

PLUMAGE ABERRATIONS OF THE REDWING
(*AGELAIUS PHOENICEUS*)

BY ROBERT W. NERO

DURING June, 1951, I repeatedly observed an adult male Redwing with a large patch of pink feathers on his throat on a marsh near Madison, Wisconsin. After taking notes on the behavior of this bird, I collected it on June 14. Impressed by its unusual marking I wrote to 28 museums and universities requesting the loan of Redwing specimens showing plumage aberrations. Ninety specimens showing some aberration were obtained from these sources as follows: Museum of Vertebrate Zoology, University of California (19); Chicago Natural History Museum (18); University of Michigan Museum of Zoology (11); Cornell University Laboratory of Ornithology (9); Milwaukee Public Museum (8); United States National Museum (8); Stanford University Natural History Museum (4); Louisiana State University Museum of Zoology (3); State University of Iowa Museum of Natural History (3); University of Wisconsin Zoology Department Museum (2); University of Minnesota Museum of Natural History (2); Carnegie Museum (1); North Carolina State Museum (1); and Yale University, Peabody Museum of Natural History (1). These specimens were collected in widely scattered localities from New York to California, and from Alberta to Mexico (including Yucatan), Costa Rica, and the Bahamas during the course of nearly a century. The series apparently includes examples of 10 subspecies. The various plumage aberrations in this group appear to occur throughout this range without any significant concentration.

During April and May, 1952, I collected 219 adult male Redwings near Madison in an effort to obtain data on the frequency of occurrence of certain of these aberrant features. About 75 of these birds showed these particular traits, and the majority of the others were found to show certain less obvious irregularities. Literature reference to 13 other specimens (of which I have examined 3) gives a total of over 300 specimens showing some plumage aberration. These form the basis for this report.

I wish to thank the ornithologists of 13 institutions for their cooperation in loaning specimens, and those of 15 other museums who kindly checked their collections. Special thanks are due Dr. John T. Emlen, Jr. for many suggestions and for criticizing the manuscript. Wilmer J. Miller, Jerome J. Chart, and Richard A. Hunt aided in various aspects of the study.

"ALBINISM" IN THE ICTERIDAE

Plumage aberrations are common among icterids and have attracted the attention of several previous observers. Deane (1876: 22) wrote: "the most interesting and striking cases of albinism are those among the Icteridae and Corvidae . . ." Kumlien and Hollister (1903: 88) reported that in Redwings "albinistic specimens are common." Edson (1928) records the occurrence of a flock of about 500 Brewer's Blackbirds (*Euphagus cyanocephalus*) in which seemingly 40 per cent of its members showed partial albinism. Various aberrant plumages have been described in the following: Bobolink, *Dolichonyx oryzivorus*, (Gray, 1879; Strecker, 1869); Cowbird, *Molothrus ater*, (Robinson, 1888); Bronzed Grackle, *Quiscalus quiscula*, (Wilson, 1930); meadowlarks, *Sturnella magna* and *S. neglecta*, (McGregor, 1896; Hoffmann, 1878; Robinson, 1888; Townsend, 1883); Yellow-headed Blackbird, *Xanthocephalus xanthocephalus*, (McGregor, 1896).

TERMINOLOGY OF ALBINISM

The term albinism has been generally applied to animals showing some degree of abnormal white coloring or depigmentation. In a more restricted sense, according to Hutt (1949), the term applies to those animals with "more or less elimination of melanin from the eye, as well as from the skin and feathers or hair," still implying, however, a gradation in degrees of albinism. This is complicated by the inability to determine in all cases, without microscopic examination, to what extent depigmentation has occurred (Pearson, *et al.*, 1911-1913). Furthermore, since strict definitive terms requiring knowledge of the genetic basis of the form concerned cannot be freely applied to animals for whom this information is lacking or unobtainable, a general classificatory system is desirable. The factors involved in plumage changes are complex and not well understood in every case. There are records of fowls changing from colored to white, and even back to colored again. Spontaneous development of white feathers (sometimes due to injuries) is fairly common (Hutt, 1949: 182-184). This is also known in wild birds. Frazier (1952), describes depigmentation in a Robin (*Turdus migratorius*) which was originally banded as a normal bird. Breeding experiments would be necessary to establish the exact genetic basis for the Redwing plumage forms described below.

Mueller and Hutt (1941) have arranged and utilized a classification of albinism formulated by Pearson, *et al.* (*op. cit.*) which seems quite satisfactory. *Total albinism* is the condition of complete absence of melanin from the eyes, skin, and feathers or hair. *Incomplete*

albinism is a condition in which the eyes, skin, or feathers are affected, but not all three. *Imperfect albinism* is the partial inhibition of pigment formation in any or all three of these areas, but not total in any. (It is equivalent to dilution as used by many authors.) *Partial albinism* is the complete or partial inhibition within localized areas. Partial albinism in the Redwing may be further considered as *random*, i.e., occurring in dissimilar areas from bird to bird; and *specific*, occurring in approximately the same area in each specimen. All these types have been found in the Redwing.

