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Prolonged Interspecific Care of Two Sibling Golden-winged Warblers (*Vermivora chrysoptera*) by a Black-and-white Warbler (*Mniotilta varia*)

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ABSTRACT.—We observed a fledgling abandonment and adoption event that subsequently led to an extended period of interspecific parental care between a male Black-and-white Warbler (*Mniotilta varia*) and two radio-tagged fledgling Golden-winged Warbler (*Vermivora chrysoptera*) siblings. Both fledglings were initially accompanied by their maternal Golden-winged Warbler until 5 and 9 days after fledging. At this time, a male Black-and-white Warbler began feeding both fledglings, and maternal care ceased. In the 23 days we monitored the fledglings between onset of interspecific feeding and independence, the male Black-and-white Warbler was observed with at least one of the fledglings on 20 of those occasions. Furthermore, the Black-and-white Warbler was seen feeding at least one of the fledglings on 16 of those visits. We photographed several feeding events. The Black-and-white Warbler remained with the fledglings until they successfully reached independence 28 days post-fledging. *Received 26 October 2015. Accepted 6 February 2016.*

Key words: fledgling abandonment, fledgling adoption, interspecific feeding, *Mniotilta varia*, *Vermivora chrysoptera*.

Until recently, the behaviors exhibited by many bird species during the post-fledging period have remained largely mysterious to biologists (Morton 1991, Baker 1993, Anders et al. 1997). Unlike with conspicuous, territorial adults, in-depth studies of post-fledging songbirds have long remained out of reach for researchers because of the secretive nature of passerines and their young during this period (Sullivan 1989, Anders et al. 1998, White and Faaborg 2008). The post-fledging period is primarily characterized by parental care of juveniles and post-natal dispersal and habitat shifts (Moreno 1984, Kershner et al. 2004, White and Faaborg 2008). Recent advances in radio-tracking technologies have allowed for the miniaturization of radio-transmitter devices such that even very small animals (e.g., Neotropical migratory birds <10g) can be tagged and tracked. As such, studies of fledgling songbirds are now possible (Sykes et al. 1990, Neudorf and Pitcher 1997, King et al. 2006). Unsurprisingly, many studies of post-fledging songbirds report fledglings being fed by their biological parents (Wheelwright et al. 2003, Grüebler and Naef-Daenzer 2010). However, interspecific feeding, where adult birds offer parental care to the non-parasitic young of another species has also been observed (Shy 1982, McNair and Duyck 1991). In fact, accounts of interspecific feeding cover a wide breadth of avian taxa, occurring in at least 22 families comprised of 71 species of non-brood parasitic birds (Shy 1982, McNair and Duyck 1991). While accounts of interspecific feeding are taxonomically widespread, the behavior is considered rare in the wild, and interspecific feeding is even less commonly reported when the adopted species has reached the fledgling phase (Shy 1982). In at least 140 cases of interspecific parenting behavior in the wild, only 41 (29%) involved fledglings (Shy 1982).

Overlap of breeding ranges and overlap in habitat use during the fledgling stage are clearly preconditions for instances of interspecific feeding (Shy 1982, McNair and Duyck 1991). In eastern North America, Black-and-white Warblers (*Mniotilta varia*) have been observed feeding the young of other wood warbler species in two independent reports (Kendeigh 1945, Rea 1945). Rea (1945) observed a male Black-and-white Warbler feeding nestling Worm-eating Warblers (*Helmitheros vermivorum*). In this case, each feeding attempt by the Black-and-white Warbler was met with aggression by the attendant adult Worm-eating Warblers, but the Black-and-white Warbler continued to feed the nestling Worm-eating Warblers. Likewise, Kendeigh (1945) observed a male/female pair of Black-

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and-white Warblers feeding an evidently orphaned fledgling Ovenbird (*Seiurus aurocapilla*).

Golden-winged Warblers (*Vermivora chrysoptera*) have extensive breeding range overlap with Black-and-white Warblers across large portions of eastern and central North America (Confer 1992, Kricher 1995). Within their overlapping ranges, both species use early-successional plant communities for nesting and brood rearing (Schulte and Niemi 1998, Bulluck and Buehler 2006). Habitats such as timber harvests host high rates of occupancy for both species with co-occurrence rates as high as 77% (Bakermans et al. 2011). Indeed, there appears to be a high potential for contact between these two species within their shared breeding range.

