Expedition to the remote Trindade Island and Martim Vaz rocks, South Atlantic to research the Trindade Petrel and the endemic frigatebirds

May 2022

The Murphy's Trindade Island Expedition

Expedition undertaken by:

Hadoram Shirihai

Expedition Report by:

Hadoram Shirihai, Vincent Bretagnolle, Fabio Olmos & Robert L. Flood

The Murphy's Trindade Island Expedition

Dedicated to Robert Cushman Murphy of American Museum Natural History

Pelagic Ornithological Expedition by:

Hadoram Shirihai

Expedition to Trindade Island and the Martim Vaz rocks, 1st–20th May 2022

Members of the expedition:
Ornithologist: **Hadoram Shirihai**
Skipper: **Roberto Bruno Fabiano**
Second-in-command, Cook & Technical Assistance: **Ivan Nachtigall Marques**

Expedition in preparation for the forthcoming Tubenoses Monograph, Volume 1,
The Gadfly Petrels by **Hadoram Shirihai & Vincent Bretagnolle**

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Photo 1 Trindade Petrel and the near-extinct Trindade Frigatebird. *(Photograph courtesy of the Tubenoses Project © H. Shirihai.)*

Report workload ***Hadoram Shirihai*** *(expedition conductor, author) contributed half of the expenses for boat use and flights to Brazil from family funds; conducted the research and drafted 83% of the report (by word count); made the breakthrough in understanding the complex plumage variation of the Trindade Petrel, including the discovery of complex underwing patterns related that can fit into a complex matrix, with eight main plumage types, facilitating recognition of each individual bird,* while the data also provided evidences that there are two clear two seasonal population, which will be our next focus of the research of the species*; captured all bird and landscape images used in the report (except staff action images taken by Roberto Bruno Fabiano and Ivan Nachtigall Marques). Post-expedition, spent two full days at the* National Museum in Rio de Janeiro *with the encouragement and assistance of Marcos Raposo and his students; additionally, for four months post-expedition, analysed over 30,000 selected images of 1,941 petrels (scored in this work), and many photos of the frigatebirds for individual monitoring.* ***Reut Nahum*** *(data handling) Hadoram's wife, dedicated four weeks to inputting individual scoring data into Excel files for the 1,941 photographed petrels, which were used in the final analyses.* ***Vincent Bretagnolle*** *(author) contributed to the five pages covering the section 'Preliminary analyses', double-checked that section, and conducted statistical tests based on data collected and ecological and behavioural questions raised during the expedition.* ***Fabio Olmos*** *(reviewer, author) provided detailed comments on the text and contributed material on the two frigatebird species.* ***Robert L. Flood*** *(content editor, author) edited the work, prepared it for online publication; and improved the content and readability, especially regarding variation in petrels. His global experiences with petrels are well reflected throughout the report. (HS)*

APRESENTAÇÃO / FOREWORD

A conservação da biodiversidade é uma missão que exige união e parcerias fortes. Os Planos de Ação Nacional para Conservação de Espécies Ameaçadas de Extinção (PAN) são ferramentas cruciais que buscam priorizar, implementar e gerenciar ações e políticas públicas para a conservação de espécies e ambientes naturais. Nesse contexto, está o Plano de Ação Nacional para Conservação das Aves Marinhas - PAN Aves Marinhas, uma iniciativa do governo brasileiro coordenada pelo ICMBio/CEMAVE, que está em seu 2o ciclo de vigência até fevereiro de 2029 e estabelece estratégias prioritárias de conservação para 14 espécies de aves ameaçadas de extinção no Brasil (a maioria albatrozes, pardelas e trinta-réis), assim como inclui três espécies categorizadas nacionalmente como Quase Ameaçadas (NT) (o Pinguim-de-magalhães, a Cagarra-de-cabo-verde e a Grazina). O PAN Aves Marinhas abrange a costa brasileira, ilhas costeiras, oceânicas e águas da Zona Econômica Exclusiva, com foco nas áreas de ocorrência das espécies. As ilhas oceânicas e costeiras são locais importantes para a reprodução de espécies do PAN. Os Parques Nacionais Marinhos (PARNAMAR) dos Abrolhos e Fernando de Noronha, além da Área de Proteção Ambiental e Monumento Natural da Ilha da Trindade, protegem importantes áreas reprodutivas de espécies de aves marinhas ameaçadas de extinção, se destacando no contexto deste PAN.

A ilha da Trindade, um hotspot de biodiversidade marinha no sudoeste do Oceano Atlântico, se destaca por abrigar sete espécies de aves marinhas que se reproduzem na ilha, das quais três estão ameaçadas de extinção. A grazina-de-trindade (*Pterodroma arminjoniana*), está categorizada como CR e utiliza apenas a Ilha da Trindade e as Ilhas Round (Oceano Índico) para reprodução. As fragata-pequena (*Fregata trinitatis), endêmica da ilha,* e fragata-grande (*Fregata minor nicolli*), também categorizadas como CR, ocorrem apenas em Trindade e encontram-se com suas populações com tamanhos muito reduzidos. O atobá-de-pé-vermelho (*Sula sula*), categorizado como Em Perigo, também possui registros históricos em Trindade. Tanto a grazina-de-trindade quanto a fragata-grande estão passando por revisões taxonômicas, podendo ser consideradas espécies endêmicas da ilha. A grazina (Gygis alba), Quase Ameaçada, possui uma importante população na ilha.

Apesar da importância de Trindade, incêndios e a introdução de espécies exóticas invasoras comprometeram o ecossistema terrestre da ilha, causando um severo impacto negativo na vegetação, devastando florestas e samambaias endêmicas. As aves que dependiam dessa vegetação para nidificar, como os atobás e as fragatas, já não são registradas reproduzindo há décadas no local. O camundongo invasor *Mus musculus*, ocorre atualmente na ilha com grande abundância, ameaçando as áreas reprodutivas da grazina-de-trindade

O projeto RETER-Trindade, com o apoio do ICMBio e da Marinha do Brasil, realizou os esforços mais recentes para a restauração do ecossistema, além de um grande esforço de pesquisa e produção de divulgação científica, gerando visibilidade em escala nacional para a biodiversidade existente na ilha oceânica mais afastada da costa brasileira, bem como trazendo subsídios para o zoneamento e gestão das Unidades de Conservação criadas. O projeto identificou os locais que historicamente possuíam ninhais de fragata-pequena, fragata-grande e atobá-de-pé-vermelho e instalou os primeiros ninhos artificiais com o objetivo de realizar testes e apoiar as atividades reprodutivas dessas aves ameaçadas.

E então, surge também a parceria com Hadoram Shirihai, que através do Fábio Olmos nos procurou para falar sobre a importante expedição realizada em Maio de 2022, cujos resultados se apresentam neste relatório. Além da importante iniciativa e dedicação para conseguir os recursos necessários para empreender à expedição, Hadoram mostrou ter o que acredito ser essencial para a conservação das espécies, uma abertura e generosidade imensa em relação aos seus conhecimentos, aos dados e registros obtidos, assim como uma disposição a uma parceria contínua. Para mim, é isso que representa as parcerias e que fortalece o desenvolvimento de um PAN. O PAN Aves Marinhas tem conseguido ótimos frutos devido aos parceiros engajados e que acreditam que a ciência e a conservação são áreas de colaboração e parceria, na qual todos juntos avançamos muito mais.

Este relatório traz informações muito importantes e que serão úteis tanto para o processo de avaliação das espécies, quanto para planejarmos os próximos passos para a pesquisa e conservação em Trindade. Os excelentes registros das espécies mais ameaçadas do Brasil, como juvenis de fragatas, mostrando que a reprodução está acontecendo, registros de atobá-de-pé-vermelho trazem a esperança que, com um ambiente adequado, podem voltar a reproduzir na ilha, dados importantes para as revisões taxonômicas, enfim, um relatório que precisamos nos debruçar, destrinchar, para aproveitar tantas informações preciosas para o conhecimento das espécies. E o melhor é saber da disponibilidade para continuar esse trabalho, para retornar na época do verão para comparar as populações, para continuar olhando do mar para a ilha e para as espécies.

Com a experiência e dedicação de todos os envolvidos no PAN Aves Marinhas, com uma gestão efetiva das Unidades de Conservação, e com a promessa de mais expedições e estudos, podemos salvaguardar o futuro da biodiversidade da ilha da Trindade, protegendo juntos esse santuário único e suas aves marinhas ameaçadas.

Biodiversity conservation is a mission that demands union and strong partnerships. The National Plans for the Conservation of Threatened Species (PANs) are crucial tools that aim to prioritize, implement and manage actions and public policies targeting the conservation of species and natural habitats. In this setting, the National Plan for the Conservation of Seabirds – *PAN Aves Marinhas*, an initiative of the Brazilian government coordinated by ICMBio/CEMAVE, is in its second implementation cycle until February 2029 and set the priority strategies for the conservation of 14 seabird species considered threatened in Brazil (mostly Albatrosses, Petrels and Terns), as well as another three species considered as Near-threatened (Magellanic Penguin, Cape Verde Shearwater and Atlantic White Tern). The National Plan covers the entire Brazilian coast, its islands and the Exclusive Economic Zone, with a focus on areas the species are known to use. Coastal and oceanic islands are important breeding sites for species listed in the PAN. The Marine National Parks (PARNAMAR) of Abrolhos and Fernando de Noronha as well as the Environmental Protection Area and National Monument of Trindade Island protect nesting sites important for threatened seabirds and are a highlight of the PAN.

