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HYBRIDIZATION BETWEEN BLACK-CHINNED (*ARCHILOCHUS ALEXANDRI*) AND RUBY-THROATED (*A. COLUBRIS*) HUMMINGBIRDS IN OKLAHOMA

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Abstract—Hybrid zones are of interest because they are systems in which direct analysis of evolution and speciation are possible. Black-chinned (*Archilochus alexandri*) and Ruby-throated (*A. colubris*) hummingbirds have breeding ranges that overlap in Oklahoma, making hybridization possible. There are only two documented cases of hybridization between these species in the literature (one in Oklahoma and one in Texas), but since 2004, 11 hybrids have been banded in southwestern and central Oklahoma. This suggests that hybridization occurs more frequently than previously thought.

"Hybrid zones" are regions where genetically distinct populations come into contact and interbreed (Barton and Hewitt 1985). These zones typically occur where breeding ranges of two closely related species overlap (Barton and Hewitt, 1985, Harrison 1993). Hybrid zones are important because they provide a model for studying divergence and speciation (Hewitt 1988). Not all hybrid zones have the same characteristics, so several theories have been developed to define hybrid zones based on dispersal and selection against hybrids (Barton 1979).

Four hybrid zone models are frequently mentioned in the literature. The first is the Environmental Gradient Model in which hybrid zones remain stable because each parental species is dependent upon specific habitat requirements. The hybrid zone occurs at the boundary of these requirements which keeps hybridizing species from blending over time (Barton and Hewitt 1989, Endler 1973, 1977, Haldane 1948, May et al. 1975, Slatkin 1973). The second is the Bounded Hybrid Superiority Model in which hybrids are more fit than the parental types in the transitional portion of the environmental gradient, but less fit outside the hybrid zone (Moore 1977, Moore and Buchanan 1985, Moore and Price 1993, Pierotti and Annett 1993). The third is the Tension Zones/Dynamic Equilibrium Model in which the hybrid zone is not affected by environmental conditions but is maintained by a balance between selection against hybrids (i.e. parental types have a reproductive advantage) and dispersal by the parental types into the hybrid zone (Barton and Hewitt 1985, Bazykin 1969, Key 1968, Moore 1977). Fourth is the Transient Hybrid Zone in which competitive interaction between species causes hybrid zones to change location. Sometimes new competitive interactions cause the local extinction or replacement of one species by another, such as Golden-winged Warblers (*Vermivora chrysoptera*) being replaced by Blue-winged Warblers (*V. pinus*) in the eastern U.S. and

Canada (Vallender et al. 2007). Monitoring the hybrid zone between two closely related species can reveal factors that contribute to speciation and/or extinction.

Oklahoma is an excellent place to study hybridization, as a number of eastern species reach their westernmost range and a number of western species reach their easternmost range in the state (Swenson and Howard 2005). The two species of hummingbirds (family Trochilidae) in the genus *Archilochus* are the only hummingbirds documented to breed in Oklahoma. Ruby-throated Hummingbirds (*Archilochus colubris*) breed in the eastern U.S. and Canada from Nova Scotia west to central Alberta, and south to eastern Texas and central Florida (Robinson et al. 1996; Fig. 1). According to the 1997–2001 Oklahoma Breeding Bird Atlas, Ruby-throated Hummingbirds were confirmed as breeders throughout eastern Oklahoma and locally in southwestern Oklahoma, but were not found in northwestern Oklahoma and the Panhandle (Reinking 2004).

