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GENE FLOW OF THE *OBSCURUS* RACE INTO THE NORTH-CENTRAL COLORADO POPULATION OF BROWN-HEADED COWBIRDS

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Abstract.—The Brown-headed Cowbird (*Molothrus ater*), a brood parasite, has recently undergone a wide range expansion and presently breeds throughout most of the United States and Canada. The small southwestern race, *obscurus,* until now has been known to breed only as far north as northern Arizona and northern New Mexico. From the literature and museum collections, it was determined that the northwestern race, *artemisiae,* has been the most abundant race in Colorado, with the eastern race, *ater,* more prevalent in the eastern portion of the state. No *obscurus* specimens from Colorado were found in museum collections. As nestlings, the *obscurus* race can be distinguished from the other two races by bright yellow rictal flanges. During the breeding season of 1985 in Boulder County, Colorado, five yellow-flanged *obscurus* cowbirds, which represented 21% of the cowbird nestlings hatched, were observed in the nests of Red-winged Blackbirds (*Agelaius phoeniceus*). In 1985 and 1986, twenty adult cowbirds, three (15%) of which were identified as *obscurus,* were collected. The wing chords of adult male *artemisiae* cowbirds collected in 1985 and 1986 were significantly smaller than adult male *artemisiae* cowbirds collected in Colorado prior to 1943. The presence of yellow-flanged nestlings and *obscurus* adults indicate a range expansion of *obscurus* into Colorado, and the trend towards smaller *artemisiae* suggests gene flow of *obscurus* into the Colorado population.

FLUJO GENÉTICO DE LA RAZA *OBSCURUS* EN LAS POBLACIONES DE *MOLOTHRUS ATER* DE LA PARTE NOR-CENTRAL DE COLORADO

Sinopsis.—El tordo de cabeza parda (*Molothrus ater*), el cual es un parásito reproductivo, ha experimentado expansión territorial recientemente y en la actualidad se reproduce en gran parte de los Estados Unidos y Canadá. De la pequeña raza del suroeste, *obscurus,* se conocía que su extensión territorial al norte llegaba hasta el norte de Arizona y de Nuevo México. De la literatura y de colecciones de museos se determinó que la raza del noroeste, *artemisiae* ha sido la más abundante en Colorado; con la raza del este, *ater* más prevaleciente en la porción este del estado. De localidades de Colorado no se encontró ningún espécimen de *obscurus* en colecciones de museos, cuyos pichones pueden ser diferenciados de otras razas por la coloración de amarillo brillante del borde rictal. Durante la época reproductiva del 1985 se encontraron en el Condado de Boulder, cinco individuos de *obscurus,* que representaron el 21% de los pichones de tordos que nacieron, en nidos de *Agelaius phoeniceus.* Durante 1985 y 1986, de 20 tordos adultos coleccionados, tres (15%) fueron identificados como de la raza *obscurus.* El largo del ala de machos adultos de la raza *artemisiae* que fueron coleccionados durante el 1985 y 1986 resultó ser significativamente menor que la de machos adultos de esta raza coleccionados en Colorado previo al 1943. La presencia de pichones y adultos de *obscurus* en Colorado, indica expansión territorial de esta raza en el área. La tendencia hacia individuos más pequeños de *artemisiae* sugiere además flujo genético de la raza *obscurus* en las poblaciones de Colorado.

The Brown-headed Cowbird (*Molothrus ater*) is a brood parasite that has undergone a wide range expansion and is presently found throughout most of the United States and much of Canada (Mayfield 1965). There

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are three recognized subspecies, the eastern race, *ater,* the northwestern race, *artemisiae,* and the small southwestern race, *obscurus.* Bailey and Niedrach (1965) suggested that only *ater* and *artemisiae* breed in Colorado. Collections at the Denver Museum of Natural History and the University of Colorado Museum indicate that historically *artemisiae* has been the most abundant race throughout most of Colorado, with *ater* appearing in eastern Colorado. Phillips et al. (1964) noted that the *obscurus* race extended only as far north as northern Arizona and northern New Mexico; they suggested that the overlap of *obscurus* and *artemisiae* in northern Arizona may be a result of a northward range expansion by *obscurus.* Before specimens from this study were deposited, there were no *obscurus* specimens from Colorado in either the Denver Museum of Natural History or the University of Colorado Museum.