Trindade Island is a marine biodiversity hotspot in the southwestern Atlantic standing out as the nesting site of seven species of seabirds, three of them considered as threatened in Brazil. The Trindade Petrel is considered as CR and nests only in Trindade and Round island (Indian Ocean). The Trindade Frigatebird (*Fregata trinitatis*), a species endemic to the island, and Trindade Greater Frigatebird (*Fregata minor nicolli*), both considered CR, nest only on Trindade and their populations are very low. The Red-footed Booby (*Sula sula*) is considered EN and, historically, nested on Trindade. Both the Trindade Petrel and the Trindade Great Frigatebird are the focus of taxonomic studies that may show they are full species endemic to Trindade. The NT Atlantic White Tern also has an important population in the island.

Despite its importance, Trindade has suffered from fires and the introduction of invasive exotic species that affected the land ecosystems of the island causing severe degradation of the vegetation and devastating the endemic forests and tree ferns. Birds relying on this vegetation to nest, such as Red-footed Booby and both Frigatebirds, have not been seen nesting there for decades. The invasive mouse Mus musculus is currently very abundant and threatens the nesting sites of the Trindade Petrel.

The RETER-Trindade Project, developed with support from ICMBio and the Brazilian Navy, carried the most recent efforts to restore the island's ecosystem, besides conducting research and producing outreach material giving national visibility to the biodiversity living in the farthest Brazilian oceanic island as well as bringing inputs for the zoning and management of the existing protected areas. The project identified the sites where both Frigatebirds and Red-footed Booby historically nested and installed the first artificial nests to test their suitability and facilitate the breeding of those species.

And now we have the partnership with Hadoram Shirihai, who through Fábio Olmos connected with us to present the expedition to Trindade in May 2022 and share its results. Besides this important initiative and the dedication to raise the necessary means to carry the expedition, Hadoram showed what I believe is essential for

conserving threatened species, an immense openness and generosity in sharing his knowledge, the data and records gathered during the expedition, as well as the disposition for a continuous partnership. For me, this is what partnerships are about and what strengthens a PAN. The *PAN Aves Marinhas* has achieved great results thanks to the commitment of its partners who believe science and conservation are areas for collaboration and joint work so we can progress further.

This report brings very important information that will be important in the process of species assessments and for planning the next steps for research and conservation in Trindade. The excellent photos of some of Brazil's most threatened species, including juvenile Frigatebirds, show that they are breeding; records of Red-footed Booby bring hope that with adequate habitat they may nest again in the island; important data for taxonomic revisions make a report one must read at length to absorb so much information that is precious for knowing those species. And the best is to know there is a willingness to continue the work, return sometime over the summer to compare populations and keep watch from the sea towards the islands and its species.

With the experience and dedication of all engaged in the *PAN Aves Marinhas* with the effective management of Protected Areas and more expeditions and studies in the future we can hope to safeguard the future of Trindade's biodiversity, protecting the unique sanctuary and its threatened seabirds.

Camila Garcia Gomes

Environmental Analyst ICMBio / CEMAVE

Coordinator of the National Plan of Conservation for Seabird

Introduction

Background and Aims

In May 2022, a long-planned expedition set sail from Brazil for Trindade Island and the Martim Vaz rocks in the South Atlantic with the main aim of studying the Trindade Petrel, classified as globally Vulnerable (Brazilian Red List considers it Critically Endangered). The expedition also allowed for the study of the near-extinct endemic frigatebirds – Trindade Frigatebird *Fregata trinitatis* and Trindade Great Frigatebird *Fregata* [*minor*] *nicolli*, and other seabirds in this remote archipelago. This expedition is one of many carried out over the past 25 years across the world's oceans under the name *Tubenoses Project*. Expedition research is preparation for the forthcoming *Tubenoses Monograph*, with the first volume focusing on the *Gadfly Petrels*. An explicit goal of the *Tubenoses Project* is to gain first-hand at-sea experience of all taxa that make up the Order Procellariforms. This at-sea experience complements findings from breeding colonies and museum collections.

Preparation for the gadfly volume has included studies of all other taxa of the so-called '*neglecta*-complex' (five species in total: Kermadec Petrel *Pterodroma neglecta*, Phoenix Petrel *P. alba*, Herald Petrel *P. heraldica*, Henderson Petrel *P. atrata*, and Trindade Petrel *P. arminjoniana*), which also involves research on the Trindade Petrel population that breeds on Round Island off Mauritius in the Indian Ocean.

The information presented in this report should be viewed as raw data accompanied by preliminary and tentative interpretations of that data. Our comprehensive analysis of the Trindade Petrel, focusing on populations, variation, and systematics from both oceans, will be published simultaneously with Bretagnolle & Shirihai (in press). The current document includes descriptions of the techniques and approaches we used during the May 2022 expedition, as well as additional data related to habitat and other seabird populations not covered in Bretagnolle & Shirihai (in press). This document aims to serve as a blueprint for ongoing boat-based surveys and research of the Trindade archipelago's seabirds for years to come by the Brazilian researchers, as boat-based surveys have proved to be an efficient way of assessing the presence and numbers of seabirds in nesting locations and at-sea around Trindade Island and the Martim Vaz rocks.

It must be stressed here (but also see the relevant sections within the report) that forerunning groundbreaking research and conservation measures have been conducted on the Trindade archipelago, particularly focusing on its flora and seabird populations, primarily focussing on petrels and frigatebirds, by various authorities and institutions from Brazil (e.g., Alves & Martims 2003, Martims & Alves 2007, Silva & Alves 2011, Silva *et al*. 2013, Alves *et al*. 2016). As a result, the archipelago and many areas along the oceanic ridges leading to it from mainland Brazil, including key sea mounts, are already highly protected and continuously monitored as a Natural Monument (6,915,536 hectares) and an Environmental Protection Area (40,237,708 hectares). The scope of the present report does not cover all of these aspects. We were fortunate to benefit from recent research on Trindade Petrel at both the Trindade and Round Islands, respectively, in the Atlantic and Indian Oceans, including studies by Silva (1995), Luigi *et al.* (2009), Brown *et al*. (2010), Leal & Bugoni (2021), and Ramos *et al*. (2017). Our acknowledgment of previous works on other seabirds is included in relevant sections of the report and we are especially thankful to Port *et al*. (2016) and Olson (2017) for their outstanding work on the frigatebirds.

Thus, we were aware that Trindade Petrel is a well-studied gadfly petrel. So, we thought hard about what contributions we could make and decided to focus on the understanding of morphological variation, taxonomy, and ecology of Trindade Petrel. We also decided to gather whatever information possible about the frigatebirds. We chose the following topics and objectives:

1. ***Study colour variation of Trindade Petrel*** The objective was to develop a system by which to classify the complex plumage variation in Trindade Petrel. Classification may improve understanding of the plumage variation and throw further light on the two seasonal breeding populations, with egg-laying peaks in April and October (Luigi *et al*. 2009), and seasonal geographic variation, both around the breeding colonies and at sea. It may lead to an explanation of inconsistencies between morph ratios at sea and on Trindade Island identified by Flood & Fisher (2013). The results of this study will be compared with museum specimens of Trindade Petrel held at the National Museum in Rio de Janeiro (RM, Brazil), American Museum of Natural History (AMNH, New York), and British Museum of Natural History (BMNH, Tring, England). Classification permits comparison with the Trindade Petrel population of Round Island, too. Improved understanding and categorisation of plumage variation also helps to eliminate 'double-counting'.
2. ***Counts of Trindade Petrel at sea*** The objective was to count the total number of Trindade Petrels attracted to chum, to count the number that fall within each plumage type classification (see '1' above), and to look for patterns of occurrence of morphs at each chumming location.

3. ***Census of Trindade Petrel at breeding sites*** The objective was to build on previous studies and to establish a boat-based repeatable method of counting the number of Trindade Petrels at / around the colonies. Previous pioneering work at colony was published by Silva (1995). More recent studies focussed on ecological and biological aspects of birds at colony, and dispersal and migration using GPS tracking devices (Leal & Bugoni 2021, Luigi *et al*. 2009). These publications provide base comparative material for breeding sites around Trindade Island, breeding schedules, and seasonality peaks.
4. ***Establishing a colony census technique*** The objective was to locate key survey points and to record the coordinates for consistency in data recording in future surveys.
5. ***Study pelagic behaviour of Trindade Petrel*** The objective was to document feeding techniques and assemblages with other seabirds, and to search for identifiable threats to the species at sea.
6. ***Study colonial behaviour of Trindade Petrel*** The objective was to document the association of Trindade Petrel with other breeding seabirds, and to identify possible threats to the species on land.
7. ***Census seabirds around archipelago*** The objective was to estimate numbers of all breeding seabird species in the archipelago with a special focus on the White Tern *Gygis alba*.
8. ***Study the endemic frigatebirds*** The objective was to document every individual of the near-extinct Trindade Frigatebird *Fregata trinitatis* and Trindade Great Frigatebird *Fregata [minor] nicolli* present during the survey as a historical record and to consolidate up-to-date base information for desperately needed future conservation efforts.
9. ***Record seabirds between Trindade Island and mainland Brazil*** The objective was to record all seabirds while sailing from mainland Brazil to Trindade Island and the Martim Vaz rocks, during chumming sessions and while in transit.
10. ***Record cetaceans*** The objective was to constantly scan for cetaceans during daylight hours and photograph them where possible.

