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CONTENTS

RESEARCH ARTICLES

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RESEARCH ARTICLES

FIRST RECORD OF BROWN-CHESTED MARTIN *PROGNE TAPERA* IN THE GALAPAGOS ISLANDS

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SUMMARY

We report two Brown-chested Martins *Progne tapera* sighted on Española Island, Galapagos, on 21 May 2011. They were identified by their large size, broad wings, moderately forked tail, deep wing-beats, wings held down in gliding flight, brown chest and back, and pure white belly and throat. The underpart colour identifies them as subspecies *P. t. tapera*.

RESUMEN

Primer registro de la Golondrina parda *Progne tapera* en las Islas Galápagos. Observamos dos Golondrinas pardas *Progne tapera* en la isla Española, Galápagos, el 21 de mayo 2011. Fueron identificadas por su gran tamaño, alas anchas, cola moderadamente bifurcada, aleteo profundo, alas apuntando hacia abajo durante planeo, pecho y dorso pardos, y vientre y garganta de un blanco puro. Por el color de las partes inferiores determinamos que las aves pertenecen a la subespecie *P. t. tapera.*

OBSERVATION

On 21 May 2011 at 16h00, we watched two large swallows flying low over the vegetation near Punta Suárez, Española Island. It was sunny, with excellent visibility and the birds were observed with binoculars for about 15 min. at *c.* 100 m distance, from several different angles and with front and back lighting. The vegetation in the coastal zone, where the swallows spent most of their time, was low Saltbush *Cryptocarpus pyriformis*. The birds were flying above the vegetation, at an altitude of 3–6 meters, but sometimes dipped through the vegetation. They flapped frequently with deep wing beats, and when gliding held their wings below the horizontal. They had broad wings and moderately forked tails, the fork less pronounced than that of the Barn Swallow *Hirundo rustica*, but more than that of the Tree Swallow *Tachycineta bicolor*. Several Galapagos Doves *Zenaida galapagoensis* flew by the swallows, which were approximately the same length or slightly smaller than the doves. Both birds had brilliant white bellies and near-white or white throats that contrasted with a broad, dull-brown band across the upper breast. At times, the white under-tail coverts seemed to wrap around the tail and were visible on the sides of the brown rump. All the dorsal feathers were dull brown.

DISCUSSION

Progne spp. are relatively large swallows. The Galapagos Dove measures 20 cm in length and the size range of *Progne* martins is 16–20 cm (Hoyo *et al.* 2004). All other American swallows are smaller. The large size, broad wings, and moderately forked tails of the birds we saw identify them as a *Progne* martin. Of the nine *Progne* species, eight always have a deep purple or blue gloss on the dorsum, with the gloss covering the entire bird in some species. The exception is the Brown-chested Martin, which is dull grey-brown above, has a distinctive broad grey-brown breast-band, "often glides on bowed wings" (Ridgely & Greenfield 2001), and flies "almost invariably near ground" Restall (2006). The two birds we saw matched all of these characteristics. Furthermore, the unmarked white belly supports identification of these two individuals as of the subspecies *P. t. tapera*, which lacks the dusky plumage that extends from the breast band along the central axis of the belly in *P. t. fusca. P. t. tapera* is considered non-migratory, and occurs in northern South America, from the Pacific coast of Colombia south to northern Peru, and east to northeast Brazil. *P. t. fusca* is

migratory, and breeds in southern and eastern South America from central Argentina north to Uruguay, and spends the non-breeding season throughout northern South America as far as Panama (Hoyo *et al.* 2004).

The most likely *Progne* species to occur on Española are the Galapagos Martin *P. modesta* which is endemic to the Galapagos islands and the Purple Martin *P. subis*, which has been recorded as a vagrant throughout the archipelago, chiefly during the boreal autumn (Wiedenfeld 2006). However, the Galapagos Martin exhibits dark coloration on the belly in all plumages, and no plumage of the Purple Martin includes a brown breast band or dorsum. Furthermore, on the date of our observation, Purple Martins were breeding in North America, with the closest colonies in southern Mexico being *c.* 2500 km away. Very few if any young would have fledged, so it is unlikely that post-breeding dispersal had begun (Brown 1997). On the other hand, *P. t. tapera* breeds on the Ecuadorian mainland coast, *c.* 1000 km from Española (Ridgely & Greenfield 2001). Brown-chested Martins have an established record of wandering and have been reported in the United States of America eight times, including as far north as Massachusetts (Iliff & Garvey 2010), >3500 km from their known breeding range and much further than the distance between the Ecuadorian mainland and the Galapagos.

Finally, the Bank Swallow *Riparia riparia*, which shares the solid brown back, brown chest-band, white throat and belly with the Brown-chested Martin, is much smaller (13 cm), has a square tail, and its flight is "fast and erratic… with shallow rapid fluttery wing beats" (Restall 2006), not the deep wing beats nor the bow-winged gliding that we saw.

For the reasons we have detailed, we conclude that the two birds observed on Española on 21 May 2011 were Brown-chested Martins. This is the first record of this species in the Galapagos Islands.

ACKNOWLEDGMENTS

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HMS *DAPHNE* IN GALAPAGOS: ITS VISIT AND LEGACY

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SUMMARY

HMS *Daphne*, for which the Daphne Isles were named, was the first British naval ship to explore Galapagos after HMS *Beagle*'s famous visit in 1835. Details of the voyage are published here for the first time. The *Daphne* spent 33 days in Galapagos, from 24 February to 28 March 1845, surveying the archipelago and assessing its suitability as an outpost for the British navy. Despite difficult and dangerous navigational conditions, possibly related to an El Niño episode, five islands (Floreana, San Cristóbal, Santa Cruz, Santiago and Isabela) were examined and land excursions made on the first four. Captain John James Onslow documented the voyage, focussing on the inhabited areas and places where freshwater could be obtained for shipping. On Floreana, where up to 350 people had lived and farmed in the highlands during the 1830s, he reported just 40 inhabitants now living at the lower spring but still farming the highlands, and surviving on the same crops reported in the 1830s, as well as by selling chickens, pigs, goats and bullocks to visiting whaleships. The tortoises, formerly the main article of trade, had been overexploited and could no longer be found on the island. Another ten people resided at the new settlement (established *c*. 1843) in Wreck Bay, San Cristóbal, farmed the highlands and hunted tortoises for trade with whalers, and 15 lived in the interior of Santa Cruz where they also cultivated plots of land. These records constitute one of the earliest descriptions of the Wreck Bay settlement and the earliest known report of agriculture on Santa Cruz Island. The *Daphne*'s surveyors, who included the captain's son (also named John James Onslow), surveyed Post Office Bay (Floreana) and the previously uncharted Conway Bay (Santa Cruz), with Midshipman George William Pakenham Edwardes producing coloured charts of these and four other bays (Freshwater Bay, San Cristóbal; James Bay, Santiago; Iguana Cove, Isabela; Gardner Bay, Española), as well as an illustrated map of the whole archipelago. Six places were named during the voyage: "Daphne Isles", "Onslow Islets", "Seymours Isles", "Gordon Rocks", "Cormorant Point" and "Daylight Point". The first three were named after the ship, its captain (and his son), and George Francis Seymour (commander in chief of the Pacific Station). Gordon Rocks has four possible namesakes: Captain John Gordon, of HMS *America*, which joined the *Daphne* for part of the voyage, his brothers George Hamilton (foreign secretary) and William (a senior member of the Admiralty) who were involved in Britain's Galapagos exploration from afar, and the unrelated Captain George Thomas Gordon of the famous paddle-steamer HMStr *Cormorant*, which also met up with the *Daphne* in Galapagos. Cormorant Point (Punta Cormorant) honours this ship, the first steam vessel ever to navigate Galapagos waters, while Daylight Point (Punta Luz del Día) appears to have been named for topographical reasons.

RESUMEN

HMS Daphne en Galápagos: su visita y su legado. El HMS *Daphne*, en cuyo honor las Islas Daphne fueron nombradas, fue la primera nave de la armada británica en explorar Galápagos luego de la célebre visita del HMS *Beagle* en 1835. Detalles del viaje del *Daphne* son publicados aquí por primera vez. El *Daphne* permaneció en Galápagos 33 días, del 24 de febrero al 28 de marzo 1845, realizando levantamientos hidrográficos del archipiélago y evaluando su potencial como base naval británica. A pesar de las condiciones de navegación difíciles y peligrosas, posiblemente debidas a un evento de El Niño, cinco de las islas (Floreana, San Cristóbal, Santa Cruz, Santiago e Isabela) fueron examinadas y se realizaron excursiones a tierra en las cuatro primeras. El capitán John James Onslow documentó el viaje, enfocándose en las áreas pobladas y lugares con disponibilidad de agua fresca para abastecimiento. De Floreana, en donde hasta 350 personas vivían y cultivaban en la parte alta durante la década de 1830, Onslow reportó solo 40 habitantes para entonces viviendo junto al manantial más abajo pero todavía cultivando las tierras altas, y sobreviviendo de los mismos cultivos reportados en los 1830, además de la venta de pollos, cerdos, cabras y vacunos a las balleneras de paso. Las tortugas, anteriormente el principal artículo de comercio, habían sido sobreexplotadas y ya no se las encontraba dentro de la isla. Otras diez personas residían en un nuevo asentamiento (establecido *c*. 1843) en Puerto Chico (Wreck Bay) en San Cristóbal, cultivando las tierras altas y cazando tortugas para comerciarlas a los balleneros, y 15 individuos vivían en el interior de Santa Cruz en donde también mantenían parcelas de cultivo. Estos registros constituyen una de las descripciones más tempranas del asentamiento de Wreck Bay y el más antiguo referente conocido de agricultura en la isla Santa Cruz. Los hidrógrafos del *Daphne*, quienes incluyeron al hijo del capitán (llamado

también John James Onslow), registraron la bahía Post Office (Floreana) y la no cartografiada previamente bahía Conway (Santa Cruz). El cadete George William Pakenham Edwardes produjo cartas ilustradas a color de las bahías mencionadas y de otras cuatro (Freshwater Bay, San Cristóbal; James Bay, Santiago; Iguana Cove, Isabela; Gardner Bay, Española), al igual que un mapa ilustrado de todo el archipiélago. Seis lugares fueron bautizados durante este viaje: "Daphne Isles", "Onslow Islets", "Seymours Isles", "Gordon Rocks", "Cormorant Point" y "Daylight Point". Los primeros tres fueron nombrados en honor a la nave, su capitán (y su hijo), y George Francis Seymour (comandante en jefe de la Estación del Pacífico). Las rocas Gordon tienen cuatro epónimos posibles: el capitán John Gordon, del HMS *America* que acompañó al *Daphne* en parte del viaje; sus hermanos George Hamilton (secretario del exterior) y William (miembro de alto rango del Almirantazgo), quienes estuvieron involucrados en la exploración británica de Galápagos a la distancia; y el capitán George Thomas Gordon (no relacionado a los anteriores) del célebre vapor de ruedas HMStr *Cormorant*, el cual también se encontró con el *Daphne* en Galápagos. Cormorant Point (Punta Cormorant) fue nombrada en honor a esta nave, el primer vapor que navegó las aguas de Galápagos, mientras que Daylight Point (Punta Luz del Día) parece haber sido nombrada por razones topográficas.

INTRODUCTION

Daphne Major Island, a small, barnacle-shaped tuff cone in the centre of the Galapagos archipelago, is famous for its iconic shape and flat-bottomed craters, and as the site of a world-renowned 40-year evolutionary study of Darwin's finches (Grant & Grant 2014). It is one of the most recognized and well-studied islands in the archipelago (Fig. 1). In contrast, very little is known about the ship for which it was named, HMS *Daphne*, and its visit to Galapagos in 1845. The ship's captain, John James Onslow, and surveying crew made several contributions to the cartography of Galapagos, naming islands and landmarks and charting bays and coastlines; these hydrographic achievements were incorporated into later editions of Admiralty Chart 1375 "*Galapagos Islands Surveyed by Capt. Robt. Fitz Roy R.N. and the Officers of H.M.S. Beagle, 1836*" which had first been published in 1841 (*e.g.* Fig. 2: 1886 edition) and Admiralty Chart 1376 "*Anchorages in the Galapagos Islands"* (*e.g*. Fig. 3), first published in 1887.

The original charts drawn during the *Daphne* voyage, however, were never published, and nor was a narrative of the visit. Thus, many details about the voyage, such as the length of time the ship spent in Galapagos, its route through the archipelago, the islands explored and observations made, have never been brought to light. Even the timing of the voyage has remained unclear, with a few Galapagos researchers noting only that it occurred sometime around 1846 (*e.g*. Grant & Grant 2014, Woram 2021), or even in 1836 (Slevin 1959). These errors may have arisen because the title of the chart of Post Office Bay included in Admiralty Chart 1376 specifies that it was made "by the Officers of H.M.S. Beagle & Daphne, 1836–46" (Fig. 3); the *Beagle* and *Daphne* charts were each completed a year after their respective 1835 and 1845 visits.

This article aims to clarify this obscure page in the history of Galapagos with information obtained principally from the UK National Archives (UKNA), UK Hydrographic Office (UKHO) and National Library of Australia (NLA), in the following manuscript documents: HMS *Daphne*'s log book for 1842–7 (Onslow 1847), G.W.P. Edwardes charts and sketches of Galapagos made during the voyage (Edwardes 1846a–g), Captain Onslow's "Remark Book" for 1845 (Onslow 1845a) and his official report of the voyage in two letters addressed to Sir George Francis Seymour (commander-in-chief of the Pacific Station 1844–7), of which the first was written in Galapagos and the second completed a month later, during the ship's return to the South American mainland (Onslow 1845b).

Figure 1. Daphne Major Island, July 2019 (photo: KTG).

THE SHIP AND ITS OFFICERS

HMS *Daphne* was an 18-gun corvette, 36.6 m long and 11.5 m broad, with a complement of *c*. 150 men (Fig. 4) (Sharp 1858, Phillips 2014). Built at Pembroke Dockyard, Wales, and launched in Aug 1838, it completed three major voyages before being retired from service. Its first naval commission was to the Mediterranean Station (Dec 1838 to May 1842) under the command of Captain John Windham Dalling (1789–1853). Galapagos was visited during its second commission, a 4-year voyage to South America and the Pacific Station (Oct 1842 to Jan 1847), under the command of Captain John James Onslow (1795–1856). The

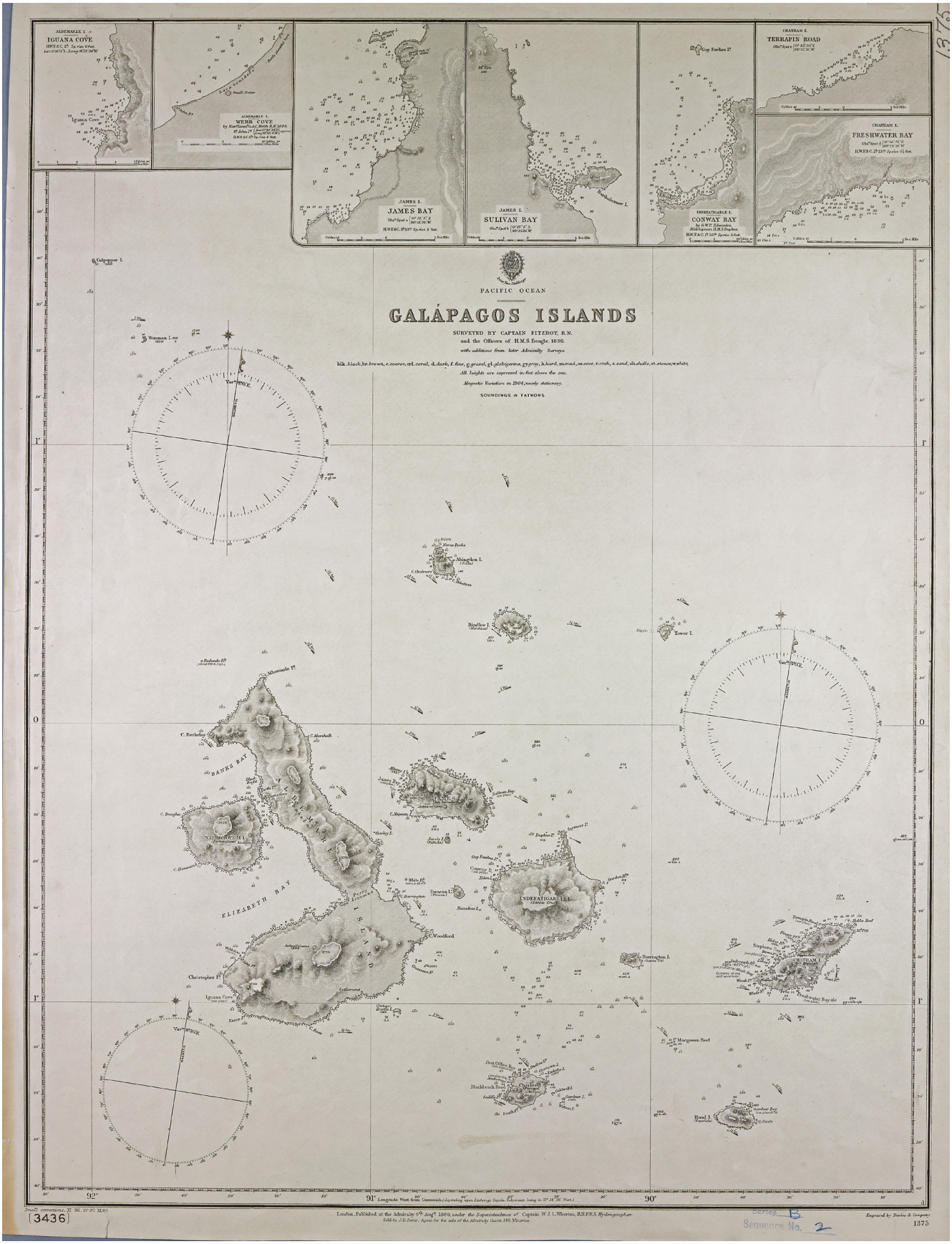

Figure 2. An edition of Admiralty Chart 1375 *Galápagos Islands surveyed by Captain FitzRoy, R.N. and the Officers of H.M.S. Beagle, 1836*, labelled 1886 with "additions from later Admiralty Surveys" (including those by HMS *Daphne*) and corrections to 1887. Probably issued *c.* 1904.

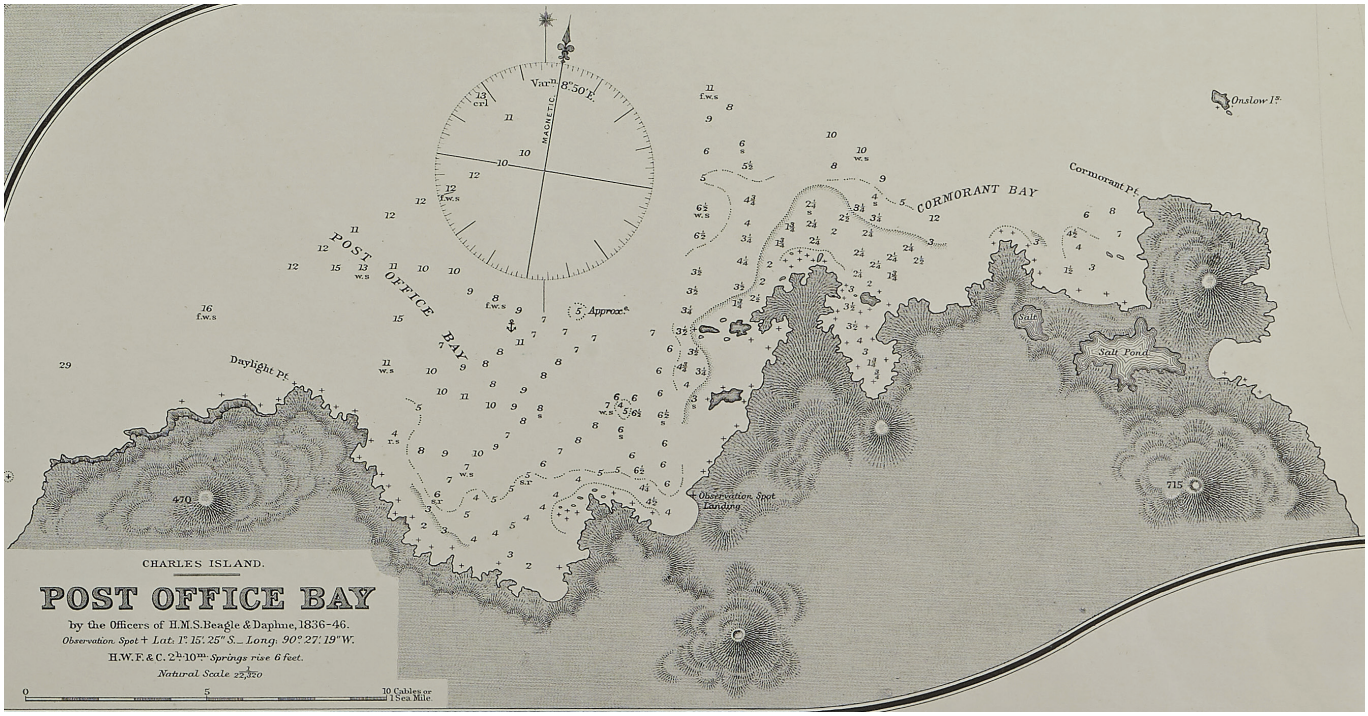

Figure 3. A chart of Post Office Bay, Floreana constructed "by the Officers of H.M.S. Beagle & Daphne, 1836–46." (from Admiralty Chart 1376, edition of 1887).

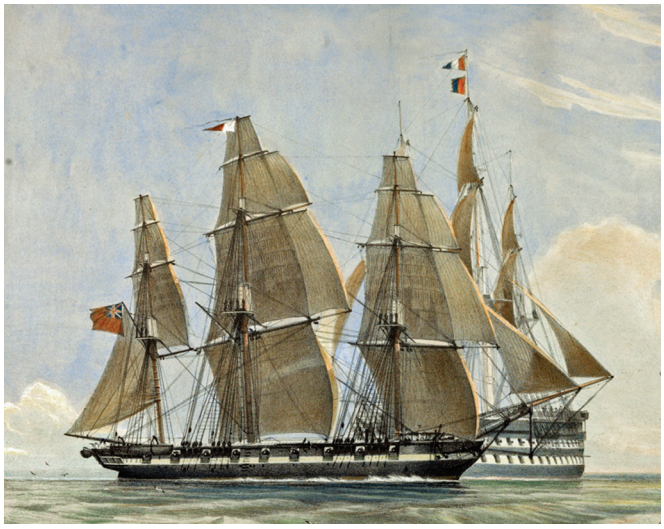

Figure 4. HMS *Daphne* in September 1842, shortly before commencing her voyage to South America. From a hand-coloured lithograph by C.H. Seaforth (painter) and C.J. Hullmandel (lithographer), National Maritime Museum, Greenwich.

Daphne returned to South America and the Pacific Station (Dec 1848 to Aug 1852), under the command of Captain Edward Gennys Fanshawe (1814–1906), but Galapagos was not revisited. The ship was sold for breaking in 1864.

The principal officers on board for the voyage to Galapagos were Captain Onslow, First Lieutenants William Barrie, Francis H. Harper, George R. Halliday, Julian F. Slight and Richard Farmer, Master Daniel McDonnell Jago, Surgeon John Moody, Assistant Surgeon George H. Somerville, Chaplain and Naval Instructor David Carson, and Midshipmen John James Onslow (the Captain's son), and George William Pakenham Edwardes (Haultain & Allen 1844).

Captain Onslow, fifth son of Admiral Sir Richard Onslow, 1st Baronet (1741–1817) (Maclean 1879), was already a famous naval officer, having commanded HMS *Clio*'s 1830–3 voyage to Chile, Peru, Panama and the Gulf of California, during which he re-possessed the Falkland Islands (Malvinas) (originally claimed by Britain in 1765, but then effectively abandoned), leaving a note of British sovereignty at Port Egmont (West Falkland) on 20 Dec 1832 and, between 3 and 5 Jan 1833, ejecting a small battalion of Argentines stationed at Port Louis (East Falkland) (Cawley 2015). This event was remarked upon by Charles Darwin when he arrived at the Falklands on HMS *Beagle* two months later, astonished to find "that the [British] Flag was now flying" (Keynes 2001, Grant & Estes 2009). The *Daphne* was Captain Onslow's next and final command. When the ship returned to England, Onslow was reprimanded at a court martial for allowing the *Daphne* to touch ground (albeit briefly, and without lasting damage) off St Catharine's Point (Isle of Wight) on 31 Dec 1846 and failing to report the incident to the commander-in-chief at Portsmouth (Hickman 1851). Master Jago, who was steering the ship at the time, was also admonished. Onslow retired from the Navy some 4.5 years later.

