

## EVIDENCE SUPPORTING A DIETARY BASIS FOR ORANGE-TIPPED RECTRICES IN THE CEDAR WAXWING

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**Abstract.**—Cedar Waxwings (*Bombycilla cedrorum*) normally have yellow-tipped rectrices, but juvenile waxwings with orange tail tips have been observed with increasing frequency in the eastern United States in the past 30 yr. Orange-tipped rectrices contain large amounts of the red pigment rhodoxanthin not found in normal yellow tail tips, and berries containing that pigment have been hypothesized as the source of rhodoxanthin in these feathers. At Powdermill Nature Reserve in western Pennsylvania, the first occurrence and subsequent increase in frequency of orange tail-banded juvenile waxwings correspond closely with the initial introduction and later growth and spread of two species of closely related honeysuckles (*Lonicera morrowii* and *L. tatarica*), one of which has been reported to contain rhodoxanthin. The ripe red berries of these shrubs are available from June through July. Nestling waxwings, which develop rectrices at this time, may be fed honeysuckle berries and consequently grow orange-tipped tails. Adults do not normally molt rectrices until the berries are no longer available, and nearly always have yellow-tipped tails. Several immature birds with orange tail bands were found growing yellow-tipped replacement tail feathers in September and October, after the honeysuckle fruiting period; two yellow-tipped birds were growing orange-tipped replacement feathers in July, when honeysuckle berries were available. Consumption of rhodoxanthin-containing honeysuckle berries may also account for orange variants in the Yellow-breasted Chat (*Icteria virens*) and Kentucky Warbler (*Oporornis formosus*).

### EVIDENCIA A FAVOR DE QUE EL COLOR ANARANJADO EN LA PUNTA DE LAS RECTRICES DE INDIVIDUOS DE *BOMBYCILLA CEDRORUM* SE DEBE A LA DIETA

**Sinopsis.**—Los individuos de *Bombycilla cedrorum* normalmente tienen la punta de las rectrices de color amarillo, aunque en los últimos 30 años, en la parte este de los Estados Unidos, se han estado avistando con mayor frecuencia individuos juveniles con la punta de las rectrices anaranjadas. Rectrices con anaranjado contienen grandes cantidades de rodoxantina, un pigmento rojo que no se encuentra en rectrices con el amarillo típico de la especie. Se ha propuesto como hipótesis que la fuente de rodoxantina en estas plumas son bayas. En la Reserva Natural Powdermill, Pennsylvania, la primera ocasión y subsecuentemente el incremento de anaranjado en la cola de juveniles de *B. cedrorum* corresponde a la introducción inicial y luego el crecimiento y dispersión de dos especies de bayas (*Lonicera morrowii* y *L. tatarica*) una de las cuales ha sido informada contener rodoxantina. Las bayas maduras de estos arbustos, las cuales son de color rojo, están disponibles de junio a julio. Los juveniles del ave en discusión, los cuales desarrollan sus rectrices durante esta época, muy bien pudieran estar alimentando de estas bayas y como consecuencia desarrollar color anaranjado en la punta de sus rectrices. Por su parte los adultos de estas aves, mudan sus rectrices posterior a la producción, de estas bayas y por ende usualmente la punta de sus

rectrices es amarilla. Varias aves inmaduras cuya punta de las rectrices era anaranjada, les estaban saliendo plumas nuevas con coloración amarilla, como resultado de la muda durante los meses de septiembre y octubre, cuando no hay disponibilidad de las bayas de *Lonicera*. Dos aves con amarillo en sus rectrices, les estaban saliendo nuevas plumas con coloración anaranjada mientras mudaban en julio que es cuando hay disponibilidad de las bayas antes mencionadas. El consumo de bayas que contienen rodoxantina, puede también ser el factor en las variantes anaranjadas de individuos de *Icteria virens* y *Oporornis formosa*.

Cedar Waxwings (*Bombycilla cedrorum*) with rectrices tipped with various shades of orange instead of yellow have been reported with increasing frequency in eastern and southern North America since about the early 1960s (Parkes and Wood 1988). Records of waxwings banded at Powdermill Nature Reserve in Westmoreland Co., Pennsylvania, photographs of birds with orange tail bands, and museum specimens indicate that the orange variant is almost entirely confined to birds in their first year, i.e., in juvenal and first basic plumage. As waxwings do not molt their rectrices at the first prebasic molt, all waxwings less than 1 yr old with orange tail tips deposited the pigment in those feathers before leaving the nest. In some populations, orange-tailed individuals have become quite common: at Powdermill Nature Reserve, 24% of the 1300 immature waxwings banded since 1983 have had orange tail bands.

