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## Death of a Darwin's Finch: a consequence of human-made debris?

Angela N. Theodosopoulos<sup>1\*</sup> and Kiyoko M. Gotanda<sup>2</sup>

**ABSTRACT**—Accumulation of human-made debris in seemingly pristine habitats is a problem occurring across a broad range of ecosystems. Such debris can be detrimental for wildlife, leading to choking, ingestion of toxic materials, entanglement, and obstruction from important feeding and breeding sites. On the Galapagos Islands, an increasing amount of human-made debris is correlated with the growing population size of permanent towns, especially the largest town of Puerto Ayora, located on the island of Santa Cruz. While previous research on the Galapagos Islands has examined the effects of human-made debris on marine animals, less is known about the implications these materials have on native terrestrial species. Here we report on the fatality of a Darwin's finch nestling we believe occurred by entanglement with a human-made string. The string was among other debris dissected from the nest, which had incorporated >7 different types of human-made debris. We discuss how Darwin's finches are responding to their human-altered habitat and the potential consequences. *Received 2 September 2017. Accepted 1 August 2018.*

**Key words:** behavioral adaptation, Darwin's finches, Galapagos, Small Ground Finch, human-made debris, nest building, urbanization.

### **Muerte de un pinzón de Darwin: ¿una consecuencia de los desechos producidos por humanos?**

**RESUMEN** (Spanish)—La acumulación de desechos producidos por humanos en hábitats aparentemente prístinos es un problema que ocurre en un amplio rango de ecosistemas. Tales desechos pueden ser

perjudiciales para la vida silvestre, provocando asfixia, ingestión de materiales tóxicos, enredos y la obstrucción de sitios importantes para alimentación y cría. En las Islas Galápagos, una cantidad creciente de desechos producidos por el hombre se correlaciona con el crecimiento del tamaño de la población de las ciudades establecidas permanentemente, especialmente de la ciudad más grande de Puerto Ayora, ubicada en la isla de Santa Cruz. Si bien investigaciones previas en las Islas Galápagos han examinado los efectos de los desechos producidos por humanos en los animales marinos, se conoce menos acerca de las implicaciones que estos materiales tienen en las especies terrestres nativas. Aquí reportamos la muerte de un pinzón de Darwin que creemos se produjo por enredo con una cuerda producida por el hombre. La cuerda se encontraba entre otros restos diseccionados de un nido, que tenía incorporado > 7 tipos diferentes de desechos producidos por el hombre. Discutimos cómo los pinzones de Darwin están respondiendo a su hábitat alterado por los humanos y las posibles consecuencias.

**Palabras clave:** adaptación del comportamiento, construcción de nidos, desechos producidos por el hombre, Galápagos, pinzones de Darwin, pinzón terrestre pequeño, urbanización.

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The Galapagos Islands are a UNESCO world heritage site internationally renowned for their unique biodiversity, including numerous endemic species. Darwin's finches are among these endemic species and have been historically isolated from humans because of the remoteness of the islands. The remarkable adaptive radiation of Darwin's finches permeated throughout the archipelago and helped inspire Charles Darwin to develop his theory of evolution (Darwin 1859, Lack 1947, Lamichhaney et al. 2015). Today Darwin's finches are a valuable tool for understanding evolution and

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its underlying mechanisms (Podos 2001, Grant and Grant 2002, Abzhanov et al. 2004). However, more recent human-mediated disturbances such as invasive mammalian predators, the invasive parasitic fly *Philornis downsi*, and urbanization are changing the selective pressures on Darwin's finches and subsequently altering their evolution and ecology (Fessler et al. 2010, de León et al. 2011).

