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Stopover on Galapagos During Autumn Migration of Bobolinks (*Dolichonyx oryzivorus*)

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ABSTRACT.—The Bobolink (*Dolichonyx oryzivorus*) is the only landbird species that is known to stop every year in Galapagos while migrating; however, its stopover ecology while on the islands is unknown. In October 2015, we searched for and captured Bobolinks in the highlands of San Cristóbal. We found Bobolinks in two fields, separated by 9.15 km, at ~425 m elevation. Average daily counts of Bobolinks on these two fields were 3.2 ± 1.8 and 4.8 ± 2.3 individuals. We caught nine individuals; body mass and fat reserves varied from 22.5–40.0 g and no fat reserves to 50–100% reserves, respectively. Both fields were dominated by grasses ranging in height from 30 cm to >100 cm, and included purple cuphea (*Cuphea* sp.). Other habitats we surveyed, where we did not observe Bobolinks, included closely cropped grass (5–10 cm), taller grasses with seed and with scattered to dense guava trees (*Psidium guajava*), and small (0.1–0.3 ha) corn plantations with seed. Six of the birds we caught had seeds of *Drymaria cordata* entwined in their feathers; while native to the Galapagos, this plant is highly invasive in other parts of the world. *Received 23 November 2015. Accepted 4 February 2016.*

Key words: Bobolink, *Dolichonyx oryzivorus*, fat storage, Galapagos, habitat selection, migratory stopover, San Cristóbal.

In September 1835, Charles Darwin collected a single Bobolink (*Dolichonyx oryzivorus*) during his 5 days on San Cristóbal, the eastern-most island in Galapagos, Ecuador (Darwin (1963). The Bobolink was unusual in his bird collection from Galapagos for two reasons. First, it was a

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migrant, while all of the other landbirds he collected were representatives of resident species or at least those that bred on the island(s). Second, Bobolinks are grassland-obligates, and although the larger islands historically maintained small pampas zones (also called fern-grass zones), the habitat was limited to a few locations above tree line where there is substantial precipitation (up to 2.5 m annually). The vegetation in this zone primarily consisted of ferns (especially bracken fern [*Pteridium aquiolinum*]) with occasional sedges and grasses (Kricher 2006). During the last 150 years, much of the fern-grass zone has been replaced by agricultural grasslands for cow grazing; a 1966 assessment estimated 5,000 cows grazing in the highlands of San Cristóbal (Colinvaux and Schofield 1976). These pastures, along with the native fern zone vegetation that remains, may serve as stopover habitat for migrating Bobolinks.

Bobolinks breed across much of the northern United States and southern Canada and winter in eastern Bolivia, Paraguay, and northeastern Argentina (Renfrew et al. 2013). Their main migration route in South America is inland, but an unknown, likely small number of Bobolinks move through the Galapagos each year, mostly during the southbound migration (Renfrew et al. 2015). The Bobolink is the only migratory landbird species that stops every year in the Galapagos (Levin et al. 2013). In October 2015, we searched fern-grass and agricultural habitats on San Cristóbal Island to find and capture Bobolinks. Here, we describe the habitat use and body condition of Bobolinks on San Cristóbal.

METHODS

Beginning with Darwin's collection, records of Bobolinks indicate that the species stops in the highlands of San Cristóbal (island total area of 558 km^2; maximum elevation 730 m). However, individual birds rather than flocks comprise the few available records, and these records did not specify site locations. We tried to gather more detailed information on potential encounter sites by interviewing staff at the Charles Darwin Foundation and Galapagos National Park (GNP), but no one knew where or when the birds could be found. GNP staff did indicate areas within the agricultural zone of the island where farmers maintained pasture for cows—there are ~1,609 ha of pasture in the agricultural zone (highlands) of San Cristóbal (Guzmán and Poma 2015).

