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Photo: Richard R. Veit

Vagrancy and colonization of St. Thomas and St. John, U.S. Virgin Islands, by Adelaide's Warblers (*Setophaga adelaidae*)

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Abstract We identified and photographed five Adelaide's Warblers (*Setophaga adelaidae*) in the Lameshur Bay area on the southeastern corner of St. John, U.S. Virgin Islands, during January 2015, and found eight birds in the same area during January 2016. Adelaide's Warblers, endemic to Puerto Rico and Vieques Island, the latter 67 km to the southwest of St. John, were first recorded in the U.S. Virgin Islands in 2012–2013 on both St. Thomas and St. John. We suggest that vagrancy of Adelaide's Warblers to the U.S. Virgin Islands, against prevailing easterly trade winds, may represent in real time the island colonization process of some passerine birds in the West Indies.

Keywords Adelaide's Warbler, colonization, island biogeography, St. John, St. Thomas, *Setophaga adelaidae*, U.S. Virgin Islands, vagrancy, West Indies

Resumen Divagancia y colonización de Santo Tomás y San Juan, Islas Vírgenes estadounidenses, por Reinita Mariposera (*Setophaga adelaidae*)—En enero de 2015, identificamos y fotografiamos a cinco individuos de Reinita Mariposera (*Setophaga adelaidae*) en el área de la Bahía Lameshur, en el extremo sudeste de San Juan, Islas Vírgenes estadounidenses. También encontramos ocho individuos en la misma zona en enero de 2016. Reinita Mariposera, endémica de las islas de Puerto Rico y Vieques y cuyo punto más cercano a San Juan dista 67 km, fue registrada por primera vez en las Islas Vírgenes estadounidenses en 2012–2013 en ambas islas: Santo Tomás y San Juan. Sugerimos que la divagancia de Reinita Mariposera en las Islas Vírgenes estadounidenses en contra de los vientos alisios predominantes del este pueden representar, en tiempo real, el proceso de colonización de una isla por parte de especies paseriformes en el Caribe Insular.

Palabras clave biogeografía insular, Caribe Insular, colonización, divagancia, Islas Vírgenes estadounidenses, Reinita Mariposera, San Juan, Santo Tomás, *Setophaga adelaidae*

Résumé Erratisme et colonisation de St-Thomas et St-John (Îles Vierges américaines) par la Paruline d'Adélaïde (*Setophaga adelaidae*)—Nous avons identifié et photographié cinq Parulines d'Adélaïde (*Setophaga adelaidae*) dans la région de Lameshur Bay au sud-est de St-John (Îles Vierges américaines), en janvier 2015, et nous avons trouvé huit individus dans la même région en janvier 2016. La Paruline d'Adélaïde, espèce endémique des Îles de Porto Rico et de Vieques - cette dernière étant située à 67 km au sud-ouest de St-John - a été mentionnée à St-Thomas et St-John (Îles Vierges américaines) pour la première fois en 2012–2013. Nous estimons que l'erratisme de la Paruline d'Adélaïde aux Îles Vierges américaines, contre les alizés dominants de secteur est, pourrait illustrer en temps réel le processus de colonisation des Antilles par les passereaux.

Mots clés Antilles, biogéographie insulaire, colonisation, erratisme, Îles Vierges américaines, Paruline d'Adélaïde, St-John, St-Thomas, *Setophaga adelaidae*

The former Adelaide's Warbler (*Dendroica adelaidae*) of Puerto Rico, Barbuda, and St. Lucia has been separated into three

species of the genus *Setophaga*: Adelaide's Warbler (*Setophaga adelaidae*) occurring on Puerto Rico and Vieques Island; Barbuda Warbler (*S. subita*) occurring on Barbuda; and St. Lucia Warbler (*S. delicata*) occurring on St. Lucia (AOU 2000, Chesser *et al.* 2011). Here we describe the recent colonization of St. Thomas and St. John in the U.S. Virgin Islands by Adelaide's Warblers and discuss how vagrancy by these birds is likely the driving force behind speciation of this group in the West Indies.