Lieutenant William Vincent Barrie (1817–73), sole son of Rear-Admiral Robert Barrie (1774–1841) and Julia Wharton Ingilby, was HMS *Daphne*'s chief surveyor. Although Barrie had never previously visited Galapagos, he was familiar

with the west coast of South America from having served as a lieutenant aboard HMS *President*, flagship of Rear-Admiral Charles Bayne Hodgson Ross, commander-in-chief of the Pacific Station 1837–41 (O'Byrne 1849). He also had family connections to Galapagos: his father had been a midshipman on HMS *Discovery* when it visited the islands in 1795, during George Vancouver's circumnavigation of the world (1791–5), and his great uncle was Admiral Alan Gardner (1742–1809), for whom Gardner Island near Floreana and possibly Gardner Islet near Española are named (Woram 1989, Grant 2017). Towards the end of the *Daphne* voyage, Barrie was promoted to the rank of commander (Anon. 1847a) and, at Valparaíso, married Dolores Wood Ramírez de Arellano, the eldest daughter of artist and military officer Colonel Charles (a.k.a. Carlos) Wood, who designed the Chilean coat of arms (Anon. 1846a). After completing the *Daphne* voyage Barrie worked for the Hydrography Department of the Admiralty and raised a family at his inherited home, Swarthdale House, Lancaster (Dawson 1885).

Midshipman John James Onslow (1827–47), the third son of Captain Onslow and Lavinia Dinning (MacLean 1879), was another of the Daphne's surveyors, "having been employed in the surveying Department" despite his young age (Onslow 1845b). With Barrie he explored various anchorages in Galapagos by small boat. He died just eight months after the completion of the *Daphne* voyage, while serving as newly-promoted Mate aboard HMS *St Vincent*, the same vessel that had hosted his father's court martial earlier in the year (Lodge 1859).

George William Pakenham Edwardes (1825–?) was tasked with drawing the charts of Galapagos. He joined the *Daphne* as a first class volunteer (Becher 1842), and was promoted to Midshipman on 1 Jan 1845, two months before arriving in Galapagos. After the voyage he served on various naval ships (including the *Collingwood*, *Star*, *Retribution*, *Linnet* and *Nile*), achieving the rank of Lieutenant in 1853. He was court-martialled on 20 Mar 1854, for "having committed a breach of the 2nd article of war" but then "honourably acquitted", the charge being found "false and unfounded" (Anon. 1854). Later that same year he left the Navy and returned to India, his place of birth, where he married Catherine Poulton in 1860.

THE VOYAGE TO GALAPAGOS

HMS *Daphne* left Portsmouth on 3 Oct 1842, and sailed to Rio de Janeiro, Brazil, where it spent the next 1.5 years protecting British interests on the east coast of South America. It then rounded Cape Horn in May 1844 and arrived at Valparaíso, Chile, Britain's naval base on the west coast of South America, on 3 Jun 1844 (Anon. 1844). Seven months later, after visits to Nicaragua, San Salvador and Guatemala (Dunlop 1847), the *Daphne*, in company with two other naval ships, the 50-gun frigate HMS *America* and the steamship HMStr *Cormorant*, sailed from Valparaíso to Callao, Peru. Then on 12 Feb the *Daphne* departed alone and headed to Galapagos, where the three ships would reunite later.

The *Daphne* sighted Floreana Island at 11h00 on 24 Feb and spent the following 32 days navigating the southern and central part of the archipelago, touching at Floreana, Santa Cruz, San Cristóbal and Isabela islands, and sending a small boat to explore Santiago Island and its environs (Fig. 5). Throughout the visit, depth soundings were taken daily and sometimes hourly by the surveyors, and many sketches of island profiles were drawn by Midshipman Edwardes. Working under Onslow's supervision, and using the ship's copy of Admiralty Chart 1375 as a template, Edwardes also drew a map of the archipelago (Fig. 5) and six charts of anchorage bays, all adorned with his landscape illustrations. Four of these, L5845 of Gardner Bay, Hood Island (which wasn't visited by the *Daphne*'s men), L5847 of Freshwater Bay, Chatham Island, L5846 of James Bay, James Island, and L5844 of Iguana Cove, Albemarle Island, are faithful renditions of the *Beagle* charts of the same places (L955, L954, L957 and L958), copies of which may have been on board the *Daphne*, and which were also depicted as small insets on Chart 1375. The remaining three charts, L5848 of Post Office Bay, Charles Island (Fig. 6), L5385 of Conway Bay, Indefatigable Island (Fig. 7) and L5843 Galapagos Islands (Fig. 5) show novel features and depth soundings recorded by the *Daphne*'s men. Edwardes completed the final drafts of these maps in 1846 and they were delivered to the Admiralty in Apr 1847 (UKHO 1846–56).

The ship's first anchorage was at Post Office Bay, Floreana, 27 Feb to 3 Mar. On 28 Feb Captain Onslow and the officers took one of the ship's cutters to Black Beach, from where they hiked "about 1 ⅔ miles" to the Floreana settlement, then situated near the first spring. There they met the acting governor of the island, "Don Felipe Betere", who informed them that a total of 40 men, women and children lived on the island along with "300 head of cattle" (mostly wild), "jackasses" which they used for transport, and chickens, pigs and goats which they sold to "North American Whalers, for flour, tobacco, sugar, salt provisions and spirits." Continuing higher up the trail, Onslow then "observed the extensive plain described by Cap^{t} Fitzroy" where about "30 acres" were planted with "bananas, plantains, pumpkins, melons, sugar cane, Indian corn, sweet potatoes, oranges and lemons", and where he estimated "double that space might be brought into cultivation" (today, the island's agricultural zone covers 290 ha, or > 700 acres: DPNG 2014). The next day was spent exploring and charting Post Office Bay and its adjacent coastlines, and discovering an additional salt pond near the salt lagoon at the northern end of the bay, which was added to Edwardes' chart (Fig. 6). Don Betere was hosted aboard the *Daphne* while the crew were employed "hogging [the] ships bottom", *i.e*. cleaning the submerged part. On 2 Mar Onslow returned to the highlands, this time with "Honble Cap^{t} [John] Gordon of [HMS] America", which had arrived at Post Office Bay from Callao on 28 Feb. On this second visit into the

Figure 5. G.W.P. Edwardes' map of the islands (L5843: Edwardes 1846a), with the route of HMS *Daphne* added by KTG (dotted line with arrows, and labels "From Callao" and "To Valparaíso").

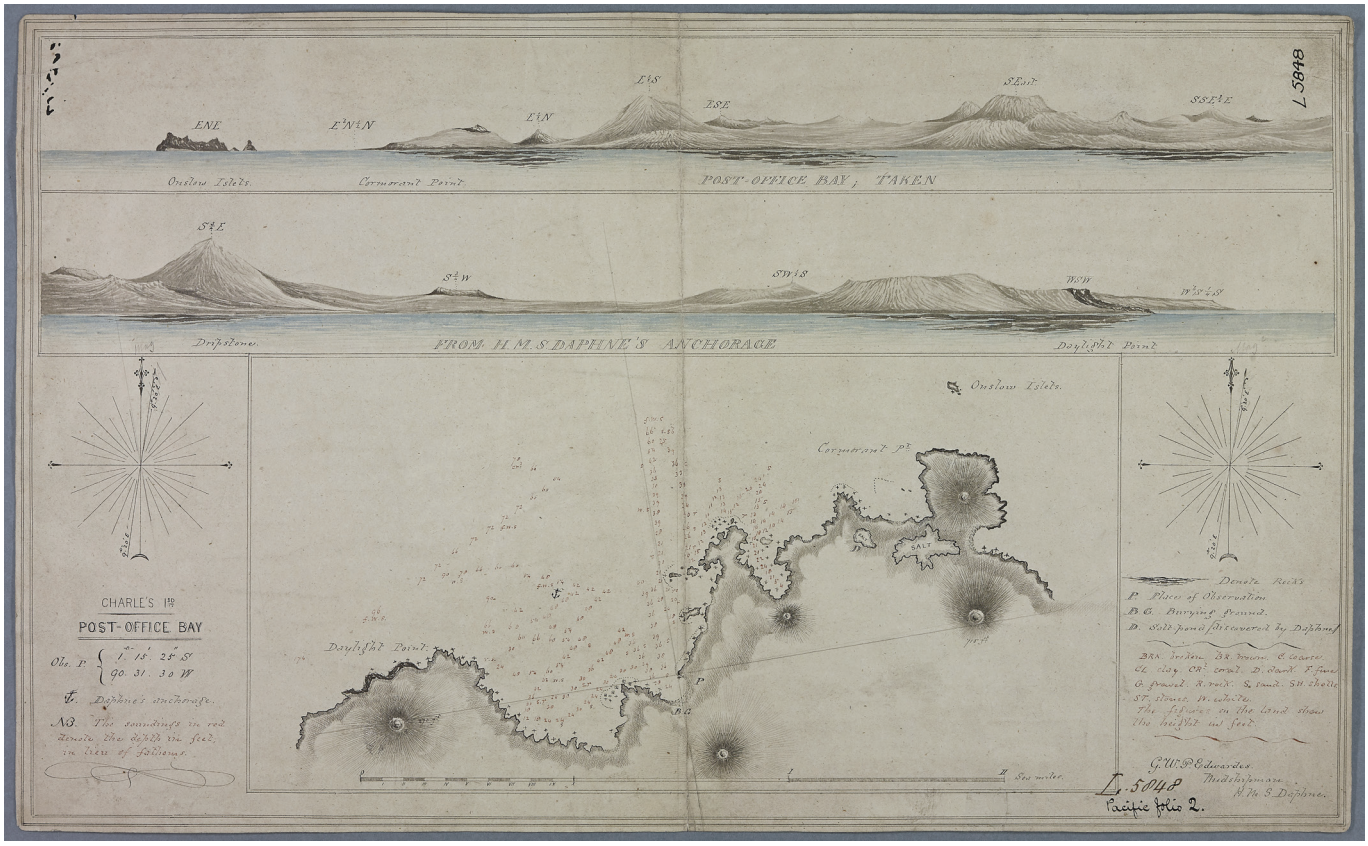

Figure 6. G.W.P. Edwardes' chart of Post Office Bay (L5848: Edwardes 1846b).

highlands, Onslow and Gordon reached the "Governor's Dripstone" (the spring at the base of Asilo de Paz), where they found "orange, lemon, and fig trees growing luxuriantly close to the water". The *America* remained anchored there until 4 Mar and in the vicinity of Floreana until 6 Mar, when it left the archipelago bound for California and the North Pacific Station (Seymour 1845a, Gordon 1846).

Leaving Floreana on 3 Mar, the *Daphne* began a slow, week-long, clockwise circumnavigation of Santa Cruz Island, stopping first to survey Conway Bay, "a fine safe bay with not less than 5 fathoms water", on the morning of 5 Mar. The bay had first been identified as an anchorage of interest by the officers of HMS *Conway* (Captain Eden) which stopped there in Nov 1834, and it was marked on Admiralty Chart 1375 (published 1841), but it had not been surveyed by the *Conway* nor by the *Beagle*. Edwardes chart L 5835 was thus the first of the anchorage (Fig. 7), and would later be added as an inset to Admiralty Chart 1375 (Fig. 2, fifth inset from left). Betere had informed Onslow that "15 fishermen lived on this Island close to the mountains, where a sufficient quantity of water exists for their sustenance… and [where] a very small proportion of land near the mountain is brought into cultivation for their use." However, Onslow found no sign of habitations, nor "of fresh water or anything like a road" from Conway Bay. The *Daphne* weighed anchor that same afternoon, at which point Lieutenant Barrie and Midshipman Onslow were dispatched in one of the ship's cutters "with 10 days provisions to survey James Is^{d} & the small islands in its vicinity".

At noon on 6 Mar the *Daphne* passed 2.5 km to the west of a small island "not named in the Chart" which Onslow dubbed "Daphne Island". Both this island and its smaller neighbour were recorded in the ship's logbook, on that day, as the "Daphne Islands" (Fig. 8). After continuing northward, the *Daphne* rounded, on 8 Mar, the "three Islands off [the] North end of" Santa Cruz, which Onslow named "Seymours Islands" "after the Commander in Chief" (George Francis Seymour). On the evening of 9 Mar the *Daphne* passed 13 km to the east of "two islands off [the] East Point of 'Indefatigable Island'" which Onslow named "Gordon Rocks" in the ship's log and on Edwardes map, and "Gordon Island" in Onslow's report to Seymour (Fig. 9). Early in the afternoon of 10 Mar, finding a current setting the ship towards the shore and winds too light to stem it, the *Daphne* dropped anchor 3 km off the southeast point of Santa Cruz (today known as Punta Rocafuerte), and remained there until a breeze picked up the following morning and allowed the ship to continue safely. At this point the *Daphne* abandoned its circumnavigation of Santa Cruz and proceeded to San Cristóbal, which it reached four days later, after passing to the west of Santa Fé (Barrington), "a mere small rocky Island, with … no fresh water", to the southeast of Floreana and within 8 km of the northwestern side of Española (Hood), another "of the small ones in this group, has no fresh water".

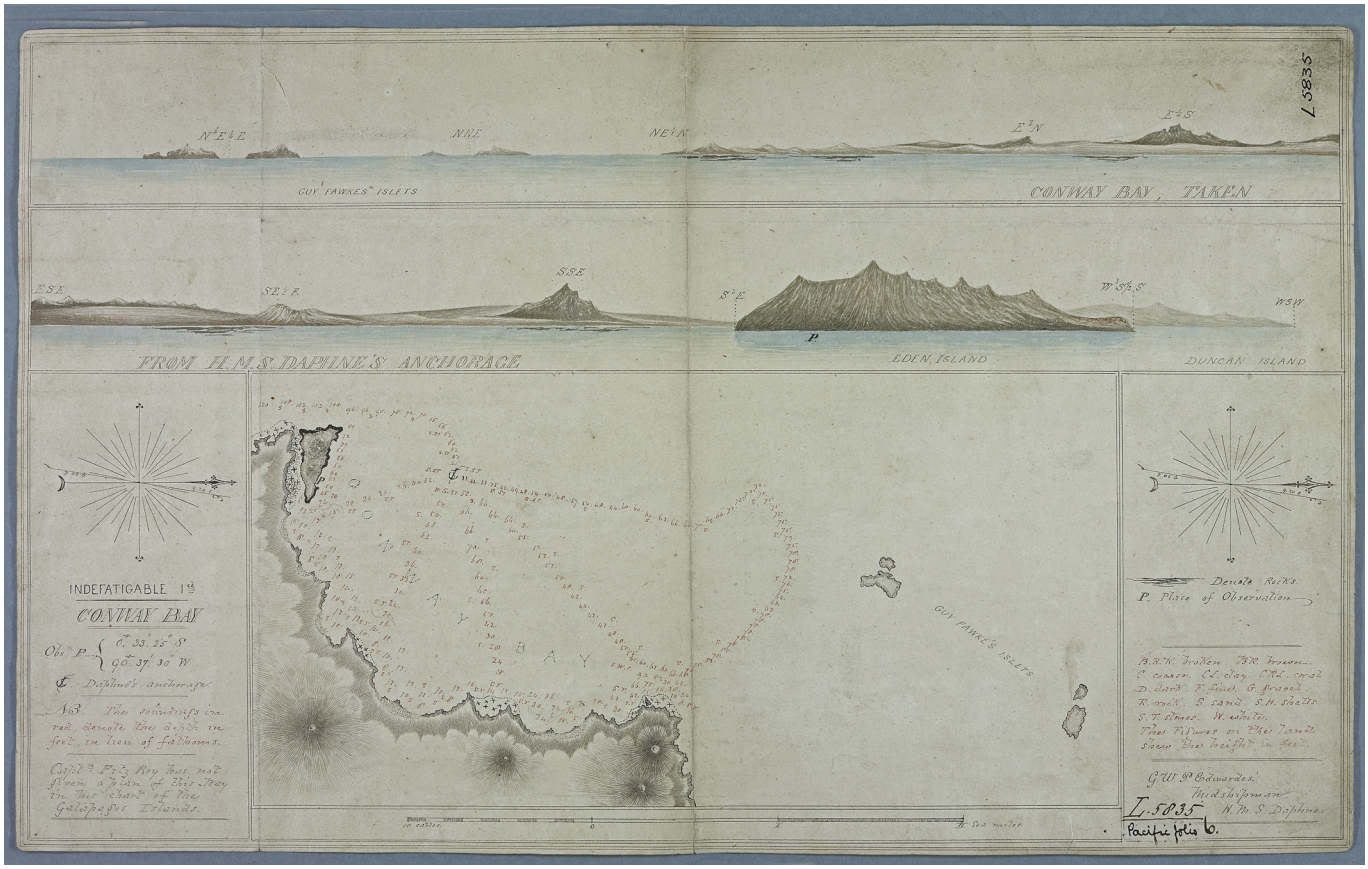

Figure 7. G.W.P. Edwardes' chart of Conway Bay (L5385: Edwardes 1846c).

Figure 8. Edwardes' sketch of the Daphne Islands (from L5843: Edwardes 1846a).

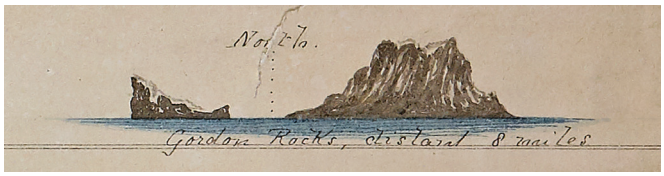

Figure 9. Edwardes' sketch of Gordon Rocks (from L5843: Edwardes 1846a).

At 10 am on 15 Mar, the *Daphne* reunited with its cutter off Wreck Bay, San Cristóbal. Upon reboarding the ship, Barrie reported that he had difficulty landing in James Bay, Santiago, "owing to the surf, and had to swim on shore". He had hiked "inland three miles, but saw no signs of cultivation"; Onslow clarified in his report that the island had, in the 1830s, been "colonized and used principally by the Whalers to boil their oil and to purchase Terrapin" but it was, in 1845, "deserted". Rábida (Jervis) was also "examined" but possibly not up close, for Onslow wrote, incorrectly, that the island has "no anchorage, or bays."

Barrie and the junior Onslow also landed at Wreck Bay (San Cristóbal) where they met "general Menez" [*sic*, General Pedro Mena] who styles himself Governor" and who lived in "two Huts" near "Wreck Point". Mena informed them that "about 10 settlers" lived on the island, subsisting "on Terrapin and extract[ing] oil from them which they barter with the whalers for flour, salt provisions, and spirits". They were also told that a small amount of land was being cultivated in the highlands, where "water exists plentifully", where "the same species of fruits" were being grown as on Floreana, and where "much [more] land might be brought into cultivation, if [Mena] had settlers to accomplish it".

With the officers back on board, the *Daphne* anchored at noon in Freshwater Bay "a very exposed anchorage with a swell setting on shore and causing a heavy surf". Over the next 3.5 days (15–19 Mar), the crew, using the ship's pinnace, took on board 35.5 tons of drinking water, breaking two oars in the process and having, at times, "to swim on shore". "Exploring parties" were also sent on land, and although "they could not penetrate far inland" due to "the thickness of the stunted wood", they saw "several" tortoises, and caught "a few".

At 10 am on 16 Mar, HMStr *Cormorant* (Captain George Thomas Gordon), on its way from Paita, Peru to Panama, anchored next to the *Daphne* for 10 h. Onslow wrote a progress report, a letter to George Seymour informing the "Commander in Chief of [his] proceedings in the Galapagos Islands", and gave a copy of it to Gordon to send to the "Secretary of the Admiralty, London" from Panama (Onslow 1845b). The paddle steamer left at 8 pm that same evening, apparently without taking on any freshwater, and arrived at Panama six days later, on the evening of 22 Mar (Anon. 1845, Gordon 1847).

On 19 Mar HMS *Daphne* sailed for Iguana Cove, Isabela (Albemarle) Island, which it reached seven days later, after passing to the south of Floreana. On 26 Mar, heavy swells "between Points Christopher and Essex" pulled the ship inshore, necessitating the use of one cutter to tow the *Daphne* away from the coast, while the other was deployed "to inspect" Iguana Cove. The next day attempts were made to advance further north up the western coast, but were abandoned "in consequence of [the] variable winds & strong currents which prevented the ship" from doing so quickly, and because Onslow believed that "in the present Season of light airs and calms" it would be unsafe "to attempt the passage between Albemarle and Narborough Islands". Although he could see "a few stunted trees near the sides of the Mountain on Albemarle, looking green" he assumed the island was, for agricultural purposes, "steril [sic], being one solid mass of Lava", adding that if there was freshwater on the southern side of Isabela, he could see no way of obtaining it. He concluded, from what he saw and "from information …[he] received from an intelligent Man, a Native of Guayaquil, who has been amongst these Islands upwards of twelve years, and was employed on the Beagle's Boats during their Survey, the only Islands capable of cultivation are Charles [Floreana] and Chatham (San Cristóbal], and at Chatham alone is water to be obtained for Shipping." On 28 Mar, with the *Daphne*'s water supply decreasing and with a long voyage ahead, Onslow "thought it prudent to quit these Islands…without loss of time" and to head back to Chile. On 19 Apr, one day before arriving at Valparaíso, Onslow wrote the second half of his official Galapagos report, which he then hand delivered to Seymour, who had been at Callao, Peru on his flagship HMS *Collingwood* (Captain Robert Smart) for much of the time the *Daphne* was in Galapagos, but who had returned to Valparaíso ten days earlier (Seymour 1845a).

After Galapagos, the *Daphne*'s next tasks were to convey British consul George Pritchard (who, in early 1844, had been expelled from Tahiti by the French and then brought to Valparaíso by HMStr *Cormorant*) to his new post at the Navigator Islands (Samoa), and then to voyage to New Zealand to support Governor FitzRoy (ex-captain of HMS *Beagle*) who was embroiled in the country's first Māori-British war (Wards 1968). After dropping Pritchard off at Apia on 26 Jul 1845, then spending six weeks (12 Aug to 2 Oct 1845) at New Zealand (Anon. 1846b) the *Daphne* returned to South America, where it remained until Aug 1846. Loaded with over a million sterling in "specie" (gold, silver bars and dollars) collected from British merchants operating on the west coast of South America, the *Daphne* then departed for England, and after surviving "a complete hurricane" off the Bay of Biscay in Dec 1846, arrived off Spithead on 1 Jan 1847 (Anon. 1847a, b) (Fig. 10).

VALUE OF THE *DAPHNE* OBSERVATIONS

The purpose of the *Daphne*'s visit to Galapagos was to assess the archipelago's suitability as a naval station and coal depot for the British government. Britain was seeking a northern locale for a new naval base on the west coast of America, and Galapagos lay strategically close to the Isthmus of Panama with its valuable, newly opened, overland trade and communications route to the Atlantic (at that time by foot, donkey and canoe) (Van Aken 1989, Gough 2016). It was the first of four expeditions (three British and one French) sent to Galapagos in the 1840s for similar reasons, with HM Ships *Herald* (Captain Henry Kellet) and *Pandora* (Lieutenant Commander James Wood) visiting for 11 days (6–16 Jan) and the French brig *Le Génie* (Captain Louis Henri, comte de Gueydon) exploring for 35 days (14 Aug to 18 Sep) in 1846, and HMS *Pandora* returning for 36 days (2 Aug to 7 Sep) in 1847. George Seymour on HMStr *Sampson* (Captain Thomas Henderson) also made a three-day inspection of two islands (Floreana and San Cristóbal), 8–10 May 1847. All these explorations were encouraged by Ecuador's first president, Juan José Flores, who hoped England and France would take possession of Galapagos lands in lieu of war debt repayment, and who, after his overthrow on 6 Mar 1845 (the same day the Daphne isles were named) in a rebellion led by his

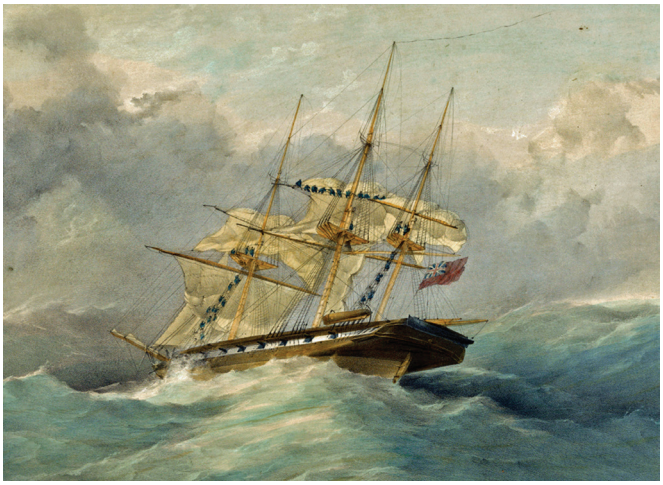

Figure 10. HMS *Daphne* on her return to England in December 1846 (from an 1847 lithograph by T.G. Dutton, at the National Maritime Museum, Greenwich).

successor Vicente Ramón Roca, kept the offer on the table through his son-in-law General Leonard Stagg (Van Aken 1989).