In a few cases the bills and feet were also affected, but little attention was paid to this condition. In some of the complete albinos and dilutes, bills and feet were paler than usual, and in 2 partial albinistic males some of the claws alone appeared depigmented.

Structural aberrations of the feathers are rare or at least were not apparent. However, two adult males (C.N.H.M. 162,962, M.V.Z. 63,895) had several contour feathers which, besides being white or gray, were rather more soft and hair-like than usual, resembling the condition known in fowls and pigeons as silkiness in which the barbules fail to interlock due to some structural deficiency (Hutt, 1949: 106). Several of the specimens with light primaries and rectrices showed what seemed like an unusual amount of wear, especially on the tips. The effect of differential wear of lighter portions of feathers has been pointed out by Dwight (1900).

TOTAL ALBINISM

Six females in the series are apparently total albinos, i.e., seem to be entirely lacking in melanic pigments. Two are labeled "pink eyed" and a third and fourth were so described in reports by the collectors (Fritz-Henning, 1893; Robinson, 1888). Another, a juvenile, entirely white and mounted with pink glass eyes, lacks data but is the size of a female. The eye color of the sixth specimen is not designated. None of these birds show any trace of the female pattern and in this respect may be differentiated from the dilute type. Carotenoid pigments were apparently not affected in these birds. All except the juvenile have a tinge of "red" on the head, throat, breast, and epaulets. These colors are respectively: Light Orange-buff (head, etc.), and Pale Salmon-orange (epaulets); Light Salmon-orange, Orange Chrome; Pale Orange-yellow, Light Salmon-orange; and Light Orange-yellow on both areas. (Capitalized colors are those of Ridgway, 1912. Throughout the remainder of the paper "red" will be used generally to refer to the appearance of assortments of the above colors.) These specimens show more red color on the epaulets

and throat than do the dilute specimens described in the next section. The variation in the amount of red in these total albinos may be an effect of age. Female Redwings are generally believed to show more red as they increase in age. Dwight (1900: 161) states that "an orange or crimson tinge may show on the 'shoulders' of the older birds." Racial variations also need to be considered. One subspecies, *Agelaius phoeniceus utahensis*, is characterized by an increase in the red pigmentation of the throat area and epaulets of females. Males of this race also show a more intense red on the epaulets than do males of races in surrounding areas (Behle, 1940: 234-235). Dwight (*loc. cit.*) notes further that females in any plumage after the post-juvinal molt may show a pinkish or salmon tinge, especially about the chin and head. Personal experience suggests that females in their first breeding season do not generally show very much of this color. Juvenile birds of both sexes may show it, however. Dwight (*op. cit.*: 160) observed young with pinkish buff and ochraceous in these areas.

Apparently collectors who obtain an albino female Redwing are so struck by the color of the epaulets, which appear much brighter red in the absence of melanin, that they are led to believe they have a male. The "perfect albino" male with the "yellowish-pink" epaulets that Robinson (1888) describes, was examined in this study (U.S.N.M. 115,452, September). No specific description of the reproductive organs is given by the collector, but judging by its size (culmen—17.6 mm.) it is questionable whether it is a male. Fritz-Henning (1893) describes a September bird as a "perfect Albino, pure white with the exception of the lesser wing coverts which are a delicate pink; eyes pink. This handsome fellow was with a flock of about 200 Blackbirds, all of normal color. It measured—Length, 8.10; extent, 12.00; wing, 4.00; tail, 3.01; bill, 0.60." I have also judged this specimen to be a female on the basis of its measurements and have accordingly placed these two specimens among the females mentioned above. In another case, a partial albinistic female was similarly mistaken for a male (see below).

White (1896) described as an "albino" a bird which was "pure white with the red and orange on the wings" and stated that it was a male. His observation of the two colors on the wings suggests that this specimen was correctly sexed. Another bird which may have been an albino male was reported by a relatively inexperienced observer who claimed to have seen an all white blackbird with "red wings" in flight during May, 1952, in Fond du Lac County, Wisconsin. I was unable to confirm this observation.

IMPERFECT ALBINISM—(DILUTION)

The most common plumage aberration apparent in female Redwings was a condition resembling dilution. This term has been used to designate specimens showing a pale version of the normal appearance due to a general reduction of pigmentation over the entire plumage (Hutt, 1949:187). *Pale* and *ghosting* have been used synonymously with this term. Hutt considers dilution in the fowl apart from albinism, apparently largely on the basis that dilution affects all pigments (carotenoid pigments may be unaffected by albinism). Since the degree of red pigmentation in the Redwing varies normally, it is impossible to decide whether or not the red has been affected. These pale Redwings may be considered dilutes in the descriptive sense of that word but cannot be strictly compared to dilution in the fowl.