We have been surveying birds at Lameshur Bay in southeastern St. John 1–4 times per year since January 2011. On each of

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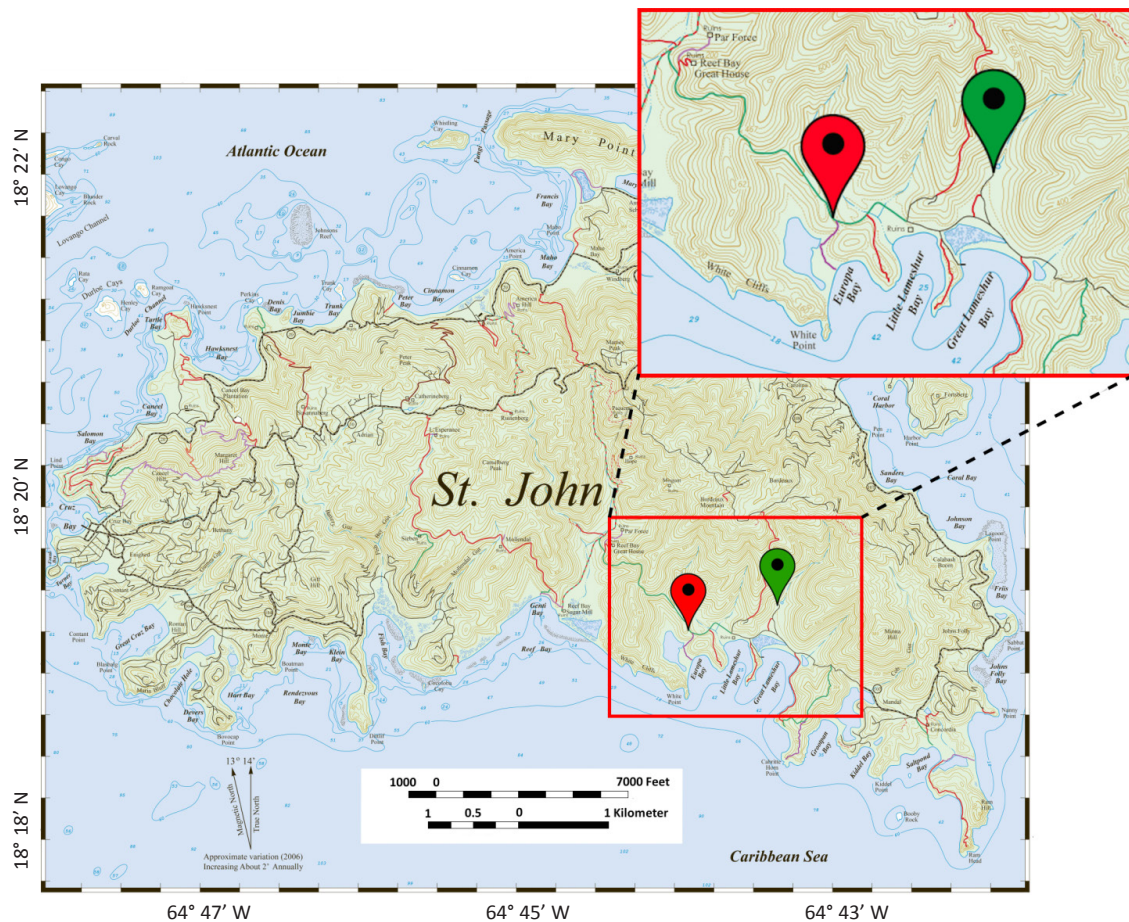


Fig. 1. Location of Adelaide's Warblers on St. John, 2015–2016. Birds were seen and heard singing at the red-marked location, Lameshur Bay Trail. The green-marked location is the Virgin Islands Environmental Resource Station.