Context of Trindade Island and Martim Vaz Rocks

Location and geography The Trindade archipelago, previously known as South Trinidad, is a part of the Brazilian state of Espírito Santo and is home to a navy-supported research station. It is made up of Trindade Island and the Martim Vaz rocks. Trindade Island (20°30'36S, 29°19'24W) is situated at the eastern end of a chain of underwater volcanoes that extends approximately 1,140 km (615 nm) off the coast of Espírito Santo, Brazil (about 1,100 km east of the continental shelf). It is situated more than halfway from the Brazilian continental shelf to the Mid-Atlantic Ridge, near the eastern end of the undersea Vitória-Trindade Ridge. Trindade Island covers an area of 10.3 km² and can be circumnavigated by sail in less than half a day. The island is an exposed summit of a large submerged volcanic archipelago, stretching around 50 km (27 nm) eastward to the Martim Vaz rocks (20°28'30S, 28°51'7W). Pico Desejado is the highest peak, near the centre, rising to 620 m (2,030 ft). To the northwest, Pico da Trindade and Pico Bonifácio are slightly lower, reaching 590 m (1,940 ft) and 570 m (1,870 ft) respectively. The most striking formation is Pico Monumento, a pillar on the west coast, which rises to 270 m (890 ft). Trindade Island is largely arid due to deforestation and its numerous phonolitic lava domes and steep volcanic plugs create an irregular coastline and form offshore rocky islets. This mountainous island provides an ideal breeding habitat for gadfly petrels.

The **human history** of the 16th to 18th centuries of Trindade Island and Martim Vaz rocks led to the ecological devastation seen today (Martims *et al*. 2007, Serafini *et a*l. 2023). The islands were discovered in 1502 by Portuguese navigators as part of the Portuguese Empire's expansion over Brazil, but a significant event occurred in 1700 when English astronomer Edmund Halley, on behalf of the British Monarchy, introduce goats and hogs to the islands as food for future visits of British sailors pursuing British interests. During these centuries, Trindade Island was a landmark on the South Atlantic trade routes, frequently visited by sailing ships to verify their nautical calculations. It was often depicted on maps of the Western Hemisphere. Pirates, whalers, treasure-hunting adventurers, and colonists all came and went on Trindade. In 1781, the HMS *Rattlesnake*, a 198-ton, 12-gun cutter-rigged sloop, was wrecked on Trindade. Commodore Johnstone on board HMS *Jupiter* had previously intended to colonise the island and claim it for Britain, leaving behind 30 sailors, 20 captured French sailors, one French woman, some animals, and supplies. They appeared to have been forgotten but were rescued a year later. The island attracted pirates and legends of buried gold persist.

Transformation impacts Trindade Island was once covered by a mixed forest with many Glandular Nakedwood *Colubrina glandulosa* trees (Witovisk *et al*. 2017), with a height of 15 m and a trunk diameter of 40 cm, until the mid-1700s. The introduction of goats in 1700 by Sir Edmund Halley led to rapid soil degradation as the goat population increased. It is likely that other invasive alien mammals were introduced by 1700. Colonists arrived in January 1783 and departed in 1793, following a fire in 1793 that contributed to significant soil erosion. Recent visits found dead Glandular Nakedwood trunks showing signs of fire, with the last live tree seen in 1965.

The island's trees were almost entirely eliminated and continued overgrazing prevented regrowth, thus Glandular Nakedwood died out. This may have benefited Trindade Petrel, which breeds on bare rocks. Pigs were eradicated from Trindade Island by the 1950s by Navy personnel as they were considered dangerous, the last goats were killed by Navy sharp shooters by 2005 after lobbying by Ruy Valka Alves from the National Museum in Rio de Janeiro as a way to help restore the vegetation and conserve water resources, and cats died out on their own. Current conservation initiatives led by Ruy Valka Alves involve the removal of remaining introduced alien mammals (mice *Mus musculus*), the preservation of remaining flora and fauna, particularly endemic species, and the reforestation of soil-favourable areas (Alves & Martims 2003, Martims & Alves 2007, Alves *et al*. 2016). Trindade Island may eventually recover a portion of its original vegetation.

The Brazilian navy maintains a small station on the island with research facilities, indicating ownership by Brazil, at a small settlement on the northeast shore in the bay Enseada dos Portugueses. The navy formerly expressed interest in building a small airbase. Experimental wind turbines and a tower for wind measurements have been built, with plans for additional wind turbines.

The Martim Vaz rocks have never been inhabited and do not have introduced mammals, but years ago were used for occasional target practice by the Brazilian navy.

In addition to the treasure trove of seabird species, Trindade Island is the primary nesting site for Green Sea Turtles *Chelona mydas* in Brazil, and Humpback Whales *Megaptera novaeangliae* use waters around Trindade Island as a nursery.

Regarding early **ornithological history**, information is limited. Apart from occasional visits by collectors, most collecting efforts were brief and part of other expeditions. These efforts are reflected in the naming of certain collected specimens, such as the Trindade Petrel (several taxa named) and the two endemic taxa of frigatebirds *trinitatis* and *nicolli*. The number of specimens and dates of Trindade Petrel specimens collected on Trindade Island vary. In the National Museum in Rio de Janeiro, there is a total of 110 specimens, with 13 collected in 1916, three in 1950, and the rest mainly in the 1980s–1990s (see Appendix 4). AMNH holds 22 specimens, mostly collected in April 1913 and from December 1924 to January 1925 (see Appendix 5). At BMNH, there are about 40 Trindade Petrel specimens, although only five of them were collected within the two main breeding periods of the two seasonal breeding populations, making them less relevant to this study.

Acknowledgments

HS thanks the many Brazilians who welcomed the creation of this important expedition, especially the owner and skipper of the boat *Pangeia* Roberto Bruno Fabiano, and his second-in-command, cook, and engineer Ivan Nachtigall Marques. They ran a first-class operation, fulfilling all of the research needs and beyond. During this expedition, we became very close friends, which is not surprising given the extreme conditions we faced, including making the cyclone 'Yakecan' escape together (see Appendix 2). Dr. Leandro Bugoni kindly discussed the selected time for the expedition with HS and provided some useful tips before the expedition. Dr. Marcos Raposo of National Museum in Rio de Janeiro and his two keen and very helpful students helped HS with his work while visiting the museum to study specimens of the Trindade Petrel and the frigatebirds before returning home after the expedition (see Appendix 4). The expedition was supported by the American Bird Conservancy through contact with Dr. Seabird McKeon, and similarly by Swarovski-Optik AG & Co KG through personal encouragements with Dale Forbes. Other collaborators who helped with the expedition design included Dr. Patricia Serafini, Andrew Whittaker, Guy M. Kirwan, and Dr. Yossi Leshem. Thanks to Dr. Patricia Serafini for advice prior the expedition. We are grateful to Steve N. G. Howell for commenting on the Frigatebird section and to Lucas Penna S. Santos for general comments on the manuscript. On a personal note, Andrew Whittaker and Guy M. Kirwan gave tremendous encouragement to HS for embarking on the expedition. A very special mention of appreciation to Ruy Valka Alves from the National Museum in Rio de Janeiro for his significant contribution to efforts to restore Trindade Island (see References for examples of work done). Last but not least, HS's wife, Reut, and their daughter, Teva, deserve thanks for their great support and encouragement in making the expedition possible. Many of the expedition's cost were covered by family resources. Allowing a husband to go on such a remote expedition is a huge undertaking. Sadly, during the final stage of the expedition, while still at sea, Reut had a miscarriage and HS could not be close to her.

Appreciation to Robert Cushman Murphy of the AMNH

Although Robert Cushman Murphy's contributions to Trindade Island ornithology were very limited, consisting of only a few days collecting Trindade Petrels mostly around the island, we have chosen to dedicate the expedition to him. This decision recognises his significant contributions to the exploration of the tropical Pacific, particularly in researching petrels under the AMNH project known as the Whitney South Sea Expedition (1920–1941). His work has had a profound influence on many seabird researchers, including us.

Photos 2–5 Landscape of east side of Trindade Island. *(Photographs courtesy of the Tubenoses Project © H. Shirihai.)*


Photos 6-7 Remains of the natural forest, south side of Trindade island. *(Photographs courtesy of the Tubenoses Project © H. Shirihai.)*


Photos 8–9 Ragged coastline of Trindade Island, southwest side (left) and northeast side (right). *(Photographs courtesy of the Tubenoses Project © H. Shirihai.)*

Photo 10 The ragged rocky habitat of the north side of the Trindade island. *(Photograph courtesy of the Tubenoses Project © H. Shirihai.)*

Photo 11 A view of the southwest side of Trindade Island. In the far left of the image, the pillar of Pico do Monumento is visible, with the pyramid-like Ilha do Sul located about two-thirds of the distance to the right. According to the data gathered during this expedition, a significant portion of the Trindade Petrel population is concentrated around these two locations. *(Photograph courtesy of the Tubenoses Project © H. Shirihai.)*

Photo 12 View of the northern side of Trindade island: far right is the pillar of Pico do Monumento. *(Photograph courtesy of the Tubenoses Project © H. Shirihai.)*

Photo 13 View of the west side of Trindade island: with the Ilha da Racha on the left, and the pillar of Pico do Monumento on the right. *(Photograph courtesy of the Tubenoses Project © H. Shirihai.)*

Photos 14–15 Martim Vaz rocks: main Island (left) and the Ilha do Sul (right). *(Photographs courtesy of the Tubenoses Project © H. Shirihai.)*

Methods

The following methods were designed to meet the research objectives set out above.

Dates The expedition targeted 1st–20th May 2022, the seasonal breeding peak of the austral autumn-winter breeders in their early chick-rearing phase (Silva 1995, Leal & Bugoni 2021, Leandro Bugoni pers. comm.).