Eleven of the skins obtained from museums may be classified in this category. The normal appearance of streaked underparts in the adult female, resulting from white or gray feathers with a darker central stripe, is changed in the dilute females to paler color, the pattern ranging from a mere trace to a nearly normal appearance (see plate), and the color of under tail coverts and rectrices varies from white to Dark Mouse Gray. The general tone of the contour plumage is Light Buff (7 skins), Light Olive to Grayish Olive and Pale Smoke Gray (2 skins), but in nearly all of the specimens individual feathers are edged with Hazel, Tawny, or Cinnamon-brown. The colors of the head, throat, and breast range from Light Buff and Cream-buff through Olive-brown and Pale Orange-yellow. The epaulet colors are Light Buff and Cream Buff, Smoke Gray, Dresden Brown, Buckthorn Brown, Ochraceous-tawny, Tawny, and Salmon-orange. This variety of colors in the dilutes is presumably partly the result of the presence of varying amounts of melanin.

Three additional dilute females, one described by McGregor (1900: 7), the second by Dwain W. Warner (pers. commun., 1951), and the third which I observed near Madison, conform to this picture. The latter bird was watched in its nesting behavior from May 20 until June 14, 1952. It laid 3 eggs which hatched, but partly due to my interference the young were lost and the bird deserted.

One immature male specimen showing what is evidently the dilution effect was examined. This bird was collected in California (M.V.Z. 90,749). The entire plumage presents a faded picture of the immature plumage, being pale brown in general appearance (Sepia to Mummy Brown) instead of the usual dull black. The breast and neck and especially the top of the head are considerably darker than the

rest of the plumage. The tips of the primaries and tail feathers are especially pale and also somewhat frayed. In some areas on the wings and back, certain feathers show a silver tone. The lesser wing coverts appear Bittersweet Orange and the greater coverts (forming the buff border of the epaulets) are more heavily spotted than usual.

A light-colored male which may have been a dilute was seen in a flock of several hundred male Redwings in Green County, Wisconsin, on November 9, 1952, by Mr. Gordon Orians, an experienced observer. His first impression was that the bird was a total albino, but closer inspection showed it to be "light tan all over." In his opinion, judging by its size, the bird was clearly a male.

The dilution effect is well known in several domestic birds (budge-rigars, chickens, turkeys, and pigeons) and has been reported in the Mourning Dove (*Zenaidura macroura*) (Graefe and Hollander, 1945) and the California Quail (*Lophortyx californica*) (Price and Danforth, 1941). In both of the latter cases the specimens were described as showing a pale version of the normal pattern. Breeding experiments were conducted with the quail, and the dilution was found to be due to a single recessive factor which was considered semi-lethal since the dilute young appeared to be weaker. Dilution in the Domestic Pigeon (*Columba livia*) was found to be sex-linked as well as recessive (Hollander, 1938: 23). Any sex-linked, recessive character in birds will appear more frequently in females than in males because the former are heterogametic. The occurrence of 14 dilute females to 2 dilute males in the Redwing suggests that the genetics of dilution in this species may be of a similar nature.

PARTIAL ALBINISM—RANDOM TYPE

This section includes the more striking cases of partial albinism in which large areas of the plumage lack melanin and also those specimens in which only a single white feather occurs.

Cases in which pale feathers tinted with a shade of red appear in adult males are very numerous. Such feathers appear in practically all portions of the plumage but are especially numerous on the more anterior regions, i.e., head, throat, and breast (see "red spotting"—table 1). In specimens lacking melanin in most of the body plumage, the red tinting is clearly seen to increase in concentration in these areas. These tinted areas, as previously mentioned, are the areas in which a reddish cast often occurs in females. The rather constant appearance of red in certain areas in these aberrant males suggests that this color may occur in all individuals, but that it is normally masked by melanic pigments as discussed later.

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I have examined 55 specimens showing a single feather of this sort and 35 others with 2, 3, or more of this type of feather. These feathers occur most frequently near the orbits, often in the orbital circlets or nearby, but they also appear on the throat and breast. Of the 219 adult males collected near Madison, 60, or 27 per cent, showed this character (table 1). Often these feathers were small and barely noticeable except on careful examination. In several cases males had small patches of pinkish feathers, especially near the eyes and on the chin and throat. White feathers lacking any tint of red are very rare on the anterior regions of adult males but appear elsewhere over the entire body as will be shown in the descriptions of certain individuals which follow.

In four of the males, pink or red feathering occurs in extensive patches which are in some cases symmetrically distributed. Three of these specimens are shown in plate 11. The bird on the left has a Light Salmon-orange throat-patch which covers the chin and throat, malar area, and lower two-thirds of the auriculars. This is the specimen mentioned in the introductory paragraph of this paper.

