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SCHEDULING DIFFERENCES OF MOLT AND MIGRATION FOR BALTIMORE AND BULLOCK'S ORIOLES PERSIST IN A COMMON ENVIRONMENT[1]

SIEVERT ROHWER
Burke Museum DB-10 and Department of Zoology, University of Washington, Seattle, WA 98195

MATTHEW S. JOHNSON
Department of Biological Sciences, Box 5640, Northern Arizona University, Flagstaff, AZ 86011

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Rohwer and Manning (1990) recently showed that Bullock's Orioles (*Icterus galbula bullockii*) migrate to the American Southwest prior to undergoing their fall molt. Thus, recently fledged young that are still in full juvenile plumage and adults that are in worn breeding plumage migrate at least as far as the southwestern U.S. and northern Mexico before undergoing their prebasic molt. Although Sealy (1979) reports that some second year male Baltimore Orioles (*Icterus galbula galbula*) may begin moving southward early in the fall molt, both the first and later prebasic molts of *galbula* take place on the breeding grounds. Rohwer and Manning (1990) suggest that *bullockii* migrates to the American Southwest before molting to escape the extremely dry late summer conditions of the coastal lowlands and intermountain west. In contrast, late summer monsoon rains characterize the American Southwest and should produce a food flush that birds could exploit to support their postjuvenile and postbreeding molts. Recently both Lazuli Buntings (*Passerina amoena*) and western populations of Painted Buntings (*P. ciris*) have also been shown to move to the American Southwest for their fall molts (Young 1991, Thompson 1991).

Because Rohwer and Manning (1990) initiated their study of these orioles to test predictions distinguishing winter versus summer explanations of delayed plumage maturation (Rohwer and Butcher 1988), the specimens they examined largely excluded *bullockii* taken east of the Rocky Mountains. This left open the possibility that the differences in the fall molt/migration schedules of *galbula* and *bullockii* might be under environmental rather than genetic control. Interestingly, Corbin and Sibley (1977) report evidence of a reduced frequency of *galbula* × *bullockii* hybrids between the mid-1950s and the early 1970s along the Platte River of eastern Colorado and western Nebraska. Rohwer and Manning (1990) suggest that the dramatic differences in the molt and migration schedules of these orioles could constitute a potent source of selection against hybrids. For this to be true, however, the differences in the scheduling of their fall molts relative to the migration must be under genetic control. To eliminate environmental control we sought to examine all late summer specimens of *bullockii* and *galbula* from the Great Plains, a region where they should experience much more similar environmental conditions than they do in their larger allopatric ranges west of the Rocky Mountains and in eastern North America.

METHODS

Specimens were examined from North Dakota, South Dakota, Nebraska, Kansas, Oklahoma, west Texas, Alberta, and Saskatchewan, as well as from the area east of the front ranges in Montana, Wyoming, Colorado, and New Mexico. Obvious hybrids were not examined in this study because practically all were collected prior to the time when *galbula* begins molting in mid-July. Undoubtedly, however, at least a few of our specimens probably represented highly backcrossed individuals of mixed ancestry.

Molt was scored in six body regions: throat, breast, flanks, crown, face, and back. In each region we lifted feathers with straight forceps at 5–10 points to look for growing feathers. This was done under a 2× magnifying lamp with illumination from a 75-W incandescent bulb. Following Rohwer (1986), the percentage of growing feathers was estimated in each region on a scale with 5% increments. Primaries and secondaries were also scored for molt. In addition all specimens were scored for the percent of their plumage that was fresh, 0% being assigned to birds entirely in worn breeding or juvenile plumage and 100% to birds in fresh basic plumage. Birds with less than 10% new plumage or with more than 90% new plumage were treated, respectively, as being in juvenile or worn breeding plumage or as being in fresh basic plumage. Hatching year (HY) males in fresh basic plumage were distinguished from after hatching year (AHY) males by their female-like appearance. We did not attempt to distinguish HY and AHY females in fresh basic plumage, so all but the five females known to be HY by skull pneumatization data were tallied in the AHY column of Table 1.

RESULTS AND DISCUSSION

This sample of specimens from the Great Plains leaves little doubt that both juvenile and adult *bullockii* from areas east of the Rocky Mountains also leave their breeding range before undertaking their prebasic molts (Table 1). Virtually all *bullockii* specimens from this

