Recent conservation efforts and identification of the Critically Endangered Mangrove Finch *Camarhynchus heliobates* in Galápagos

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El Pinzón de Manglar *Camarhynchus heliobates* es la especie más rara del grupo de los pinzones de Darwin, y su distribución está restringida a los manglares de la costa de Isabela. Aproximadamente 100 individuos sobreviven y están amenazados principalmente por la depredación de la rata introducida *Rattus rattus* y por el parasitismo de la mosca *Philornis downsi*. Un amplio programa de conservación se inició en 2006 con el fin de estudiar las aves sobrevivientes, reducir sus amenazas y restaurar la especie en sitios históricos donde anteriormente se la registró. Un número creciente de pinzones en los sitios donde actualmente existe significará mayores probabilidades de dispersión a los sitios históricos. La identificación correcta es necesaria para seguir y monitorear la dispersión de las aves. Esta publicación pretende ayudar a la identificación de la especie y da pautas para distinguirla del Pinzón Carpintero *Camarhynchus pallidus*, una especie estrechamente emparentada al Pinzón de Manglar. Las dos especies pueden distinguirse por el patrón de coloración de la cabeza y por su canto fácilmente diferenciable.

Mangrove Finch *Camarhynchus heliobates* was the last species of Darwin's finches to be described[13]. Known historically from at least five different localities on Isabela and two on Fernandina[3,8], currently Mangrove Finches occur at two small mangroves on the north-west coast of Isabela, at Playa Tortuga Negra (PTN; 1 in Fig. 1; 18 ha) and Caleta Black (CB; 2 in Fig. 1; 10 ha), separated by 2 km of barren lava with three smaller mangroves.

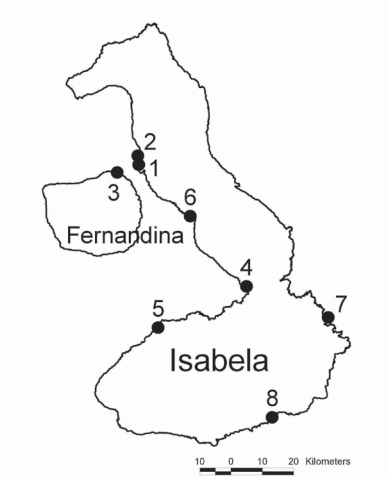

Figure 1. Recent and possible range of Mangrove Finch *Camarhynchus heliobates* in the Galápagos Islands. 1, 2, 7 = known breeding areas at Playa Tortuga Negra, Caleta Black and Bahía Cartago in south-east Isabela; 3, 8 = recent sightings at Punta Espinosa, Fernandina, and near Puerto Villamil; 4, 5, 6 = possible new range due to dispersal to Bahía Urvina, Punta Moreno and Bahía Elizabeth.

A second population persists on the south-east coast around Bahía Cartago (7 in Fig. 1; c.300 ha; Figs. 12–13) c.70 km from the main population in the north-west[3] (Fig. 1). Most recent population estimates number c.100 individuals at all sites combined[5], making Mangrove Finch certainly the rarest of the Darwin's finches and possibly that most at risk of extinction.

The Mangrove Finch Project

Following initial research into the status of Mangrove Finch, led by FHV, an extensive study by the Durrell Wildlife Conservation Trust, Charles Darwin Foundation and Galápagos National Park was initiated with funding from the UK government's Darwin Initiative programme in 2006. The project had four components: (1) research and monitoring of extant wild populations; (2) control of Black Rats *Rattus rattus* and other

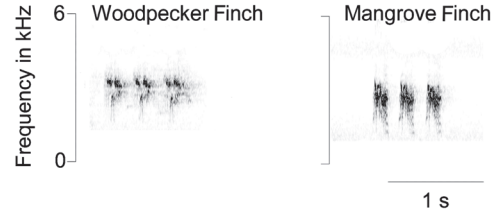

Figure 2. Sonograms of Woodpecker Finch *Camarhynchus pallidus* and Mangrove Finch *C. heliobates*, both recorded at Playa Tortuga Negra, Isabela, in 2009 with a Marantz PMD 660 solid state recorder (sampling rate: 44.1 kHz) and a Sennheiser ME67 directional microphone by BF. Sonogram prepared using Avisoft SASLABPro (R. Specht, Germany) by H. Brumm.