Analysis of orange-tipped feathers by Hudon and Brush (1989) revealed a large amount of the red carotenoid pigment rhodoxanthin (22–44% of the total carotenoid content). In waxwings this pigment “is obtained directly from the diet and, presumably, deposited unmodified in the variant tail feathers” (Hudon and Brush 1989:361). After examining several likely sources, Brush (1990) found rhodoxanthin only in the red berries of Morrow’s Honeysuckle (*Lonicera morrowii*). In this note, we provide further evidence that rhodoxanthin-containing honeysuckle berries are the cause of abnormal orange rectrix tips in Cedar Waxwings.

Both Morrow’s and the closely related Tartarian honeysuckle (*L. tatarica*) are common and widespread at the Powdermill bird-banding station, having been planted there by the Pennsylvania Game Commission as wildlife food in 1960 (M. G. Netting, pers. comm.). These honeysuckles were probably planted widely in the northeastern United States by various wildlife agencies at about this time, following the U.S. Soil Conservation Service’s strong endorsement of Tartarian honeysuckle as an especially valuable shrub for developing farm wildlife habitat in that region (Edminster 1950). Although Brush (1990) did not test it for carotenoid content, the red-berried Tartarian honeysuckle almost certainly contains rhodoxanthin, because it hybridizes easily with Morrow’s honeysuckle (Bailey 1925).

There is a close relationship between the planting and spread of these honeysuckles and the occurrence of orange tail-banded waxwings at Powdermill. Our first encounter with an orange tail-tipped waxwing was in 1964 (banding at Powdermill began in 1961). As plantings of Tartarian honeysuckle generally do not begin to produce fruit until their third or fourth year (Edminster 1950), it is not surprising that no orange tail-banded waxwings were observed in the 3 yr prior. Until 1971 this vari-

ation was relatively uncommon; less than 5% of immature waxwings had orange tail tips. By the early 1970s the honeysuckle bushes at Powdermill had matured and spread to become a food source of major importance to nesting waxwings, and the percentage of immature birds with orange tail tips increased accordingly: by 1980 the incidence of this variation was 15%, and by 1985 it had risen to nearly 25%.

As the orange tail band variation is virtually restricted to immature waxwings, Hudon and Brush (1989) suggested that the source of rhodoxanthin in variant waxwing tail feathers might be a food that was available or abundant when juveniles were growing their rectrices, and not during the later prebasic molt period of adults. The phenology of waxwing molt at Powdermill lends support to this idea. Nestlings grow their juvenal plumage (including rectrices) mostly in late June and July, which coincides with the availability of ripe Morrow's and Tartarian honeysuckle berries at Powdermill (Mulvihill and Leberman, pers. obs.). Adults captured at this time at Powdermill frequently have their crops and gullets crammed with honeysuckle berries, which is how they carry food to their nestlings (Bent 1950). Thus, juveniles may be fed these berries while their rectrices are forming. The earliest that adult waxwings begin their prebasic molt is mid-August, and most do not molt their rectrices until much later (Mulvihill, unpubl. data). Morrow's and Tartarian honeysuckle berries are no longer available to waxwings by this time. We have never observed an adult waxwing (i.e., a bird that has completed at least two prebasic molts) with a completely orange-tipped tail, and almost all adult waxwings have had entirely yellow-tipped tails.

The hypothesis that rhodoxanthin obtained through honeysuckle berries is responsible for orange-tipped tail feathers is further supported by observations of birds growing replacement rectrices (three specimens in the collection of the Carnegie Museum of Natural History and six Powdermill banding records). CM 162690 is a male Cedar Waxwing collected by D. S. Wood at Powdermill on 14 Sep. 1983. It is a young bird in heavy first prebasic body molt, with about  $\frac{2}{3}$  of the streaked juvenal plumage remaining. Its unworn, fully grown rectrices have bright orange tips with the exception of #2 on the right side, which is only  $\frac{3}{4}$  grown and has a bright yellow tip. This latter feather is of "adult" shape (broader and more rounded at the tip) and has the more extensive tip pigmentation typical of adults. CM 168459 is an immature male waxwing found dead by P. Dalby in Clarion, Pennsylvania on 14 Oct. 1989. It is in heavy first prebasic molt with a small amount of juvenal plumage still visible. Left rectrix #3 is only  $\frac{1}{4}$  grown and has a bright yellow tip that contrasts with the orange tips of the other tail feathers. In addition, five similar immature waxwings with orange juvenal tail bands have been banded and released at Powdermill: a bird caught on 7 Sep. 1979 (USFWS band 1231-95734) was growing one yellow-tipped rectrix; another on 8 Sep. 1979 (USFWS band 1251-07023) was growing two yellow-tipped tail feathers; a third banded on 23 Sep. 1991 was also growing two yellow-tipped replacement rectrices; and two immature waxwings captured on

