

= Black @-@ throated blue warbler =

The black @-@ throated blue warbler (*Setophaga caerulescens*) is a small passerine bird of the New World warbler family . Its breeding ranges are located in the interior of deciduous and mixed coniferous forests in eastern North America . Over the cooler months , it migrates to islands in the Caribbean and Central America . It is a very rarely found in western Europe , where it is considered to be a non @-@ indigenous species . The black @-@ throated blue warbler is sexually dimorphic ; the adult male has a black face and cheeks , deep blue upperparts and white underparts , while the adult female is olive @-@ brown above and light yellow below .

Predominantly insectivorous , the black @-@ throated blue warbler supplements its diet with berries and seeds in winter . It builds its nests in thick shrubs and the closeness of its nesting sites to the ground make it a favored species for the study of warbler behavior in the wild . The black @-@ throated blue warbler defends its territory against other birds of the same species for both nesting and winter habitats . As the black @-@ throated blue warbler requires large , unbroken forest areas for nesting , its numbers are declining .

= = Taxonomy and phylogeny = =

The German naturalist Johann Friedrich Gmelin described the black @-@ throated blue warbler in 1789 . Its species name is the Latin adjective *caerulescens* meaning " turning blue " .

The black @-@ throated blue warbler is one of the New World warblers or wood @-@ warblers in the family Parulidae . This species was originally placed under the genus *Dendroica* . It was recently adjusted to be a member of genus *Setophaga* along with all other members of the genus *Dendroica* , based on the findings from a recent phylogenetic analysis of mitochondrial DNA and nuclear DNA in 2010 . The old genus *Dendroica* was then deleted . Within the genus , it appears to have no particularly close relatives .

The species breeds in North America and winters in the Caribbean . Some studies have observed significant differences in terms of migratory behavior and plumage color between northern and southern populations within the breeding range . The northern population mainly winters in the western Caribbean (Cuba and Jamaica) while the southern population usually spends the winter on eastern islands (Hispaniola and Puerto Rico) . Moreover , males in the southern population have darker plumage than those in the northern population . These differences have led biologists to consider them as separate subspecies . However , a recent study in the United States reveals no significant genetic differentiation between northern (samples from Michigan , New Hampshire and New York states) and southern populations (sample from North Carolina) . The study results actually show a recent population expansion from a single glacial refugium , therefore the current populations are homogeneous in terms of genetics . The differentiation that is observed between the northern and southern populations should have occurred quite recently .

= = Description = =

The black @-@ throated blue warbler measures 13 cm (5 @.@ 1 in) in length and weighs 8 @.@ 4 ? 12 @.@ 4 g (0 @.@ 30 ? 0 @.@ 44 oz) . The adult male has white underparts with a black throat , face and flanks . The upperparts are deep blue . The immature male is similar , but with greener upperparts . The female has olive @-@ brown upperparts and light yellow underparts with darker wings and tail , gray crown and brown patches on the cheek . Both sexes have a thin pointed bill and small white wing patches which are not always visible . Like many other warbler species , it has colorful plumage during the spring and summer . However , outside the breeding season its plumage is drab and less distinctive . In the fall , the black @-@ throated blue warbler can be distinguished by its small white wing patches . Juveniles have brown upperparts with a creamy supercilium and brownish spots on the throat , the breast and the belly .

The bird 's song can be described as a buzzed zee @-@ zee @-@ zeeee with an upward inflection . Its call is a flat ctuk .

= = Distribution and habitat = =

The black @-@ throated blue warbler is a migratory species . It breeds in temperate mature deciduous forests or mixed coniferous @-@ deciduous forest with a thick understory . The species is often found in hilly and mountainous regions in the northeastern United States and southeastern Canada . In late summer , it migrates to the tropical wooded and scrub habitats in the Greater Antilles for wintering . Along the migration route , the black @-@ throated blue warbler can be observed in habitats such as parks and gardens . Its nesting site is more important than its foraging site in playing a role in determining the habitat of the black @-@ throated blue warbler . The black @-@ throated blue warbler is an open @-@ nesting species , that nests very close to the ground so it has to choose a protected nesting site where the risk of predation is relatively low .

= = Behavior = =

= = = Feeding and foraging = = =

The black @-@ throated blue warbler forages actively in low vegetation , sometimes hovering or catching insects in flight . It often forages in one area for a while before moving on to the next . It mainly eats invertebrates such as caterpillars , crane flies , and spiders . It may supplement its diet with seeds , berries , and fruit in the winter .

Males and females prefer different foraging sites . While males usually hover among the higher shrub foliage between 3 and 9 m (9 @.@ 8 and 29 @.@ 5 ft) , females tend to forage at lower strata . The time within a breeding season influences where the males forage . When it is time to feed the fledglings , males come down to the same foraging strata as females . The black @-@ throated blue warbler mostly forages in the understory instead of the canopy . The large leaves and long branches in the understory affect its foraging behaviors . The black @-@ throated blue warbler more often hovers rather than gleans its prey because it is more difficult to glean among thick understory foliage .

= = = Breeding = = =

The black @-@ throated blue warbler is a monogamous species . Its breeding season usually begins in May and ends in July . As a songbird , the male black @-@ throated blue warbler attracts a female ? s attention by singing a soft melody . He then follows the female while she is foraging or searching for nesting sites . As soon as the female stops to rest , the male droops his wings slightly , stretches his head forward and up , opens his bill , and faces the female . The female also makes displays to the male by vibrating her wings . In response , the male mounts the female for 2 ? 3 seconds and then flies off .

A 1996 , researchers showed that the black @-@ throated blue warbler prefers to reside in hardwood forests with higher shrub densities where food is more abundant compared to lower shrub density plots . Within these high shrub density habitats , not only is there a higher density of warblers , but the population age average is also older , being composed of males and females who are at least two years of age .