Transport The 13.4 m yacht *Pangeia* was used throughout the expedition. It is owned and skipped by Roberto Bruno Fabiano. It is a moderate-sized ocean-going yacht, large enough to deal with rough seas, small enough not to frighten seabirds. A powerful engine ensured progress even in calm periods. Sailing made the expedition economically viable. The modest size of the yacht with the addition of the engine were ideal for conducting surveys of breeding colonies along the northern, western and southern coastal areas. These coastal regions feature many rocks and narrow bays permitting close approach to study colonies and obtain high quality photographs. Boat-based and camera-based studies are non-invasive, do not disturb birds at colony, and do not introduce invasive species or viruses.

Chumming Several methods were employed for '*stationary chumming*' sessions, mostly by placing fish oil on the ocean surface to attract petrels by smell. Oil was deployed every 30 minutes using a half to a whole litre. Depending on tide and wind conditions, oil usually formed a long slick that the petrels explored giving excellent opportunities to study and to photograph them. This was augmented from time to time with frozen or unfrozen fish material placed in the middle of the oil slick. Sometimes the fish products were secured inside an onion bag with a floater on top, preventing it from sinking and providing a marker. An oil drip was operated while sailing as successfully used on previous long-range expeditions (e.g., Flood & Zufelt 2021, Flood *et al*. 2022, 2023).

Optics, camera and GPS Equipment included 8x32 Swarovski binoculars, Alfa 1 Sony mirrorless body camera with 200–600 mm zoom lens (up to 30 images per second), and Garmin GPS on board for navigation and marking locations. High-definition photography helps by permitting feather by feather analysis. (Further details from similar expeditions are found in Shirihai 2008 and Shirihai *et al*. 2009, 2010.)

Photos 16–17 Surveying the coastal area of Trindade Island from the yacht. On the right, just off Ilha do Sul, is one of the main concentrations of the Trindade Petrel, as well as where both species of frigatebird occur. *(Photographs courtesy of the Tubenoses Project © H. Shirihai.)*

In correspondence with the main objectives, the following methodologies were designed for the expedition:

1. ***Classification of complex plumage types of Trindade Petrels*** Similar to Humpback Whales, which can be individually identified by the pattern on the underside of their tail flukes, it is possible to reliably recognise many of the petrels by their unique head, throat, chest, and underbody colorations, along with their complex and unique underwing patterns, similar to a fingerprint. With high-definition photography it is possible to undertake feather by feather analysis and determine recurring patterns. What we have learned so far is that variation in Trindade Petrel can be classified into 56 basic metrics of plumage combination patterns. These were eventually simplified to 32, which can be broadly grouped into eight main plumage types (Figure 1). Grouping the petrels into these plumage types makes it easier to avoid 'double-counting'. These methods are further explained in Figure 1.

Three main characteristics of the underwing were analysed and scored: (1) extent of visible white in the primary bases that form patches / flashes (coded as P). (2) and (3) the extent of white in the median secondary coverts versus the degree of development of darkening in the longest / rear lesser secondary coverts, respectively (coded as C1 and C2). All were scored from 1 to 5. Birds that could not be scored and classified, such as those where not all of the necessary feather tracts were visible in photos, were omitted from the process and the final total.

An assessment of plumage variation was conducted for all chumming session, as well as at colonies around Trindade Island and the Martim Vaz rocks (Expedition Log). Results provide the first basic analysis of plumage variation and comparisons between the sites. Advanced analyses will be presented in Bretagnolle & Shirihai (*in press*). In due course, 'signatures' of individuals may permit automated pattern recognition as with whales, whale sharks, tigers, jaguars and so on. Understanding variation in Trindade Petrel will help to answer many questions regarding their geographic variation, especially seasonality, both around their breeding Atlantic islands and over their dispersal / migratory ranges. Additionally, a comparison will be made with the Trindade Petrels of Round Island (Indian Ocean), where a similar study has already been conducted. All of this field data will be compared with previously collected data from museum collections at AMNH, BMNH, and RM. The results will be published fully in Bretagnolle & Shirihai (in press), as well as in the forthcoming *Gadflies* volume.

Figure 1: the 8 main morph-types of Trindade Petrel *Pterodroma arminjoniana* from dark to light (during one chumming session on May 8, 2022, off Trindade Island; Tubenoses Project © H. Shirihai)

Additional note to Figure 1 18 birds were selected out of the 365 photographed during one chumming session off Trindade Island on 8th May 2022 (Figure 2, Expedition Log, Appendix 1, with a complete list in Appendix 3). They show the eight main plumage types, each with some variation. (The percentage given for each is a percentage of 1,941 petrels that were photographed and individually identified during the entire expedition; not included are the 11.3% of uncertain cases – see Results below for further detail.)

Additional notes to Figure 1
Note how each bird has a unique combination of patterns and marks that can be used for individual identification aiding double-counting control for each session.

1st-row (top-left) shows a dark morph with two orange arrows pointing to the moult limit in the inner upperwing coverts and some white marks made by disturbed feathers and / or feather wear – as an example of marks used in the process of individual identification of all birds.

For the **third petrel from the left** (first row), the orange arrows point to 12 marks that make this dark morph individual 'unique' from below. Clockwise from arrow 1: (1) dark belly (making it a dark morph); (2) bill shape / marks; (3) light marks around the head (mostly around the eye); (4) missing median primary coverts; (5) relative patterns and darkness and exposed paler bases among the secondary coverts; (6) wear in the tail-tip; (7) light marks made by feather wear on the dark body; (8) shape and size of light marks on the inner long underwing-coverts; (9) size of exposed basal white primary patches; (10) wear or damage to primary tips; (11) pattern of the greater primary coverts; (12) pattern of the median primary coverts.

Additional notes to Figure 1 Similarly, the process in the individual ID of the light morph (**bottom-left petrel**) included checking 16 marks from below, as indicated by the orange arrows, combining to make this bird 'unique'. In this process, included clockwise from arrow 1: (1) extensive white belly (indicating it is a light morph); (2) development of a pale throat versus a dark breast band/collar; (3) bill shape / marks; (4) light marks around the head (mostly on the loral area and around the eye); (5) the development (size and shape) of the leading / marginal silvery white line; (6) damage / missing secondaries coverts; (7) relative patterns of darkness and exposed paler bases among the secondary coverts (including the degree of whitening in median secondary coverts versus the degree of development of darkening of the longest / rear lesser secondary coverts); (8) shape and size of light marks on the inner long underwing coverts; (9) shape, size, and markings on the body sides (flanks); (10) wear in the tail-tip; (11) patterns including barring development to the undertail-coverts; (12) size of exposed basal white primary patches; (13) wear or damage to primary tips; (14) pattern of the greater primary coverts; (15) missing / gaps in lesser / median primary coverts; (16) pattern of the median primary coverts.