The center specimen is more complexly colored, having several white feathers (median coverts, crown, back, and primaries) as well as the broad breast patch and abdominal patch. The chin and throat bear the deepest Salmon-orange. In this case the patch is less symmetrical and does not cover as much area on the head as in the former specimen. The light area which spreads across the breast and down the ventral tracts is Light Salmon-orange. The abdominal extension is formed by the light feathers of the medial edge of the ventral tracts overlying the sternum. There are more light feathers on the left side than on the right. Nearly all of the white feathers show a slight tinge of Orange-pink, but the color is deepest on the throat, chin, and head. This specimen also has two rows of Light Salmon-orange feathers encircling the nape and occipital region.

In the specimen on the right, both the wings and rectrices are completely white, the throat and breast appear as one colored patch, and the abdominal area is light from flank to flank. Again the throat and chin are the deepest Orange-buff. This color becomes Light Orange-buff on the feathers of the lower breast and throat. A line of Pale Orange-yellow feathers runs from the throat to the occipital region on the right side of the head. This bird also has some of the primaries and rectrices faintly tinged with Orange-pink. The epaulets are Orange Chrome, corresponding with the general color of the tinted areas. This is an immature specimen.

A young male collected in 1950 in North Carolina is described by Harry T. Davis (pers. commun., 1951) as having white primaries in

each wing and 2 white tail feathers, as well as an irregular design across the breast $2\frac{1}{4}$ inches wide with a projection almost to the base of the tail. The light area of the breast had a "reddish orange" tinge; the belly area, a slight suffusion of "yellow." The epaulets varied from "orange to lemon."

McGregor (1896) depicts a male which has white feathers in the secondaries, rectrices, upper and under coverts, flank, breast, throat, and sides of the head. I examined this specimen (S.U.N.H.M. 6,474) and found it quite as described. The slight tinge of color might be better described as Light Salmon-orange. The epaulets are the normal Scarlet to Scarlet-red. An interesting feature is the apparent alternation of rows of normal and aberrant feathers encircling the body throughout most of its length.

Another adult male showing considerable areas lacking melanin was collected by me on August 2, 1952, near Madison (U.W.Z. 14,329). On the right wing the first 2 primaries, 5 primary coverts, and several feathers at the base of the primary coverts are white. The remainder of the wing plumage is normal. On the left wing all of the primaries, the primary coverts, and the alula and surrounding area are white. There is a patch of pink feathers on the chin and another on the right malar region. There is also a large asymmetric white area on the breast, from the sternal notch to the end of the sternum. Red tinting of these light feathers (largely Salmon-orange) appears in the metacarpal region, faintly on the outer webs of the primaries and coverts, and on the tips of some of the contour feathers of the breast patch. This specimen was taken while in the midst of his molt and lacks many feathers, especially about the head and neck, but this condition permits an examination of the plumage of two seasons. Of the 9 left primaries which are white, for example, the first 3 are of the previous plumage, appearing worn and lacking the red tint. Similarly the first 4 worn primary coverts present a fine contrast to the remaining new coverts. All of the affected areas show tiny new feathers lacking melanin, suggesting that the albinotic condition of this specimen is permanent.

Random partial albinism appears to be of less frequent occurrence in females than in males, but of course would not be as easily detected in the light pattern of the female plumage. One female specimen examined by me showed white feathers in these areas: 8 on the crown, 1 in the left scapular tract, 2 on the left lower throat, and 2 on the right upper breast. Emerson (1902) reported a female with 2 white feathers on each side of the tail, 2 primaries in the right wing, and 1 in the left. Jewett (1910) listed a female with 3 or 4 white primaries in the left wing.

One might infer that the "albino" described by Littlejohn (1901) was a male, since he stated that the epaulets were paler than normal and that the tail feathers were black. However, I have examined this specimen (S.U.N.H.M. 7,559, August), and although it is labeled male, have judged it to be a female on the basis of its plumage and size (culmen—17mm., wing—101mm.). He has described the specimen fairly well, stating that nearly the whole body was white except for half a dozen feathers on the breast and in the middle of the back. The top of the head and the wings were described as being nearly normal. He also noted that there was a "rosy hue" on the breast and throat (Light Salmon-orange). An important feature in this specimen is that half of the feathers of the epaulets are aberrant and half are normal. The distal lesser secondary coverts are of the normal diffused chestnut appearance (really dark brown feathers edged with chestnut), but the proximal half of this series of feathers lacks the dark color and streaking and is Bright Orange Chrome to Flame Scarlet, showing plainly the effect of masking of red pigment by the darker melanic pigment.