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Figure 3. Male Mangrove Finch *Camarhynchus heliobates*, Caleta Black, Isabela, April 2008; strong whitish face pattern, greyish mantle and greyish-brown wing-coverts; the breast and belly are plain whitish in this individual (Birgit Fessl)

Figure 4. Mangrove Finch *Camarhynchus heliobates*, Punta Espinosa, Fernandina, November 2008; closely resembles the bird in Fig. 3 except for the creamy supercilium and upper breast (Nick Athanas)

Figure 5. Male Mangrove Finch *Camarhynchus heliobates*, Playa Tortuga Negra, Isabela, December 2006; strong facial pattern, greyish head and mantle, brownish wing-coverts and dark-mottled upper breast (Birgit Fessl)

Figure 6. Female Mangrove Finch *Camarhynchus heliobates*, Caleta Black, Isabela, April 2007; rather plain brownish with weak facial pattern and brownish breast similar to Woodpecker Finch *C. pallidus*, but greyer mantle and considerably smaller bill (Birgit Fessl)

Figure 7. Female Mangrove Finch *Camarhynchus heliobates*, Playa Tortuga Negra, Isabela, December 2006; supercilium indistinct but reaches in front of eye, mantle and head greyish brown, breast plain with few speckles, bill relatively short and slim (Birgit Fessl)

Figure 8. Mangrove Finch *Camarhynchus heliobates*, Playa Tortuga Negra, Isabela, February 2008; supercilium very short, but well marked, with strongly streaked breast, greyish-brown mantle and short bill (Michael Dvorak)

Figure 9. Male Mangrove Finch *Camarhynchus heliobates*, Playa Tortuga Negra, Isabela, December 2006; uniform black head and upper breast typical of some older males (Birgit Fessl)

Figure 10. Male Mangrove Finch *Camarhynchus heliobates*, Playa Tortuga Negra, Isabela, January 2008; black head and breast, and dark grey mantle (Birgit Fessl)

introduced animals; (3) characterisation of habitat and the suitability of other mangrove sites; and (4) evaluation of captive breeding and translocation of birds to selected historical and / or new mangrove sites. Field studies included surveys to estimate population size and distribution, during which birds were captured and ringed. Blood samples were collected to establish genetic relationships (K. Petren *et al*. unpubl.) of individual birds and overall genetic variability within the population. Some direct behavioural observations were made to further knowledge of the species' ecology, e.g. on diet and breeding. The most important threats identified were predation by Black Rats[5] and nestling mortality due to parasitism by larvae of the botfly *Philornis downsi*, a fly first recorded in the islands in the 1960s and probably introduced[2,4]. Tests for efficient control techniques including a programme of fly control were established. The impact of introduced insect-borne avian diseases such as avian pox[15] or malaria[10] on the survival of Mangrove Finch is unclear but studies are underway. The results will be published elsewhere.

Although Mangrove Finches might naturally disperse outside their currently known range, human-assisted dispersal might increase the frequency of such events. Mangrove Finch is very similar to its sister species, Woodpecker Finch *Camarhynchus pallidus*, which also occurs at the main breeding sites of Mangrove Finch. This paper provides guidelines for distinguishing the two species and aims to encourage birders to report sightings of Mangrove Finch.