The *Daphne* was also the first British naval vessel to explore Galapagos after HMS *Beagle*'s famous visit ten years earlier (15 Sep to 20 Oct 1835), when Admiralty Chart 1375, the first clearly navigable map of the archipelago, was made. This map, along with FitzRoy's observations and other information provided by the Admiralty, enabled Onslow to steer the *Daphne* directly to the inhabitable islands and focus on the places already identified by FitzRoy and others as having desirable qualities (*e.g*. fertile soil, freshwater, safe harbour) for settlement and shipping purposes. These places included Santa Cruz, an island that had not been explored on land by the *Beagle* men, but where the officers of HMS *Conway* had discovered in 1834 "good landing for boats" at "Duncan Bay" (later named "Conway Bay") and plentiful supplies of turtles and tortoises (Allan 1836).

Onslow was cautiously optimistic about the prospect of turning Galapagos into a naval outpost. He believed that Floreana, with its rich soil and secure "Anchorages, Bays and landing places ... from its position, might be made useful to British Interests as a coal and naval depot", an opinion shared by John Gordon, of HMS *America*, who was also "favourably impressed with [Charles Island's] verdure and the goodness of the anchorage in the Road." (Seymour 1845b). The island had limited supply of "bullocks & vegetables" and an insufficient and not easily accessible water supply, but Onslow felt the water problem could be overcome by collecting the highland spring water and piping it to the coast. He suggested, with words remarkably prescient of what came to be *c*. 170 years later, that "a large reservoir might be made near to the [Governor's] "Dripstone" together with several Tanks, which during the rainy season would be filled and greatly add to the supply of water". He suspected, however, that Floreana could not "be maintained as a colony unless at an expense to the Crown of Great Britain, for several years". He was less positive about San Cristóbal for the primary reason that Freshwater Bay, "the only place to obtain fresh water for shipping" was in his opinion "by no means a safe one and nothing but the actual want of water can justify a ship of war going there". As for the other islands, he thought they had little to offer, and in general he warned that during the hot season "difficult, nay dangerous" navigational conditions prevail in the archipelago, with calms, "strong currents setting to the Southward", and "a heavy swell on shore which renders anything but steam navigation dangerous". The *Daphne*, despite having the reputation of responding "like a racehorse to the spur" (Sharp 1858) had progressed but slowly through the archipelago, had failed to reach the northern islands and had "twice" been in peril of running ashore.

Although the sea conditions described by Onslow are not atypical of a normal hot season, when the Humboldt Current and southeast trade winds slacken and the Southern Equatorial and Panama currents flow into the archipelago, there is some evidence (unusual amounts of rainfall recorded in northern Peru between 1844 and 1846) that a moderate to strong El Niño episode was imminent or underway (Quinn 1992, Ortlieb 2000). Onslow wrote of "intensely hot" weather in March, and an unusual current off San Cristóbal "setting the Ship East 1½ knots an hour", which could indicate the presence of an El Niño, but the rainfall recorded in the *Daphne*'s logbook (on nine out of 28 days in March), and the sea and air temperatures recorded by HMS *America* at Floreana between 28 Feb and 6 Mar (sea 78.6–83°F, mean 81.3°F; air daily maximum 82–86°F, mean 84.2°F; air daily minimum 72–78°F, mean 76°F), are inconclusive. I found no temperatures recorded in the Galapagos pages of the *Daphne*'s log, which might have indicated late March conditions. There is stronger evidence that an El Niño was affecting the islands later in the year, for at the beginning of November (a normally dry month) the New Bedford whale ship *Niger* reported "shears of rain" off Española (Perry 1845), and in early Jan 1846 the men on the *Herald* and *Pandora* experienced prolonged heavy downpours at Floreana and Santiago, and high surf on both these islands and San Cristóbal, with running brooks and "extraordinary" numbers of locusts (indicative of significant rainfall several weeks earlier) also observed on Floreana (Seemann 1853).

The next visitors (Gueydon on *Le Génie*, Seymour on the *Sampson* and Wood on the *Pandora*) arrived during cooler months, and experienced easier sailing. They all wrote favourably about San Cristóbal (Gueydon 1847, Seymour 1847, Wood 1847), with Seymour declaring it "better calculated for settlement, than "Charles Island" having Water…for Shipping,..a better Anchorage, and possessing a greater quantity of Soil capable of cultivation". Ultimately, however, Britain and France concluded that Galapagos, having no natural coal stores and thus unable to be a self-sufficient coaling station (Samson 1999), was not worth the risk of provoking international conflict with each other, or with the United States, which was heavily invested in whaling the archipelago, and abandoned their plans for ownership (Van Aken 1989).

Unlike the *Beagle*, the *Daphne* did not have a naturalist on board and no natural history observations or collections were made during the voyage. Nevertheless Onslow's remarks on the human occupants of the archipelago, and on the introduced crops and domestic animals they raised, are of value to the natural historian for they shed light on how and where the natural environment was being modified by human activities at the time. Onslow was the first foreigner to report on Galapagos during the second phase of colonization, *i.e.* after the original Floreana settlement (inaugurated 1832) had effectively collapsed (by 1842), after founding Governor José Villamil brought new recruits to the archipelago in 1843–4 (Latorre 1999), and when new islands were being settled and new lands exploited. His remarks about the Wreck Bay settlement on San Cristóbal, which did not exist when HMS *Beagle* visited in 1835,

constitute the oldest known descriptive account of this tiny hamlet, which evolved into the town now known as Puerto Baquerizo Moreno, the capital of Galapagos Province. This settlement effected the rapid destruction of the southern San Cristóbal tortoise population, as the settlers slaughtered them for consumption and for sale to the whaling and oil markets (Wood 1847, Seemann 1853). Onslow noted that the *Daphne* men found tortoises at Freshwater Bay, but just two years later, commander Wood and the men of HMS *Pandora* could not find a single one in the southern parts of the island (and "but few…on the Northern slopes of the hills"), with Wood (1847) remarking that within "three months" it is predicted that "the wild dogs & the supply of food they afford to Whalers & Settlers will soon destroy all that remain".

Onslow's words about Santa Cruz give us the earliest record of agriculture on this island, and thus a starting point for when non-native plants were introduced to it. This is particularly useful because the early history of cultivation on Santa Cruz, before San Cristóbal resident Manuel Julián Cobos established farms in the Salasaca and Santa Rosa regions of the highlands in "the late 1800s" to provision the workers he periodically sent to Santa Cruz to hunt tortoises and gather lichen for his orchilla business (Rendón 1965, Lundh 1995), has been poorly elucidated. José Villamil (Latorre 1999) reported a small group of people residing on Santa Cruz in Dec 1837 but made no mention of farming by them. Indeed, they appear to have left by July 1838 (Du Petit-Thouars 1841) and thus were probably only there temporarily, to fish and hunt tortoises for the Floreana settlement, just as other Floreana settlers were employed on Santiago Island, from 1835 to 1837, also apparently without farming (Onslow 1845, Latorre 1999, Grant & Estes 2009). However, Villavicencio (1858), an author who never visited Galapagos himself, claimed there were abandoned banana plantations and sweet potatoes on Santa Cruz in 1858. Onslow did not observe where the Santa Cruz inhabitants and their farms were located in 1845, but Gueydon, in 1846, found "two or three huts" at the base of the hill in what is now known as Whale Bay (Bahía Ballena), 5 km south of Conway Bay, and from there, a path leading "ten or twelve miles" into the interior (Slevin 1959). From this it appears that the cultivated plots were in the area that Cobos began farming some decades later.

As for Floreana, Onslow documented three changes that had occurred since the 1830s. First, the cattle, which FitzRoy (1839) witnessed being introduced to the island on 16 Oct 1835, had increased to 300 head, more than double the 130 reported by Du Petit-Thouars (1841) who visited in 1838. Second, the human population had decreased to 40, from *c.* 100 in 1838 (having been *c*. 350 in 1835). Later in 1845 it would drop further, as "the greater number of the exiles" still living in Galapagos "were recalled by the party who attained power" when President Juan José Flores was overthrown in Mar 1845 (Seemann 1853), and by 1847 it was "about 25" (Seymour 1848). Third, the seat of the settlement had moved: in the 1830s the residents lived predominantly in the highlands, next to their farms, a situation that FitzRoy criticised: "a house on the dry ground, and plantations in the moist valley, would answer better" to living in perpetual damp. By 1845 the inhabitants were still farming in the highlands but were residing lower down near the first spring, where FitzRoy (1839) had recorded just "a few huts", of which only "two or three" were occupied in 1838 (Du Petit-Thouars 1841) (Fig. 11). The move appears to have been long term, for later 19th-century visitors reported the same lower location for the settlement (Borrowman 1847, Seemann 1853, Wolf 1879), and Albert Hastings Markham, captain of HMS *Triumph*, who visited in Feb 1880, stated that "When the island was visited by Darwin in 1836 [*sic*], the settlement was situated about two miles from the site of the one now existing" (Markham 1880).

A LEGACY OF NAMES

The most obvious legacy of HMS *Daphne*'s visit to Galapagos is the six place names that were bestowed during the voyage: Daphne Isles, Seymours Isles, Gordon Rocks, Onslow Islets, Daylight Point and Cormorant Point. The *Daphne*'s logbook and Onslow's report indicate that the first three of these were given in March 1845. The last three were also named during the voyage (for they are found on Edwardes finished sketches and charts of Galapagos, all of which were completed in 1846 and thus before the *Daphne* returned to England) but not necessarily while the ship was still in Galapagos.

Unlike many of the English names that had been given to Galapagos Islands, primarily by Ambrose Cowley in 1684 and James Colnett in 1793–4, and which were, in 1892, replaced by Spanish names (McEwen 1988), all but one of the four names given to islands by the *Daphne* crew are still in dominant use today. The exception is Onslow Islet, which has given way to Corona del Diablo or Devil's Crown. These were also the last Galapagos islands to be given English names by the Royal Navy although British naval ships continued to name Galapagos topographical features other than islands throughout the 19th century (*e.g.* Magicienne Rock, a submerged reef in Gardner Bay, Española, named in 1857 after HMS *Magicienne*, and

Figure 11. Edwardes' sketch of the Floreana settlement showing its location below the northwest flank of the highet peak, Cerro Pajas (from L5843: Edwardes 1846a).

Sappho Cove on San Cristóbal, named in 1883 after HMS *Sappho*: UKHO 1905). Cousins Island, the last Galapagos island to have been given an enduring English name, was named *c.* 1969 by a British civilian, Robert Cousins (Woram 2021).

The Daphne Isles were clearly named after HMS *Daphne*. Today they are distinguished as Daphne Major (Daphne Mayor) and Daphne Minor (Daphne Menor or Daphne Chica), the qualifiers having been introduced by William Beebe (1924), who also named the small rock off Daphne Major (which is included in Edwardes' sketch of the "Daphne Isles") Wheeler Rock, after entomologist William M. Wheeler (Woram 2021).

The three "Seymours Isles" were named in honour of Admiral George Francis Seymour (1787–1870). Even though Seymour visited Galapagos two years later on HMStr *Sampson*, on route from Panama to Paita, he never saw "his" isles for the ship touched only at San Cristóbal (where 12 tortoises were purchased from the Wreck Bay settlement) and Floreana (where he visited the Governor's Dripstone) (Henderson 1847, Seymour 1848). Today only two of the original Seymours Isles bear the Admiral's name; North Seymour, which has no other designation, and South Seymour, today more commonly known as Baltra (Grant 2024). The middle isle is now called Mosquera, after Ecuador's 25th President (Dec 1938 to Nov 1939) Aurelio Mosquera. It was also dubbed Seal Island by the US Navy in 1843, presumably in reference to its sea lion population, but this name is no longer in use (Woram 2021).

Onslow did not specify whom he named the Gordon Rocks after, and there are several possibilities. One is John Gordon (1792–1869), youngest son of George Gordon, Lord Haddo (1764–91) (Boase 1892). John was the "Honorable Captain" of HMS *America*, who joined Onslow at Floreana Island for three days in Feb–Mar 1845. John's two older brothers, George Hamilton Gordon (1784–1860), 4th Earl of Aberdeen, and Vice-Admiral William Gordon (1784–1858), are also contenders, as they were both involved in Britain's interest in Galapagos at the time of the *Daphne*'s visit: George as foreign secretary, and William as a senior member of the Board of Admiralty and an associate and correspondent of George Seymour. William has previously been proposed as the namesake of Gordon Rocks (Woram 2021).

While it is likely that the Gordon Rocks were named in honour of at least one member of this high ranking Scottish family, the name could also be a nod to the unrelated Captain George Thomas Gordon (*c.* 1807–1887), from Devon, England (Walford 1869, Boase 1892), commander of HMStr *Cormorant*, which accompanied the *Daphne* and the *America* from Valparaíso to Callao before the Galapagos trip, met the *Daphne* at Freshwater Bay, San Cristóbal on 16 Mar 1845, and conveyed Onslow's Galapagos progress report to Panama. Seymour considered this Gordon (who obtained the rank of Rear Admiral in 1864: Boase 1892) to be one of the best steamship officers in the Navy (Gough 2016). After Galapagos, Seymour ordered him to take the *Cormorant* to the North Pacific Station to spend a year (mid-1846 to mid-1847) assisting British interests and towing sailing vessels back and forth across the Strait of Juan de Fuca, against unfavourable tides. In British Columbia, Gordon River and Gordon Head on Vancouver Island are named after him, and Cormorant Island, east of Port McNeill, and Cormorant Point near Gordon Head, honour the ship he commanded (Humphreys 2001).

The Onslow islets (Fig. 12) were presumably named after Captain John James Onslow, though the honour may extend to his son, the junior John James, who probably helped to survey them. Unlike the other islands named during the *Daphne* voyage, none of which had earlier names, the Onslow islets already bore several, though none appeared on Admiralty Chart 1375. The oldest name was "Abbey Ruins", on a manuscript map owned by William Wyndham Grenville (1759–1834), Prime Minister of the U.K. 1805–7, which is now in the Greenwich Maritime Museum. The origins of this map (Anon. *c.* 1803: GREN 85/12) are unknown, but three of the other unique labels on it, "C[ape] Grenville" on the southeast-facing coast of San Cristóbal, just north of the bay today known as Bahía Rosa Blanca, "Camelford Bay" (Post Office Bay) on Floreana, and "Willding Rock", a "sunken and dangerous" rock depicted near Gardner-by-Floreana, which probably refers to the "dangerous breaker" later noted there by FitzRoy (1839), strongly suggest that it may have been made by someone on the whaleship *Willding* (Captain John Borlinder), which visited Galapagos in Oct 1803 and which was owned by Grenville's brother-in-law, Thomas Pitt, 2nd Baron Camelford (1775–1804). When the *Willding* returned to England in 1805 it passed into Grenville's hands, Lord Camelford having died in a duel the year before (Cockburn 1804, Jackson 2005, Clayton 2014). GREN 85/12 was the first English map to depict Charles Island (Floreana) in full outline and with labelled bays and headlands; not until 1820, when James Colnett's "Chart of the Galapagos..." (Colnett 1798) was re-issued with "Additions & Corrections to 1817" (Colnett 1820), were Post Office Bay and the islet in question shown. GREN 85/12 appears never to have been used or reproduced, with none of its labels transferred to any subsequent map. In 1813 Onslow Islet had been dubbed "Devil's Rock or Rock Dismal" by Captain David Porter of the US Frigate *Essex* (Porter 1815), which may be the origin of the modern name Devil's Crown (Corona del Diablo), but on William Hooker's map of the archipelago, published in the second edition of Porter's narrative (Porter 1822) it was labelled "Diamond Rock".

Daylight Point and Cormorant Point designate the western and eastern headlands of Post Office Bay, Floreana, as seen on Edwardes chart (L5848) (Fig. 6) and Admiralty Chart 1376 (Fig. 3). "Daylight Point" ("Cape Barry" on Grenville's map), was presumably named

Figure 12. The Onslow islets (left) and Daylight Point (right), Floreana, sketched by Edwardes (from L5843: Edwardes 1846a).

for topographical reasons; from the perspective of a ship anchored in Post Office Bay, the red-orange cinder cliff at Daylight Point (today known as Point Daylight or Punta Luz del Día), is one of the first and most striking landforms to be illuminated by the rising sun (Fig. 12). It also lies in the direction of the setting sun, where daylight lingers longest.

Cormorant Point almost certainly honours HMStr *Cormorant*, the first steamship ever to enter Galapagos waters, on 16 Mar 1845. The next steam vessels to visit Galapagos were HMStr *Sampson* in May 1847, HMStr *Magicienne* in 1857 and the United States steamer *Hassler* in 1872, after which most naval, merchant, and scientific expedition ships visiting Galapagos waters were steamships or had auxilliary steam power, until the 1930s when diesel engines took over. The *Cormorant* was a famous paddle-wheel steamer of six guns, 53 m x 11 m, built and launched at Sheerness in 1842 and which served the Navy until 1853 (Fig. 13). It was already distinguished for being the first ship to voyage by steam to Tahiti (19 Feb to 13 Mar 1844), Hawai'i (18–30 May 1846) and British Columbia (Jun 1846) (Kemble 1949, Pritchard 1866, Akrigg & Akrigg 1975), but its short, pioneering visit to Galapagos (15–16 Mar 1845), has been overlooked. The *Cormorant* was one of the first four British steamships (and first two Royal Naval steamships) to operate on the west coast of South America. The steam packets *Chili* (Captain William Glover) and *Peru* (Captain George Peacock) had been the first to pass westward through the Straits of Magellan in Sep 1840, brought by William Wheelwright to ferry letters and goods up and down the coasts of Chile and Peru for the Pacific Steam Navigation Company (PSNC), while HMStr *Salamander* (Captain Andrew Snape Hammond) and the *Cormorant* navigated the strait in Mar and Nov 1843 respectively (Anon. 1843, Peacock 1879, Collard 2014). In 1844, after an overland passage across Panama was established that allowed communications with England to be sent via Chagres on the Atlantic side of the isthmus, the *Cormorant* became the first west coast steamship to receive and deliver Admiralty dispatches at Panama. Onslow's letter for the Secretary of the Admiralty, sent from Galapagos on the *Cormorant*, represents one such. Towards the end of its naval career, in the early 1850s, the *Cormorant* was used to capture slave ships off the coast of Brazil, under the command of Captain Herbert Schomberg (Thomas 1997) (Fig. 13).

There is no indication that Cormorant Bay (the harbour adjacent to Cormorant Point) was named at the same time as Cormorant Point. The latter ("Cormorant-Spitz") is mentioned and illustrated (Fig. 14) in Theodore Wolf's book about his visit to Galapagos in 1875 (Wolf 1879) but "Cormorant Bay" does not appear in print (as far as I have determined) until the Oct 1887 edition of Admiralty Chart 1376 (Fig. 3). Woram (2013) suggested that Cormorant Bay got its name from another British naval steam ship called *Cormoran*t, which (he wrote) visited Galapagos "ca. 1886", actually 25 Jul to 2 Aug 1886, under Captain Jasper Edmund Thomas Nichols (Nichols 1887). This was a 51.8 x 11 m composite screw-propelled steamer, launched from Chatham Dockyard, Kent, in 1877 and broken up in 1949 (Fig. 15) (Mitchell 1881, Brock & Greenhill 1973). Nichols (1887) reported that, after stopping for the night of 25 Jul 1886 at Gardner Bay (Española Island), the ship anchored "in Cormorant Bay" (Floreana) 26–28 Jul 1886,

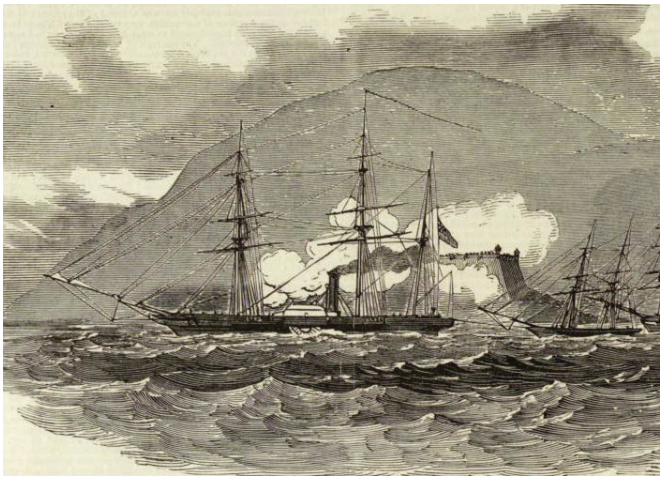

Figure 13. HMStr *Cormorant* (1842–1853) in pursuit of slave traders off Paranaguá, Brazil (from Anon. 1850).

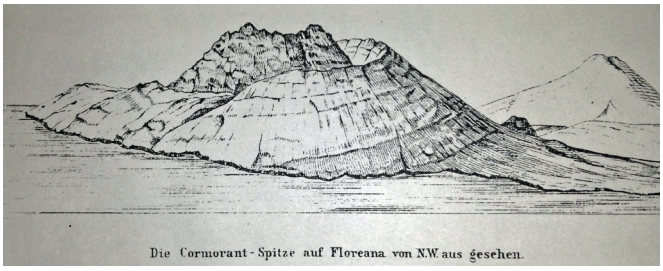

Figure 14. "Cormorant Point on Floreana as seen from the NW." Drawn by Theodore Wolf during his 1875 visit (Wolf 1879).

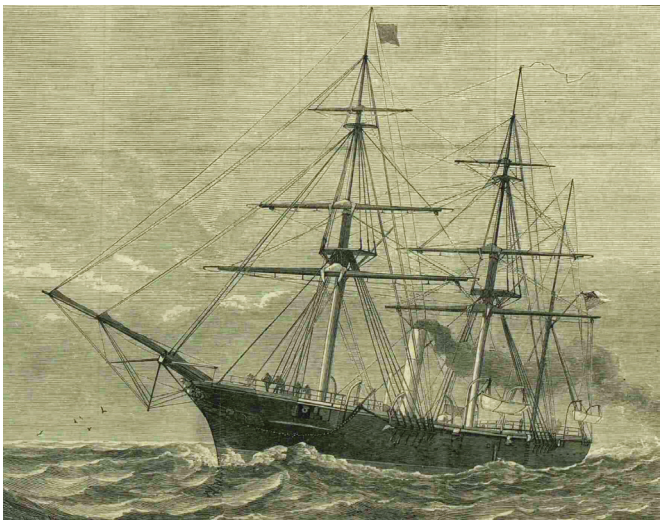

Figure 15. The second HMStr *Cormoran*t (1877–1949) (from Anon. 1878).

then moved to Isabela and anchored 28–29 Jul in "Webb's Cove" (now Webb Cove), named after the ship's Navigation Lieutenant, George A.C. Webb (Slevin 1959, Woram 2013). The southwestern tip of this cove, St John Point (which is labelled on Admiralty Chart 1375 "with corrections to 1887": Fig. 2, second inset from left), was probably named after the *Cormorant*'s Lieutenant Percy Stuart St John. The ship then proceeded to "Port Chico" (Wreck Bay) on San Cristóbal Island and anchored there from 30 Jul to 2 Aug before leaving the archipelago for Panama (Nichols 1887).

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TWO CHILEAN SHIPS AND THEIR CONTRIBUTIONS TO THE CARTOGRAPHY OF GALAPAGOS

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SUMMARY

In the early years of Chile and Ecuador's military alliance, the Chilean Navy made two official visits to the Galapagos Islands. The first took place in 1887, when the steam corvette *Chacabuco*, captain Federico Chaigneau, visited one island (San Cristóbal) for six days (20–26 November). The second was in 1910 when the naval-training steamship *General Baquedano*, captain Arturo Acevedo, explored five islands (San Cristóbal, Floreana, Isabela, Santiago, Santa Cruz) for 24 days (25 March to 17 April). The visits were to enable Chile to learn about its ally's most remote territory, as well as hydrographic surveying expeditions, to improve navigational knowledge. Reports of the visits, written by the ships' captains, were published in the Chilean naval journal and the hydrographical results were sent to the UK Hydrographic Office, where they were incorporated into the British Admiralty's sailing directions for South America and nautical charts of Galapagos. As a result of this international cooperation, navigational safety was improved and nine place names were added to the Galapagos map: Punta Chacabuco (on San Cristóbal); Bahía Cartago, Bahía Isabel and Bahía (Puerto) Villamil (Isabela); Bahía Baquedano and Puerto Núñez (Santa Cruz); Isla Baltra and its northwestern cove, Caleta Birs (now Caleta Aeolian); Canal Ilabaca (now Itabaca) between Santa Cruz and Baltra. Here I provide a description of the ships, a summary of the captains' accounts, and a discussion of their surveys, the observations they made at the highland settlement of Progreso on San Cristóbal, and the introduced plants and animals they recorded, which include three first records for Galapagos (Pineapple *Ananas comosus*, Mango *Mangifera indica*, Giant Granadilla *Passiflora quadrangularis*) and confirm an earlier, since overlooked, record of Grapes *Vitis vinifera* on San Cristóbal. I also provide an analysis of the new place names, the origins of which have long been a mystery. I suggest that Baltra was named after the *General Baquedano*'s Lieutenant Humberto Baltra Opazo, in charge of surveying the northern coast of Santa Cruz, Canal de Itabaca (originally Ilabaca) was named after Julio Ilabaca León, an officer-in-training on the *General Baquedano*, and Puerto Núñez, which was originally applied to what is now Academy Bay (site of modern day Puerto Ayora) rather than the bay further east on Santa Cruz as it does today, honours Miguel Núñez, "jefe territorial" of the archipelago in 1910.