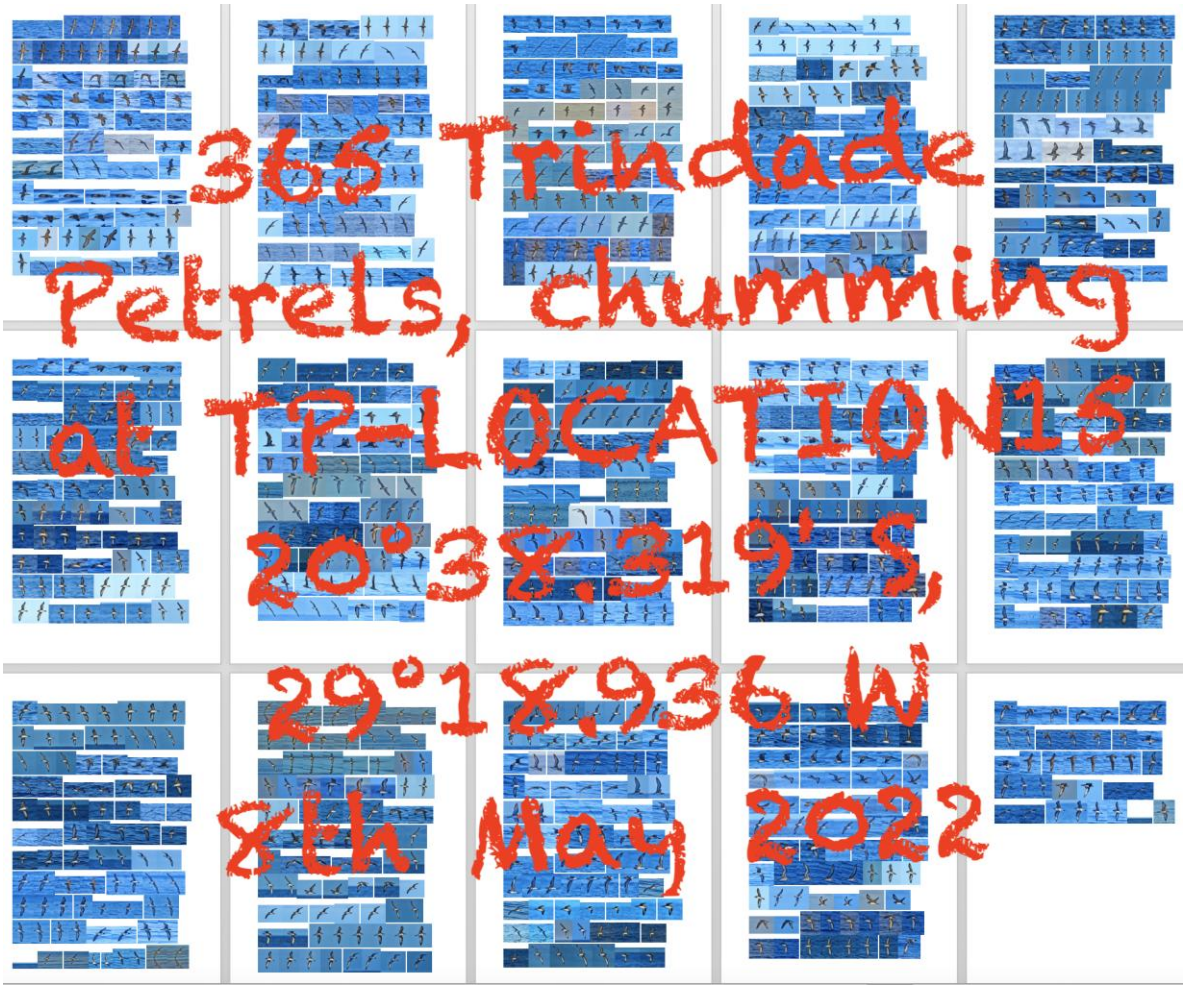


Figure 2 As an example, during a chumming session off Trindade Island on 8th May 2022, a conservative estimate suggested there were about 400 Trindade Petrels. However, after individual identification, it was determined that 365 petrels were photographed (as shown in the photos). The individual data from that session is provided in Appendix 3 as a sample. The recoded data for the 365 Trindade Petrels of the 8th May are listed fully under each of the plumage types. During this process, each individual is given a unique 'passport number', for example "TP 83", which includes information about location, time, and other behavioural data. Additionally, a final plumage sequence code is assigned based on plumage scoring readings of body and underwing patterns. It should be stated that this process was found to be tedious and time-consuming.

2. ***Systematic counts of the number of Trindade Petrels at sea*** Trindade Petrels were attracted to the yacht by chumming. Chumming was carried out daily at pre-chosen locations around the archipelago, mostly while drifting, with a cumulative 60 hours of chumming. Counts were made of the number of birds that approached the slick. Every 15 minutes a 1-minute count was made across 180° viewing angle off the stern of the yacht. For example, during a 6-hour chumming session on 8th May, 19 counts were made, with 12 to 83 birds logged per minute. A conservative rough estimate of 400+ petrels was made for the whole session from these figures. As many of the birds as possible were photographed and coded (e.g., 'TP 40') and subsequently plumage details established to prevent individuals from being counted more than once. As an example, on the 8th May, 400+ Trindade Petrels were estimated, of which 365 were photographically documented. In a final stage of checks, all petrels photographed from the previous two days were also checked to eliminate double-counting.

3. ***Study pelagic behaviour*** Feeding techniques for collecting prey were recorded and photographed under different oceanic conditions, at various distances from the island. Notes were taken on feeding associations with other seabirds. Being a scavenger, Trindade Petrel could be in danger of becoming a bycatch victim to the fishing industry, so behaviour near the yacht was closely scrutinised.

4. ***Census Trindade Petrels at breeding sites*** This involved the design of a census technique and setting logging coordinates for future studies. Three days were spent around the Ilha do Sul (11th–13th May) to monitor the number of petrels and document colonial behaviour and plumage variation. Similar studies were carried out on the 13th–14th May on the largest breeding colony known on the island, atop the Pico do Monumento. On 13th

May, we also circumnavigated Trindade Island, checking most if not all of the historically known colonies visible to the yacht. Most colonies and nests are inaccessible by land, or require great effort to reach them. The main colonies are located on the north, west and south sides of the island and are coastal, hence visible from a boat. Thus, we established a boat-based repeatable method of counting the number of petrels at / around the colonies. Work was undertaken without the need to disturb birds. Trindade Petrel is diurnal making daytime studies possible. The yacht with protected keel proved ideal for the job as it could be manoeuvred to within a few meters of the rocks and cliffs below the colonies. Every 15 minutes, a 1-minute-count was made of birds in view. At Pico do Monumento, counts were backed up by photographing the gatherings of petrels (e.g, see Photos 18–19, with 207 Trindade Petrels atop Pico do Monumento). All petrels photographed were checked to avoid double-counting. Numbers were estimated for each location. Coordinates were logged for points of observation for future surveys.

Photos 18–19 A total of 207 Trindade Petrels atop Pico do Monumento in one view on 13th May 2022. *(Photographs courtesy of the Tubenoses Project © H. Shirihai.)*

5. ***Study colonial behaviour*** Possible identifiable threats to the species on land were searched for when studying colonies. We also spent time documenting colonial behaviours and learning how to interpret the number of petrels seen around the colonies. Interrelations with other breeding seabirds around colonies were documented, especially with the White Tern and the frigatebirds.

6. ***Study endemic frigatebirds*** Every individual encountered was photographed, permitting the study of age-related and sex-related plumage variation. Photographs of all documented individuals are given in the results section.

7. ***Surveying other breeding seabirds*** We censused all other breeding seabird species around the archipelago using the same locations and approaches as mentioned in points 4–6 above. We placed special emphasis on the White Tern and the two frigatebirds. Estimated numbers are given in the results.

8. ***Approach to breeding locations*** – ***environmental and conservation measures during research*** All observations and censuses of colonies, as well as photographic documentation, around Trindade Island were conducted from the yacht while at sea. The yacht was confirmed pest-free. No landing took place on any shore, rock, or island in order to avoid disturbance to the breeders, to prevent the spread of invasive alien animals and plants, and to minimise the risk of avian diseases. For future visitors and researchers, we recommend following the same protocol by *not landing on these rocks where breeding is taking place as it could significantly affect breeding success.*

9. ***Record seabirds while in transit*** We recorded the species and numbers of all seabirds observed during the long journeys from mainland Brazil to Trindade Island and the Martim Vaz rocks. As part of this, we documented in great detail the spectacular migration of Great Shearwater. We kept records of the locations where the birds were recorded and the water depth, paying special attention to the diversity of species around the many seamounts between Trindade Island and mainland Brazil.

10. ***Record cetaceans*** Cetaceans were looked for by constant scanning during daylight hours. Sightings were photographically documented where possible. All observations were logged.

Photo 20 HS with the skipper Roberto, planning navigation and expedition activities. *(Photograph courtesy of the Tubenoses Project © H. Shirihai.)*

The Trindade Expedition May 2022 – navigation:

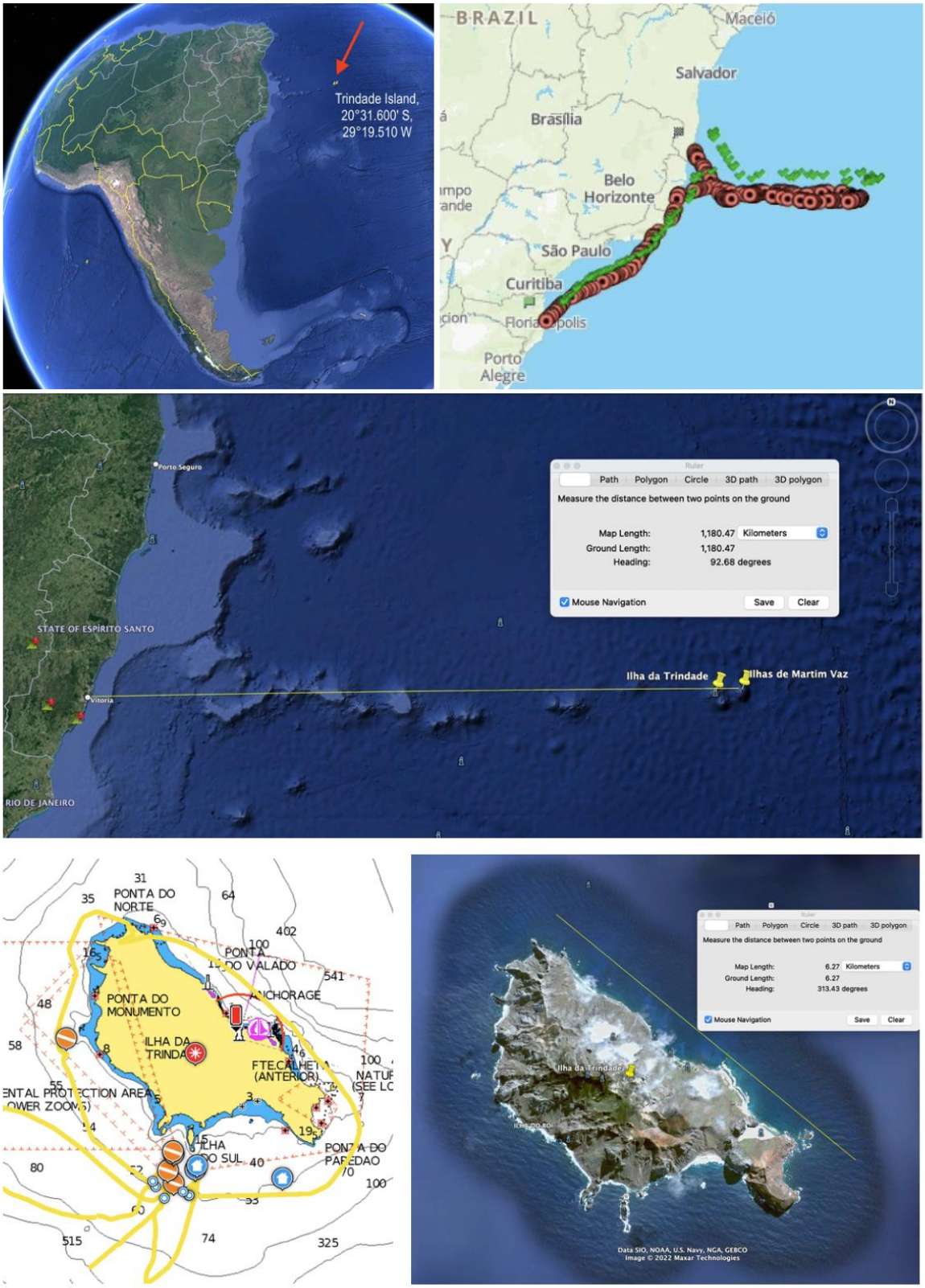


Figure 3 The top three maps display the route of the expedition from 1st–20th May 2022, as well as the location of Trindade Island. The bottom left map shows the recorded navigation around the island, while the bottom right map shows an aerial view of Trindade Island.

