PLUMAGE VARIATIONS AND PLUMAGE CHANGES AMONG EASTERN PURPLE FINCHES

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THE movements of the Eastern race of Purple Finches (*Carpodacus p. purpureus*) even at nesting time seem inscrutable, and their variations in color, if they are indications of sex, are also puzzling.

At our banding stations in Peterboro, New Hampshire, and Cohasset, Massachusetts, during the last five years, we have banded about two thousand birds of this race. Early in the work we came to recognize that the most variable parts of the plumage of the olivaceous birds (excluding birds in juvenal plumage), females and immature males, were the rump feathers and upper-tail coverts, especially the former. The two most frequent and most obvious differences in the coloration of these parts lie in their yellowness, that is in the feebleness or intensity of this color, so that we came to divide most of the olivaceous birds referred to into two classes—(1) those "especially yellow-olive" (abbreviated into "EYO" in our bird journals and on our individual record cards), and (2) birds not showing this coloration conspicuously were dubbed "not especially yellow-olive" (abbreviated into "NEYO"). These designations refer to the rumps exclusively. Other much less frequent colorations of the rump among olivaceous birds which received systematic attention were described as "Pallid," "Rosy," "Brown," and "Reddish-brown," "Mixed Yellow and Brown," "Mixed Rosy and Yellow," etc.

These variations in the rump colors of olivacecus birds have served as a basis for studies of their relations to sex, age, seasons of the year, etc., in an attempt to ascertain if they afford criteria by which it would be possible accurately to identify by sight alone young males in their first nuptial plumage and females of corresponding age and older.

We have been able in a number of instances to note changes taking place in rump coloration of the same birds from year to year, for periods of four to five years, in fact in all we have seven birds which up to this season (April, May and June,

1927) have returned to our Peterboro station for the fourth time (Returns-4)*.

In cases where olivaceous birds assumed rosy rumps, with or without yellow-olive patches forming part of the rump feathers, other portions of the plumage were also usually rosy or contained rosy feathers, notably the crown, nape, chin, throat, and the tips of the greater coverts.

It was also early noted that the percentage of Purple Finches captured showing EYO characteristics reaches a maximum during April and May, and a minimum during the winter months. For example, of three hundred and thirty-nine birds banded in Cohasset, Massachusetts, from January 1, 1927, to May 1, 1927, eighty-five being males in "Rosy" plumage, one hundred and ninety-nine were NEYO, twenty-five were EYO and thirty had brownish, brownish-red, or reddish rumps, the ratio of EYO to NEYO being approximately 1 to 8. On the other hand, of forty-six new birds banded in Peterboro, New Hampshire, between April 16 and May 2, 1927, fifteen were NEYO, thirteen were EYO and eighteen were males in "Rosy" plumage, or an EYO ratio to NEYO of approximately 1 to 1. During a comparable period, twenty-eight returns were recorded in Peterboro (Returns-1 to Returns-4), and of these, omitting eighteen rosy males, four were NEYO and seven were EYO, a ratio of EYO to NEYO of approximately 2 to 1. A great preponderance of EYO birds captured in Cohasset during the same period was also noted.

In order to investigate several of the problems raised by the above statistical study, a representative series of rump feathers from olivaceous birds was collected by plucking several feathers from each bird studied and mounting them immediately between two glass slides, the mounts being studied at once in order to obviate possible fading, a low-power microscope and a high-power lens being used. In addition we obtained mounts of rump feathers from rosy males ranging in age from approximately two years to at least

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* As it has seemed necessary to give a name to a record of a bird banded at a station to which it returns another season after having made one or more migrations to and from its wintering or summering area, we have used exponents above and following the word return to indicate the fact and the number of times a bird has returned, thus: "Return^{1}, Return^{2}", etc. (see The Auk, Vol. XLI, p. 329, footnote). As these exponents are likely to be confused with reference numbers to footnotes, we now write the figures on the same line as the word return, and connect them with a hyphen, thus: Return-1, Return-2, etc. Recoveries may be designated in the same manner, thus: Recovery-1, Recovery-2, etc., in cases where a bird banded at one station is trapped at another station for one or more times, migrations as above indicated intervening between takings in each case.