Here, we describe our extensive observations of interspecific parental care of two sibling Golden-winged Warblers by an adult male Black-and-white Warbler in northeastern Pennsylvania. Our observations are the first reported instance of Golden-winged Warblers being involved in interspecific feeding activity in any capacity and represent the longest instance of interspecific care of fledglings by a wild non-captive passerine (Shy 1982, McNair and Duyck 1991). Our observations and previously reported instances of interspecific care raise the question of the relative frequency of interspecific parental care in wood warblers.

METHODS

The observations presented here were made during our primary study of fledgling ecology of Golden-winged Warblers within Pennsylvania's Delaware State Forest, where breeding populations of Golden-winged Warblers are relatively common (Wilson et al. 2012). We began searching for nests of Golden-winged Warblers in mid-May within regenerating timber harvests. To locate Golden-winged Warblers' nests, we used (i) active searching techniques (in areas with high perceived probability of hosting a nest), (ii) observations of nest-building behaviors, and (iii) observations of parental feeding of nestlings or alarm chips. In addition to monitoring each located nest every 3 days, we also recorded the phenotypes (Golden-winged Warbler, or Blue-winged x Golden-winged Warbler hybrids) of adult birds involved in the care of each nest.

When nestlings were 6–7 days old, we randomly selected two per nest to be fitted with a 0.4-g radio-transmitter (<5% fledgling total body mass) and tracked daily. We chose birds of this age as they were large enough to carry a transmitter in the nest but least likely to force-fledge as a result of our handling (Streby et al. 2013). We tracked radio-marked fledglings daily between 0500 and 1400 Eastern Daylight Time (EDT), and we visually confirmed their survival and habitat use. Upon arriving at a fledgling's location, we observed the target individual for 5–60 mins. Although we occasionally had to approach fledglings closely to confirm daily survival, behavioral observations of adults and juveniles were usually made from a distance (>10m) at which all birds appeared to behave in an undisturbed manner. Upon visual confirmation of a fledgling's location, we collected its coordinates with a handheld GPS unit (eTrex 20, Garmin International Inc., Olathe, KS, USA). We followed this tracking protocol daily until fledgling mortality or radio-transmitter battery failure (~30 days post-activation).

OBSERVATIONS

Between 10 June and 2 July 2015, we closely monitored (up to 1 hr/day) one family of Golden-winged Warblers in response to an interspecific feeding observation. The nest belonging to this pair was similar to other conspecific nests (n = 156) monitored during our primary study. This particular nest was found within a 67-ha timber harvest and was built directly on the ground, anchored to a dead goldenrod (*Solidago* sp.) stem. The final clutch size of six was slightly above the mean of 4.90 ± 0.09 SE for all nests (n = 39) of Golden-winged Warblers we monitored in 2015. The nest was tended by an un-banded male/female pair of phenotypically normal Golden-winged Warblers, and they successfully hatched their full clutch of six eggs. We attached transmitters to two of the six young from this nest and monitored them daily after all six successfully fledged. There was no discernable difference between the two radio-tagged fledglings from this nest, and other radio-tagged fledglings (n = 33) studied in 2015. Both radio-tagged individuals were accompanied by their mother upon fledging (5 June), and sole

FIG. 1. Two feeding sequences between the male Black-and-white Warbler and a fledgling Golden-winged Warbler carrying a radio-transmitter. (A) The Black-and-white Warbler approaches the begging juvenile with a crane fly (family: Tipulidae). (B) The fledgling Golden-winged Warbler with the crane fly in its mouth. (C) The Black-and- white Warbler approaches the juvenile with a smooth green caterpillar and a moth and (D) places both items into the juvenile's mouth.

maternal care of the two radio-tagged fledglings continued until 4 days post-fledging (9 June).