our visits, we have hiked the Lameshur Bay Trail (Fig. 1), which runs from Little Lameshur Bay and the Virgin Islands Environmental Resource Station ($18^{\circ}19'13.63''\text{N}$, $64^{\circ}43'45.82''\text{W}$) to the Reef Bay Trail, 4 km to the west ($18^{\circ}19'37.66''\text{N}$, $64^{\circ}44'30.07''\text{W}$). The entire area is within Virgin Islands National Park. On 6 January 2015, we recorded two unfamiliar warblers along the Lameshur Bay Trail, about 1.5 km west of Little Lameshur Bay. The birds foraged actively from the treetops, ~10 m above ground, to about eye level, and interspersed foraging bouts with pauses for singing. They were rather tame and easily observed, and were identified as Adelaide's Warblers. We took a series of photographs (Fig. 2), attracted the birds by playing recordings of their songs made in Puerto Rico, and attempted, unsuccessfully, to mist net them.

Over the course of the next 9 days, 7–15 January, we searched for the birds daily for 2–3 hr at a time covering all portions of daylight hours and identified the presence of five separate individuals. The birds were most active during approximately 0900 to 1400, but were surprisingly quiet and difficult to find during dawn and the early (before 0800) morning hours. They responded enthusiastically to recordings of their songs, as well as to “spishing” and “squeaking” sounds made by the human observers. We identified three different probable males among the birds present because they were singing, and also identified two others that may have been females (no singing and duller plumage;

Curson *et al.* 1994). Staicer (1996) documented that some female Adelaide's Warblers do sing (about 10%), but these female songs differ somewhat from those of males. Nevertheless, we cannot assess with absolute certainty how many of the singing birds that we saw were males, but they sang very frequently, which is more typical of males (Toms 2010a). From 4–14 January 2016, we found eight different birds along the same stretch of trail, all of which sang at least once, but again we cannot confidently assess how many were males.

In light of the recent taxonomic separation of Adelaide's Warbler into three species (AOU 2000), we wanted to ascertain to what species the Virgin Islands birds belonged. The individuals we saw differed from the descriptions of Adelaide's Warbler in Raffaele *et al.* (2003) in that there were broad blackish streaks on the flanks and variation in coloration of the lower eye crescents. To account for this discrepancy, we examined specimens of Adelaide's and St. Lucia Warblers at the American Museum of Natural History (AMNH; Table 1). While the AMNH lacked specimens of Barbuda Warbler, photographs and descriptions of it consistently show unstreaked upper- and underparts, and a gray rather than blackish forecrown, the blackish forecrown being most developed in St. Lucia Warbler and intermediate in Adelaide's Warbler (Toms 2010a, 2010b, Diamond 2011). The AMNH specimens ($n = 6$ Adelaide's Warblers from Puerto Rico and $n = 6$ St. Lucia Warblers from St. Lucia) showed black streaking on

the underparts of birds from both Puerto Rico and St. Lucia, although the streaking was faint on St. Lucia specimens. Furthermore, we found that on specimens from Puerto Rico, the lower eye crescent was white, in contrast to the observed warblers on St. John, of which some had yellow lower eye crescents (Fig. 2a) while others had more whitish ones (Fig. 2b). In addition, Ridgway (1902; quoted in Toms 2010a) states that adult male Adelaide's Warblers have yellow lower eye crescents ("suborbital spots"), whereas juveniles can have either yellow or white suborbital spots. Although Curson *et al.* (1994) imply that adult females do not differ from adult males in this respect, the bird shown in Fig. 2a was singing frequently and clearly has a yellow lower eye crescent, while the bird in Fig. 2b was not singing and has a white crescent. Further work is needed to fully understand the species- and population-level variation in eye crescent coloration in this group of warblers, but we speculate that it could possibly differ between sexes or age groups of Adelaide's Warbler. Nevertheless, we assert that the birds we saw and photographed in the U.S. Virgin Islands most closely resemble Ade-

Table 1. Plumage characteristics of Adelaide's (Puerto Rico) and St. Lucia Warbler (St. Lucia) specimens in the American Museum of Natural History.