The occurrence of red on the outer web of the primaries of some of the "white-winged" specimens leads to an interesting point. As previously mentioned, the male collected at Madison in August, 1952, had some white primaries from a previous molt and others from a recent molt. Only the recent feathers showed the red tinge on the margin of the outer web. The remaining normally pigmented primaries (black) showed the "brown" margin of the fall plumage. The edges of these feathers (as well as the tips of the body feathers which show this fall pattern) appeared not so much "brown" as "red" (Salmon-orange) when viewed under a binocular microscope. Thus a visual examination leads me to attribute the color of these feather edges to a carotenoid pigment rather than a melanic pigment. The red on the margins of the white primaries may be partially masked by melanin in the normal plumage to produce the light edging which characterizes the fall plumage. On this basis one could expect that an albino male collected shortly after the assumption of new plumage would show more red color on the edges of the primaries, etc., than would a late spring or summer specimen, because the light edges assumed in the post-nuptial molt normally have disappeared by spring.

PARTIAL ALBINISM—RESTRICTED TYPE

Breast Banding.—A character which appears in adult males as a nearly concealed band of white-marked feathers across the breast

has been found in 22 specimens obtained from museum collections. This same character was found to occur in 24, or 11 per cent, of 219 adult males collected within 60 miles of Madison, Wisconsin (table 1). Its appearance in specimens from Canada, Yucatan, and Costa Rica, and from New York to California, shows that it has a widespread occurrence. Whether the 11 per cent figure is general over this area remains to be determined. Three specimens showing this character are shown in plate 11. Considerable disarrangement of the breast feathers of the pictured birds was necessary to reveal the white-marked feathers, and in none of the specimens are all of the white-marked feathers apparent. In most museum specimens, and in nearly all fresh specimens, the majority of the marked feathers are concealed by overlapping feathers. Undoubtedly more specimens showing this character could be found in collections if a closer examination were made.

In prepared specimens the band across the breast often appears more posteriorly than on the fresh bird. Actually the marked feathers usually occur along the ventral tracts on the upper breast from about shoulder level to 10 to 35 mm. posteriorly (measuring from the base of the feathers). Generally the number of marked feathers on each ventral tract is about equal, but in a few cases it is not. In some cases these feathers are limited to the medial edges of the ventral tracts; in others, to the central portion; and in some extensive cases cover the entire width of the tracts. The actual number of feathers on each tract generally varies from 3 or 4 to 50. One specimen was found with only a single feather of this same type. The general effect may be a crescent or a wide band across the breast.

The white area on each feather is subterminal rather than terminal and is thus generally concealed by the overlapping plumage. This white marking somewhat resembles "barring" in fowl, in which a sex-linked gene inhibits the deposition of melanin within the individual feather, causing a white bar on a feather that would otherwise be all black (Hutt, 1949: 202-203). In the breast banding, however, the white area occurs nearly always on only one web of each feather—generally on the lateral web—and does not always extend to the edge. It is this peculiar asymmetry which is most characteristic of the trait. A similar asymmetry has been reported for the condition known as "spangling" in the Silver Spangled Hamburg chicken (Landauer, 1930: 81). In these birds individual feathers over much of the plumage are white and tipped with black which is more extensive on the medial than the lateral web of each feather.

In the Redwing the extent of the light marking varies from large

areas extending from the shaft to the edge of the vane to a mere trace bordering the rachis. Feathers with larger white areas are usually located medially and posteriorly to the others. Rarely they may be anterior to the feathers with the smaller markings. In many specimens all or most of the marked feathers may show a similar-sized area. Often the very narrow light area bordering the rachis requires careful scrutiny to be detected. In the examination of the fresh specimens it was found that it could be best detected by looking at the underside of the breast feathers.

Although in most cases the light area occurs on one web only, in a few specimens it extends over both webs. In one unusual specimen (C.N.H.M. 29,570) a broad light area occurs on both webs of nearly all the marked feathers and also extends to the margin of the web. In many of these feathers the distal part of the light area has worn away, leaving a bare shaft for 1-2 mm. between the light area and the small dark tip which is not as worn.

Occasionally a few marked feathers also occur on the ventral tracts anterior to the shoulder joint, some reaching to at least the middle of the neck. In these cases especially there is likely to be found a reversal of the position of the light spot from the lateral web to the medial. A similar reversal of asymmetry is found in the spangled fowl. Landauer (1930) stated that of the throat feathers on the *left* body side of the fowl almost all the feathers near the median line have spangles with the right symmetry type, i.e., they are darker on the lateral web rather than on the median web. Landauer has further shown that in the fowl the per cent of feathers with the opposite spangle type increases with the distance from the median line.

Eight specimens in the series show a tinge of Salmon-orange on the white areas, particularly near the black tip. In the other albinistic forms the red color is more or less limited to the distal third of each feather.