Characteristics of Mangrove Finch

Morphology.—Birds were mist-netted and ringed using a numbered metal ring (right leg at CB, left at PTN) and an individual colour combination on the other leg. We initially used cellulose or Darvic rings but these disappeared from birds very rapidly and we subsequently used coloured aluminium rings (n=14). In total, we ringed 23 birds at PTN, one in a small mangrove north of PTN, nine at CB and one in south-east Isabela (Bahía Cartago, Fig. 12). Of these, 26 were sexed as males on behaviour (e.g. song) or plumage, four as females following nest observations or presence of brood patches, and four were caught as juveniles making sexing impossible. We measured wing length, tarsus and bill dimensions following Grant[7]. To reduce errors, bill dimensions were measured twice and means calculated. One bird from PTN was genetically identified as a Woodpecker Finch (Fig. 16) and another showed a significant level of hybridisation (Fig. 15; K. Petren *et al.* unpubl.). These two were treated separately for analysis (Table 1, group 3). Since we had few data for Woodpecker Finches on Isabela we used data from Santa Cruz for comparison: four birds from the arid zone and ten from the humid *Scalesia* zone. All measurements were taken by BF. For analysis, we used ANOVA with Bonferroni *post-hoc* test to identify significant differences between groups. The bird from south-east Isabela was excluded from analysis, as it showed morphological as well as genetic differences and a distinctive song type[1,3] (Table 1). An ANOVA for all characters combined except mass (for difference in sample size, see Table 1) gave significant differences (F=9.8, df_{effect}=20, df_{error}=68; p<0.001). ANOVA for mass also differed between the three groups (F=45.2, df=2; p<0.001). For differences between single groups see Table 1.

Plumage.—Descriptions are based on field work in 1997–2009. During 2007–09 detailed observations on the entire breeding population of Mangrove Finch were undertaken. We photographed all those caught in mist-nets (see above) and some wild birds at PTN. Additionally, we observed several hundred Woodpecker Finches on Santa Cruz and Isabela.

There is no single diagnostic plumage character that separates the two species. Mangrove Finches are variable in most characters but generally

show some consistent traits. Males and females of both species cannot be separated with confidence except for those older male Mangrove Finches acquiring black feathers on the head (Figs. 9–11). Overall, Woodpecker Finch is much plainer than Mangrove Finch with a warmer and paler brownish coloration (Figs. 15–18). In contrast, all Mangrove Finches show a rather darker, often more greyish tone to the mantle and head. The best plumage character to separate the two species is head pattern. Mangrove Finches show a broad whitish or (rarely) creamy supercilium broadest above the eye and widening in front of it, in some birds forming a paler area between the bill base and the irides (Figs. 3–8). Woodpecker Finches usually possess an indistinct, creamy supercilium rarely extending in front of the eye (Figs. 15–18). Another good field mark is the coloration of the breast, flanks and upper belly. Many Mangrove Finches show distinctive black speckles of variable extent (e.g. Figs. 5, 7 and 8). However, some individuals show reduced speckling (Figs. 3–4). Three of four females trapped had a rather plain breast (Fig. 6) as did at least one male (Fig. 3). Initially, these birds look like Woodpecker Finches, which rarely show any streaks, specks or dots on their breast and never on the belly or flanks (Figs. 15–18). The nape to rump of Mangrove Finch is medium greyish brown, the greater coverts, primaries, secondaries and rectrices slightly darker with paler brownish fringes. Woodpecker Finches from Santa Cruz are overall warmer, more yellowish brown. The two Woodpecker Finches from PTN were also brownish but closely resembled some female Mangrove Finches.

Male Mangrove Finches possess a unique character not shared by any Woodpecker Finch: like other tree finches of the genus *Camarhynchus*, with age some become progressively blacker on the head and breast (Figs. 9–11). Of 26 trapped males, ten showed some black on the head. However, only a very small number possessed a complete black 'hood' (just four of c.45 observed in the field in 2009), whereas Small Tree Finches *C. parvulus* develop a black hood within five years[9]. Therefore, it seems that this character varies to an as yet unknown degree in the population.

Song.—Songs of the two species are readily distinguished by experienced observers (Fig. 2). Vocal activity is greatest during the breeding season, e.g. with the onset of heavy rains, normally from December to mid April. Mangrove Finches typically sing 3–4 syllables: *tscha- tscha-tscha-tscha … tscha-tscha-tscha-tscha*. Mangrove Finches in the south-east sing very differently from those in the north-west[3], the song being slower, *tschrrm-tschrrm-tschrrm*, with each syllable repeated 2–3 times. Playback experiments revealed that Mangrove Finches of both populations differentiate song types[1]. As song is culturally transmitted in Darwin's finches[6], it is possible to find Mangrove Finches singing like Woodpecker Finches as noted twice during the study period. Woodpecker Finches at PTN sing 3–6 syllables, usually four. The song sounds more metallic and melodious (*tschue-tschue-tschue-tschue*) and its frequency is slightly higher. Some birds add a soft whistle at the end of their song, which is never heard in Mangrove Finches.