six years, one instance being a Return-4 banded as an adult male May 3, 1923, then at least two years old.*

Similar sets of feathers were also taken from EYO birds ranging in age from one year to five years or more. Ridgway, whose detailed description of this race based on thirty skins, makes no mention of the greater olivaceousness of the rumps of some birds, but Coues† describes the upper parts of females and young as "olivaceous-brown, more clearly olivaceous on the rump."

Magee writing in *The Auk*, Vol. XLI, pp. 606-610, 1924, makes numerous references to plumage colorations, stating his belief that bright crimson males are at least four years old. Also that "The shadings on rump vary much more than the balance of the plumage—from rump as dark as back with no yellowish, [our NEYO birds] to rump considerably lighter than back with no yellowish [probably our pallid coloration], then from rump with just the faintest yellowish tinge (so faint in some you are doubtful if there is any) to a very distinct and bright yellowish olive [our EYO birds]. I am pretty well satisfied that the darkest birds showing no yellowish are old females and those at the other extreme with bright yellowish olive rumps are young males," p. 608.

The classical paper by Dwight on Molts‡ brings out the fact that the brightening of the feathers of the adult male Purple Finch at nesting time is caused by the loss of barbules by abrasion, giving rise to the "bright rosy carmine" feathers of the adult nuptial dress. This brightening of the plumage Dr. Dwight states is not a pigmentary change, but is due to the loss of the whitish barbules, leaving the rosy barbs bare

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* In a recent paper by M. J. Magee entitled "Summary of Trapping and Banding Operations in Northern Michigan", Wilson Bulletin Vol. XXXVIII, No. 3, p. 164, the following occurs:

" 'The Crimson plumage [of the Purple Finch] is not acquired until the bird is at least a year old, and in many not until at least two years old.' " "Many young males trapped in the spring acquire the adult plumage by fall."

He cites the case of No. 58864, stating that it was banded May 12, 1923 as a young male or female, showing no "crimson color" the following September, but as a return on May 7, 1925, it was in adult male plumage. This record gives the data on which he determined the age of the bird when it assumed its "Rosy" plumage, namely at the first postnuptial molt. He is less specific in submitting evidence that male Purple Finches acquire rosy plumage at the partial postjuvenal molt, that is when they are three to four months old. Our experiences at Peterboro and Cohasset contravene Mr. Magee's conclusion in this latter respect, and confirm his observations illustrated by No. 58864 if this bird on as early a date as May 12th was indeed in juvenal plumage. Up to 1927 we have banded approximately two hundred and fifty Purple Finches in juvenal plumage and of these a fair proportion returned the following year, but in no instance as an adult male.

† Key to North American Birds". Fifth Edition, Vol. I, p. 381.

‡ "The Sequence of Plumages and Moults of the Passerine Birds of New York" by Jonathan Dwight, Jr. Annals N. Y. Acad. Science, Vol. XIII, Part 1, Oct. 19, 1900, pp. 73 to 345 and accompanying plates.

and glistening. He states that this process of intensifying the rose color is "wholly an optical delusion" (p. 174), a statement quite at variance with our view of the phenomenon, which appears to be very real and entirely due to removing from the barbs the dark-gray barbules which tend to give them when present a more pinkish tone.

As Dr. Dwight appears not to have studied the effect of a similar loss of barbules at nesting time as affecting the *yellowness* of Purple Finches not adult males, we have a justifiable reason for publishing the following observations, based largely on a study of rump feathers taken from olivaceous birds, in part of known age, and a few rump feathers collected from old males of varying ages up to at least six years.