The black @-@ throated blue warbler uses social cues in its evaluation and choice of nesting sites . In particular , it listens to the post @-@ breeding songs given out by other males . These songs have strong temporal dependencies . Males sing at the beginning and the peak of breeding season , but songs are not indicative of reproductive success . Near the end of a breeding season , a male that has successfully mated continues to sing while a male that has failed to reproduce abandons the habitat . Therefore , post @-@ breeding songs are reliable indicators of reproductive success within the particular habitat and convey essential information to the natal and breeding dispersers . In comparison to the traditional idea of direct assessment of the vegetation structure , the vocal cue

is much more efficient and easier to obtain , hence revealing the advantage of social communication in survival and reproduction . A female , however , does not respond to post @-@ breeding songs directly . Instead , she is likely to rely on the presence of males in deciding nesting sites .

= = = Extra @-@ pair mating = = =

Although the black @-@ throated blue warbler is a socially monogamous species , males are frequently observed in territories of other males , suggesting the occurrence of extra @-@ pair matings . Nestling parentage is identified by microsatellites in a study plot at the Hubbard Brook Experimental Forest in New Hampshire . The results show that extra @-@ pair fertilization occurs and that the majority of the extra @-@ pair sires come from males in neighboring territories . Only very few extra @-@ pair sires are from distant territories . This local reproductive interaction is also supported by another study conducted earlier , which finds that extra pair fertilizations are strongly and positively correlated with local synchrony but there is no significant association with population level synchrony .

Males engage in mate guarding during the period females are most vulnerable to successful extra pair copulations . They usually stay close to their social mate , singing slowly on the side and following the mate while she is foraging or searching for a nesting site . The guarding behavior , though , may conflict with males ? pursuit of extra @-@ pair fertilizations . It is not yet clear to what extent a male will prefer mate guarding over extra @-@ pair fertilizations . Male retention studies have shown that removal of a male increases the chance of extra @-@ pair offspring in the brood , suggesting that mate guarding reduces extra @-@ pair fertilization attempts . The extra @-@ pair fertilization rate nonetheless cannot be eliminated even if males are allowed to stay near their social mates during fertility risk period . Several hypotheses try to explain this phenomenon : females may be able to manage extra @-@ pair mating even while its social mate is guarding it , or females may reject extra @-@ pair copulation attempts by other males in the absence of male guarding .

Females who participate in extra @-@ pair fertilizations may incorporate better genes in their offspring than they could get with their social mate , but they are likely to receive less help with parental care from their social mates because of cheating . Extra @-@ pair fertilization , therefore , can be costly to females as well . A possible theory why extra @-@ pair fertilization occurs is that female organisms select males with overall high heterozygosity or dissimilar genetics from themselves . A microsatellite study suggests an alternative to heterozygosity selection . Because no correlation is found between female extra @-@ pair fertilization frequencies and the overall heterozygosity of their social mates , it is suggested that females may choose only a selective set of heterozygous genes , particularly the MHC locus , which can affect the immunocompetence of offspring .

= = = Sexual selection = = =

Males ? differential recognition of local and nonlocal songs has been studied in two populations : one in the northern United States (New Hampshire) and the other in the southern United States (North Carolina) . An asymmetry of response has been found between the two populations . The northern black @-@ throated blue warbler responds strongly to local songs but relatively weakly to the song of southern warblers . In contrast , a warbler from the south responds equally to songs from both the north and the south . A potential explanation of this asymmetry is the difference in female preference between the northern and southern black @-@ throated blue warblers . Females from the north are less likely to mate with a ? heterospecific ? male from the south ; therefore it is not necessary for a northern male to respond strongly to the song of a southern challenger . It is possible that a barrier to gene flow from south to north exists while a barrier to the reverse does not . Therefore , female choice of male songs is likely to play a role in gene flow and reproductive isolation , which may eventually lead to diversification .

It has long been believed that a male black @-@ throated blue warbler achieves reproductive maturation well into its first breeding season . A yearling participates in extra @-@ pair mating and

cuckoldry as much as or even more than older males . However , research by Graves has found opposing evidence in terms of testicular size and sperm production . Directional asymmetry is present in many passerine birds . The left testicle is often larger in size than the right one , and this holds true for both yearling and older male warblers . However , the testicle to body mass ratio nonetheless is much lower in yearlings than in older males . Moreover , older males have a greater degree of directional asymmetry than do yearlings . Because the size of testes in birds is correlated to the ejaculate quality , it is likely that females employ age @-@ dependent choice in favor of older males who can be distinguished by their definitive age @-@ specific plumage .

= = Status and threats = =

The black @-@ throated blue warbler enjoys a large range and a big population . Its population trend is currently increasing . This species was ranked as Least Concern by the IUCN in 2012 . Deforestation and habitat fragmentation are threatening the black @-@ throated blue warbler in its tropical wintering areas . A report in 2000 discussed the impact of global climate change on the population dynamics of the black @-@ throated blue warbler by an observation from 1986 to 1998 . In particular , the effect of El Niño Southern Oscillation (ENSO) was studied in relation to the survival , fecundity and recruitment of this migratory bird . It was found that El Niño years (the warm South Pacific oceanic phase) were associated with lower adult survival rate in their wintering ground , Jamaica , lower fecundity in the breeding habitats in New Hampshire of the United States , and lower annual recruitment of yearlings and juveniles to both breeding and wintering grounds . All the three factors were relatively higher during La Niña years (cold South Pacific ocean) when the weather was wetter and the food availability was much more abundant . Long @-@ term global warming can aggravate the ENSO effect , adding to the fluctuation of the black @-@ throated blue warbler population .