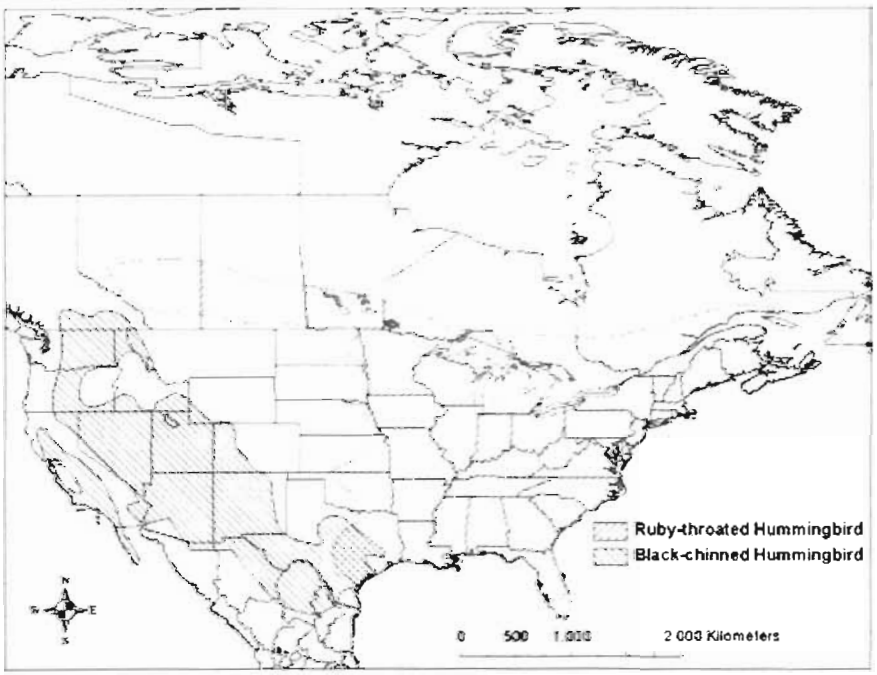

Figure 1. Breeding range of Black-chinned and Ruby-throated hummingbirds (http://www.natureserve.org).

Black-chinned Hummingbirds (*Archilochus alexandri*) breed from central Texas and northern Mexico west to California and northern Baja California and north to interior southern British Columbia (Baltosser and Russell 2000; Fig. 1). Although many published range maps do not show the species breeding in Oklahoma (e.g. Baltosser and Russell 2000, Howell 2003), Black-chinned Hummingbirds were confirmed as breeders in Comanche and Cimarron counties, and were listed as probable breeders in Stephens

County during the 1997–2001 Oklahoma Breeding Bird Atlas (Reinking 2004). In addition, Black-chinned Hummingbirds have recently been documented breeding as far north as Grady County, Oklahoma (Butler et al. 2007) and Thompson et al. (2011) suggested that the species might breed in southwestern Kansas indicating a possible northern shift in breeding range.

The distribution of Black-chinned Hummingbirds in Oklahoma during the breeding season is not well understood, perhaps because female Black-chinned Hummingbirds are difficult to separate from female Ruby-throated Hummingbirds. Identification typically relies upon a detailed study of individual primaries and rectrices (Pyle 1997). In order to identify the Oklahoma counties where this species occurs during the period mid-May through June (i.e. when birds should be on territory and before individuals begin migrating south), county records of Black-chinned Hummingbirds in Oklahoma were obtained from Sutton (1967), Vacin (1969), Brown (1973), Hawthorne (1977), Baumgartner and Baumgartner (1992) Reinking (2004), and Tyler (2005). Black-chinned Hummingbird data were also downloaded from the North American Breeding Bird Survey website (http://137.227.245.162/bbs/). In addition, county records were obtained from *North American Birds* for the period 1973–2008. Finally, a request for sightings was sent out to the OKBIRDS-L listserv. Black-chinned hummingbirds have been observed in much of western Oklahoma, east to Bryan County and north to Grant County (Fig. 2)

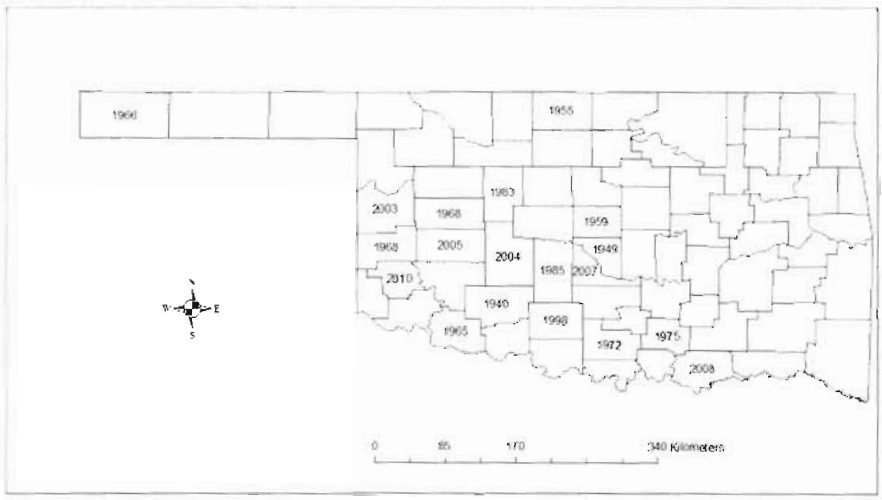

Figure 2. Oklahoma counties with records of Black-chinned Hummingbirds during May and June. The year of the first May or June record is indicated.