Recent records of Mangrove Finches away from breeding sites

In 2008–09 three sightings outside the main breeding area were documented. On 22 March 2008, G. Merlen & N. d'Ozouville photographed a silent bird in El Estero mangrove (west of Puerto Villamil; 8 in Fig. 1; Fig. 14). The bird possessed a strong facial pattern, dark mottled breast and comparatively short bill, which characters combined identified it as a Mangrove Finch. But, during four subsequent visits by BF & MD (May 2007, February 2008 and 2009, March 2009) the species' presence at the site could not be confirmed. On 26 November 2008, N. Athanas *et al*. observed a tentative Mangrove Finch in a small mangrove at Punta Espinosa on Fernandina (3 in Fig. 1; see Fig. 4). Identification was less straightforward, but the rather short bill, strong face pattern, and greyish mantle and head all suggest Mangrove Finch. The plain breast is shared by Woodpecker Finch, but is within the variation of Mangrove Finch; several trapped at PTN were very similar (Fig. 3). Photographic and video documentation is online at www.webfoundations.com/temp_photos/finch/Possible_Mangrove_Finch.wmv. On 25 November 2009, another individual was photographed at Punta Espinosa by A. Vásquez *et al*. The bird was discovered by its song and photographed. It showed all the characters of a typical Mangrove Finch (bill shape, face pattern, greyish-brown mantle and mottled breast).

Discussion

Mangrove and Woodpecker Finches are closely related sister taxa[12] and strongly resemble each other[11]. Based on specimens, Woodpecker Finches from Santa Cruz have larger bills and paler plumage than those on Isabela[14]. Comparisons between specimens of Woodpecker Finch from Isabela and Mangrove Finches revealed that bill and tarsi measurements were significantly smaller for the latter, whereas Mangrove Finches had longer wings[14]. We confirmed that in most measurements Mangrove Finches are significantly smaller than Woodpecker Finches on Santa Cruz (Table 1). The two Woodpecker Finches caught at PTN were more similar to Santa Cruz Woodpecker Finches than to Mangrove Finches (Table 1).

Table 1. Bill, tarsus and wing dimensions (in mm), and mass data for Mangrove Finches *Camarhynchus heliobates* (group 1), Woodpecker Finches *C. pallidus* from Santa Cruz Island (group 2) and two individuals genetically and morphologically identified as Woodpecker Finches from PTN (group 3) as well as the data for the single bird trapped in south-east Isabela (Bahía Cartago). Significances between groups were calculated with a Bonferroni *post-hoc* test. Numbers sampled are in parentheses.

	Mean ± SD (n)				Significant differences between groups
	Mangrove Finch, Isabela (group 1)	Woodpecker Finch, Santa Cruz (group 2)	Woodpecker Finch, Isabela (group 3)	Bahía Cartago	* <0.5 ** <0.01 *** <0.001
Bill length (head)	31.5 ± 0.7 (31)	35.0 ± 0.5 (14)	33.5 ± 2.4 (2)	31.3	1*2 *** 1*3 *** 2*3 *
Bill length (to feathers)	15.0 ± 0.8 (31)	16.9 ± 0.6 (14)	17 ± 1.1 (2)	13.8	1*2 *** 1*3 ***
Bill length (to nostrils)	10.0 ± 0.5 (30)	11.8 ± 0.4 (14)	11.4 ± 1.4 (2)	9.3	1*2 *** 1*3 ***
Bill depth	7.5 ± 0.3 (31)	8.1 ± 0.4 (14)	7.8 ± 0.1 (2)	7.6	1*2 ***
Bill width	6.2 ± 0.4 (31)	6.6 ± 0.2 (14)	6.1 ± 0.0 (2)	5.55	1*2 ***
Bill gape	9.6 ± 0.6 (31)	9.8 ± 0.4 (14)	9.8 ± 0.2 (2)	8.3	Ns
Tarsus	24.2 ± 1.1 (31)	24.9 ± 1.1 (14)	25.7 ± 1.3 (2)	23	Ns
Tarsus diameter 1	1.5 ± 0.1 (31)	1.7 ± 0.3 (14)	1.6 ± 0.1 (2)		1*2 **
Tarsus diameter 2	2.1 ± 0.3 (31)	1.9 ± 0.4 (14)	2.5 ± 0.2 (2)		Ns
Wing length	71.4 ± 2.4 (31)	74.1 ± 1.4 (14)	72.5 ± 2.1 (2)	73	1*2 **
Mass (g)	18.9 ± 1.3 (14)	25.6 ± 2.4 (14)	19.6 ± 0.6 (2)		1*2 *** 2*3 ***