On 12–23 October 2015 between 0530 and 1400 Galapagos Time (GALT), we searched the available agricultural and fern-grass zone habitat in the highlands, walking through open areas, listening for distinctive flight call notes, and attempting to draw quiet birds out by broadcasting songs of the Bobolink. This audio recording included a loop of song, chips, and flight notes. We identified habitat in the highlands through the local knowledge of taxi drivers, who knew the island roads and owners of most farms (to request permission to enter). We found and searched for Bobolinks at the only three open grassland parcels >0.1 ha where the grass was in full seed phase. We also searched at the small corn plantations we came across with tassel seed, as Bobolinks may feed on corn tassels on their wintering grounds (Pettingill 1983). Furthermore, we used Google Earth (Google Inc., Mountain View, CA, USA) to look for potential habitat that we might not see from roads. Once birds were located, we set up two 12-m long mist-nets, and broadcasted repeating audio mixes of Bobolink calls, chips, and song from one or two speakers placed at least 50 m apart. The speaker(s) was placed ~20 m away from the mist-net to avoid capturing non-target species. We then tried to flush individual Bobolinks into the mist-nets. Once captured, we scored fat reserves in the furculum (0 = no fat, 1 = trace, 2 = 5–25% full, 3 = 25–50% full, 4 = 50–100% full, 5 = bulging), made morphological measurements (mass, wing chord, tarsus, and bill length, width, and depth), collected a 50 μL blood sample from the brachial vein for a blood parasite study, and banded (U.S. Geological Service band only) each bird. We used Google Earth to measure distance between sites.

OBSERVATIONS

We first encountered Bobolinks on 12 October 2015 at Finca de las Gemelas (Fig. 1a; 422 m elevation; 0° 53′ 26.23″ S, 89° 27′ 15.35″ W), 2.5 ha, square in shape, with an open view to the

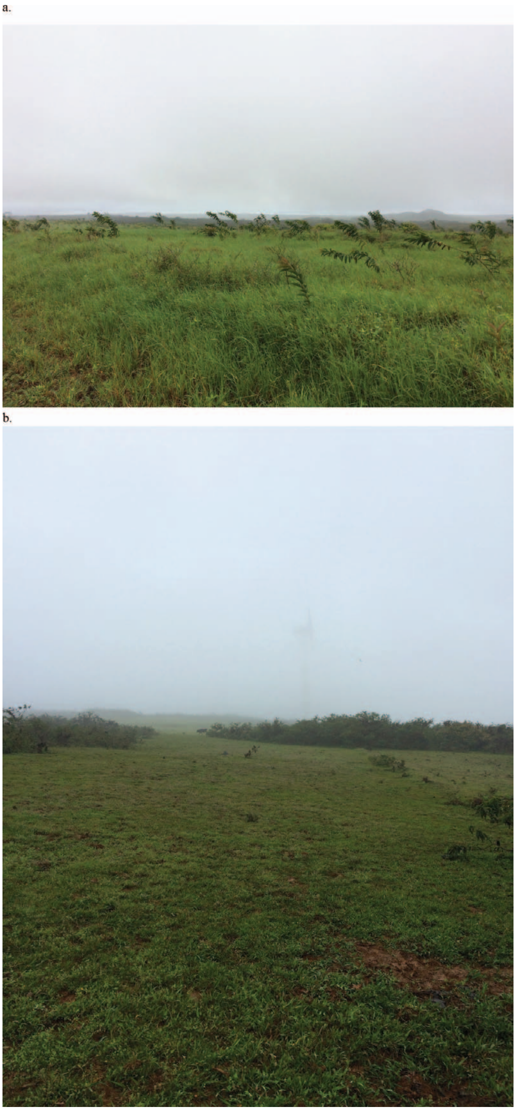

FIG. 1. Habitat where migrating Bobolinks were regularly encountered (a) and not encountered (b) on San Cristóbal Island, Galapagos, Ecuador.

ocean, and the first agricultural or fern-grass zone patch >0.5 ha when moving up in elevation from the southeast coast. The nearest grass patch >0.1 ha was more than 1.5 km away. This field was ungrazed for 3–4 years and vegetation height was > 100 cm above dense litter. The dominant plant was mature Bermuda grass (*Cynodon dactylon*), and other prominent species included purple cuphea (*Cuphea* sp.), guava (*Psidium guajava*), and *Miconia* sp. We observed five birds within a loose flock, and captured two of these birds. We visited Finca de las Gemelas four additional times, counted a daily mean of 3.2 ± 1.8 (SD) birds (max = 5; min = 1), but we were unable to capture any additional birds. We resighted at least one banded bird on two occasions, but because the birds were not color banded with unique patterns, we do not know which individual(s) were resighted.