Geographic variation in rictal flange color in nestling Brown-headed Cowbirds correlates with the known distribution of the three subspecies (Fleischer and Rothstein 1988, Rothstein 1978). Fleischer and Rothstein (1988) suggested that, as nestlings, the *obscurus* race may be distinguished from the other two by bright yellow rictal flanges; *ater* and *artemisiae* have white or extremely pale yellow flanges. No intermediate forms have been reported. The purpose of this paper is to report the presence of *obscurus* in north-central Colorado and to report a general trend towards smaller cowbirds in Colorado.

STUDY AREAS AND METHODS

Assessing subspecies status of nestlings.—We searched for parasitized Red-winged Blackbird (*Agelaius phoeniceus*) nests in nine cattail (*Typha latifolia* and *T. angustifolia*) marshes and two flooded willow (*Salix* sp.) stands in eastern Boulder County, Colorado, from 1984 through 1986. As part of other studies (Ortega and Cruz 1988, 1991), we transferred 23 cowbird eggs from Red-winged Blackbird nests to Yellow-headed Blackbird (*Xanthocephalus xanthocephalus*) nests in the same area. Consequently, some cowbirds were raised and followed in Yellow-headed Blackbird nests. Nests were identified with uniquely coded tags; they were visited every 1–3 d, and nest contents were recorded. Rictal flange color was noted for all nestling cowbirds, and color slides were taken for all yellow-flanged cowbirds and most white-flanged cowbirds.

Assessing subspecies status of adult cowbirds.—Adult cowbirds were collected during May and June in 1984–1986 at a cattle feed lot near the most southern of Swede Lakes, 11 km northeast of Boulder, Boulder County, Colorado. We captured cowbirds in mist nets with permission from the U.S.F.W.S. (PRT-677812) and the Colorado Division of Wildlife (86-0070). Twenty after-second-year (ASY) and second-year (SY) cowbirds were prepared as study skins and deposited at the University of Colorado Museum.

Cowbirds were weighed with a 50-g or 100-g Pesola spring scale immediately after collection and measured with a Mitutoyo metal dial caliper. Measurements were taken of wing chord, tarsus length, culmen

TABLE 1. Ranges (in mm with means in parentheses) of measurements of three races of Brown-headed Cowbirds (Oberholser 1974).

Race	Sex	Wing chord	Culmen length
artemisiae	Male	110.0–117.3 (113.5)	17.5–19.8 (18.3)
	Female	97.1–104.9 (101.9)	15.0–17.0 (15.7)
obscurus	Male	94.7–104.6 (100.3)	15.2–17.8 (16.5)
	Female	87.6–90.9 (89.7)	13.5–14.5 (14.0)
ater	Male	104.9–113.8 (109.2)	17.3–18.8 (17.5)
	Female	96.5–101.1 (97.6)	15.0–16.0 (15.2)
Race	Sex	Bill depth	Tarsus length
artemisiae	Male	9.7–10.7 (10.2)	26.2–28.8 (27.7)
	Female	9.4–10.4 (9.9)	25.9–27.9 (27.2)
obscurus	Male	8.6–10.4 (9.1)	22.6–26.4 (24.1)
	Female	8.6–9.1 (8.9)	22.6–23.9 (23.4)
ater	Male	10.2–11.4 (10.7)	24.4–26.7 (25.7)
	Female	9.9–10.7 (10.2)	23.6–25.9 (24.6)

length, length between nares and culmen tip, bill width, and bill depth according to standard museum measurements (Baldwin et al. 1931). Where possible, specimens were identified to subspecies level according to Oberholser (1974). The relative sizes of males and females of the three races are shown in Table 1 (Oberholser 1974).