Although it appears that in most specimens the breast banding was concealed, some of them have extensive markings which might have been visible on the living bird. Hackett (1913: 37) observed a live male in the field which had an "abnormal light spot on the breast" which might have been of this kind. It seems likely that the following reported specimens were also of this type. Brewster (1868) collected an otherwise normally plumaged male which had a "crescent-shaped mark, of a bright orange color on the breast; this was about equal in size and form to the half of an old-fashioned copper cent." And Kumlien and Hollister (1903: 80) noted "two or three specimens with a pink crescent on the breast."

Possibly populations of Redwings may be located in which this character appears in higher frequency and in which it might be investigated genetically. Under isolated conditions a recessive gene character might appear in higher frequency. Edson (1928) suggests this as a possible cause of the appearance of a flock of Brewer's Blackbirds with a high number of white-spotted members. Hanson (1949: 170) states the same for Canada Geese (*Branta canadensis*) showing large numbers of white-spotted individuals in flocks migrating through Illinois.

So far there has not been found any female or immature male showing this character. It is possible that it is expressed only in the adult male, but it is also possible that it has been overlooked due to the generally lighter and streaked plumage of the females and the dull plumage of the immature males. Also there were fewer specimens of this kind available for study.

Metacarpal Red.—The red or orange color of the epaulet of the male often extends along the edge of the wing to the base of the alula. Thus the small feathers covering the base of the alula are often red, a feature which is sometimes noticeable even in the field. However, the appearance of red color on the small feathers beneath the alula, i.e., overlying the metacarpals and digits, and particularly along the edge of the wing as well as on the underside in this area, seems to have been largely overlooked, although Coues (1903: 469) wrote that "occasionally, there are traces of red on the edge of the wing and below." This condition was first brought to my attention in the aberrant specimens which lacked melanin in this area, for in them the small metacarpal feathers were quite noticeably red, much as in the epaulet. Forty-three, or 20 per cent, of 219 males showed this character (table 1).

The greatest amount of metacarpal red feathering was observed in 3 birds which had some white wing feathers. In one (plate 11, bottom row, second from left) the metacarpal feathers are nearly all red, although the remainder of the wing plumage is white. However, there is no sign of red on the corresponding feathers of the other wing, which is the usual black. The specimen immediately to the right of this bird on the plate has red metacarpal feathers on both of its otherwise white wings (excepting the epaulets). A third specimen collected during the study also has very noticeably colored metacarpal feathers. On the left wing, of which all the primaries and the area including the alula lack melanin, the metacarpal feathers are all Bright Salmon-orange excepting one which is the normal black. On the right wing, only the first 3 primaries and the distal portion of the metacarpal

area lack melanin; the alular feathers and the rest of the wing feathers are black. However, that portion of the metacarpal area which does lack melanin is Salmon-orange.

These facts strongly suggest that red pigment normally persists in the metacarpal area masked by black pigment. This is further supported by evidence from normal birds. In normal specimens, i.e., not generally albinistic, this area is usually black, but some individuals show a trace of red on a few of the metacarpal feathers, particularly along the edge of the wing. In some cases the black feathers have red tips, often very slight but occasionally larger; and sometimes even the entire feather may be red. The red also occurs asymmetrically and in these feathers is usually on the lateral web. In some cases, red feathering may extend to the underside of the wing in this area and even from there to the epaulet. Juveniles and immatures of both sexes sometimes show a slight amount of red on the tips of these feathers, but in the majority the tips are buffy or gray. Females ordinarily have light-tipped metacarpal feathers, and in those birds showing greater amounts of red in the epaulets the metacarpals are plainly tipped with red.

Species which have bright colors, such as red or yellow, in some limited area of their plumage often have these colors repeated in the feathers of the metacarpal area, e.g., Eastern and Western meadowlarks, and White-throated Sparrows (*Zonotrichia albicollis*). The Rose-breasted Grosbeak (*Pheucticus ludovicianus*), and the Scarlet Tanager (*Piranga olivacea*) show considerable red in this area of the wing in sub-adult plumage, and usually this part of the adult plumage is all black, but in a few Scarlet Tanagers I have found red feathers scattered among the black. This is also the case in the Yellow-headed Blackbird and is especially interesting here because in this form many of the feathers surrounding the metacarpal area are normally all white.

White Belly-spot.—Males, females, and immatures often show a tendency for failure of melanic deposition in a tuft of small body feathers in the middle of the belly. This small group of white feathers is always concealed by the large contour feathers of the ventral tracts. However, when the latter are blown apart this spot can be readily discerned, at least on fresh specimens. Usually it is lost or rendered difficult to see in the process of preparation. This group of white feathers occurs most frequently over the posterior centimeter of the sternum, but also occurs posterior to this, on the abdomen. It is practically always in the midline. It ranges in extent from a few feathers to a dozen or more, in one specimen covering an area 15 × 15

mm., and in another covering most of the belly. Of 219 adult males, 51, or 23 per cent, had this character (see table 1). No correlation with age was found in four live banded birds examined in the field.