The barbs of the rump feathers of olivaceous Purple Finches range in color from nearly white through very pale olive-yellow to olive yellow. Less frequently they are glistening primuline yellow. In no unusual cases (see detailed description of 83998 below) a bird may possess a rump with olive-yellow feathers indiscriminately mixed with rosy feathers, or the two colors may be segregated. These colored barbs determine the rump coloration almost exclusively during April and May. After the postnuptial molt, these colors in the new barbs are commonly masked more or less by silky-white to gray or dark-gray barbules, the rumps usually becoming NEYO.

The intensity of the olive-yellow color varies in different birds as already stated, and the *area* of the feather so colored also varies, both appearing to reach a maximum in old birds. In nearly all rump feathers examined the color of the barbs of both olivaceous birds and of rosy males decreases gradually from their tips to zero at the union with the rachis, and they also successively decrease in color to zero at the union of the pennaceous and plumulaceous portions of each web.

Under low magnification the rump coloration of NEYO birds is found to be due to the presence of smoky-gray barbules occuring quite to the tip of the barb, hiding the barb color, the barbs varying in color in different birds, as stated above, and at different ages, as shown below.

The intensity of the rump coloration in EYO birds is due to the yellowness of the barbs, the area covered on each feather, i. e. the number of the yellow barbs, and the number of barbules lost or broken, the two types of rump coloration intergrading.

In cases where the rump is pallid, the lens shows light-

colored to nearly white barbs, the pallid effect obviously increasing with the loss of barbules.

Other rumps vary in color from brownish to brownish-red to rosy, in solid colors, intermingled colors, or in patches of solid color. A series of mounts of such feathers show (1) that a pale brown rump is due to pinkish-brown barbs largely masked by little-abraded very dark-gray barbules, the colored areas being small; (2) that a brown rump is due to reddish-brown barbs partially masked by dark-gray barbules, both showing little abrasion, the colored areas often being one-fourth by one-fourth inch across; and (3) a reddish-brown rump is due to loss of barbules when the barbs are reddish-brown or to feathers with rosy barbs partially masked with dark barbules.

A few rosy or crimson feathers are not confined to old male- (as pointed out by Magee*) but are occasionally found plentis fully on females if the accepted view be true, namely that male Purple Finches become rosy when they assume their second winter plumage. The rosy feathers from such rosy-rumped females vary in color from pink in some examples to crimson in others, the terminal four to forty barbs carrying most of the color, often being highly and uniformly colored even to their junction with the rachis. The yellow-olive feathers associated with such crimson ones are usually of a particularly intense color also.

Several examples follow giving details of plumage changes taking place on the same bird during a series of years.

Purple Finch No. 83998, banded as an EYO bird June 15, 1924, a return-3 at Peterboro, N. H., in 1927. Rump on May 14, 1927, dull rosy with central patch of rich olive-yellow feathers. As a return-1 and a return-2 the rump continued to be plain EYO, but as a return-3 the rump showed a large area of rosy feathers. This bird is at least four years old and is a female.

Purple Finch No. 66881, banded at Peterboro, N. H., July 15, 1923, a return-4, May 1927, a female. Rump coloration not observed when banded. As a return-1, July 5, 1924, rump was EYO. As a return-2, on May 31, 1925, rump was reddish-brown. As a return-3, May 15, 1926, rump was NEYO. As a return-4, May 9, 1927, rump was NEYO. This bird is at least five years old.

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*Loc. cit. p. 165. Magee says, regarding the occurence of rosy feathers on female Purple Finches: "A reddish-feather or two does not necessarily mean that the bird is a young male."

Purple Finch No. 66858, banded at Peterboro as an olivaceous bird, June 30, 1923, a return-4 May 14, 1927. As a return-1, July 20, 1924, rump was NEYO. As a return-2, rump was EYO. As a return-3, rump was NEYO. As a return-4, rump was reddish-brown. This bird is believed to be a female and is known to be at least five years old.