On 10 June, 5 days post-fledging, we first observed one of the radio-tagged fledgling Golden-winged Warblers being led by a male Black-and-white Warbler. The Black-and-white Warbler produced quiet chipping calls to which the fledgling responded by following. This observation was accompanied by multiple instances of the adult male Black-and-white Warbler feeding the radio-tagged offspring. The second fledgling continued to be fed by the female Golden-winged Warbler through 10 June; however, this was the last day we observed the female caring for this offspring. We last observed the female Golden-winged Warbler on 12 June when she was chipping with a prey item near the first radio-tagged fledgling, but she eventually ate the item herself and flew away. On 14 June, we observed the male Black-and-white Warbler feeding the second radio-tagged fledgling Golden-winged Warbler. From 14 June to independence, the two fledglings remained within close proximity of each other (on average 17.5 m across 19 relocations) and the male Black-and-white Warbler. Between fledging and reaching independence (28 days), we recorded the Black-and-white Warbler with at least one of the radio-marked fledgling Golden-winged Warblers 20 times (71% of visits).

From 10–23 June, we regularly observed the Black-and-white Warbler feeding crane flies (Order: Diptera, family: Tipulidae) to the fledglings (Fig. 1), as well as feeding unidentified moths (order: Lepidoptera) between 23 June and 2 July. On very few occasions, we observed the Black-and-white Warbler feeding caterpillars to the

fledglings (Fig. 1). Between fledging and independence, we recorded the Black-and-white Warbler feeding the juvenile Golden-winged Warblers on 16 visits (57% of visits). Other radio-tagged fledgling Golden-winged Warblers we monitored (n = 33) had conspecific parents and were primarily fed green caterpillars during June, with adult moths occasionally being fed from late June through early July. The Black-and-white Warbler remained with the fledgling Golden-winged Warblers until they reached independence (28 days post-fledging, 3 July). Independence was marked by the radio-tagged siblings moving away from each other as well as the absence of parental care. Based on these criteria, both radio-tagged fledgling Golden-winged Warblers reached independence on 3 July. On this date, the fledglings were >1 km apart and the male Black-and-white Warbler was not observed with either fledgling thereafter.

DISCUSSION

We present here the first reported case of interspecific parental care involving offspring of Golden-winged Warblers and a non-*Vermivora* sp. Because we studied Golden-winged Warblers using radio-telemetry, we had the ability to monitor two fledgling Golden-winged Warblers daily and detail their interspecific relationship with an adult Black-and-white Warbler over the course of 23 days. Despite observation bouts lasting up to 60 mins, we never observed the fledglings being provisioned by Golden-winged Warbler parents once the male Black-and-white Warbler was observed feeding the fledglings. Thus, we conclude that the Black-and-white Warbler assumed parental care. The Black-and-white Warbler was frequently seen with at least one fledgling (71% of visits) and was often observed provisioning them (57% of visits). These patterns of behavior suggest that the Black-and-white Warbler successfully reared both fledglings to independence with no subsequent help from the conspecific parents after day 5 post-fledging. Interestingly, the successful rearing of these birds occurred despite the contrasting diet (mostly green caterpillars) offered by adult Golden-winged Warblers, and by the Black-and-white Warbler (mostly adult crane flies). Additionally, in at least two observations, we recorded the juveniles probing leaves on their own, a characteristic foraging behavior used by Golden-winged Warblers, believed to be important for capturing caterpillar prey (Confer 1992).

Several other studies (Hayward 1937, Jackson 1941, Kendeigh 1945) reported that interspecific feeding occurred after abandonment of young. Because we visited fledglings daily, we observed the adoption of these fledglings while simultaneously watching parental care by the mother cease. Our initial observation of the Black-and-white Warbler male caring for the fledgling Golden-winged Warblers was not marked by immediate abandonment of both fledglings by their mother. Thus, we conclude that there was a period of overlap between adoption, and abandonment of the young by their mother. Additionally, in contrast to another known instance of interspecific feeding involving a Black-and-white Warbler (Rea 1945), the female Golden-winged Warbler relinquished parental duties to the Black-and-white Warbler with no apparent interspecific aggression, suggesting that the female Golden-winged Warbler willingly abandoned two of her young. Because only two of six sibling fledglings were radio-tagged, we are unable to speak to the parental care of the other four fledglings. However, because Golden-winged Warblers are a brood-splitting species (where male and female led broods part ways on the landscape; Peterson 2014), it is unlikely that the Black-and-white Warbler cared for both groups of fledglings. Further, we are unable to verify that the female Golden-winged Warbler did not care for non-radio tagged fledglings after the Black-and-white Warbler assumed care of her two radio-tagged fledglings. Perhaps her abandonment of the two-radio-tagged fledglings was facilitated by her inability to care for a higher than average brood size (n = 6). Further, the absence of aggression may have been related to the fact that these juveniles had already fledged the nest, during which time Golden-winged Warblers are known to tolerate the presence of other birds, often foraging with their young in mixed flocks (Will 1986; DJM, pers. obs.).