White Tail-base.—Another unpigmented area frequently occurs on the base of the rectrices. This area is, of course, ordinarily concealed by both sets of tail coverts and can only be seen by lifting these. The condition is not easily observed in prepared specimens, but the series of adult males collected during this study provided an opportunity for an analysis of this trait. The amount of light area is not always the same on each feather and is also asymmetrical, the median web showing the most white. This appears to depart from Landauer's rule for asymmetry described under *breast banding*, but the rectrices are in the median plane where reversals of asymmetry may occur. The entire pattern of white formed by the several tail feathers is usually symmetrical but not always so, and in such cases it is usually the central feathers which show the most white. A sample of 166 adult males yielded 146, or 88 per cent, showing some white on the base of the rectrices (table 1).

A measurement of this white area was taken with a metric rule pushed under the coverts to the base of the tail. Only the length of the light area measured from the tail base was used. Of 127 males measured, 11 per cent had a white area 1 to 5 mm. long; 29 per cent, 6 to 10 mm.; 42 per cent, 11 to 15 mm.; and 12 per cent, 16 to 20 mm. Two birds had white areas between 21 and 25 mm., and four birds, over 25 mm.; these longest areas, however, were mainly on one or two central feathers.

Both immature males and females also show an apparently similar condition, but insufficient numbers of these were collected to permit a comparable analysis.

In the supposition that age might be a factor influencing the extent of the white area, I examined two skins and four live adult males of known age, but found no correlation with age. A bird three years old had a white area 14 mm. in extent; another one of at least the same age had no white. A five-year-old bird had 25 mm.; another of at least the same age had no white. A six-year-old bird had 13 mm.; and an eight-year-old bird (possibly older) had 20 mm. Six caged individuals and one wild bird which had from 5 to 20 mm. of white on the base of the rectrices each showed a similar amount after a normal molt. This also suggests that this trait is constant and permanent, thought perhaps only somatic.

One wild male had a single pink feather in approximately the same position on his head in 2 successive seasons. Similar observations on other aberrant birds would be informative.

DISCUSSION

Frequency of Occurrence.—Table 1 shows the frequency of occurrence of 5 traits in adult male Redwings collected at random within a 60 mile radius of Madison, Wisconsin, from April 6 to May 24, 1952. A statistical analysis showed a significant negative association between white tail base and metacarpal red. The former appeared less fre-

TABLE 1
FREQUENCY OF OCCURRENCE OF FIVE PLUMAGE TRAITS IN ADULT MALE REDWINGS

<i>Trait</i>	<i>Sample</i>	<i>Number</i>	<i>Per Cent</i>
"Red Spotting"	219	60	27
Breast Banding	219	24	11
Metacarpal Red	219	43	20
White Belly-spot	219	51	23
White Tail-base	166	146	88

quently in those specimens which showed metacarpal red than in the rest of the sample. This relationship should be investigated further. No other association was apparent. Of 166 males thoroughly examined only 6 lacked one or the other of the above characters. On this basis, 96.4 per cent showed some deviation from the wholly dark plumage (excepting epaulets).

It would be interesting to know whether similar plumage conditions exist in other species. I examined a small series of adult male Tricolored Redwings (*Agelaius tricolor*) and found some red feathers on the heads of a few. Species with solid coloring, such as male blackbirds, would, of course, be easiest to examine. A few quantitative studies have been made on the occurrence of plumage aberrations in wild birds. The Micheners (1936) reported that of 30,000 birds of various species (excluding House Sparrows, *Passer domesticus*) handled during banding operations, only 17, or about 0.05 per cent, showed any albinism. The Micheners seemed to feel that this represented a fair approximation of the amount of albinism in wild birds. Hicks (1934) examined 10,000 European Starlings (*Sturnus vulgaris*) and found only 11, or 0.1 per cent, with white feathers. It seems probable that slight degrees of albinism could be shown to occur in greater percentages in these species if more detailed examinations were made.

Evidence of Masked Red Feathers.—One of the more interesting revelations disclosed by these studies of aberrant plumages is the appearance of "red" color in certain areas of the plumage where it is usually masked by darker pigments. The "red" or "orange" color

seen in albinistic Redwings appears to be not in itself an aberration, but a character of regular occurrence normally masked by heavier black pigment. Test (1942) has shown that in flickers (*Colaptes*) red, yellow, and orange carotenoid pigments may be concealed by melanic pigments. He states (*op. cit.*: 371) that "in the malar feathers of the males of some kinds of flickers the red pigments are completely masked by melanins."