Differences in bill size are rather difficult to assess in the field and should be used in conjunction with song and the plumage characters described above. The overall greyish-brown appearance, strong face pattern and speckled / mottled breast are particularly useful field marks for Mangrove Finch. Most Woodpecker Finches have much less pronounced supercilia, a brownish mantle and head, and a plain breast lacking speckles. However, some female Mangrove Finches are probably impossible to separate from Woodpecker Finch on plumage alone.

The intensive population studies during 2007–09 revealed an increase in productivity following rat control measures[5]; subsequently, there were multiple sightings during January–March 2009 in small mangroves between PTN and CB indicating dispersal. It is to be expected that such individuals might also appear at other mangroves in the wider environs. The two recent sightings on Fernandina (see above) probably relate to birds from the main breeding sites at PTN and CB. Because all visitors to Galápagos are restricted to certain areas, the following sites with larger mangroves are especially relevant for possible Mangrove Finch sightings (numbers refer to Fig. 1): on Isabela, Bahía Urvina (4), Bahía Elizabeth (6), Punta Moreno (5), and on Fernandina, Punta Espinosa (3). In southern Isabela there are various mangroves around Puerto Villamil (8), most of them accessible to visitors. The March 2008 record in this area was the first since 1905 and was entirely unexpected. This bird probably originated from the small population in south-east Isabela and shows the potential for dispersal from this breeding area.

We hope that ornithologists will become aware of the possibility that Mangrove Finches could occur at these sites in the future and this paper will enable them to correctly identify these birds. To assist the Mangrove Finch Project, please send all future records (if possible including a detailed description) to Glyn.Young@durrell.org.

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Figure 11. Male Mangrove Finch *Camarhynchus heliobates*, Playa Tortuga Negra, Isabela, March 2009; all-black head and breast, and dark brown mantle (Michael Dvorak)

Figure 12. Male Mangrove Finch *Camarhynchus heliobates*, south-east Isabela, February 2009; only faint supercilium, mantle and head plain grey, greyish breast; this individual is rather different from all birds in north-east Isabela (Birgit Fessl)

Figure 13. Male Mangrove Finch *Camarhynchus heliobates*, south-east Isabela, February 2008; white supercilium very short but well marked, greyish-brown mantle, whitish underparts, densely streaked / spotted breast, and short slim bill (Michael Dvorak)

Figure 14. Mangrove Finch *Camarhynchus heliobates*, Puerto Villamil, Fernandina, March 2008; strong face pattern, breast heavily mottled black, and relatively short bill (Godfrey Merlen)

Figure 15. Male Woodpecker Finch *Camarhynchus pallidus*, Playa Tortuga Negra, Isabela, April 2008; indistinct supercilium, uniform brown mantle and wing-coverts, unspeckled breast, and long massive bill (Birgit Fessl)

Figure 16. Male Woodpecker Finch *Camarhynchus pallidus*, Playa Tortuga Negra, Isabela, April 2008; no supercilium, uniform brown mantle and head, and very long bill (Birgit Fessl)

Figure 17. Juvenile Woodpecker Finch *Camarhynchus pallidus* from the dry zone, Santa Cruz; short supercilium, uniform brownish mantle and head, pale creamy breast and long bill (Erica Cartmill)

Figure 18. Woodpecker Finch *Camarhynchus pallidus* from transition zone, Santa Cruz, February 2008; no distinct supercilium, entire face yellowish white, no streaks or speckles on breast, and throat, breast and belly yellowish (Michael Dvorak)

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