	Puerto Rico (<i>n</i> = 6)	St. Lucia (<i>n</i> = 6)
Upper eye crescent	yellow	yellow
Lower eye crescent	white	yellow
Black "spectacle"	weak	bold
Streaks on flanks	faint to bold	faint
Back	gray; faint streaks	brownish; unstreaked

laide's Warblers from Puerto Rico rather than St. Lucia Warblers from St. Lucia, due to variation in eye crescent coloration, weaker black spectacle, blacker and more crisply delineated streaks on the breast and flanks, and grayer upperparts with faint black streaks.

Adelaide's Warblers were first discovered in the U.S. Virgin Islands in 2012 (Norton *et al.* 2013a, 2013b, 2013c, Rune and Conlon 2016). On 24 March 2012, four birds were found on the western side of St. Thomas near Santa Maria Bay, 28 km west of Lameshur Bay, St. John, and later, on 17 December 2012, six individuals were recorded (Rune and Conlon 2016). On 6 January 2013, a single Adelaide's Warbler was recorded along the Lameshur Bay Trail, St. John (Rune and Conlon 2016).

Combining our observations with those of Rune and Conlon (2016), it seems that a minimum of 14 vagrant birds were present on St. Thomas and St. John in the period March 2012–January 2016. It has been proposed that vagrancy is the main mode of island colonization by Caribbean birds (Lovette *et al.* 1999). There is substantial molecular evidence that colonization of the Caribbean by birds has been on a species-by-species basis, with dates of colonization of one species separated widely from that of others, or exactly what one would expect given colonization by individual instances of vagrancy or long-distance dispersal (Lovette *et al.* 1999). This raises the question of how the dynamics of individual invasion histories transpire. We hypothesize that our observations of Adelaide's Warblers on St. John and other reported observations on St. Thomas (Rune and Conlon 2016) represent an instance of colonization by vagrancy in progress.

The appearance of Adelaide's Warblers in the Virgin Islands is likely the result of active dispersal away from Puerto Rico or Vieques Island (the latter 67 km southwest of St. John) and towards the U.S. Virgin Islands. It is unlikely that these birds were "wind-drifted," either by the easterly trade winds or by any tropical storm or hurricane, as any of these mechanisms would favor dispersal towards the west and would hinder flying towards the east, which Adelaide's Warblers in the U.S. Virgin Islands must have accomplished. Adelaide's Warblers are not known to be kept in captivity on St. John, and even if they were, or are kept illegally, it seems vanishingly unlikely that they would be transported to a remote part of a national park on St. John accessible only via hiking trail. Therefore, it seems the most probable way these birds could have reached the U.S. Virgin Islands is by active dispersal.

Our observations of Adelaide's Warblers in the U.S. Virgin Islands suggest we have documented in real time part of the



Fig. 2. (a) Adelaide's Warbler, Lameshur Bay Trail, St. John, January 2015. Note distinctly yellow crescents above and below eye. Photograph by R.R. Veit. (b) Possible female Adelaide's Warbler, Lameshur Bay Trail, St. John, January 2015. Note much less yellow and more whitish coloration on crescent below eye and supercilium behind eye. Photograph by E. Dluhos.

process by which some passerine birds have colonized islands in the West Indies. These observations are significant because vagrancy of Adelaide's Warblers from Puerto Rico to the U.S. Virgin Islands occurred against the prevailing trade winds, and is therefore consistent with the pattern of range expansion in the Adelaide's, Barbuda, and St. Lucia Warbler clade documented by analysis of mtDNA, i.e., dispersal and subsequent speciation of Barbuda and St. Lucia Warblers occurred from west to east, against the prevailing winds, and not vice versa (Lovette *et al.* 1998).

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