Prolonged examples of interspecific feeding have been documented by previous researchers. For example, McGowan (1990) observed a pair of Fish Crows (*Corvus ossifragus*) feeding a fledgling Blue Jay (*Cyanocitta cristata*) that began residing within their nest (for reasons unknown)

over the course of 12 days, and Carr and Goin (1965) observed a pair of Eastern Bluebirds (*Sialia sialis*) over the course of 25 days first feeding five nestling Northern Mockingbirds (*Mimus polyglottos*), and later the same mockingbirds after they fledged. Nevertheless, review of known examples for passerines suggests that interspecific feeding events that extend to 23 days, and particularly those resulting in fledgling independence, are quite rare (Shy 1982, McNair and Duyck 1991). The timeframe of our observations, and the lack of any sightings of juvenile Black-and-white Warblers, suggests that the male Black-and-white Warbler lacked fledglings of its own. We conjecture that this male may have been unmated or experienced a nest failure, and was thus available to provision the fledgling Golden-winged Warblers. In the case of nest failure, the Black-and-white Warbler may have used the Golden-winged Warblers as an outlet to expend excess feeding energy that accrued before losing its own young (Skutch 1961).

The begging calls of the fledgling Golden-winged Warblers may have been enough to trigger this behavior in the Black-and-white Warbler (McNair and Duyck 1991, Dróżdż et al. 2004, Farmer et al. 2008). Farmer et al. (2008) suggested that a pair of Palila (*Loxioides bailleui*) may have been unable to provide for their higher than normal amount of young, leading one offspring to solicit food from an interspecific parent. In fact, such observations have been made before involving begging Golden-winged Warbler fledglings in Minnesota (DJM, pers. obs.), but their requests for food were unfulfilled in those cases. Such observations usually involved a fledgling loudly begging in close proximity of a heterospecific adult followed by no response by the unrelated adult.

The rarity of observed interspecific feeding events is likely because of the high energy expenditure incurred when an adult provides food for a fledgling, and the seemingly absent evolutionary advantage to doing so in an interspecific context (Shy 1982, Cockburn 1998). Although the parental behavior of the Black-and-white Warbler was misdirected (Shy 1982, Brown 1987), evolutionary explanations for this type of behavior suggest that it is possible that the male acquired useful brood-rearing experience (Shy 1982). This experience may, in turn, improve the Black-and-white Warbler's reproductive success in subsequent breeding seasons, as is the case with many after-second year birds (De Steven 1978) and birds that assist parents through cooperative breeding (Emlen 1982). Regardless of any benefit conferred, our observations suggest that an interspecific parent is capable of provisioning multiple non-brood-parasitic fledglings for an extended period of time. Our observations clearly demonstrate that the male Black-and-white Warbler successfully completed the rearing of two fledgling Golden-winged Warblers to independence with no obvious detriment to the fledglings' development. While it seems unlikely that we will ever know how this interspecific brood-rearing event influences future reproductive success (i.e., pairing success, nestling and fledgling provisioning) of the two Golden-winged Warblers, the duration and outcome of these observations speaks to the resiliency of fledgling songbirds.

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Hanging out at the Airport: Unusual Upside-down Perching Behavior by Eurasian Jackdaws (*Corvus monedula*) in a Human-dominated Environment

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ABSTRACT.—Animals occupying human-dominated environments show the capacity for behavioral flexibility. Corvids are among the most intelligent synanthropic bird