RESUMEN

Dos naves chilenas y sus contribuciones a la cartografía de Galápagos. En los primeros años de la alianza militar entre Chile y Ecuador, la Armada chilena realizó dos visitas oficiales a las islas Galápagos. La primera tuvo lugar en 1887, cuando la corveta a vapor *Chacabuco* (capitán Federico Chaigneau) visitó una sola isla (San Cristóbal) por seis días (20–26 noviembre). La segunda ocurrió en 1910 cuando el vapor escuela naval *General Baquedano (*capitán Arturo Acevedo) exploró cinco islas (San Cristóbal, Floreana, Isabela, Santiago, Santa Cruz) durante 24 days (25 marzo al 17 abril). Estas visitas procuraban a Chile la oportunidad de estudiar el territorio más remoto de su aliado, a la vez que realizar expediciones para mejorar el conocimiento hidrográfico. Los reportes de estas visitas compilados por los sendos capitanes fueron publicados en la revista naval de Chile, y los resultados hidrográficos fueron enviados a la Oficina Hidrográfica británica, donde fueron incorporados a las directivas de navegación para América del Sur y las cartas náuticas de Galápagos publicadas por el Almirantazgo británico. Como resultado de esta cooperación internacional, la seguridad de tránsito marítimo mejoró y los nombres de nueve lugares fueron añadidos al mapa de Galápagos: Punta Chacabuco (en San Cristóbal); Bahía Cartago, Bahía Isabel y Bahía (Puerto) Villamil (Isabela); Bahía Baquedano y Puerto Núñez (Santa Cruz); Isla Baltra y su caleta noroccidental, Caleta Birs (hoy Caleta Aeolian); Canal Ilabaca (hoy Itabaca) entre Santa Cruz y Baltra. Aquí proporciono una descripción de las naves, un sumario de los reportes de los capitanes, y un recuento de sus investigaciones, las observaciones que realizaron en el asentamiento Progreso de la parte alta de San Cristóbal, y las plantas y animales introducidos que registraron, los cuales incluyen los primeros registros en Galápagos de tres especies (Piña *Ananas comosus*, Mango *Mangifera indica*, Badea *Passiflora quadrangularis*) y confirman un registro previo y pasado por alto de Uva *Vitis vinifera* en San Cristóbal. Además, proporciono un análisis de los nuevos nombres geográficos, cuyos orígenes han permanecido un misterio por largo tiempo. Sugiero que Baltra fue nombrado en honor al Teniente Humberto Baltra Opazo del

General Baquedano, a cargo del levantamiento de la costa norte de Santa Cruz; el Canal de Itabaca (originalmente Ilabaca) fue nombrado en honor a Julio Ilabaca León, Guarda marina de segunda en el *General Baquedano*; y Puerto Núñez (nombre originalmente aplicado a lo conocido hoy como Bahía Academia, sitio de asentamiento actual de Puerto Ayora, en lugar del de la bahía más al este en Santa Cruz, como se aplica hoy) fue nombrado en honor de Miguel Núñez, jefe territorial del archipiélago en 1910.

INTRODUCTION

As a direct consequence of the War of the Pacific (1879–84), a conflict fought largely at sea between Chile on one side and Peru and Bolivia on the other, Chile and Ecuador began developing a military alliance against their common neighbour and territorial foe, Peru. This alliance continues today and is considered one of the closest in South America. The military cooperation between the victorious Chile, re-established as the dominant naval power on the west coast of South America, and Ecuador, which had been neutral in the War of the Pacific but had its own history of border disputes with Peru, aimed to strengthen defences on either side of Peru. The cooperation included bilateral education programmes, with Ecuadorian students trained in Chile's Naval Academy at Valparaíso and Chilean naval instructors sent to teach at the military school in Quito, Ecuador, the donation of surplus arms and ammunitions to Ecuador, and general assistance with national defence (Burr 1955). It was in this context that the Chilean Navy made two visits to the Galapagos Islands, one with the steam corvette *Chacabuco* in 1887 and the other with the steamship *General Baquedano* in 1910. The voyages were naval training excursions, but were also scouting missions to allow Chile to learn about the productions and geography of Ecuador's offshore territory, and hydrographic surveying expeditions to improve navigational knowledge about the area. Chile alone of the two countries had a naval hydrographic department at the time (Gorziglia 1994).

Despite the political significance of the visits, the voyages are barely mentioned in history books. Most references to the *Chacabuco* focus on its early hydrographic explorations of southern Chile and its participation in the War of the Pacific, while the *General Baquedano* is best known for its annual investigative expeditions to Easter Island (Rapa Nui) and its naval-training voyages to port cities around the world. In Galapagos the ships are remembered in two place names, Punta Chacabuco on Isla San Cristóbal, and Bahía Baquedano on Isla Santa Cruz, but there has been little understanding of when or why the ships visited Galapagos, where they went or what they accomplished. Bognoly & Espinosa (1905) and Slevin (1959) briefly mentioned the *Chacabuco*'s visit in their respective histories of Galapagos, and Woram (2021a) noted the *General Baquedano*, but none provides an account of the ships' movements or activities, while Slevin (1959) incorrectly identified the *Chacabuco*'s captain as "Francisco Vidal Gormaz" and the year of the ship's visit as ''1837".

The dearth of information about the visits might suggest they were unremarkable, perhaps politically symbolic but not otherwise meaningful, or poorly documented, but this was not the case. Detailed reports, documenting the places explored, the activities performed and observations made, were written by the ships' captains at the conclusion of the expeditions, and published as three lengthy articles in Chile's naval journal, *Anuario Hidrográfico de la Marina de Chile*. Extracts from the account of the *Chacabuco*'s voyage, written in Feb 1888 by Captain Juan Federico Chaigneau (1849–1918), were published in 1890, as a quote within an article about the Galapagos Islands written by Francisco Vidal Gormaz (1837–1907), founding director (1874–91) of the Hydrographic Office of the Chilean Navy (Vidal Gormaz 1890). Chaigneau's full report, which includes an account of the *Chacabuco*'s visit to Panama (before Galapagos), and Tahiti (after), was published later (Chaigneau 1894). The account of the *General Baquedano's* voyage, written by Captain Arturo Acevedo Lay (1873–1939) in May 1910, was published after he, too, became director of Chile's Hydrographic Office (Acevedo 1918).

The hydrographic results of the voyages were also published in England, after the Chilean Hydrographic Office sent copies of the captains' reports and the charts and tables of hydrographical data constructed during the voyages to the United Kingdom Hydrographic Office (UKHO). It is not clear when exactly these documents were received, but the *Chacabuco*'s hydrography was incorporated into UK navigational aids by 1894 (within six years of the completion of that voyage) and the *General Baquedano*'s from 1911 (the year after its Galapagos visit). Chile sent these results in recognition of the value of "international cooperation in the field of hydrography" for safe navigation, a transformative idea that had been promoted during the inaugural International Maritime Conference of 1889, which stressed the need for standardized "nautical charts and ancillary publications" that could be used by "mariners of all nationalities" (Kappor 1976). At the time the UKHO was the dominant provider of navigational aids for mariners worldwide, producing up-to-date charts and pilot guides for all regions of the world, and it was the main organization creating maps and sailing directions for the Galapagos. These were based on the ground-breaking survey of the archipelago conducted for the British Admiralty in 1835 by Captain FitzRoy and the surveyors of HMS *Beagle*, during Charles Darwin's famous visit to the archipelago, and they reflect a much longer history of English dominance in the cartography of the

islands, pre-dating the UKHO's formation in 1795. Many of the island names on FitzRoy's chart had been introduced in 1684 by the English buccaneer Ambrose Cowley, while others were designated in 1793–4 by Royal Navy Captain James Colnett, who also made the first recognisable chart of the archipelago (Grant 2017, Woram 2021b). At various times between the 16th and 19th centuries, other countries (e.g. Spain, France and the United States of America) had mapped or published navigational information about the islands, but by the time of the Chilean visits, no country had come close to matching the quantity and quality of navigational material provided by the U.K. Although Chile's hydrographic department, established in 1874, had surveying and cartographical expertise, it only printed charts and aids for its own territories, while Ecuador did not have a cartographic or hydrographic service until Isidro Ayora (President of Ecuador 1926–1931), took the initiative to establish a national mapping agency, the Instituto Geográfico Militar, in 1928 (Capelo 2010), and Alfredo Baquerizo Moreno, during his third term as President (1931–2) founded a hydrographic department, the Instituto Oceanográfico de la Armada (INOCAR), in 1932 (Anon. 1997).

The UKHO worked pertinent information from the Chilean documents into its charts of Galapagos: *c.* 1894 the *Chacabuco*'s survey was incorporated into Admiralty Chart 1376 (*Anchorages in the Galápagos Islands*, first published 1887, revised periodically until 1941), and *c.* 1920 the *Baquedano*'s contributions were added to Admiralty Chart 1375 (*Galapagos Islands Surveyed by Capt. Robt. Fitz Roy R.N. and the Officers of H.M.S. Beagle, 1836*, first published 1841 and periodically updated until 2011: A.-M. Fitzsimmons pers. comm.). For many years, these two charts were by far the best Galapagos maps and nautical charts available internationally, and remained so until the U.S.A. and Ecuador launched naval and aerial mapping campaigns and began producing new aeronautical charts of the archipelago in the 1940s and 1980s respectively. In 1899 the United States Hydrographic Office (USHO: established 1866) began issuing its own chart of Galapagos, Chart 1798 (*Galapagos Archipelago*), which was used by and updated from early 20th century American visitors (*e.g.* the California Academy of Sciences expedition of 1905–6), but until the 1950s it was a copy of British Admiralty Chart 1375 and a slightly less accurate one.

The Chileans' information was also incorporated into *South America Pilot*, the British Admiralty's main multi-part publication of sailing directions and navigational information for South America, which was updated every few years with information acquired primarily from British surveys but also from hydrographic offices elsewhere. Galapagos was initially addressed in Part 2 (also known as NP-6), a volume that was originally compiled by FitzRoy, with Captain P.P. King of HMS *Adventure* (Fitzroy & King 1860), then republished with changes (UKHO 1895, 1905), and with a 1911 supplement to the 1905 edition (UKHO 1911). Later, the archipelago was addressed in Part 3 (NP-7) (*e.g.* UKHO 1915, 1927, 1941). The first issue to refer (indirectly) to results from the *Chacabuco* was UKHO (1895), in a footnote referencing Chart 1376, which included survey data from the *Chacabuco*, while the first issue to incorporate results from the *General Baquedano* was UKHO (1911). For many years, *South America Pilot* was the primary source of navigational information for the region, and was the model for similar guides produced in other countries. For example, in 1890 the USHO began producing its own versions of *South America Pilot*, based largely on and generally printed a year after the UKHO's issues, with Galapagos first addressed in volume "H.O. No. 89" (USHO 1890, 1896, 1905) and later in "H.O. No. 174" (*e.g.* USHO 1916, 1928).

The Chileans' results were given international importance by their incorporation into the British Admiralty's publications, far greater than if Chile had shared them with only Ecuador. Paradoxically, this meant that Chile never received proper recognition for contributing to the hydrography and cartography of Galapagos and its harbours, for even though the Chilean Hydrographic Office is listed as a source in the foreword to *South America Pilot*, the surveyors of the *Chacabuco* and *General Baquedano* are not credited in the Galapagos section and maps. With the exception of Chacabuco Point and Baquedano Bay, it is not obvious that they named, surveyed, charted or described any places in Galapagos at all. Only by analyzing various editions of charts 1375 and 1376 and *South America Pilot* in the context of Chaigneau's and Acevedo's published articles does the extent of their contributions become clear.

Here I provide a description of the ships, a summary of the captains' narratives, a discussion of some of their observations, and an analysis of their hydrographic, cartographic and nomenclatural contributions which are their enduring legacy. Unless otherwise indicated, all quotes are from Chaigneau (1894) and Acevedo (1918), translated from Spanish.

THE SHIPS, THEIR VOYAGES AND OBSERVATIONS

Chacabuco

The *Chacabuco* was a 66 x 10 m steam corvette of 1101 ton (1119 t) displacement, one of two identical ships (with the *O'Higgins*: Fig. 1) built for the Chilean Navy in London, England, in 1866 (Brassey 1882, Viel 1887, Vargas Cariola & Silva Vargas 2019). Initially used for hydrographic expeditions to southern Chile and then for fighting in the War of the Pacific, the *Chacabuco* served as a naval ship from 1868 to 1890, after which it was converted into a pontoon, and then scrapped in 1909. It was the second of four successive Chilean naval vessels named *Chacabuco* after the 1817 Battle of Chacabuco, during the War of Independence from Spain.

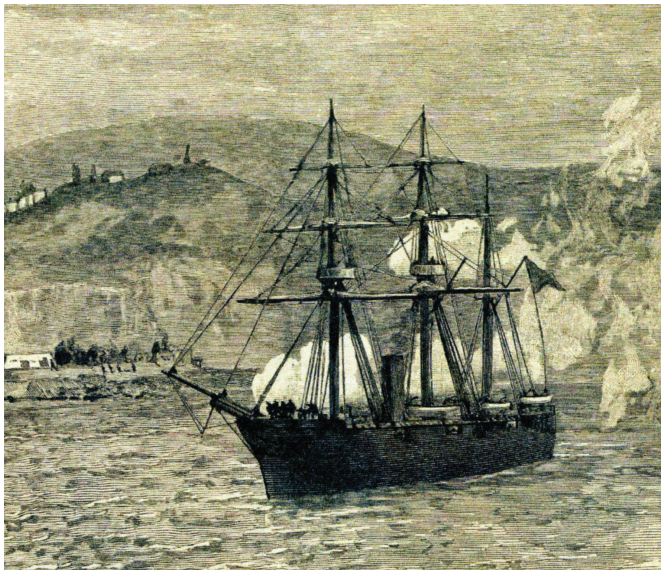

Figure 1. The *Chacabuco*'s twin, the *O'Higgins*, at Valparaíso, Chile, in 1891 (Wells 1891).

The *Chacabuco* visited Galapagos for six days (20–26 Nov) in 1887, during a 4.5 month (4 Oct 1887 to 23 Feb 1888) naval training and fact-gathering voyage that also stopped at Panama and Tahiti. Just one Galapagos island was visited, Chatham (San Cristóbal), where the ship anchored in "puerto Chico" (also known as Wreck Bay and, since 1917, as Puerto Baquerizo Moreno: Latorre 1999) and a hydrographical survey of the bay was conducted, as a training exercise and to add to the chart of the same bay that had been made by the Italian ship *Vettor Pisani* in Mar 1884. Time was also spent unsuccessfully attempting to retrieve the *Chacabuco*'s port anchor chain, which was lost in 80 m of water when a corroded link broke. On shore the officers explored the vicinity of Puerto Chico and the highland settlement of Progreso, collecting specimens of common native plants, seeds from some of the crops grown, and information on the inhabitants, their occupations and constructions. Chaigneau began by examining the lighthouse that stood at the back of the landing beach, which had been erected earlier that year or in late 1886, and which he had read about in a recent naval memo (Vidal Gormaz 1887). He found that the lamp was situated not 92 m above sea level (as published in the memo) or "302 ft" (as incorrectly described by Edwards 1887), but rather 12 m above sea level and 9 m from the ground. It stood on a wooden tripod-like structure and was lit every night, even at full moon, with the white beam reaching "8 to 10 miles" in clear weather (*cf.* "4 miles" in Edwards 1887 and Vidal Gormaz 1887). Nearby stood a small shed for storing products for export to Guayaquil, namely tortoise oil, sugar cane spirit, bacalao (grouper), and orchilla lichen (*Roccella gracilis*), as well as "cal de piedra" (quicklime) which Chaigneau explained was made by firing a "whitish rock" (presumably tectonically-uplifted or storm-loosened calcareous material from the sea floor), that existed near the shore, in an oven constructed there, and which was used in sugar refining. Following a path that led inland from the beach, Chaigneau and the officers hiked to Progreso, at *c.* "200 m" elevation, where they found a small sugar mill with an alembic still, plantations of sugarcane (*Saccharum officinarum*) and a hacienda. There they met Lieutenant Colonel Pedro Jaramillo, the first "jefe territorial" (army governor) of Galapagos, who told them that the proprietor of Progreso and owner of the hacienda and sugar mill, Manuel Julián Cobos, was away on one of the other islands collecting orchilla lichen, which produced a dye that fetched "good prices in Europe" and was one of Cobos's principle exports and sources of income. From Jaramillo, Chaigneau learned there were 140 inhabitants (including 20 women) on the island, most of whom worked for Cobos, and that they lived on the meat of the wild cattle they hunted and on the crops they cultivated, including coffee (*Coffea* sp.), "plátanos" (plantains *Musa* sp.), sweet potatoes (*Ipomoea batatas*), cassava (*Manihot esculenta*), potatoes (*Solanum tuberosum*), "frejoles" (beans Fabaceae), "melones" (melons *Cucumis melo*), and pineapple (*Ananas comosus*), the last constituting the first record of pineapples growing in Galapagos (*cf.* Lundh 2006). There were a few horses used for transport, and feral dogs, goats and donkeys. Although the island clearly had a favourable climate with sufficient rain for a variety of crops, freshwater for the settlement, obtained from nearby springs and gullies, was often scarce, allegedly due to the large quantities consumed by the cattle, and the porous nature of the soil. The amount of arable land on the island was also limited, the lowlands being too dry and rocky for cultivation and producing only cactus, dry shrubs and a native cotton ("algodoncillo"). Having just spent ten days (22 Oct to 1 Nov) at Panama studying the construction of the Panama canal, Chaigneau thought that Galapagos, due to its geographical location, could potentially take on great importance once this artery was opened, as long as a coal depot for steam ships could be established in the islands. This was an idea that had been raised by the British over 40 years earlier when the steamship HMStr *Cormorant* made its pioneering visit (Grant 2024). Chaigneau did not believe, however, that an agricultural colony of any great importance could ever be sustained on Chatham.

General Baquedano

The *General Baquedano* (Fig. 2: sometimes spelled *Jeneral Baquedano* and often abbreviated to *Baquedano*) was a 73 x 14 m steam corvette of 2500 tons (2540 t), built by Armstrong Whitworth in Elswick, England in 1898 and launched in 1899 (Office of Naval Intelligence 1900). It was named after the Chilean military general Manuel Jesús Baquedano González (1823–97) and was the second of four Chilean naval vessels to bear his name. The ship was used by the Chilean Naval School as a training and expedition vessel from 1899 to 1935, conducting annual visits to Easter Island

Figure 2. The corvette *General Baquedano c.* 1916 (from León León 1920).

(Rapa Nui, annexed by Chile in 1888), as well as longer voyages to more distant parts. It was scrapped in 1959 (Conrich & Mückler 2016).

The *General Baquedano*'s visit to Galapagos in 1910 followed the ship's mission to return to Guayaquil several Ecuadorian students who had been studying at Chile's Naval Academy but had been recalled in the face of rising tensions with Peru, and to help deliver ammunitions from the Chilean government. This move incensed Peru and almost sparked a war that was avoided through international arbitration (Anon. 1923). At Guayaquil the ship was given an "extraordinary" welcome, with the men aboard returning the "fraternal greeting" in equally brotherly spirit, "the entire crew feel[ing] an intense joy to see the always victorious flags of Ecuador and Chile linked" (Anon. 1910). The ship then spent 24 days (25 Mar to 17 Apr) in the Galapagos (Fig. 3), visiting five islands

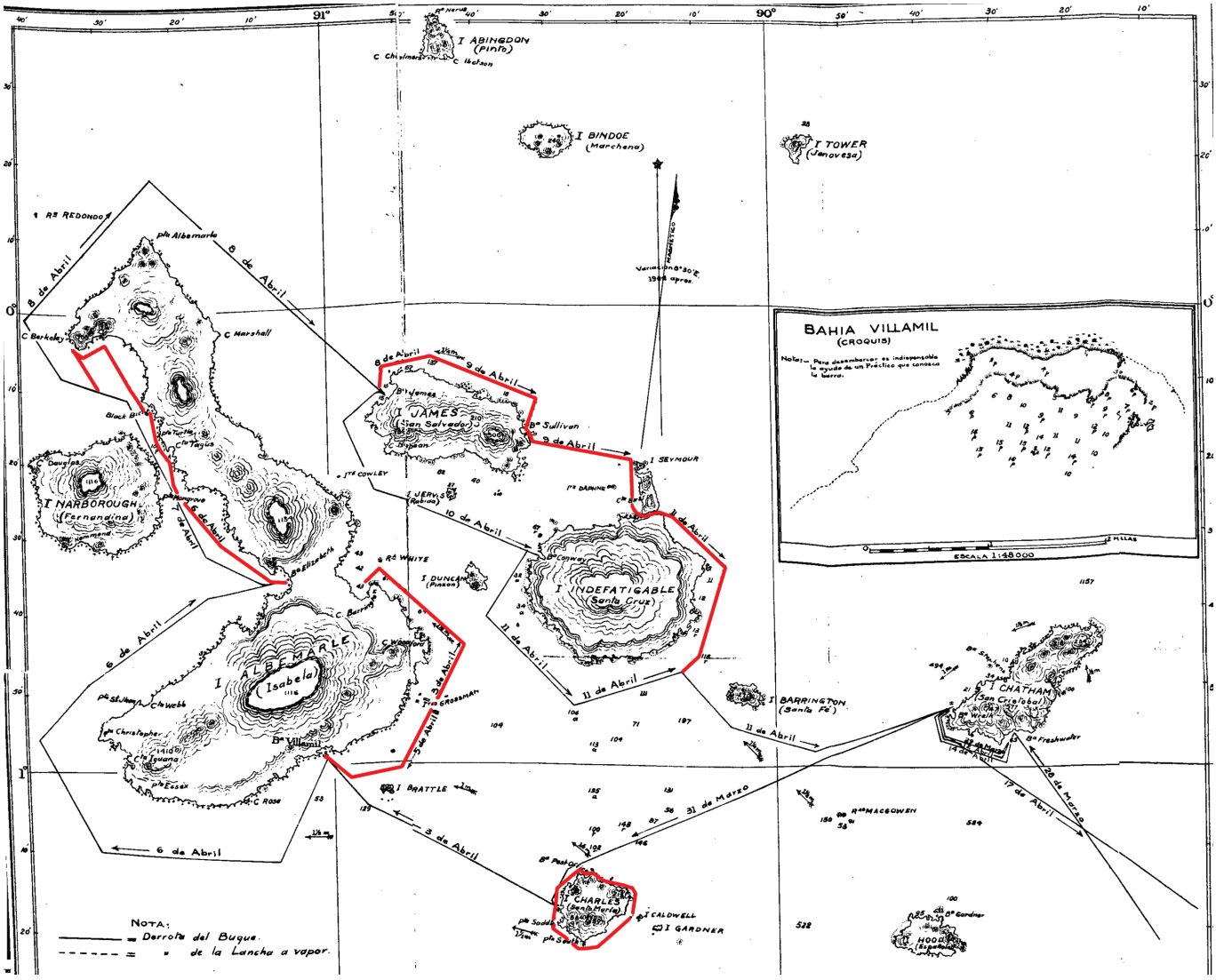

Figure 3. Map of the Galapagos Islands showing the *General Baquedano*'s route through the archipelago (solid line), and that of its steam launch (dotted line, here traced over in solid red for improved clarity), with inset chart of Bahía Villamil constructed during the voyage (from Acevedo 1918).