Purple Finch No. 92256, banded as an olivaceous bird April 28, 1924, by Conover Fitch at Cohasset, Massachusetts. A recovery-1 at our Cohasset station on March 14, 1925, with rump extremely brown. A recovery-2 May 9, 1926, an EYO bird, and as a recovery-3 April 27, 1927, the rump was NEYO. Later, in May 1927, the bird repeated, showing a clean, polished band—additional evidence that it is a female, since rosy males have never been taken by us wearing bands polished by rubbing against the eggs during incubation*.

Purple Finch No. 92271, banded as an olivaceous bird May 18, 1924, by Conover Fitch in Cohasset, Massachusetts, and hence now at least four years old, an adult male. Recovered at our Cohasset station three successive years (a recovery-3). Rump feathers showed complete loss of barbules for about one-fourth inch, bringing the crimson barbs close together, resulting in a rich crimson color. The undertail coverts were rosy-tipped. This character is met with to a varying degree in the older males and appears to be at a maximum in birds five to six years old.

Purple Finch No. 41909, banded at Cohasset, Mass., as an adult male May 3, 1923, a return-4 May 18, 1927, and hence at least six years old this month (June 1927). Feathers from rump and undertail coverts studied. Rump feathers are remarkable for the intensity of crimson color which involves for their entire length twenty barbs on each side of the rachis. For a distance of one-fourth inch from the tips of the feathers there is a nearly complete loss of barbules. The vivid crimson also extends to the extreme tips of the little-abraded barbs, and the tips of the under-tail coverts show considerable abrasion and a total lack of the rosy color at the tips of each barb, as if depigmented.

By transmitted sunlight the crown feathers of male Purple Finches when elevated are crimson throughout the year, except during the molt. In case of very old males, like 41909, by the combined increase of the colored area of barbs and the

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* In this Bulletin for July 1925, p. 52, a note was published on "Polished Bird Bands" by Charles L. Whittle.

increased intensity of their crimson coloration as exposed by abrasion, the birds as a whole have a marked crimson aspect, so conspicuous indeed that under favorable light conditions they can often be distinguished, even at a distance, from young adult males, at least during April, May and June.

From the above considerations, it is believed to be highly probable (1) that a preponderating percentage of olivaceous birds with EYO, rosy, or brown rumps, or with mixtures of these colors are old females; (2) that the majority of the birds (omitting those in juvenal plumage) having NEYO rumps are young males and young females in first winter plumage.

Little has been said about Purple Finches in juvenal plumage since the perfection of their feathers, their softness and their generally more buffy coloration, particularly the wing bars, etc., serve to distinguish them from older birds.

Our observations strongly indicate that in New England adult male Purple Finches in moving to their nesting grounds precede the old females in the main, though closely followed by the latter, and that the old females arrive earlier than the main body of the migrants. These conclusions are indicated by the following twenty-eight returns already mentioned, taken in Peterboro between April 30 and May 20, 1927:

Adult Males		17
Eyo birds 7	All at least two years old	
Neyo " 4	and hence females	11

Each season the first Purple Finches seen are rosy males, and Magee reports this to be true at his banding station in northern Michigan.

In Cohasset during the corresponding period in 1927, twenty-four returns were recorded, made up as follows:

Adult Males		10
Neyo birds 1	All but one at least two	
Eyo " 13	years old and hence females	14

Compare these records with the birds banded in Cohasset during the last two weeks of migration:

Adult Males	1
Eyo birds	4
Neyo birds	26*

The Peterboro records for a comparable period are closely similar.

Cohasset, Massachusetts, June, 1927.

* Our Peterboro station, which is situated approximately seventy miles northwesterly of our Cohasset station, is operated from about April 1st to about November 15th each year, no Purple Finches wintering there. Hence the appearance of the birds in the spring as migrants is most obvious. In Cohasset, however, the station is in operation throughout the year and Purple Finches are banded every month, the fewest in June and the largest number during February, March and April. These conditions make it difficult at times to distinguish between migrants and seemingly permanent residents. As would be expected the migratory movement north arrives in Cohasset considerably earlier than it reaches Peterboro.