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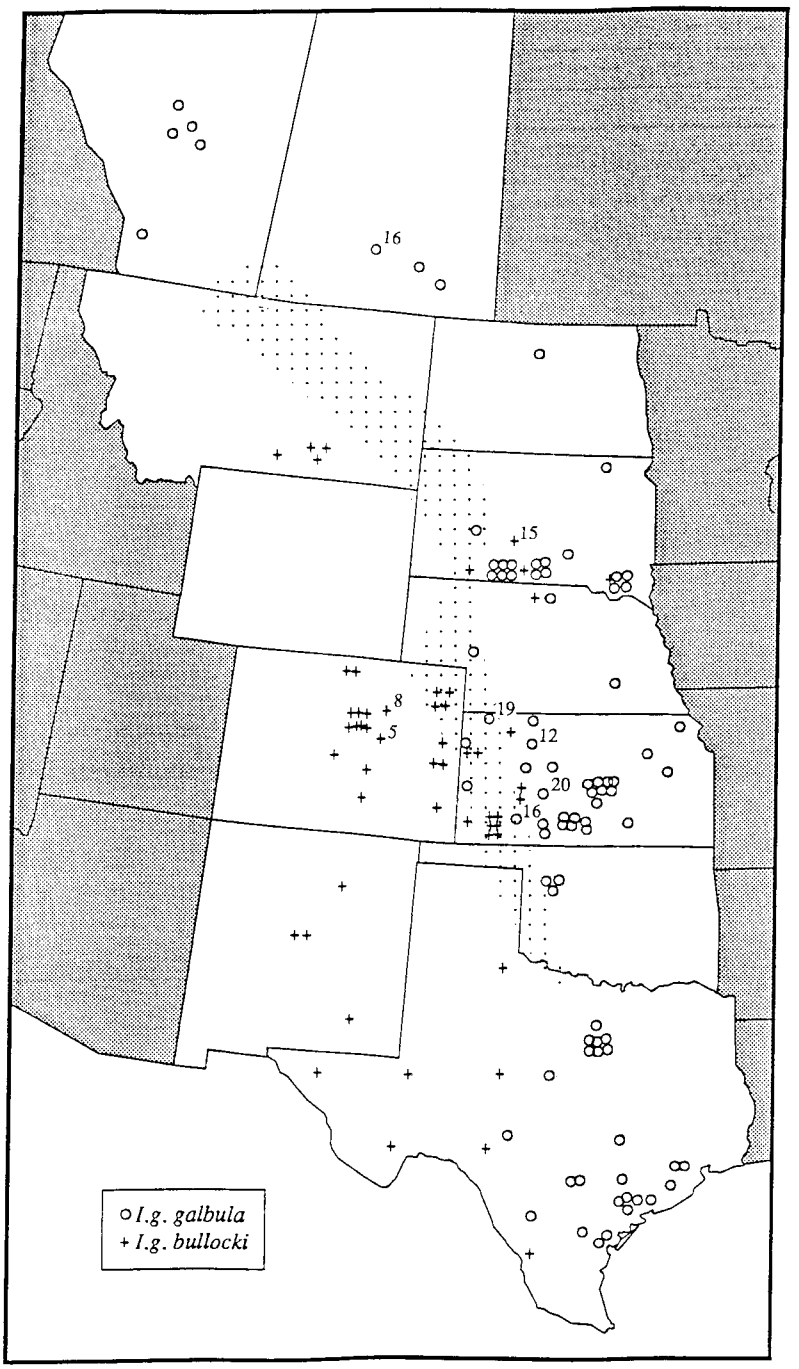

FIGURE 1. Collection localities for the *galbula* (○) and *bullockii* (+) specimens included in this study. Light stippling shows the hybrid zone after Rising (1983). For multiple specimens from a single locality, the number of birds is given above and to the right of the species symbol.

TABLE 1. Numbers of hatching year (HY) and after hatching year (AHY) orioles from the Great Plains listed by species, plumage and date.

	galbula						*bullockii*					
	Juvenile or worn breeding plumage		Molting		Fresh basic plumage[1]		Juvenile or worn breeding plumage		Molting		Fresh basic plumage	
	HY	AHY	HY	AHY	HY	AHY	HY	AHY	HY	AHY	HY	AHY
July 1–15	4	31	2	3	0	0	7	36	0	0	0	0
July 16–31	3	6	9	9	0	1	10	1	2	1[2]	0	0
Aug 1–15	0	0	2	13	2	4	12	2	0	0	0	0
Aug 16–31	0	0	0	2	4	27	6	0	0	0	0	0
Sept 1–15	0	0	0	2	11	25	1	0	0	1[3]	0	0
Sept 16–30	0	0	0	0	1	12	0	0	0	0	0	0

[1] Females were entered in this category as AHY birds, except for five birds known to be HY by skull ossification data.
[2] This adult male (Bell 21042) from Gregory Co., South Dakota was replacing primaries 1–3 but showed no body molt.
[3] This adult male (Bell 25716) from Keyapasha Co., Nebraska had completed its body molt but was still growing primaries 7–9.

area either are adults in worn breeding plumage collected in midsummer or are birds entirely in juvenile plumage collected in July or August. Only a single *bullockii* specimen (Bell Museum 25716) had completed its body molt in this breeding area. For *galbula,* however, specimens in molt and specimens in fresh basic plumage are relatively common from the Great Plains (Table 1). We have plotted the distribution of these specimens in Figure 1 where the hybrid zone is also shown (after Rising 1983).

The data of Table 1 and Figure 1 leave little doubt that the dramatic differences in scheduling of the fall molts relative to the fall migration in these two orioles persist where their ranges abut east of the Rockies. That *bullockii* migrates before molting and *galbula* migrates after molting in a region where environmental conditions are much more similar than is the case throughout most of the allopatric ranges of these forms, refutes with reasonable confidence the possibility that these differences are environmentally controlled. We conclude, therefore, that the differences in scheduling of the fall molts and migration between these two orioles are under genetic control. If this is true, these differences could provide a basis for selection opposing hybrids. In support of this idea, Rohwer and Manning (1990) report a hybrid female taken on 1 November in Chihuahua that apparently was undergoing a *second* complete fall molt of her primaries. Perhaps she had molted on her breeding grounds prior to the fall migration, as does *galbula,* and then molted **again** after her fall migration, as does *bullockii.* From studies of F_1 hybrids, Gwinner and Neusser (1985) provide direct evidence that differences in the timing and duration of the postjuvenile molt in African and European populations of Stonechats (*Saxicola torquata*) are under genetic control.

Galbula and *bullockii* also differ in their prealternate molts. Most yearling male *galbula* undergo a moderate to extensive molt of body feathers in spring, while yearling male *bullockii* rarely molt at all in the spring (Rohwer and Manning 1990). If this difference is also under genetic control it should constitute a further source of selection against hybrids.

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