Prime Results

Trindade Petrel *Pterodroma arminjoniana*

Eight plumage types

Trindade Petrel is dimorphic; light morph with white breast to undertail-coverts, and dark morph with all dark underbody. Further analysis identified eight plumage types within the two morphs, illustrated in Photos 21–32.

Darkest (max-dark) – D

Photo 21 Plumage variation in Trindade Petrel (see next section for details). *(Photograph courtesy of the Tubenoses Project © H. Shirihai.)*

Darkest (max-dark) – D

Photos 22–23 Plumage variation in Trindade Petrel (see next section for details). *(Photographs courtesy of the Tubenoses Project © H. Shirihai.)*

Dark-grey – Dg

Dark-brown – Db

Photos 24–25 Plumage variation in Trindade Petrel (see next section for details). *(Photographs courtesy of the Tubenoses Project © H. Shirihai.)*

Flecked – F

Photo 26 Plumage variation in Trindade Petrel (see next section for details). *(Photograph courtesy of the Tubenoses Project © H. Shirihai.)*

White-bellied – Wb

Photo 27 Plumage variation in Trindade Petrel (see next section for details). *(Photograph courtesy of the Tubenoses Project © H. Shirihai.)*

Light Palest/Midway – L/M (barred variant)

Midway – M

Light (palest) – L

Light (palest) – L

Photos 28–31 Plumage variation in Trindade Petrel (see next section for details). *(Photographs courtesy of the Tubenoses Project © H. Shirihai.)*

Photo 32: Trindade Petrel Light (palest) (see next section for details). *(Photograph courtesy of the Tubenoses Project © H. Shirihai.)*

Colour variation – basic data

As explained under Methods (point 1), it was possible to recognise individually and quite reliably many of the photographed Trindade Petrels (and thereby avoid double-counting). Also, it was possible to make a breakthrough in the understanding of mechanisms of the complex dimorphism of this petrel by designing a system to analyse the data based on underpart coloration and patterns. This may help to better understand differences in morph mix of the two seasonal breeding populations of Trindade Petrel. In this expedition report we provide preliminary results.

In May 2022, a total of 1,941 Trindade Petrels (total sample) were photographically documented, thereby examined, and plumages scored in preparation for statistical analysis. As illustrated above, tentative results found eight plumage types (Photos 21–32). Classification was not possible for 11.3% of the sample as the underparts and / or underwings were not fully visible. About 0.2% of birds fell outside of the eight classifications and are left unclassified (U). The remaining 88.5% breakdown as follows (also see pie chart in Figure 5):

1. Darkest (D) – 6.1 %
2. Dark brown (DB) – 1.1 %
3. Dark-grey (DG) – 0.8 %
4. Flecked (F) – 1.1 %
5. White-bellied (WB) – 12.6 %
6. Midway (M; between L and WB) – 31.6 %
7. Light/Midway & barred (LB = Lf & Mf) – 0.4 %
8. Light (L) – 34.8 %

(The 11.3% of uncertain cases mostly refer to birds that fall between the categories of L/M, L/M/Wb, and M/Wb.)

While the results of this work largely agree with Luigi *et al*. (2009) – that Trindade Petrels with white underparts dominate, we found fewer dark and near-dark plumage types compared to their work. Luigi *et al*. (2009) provide data based on 435 petrels surveyed between 1998 and 2000, and 278 petrels in 2006 and 2007. They report from the first survey that 60.2% belonged to what they considered the light morph, 31.7% to the dark morph, and 8.1% to the intermediate morph. In the second survey, 65.1% belonged to the light morph, 22.7% to the dark morph, and 12.2% to the intermediate morph. However, they did not specify time of year or population their analyses covered, making it impossible to make meaningful comparisons with the present work. Additionally, the categorisations of plumage types differ significantly between our study and Luigi *et al* (2009).

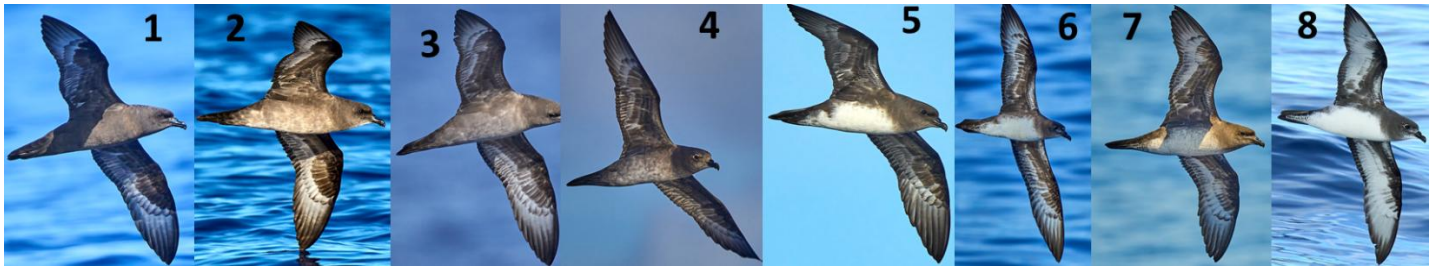


Figure 4 The coloration and pattern of the eight plumage types recognised by this study, ranging from the darkest (left) to the lightest (right) morphs. Large-sized images of the same individuals are presented above in Photos 21–32.

In summary, eight main plumage types were recognised (Figures 4 & 5), which broadly group into two morphs: Dark morph (and variations) and light morph (and variations), with variation mainly in the underwing pattern. There is no 'true' intermediate morph. The light morph (=L) and associated variations (M, Wb, and all kinds of intermediate examples / combinations) account for approximately 90.8% of the petrels examined in May 2022. Less than 10% are dark morph or variations that are paler or less uniformly dark but still close to the dark morph. All types can show a variable degree of exposed white primary bases and often secondary bases (and their related underwing coverts, too), but not the White-bellied (WB), which has a consistent dark underwing and therefore is very similar, if not identical to Phoenix Petrel. Unlike the White-bellied, the Light and Midway have consistent white underwing patches / panels. Thus, only Dark and associated variations have an extremely variable development of white remige panel, from moderate to none (completely dark underwings). It is fascinating to establish that Light and Midway Trindade Petrels occur with an almost identical plumage and underwing pattern to Herald Petrel, likewise Dark Trindade Petrel without the white primary patch is like Henderson Petrel. Trindade Petrel variation encompasses almost the entire variation of the *'neglecta*-complex'.

Morph variation of Trindade Petrels held in the National Museum in Rio de Janeiro, studied by HS in May 2022, for austral autumn-winter breeders, collected February–June, is 76.5% light morph and 23.5% dark morph. Dominance of light morphs is consistent with results of the current expedition. Morph variation of the austral spring-summer breeders, collected August–December, is 39.3% light morph and 60.7% dark morph. These findings shed some light on why Trindade Petrels in the North Atlantic recorded almost exclusively during the boreal late spring–summer are predominantly dark morph (Flood & Fisher 2013). The expedition methods should be repeated for the austral spring–summer breeders to test these findings.

Preliminary analyses

Below we report several statistical tests on the data collected during the 2022 expedition, which provide initial insights into the complexity of plumage variation in the Trindade Petrel. Eight plumage types were identified within the light morph and dark morph combined and their relative abundance is shown in Figure 5. Our initial impression is that the observed plumage complexity extends beyond mere individual variation. Results raise fascinating ecological possibilities, including plumage signaling, population limits, social organization, dispersal,

and more, which warrant further research. Ultimately, gaining more knowledge about the species' ecological behaviours will aid conservation efforts. More advanced analyses will be detailed in Bretagnolle & Shirihai (in press) where the statistical methods are explained in detail.

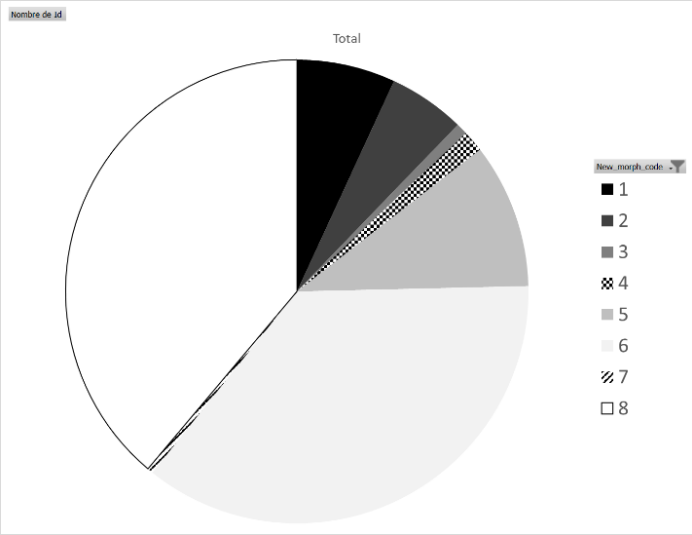


Figure 5 Pie chart showing relative abundance of the eight plumage types. Type 1=darkest, type 8=lightest; 4=flecked; 7=barred.