RESULTS

Five of the 34 cowbird eggs that hatched produced nestlings with bright yellow rictal flanges. All five yellow-flanged birds were found in 1985 and represent 21% of cowbird nestlings hatched that year. No intermediate forms between bright yellow and white were observed; however, two of the five yellow-flanged birds were in nests that contained two cowbird eggs. In both cases, the other cowbird egg hatched a white-flanged cowbird.

Measurements of all birds deposited in the University of Colorado Museum from this study are listed in Table 2. Of 20 SY and ASY cowbirds collected, 12 (60.0%) were identified as *artemisiae,* three (15.0%) were identified as *obscurus,* one (5.0%) as *ater,* and four (20.0%) were not unidentified to subspecific level. The two females identified as *obscurus* had wing chords intermediate between *obscurus* and *artemisiae,* but their bills are well within the range of *obscurus* and well outside the range of *artemisiae.* All birds identified as *artemisiae* had long slender bills with straight culmens, whereas the *ater* had a more convex, deeper bill. Individuals identified as *obscurus* had bills similar to *artemisiae* in shape but smaller. If *obscurus* has recently expanded its range into Colorado, one could predict that incorporation of *obscurus* genes into the population would produce individuals with some intermediate characters and that the population would show a trend towards smaller individuals. Indeed, ASY males collected in this study and identified as *artemisiae* have sig-

TABLE 2. Measurements of after-second-year (ASY) and second-year (SY) Brown-headed Cowbirds collected in Boulder County, Colorado, 1984–1986. All specimens are deposited in the University of Colorado Museum.

	Museum number	Date	Weight (g)	Wing length (mm)	Tarsus length (mm)	Culmen length (mm)	Nares–culmen tip (mm)	Bill width (mm)	Bill depth (mm)
ASY females									
artemisiae	UCM 11591	05/18/1986	32.0	97.77	23.07	16.07	10.54	8.28	9.23
	UCM 11444	05/18/1986	40.0	98.55	23.30	15.34	10.12	8.34	9.75
obscurus	UCM 11447	06/18/1986	28.0	95.13	22.16	13.02	9.52	7.46	8.37
	UCM 11624	06/04/1984	35.5	95.10	22.82	14.17	10.17	8.07	9.38
unidentified	UCM 11592	05/10/1986	46.0	96.46	23.62	15.31	9.90	8.12	9.47
	UCM 11622	06/02/1986	42.0	101.43	24.24	16.13	10.57	8.97	9.70
	UCM 11626	05/15/1985	41.0	97.36	23.47	15.68	11.12	8.07	9.71
ASY males									
artemisiae	UCM 11445	05/10/1986	63.0	113.85	25.89	16.92	11.68	8.84	10.45
	UCM 11100	05/10/1986	62.0	113.10	26.84	19.23	13.38	9.29	10.52
	UCM 11623	05/12/1986	53.0	108.25	25.72	17.72	12.09	9.63	10.33
	UCM 9999	05/14/1986	54.0	110.71	25.70	18.49	12.27	9.81	9.78
	UCM 11628	05/14/1986	50.5	107.22	25.18	16.18	11.35	8.92	9.92
	UCM 11645	05/14/1986	54.0	106.05	25.58	16.98	11.08	9.02	10.28
ater	UCM 11442	05/10/1986	54.0	111.52	25.86	17.72	11.82	8.88	10.38
SY males									
artemisiae	UCM 11627	05/14/1986	49.0	109.30	24.74	17.65	12.23	8.92	10.20
	UCM 10000	05/14/1986	55.0	111.38	26.26	17.56	12.26	9.27	10.68
	UCM 11646	05/18/1986	56.0	104.72	24.73	17.33	11.77	9.03	10.30
	UCM 11443	05/12/1986	59.0	116.64	25.12	17.82	11.95	9.63	10.20
obscurus	UCM 11446	05/10/1986	49.0	101.55	22.68	15.90	11.42	8.42	9.17
unidentified	UCM 11625	05/16/1984	59.0	106.05	25.27	17.94	12.38	9.12	9.62

TABLE 3. Measurements of *artemisiae* cowbirds collected in Colorado prior to 1943. Specimens are from both the University of Colorado Museum (UCM) and the Denver Museum of Natural History (DMNH).