(San Cristóbal, Floreana, Isabela, Santiago, Santa Cruz), and stopping at seven anchorages: Wreck Bay, Black Beach, Puerto Villamil, Isabel Bay (within Elizabeth Bay), James Bay, Conway Bay, and Academy Bay (which Acevedo referred to as Puerto Núñez). It also sent a small steam launch and landing skiff to examine Cartago Bay, Tagus Cove and Banks Bay (Isabela), Sulivan Bay (Santiago), the northern coast of Santa Cruz, and the Seymour Isles (Baltra, North Seymour and Mosquera). Hydrographical surveys, involving triangulations and soundings, were conducted at most of these places, and charts were made of some of the bays.

The ship's first stop, after leaving the continent on 17 Mar and traveling by steam when close to shore and by sail in the open ocean, was Freshwater Bay, San Cristóbal, where it anchored for two days (26–28 Mar) and took aboard 160 tons of freshwater. It then moved to "puerto Wreck" (Wreck Bay), anchoring just north of Punta Lido and remaining there for another two days (29–31 Mar). On land, Captain Acevedo met Miguel Núñez, administrator of the colony and its sugar operation and "jefe territorial of the archipelago". Acevedo explained the goals of the voyage, to visit "all the principal islands of the archipelago" in order to carry out a program of instruction for the midshipmen on the ship, and invited Núñez to join the *Baquedano* on its tour of the islands. Núñez accepted and brought with him "Tomás Leveck" (elsewhere spelled Thomas Levick, also known as "Johnson of London": Grant & Estes 2015), retired captain of the settlement's schooner *Manuel J. Cobos*, whom Núñez insisted was "the only person on San Cristóbal who can provide information on the navigation in these islands" having lived in Galapagos for "more than 40 years", and two "vaqueanos" (*sic*, baquianos or local guides) who were also long-term residents, and knew "all the islands".

The *Baquedano*'s next stop was Black Beach (now also known as Puerto Velasco Ibarra), Floreana, from 31 Mar to 3 Apr, where most of the ship's complement ("100 sailors" divided into small groups, under the command of officers), was given leave to explore the highlands, while a few men circumnavigated the island in the steam launch. Floreana was not then inhabited but the men could see ample evidence of previous occupation: lemon and orange trees growing around the highland pond, wild cattle, pigs and donkeys. Acevedo was informed that Floreana's most recent inhabitant, Antonio Gil, had lived on the island for four years and raised a large number of cattle for their hides, but that he had since moved the industry to Isabela. With Núñez's permission a calf (one of more than 1000 head of cattle reportedly still on the island) and a pig (even more numerous than the cattle) were killed for a roast on shore. Two men got temporarily lost in the interior, which delayed the ship's planned departure from the island by a day.

The next anchorage was Puerto Villamil, Isabela, 3–5 Apr. Acevedo described the approach to the landing beach, where there was a wooden dock for embarking animals, as very tricky, and warned that "in no case should it be attempted without a knowledgeable pilot". He also noted that the NW point of the bay projected much further out than was shown on "the English map 1375" (*i.e.* British Admiralty Chart 1375, *Galapagos Islands Surveyed by Capt. Robt. Fitz Roy R.N. and the Officers of H.M.S. Beagle, 1836*). He consequently ordered the bay to be surveyed by the *Baquedano*'s naval students under their instructor, First Lieutenant Alejandro García, and attached the resulting chart, triangulation and sounding data to his official report. These items were not included in Acevedo's published article, but that did include a map of the *Baquedano*'s route through islands, and a small inset sketch of "Bahía Villamil" (Fig. 3). At midday on 3 Apr, Second Lieutenant Isidoro Becerra left in the steam launch to explore Cartago Bay on the east side of the Perry Isthmus, landing at four different places and discovering that the verge of mangroves along the entire coast within the bay, obscuring the open expanse of lava behind, was never more than 150 m thick. After sounding the bay he returned to the *Baquedano* on the morning of 5 Apr.

Leaving Puerto Villamil that same evening, the *Baquedano* then headed to the western side of the Perry Isthmus where it anchored in "bahía Isabel" (the inner reaches of Elizabeth Bay), at 15h30 on 6 Apr, a "half mile from the larger of the two islets that exist in the NE part of the bay" (now called the Mariela Islets), where it remained until 11h15 on 7 Apr. García was tasked with making a quick chart of Bahía Isabel, which was attached to Acevedo's report (but not published), and with examining the land, which was found to be similar to Cartago Bay, consisting of fields of lava obscured by stretches of mangrove forest. Lieutenant Guillermo Vargas Chacón and Lieutenant Federico Wilson were sent in the steam launch to explore Tagus Cove and Banks Bay. Levick informed Acevedo that the mangrove-lined inlets close to the *Baquedano*'s anchorage extended far inland, "almost to Cartago Bay" (an exaggeration) and were navigable by small boat at high tide, that a small water seep existed just south of Tagus Cove but had not produced much water since a "yankee" had attempted to enlarge it with dynamite two years earlier, and that there was a cove, north of Tagus Cove and "punta Tortuga", where small vessels could anchor in front of a mangrove thicket and land on a black sand beach (today called Playa Tortuga Negra). He assured the captain there were no more coves or harbours of any practical significance elsewhere on Isabela but that ships could anchor at a point (probably that now known as Punta Alfaro) facing Cowley Islet, where tortoises had been taken "in 1870" from the flanks of Cowley (now known as Alcedo) Volcano (Heller 1903).

After leaving Elizabeth Bay and navigating northward between Fernandina and Isabela Islands, the *Baquedano* picked up the steam launch off Cape Berkeley just after sunset. The ship's progress, which was already slow in order to conserve coal, was further impeded when it rounded Albemarle Point (the northern extreme of Isabela) and encountered a strong current flowing towards the northwest, away from their next destination, James Bay, Santiago, which was

consequently not reached until 18h20 on 8 Apr. Anchoring in the northern part of the bay, off the beach now known as Espumilla, the *Baquedano* remained there until 2h00 on 10 Apr. Shore parties were landed on 9 Apr, but no efforts were made to penetrate far inland, there being insufficient time to cut trails through the thick vegetation. The bay was calm during their brief visit, but Levick informed Acevedo that the area was often plagued by strong winds and heavy surf which could make landing impossible. He further explained that the beach was a favourite nesting place for turtles but that the eggs were devoured by the numerous wild pigs that lived on the island. The pigs, he warned, were also very dangerous to humans; the "vaqueanos" knew of several men who had been badly bitten by boars while they were collecting orchilla on the island in years past. No pigs were seen by the Chileans, but, perhaps alarmed by the vaqueanos' tales, they were quick to shoot a feral donkey that approached as if, they thought, to charge them. From James Bay, Second Lieutenants Isidoro Becerra and Humberto Baltra were dispatched in the steam launch to explore the lands around "puerto Sullivan [*sic*]" on Santiago, then to proceed "to the north part of Indefatigable to make a quick chart of the bay located to the west of the Seymour isles" and then to make another chart of a bay that Acevedo (1918) referred to as "puerto Núñez", on the southern side of Santa Cruz, which was also to be the point of rendezvous with the *Baquedano*.

The ship then continued to Conway Bay, Santa Cruz, where it anchored at 10h30 on 10 Apr. Acevedo wrote that the bay was calm and spacious, and would make a good port if only freshwater, which their local guides insisted was abundant in the highlands of Santa Cruz, could somehow be brought down to the coast. On the morning of 11 Apr the *Baquedano* continued southward, arriving at the bay that Acevedo (1918) called "puerto Núñez" at 10h30. The steam launch, however, was late, and therefore out of time to survey it, as originally planned. Acevedo had to content himself with describing the harbour from what he could see and what Levick told him. His description of vertical black cliffs, a vegetated islet in the eastern part of the entrance to the bay (clearly the islet now known as Caamaño), a small inlet in the furthest reaches of the bay where freshwater could be obtained from a small crack, of rough seas at the western point of the bay and of a long sandy beach (now known as Playa Tortuga) further westward of this point, all indicates that the name Puerto Nuñez referred to the bay now called Academy Bay, and not the large bay further east, as it does today.

Becerra and Baltra provided Acevedo with their report, dismissing Sulivan Bay as having little to offer except a place to anchor, but being more positive about "the bay to the west of the Seymour isles, on Indefatigable island, [which] offers a good anchorage, even though somewhat deep". This bay ended up bearing the *Baquedano*'s name. The men had also explored the channel between "Islote Baltra" and Santa Cruz and found it passable by small vessels, but only at high tide when soundings > 4.5 m could be measured. They warned that the tidal range seemed to be amplified within the strait, and that great care had to be taken at low tide to avoid becoming grounded on numerous rocks and shallows. Nonetheless they had successfully navigated the canal in the steam launch, and it had taken "12 miles" off the safer route around the north of the Seymour isles.

After hoisting aboard the steam launch and skiff off Puerto Nuñez, the ship returned to San Cristóbal, anchoring off Punta Lido on the night of 11 Apr. The next morning it moved to Freshwater Bay where two days (12–14 April) were spent attempting to take on freshwater, under incessantly windy conditions. The ship then returned to Wreck Bay where 100 m^3 of firewood were purchased in lieu of coal, and loaded aboard over three days (14–17 Apr). During this time the midshipmen, under the direction of Lieutenant García, were tasked with sounding and surveying Wreck Bay, using triangulation and astronomical observations to determine location. The officers also explored on shore. Acevedo noted that a 200 m wooden landing dock had been constructed sometime between Chaigneau's visit in 1887 and the assassination of Manuel J. Cobos (and jefe territorial Leonardo Reina) in 1904, with a Decauville rail line that ran from it to some bodegas at the back of the beach. The lighthouse was still there, next to the hut that was now inhabited by Levick, and near the landing dock was a small patch of calcareous rocks on shore, where lime was still being produced for the sugar refinery. Following the path to Progreso, which Acevedo described as being inland at *c.* 7 km and at an elevation of *c.* 288 m, Acevedo found another Decauville railway stretching 5 km between the sugar plantations that Cobos had established in 1881 and the steam-operated factory that he had built in 1889 to replace the original animal-powered mill that Chaigneau had seen in 1887. A "5 mile" (*c.* 8 km) aqueduct of galvanized iron had also been installed to carry water to the factory, as the nearby springs yielded insufficient for its operation. Acevedo learned that the sugar factory, which was then owned by Cobos's brother-in-law Rogelio Alvarado (Latorre 1999), though Acevedo makes no mention of this, operated year-round and (supposedly) produced up to 30,000 quintals (3000 tonnes) of refined sugar and 14,400 litres of cane spirit annually. The population of Progreso had more than tripled since Chaigneau's visit 23 years earlier: 480 people now lived on the island, including 60 women and 40 children, of whom 206 people worked at the factory. The island also supported 800 head of cattle, about 100 horses, and feral and domestic donkeys but reportedly few, if any, pigs, although pigs had been said to be "in great numbers" on the island in 1875 (Cookson 1875). About 220,000 coffee plants had been planted during Cobos's reign and were producing 3000 quintals (300 tonnes) of coffee beans per year. Acevedo also recorded the following crops on the island: sugarcane, maize (*Zea mais*), potatoes, sweet potatoes, cassava, beans, pumpkins (*Cucurbita* sp.), oranges (*Citrus* sp.),

figs (*Ficus carica*), guavas (*Psidium guajava*), "ciruelas" (probably Hog Plum *Spondias purpurea*), melons, plantains, pineapples, grapes (*Vitis vinifera*), badeas (Giant Granadilla *Passiflora quadrangularis*) and mangos (*Mangifera indica*). The last two plants in this list are first records for Galapagos; they were next recorded growing on Santa Cruz in the 1930s (Lundh 2006). Grapes had previously been reported by Serra (1886), growing at Progreso in 1884, but this record (as well as Acevedo's) seems to have been subsequently overlooked (*e.g.* Lundh 2006). Acevedo also noted a large number of introduced "jarcia manila" plants from which the labourers made "a fine-looking rigging rope" called "enequen" (henequén). Although jarcia manila refers to sisal *Agave sisalana* and henequén to *A. fourcroydes*, the plants were probably *Furcraea hexapetala*, as already recorded, along with its use for rope, in 1906 (Stewart 1911: "*F. cubensis*"). Acevedo believed the fibres could "be a material for industrial exploitation", to replace orchilla, which was no longer collected because commercial quantities could no longer be found due to overharvesting and because a cheaper, synthetic dye had undercut the industry. He was even more optimistic about the fishing industry, which he thought held great potential, as the groupers and lobsters in the archipelago were exceptionally large and abundant and the prices in the markets of Ecuador were high. He realized, however, that there would be significant challenges in establishing a profitable fishing venture, as it would require adequate vessels, initial capital, a regular steamship service, and improved communications on the mainland.

VALUE OF THE CHILEAN RESULTS

The visits of the *Chacabuco* and the *General Baquedano* to the archipelago are of interest for what they tell us about the early years of the settlement of Progreso on San Cristóbal, and for the results of their hydrographic surveys, which not only improved navigational knowledge but also added names to the Galapagos map.

Although much has been written about Progreso, its founder Manuel Julian Cobos, his sugar refinery and his despotic rule over his workers until his assassination (*e.g.* Bognoly & Espinosa 1905, Latorre 1991, 1999, Woram 2005, Hennessy 2019), the Chilean reports, written when the settlement was about 12 and 35 years old respectively (Cookson 1875), provide interesting details with regard to the settlement's installations, the size of its human population, the variety of crops grown and the kinds and numbers of domestic animals raised there, all useful for understanding how the island and its fauna and flora have changed as a result of human impact. The reports include the first records of three introduced crop plants, all still cultivated in the islands, and useful confirmation of the abundance and spread of other cultivated plants and domestic animals. They illustrate the shift in the Galapagos economy between 1887 when it was based largely on indigenous natural resources (mainly orchilla lichen, also tortoise oil), with some dependence on agricultural products (*e.g.* sugarcane), and 1910 when it had become based almost exclusively on introduced agriculture, principally sugarcane (for spirit) and coffee on San Cristóbal, and cattle for hides on Isabela. As noted by Acevedo (1918), the change was partially driven by the development of synthetic aniline dyes in the 1890s and the decline of the oil market, but it was also largely a consequence of over-harvesting. The lichen had suffered four decades of intensive collecting by José Valdizán, Manuel J. Cobos, José Monroy and the employees of their Orchillera Company, founded in the late 1850s (Cookson 1875), while the tortoises had a much longer history of hunting by pirates, whalers, colonists and scientific collectors, and predation by introduced mammals (Townsend 1926, Grant & Estes 2009, Gibbs *et al*. 2021). The tortoise oil that Captain Chaigneau found in the bodega at Wreck Bay in 1887, ready to be exported to Guayaquil, would not have been locally sourced, for the tortoise population that once occupied southern San Cristóbal was almost certainly extirpated in the 1840s (Wood 1847, Grant & Estes 2009, Grant 2024). Instead it probably came from the tortoises on Isabela and Santa Cruz Islands, which, due to their large size, were prized for their oil, and unlike most other tortoise populations in the archipelago were still "not rare" by the end of the century (Cookson 1875, Heller 1903, Townsend 1926). However by 1910 even they had almost disappeared, according to Acevedo, and only a few small individuals were being sold on the mainland, at a very high price due to their scarcity. Acevedo attributed their demise to the constant persecution exacted upon them by humans for meat and oil, but also on "the incessant, deadly war" inflicted on the young tortoises by feral dogs, "in great numbers" on some of the islands. He believed the dogs would eventually cause their extinction, except on Santiago where there were no dogs and where tortoises could still be found in the highlands. Although Acevedo gave the impression that the tortoises were no longer exploited for profit on a significant scale, and that the only natural resources being collected were sulphur (from Isabela), salt (on Santiago and "other islands"), and calcareous rock from Wreck Bay, it is clear from subsequent reports that tortoises on Isabela were still being killed for oil throughout the first half of the 20th century (Gibbs *et al.* 2021).

The hydrographic surveys conducted by the *Chacabuco* and the *General Baquedano* were naval training exercises supervised by trained hydrographers. One of them, Federico Chaigneau, had specialized in that field early in his career (Figueroa 1888), and two others, the *Baquedano's* captain Acevedo and naval instructor Alejandro García Castelblanco (1881–1938) later became directors of Chile's Hydrographic Office. Thanks to the UKHO and its broad dissemination of the Chilean information, the surveys resulted in several improvements to navigational knowledge and safety in the

islands. The *Chacabuco*'s survey of Wreck Bay was especially useful, for the bay was, at the time, the only inhabited port in the archipelago and the point of entry for most ships (merchant, naval and scientific) navigating through Galapagos, and certainly for all those needing to provision. With an extensive reef at its entrance it was a hazardous place for ships. Named by James Colnett after the remains of a shipwreck were found there by his crew in 1793, it has been the site of several other wrecks and groundings since (Grant 2017, Woram 2021c). A chart of Wreck Bay, based on surveys by HMS *Pandora* in 1847 and the Italian corvette *Vettor Pisani* in 1884 (Serra 1886), had been published on Admiralty Chart 1376 in Oct 1887 but the *Chacabuco* improved on this by revealing additional shallows around Schiavoni reef and extending the coastline survey south of Malamocco Point (Fig. 4).

Although the *General Baquedano*'s survey did not result in any coastlines being altered on the British maps, its navigational contributions were extensive. Thanks to the pilotage of Levick, who had lived and worked as a captain in the islands for 42 years (Grant & Estes 2015) and directed the ship and its steam launch to what he knew as the best anchorages in the central archipelago, twelve bays and coastal areas were examined by the *General Baquedano*'s surveyors. Six of these were already well known to the UKHO: anchorage charts of Wreck Bay, Black Beach, Tagus Cove, James Bay, Sulivan Bay and Conway Bay had already been published as insets on Charts 1375 and 1376 and had been identified and described in *South America Pilot*. However the remaining six sites, *i.e.* Bahía Villamil, Bahía Isabel (*sensu* the innermost part of Elizabeth Bay), Bahía Cartago, Baquedano Bay, Canal Itabaca and Puerto Núñez (meaning Academy Bay) were new to the British Admiralty in that, although their coastlines were delineated on Chart 1375, the harbours and channel had not been identified by name, nor described in any UKHO publication. The additions to *South America Pilot* and Chart 1375 represented a significant increase in the number of harbours and coastal areas in the archipelago which mariners could identify by name and navigate with some prior knowledge. Three of the areas identified by the *Baquedano* are today among the most populated and frequently visited areas in Galapagos, and became that way within just a few decades of the Chileans' visit: Puerto Villamil, inhabited for about 15 years, had never been charted; "puerto Núñez" (Academy Bay), was colonized by 1926, with the settlement then named Puerto Ayora after President Isidro Ayora (Pan American Union 1927); and Baltra Island was first occupied in 1942, by the U.S. military.

THE CHILEANS' LEGACY OF PLACE NAMES

The hydrographic information contributed by the *Chacabuco* and the *General Baquedano* was novel and useful, but has largely been superseded by more accurate survey. Their more lasting contribution is the nine place names that were added to the Galapagos map as a consequence of their visits, all but one of which are still in use today: Punta Chacabuco, Bahía Baquedano, Isla Baltra, Canal Itabaca, Caleta Birs (now known as Aeolian Cove), Puerto Núñez, Bahía Cartago, Bahía Isabel and Puerto Villamil. Four of the names are clearly Chilean: Point Chacabuco and Baquedano Bay were named, probably by the UKHO, after the Chilean ships, while Baltra Island and Canal Itabaca were named

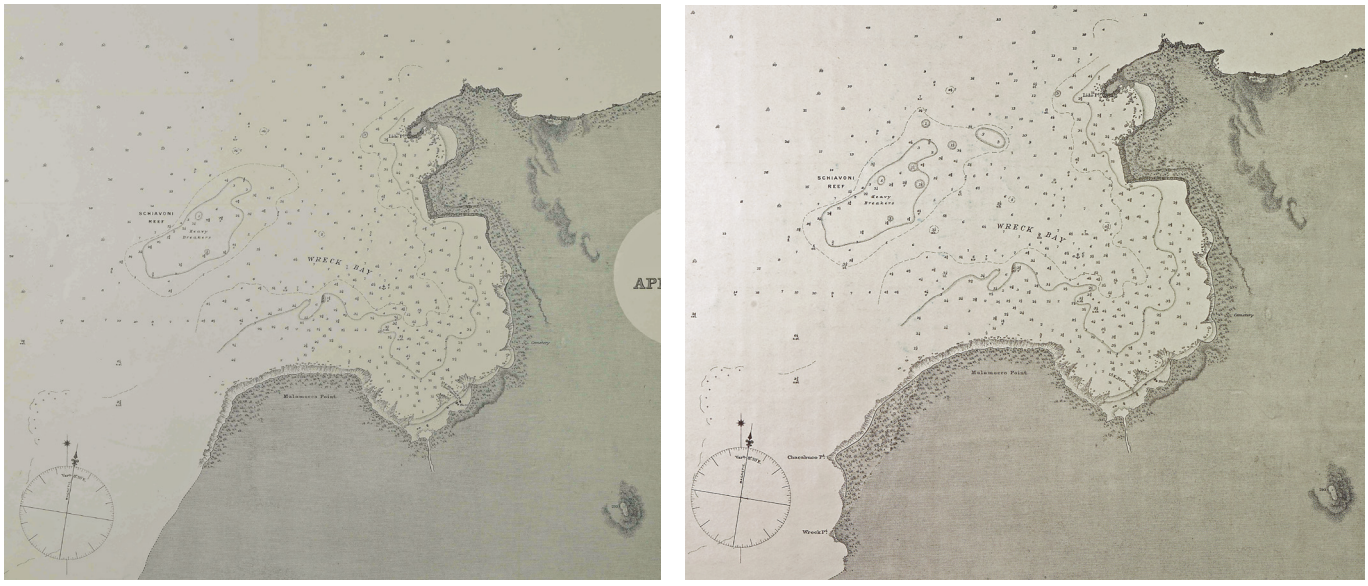

Figure 4. Wreck Bay, San Cristóbal, from two copies of Admiralty Chart 1376 in the Archives of UKHO: copy OCB 1376-B2 of the first edition published in Oct 1887 (left), and copy OCB 1376-B4 with corrections to May 1894 (right), showing modifications to Schiavoni Reef and the addition of coastal details south of Malamocco Point, including the labels Chacabuco Point and Wreck Point.

by and after men on board the *General Baquedano*. Puerto Núñez, Bahía Cartago and Caleta Birs may also have been named by the *General Baquedano*'s men, but they could, alternatively, have been local names that might never have made it onto an official map of Galapagos had it not been for the Chileans recording them and introducing them to the UKHO. Puerto and Bahía Villamil, and Bahía Isabel, were pre-existing, published, names that were, nevertheless, first brought to the attention of the UKHO by the *General Baquedano*'s report (Table 1).

Table 1. Place names added to the Galapagos map as a result of the surveying voyages of the *Chacabuco* in 1887 and the *General Baquedano* in 1910.

English (Spanish) name	First added to a UKHO publication	First known publication	Named after	Named by (approx. date)
Names of Chilean derivation:				
Chacabuco Point (Punta Chacabuco)	1894	Admiralty Chart 1376 (1894 ed.)	Ship *Chacabuco*	UKHO 1894
Baquedano Bay (Bahía Baquedano)	1911	UKHO (1911)	Ship *General Baquedano*	UKHO 1911
Baltra Island (Isla Baltra)	1911	UKHO (1911)	Humberto Baltra	Acevedo? 1910
Ilabaca/Itabaca Channel (Canal de Ilabaca/Itabaca)	1911	UKHO (1911)	Julio Ilabaca	Acevedo? 1910
Names of unknown origin, either pre-existing names learned by Acevedo or new names provided by him:				
Birs Cove (Caleta Birs)	1911	UKHO (1911)	?	Acevedo? 1910
Port Nuñez (Puerto Núñez)	1911	UKHO (1911)	Miguel Núñez	Acevedo? 1910
Cartago Bay (Bahía Cartago)	1911	UKHO (1911)	?	Acevedo? 1910
Pre-existing published names learned by Acevedo and provided to UKHO by Chile's hydrographic office:				
Port Villamil (Puerto Villamil)	1911	Bognoly & Espinosa (1905)	José Villamil	Gil 1893
Isabel Bay (Bahía Isabel)	1911	Villavicencio (1858a, 1858b)	Santa Isabel?	?