The breeding ranges of Ruby-throated Hummingbirds and Black-chinned Hummingbirds overlap in central and southern Oklahoma making hybridization possible. Possible hybrids of these two species have been observed in Oklahoma County, Oklahoma (Vacin 1969) and Grayson County, Texas (Pulich 1988). The reported Oklahoma hybrid was male and had purple iridescent feathers with a reddish tint in a band on the lower portion of the gorget (Vacin 1969). The reported Texas hybrid was found dead and was not described (Pulich 1988).

In April of 2006 and 2007, 183 hummingbirds were banded by N. Batchelder within Grady and Comanche Counties (Fig. 3) to determine the relative proportion of Black-chinned Hummingbirds to Ruby-throated Hummingbirds. Thirty-seven Ruby-throated hummingbirds and 136 Black-chinned hummingbirds were banded during the study period. Twenty-one were adult male Ruby-throated hummingbirds and 62 were adult male Black-chinned hummingbirds. Ten apparent male hybrids (Fig. 4) were banded that were very similar to the description provided by Vacin (1969).

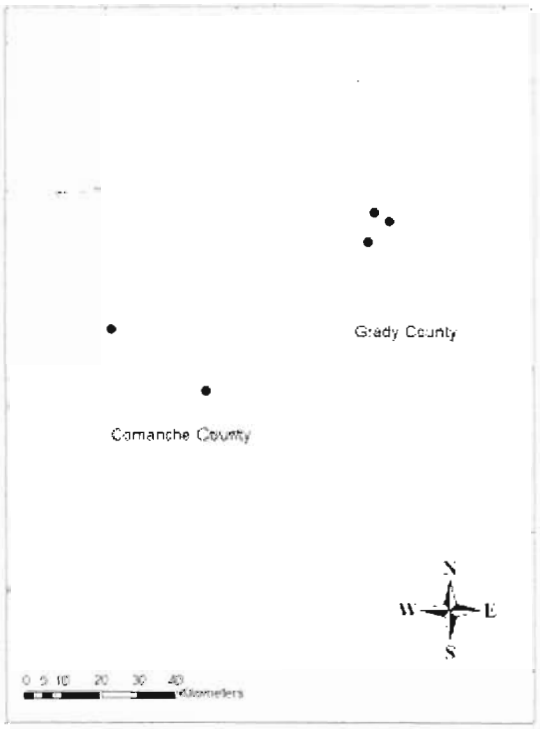

Figure 3. Approximate locations in Grady and Comanche counties where N. Batchelder banded 183 hummingbirds in 2006 and 2007.

From 2007 to 2009 we banded 77 hummingbirds in Grady County to document the presence of hybrids. Thirty Ruby-throated hummingbirds and 46 Black-chinned hummingbirds were banded during this period. Nine were adult male Ruby-throated hummingbirds and 15 were adult male Black-chinned hummingbirds. One apparent male hybrid was banded during the study. We identified male hybrids as those with intermediate gorget coloration between purple and red. Female hybrids were not identified due to the similarity between the females of the two species.

Figure 4. Comparison of gorget color in adult male *Archilochus* hummingbirds. Ruby-throated (left) has a red gorget forming a wide band across the throat. Black-chinned (center) gorget is black on the chin with a lower band of purple on the throat. Apparent hybrids (right) have a magenta gorget on the throat with black feathers comprising about thirty percent of the chin. (Photographs by courtesy of C. Butler.)

During the course of this study, 30 adult male Ruby-throated hummingbirds, 77 adult male Black-chinned hummingbirds, and 11 male hybrids were banded. A total of 118 adult male hummingbirds were banded, with 9.3% of them being apparent hybrids. Banding 11 apparent male hybrids from 2006 to 2009 suggests that hybridization between the two *Archilochus* species in Oklahoma is widespread. Previously, apparent hybrids had only been reported from Oklahoma City, OK and Sherman, TX, but we have determined that they are more numerous than previously thought. Black-chinned Hummingbirds appear to be expanding their range farther north, causing more frequent overlap with Ruby-throated Hummingbirds. Although further study is called for, the relatively extensive hybridization in Oklahoma appears to fit the Transient Hybrid Zone model. It would be interesting to study the extent of hybridization between these two species in central and northern Texas where their ranges have historically overlapped to

determine whether hybrids are also relatively common in this area. In order to identify female hybrids, we believe that a genetic analysis (mtDNA analysis to determine the maternal species and microsatellite analysis to determine the paternal species; Helbig et al. 2001) would be required. While the gorget coloration can be used to identify apparent male hybrids, a genetic analysis combined with an analysis of apparent hybrid wing length and shape, culmen length, dorsal feather color, and flank feather color needs to be done to assist in field identification of non-adult male hybrids.

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