In Figure 6, we show the variation (%ges) of the eight plumage types according to locality. There is indeed some spatial variation; for example, a greater percentage of dark forms were observed at sea to the west and southwest of Trindade Island. Additionally, in cases where there were repeated observations (Ilha do Sul and southwest Trindade) there was day-on-day variation.

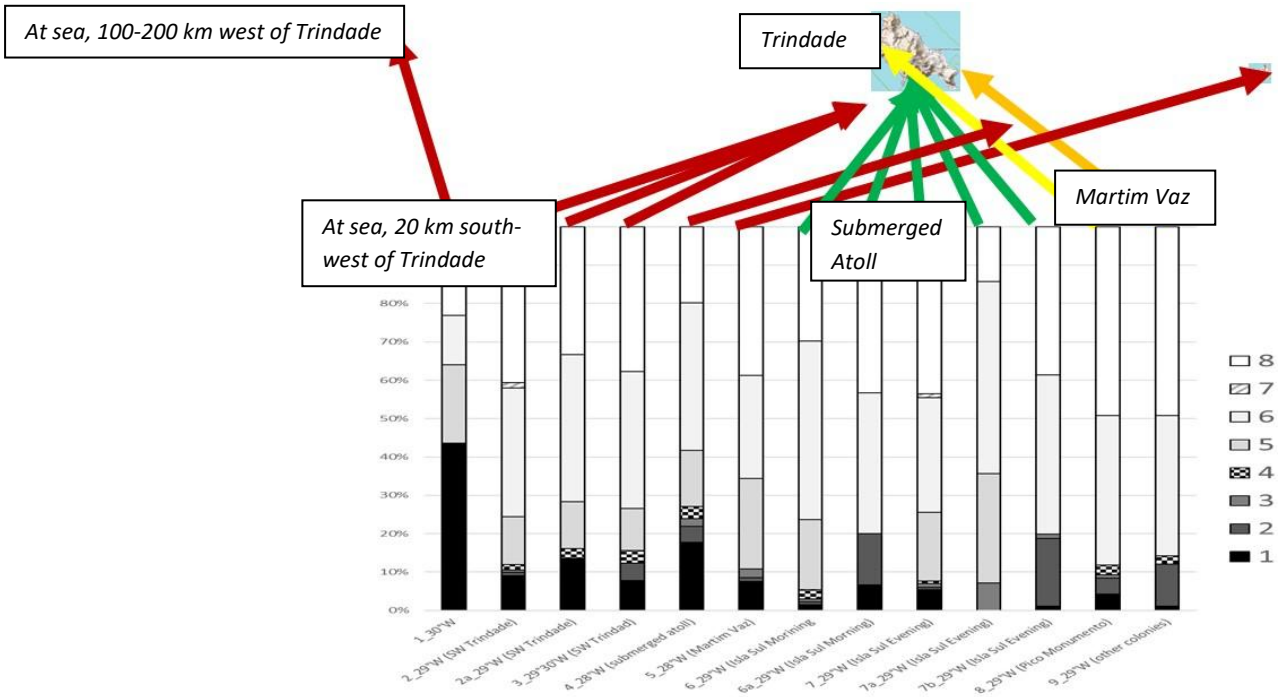


Figure 6 Plumage type distribution by location (%ges). Type 1=darkest, type 8=lightest; 4=flecked; 7=barred.

However, it must be borne in mind that sample sizes differ greatly between days. Despite this heterogenity, one can still see that birds observed at sea (far from colonies) tend to contain a higher percentage of dark morphs. The ones observed at Martim Vaz rocks, however, seem to be very similar to Trindade Island in terms of percentage of plumage types. Results of sessions from Ilha do Sul and from southwest Trindade are summarised in Figure 7.

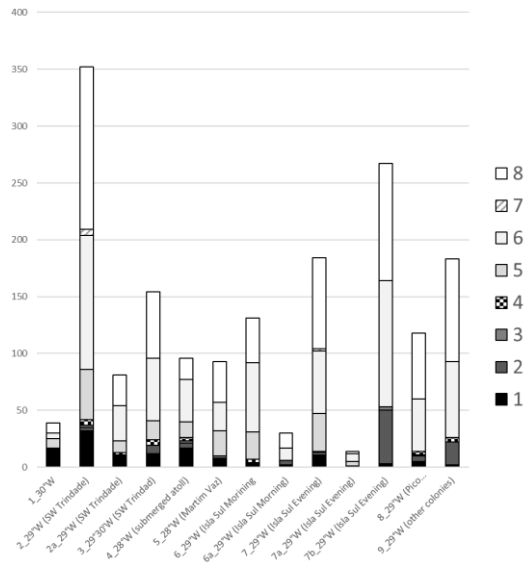


Figure 7 Plumage types around Trindade Island, per locality and per day, in frequency of occurrence. Compare to Figure 6 in which the same data is shown in %ges. Type 1 =darkest, type 8=lightest; 4=flecked; 7=barred.

Plumage type ratios between oceanic areas around Trindade Island The most unusual and relatively large number of dark-morph Trindade Petrels in one area was noted on 7th May, above the seamount approximately 100 nm west of Trindade Island (see Expedition Log). Out of 36 Petrels, 17 (47.2%) were dark morph. This suggests a dimorphic bias in certain areas. In comparison, on 8th May, about 6 nm southwest of Trindade Island, only 11.5% of the 365 petrels observed were dark morph. This suggests that when the petrels are further away from the island, they are more clearly divided into morphs. Further research is required.

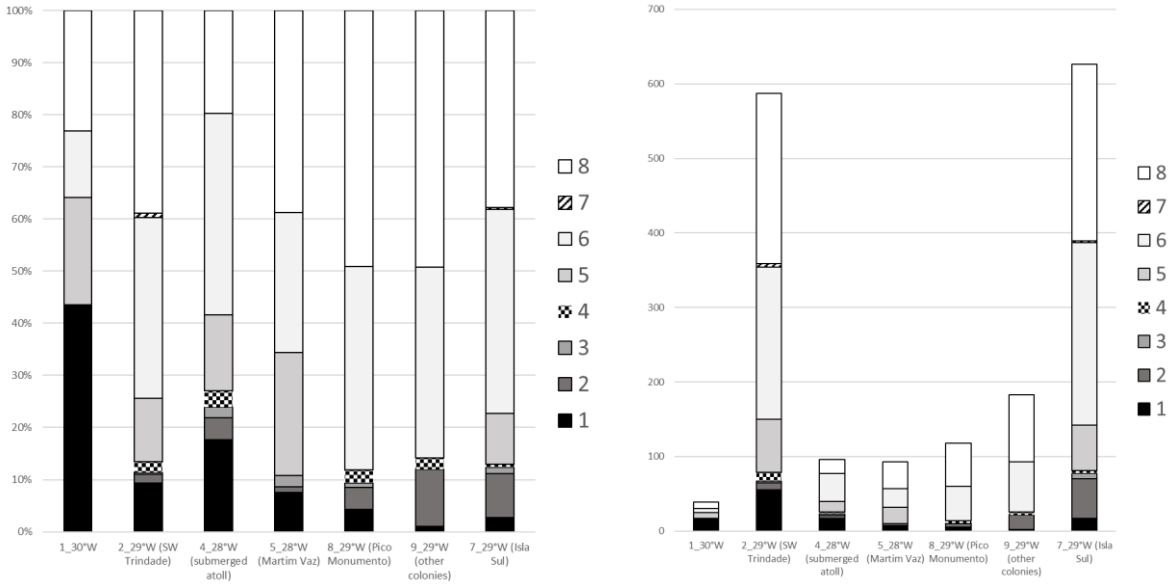


Figure 8 Plumage types according to simplified and agregated spatial location. Type 1=darkest, type 8=lightest; 4=flecked; 7=barred. Left, percentages; right, frequency of occurrence.

Again, it can be seen that the %ge of dark birds is higher to the west and southwest of Trindade Island and at the submerged atoll, compared to observations made at the breeding colonies. Among the four breeding colony locations, birds from Martim Vaz rocks may show a higher %ge of White-bellied birds (Wb, column 5, Figure 8).

Plumage type ratios between and within colonies on Trindade Island A census was taken at the two major colonies, Ilha do Sul and Pico do Monumento. The former is a rather low rocky island, the latter is a high pillar on top of which the petrels breed. Plumage type ratios at the two locations were similar. The former had 94.3% light

variants and 5.7% dark variants, the latter had 97% light variants and 3% dark variants. Atop Pico do Monumento, the White-bellied (Wb) variant was most abundant, at 18.9% of the birds, though on Ilha do Sul only 2.6% were Wb. At Ilha do Sul there was a significant difference in the presence of dark variants in the morning, with 1.1% of birds, compared to the afternoon–evening, with 15% of birds. This reflects observation at sea, where the bulk of dark variants were observed in the morning, suggesting that dark variants vacate the colony earlier in the day than light variants. Evidently, colony studies at different times of the day can produce different ratios.

Plumage type ratios around and on the Martim Vaz rocks All 30 Trindade Petrels observed above the Martim Vaz rocks were light variants. However, during chumming sessions west of the group, the ratios were c 90% light morph and c 10% dark morph.