On 16 October 16 2015, we encountered Bobolinks at Santa Monica, an agricultural complex owned by the Ecuadorian military (435 m elevation, 0° 54′ 29.25″ S, 89° 32′ 05.08″ W). Santa Monica is on a west-facing slope, 9.15 km west of Finca de las Gemelas. This parcel included a 1.3-ha grass-dominated, lightly-grazed pasture segmented into five (non-equally sized) paddocks with barbed wire and live electrical fencing. During our periods of observation, Bobolinks spent most of their time within this central parcel. In addition to grasses (species unknown), the vegetation included purple cuphea (*Cuphea* sp.), drymaria (*Drymaria cordata* L.), and occasional trees (species unknown) ~4–5 m in height. The central paddock was the largest in the complex (~0.75 ha), with vegetation ~30 cm tall. Two of the surrounding paddocks had recently been grazed, and had vegetation heights of 10–15 cm; two paddocks were ungrazed, and vegetation height was >100 cm. A larger pasture (2.45 ha) was directly across the road, to the northwest. This pasture more closely resembled the native fern-grass zone vegetation, as it was dominated by bracken fern. Finally, there was a smaller, adjacent grass-based pasture, across a 10-m wide gully, directly to the southwest of this field. We captured a total of seven Bobolinks on three different days in the central paddock. Birds foraged only in this paddock and the ungrazed paddocks; they frequently perched in the trees in the small grazed paddocks and rarely used the larger, fern-dominated pasture. We visited Santa Monica seven times, with a mean daily count of 4.8 ± 2.3 (SD) Bobolinks (max = 8; min = 2). While we did not recapture banded birds, we resighted banded birds on 3 different days, and saw up to two banded birds at the same time.

Six of the seven birds caught at Santa Monica had 1–2 drymaria seeds entwined in their feathers. These seeds were found on the flank, rump, vent, and head. We also noted drymaria on the endemic, non-migratory Small Ground Finch (*Geospiza fuliginosa*). Drymaria is native but not endemic to San Cristóbal. When in bloom, each flower has long, sticky spines, which become entangled in feathers. Migrating Bobolinks could be vectors of dispersal from Galapagos to the South American mainland. The potential for dispersal, however, may be low. As the flower matures to a seed, the spines dry, decreasing their potential to stay entwined within a feather during a transoceanic flight (A. Jamarillo, pers. comm.). Drymaria is a highly invasive species in tropical and subtropical regions throughout the world, growing in dense mats at ground level, and thereby limiting germination by native plants (Holm et al. 1997, ARS 2014). While agriculture is generally considered the primary dispersal agent, our observations suggest that migratory birds, including Bobolinks, may also play a role in spreading Drymaria.

Body condition varied among the nine Bobolinks we captured. Five birds had zero fat, one had trace fat, one had 25–50% fat, and two had 50–100% fat in the furculum. Average (SD) body mass was 29.0 $\pm$ 5.4 g (min = 22.5, max = 40).

Our observations suggest that Bobolinks select lightly-grazed to ungrazed grasslands with some structural diversity in the grass layer, and few trees. Grasslands we searched that did not have Bobolinks were generally heavily grazed and/or had a broken tree canopy. The majority of open, relatively treeless grasslands we encountered on San Cristóbal was cropped to 5–10 cm by cows (Fig. 1b). Grasslands with significant canopy cover of *Psidium guajava* typically had ~30 cm-high grass, but appeared to have very little seed and vegetative diversity. Bobolinks did not appear to select areas where grass seed was most abundant or most dense. In fact, we observed one individual consume two large (2–3x bill length) caterpillars, and others apparently feeding on flower heads of purple cuphea.

Bobolinks stopping on San Cristóbal during their southbound migration were restricted to a small number of middle-elevation patches that had substantial and complex, but not necessarily fully mature (with seeds), grass-based vegetation. They tended to congregate in loose flocks of 3–5 individuals. Body mass and amounts of fat present varied, suggesting that Bobolinks arrive to Galapagos from long oceanic flights, and need considerable time on the islands to rebuild fat stores. Finally, six of the nine Bobolinks we captured had seeds entangled in their feathers, suggesting the potential for Bobolinks to serve as vectors in seed dispersal from Galapagos to the South America mainland.

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