17 Oct. 1991 (USFWS bands 1471-24829 and 1471-24839) were growing one and four yellow-tipped replacement rectrices, respectively. All of these birds were growing their yellow-tipped tail feathers at a time (late August to early October) when honeysuckle berries were no longer available.

Two birds demonstrate the reverse phenomenon: they had normal yellow-tipped tails when initially banded but were found growing orange-tipped replacement rectrices at a later recapture. The first of these was banded on 3 Jul. 1985 (USFWS band 1331-38449) and recaptured 39 d later with two orange-tipped rectrices growing in. The second was banded on 27 May 1988 and recaptured and collected 36 d later (CM 168454), at which time right rectrices 4, 5, and 6 were orange-tipped and approximately  $\frac{1}{3}$  grown. At the time when these two waxwings were growing their orange-tipped replacement tail feathers, adult Cedar Waxwings were consuming large quantities of ripe honeysuckle berries, in addition to feeding these berries to their nestlings. Thus, adults undergoing adventitious molt of their tail feathers during the fruiting period of the honeysuckles may, like juveniles, grow orange-tipped rectrices. This color variation is virtually restricted to immature waxwings because of differences in the normal timing of tail feather molt between the age classes, as suggested by Hudon and Brush (1989).

If honeysuckle berries are the cause of orange variant waxwings, then similar variants might be expected to occur in other species that have yellow plumage and consume these fruits. Thus far, we have observed orange plumage in place of normal yellow coloration in two other species: Yellow-breasted Chat (*Icteria virens*) and Kentucky Warbler (*Oporornis formosus*).

The Yellow-breasted Chat is a common breeding bird at Powdermill, where it inhabits brushy hedgerows with abundant honeysuckle. Chats consume a variety of fruits in the summer, and these may make up a large proportion of their diet (Bent 1953). The earlier nesting of this species, compared to the Cedar Waxwing, means that the prebasic body molt of both young and adult birds coincides with the fruiting of Morrow's and Tartarian honeysuckle at Powdermill (Mulvihill, unpubl. data). We first encountered an "orange-breasted" chat in 1964, the same year that we recorded our first orange tail-banded waxwing. In the past five years, six out of 12 adult and three out of 16 juvenile chats have been recorded with bright orange incoming or freshly molted breast feathers that contrasted with any yellow unmolted breast feathers.

The Kentucky Warbler may also include berries in its diet during summer (Bent 1953). CM 168430, an adult female Kentucky Warbler collected at Powdermill on 14 Aug. 1988, is in the latter stages of its prebasic molt and has an orange-yellow superciliary, chin, throat and breast. A similar bird was banded at Powdermill on 22 Aug. 1991 (USFWS band 2091-92257). This species begins its prebasic body molt around the middle of July, when honeysuckle berries are still available (Mulvihill, unpubl. data). As these are the only Kentucky Warblers we have observed with a suffusion of orange, such variants are apparently much rarer in

this species than in the chat. In general, the Kentucky Warbler probably consumes proportionately many fewer berries than the chat, and honeysuckle shrubs occur much less frequently in its woodland breeding habitat. It is possible, of course, that some other food, as yet unanalyzed, may contain pigments responsible for the orange variation in this species.

We believe that the relationship between the presence of abnormally orange feathers and the observed timing of the molt of those feathers, whether normal or adventitious, makes the case for a dietary basis of orange color variants in the Cedar Waxwing (and possibly also in the Yellow-breasted Chat and Kentucky Warbler) even more compelling. We are convinced that the red carotenoid pigment rhodoxanthin, found in the berries of certain honeysuckles introduced widely into the northeastern United States in the past few decades, accounts for this variation.

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