Museum number	Date	Location	Wing length (mm)	Tarsus length (mm)	Culmen length (mm)	Nares–culmen tip (mm)	Bill width (mm)	Bill depth (mm)
ASY females								
DMNH 3208	05/12/1915	Montezuma Co.	100.67	24.12	16.02	10.57	8.41	9.38
UCM 11436	Spring 1908	El Paso Co.	97.39	22.66	15.42	9.98	8.48	9.54
SY females								
DMNH 14370	05/1912	Jefferson Co.	100.67	22.48	15.04	10.20	8.13	9.17
DMNH 3547	05/06/1913	Montezuma Co.	99.17	23.74	15.57	10.49	8.08	9.62
ASY males								
DMNH 3207	05/16/1913	Montezuma Co.	109.73	25.84	17.67	12.98	8.59	10.07
DMNH 23919	05/16/1942	Arapahoe Co.	113.55	26.40	15.82	10.90	9.27	10.90
DMNH 4640	05/15/1915	Montrose Co.	114.20	25.32	16.70	12.05	9.27	9.65
UCM 11435	Spring 1908	El Paso Co.	115.46	26.84	18.33	12.66	9.77	11.59
UCM 11434	12/06/1875	Fremont Co.	114.91	24.60	16.32	11.77	8.87	9.75
SY males								
DMNH 1329	06/19/1911	Routt Co.	115.57	26.03				
DMNH 27608	05/30/1900	Henderson Co.	118.14	26.19	17.46	12.38	9.62	

nificantly shorter wing chords than *artemisiae* ASY males collected in Colorado prior to 1943 (Table 3), with the ranges barely overlapping ($P < 0.05$, $t = 2.168$, df = 9, 1-tailed t-test). The sample of all ASY male cowbirds collected in this study, regardless of subspecific status, also had significantly shorter wing chords than *artemisiae* ASY males collected in Colorado prior to 1943 ($P < 0.05$, $t = 2.177$, df = 9, 1-tailed t-test). Other measurements, however, did not differ between recent and historic specimens.

DISCUSSION

The *obscurus* race has undergone a northward range expansion in California (Fleischer and Rothstein 1988), but the present, northern extent of the eastern and central portions of its range is not well known. In 1929, the *obscurus* race was found north only as far as lower California in the contiguous United States (Friedmann 1929). Bent (1958) and Phillips et al. (1964) reported that the breeding range of the *obscurus* race extended only into extreme southwestern Utah, north-central and southeastern Arizona, north-western and central-southern New Mexico, and western and southern Texas. The presence of yellow-flanged cowbird nestlings and *obscurus* adults may indicate a northward expansion by *obscurus* into north-central Colorado, and the smaller size of the cowbirds collected in this study as compared with historic specimens suggests that *obscurus* genes may already be well incorporated into the Colorado population.

The occurrence of two nests that contained both a yellow-flanged and a white-flanged cowbird is noteworthy. The eggs may have been laid by two different females or they could have been laid by one female. If the eggs were laid by the same female, this suggests that one of the nestlings (most likely the white-flanged nestling) may be heterozygous for rictal flange color. If yellow flange color is the result of a recessive allele, this may explain why yellow-flanged cowbirds do not appear more often in Colorado. To comprehend more fully cowbird races, the range of *obscurus,* and the genetics of rictal flange color in nestling cowbirds, the nestling flange color should be monitored by individuals working with cowbirds and with cowbird hosts, particularly close to the zones of overlap.

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