The areas in which red appears to be masked by black in Redwings, as previously mentioned, are chiefly the head, throat, breast, and metacarpal area. It is of interest to note again that normal old females as a rule have red in these same areas. And again we note that young of both sexes may also show a tinge of similar color in these areas.

An attempt was made to show the presence of "red" pigment in the black feathers of a series of adult male Redwings by extracting pigments with a weak solution of NaOH and examining the extractions with a Beckmann spectrophotometer. Extractions were made from the epaulets, primaries, tail feathers, and head and breast feathers. The results, though far from conclusive, seem worth presenting and may serve as indications for further analysis. The color of the extract from the epaulets covered the range from yellow to red with an apparent preponderance of pigment in the yellow range. This suggests that the observed color of the epaulets is due to a combination of pigments. Extracts from both the primaries and rectrices, and head and breast feathers, showed a slight amount of yellow pigment in exactly the same range. This shows that there is some colored pigment masked by black in several of the body feathers just as Test (1942) has shown to be the case in flickers. The "red" colors of the breast feathers, etc., in aberrant Redwings probably consist of some portion of the array of pigments present in the epaulets. A similar situation probably accounts for the diversity of pigmentation of the epaulets of immature male Redwings. Test (*op. cit.*) has shown that the red, yellow, and orange colors of flickers consist of various mixtures of carotenoid pigments.

What significance the concealed red areas may have is largely a matter of speculation. One is tempted, however, to draw comparisons with related South American blackbirds which show red or yellow pigment in these areas, such as *Agelaius icterocephalus* which has a yellow (Lemon Chrome) head and breast, and *Agelaius ruficapillus* which has a reddish-brown crown and throat patch. Many other icterids have red and yellow pigmentation over much of their plumage.

Behavior of Abnormally Plumaged Birds.—The scarcity of observations of the behavior of abnormally plumaged birds has been pointed

out by Lee and Keeler (1951). They conclude, however, that "certain pigment variations in birds possess correlates in the modification of morphology, physiology, and behavior . . ." Signs of morphological and physiological correlations were most apparent (defective vision, lessened activity, etc.). Behavioral correlates were largely in degree of wildness. Several albinistic birds were noticeably tamer than their normal fellows, but a few (other species) were more shy and more wild. Two appeared as the leaders of their respective flocks.

There is a possibility that unusual behavior patterns in some abnormally pigmented birds may be *acquired* in the course of acceptance or active rejection by others of their kind.

I had observed the "pink-throated" male which I collected in June, 1951, for a period of several days preceding that date. No unusual behavior of any kind was noted. He held a territory which he defended with normal song and threat against neighboring Redwings and a Yellow-headed Blackbird, and he had two mates who each had successful nests. The dilute female Redwing observed at Madison in 1952 nested successfully. This would seem to indicate normal behavior and acceptance by her kind. At times she seemed more wary than other females, but this is a difficult thing to assess. Another of the dilute females, a fairly dark-plumaged bird (Y.U., P.M.N.H. 3,553), had this notation on the label: "one of large flock, chased a long time before taken. The other birds were trying to drive this one out of the flock."

[On September 7, 1953, in northern Illinois, Mr. David Skaar, a competent observer, watched what seemed to be a complete albino female Redwing "among an immense flock of Redwings gathering in a marsh at sunset. Other Redwings (all males) appeared to be chasing it repeatedly. It would twist and turn attempting to evade them, but always returned to the flock."]

Evenden and Storm (1950) reported an "albino" Barn Swallow (*Hirundo rustica*) which was "constantly chased by the other swallows." In another case (de Balsac, 1951), two young, almost completely albinotic birds of the same species, although apparently ignored by their fellows when perched, were not permitted to join the flock. Whenever they attempted to join, the other swallows would give alarm cries and several would pursue them until they left the vicinity. The albinistic birds, in spite of their gregarious instincts, were compelled to remain in isolation. The same observer reported a domestic hen which had frizzled feathers and which was so persecuted by the other hens that it had to hide during the day and came out only in the evening to get food.

SUMMARY

1. Plumage aberrations, mostly in pigmentation, were found in over 300 Redwings. Ninety aberrant specimens of both sexes were obtained on request from 28 museums. Descriptions of 13 specimens were found in the literature. Practically all of 219 adult males collected near Madison, Wisconsin, in 1952 were found to show some deviation from the wholly black plumage.

2. These aberrations have been classified as: total albinism; imperfect albinism; partial albinism—random and specific. The forms within these categories have been described in detail, and the frequency of occurrence of several of them in a sample of 219 is shown.

3. Considerable evidence was found suggesting that "red" pigment normally occurs in the anterior regions especially of the adult male Redwing where it is masked by black pigment.

4. The behavior of abnormally plumaged birds is discussed.

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*University of Wisconsin Zoology Department, Madison, Wisconsin,
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