Apart from Point Chacabuco, clearly associated with the voyage of that ship, the other eight place-names were either coined by or brought to the attention of the UKHO by the *General Baquedano*. The UKHO published all eight for the first time in 1911 (UKHO 1911) with descriptions matching in wording or detail those written by Acevedo or shown on his route map (Fig. 3), thus leaving little doubt that they were obtained from the captain's original report and the sketch charts produced under his watch. Several of the names ("Baltra I & Puerto Nuñez", "Bahía Cartago", "Isabel Bay", "Port Villamil", "Anchorages [on] Indefatigable") are also mentioned in hand-written notes in the margins of one of the UKHO's surviving copies of UKHO (1905) (copy SAR1-6-1), as places to be added to the next edition. This corrects the chronology of Woram (2021d) who wrote that the names Baquedano, Baltra, "Ilabaca" and Birs were first published by UKHO (1927), with the handwritten margin notes naming "Baltra I & Puerto Nuñez" appearing on a copy at UKHO of the "1915" edition. All eight names were also added to British Admiralty Chart 1375 sometime between 1920 and 1930 (most likely earlier than later); of the surviving maps in the 1375 series at the UKHO (which are now catalogued with the designation OCB or "Old Copy Bundles"), OCB 1375-B3, bearing "small corrections" added in 1920, 1926 and 1930, and issued in or shortly after 1930, is the oldest version to show the eight names (Fig. 5). If earlier versions were issued, they are no longer held in the UKHO archives. The latest previous version in the archives, OCB 1375-B2 showing corrections to 1887, does not bear the names as it was probably printed *c*. 1904, *i.e.* before the *Baquedano* voyage, as indicated by a titular subheading reading "Magnetic Variation in 1904, nearly stationary".

Chacabuco Point (Punta Chacabuco)
Situated between Wreck Bay and Wreck Point on San Cristóbal, Chacabuco Point is the only place name to result from the *Chacabuco*'s visit to Galapagos. It clearly honours the ship, but may not have been named by the Chileans, for neither Chaigneau (1894) nor Vidal Gormáz (1890) included it in their respective articles. Instead it was probably given by the British Admiralty when they added the point and its label to Admiralty Chart 1376 (Fig. 4). It was first added to *South America Pilot* in 1941 (UKHO 1941).

Baquedano Bay (Bahía Baquedano)
Baquedano (misspelled "Barquedano" in UKHO 1911) Bay clearly honours the *General Baquedano* and identifies a bay on the north coast of Santa Cruz. As Acevedo did not name this bay in his published report, the name may have been bestowed by the British Admiralty. However, Acevedo's description of a "bay to the west of the Seymour islets, on Indefatigable island, good anchorage, although somewhat deep, its bottom being clean except at the vertex of the right angle formed by Baltra and Seymour islets with the north coast of Indefatigable island, where there are rocky outcrops" clearly matches that of the "Baquedano Bay" described in UKHO (1915) as "situated on the north coast of

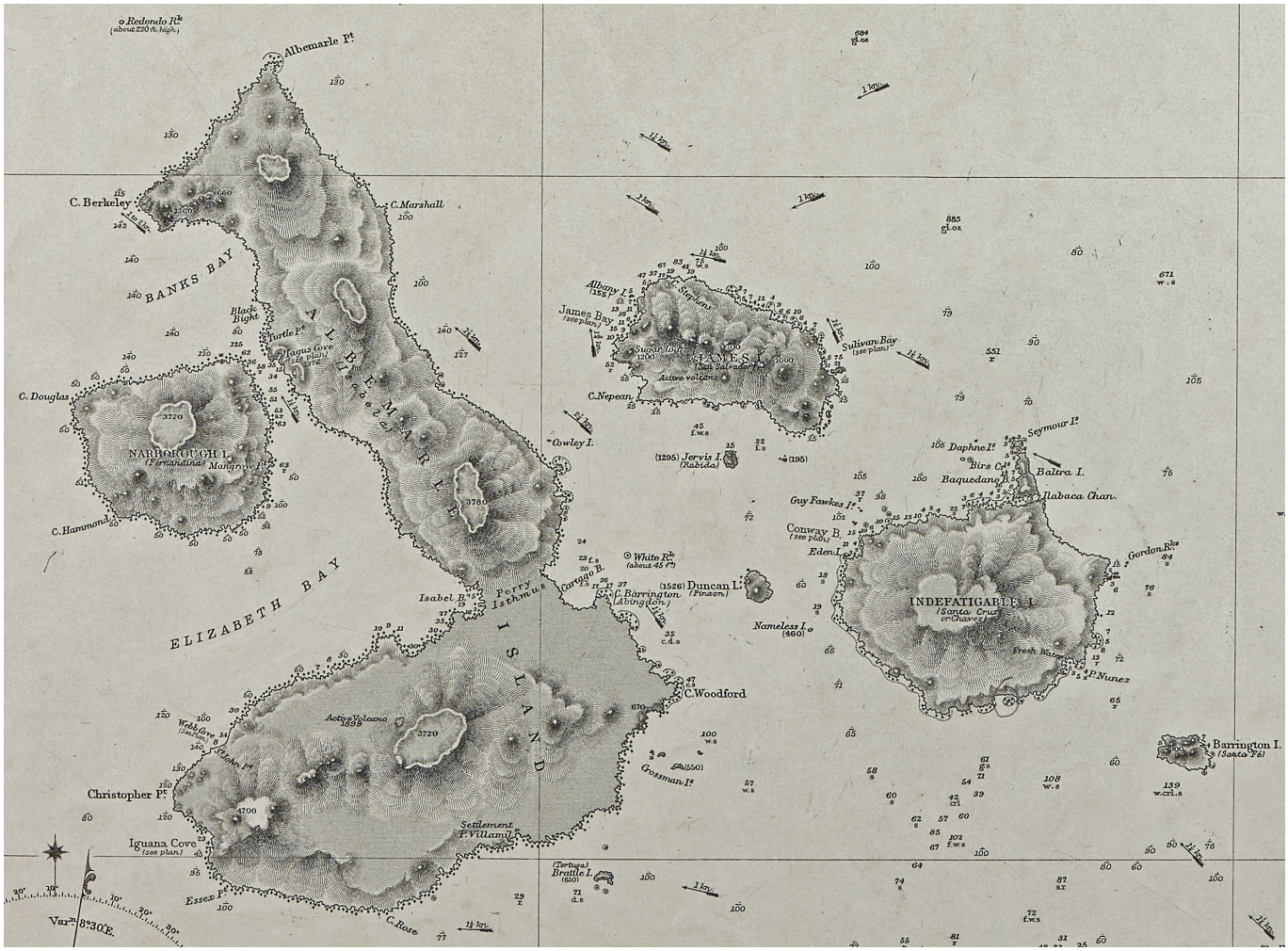

Figure 5. The central part of the Galapagos archipelago on copy OCB 1375-B3 of Admiralty Chart 1375, showing corrections to 1930, and bearing the new labels for Baltra Island, Birs Cove, Baquedano Bay, Ilabaca Channel, Port Nunez, Cartago Bay, Isabel Bay and Port Villamil (archives of the UKHO).

Indefatigable island, westward of Baltra island, the southern and larger of the Seymour islands, affords good anchorage abreast of a sandy beach and close southward of Birs cove on the latter island."

These descriptions indicate that Baquedano Bay referred, at least originally, to the large open bay now known locally as "La Tranca", at the western entrance to Canal de Itabaca, the channel between Baltra and Santa Cruz Islands (Fig. 6). However there appears to have been some uncertainty at the UKHO as to its exact location or scope, because the position of the "Baquedano B." label on OCB 1375-B3 suggests that it referred to a bay on Baltra Island (Fig. 6), as does UKHO (1941), which stated that it occupied the "next bight, southward of Birs Cove", an area today colloquially known as "Salinas" (S. Cruz pers. comm.). A handbook by British Naval Intelligence (Darby 1943), also places "Bahía Baquedana" (*sic*) "on the west coast of Baltra". Uncovering the original chart of the area made by Lieutenants Baltra and Becerra might resolve this matter, but in any case the above evidence indicates that "Baquedano Bay" did not correspond to Borrero Bay (further west on Santa Cruz), as has been proposed (Woram 2021e).

Caleta Birs (Birs Cove)

Caleta Birs is the harbour now known as Caleta Aeolian or Aeolian Bay (and also as Bahía Seymour or Seymour Bay) on the northwest side of Baltra Island; today it is an important anchorage for tour vessels connecting with Baltra airport, and the location of the archipelago's principal fuelling station. Acevedo did not describe this bay in his narrative, but it is labelled on his route map (Fig. 3). The meaning of the name and who assigned it remain unknown. Birs is an uncommon surname found mainly in France, the United Kingdom, Russia, and North America, but it is not a Chilean name, and even though the Chilean Navy was dominated by British, Irish and American officers during the Wars of Independence in the early 19th century, I have found no record of a Birs serving the country. Possibly the label was given by Levick, who was English, or another local of northern origins, for apart from the U.S.

scientific expeditions that visited the island at the turn of the century (the Hopkins Stanford Galapagos Expedition of 1898–9 and the California Academy of Sciences expedition of 1905–6), the Seymour Isles were rarely visited by mariners until William Beebe explored Galapagos, including "Seymour Bay", in 1923, and wrote a popular book (Beebe 1924) that inspired a succession of private yacht owners to discover for themselves the places that had so enchanted the lyrical author.

The name Aeolian Bay, which has replaced Caleta Birs, appears to have originated in or shortly before 1940. In Apr 1941, Schmitt (1941), who had visited the island three times previously (in 1933–8), and who knew the bay as "Velero Bay" (Schmitt 1935) or "South Seymour Anchorage" (Schmitt 1938), found the name "Aeolian Bay … cut in stencil fashion on a piece galv[anized] iron, underneath [which was] a sea turtle shell forming a roof over a small 3 x 5 black covered note book in which visitors may write names". Schmitt recorded one of those names, USS *Lapwing*, Oct 1940; possibly the ship responsible for leaving the artefacts and even for bestowing the name. An alternative origin for the name and perhaps also for some of these objects might have been a visiting yacht from the Aeolian Yacht Club of San Francisco, California.

Isla Baltra (Baltra Island)

Today home to the archipelago's busiest airport and an Ecuadorian (formerly U.S.) military base, Baltra was almost certainly named after Lieutenant Humberto Baltra Opazo (1884–1950), the naval officer on board the *General Baquedano* who, with Isidoro Becerra Saavedra (b. 1884), was tasked with surveying "Islote Baltra" (Acevedo 1918). Baltra is a common surname in Chile, though not elsewhere in South America. Humberto, who graduated from Chile's Naval Academy in 1902 after distinguishing himself as an outstanding naval cadet in 1899 (Merlet Sanhueza 2013) and who later rose to the rank of "capitán de corbeta" (lieutenant commander) (Anon. 1920), appears to have been the only Baltra in the Chilean Navy during the first decade of the 20th century (Artigas 1909).

Canal de Itabaca (Itabaca Channel)

Between Baltra and Santa Cruz islands, this channel was probably named after Chilean naval officer Julio Ernesto Ilabaca León (b. 1891) (Merino 1919). Itabaca is almost certainly a misspelling because even though "Itabaca channel" appears in UKHO (1911), it was changed to "Ilabaca channel" for the 1915 and 1927 editions and for OCB 1375-B3 (Fig 6.). Further, Itabaca does not appear to be a recognized surname anywhere in the world (as far as can be determined from genealogy references such as ancestry.com), whereas Ilabaca is a known surname in Chile and there were two men of this name in the Chilean navy at the time of the *Baquedano*'s visit, Julio and his younger brother Guillermo Antonio (b. 1892) (Artigas 1909, Merlet Sanhueza 2013). A partial ship's manifest (Anon. 1910) shows that Julio Ilabaca was on the *General Baquedano* for its Galapagos visit, as an officer-in-training ("guarda marina de segunda"). Perhaps the channel was given his name if he assisted Lieutenants Baltra and Becerra in their pioneering survey of it.

The eventual reversion to the misspelling "Itabaca" appears to have been facilitated by the North Americans, with "Canal de Itabaca" appearing in "The Millionth Map of Hispanic America" (American Geographical Society 1927, Platt 1927). Unless it made its own typographical mistake, the American Geographical Society appears to have obtained the misspelt name from UKHO (1911), as the USHO did not name the channel on its publications until 1960, when the Naval Oceanographic Office (the new name for the USHO) added a description of "Canal de Itabaca" to its equivalent of *South America Pilot* (Naval Oceanographic Office 1960). While the UK continued to use "Ilabaca" into the

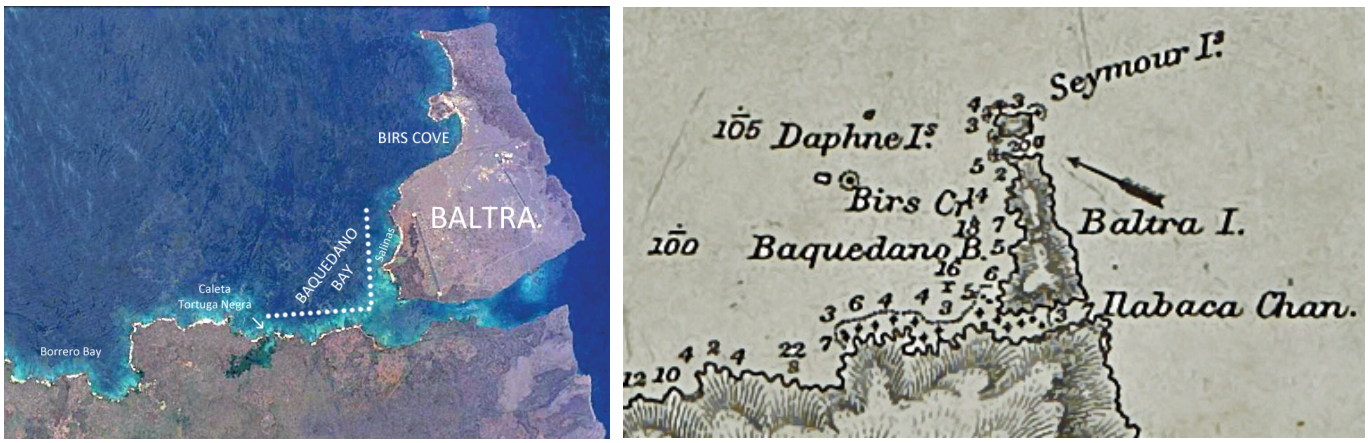

Figure 6. The approximate location of Baquedano Bay: (left) as plotted according to the description in UKHO (1915) and (right) as shown on Admiralty Chart 1375, edition printed sometime after 1930 (copy OCB 1375-B3 in archives of the UKHO) .

1950s (*e.g*. Darby 1943, OCB 1375-B5 with corrections to 1952), U.S. sources adopted "Itabaca" (*e.g*. Bumstead 1936, Hanson & Raymond 1944, Bowman 1946), with the U.S. government recognizing Itabaca as the "official" name, and Ilabaca as an unapproved variant (U.S. Board on Geographic Names 1957).

Puerto Núñez (Port Núñez)

On Santa Cruz Island, Puerto Núñez was most likely named after San Cristóbal resident Miguel Núñez (b. 1881), administrator of Progreso from 1904 to 1910, jefe territorial of Galapagos from *c.* 1908 (possibly earlier) until Nov 1910 (Anon. 1904, 1909a, 1911, Nuñez 1910), and son of Tácito Núñez (1851–1927), who was jefe territorial in 1900 (Latorre 1999). Although Miguel lived on San Cristóbal, he clearly knew Santa Cruz well for he told Acevedo that he preferred it, with its "natural pastures" and abundance of highland water, over all the other islands, and had asked the Ecuadorian government for 80 ha of its land for himself and his family (Acevedo 1918). In 1910 Santa Cruz was uninhabited but its highlands had been visited by San Cristóbal residents since the 1840s, first from a landing on the west coast. This landing place was known later in the 19th century as Puerto de las Chacras and, since at least the mid-1950s, Whale Bay or Bahía Ballena (Lundh 2004). However, since *c*. 1870, they had also reached the highlands from a bay in the south, originally known as "Puerto de la Aguada" and "la Aguada de Chávez" (Habel 1868, Slevin 1905, Lundh 2004), and today called Academy Bay (Lundh 2004, Grant & Estes 2015, Grant 2024). This was the bay which Acevedo (1918) referred to as Puerto Núñez, a name that was either told to him by his Galapagos host and shipboard guest Miguel Núñez, or invented by Acevedo to honour Núñez. By 1910 the name Academy Bay had already been given to this bay by the California Academy of Sciences 1905–6 expedition aboard the research vessel *Academy* (Slevin 1905) but it may not have been communicated to local residents and was not published until 1911 (Stewart 1911), so would have been unknown to the Chileans. It was also unknown to the UKHO when "Port Nuñez" was added to UKHO (1911) with descriptors (*e.g*. freshwater and an islet) drawn from Acevedo's account, which clearly refer to what is now known as Academy Bay.

Today Puerto Núñez identifies a different bay, on the southeast coast of Santa Cruz, where the modern visitor site El Garrapatero is located. The change appears to have occurred sometime between 1927 and 1941, after the UKHO learned of the precedence of "Academy Bay", perhaps from the *c.* 1926 USHO Chart 1798 (Fig. 7). It added that name in UKHO (1941), along with details about its settlement (established 1926) and modified the previous description of Port Nuñez (UKHO 1911, 1915 and 1927) by removing the descriptors (*i.e.* freshwater and an islet) that applied to Academy Bay.

At this point, Port Nuñez came to designate a bay to the east of Academy Bay, probably because of an earlier misunderstanding. Although Acevedo (1918) had written in his report that Puerto Núñez lay "in the southern part" of the island, UKHO (1911, 1915, 1927) stated that it lay on the southeast side, and Chart OCB 1375-B3 placed the "P. Nunez" label over the southeast extremity of the island (alongside the words "Fresh Water", which is not found there but at Academy Bay) (Fig. 5). It appears that the UKHO was misled as to the location of Port Nuñez by the combination of Acevedo's route map (Fig. 3), which shows the track of the Baquedano meeting that of its launch off southeast Santa Cruz, and Acevedo's (1918) comment that the two vessels met "in front of" Puerto Núñez. The UKHO's confusion, which was also hinted at in a hand-written note "Academy Bay – query position" in the margin of the UKHO's archived copy of UKHO (1927), nevertheless made it easy for UKHO to add the Academy Bay label in its correct place on later versions of Chart 1375 (e.g. OCB 1375-B4 with corrections to 1948), without having to remove or shift the P. Nuñez label from its position in the southeast. The words "Fresh Water" were also retained next to the P. Nuñez label on OCB 1375-B4, but this was clearly an oversight, given the removal of these words from UKHO (1941).

Bahía Cartago (Cartago Bay)

Cartago Bay, on the east coast of Isabela, has origins that remain a mystery. In 1909, the USS *Yorktown* surveyed and charted the bay as a prospective coaling station and, finding it "hitherto unnamed", called it "Cruiser Bay" (Anon. 1909b), though the Chileans would have been unaware of this. We do not know whether the name Cartago was a pre-existing local one or was given by the Chileans, but it was they who introduced it to the UKHO, which published it (UKHO 1911) and added it to Admiralty Chart OCB 1375-B3 (Fig. 5). Cartago Bay was then added to the USHO's Chart 1798 sometime before 1926 (Fig. 7: Townsend 1926) and was described in USHO (1928), as "Cartago (Cruiser) Bay".

Bahía Isabel (Isabel Bay)

Bahía Isabel refers to Elizabeth Bay (Bahía Elizabeth) or a part of it, on the western side of the Perry Isthmus, Isabela Island. The name Elizabeth Bay dates from the 17th century (Hack 1687, Moll 1699) and appears to honour Lady Elizabeth Cavendish (1654–1734), wife of Christopher Monck, 2nd Duke of Albemarle, for whom Albemarle Island (now Isabela Island) was named. Bahía Isabel is a literal translation of Elizabeth Bay, but probably derives at least in part from "Isla Santa Isabel", a name given to Albemarle Island by the Spaniards sometime before 1748 (Fuente 1748). Elizabeth Bay was already well known to the UKHO before the *General Baquedano*'s visit: it is named in Fitzroy & King

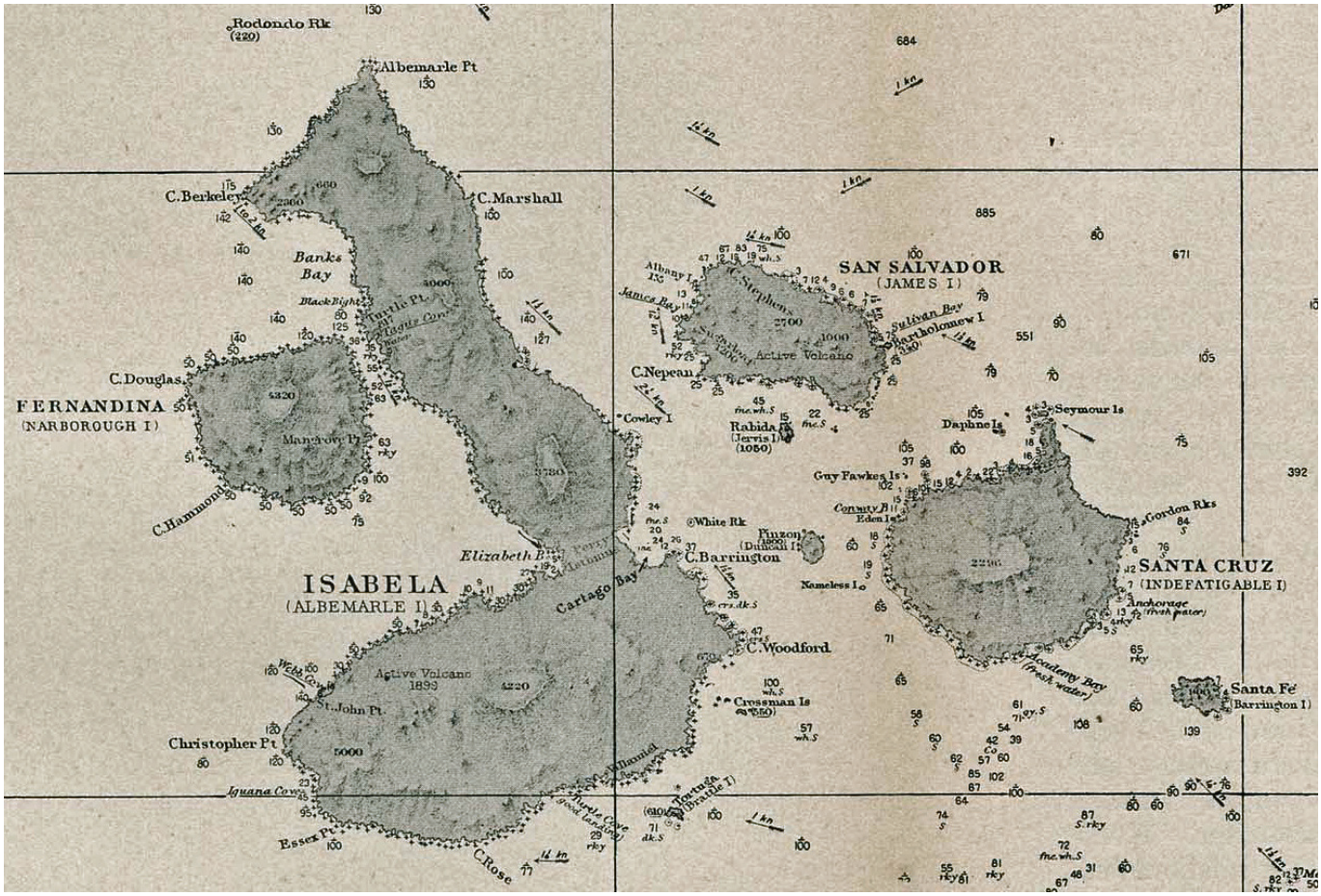

Figure 7. The central part of the Galapagos archipelago, from a version of USHO Chart 1798 in Townsend (1926). .

(1860) and UKHO (1895 and subsequent editions), where it is described as a large bay extending between Christopher point, its southern extreme, and Narborough island, its northern shore, and it is labelled accordingly on all editions of Chart 1375 (*e.g.* Fig. 5). In contrast, Bahía Isabel was not referenced in UKHO publications until after the *General Baquedano*'s visit, even though the UKHO surely knew of the name from Vidal Gormaz (1890), who specified that it was synonymous with "bahía Elizabeth", and perhaps also from earlier publications in Spanish, where it appears in various forms such as "la gran Bahía de Santa Isabel" (Anon. 1801), "bahía Ysabel" (Villavicencio 1858a, 1858b), "bahía Isabel" (León Mera 1875) and "bahía Santa Isabel" (Wolf 1887).

Acevedo (1918) used both Bahía Isabel and Bahía Elizabeth. Bahía Isabel appears in his text, once to name the southernmost of two large bays on the west coast of Isabela (the northern one being "bahía Bancks" *sic* Banks), explaining that ships often went to both bays to catch "baccalao" and turtles, and twice in reference to the innermost portion of this large southern bay, *i.e.* the small inner bay where the *General Baquedano* anchored and which was charted for the first time by Lieutenant García. Bahía Elizabeth appears on his route map (Fig. 3), where it too designates this inner bay. The position of the Bahía Elizabeth label on Acevedo's map does not correspond with that of Elizabeth Bay on Chart 1375, a copy of which Acevedo had on board, so it seems likely that Acevedo was influenced by Vidal Gormaz (1890) who wrote that "Bahía Isabel (Elizabeth)" occupies the "fondo" (innermost part) "of the right angle formed by Albemarle Island, facing west", with Christopher Point at its southern tip and Narborough Island forming its northern shore. Most of this description appears to be a translation of FitzRoy & King's (1860) account, but made ambiguous by its combination with the word "fondo", which perhaps persuaded Acevedo to apply "B. Elizabeth" to the inner bay.