Of these changes, urbanization has rapidly increased in some of the permanent towns on the Galapagos. A flourishing tourism industry and high immigration rates have increased the Galapagos' provincial population size from ~9,800 documented residents in 1990, to >25,000 in 2015 (INEC 1990, 2015). Tourism is at an all-time high with a record number of ~225,000 visitors to the islands in 2015, an impressive increase from the 162,000 visitors recorded in 2007 (Observatorio de Turismo de Galapagos 2007, 2015). This exponential increase in permanent residents and visiting tourists corresponds to an increase in urban infrastructure and ultimately more human-made debris in these towns (Seto et al. 2010). Even with this massive increase in urbanization in Puerto Ayora, the largest town on the Galapagos Islands, we still lack substantial knowledge regarding the effects associated with human-made debris on wildlife on the Galapagos Islands. Here we report our observation of the fatality of a Small Ground Finch (*Geospiza fuliginosa*) nestling we believe resulted from entanglement in human-made string used as nesting material.

On the afternoon of 6 April 2017 in downtown Puerto Ayora (0.74703°S, 90.31272°W), we made the following observation. A breeding pair of Small Ground Finches had built a nest 2.2 m above the ground in an *Opuntia* tree cactus. The nest had a characteristic dome shape with a small circular opening on its side (Lack 1947). Based on prior observations, we knew the nest was active with nestlings that had either fledged or were close to fledging (12–14 days; Grant and Grant 2014). A finch was also observed at the entrance of the nest, and closer inspection revealed that it was a dead nestling, hanging in front of the entrance to the nest. Upon removal of the nestling, we noted that one end of a piece of human-made string was wrapped around the nestling's neck (Fig. 1) and the other end had been woven into the nest.



**Figure 1.** The Small Ground Finch nestling entangled in a piece of human-made string recovered from its nest in Puerto Aroya, Galapagos, 6 April 2017.

After confirming no other nestlings were in the nest, we collected and dissected the nest to identify human-made debris (Fig. 2) and *Philornis downsi*. We recovered 6 *P. downsi* pupae from the nest, a relatively low infection intensity compared to previous studies examining *P. downsi* parasitism on Santa Cruz Island (average range: 19–38 larvae; Fessler et al. 2006, Knutie et al. 2014). Furthermore, visual inspection of the fledgling's nares did not exhibit the characteristic enlargement associated with intense *P. downsi* infestation (Galligan and Kleindorfer 2009). Thus, we found little evidence that the cause of the nestling mortality was parasitism by *P. downsi*.

Further inspection of the nest revealed several different types of human-made debris including fishing line, string, cigarette butts, straw wrappers, cloth, gum wrappers, and pieces of tarp (Fig. 2). Contrary to natural ground finch nest building materials, many of the collected items of debris do not easily degrade and will not pull apart with tension. To determine the potential sources of the



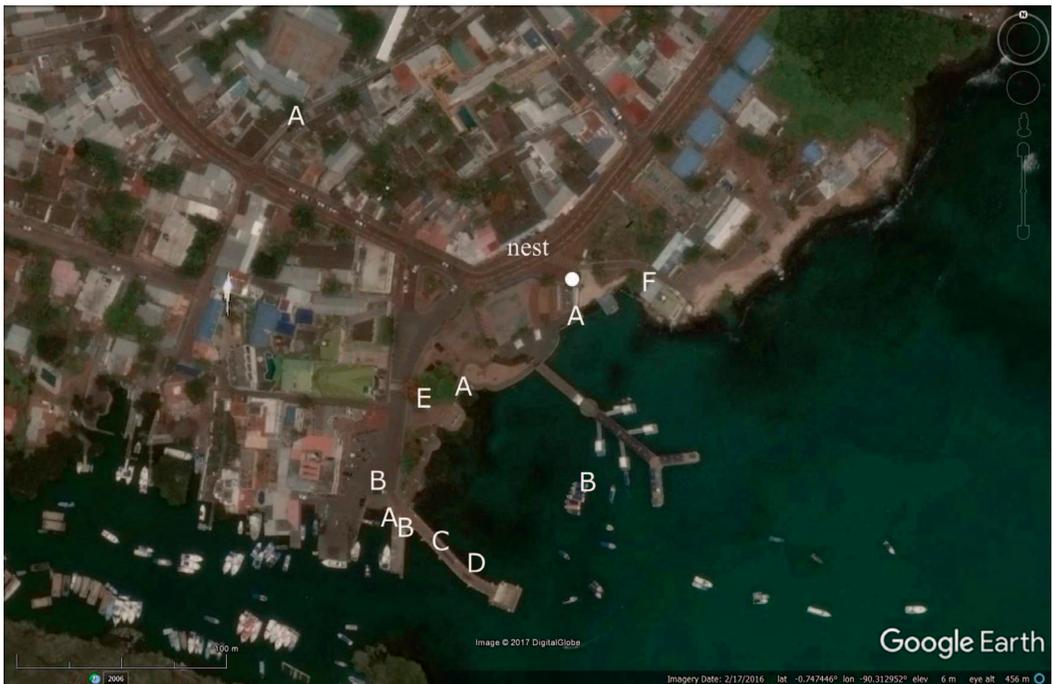
**Figure 2.** Human-made debris collected on Puerto Aroya, Galapagos, April 2017, and separated from the focal nest. Letters correspond to debris found near the nest site in Figure 3.

