circulating in the blood in dissolved fat. They are deposited in feathers as keratinization proceeds. Orange color results from a mixture of red and yellow lipochromes. In my birds, therefore, lipochrome synthesis not only increased during the first year but the proportion of red to yellow lipochromes increased at the same time, showing up at the molt in the second summer. These birds showed no further change in color after the second winter plumage. This could be related to inherent metabolic factors or to diet. Rawles (1961) states that pigments are synthesized in plants and transformed in animals; therefore, quality of pigment in redwings may be diet related, as Brush and Power (1976) found to be the case in house finches (*Carpodacus mexicanus*).

Redwing females with bright red epaulets have been reported by various observers, and I have records of a few captured on South Bass Island during fall migrations. These latter were adults of unknown origins and ages. Meanley and Bond (1970 p. 23) describe breeding adult

female redwings from eastern United States with "shoulder patch usually crimson." Payne (1969) observed redness increasing with age in redwings and tricolored blackbirds (*Agelaius tricolor*) in California:

"Females of both species can be aged by differences in plumage. The lesser marginal coverts (=epaulets) of the upper surface of the wing of young females which have unpneumatized areas in the skull and a bursa generally lack any trace of red, while adult females usually have either a few orange feathers in this tract, or more often, red or reddish-brown feathers" (p. 57).

It appears that red and yellow pigments in redwing females increase with age, becoming apparent in feathers of the first and second winters, and that the ratio of red to yellow pigment also increases with age. The metabolism responsible for the increased proportion of red pigment is genetically controlled, but to what extent this may be influenced by diet was not determined by this study.

The presence of red shoulder patches on females in the eastern and western parts of the United States and their near-absence on the Bass Islands may be due only to genetic differences in the breeding populations of the areas, but two lines of evidence suggest that differences in diet may influence the metabolism of color pigments:

First, male and female redwings differ in food selection. Banding records from South Bass Island show that male redwings are captured in decoy traps in greater numbers than females (Dyer and Miskimen 1974). In 1969, the ratio of banded hatching year (HY) males to HY females was 3:1 and the ratio for after hatching year (AHY) was 9:1. In 1970, the ratios were 2:1 and 7:1, respectively. The decoy traps were baited with cracked corn, which was apparently more attractive to males than to females (Dyer and Miskimen 1974). Studies by Miskimen and Dolbeer (1976), Stone (1973), and Williams (1975) all showed differences in stomach contents of male and female redwings. Stomachs of males in all three studies contained higher proportions of crop grains, and stomachs of females contained relatively more weed seeds and animal material. In her study

with captive redwing males, Miskimen (1960 p. 5) noted: "Oats and cracked corn were eaten in varying quantities throughout the study, but wheat, mixed songbird seeds, and prepared protein feed for poultry were never eaten." Captive female redwings, however, were observed to select small seeds from a commercial wild bird seed mixture, leaving larger seeds uneaten (Miskimen, pers. obs.). These observations show a potential basis for important effects of diets of wild redwings based only on responses to food items.

Secondly, the wide distribution of red-winged blackbirds across the North American continent gives opportunity for selection of widely differing diets in birds such as redwings that readily adjust to practically any available food. Not only are different plants available in eastern, western, and mid-western regions but soils provide different grits available to birds. Miskimen and Dolbeer (1976) recorded 13 kinds of grit in the stomachs of 90 redwings collected in one area. These numbers could be multiplied many times, continent-wide, and soluble portions could influence the birds' nutrition and metabolic products, including color pigments.

In view of the above, there is need for further study along the lines of behavior and geographic distribution. These factors may affect diets of female red-winged blackbirds and through the diets the quality of feather color pigments.

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