Acevedo's focus on the small inner bay, his use of "Isabel" for both the inner and the greater bays, and of "Elizabeth" only for the inner bay, might explain why the UKHO decided to add "Isabel Bay" to its publications (beginning in 1911), to designate the inner bay and distinguish it from the greater Elizabeth Bay (Fig. 5). Isabel was misspelled "Isobel" in UKHO (1911), but corrected in UKHO (1915, 1927) and on Chart OCB 1375-B3 (Fig. 5). The name "Bahía Isabel" is still used today, sometimes to distinguish the inner bay where the Mariela Islets are found (as used in UKHO 1911, 1915, 1927 and Chart 1375), and sometimes as a synonym for the greater Elizabeth Bay.

Puerto Villamil

Puerto Villamil on Isabela is a tribute to José Villamil, the first Governor of Galapagos. The name was given by Antonio Gil, when he moved from Floreana to Isabela in 1893, and was already published (Bognoly & Espinosa 1905) and in common usage (*e.g*. by the California Academy expedition of 1905–6) by the time of the *General Baquedano*'s visit. However, the surveyors of the *General Baquedano* made the first known chart of "Bahía Villamil" (Fig. 3), and Captain Acevedo and the Chilean Hydrographic Department brought the name to the attention of the UKHO. UKHO (1905) had mentioned an unidentified "Settlement — on the southern shore of Albemarle" but the name "Port Villamil" was first incorporated into the 1911 edition.

The nine names added to the Galapagos map as a result of the surveys by the *Chacabuco* and *General Baquedano* were the first new Galapagos place names endowed since 1892, when Ecuador, by official decree, changed the name of the archipelago to "Archipiélago de Colón" (in commemoration of the 400th anniversary of the arrival of Christopher Columbus in the Americas) and gave new Spanish names to 13 of the major islands. The decree also stated that all future names given to islets, rocks, points and bays in the archipelago should commemorate notable people in the history of Ecuador, a request that was clearly not honoured by the Chileans and the UKHO. The Chileans were not ignorant of Ecuador's wishes, for the decree was discussed by Acevedo (1918) and had been by Vidal Gormaz (1890), who transcribed it as written on 8 Aug 1890 and a list of objections to it by A. Flores (the Ecuadorian Minister of Instructions in Quito). One of Flores's principal points, to which Vidal Gormaz (1890) and Acevedo (1918) fully adhered, was that changing familiar island and other place names would cause widespread confusion. Acevedo pointed out the history of disorientation arising from the names introduced by Cowley and Torres in the 17th and 18th centuries respectively, until clarity had been achieved with the publication of "the English chart No. 1375", which incorporated Cowley's names and others introduced by James Colnett in 1793–4 (Grant 2017). In his report, Acevedo used both Spanish and English names of the principal islands he visited, but mostly the latter, pointing out that the map of Archipiélago de Colón, which the Ministry of Instructions was to have printed in Europe with the names specified in the decree, had "not yet been ordered". Nevertheless, the decree's Spanish names for the 13 islands had been incorporated into Chart 1375 and UKHO (1905) by the time the *General Baquedano* visited Galapagos (they are shown on OCB 1375-B2, produced in or after 1904).

Despite the non-Ecuadorian origins of most of the nine names associated with the Chilean voyages, they should not be assumed to be a slight to Ecuador. As mentioned earlier, the two names honouring the Chilean ships (Chacabuco Point and Baquedano Bay) were probably not coined by the Chileans themselves, but by the British Admiralty. Those aside, the Chilean surveyors would for practical reasons have had to identify the places they examined as they went along, by either recording existing local names or providing new names of their own. They may not have thought, at the time, that the names they used would ever be incorporated into an official map. For instance, the two places that clearly reference Chilean men, Baltra Island and Canal Itabaca, do not honour illustrious people in Chile's history, nor even senior officers on the ship. Instead they refer to naval officers of quite low rank. In contrast, one of the names given by the Chileans and another recent one recorded by Acevedo (1918) do celebrate Ecuadorian officials: Puerto Núñez and Puerto Villamil. Along with "Santo Tomás" on Isabela (honouring Bishop Tomás de Berlanga who discovered Galapagos in 1535), which was named by Antonio Gil at the same time as Puerto Villamil, these were the first Galapagos place names bestowed after the 1892 decree, which celebrate notable figures in Ecuadorian history. Today there are many more, but all came later.

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IS PHOTOGRAPHIC COMPARISON A RELIABLE AUXILIARY METHOD FOR IDENTIFICATION OF INDIVIDUAL GALAPAGOS PENGUINS *SPHENISCUS MENDICULUS*?

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SUMMARY

Photographic identification can be a useful tool in wildlife monitoring, as long as it can accurately identify individuals. Here, we evaluate its use as an identification method auxiliary to traditional marking, for Galapagos Penguins *Spheniscus mendiculus*. We used a free photographic identification program (Interactive Individual Identification System: I^{3}S) to find and rank matches in a set of 402 photos of the ventral spot patterns of 285 individual penguins marked with Passive Integrated Transponders (PIT). The photos were taken at three breeding sites in 2012–2014 and 2017. We first used the program's "Automatic" analysis to evaluate the performance of its "Classic" and "Spot" versions at matching photographs of known identity. We found that the Classic version was better than Spot at identifying the penguins, with a 70 % probability of correctly identifying a new photo when comparing it to two previous reference photos per individual (irrespective of year of the previous photos), and an 85 % probability of including the correct match of the new photo in the top 20 ranked matches. These probabilities dropped to 55 % and 78 % respectively, when using only one prior photo per individual. We then used the program's "Manual" analysis to match a later photo to only one prior photo per individual. When examining recaptures within the same year, we obtained a 61 % probability of a correct match, but only 31 % for recaptures from different years. The probability increased to 82 % when photos from all years were categorised by sex and colony. Ventral spot patterns of immatures were retained into adulthood. Photographic identification can most reliably be used for studies within a single season and site, while for longer-term studies it could help in cases where a PIT is lost.

RESUMEN

Identificación fotográfica como método auxiliar para identificar individuos del Pingüino de Galápagos *Spheniscus mendiculus*: ¿Es confiable? La identificación fotográfica es una herramienta útil en el monitoreo de vida silvestre, siempre que se pueda identificar individuos con precisión. Evaluamos su uso como método complementario al marcado tradicional para el Pingüino de Galápagos *Spheniscus mendiculus*. Utilizamos un programa gratuito de identificación fotográfica (Sistema de Identificación Individual Interactivo: I^{3}S) para buscar y graduar coincidencias en un conjunto de 402 fotos de los patrones de puntos ventrales en 285 pingüinos marcados con Transpondedores Pasivos Integrados (PIT). Las fotos se tomaron en tres sitios de reproducción en 2012–2014 y 2017. Primero usamos el análisis "Automático" del programa para evaluar el desempeño de sus versiones "Classic" y "Spot" para emparejar fotografías de identidad conocida. Observamos que la versión Classic fue mejor que la Spot en la identificación de pingüinos, con un 70 % de probabilidad de identificar correctamente una nueva foto al compararla con dos fotos referenciales previas por individuo (sin tomar en cuenta el año de dichas fotos); y un 85 % de probabilidad de incluir la combinación correcta de la nueva foto entre las 20 mejores coincidencias. Mientras que, al utilizar solo una foto previa por individuo, estas probabilidades bajaron al 55 % y al 78 % respectivamente. Luego, usamos el análisis "Manual" del programa para comparar las fotos más recientes con una sola foto previa por individuo. Al examinar las recapturas dentro del mismo año obtuvimos una probabilidad del 61 % de coincidencia correcta, pero solo un 31 % entre recapturas de diferentes años. La probabilidad incrementó a un 82 % al categorizar las fotos de todos los años por sexo y colonia. Los patrones de manchas ventrales de los inmaduros permanecieron en la edad adulta. El uso de la identificación fotográfica puede ser más confiable para estudios dentro de una sola temporada y sitio; mientras que para estudios a más largo plazo, podría facilitar la identificación de individuos que perdieron su PIT.

INTRODUCTION

Conservation of the endangered Galapagos Penguin *Spheniscus mendiculus* (Freile *et al*. 2019) requires accurate identification of individuals, to determine survival rates and relate these to threats such as climate change, human interaction, introduced species and parasites (Vargas *et al*. 2007, Carrera-Játiva *et al*. 2014, Crawford *et al*. 2017, Jiménez-Uzcátegui *et al*. 2019). Metallic or plastic leg or wing bands as used to identify individuals of other bird species are less suitable for penguins, partly due to their morphology (Richdale 1951, Culik *et al*. 1993, Gauthier-Clerc *et al*. 2004, Petersen *et al*. 2005). This has led to the use of Passive Integrated Transponder (PIT) tags placed under the skin, though these can only be read at close proximity (within 40 cm) (Renner 2000).

Photographic identification (photo ID) offers an alternative to banding and PIT tagging. Photo ID uses the unique variation in phenotypic markings or permanent scars to identify individuals, and is especially useful for species that are difficult to capture or handle (Marshall & Pierce 2012). To be applicable, the phenotypic marks must be relatively constant throughout the animal's life, with sufficient variation between individuals to tell them apart. Unfortunately, most bird species lack obvious variation, resulting in limited use of this method in birds (Murn 2012). With the exception of Sherley *et al*. (2010), the few bird studies that have used photo ID typically employed time-consuming manual identification rather than an automated method (Chardine 2002, Zuberogoitia *et al*. 2013, Cerón 2015, Williams & Thomson 2015).

The aim of this study was to evaluate whether photo ID of Galapagos Penguins is a useful auxiliary method to identify individuals in a marked population, including where individuals might lose their tags. We assessed the suitability of the I3S photo ID computer program for identifying individuals of the species, using photographs of PIT-tagged birds recaptured during the study period. We identified the best performing version of the program and tested its ability to match photos taken within and between years. We also used these photos to determine whether there was any movement between colonies and if the plumage marks used for photo ID remain stable when immature birds moult to adult plumage.

METHODS

Three Galapagos Penguin breeding sites were studied, on or offshore of Isabela Island: Caleta Iguana (0°58'36"S, 91°26'42"W), Puerto Pajas (0°45'18"S, 91°22'30"W) and the Marielas Islets (0°35'48"S, 91°5'24"W) (Fig. 1). This study was a component of a mark-recapture program operating since 2001, in which individuals were marked with a subcutaneous PIT tag in the left tarsus area. In 2012–14 and 2017, pictures of the underparts were routinely taken of 285 PIT-tagged birds from a distance of 30–50 cm, with a Panasonic Lumix DMC-SZ1 camera. Each capture of an individual was considered an independent event.

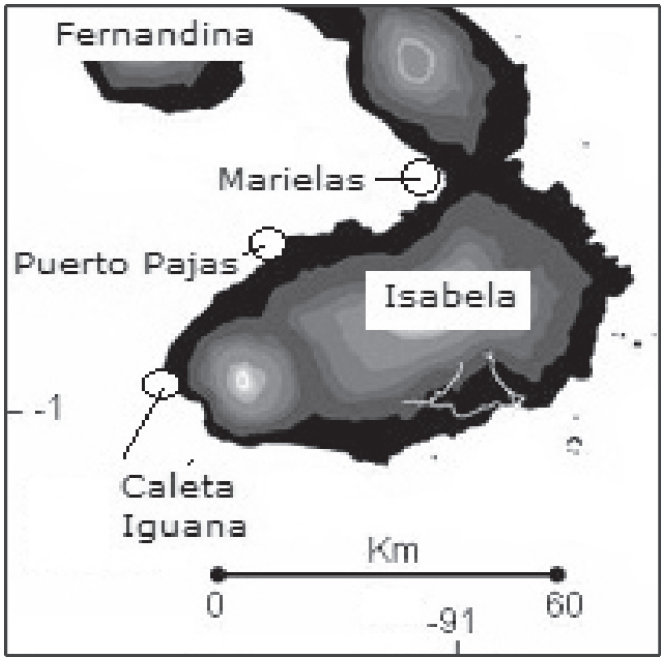

Figure 1. Galapagos Penguin breeding colonies (Caleta Iguana, Puerto Pajas, Marielas) sampled in 2012, 2013, 2014 and 2017.

The photographs were analyzed using the Classic and Spot versions of the Interactive Individual Identification System (I³S). This open-licence, semi-autonomous software extracts the spot pattern of a picture, compares it against previous photos in the database, and provides a best possible match list. The Classic version is the simpler, working only with the position of the markings on the individual to be analysed, while Spot considers in addition the shape and size of an ellipse traced over the relevant marks, chosen by the researcher (see Tienhoven *et al*. 2007, <www.reijns.com/i3s>).

I³S searches for matches in four main ways, "Automatic" and "Manual" analysis, each using "Classic" or "Spot" versions. For the Classic version a mark is placed at the centre of each plumage spot, and for the Spot version an ellipse or circle is placed around the spot, depending on the shape of each spot. Automatic analysis can be used to evaluate the performance of each of the software's versions, by attempting to match photographs of known identity, then generating the probabilities of obtaining a correct match to show how suitable the software may be for working with the species in question. For Automatic analysis, two options may be used, simple and elaborate, of which we used elaborate, where the user chooses the

number of comparisons among photos and the number of reference photos to consider, whereas in simple evaluation these criteria are set by the software defaults. For identifying new photographs, Automatic analysis may also be used to generate the probability of a new picture matching individuals that are already in the database. In contrast, with Manual analysis, the researcher searches for matches to a new photograph, in either the whole database or a subset of photos filtered according to criteria such as sex, age or colony.

We first ran Automatic analysis to evaluate the software, using the percentages of correct matches in the whole database (containing all the photos of the four years), to assess the identification success rates of the Classic and Spot versions. The program requires points of reference, for which we used the body insertion points of the right and left flippers, and the central posterior part of the body (Fig. 2).

We then used Manual analysis to match newer photos to one previous reference photo per individual (more than one previous photo were available for only a few individuals), in order to compare the success of identifying birds recaptured the same year or at longer intervals. We set the software to accept a minimum of three spots and a maximum of 20, because only 1 % of penguins had > 20 spots on the underparts. Using the program's zoom function each photo was inspected at 65–90 % greater than original size, to avoid missing details and to discriminate real spots from dirt such as faecal residues on the feathers. For this analysis, five data sets were used: the overall database containing all individuals from all four years, and four subsets, one for each year of study (2012, 2013, 2014, 2017). Searches for matches were done within the four single-year data sets with birds recaptured and photographed the same year, while the overall database was searched for matches of birds recaptured and photographed in different years. When the Manual analysis did not include the correct match within the top five ranked photos, we filtered the data by sex (determined by measurements, and by genetic analysis of some individuals: Travis *et al*. 2006, Jiménez-Uzcátegui *et al*. 2021) and breeding colony where the individual was photographed to see whether this improved identification success.

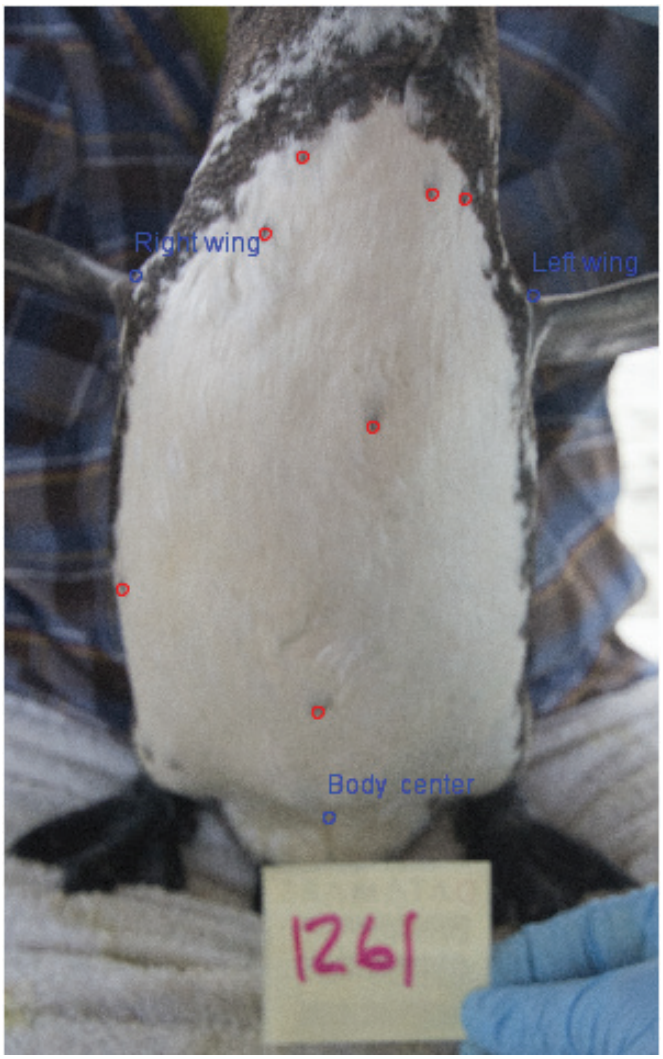

Figure 2. Screenshot from I³S Classic version, showing the points of reference (labelled) and the marks chosen for analysis (other circles).

Although we also determined age (immature and adult) according to plumage (individuals less than two years old have white feathers on both sides of the cheeks), we did not include immatures in the main analyses due to their low number. However, the photographs of immatures were analysed separately to verify whether the marking pattern is constant until adulthood, or changes as the birds age.

RESULTS

We had a total of 402 usable photos of 285 PIT-tagged individuals, comprising 31 photos of 31 individuals in 2012, 128 photos of 114 individuals in 2013, 152 photos of 141 individuals in 2014 and 91 photos of 45 individuals in 2017. In total, 48 recaptures that provided new photos of previously photographed birds were recorded over the four years of study.

Software evaluation using Automatic analysis

Both Classic and Spot versions showed that the probability of identifying a new photo of an individual increased as the number of reference photos of the individual increased (Table 1) but, because the Classic version performed better, we used only this version for the Manual analysis.

Identifying new photos by Manual analysis

Out of the 28 photos of recaptures within a year, 61 % (17 photos) were identified correctly (i.e. prior photo placed in the first position on the list of best matches), 18 % (five photos) had the prior photo in second to fifth position, 18 % (five photos) from sixth to 49th position, and 4 % (one photo) could not be matched, perhaps because

Table 1. Probabilities (%) of finding a match for a new photo of a bird that was already in the database, generated by Automatic analysis (elaborate evaluation) using one or two reference images (RI) per individual, in Classic and Spot versions of the software I³S.

	Classic		Spot	
Position	**1 RI**	**2 RI**	**1 RI**	**2 RI**
top 1	54.9	70.1	46.8	64.0
top 1–5	66.3	74.8	59.9	72.9
top 1–10	70.9	79.5	63.6	78.9
top 1–20	77.7	84.6	68.9	82.4

dirt particles affected the pattern. Of the 28 photos, the six whose match had not ranked in the top five improved their placing when we filtered by sex and colony data.

Of 48 photos of recaptures between years during the four years of study, 31 % (15 photos) were identified correctly (in first position on the list of best matches), 19 % (nine photos) from second to fifth position, 15 % (seven photos) from sixth to tenth, 29 % (14 photos) from 11th to 49th, and 6 % (three photos) had no matches. Out of the 48 photos, 23 of the 24 birds that did not make the first five positions improved their placing when sex and colony filtering was used, the exception being one adult individual that in 2013 had no spots but which had two spots in 2017.

All recaptures of individuals were made in their original colony, *i.e*. we found no colony relocations.

Two individuals were photographed when immature and again when adult, one in July 2013 and as an adult in April 2014, the other in December 2013 and as an adult in September 2014. Manual analysis located the earlier photo of the first of these birds as first place match for its later photo, and for the second bird (Fig. 3) the analysis placed its earlier photo in second place match to its later photo..

DISCUSSION

As evaluated by Automatic analysis, the Classic version of the I³S software performed slightly better than the Spot version for identifying photos of individual Galapagos Penguins. The percentage of photos correctly identified was lower by Manual analysis than by Automatic, but improved with the number of reference photos, and was better for photos categorised by sex and colony, and taken within a year rather than in different years. Identification is best achieved by using both Automatic and Manual versions, but the low percentage of recognition means that the photo ID technique is inaccurate as a substitute for traditional capture-mark-recapture methods. Photo ID may however be used as an auxiliary method to identify individuals within a single season and site, or when the individuals show big spots or scars.

Our results support the suggestion of Boersma *et al*. (2013), that the pattern of spots on the ventral surface of adult Galapagos Penguins is individually distinctive and with few exceptions lasts over time. We found that only one adult's spot pattern changed notably in four years. On the other hand, unlike in other *Spheniscus* species, whose pattern changes when immatures moult into adult plumage (Burghardt *et al*. 2004), we obtained records of two Galapagos Penguins in which the spot pattern remained constant and characteristic from immature to adult, although the distance between spots increased because the adults were bigger.

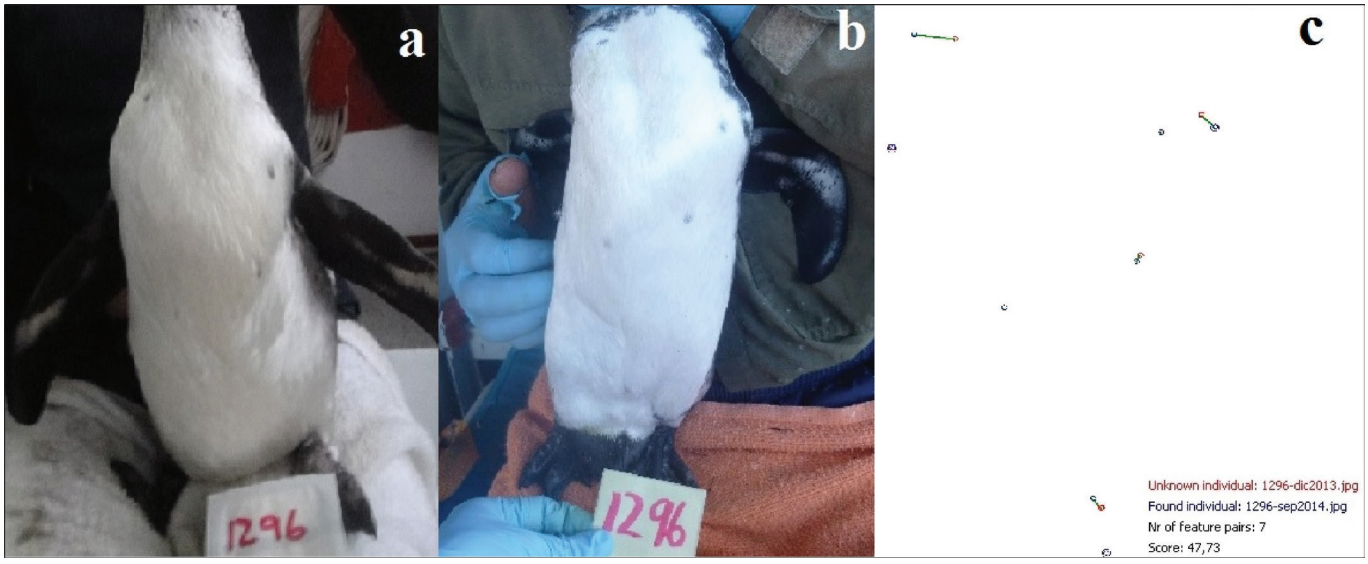

Figure 3. Photo identification of bird 9810981029-29052, (a) as an immature in December 2013 and (b) as an adult in September 2014, and (c) overlay of the spot patterns extracted from the two pictures, with lines linking spots that the I³S software identified as matching.

Some advantageous features of the I³S program compared with other software are that it allows pattern discrimination despite variation in lighting conditions (Sherley *et al*. 2010), and its Automatic option reduces the time required to search manually for matches in a database with many photos, while avoiding human error from manual matching (Kelly 2001). The program produces lists of best matches, which enable researchers to narrow down the number of possible match individuals and then refine the search by using additional filters to reduce the incidence of false positives and false negatives. Some disadvantages of I³S are that the algorithm works on a two-dimensional model, whereas the zone of interest is not flat and changes depending on posture (Kelly 2001). The feathers also need to be clean to avoid particles affecting the identification.