human-made debris, we conducted visual transects near the finch nest where items of debris could have easily been collected by birds for nest building. We located several sources that matched the human-made debris found in the nest (Fig. 3) within 300 m of the nest, most found on the ground or in nearby foliage, demonstrating that such debris is readily available as nest building material.

Several of our collected items of debris, such as colored twine and gum wrappers, do not resemble the preferred nest-building materials in undisturbed ground finch habitat. Typically, ground finches construct nests using natural materials such as leaves, grass, stems, lichen, and native cotton (Lack 1947, Kleindorfer 2007). Previous observations on Darwin's finches have reported they can incorporate cotton when offered as nest building material (Knutie et al. 2014). Thus, the use of human-made debris for nest building by Darwin's

finches could be a result of opportunism as previously reported with nesting birds in urban environments (Wang et al. 2009, Suárez-Rodríguez and García 2017). For example, House Finches (*Haemorrhous mexicanus*) in Mexico City incorporate cigarette butts into their nests, possibly to combat infestation by ticks and other ectoparasites (Suárez-Rodríguez and García 2017). Other studies have cited human-made debris as having negative consequences on nesting birds (Votier et al. 2011, Townsend and Barker 2014).

Human-made debris resulting from urbanization likely has negative implications for many iconic species on the Galapagos Islands. Conserving the biodiversity and wildlife of the Galapagos will require waste management practices and sustainability efforts that mitigate the impacts of increasing urbanization and tourism. Although humans inhabit only 3.3% of the archipelago in 4 permanent towns, the waste produced in these