The main advantage of photo ID, for a species of conservation concern such as the Galapagos Penguin, is that it does not cause physical trauma compared with subcutaneous injection of a PIT tag or application of toe rings that break the interdigital membrane (*cf*. Ellenberg *et al*. 2006). However, its limited accuracy results in it being most useful for studies within a single season and site, while for longer-term studies it remains to be seen whether the accuracy could be refined.

To improve the effectiveness of photo recognition, we recommend: continuous monitoring to obtain a good number of photos from new and recaptured individuals; standardising the position of individuals to be photographed (Cerón 2015); including at least three reference photos of each individual to increase the possibilities of obtaining at least one of high quality (Kelly 2001, Steviek *et al*. 2001); improving the matching probability (Tienhoven *et al*. 2007); using filters such as locality, date, age and sex to refine the identification match.

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FIRST RECORD OF THE FUNGUS *ENTOMOPHTHORA* INFECTING *PHILORNIS DOWNSI*, AN INVASIVE FLY IN THE GALAPAGOS ISLANDS

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SUMMARY

The vampire fly *Philornis downsi* is an obligate bird parasite that was introduced into the Galapagos Islands, probably accidentally from mainland Ecuador. Subsequently, the fly dispersed to most islands in the archipelago, negatively impacting endemic land-bird populations. We report here the discovery of an entomopathogenic fungus of the genus *Entomophthora*, likely within the *E. muscae* complex, infecting *P. downsi* in the Galapagos Islands. The fungus was identified based on its morphology. This appears to be the first record of a member of *Entomophthora* parasitizing the genus *Philornis*, and the first record of a fungus in the *E. muscae* complex infecting any insect species in Galapagos. We hypothesise that this fungus is introduced rather than native in Galapagos and recommend further research on entomopathogenic fungi in South America.

RESUMEN

Primer registro del hongo *Entomophthora* infestando *Philornis downsi*, una mosca invasora en las Islas Galápagos. La mosca vampiro *Philornis downsi* es un parásito obligado de aves que probablemente fue accidentalmente introducida en las Islas Galápagos desde Ecuador continental. Luego de su introducción, *P. downsi* se dispersó a la mayoría de las islas del archipiélago donde está afectando negativamente las poblaciones de aves nativas y endémicas. Aquí presentamos la descripción de un hongo entomopatogénico en el género *Entomophthora*, probablemente dentro del complejo de especies *E. muscae*, que fue descubierto infestando a *P. downsi* en las Islas Galápagos. El hongo fue identificado por sus características morfológicas. Este estudio representa el primer registro de *Entomophthora* infestando el género *Philornis*, y el primer registro de un hongo en el complejo de especies *E. muscae* infestando una especie de insecto en las Islas Galápagos. Proponemos la hipótesis que este hongo es una especie introducida a las Islas Galápagos y recomendamos más investigaciones enfocadas en los hongos entomopatogénicos en Sudamérica.

INTRODUCTION

Many fungal species in the order Entomophthorales play important roles in regulating insect host populations. These fungi may cause epizootics that reduce host populations to near zero locally, hence their potential for managing pests (Pell *et al*. 2001). Entomophthorales fungi can be difficult to collect as they often occur in restricted sites, and their visible infections are short-lived and seasonal. In addition, culturing them in the laboratory has proved difficult (Pell *et al*. 2001, Sacco & Hajek 2023).

The *Entomophthora muscae* species complex includes a number of species and strains (Keller 1984) that are obligate insect pathogens with a host range mostly restricted to cyclorrhaphan Diptera (MacLeod *et al*. 1976, Pell *et al*. 2001, Jensen *et al*. 2006, Sacco & Hajek 2023). *Entomophthora* fungi infect and consume the host, and some species change host behaviour (Roy *et al*. 2006). The *E. muscae* life cycle starts when conidia discharged from previously infected hosts land on the cuticle of a new host. Fungal cells then penetrate the host cuticle using mechanical pressure and enzymes to reach the haemolymph (Pell *et al*. 2001, Elya & De Fine Licht 2021). Once within a host, *E. muscae* initially grows as protoplasts, proliferating in the haemolymph using non-essential organs for food, keeping the host alive. Through most of the course of an infection, there are few obvious symptoms, although feeding by the host decreases

as the infection progresses. As host resources are consumed, the fungus alters its host's behaviour such that infected flies climb to a high location and die in a characteristic posture with the wings spread away from the abdomen, an ideal position for conidia dispersal (Krasnoff *et al*. 1995). Host death is probably caused by starvation when the fungus has consumed all reserves (Pell *et al*. 2001). Spore dispersal occurs either by forcible discharge of infectious conidia (responsible for infection during the season when hosts are active) or by the formation of thick-walled resting spores capable of overwintering, which are not infective. After surviving winter in the soil, the resting spores produce infective conidia (Roy *et al*. 2006). Primary conidia discharge directly from the dead host, while secondary conidia form when primary conidia land on non-host substrates. The cycle starts again when conidia from a dead host land on a new host, or when a susceptible host comes in contact with conidia from the environment (Elya & De Fine Licht 2021).

The avian vampire fly *Philornis downsi* was introduced into the Galapagos Islands before 1964, presumably accidentally (Causton *et al*. 2006, Kleindorfer & Sulloway 2016, Fessl *et al*. 2018). It is native to the Caribbean and South America, including Ecuador (Dodge & Aitken 1968, Couri 1984, 1999, Mendonça & Couri 1999, Silvestri *et al*. 2011, Bulgarella *et al*. 2015). It is an obligate avian parasite, whose adults feed on fruit, flowers or decaying organic matter (Teixeira 1999, Fessl *et al*. 2018, Bulgarella *et al*. 2022) and the females lay eggs in bird nests containing eggs or nestlings, where the resulting larvae feed on the developing nestlings (Fessl *et al*. 2006). The first-instar larvae feed inside the nares, while the second and third instars feed externally by rasping the skin and ingesting serum and blood (Teixeira 1999, Fessl *et al*. 2006, O'Connor *et al*. 2010). The *P. downsi* invasion of Galapagos has had detrimental effects on some land-bird species, several of which are threatened with extinction (Kleindorfer & Dudaniec 2016, McNew & Clayton 2018, Bulgarella *et al*. 2019). Following its introduction to the islands, *P. downsi* has expanded its host range to include at least 19 Galapagos endemic bird species, including 11 species of Darwin's finch Geospizinae (Bulgarella & Heimpel 2015, Fessl *et al*. 2018, Coloma *et al*. 2020, Anchundia & Fessl 2021).

Little is known about the pathosphere of *P. downsi*, either in its native or invasive ranges. Two studies in Galapagos found that the gut microbiome of larval and adult flies shifts in bacterial species composition, and between flies reared in the laboratory and those captured in the field (Ben-Yosef *et al*. 2017, Jose *et al*. 2021). In larvae, the bacterial assemblage differs between host bird species, with larvae parasitizing strictly insectivorous finches harbouring significantly different microbiomes compared to larvae parasitizing finches with broader feeding habits (Ben-Yosef *et al*. 2017). Trypanosomatids have also been detected in the tissue of *P. downsi* flies in Galapagos (Pike *et al*. 2020), corresponding to species most closely related to the genera *Crithidia* and *Blastocrithidia*. Beyond these studies, we are not aware of any other research conducted on pathogens affecting *P. downsi* elsewhere.

Here, we describe the discovery of an *Entomophthora* fungus, probably of the *E. muscae* species complex, infecting live *P. downsi* adults.

METHODS AND OBSERVATIONS

The fungus was found infecting a shipment of 30 live adult female *Philornis downsi*, which was taken from Galapagos to a quarantine laboratory at the University of Minnesota, U.S.A. for studies to evaluate potential biological control agents (Bulgarella *et al*. 2015, 2017). The flies were collected 18–22 Jul 2014 in McPhail traps containing papaya juice (Causton *et al*. 2019) at two sites on Santa Cruz Island: El Barranco (0.738418°S, 90.301670°W; 15 m a.s.l.), which is in the dry lowland zone, and Los Gemelos (0.626111°S, 90.386111°W; 500–600 m a.s.l.), a highland site in the humid *Scalesia pedunculata* forest. The collection occurred during the cool season when host nestlings are typically scarce and most flies captured are female (Causton *et al*. 2019, Bulgarella *et al*. 2022). The flies showed no sign of fungal infection at the time of collection, during the holding period in the laboratory, or during the packaging phase. Shipment procedures followed strict biosafety standards. Flies were placed in plastic containers with small air holes covered by netting, which were then placed in plastic boxes sealed with biosecurity tape to avoid an accidental insect release during transit. Before leaving the laboratory, the boxes were placed inside a cotton pillowcase. They were then hand-carried under permit within the plane's cabin. The shipment departed from the Galapagos Islands on 23 Jul 2014. On 25 Jul 2014, we received it at the quarantine facility at the University of Minnesota. Upon opening the box in the receiving room, five of the 30 flies were dead, with signs of a fungal infection. Blooms of white mycelium protruded through the intersegmental membranes and white conidia were observed on the bodies (Fig. 1). We examined the mycosed flies and photographed the fungal conidia with an inverted phase contrast microscope fitted with 20 × and 40 × objectives. We did not use any stain. We photographed the dead flies and isolated the 25 flies that were still alive in a cage in a separate room to avoid fungal spillover to the *P. downsi* fly colonies held in quarantine at the University of Minnesota. The following day (26 Jul 2014), three more flies were dead, one showing signs of the fungus. At that time, we euthanised all flies by freezing.

The myscosed flies presented the characteristic striped appearance of infection with *E. muscae*, with white mycelium piercing through the weakest points of the fly exoskeleton at the intersegmental membranes and on the ventral abdomen (Fig. 1; Elya & De Fine Licht 2021). The finger-like conidiophores were characteristic of *Entomophthora*, and

the broadly ellipsoidal primary conidia, with a papillate apex and flattened base (Fig. 2), typical of those described for the *E. muscae* complex (MacLeod *et al*. 1976, Gryganskyi *et al*. 2013, R.D. Moon pers. comm.).

DISCUSSION

We are certain that these flies were infected in the Galapagos Islands, rather than during transit to Minnesota, given the duration and characteristics of the *Entomophthora* life cycle, whereby the fungus initially consumes the host resources internally with no overt signs of infection. Infected adult flies can live longer than four days before showing any signs of fungal infection and later succumbing to it (Krasnoff *et al*. 1995, Pell *et al*. 2001). Under laboratory conditions, fruit flies *Drosophila melanogaster* infected with *E. muscae* die within 4–5 days (Elya et al. 2018); in House Flies *Musca domestica*, death occurs 5–7 days after exposure (Kramer & Steinkraus 1981, Hansen & De Fine Licht 2017). Based on these data, the fungus would already have begun to feed on the internal organs of the wild *P. downsi* flies collected on the islands 18–22 July, before they were packed and sealed for transportation. Conidiophores are not expected to penetrate out of the host cuticle until after death, and infections are only visible for *c*. 24 h. By the time the box was opened in Minnesota on 25 July, the fungal hyphae were visible on the fly cadavers. Thus, the timing of events does not support an infection during transit.

Our observations represent the first record of a species in the *E. muscae* complex, infecting any insect species in the Galapagos Islands. This is also the first time that a species of *Entomophthora* has been associated with any member of the genus *Philornis*. Our identification was based on the phenotypical characteristics of the fungus, as our attempts to extract fungal DNA failed. We homogenised samples manually with a mortar and pestle in liquid nitrogen to lyse the fungal cell wall but obtained no measurable quantities of DNA. It is difficult to obtain sufficient quantity and quality of DNA or RNA in Entomophthorales due to the high activity of DNAases and RNAases, which results in nucleic acids being highly degraded or hardly visible on gels after extraction (Gryganskyi & Muszewska 2014). While the species identity remains to be confirmed by genetic analysis, based on the host association it seems likely that our fungus represents a species in the *E. muscae* complex, a paraphyletic group of at least seven described species. The host range of *E. muscae* is thought to be mainly restricted to dipterans within the Cyclorrhapha (Steinkraus & Kramer 1987, Pell *et al*. 2001, Jensen *et al*. 2006, Elya & De Fine Licht 2021, Sacco & Hajek 2023), although a few associations with coleopterans and hymenopterans have been reported (Eilenberg *et al*. 1987, Jensen & Eilenberg 2000). Sacco and Hajek (2023) concluded that the majority of species of arthropod-pathogenic fungi in the family Entomophthoraceae are specialists, commonly infecting hosts within one insect

Figure 1. Top row, two wild *Philornis downsi* flies killed by *Entomophthora muscae*-like fungus, showing the typical banding pattern of white mycelium growing through the intersegmental membranes; bottom row, flies with the white conidia having discharged from the dead bodies (photos: MB).

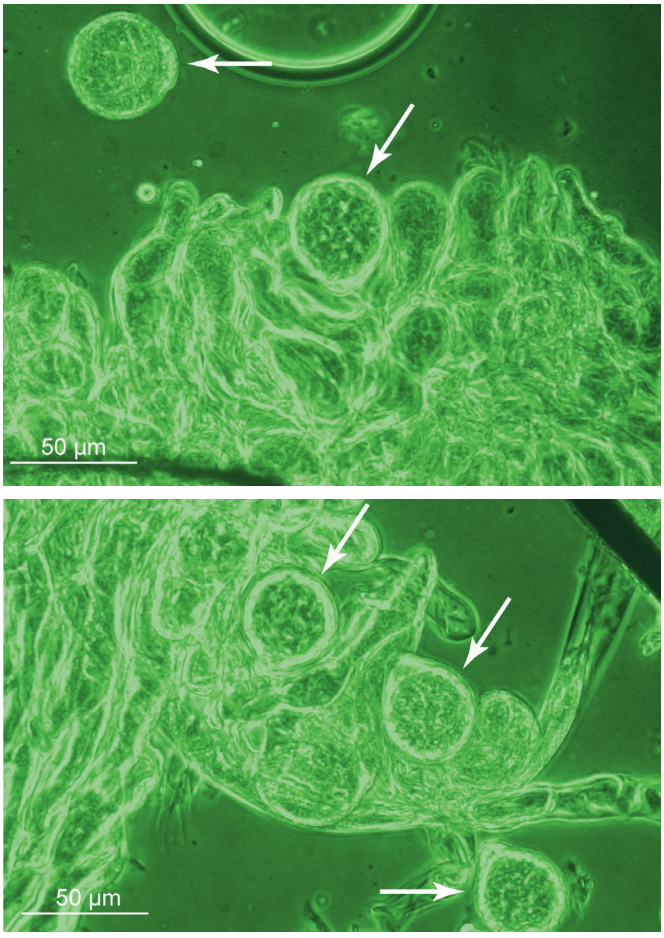

Figure 2. Microphotographs taken from infected *Philornis downsi* flies in this study, showing the characteristic conidia; each white arrow points to a conidium (photos: TK).

family. We found two previous Galapagos records of unidentified *Entomophthora* species infecting insects in the orders Hemiptera and Lepidoptera (Evans & Samson 1982, Cannon & Evans 2004), but they are probably species other than E. muscae, based on their host associations.

Flies infected with species resembling *E. muscae* have been recorded from much of the temperate zone (Pell *et al*. 2001) but records from South America of Entomophthorales identified to species level are limited to Argentina (Lastra *et al*. 2006), Brazil (Madeira 1998) and Chile (Aruta *et al*. 1984). To our knowledge, no dipteran-infecting Entomophthorales has been reported from Ecuador. It is not surprising that no observations of *Entomophthora*-like symptoms have been reported on flies from Galapagos despite numerous collections, beginning with Darwin's in 1835 (Sinclair 2023). Visible mycelial growth from insects killed by *Entomophthora* decomposes in as little as 24 h and what is left of the host body desiccates. Saprobic fungi may then consume the remains, or the cadaver can be dislodged from the surface to which it was adhered (Elya & De Fine Licht 2021), making it easy for non-specialists to overlook these entomopathogenic species. Further, a sampling bias whereby infections of host species of economic importance are more often reported than those of native species in natural settings has been identified (Sacco & Hajek 2023). Accordingly, this fungus has not been found in Galapagos since our study. Colonies of *P. downsi* flies are maintained at the Charles Darwin Foundation's entomological laboratory, where observations of white fungus-covered flies have been almost zero since the finding reported here, suggesting either that infestation rates are low, or laboratory conditions are not favourable for fungal proliferation. *E. muscae* germinates only under locally saturating (100 %) humidity (Kramer 1980a, b). It is thus likely that the infected flies in our shipment originated from the highland Scalesia habitat, a humid cloud forest with a high density of dead trees offering suitable habitat for wood-colonizing arthropods, where fungus-infected insects were previously collected by chance (Evans & Samson 1982).

We hypothesize that the *Entomophthora* species we found is more likely to be introduced rather than native to Galapagos, and that its introduction was associated with fly introductions from mainland Ecuador, consistent with the clear pathway of flies being introduced from the mainland. The latest Diptera checklist for Galapagos includes 86 species of introduced cyclorrhaphans, with the rate of introductions increasing over the past few decades (Sinclair 2023, Ramírez *et al*. 2024). The life cycle of the fungus also facilitates its introduction by plane or ship, since infected adults can live for 4–7 days before showing infection signs and later dying (Krasnoff *et al*. 1995, Pell *et al*. 2001).

From a conservation standpoint, the discovery of *Entomophthora* infecting *P. downsi* in Galapagos suggests the potential of this fungus to help control the invasive fly. We recommend a broad sampling effort to detect Entomophthorales in populations of *P. downsi* and other fly species in the islands. We also hope that our discovery will fuel more research on these fungi in South America.

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Galapagos Research

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Research Articles must be original contributions that deal with subjects of relevance to Galapagos science or conservation (including all the subject areas listed above). Material published or accepted for publication elsewhere, in whole or in part, will not normally be accepted. Wherever possible, manuscripts should have been critically scrutinised by at least one specialist in the relevant field, before submission to the journal. Papers from Charles Darwin Research Station staff and volunteers should be reviewed by their Progamme Leader prior to submission. Submitted manuscripts will be sent by the Editor to at least one expert referee (normally two) for critical review.

Galapagos Commentary items, which should not normally exceed 1000 words, may include notices of happenings in the islands that affect science or conservation, recent or forthcoming major events or publications about Galapagos (including book reviews), achievements in Galapagos science or conservation opinion or discussion of Galapagos science or conservation issues, and more general or popular articles that have relevance to Galapagos science or conservation.

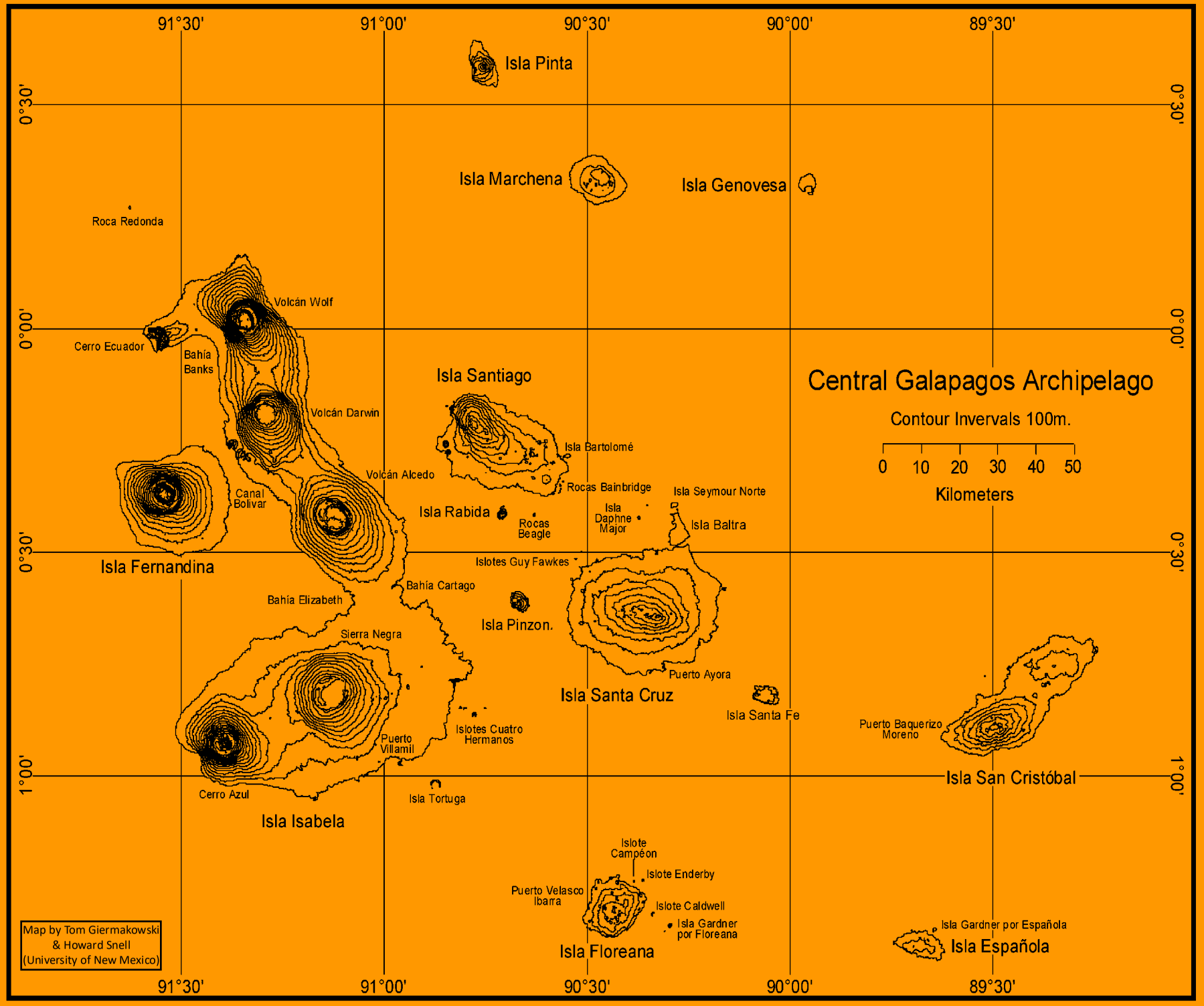
Format of tabular material, numbers, metric units, references, *etc*. should match recent issues. Note particularly: dates should be in the form 2 Feb 1990 but months standing alone in text may be written in full; times of day are written 6h45, 17h32 and coordinates in the form 0°46′N, 1°4′W (no leading zeros); numbers up to ten are written in full, except when followed by abbreviated units (*e.g*. 6 m), numbers from 11 upwards are written in figures except at the beginning of a sentence. All references mentioned in the article, and only such, must be entered in the bibliography.

Locality names should be widely recognised and in current use where possible. Articles citing older names, or localities that are not widely known, should contain a map or gazetteer, including all such localities mentioned. **Scientific names** should follow a recognised authority, which should be cited in papers dealing with taxonomic issues or lengthy species lists. Scientific names of **plants** should follow the World Flora Online <https://www.worldfloraonline.org/>, unless sound reasons for following a different scheme are presented.

Figures should be prepared as for final reproduction, allowing for reduction to fit column or page size. Figures prepared in or scanned into an appropriate graphics format, saved at high resolution and submitted electronically are preferred. Figures should not be included in a Word file. Low-resolution files or poor-quality scans will not be accepted. When designing Figures, pay attention to *Galapagos Research* column size and page-shape. Authors are encouraged to submit **photographs** that illustrate salient points of their articles. Photographs should be high-contrast (for publication in monochrome) and high resolution. Photographs should be supplied in graphics file format (*e.g*. jpg or tif) and should not be pasted into a Word file. Photographers other than the paper's authors should be credited. Consult the Editor for further advice.

All Research Articles (but not Commentary notes) should include a **Summary**, not exceeding 5% of the paper's length. The Summary should briefly refer to the major findings of the paper and not simply outline what was done in the study. Summaries will be published in both English and Spanish and will be translated if necessary by the editorial team.

Accepted articles will be published **Online First**, on the CDF website, and cannot be altered further thereafter. They will normally be included in the next printed issue, which then becomes the definitive version. **Offprints** will not be supplied, but authors will be sent a pdf file of their article, free of charge.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Isla Fernandina
Isla Santiago
Isla Bartolomé
Rocas Bainbridge
Isla Rabida
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Isla Seymour Norte
Isla Daphne Major
Isla Baltra
Central Galapagos Archipelago
Contour Invervals 100m.
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Kilometers
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Bahía Cartago
Bahía Elizabeth
Isla Pinzon.
Sierra Negra
Puerto Ayora
Isla Santa Cruz
Isla Santa Fe
Puerto Baquerizo Moreno
Islotes Cuatro Hermanos
Puerto Villamil
Cerro Azul
Isla Tortuga
Isla Isabela
Isla San Cristóbal
Islote Campéon
Islote Enderby
Puerto Velasco Ibarra
Islote Caldwell
Isla Gardner por Floreana
Isla Floreana
Isla Gardner por Española
Isla Española
Map by Tom Giermakowski & Howard Snell (University of New Mexico)