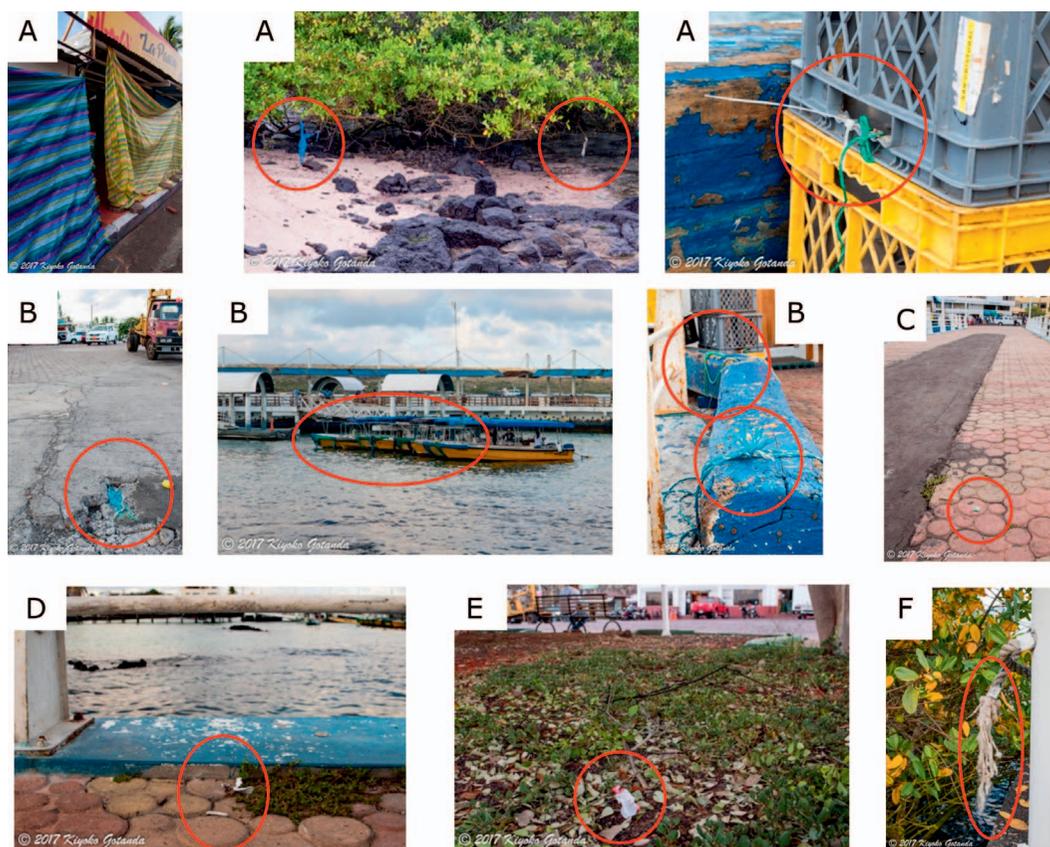
**Figure 3.** Area surrounding the nest in Puerto Aroya, Galapagos, where the nestling was found on 6 April 2017. Letters correspond to location and sources of the anthropogenic debris found in the nest (Fig. 2). All sources of debris were within 300 m of the nest.

urban environments is readily dispersed to uninhabited areas by wind and ocean currents.

Waste management by the Municipal Government of Santa Cruz (MGSC) has improved since the implementation of the integrated solid waste management system in 2006 (Hardter 2008). We suggest further modifications could be employed that would continue lowering the amount of human-made debris present in the environment. For example, many of the trash receptacles in Puerto Aroya do not have lids, and we observed finches and other birds perching on the edges or inside of the receptacle to access the items in the bins. Uncovered receptacles also facilitate trash blowing out and debris scattering in the surrounding area. Providing trash receptacles with lids in both public and private areas and increasing their numbers in areas with heavy foot traffic could help reduce distribution of human-made debris. Additionally, we encourage the MGSC to further develop and implement effective policies and to communicate such practices to encourage the

proper storage and disposal of trash in both public and private areas. Finally, while the MGSC regularly cleans public spaces such as parks and walkways several times per week (Ragazzi et al. 2014), human-made debris persists in most public areas of Puerto Aroya because of the sheer volume of waste produced. We support Ragazzi and colleagues' findings that incentives for community organization of waste removal from public spaces could help mitigate the accumulation of waste and prevent dispersal of human-made debris into the ocean and other fragile habitats of the Galapagos.

Because of the rapid urbanization of inhabited islands on the Galapagos and the increase in tourism, future research that examines the possible consequences of urbanization on native species is vital. We also suggest a continued effort to improve waste management services on the Galapagos Islands. Our observation is one of many signs that urbanization can have negative impacts on Galapagos wildlife, including the iconic Darwin's finches.



**Figure 4.** Detailed photos showing potential sources of human-made debris in Puerto Aroya, Galapagos. Letters correspond to locations in Figure 3. Red circles indicate a potential source of debris or the same type of debris found in the nest.

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