Provisional plumage-related modelling Based on the detailed delimitation of the plumage variation (eight plumage types) in Trindade Petrel, we tentatively tested the correlation between this variation and the underwing pattern by examining the main feather tracts and scoring them. We analysed three main factors that contribute to the variation of the underwing: (1) the degree of white in the primary bases (coded as P); (2) the degree of white in the median secondary coverts (coded as C1); and (3) the degree of darkening in the longest / rear lesser secondary coverts (coded as C2). Each factor was scored on a scale from 1 to 5. The distribution of scores for the three parameters among all birds is presented in Figure 9.

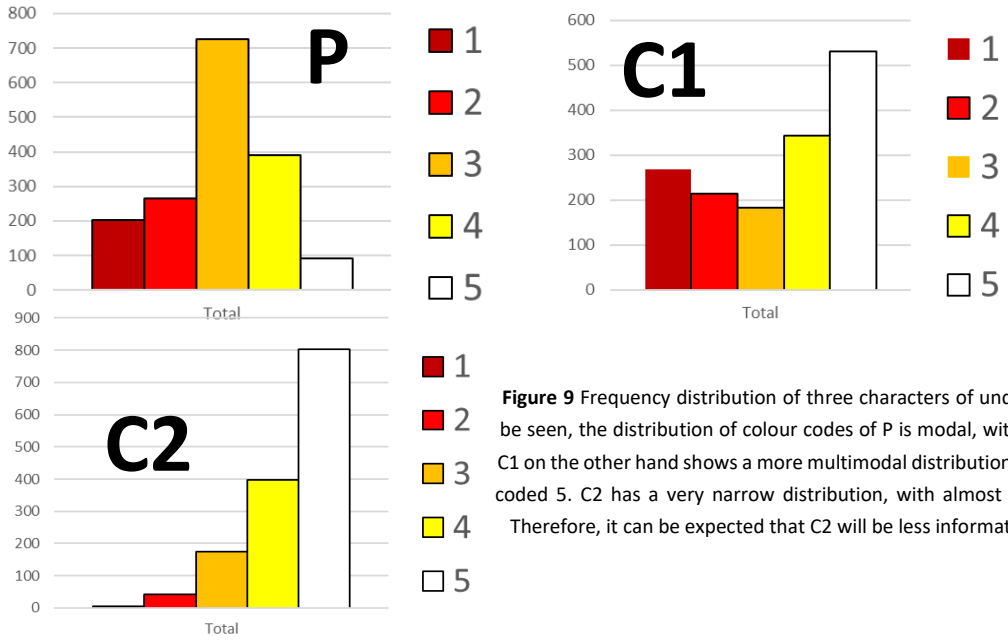


Figure 9 Frequency distribution of three characters of underwing pattern. As can be seen, the distribution of colour codes of P is modal, with a majority being P=3. C1 on the other hand shows a more multimodal distribution, though most birds are coded 5. C2 has a very narrow distribution, with almost all birds coded 4 or 5. Therefore, it can be expected that C2 will be less informative.

We investigated the relationships between plumage types and underwing pattern through the following tests. In the first set of analyses, we used three underwing characters to determine if they statistically differed among the eight plumage types. The analysis tested whether the three parameters could statistically differ among plumage types and predict them. This analysis was performed on 542 individuals with a complete dataset. Whether underwing coloration was predictive of plumage type was tested using ordinal logistic regression analysis. Plumage types were also investigated using multivariate analyses. Since the variables were qualitative (though ordinal), we used multiple correspondence analysis (MCA) to investigate relationships between colour types and underwing patterns. The results showed that each variable significantly differed among plumage types, with all three parameters being highly significant (refer to Table 1).

Table 1 Results of ordinal logistic regression with plumage types being the dependant variable and the three underwing parameters being the independent variables.

	Value	*Std. Error*	*t value*	*p value*
P	*0.7940953*	*0.1558638*	*5.0948012*	*3.491073e-07*
C	*1.2608371*	*0.1318306*	*9.5640713*	*1.132133e-21*
C2	*-0.4599431*	*0.1562978*	*-2.9427347*	*3.253270e-03*

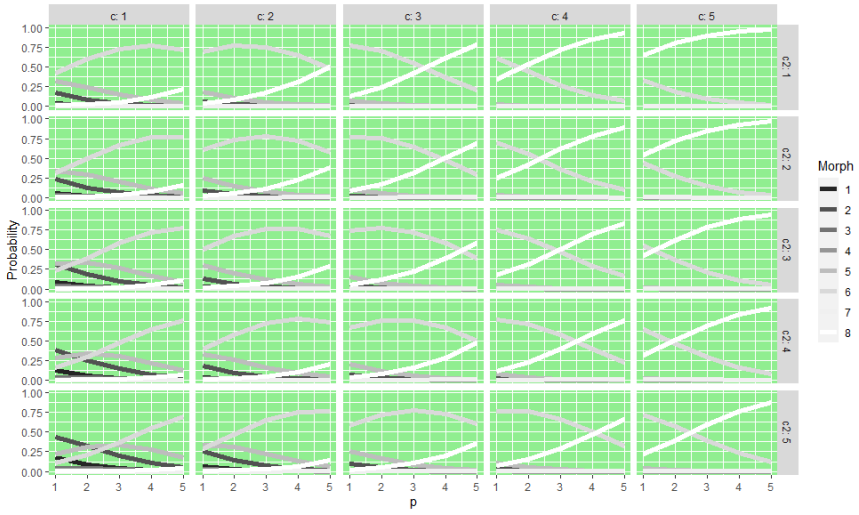


Figure 10 Relationships between plumage types and underwing pattern. Results expressed as the probability of belonging to the eight different plumage types according to the category (in five classes) of each of the three underwing parameters.

In addition, for some of the plumage types, the three parameters are predictive (Figure 10). The palest plumage (type 8, *cf*. Figure 4) may be predicted by increasing p-value and c-value. Plumage type 6 may be predicted by decreasing p values when the c value is above 2. Dark plumage types 1–3 are predicted only at very low p values and c values. Finally, multivariate analyses were undertaken where the plumage type was added as a dummy variable (i.e., it did not contribute to the analysis).

Figure 11 shows that the three variables (C and P being highly correlated with each other) do not predict well the eight plumage types. For instance, in the multivariate space, the three dark plumage types (particularly dark grey birds) encompass almost all other birds, from the darkest at the left part to the lightest on the right part (yellow in Figure 11). If we exclude dark grey birds, however, we can see that the multivariate analysis tends to describe a general gradient (from left to right) with dark birds on the left and light birds on the right, white bellied birds being an exception (classed close to dark birds). Note two extreme individuals from this latter group (white bellied, see arrow): petrels #1009 and #1776.

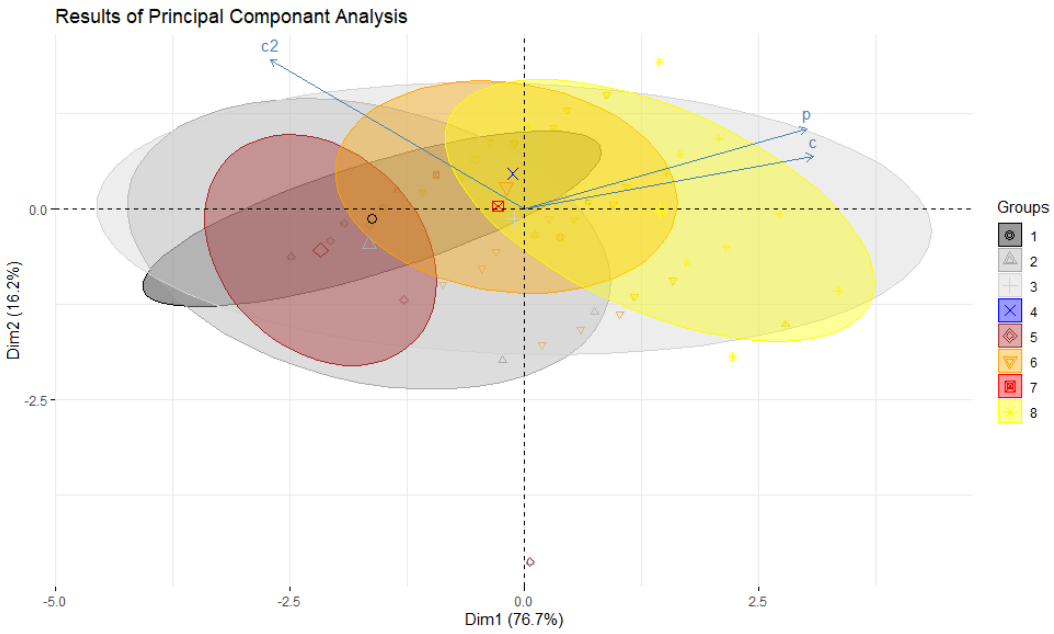


Figure 11 Results of a multiple correspondence analysis performed on each of the eight plumage types and four coloration characteristics.

Apparent congregation of plumage types on the ocean One very clear behaviour was evident in all chumming sessions. In each session, which lasted from a few hours up to a full day, there was a constant visit of petrels. However, there were also peaks and low periods in numbers, and there was often a sudden influx of birds. When the latter happened, the petrels often came in small groups comprising the same plumage type. Since the time was recorded of all the 1,941 Trindade Petrels captured photographically, it was possible to calculate the prime time visit of the different plumage types on the chum slick. Interestingly, the data shows that the bulk of the dark morph (and variations) were recorded early morning, mostly in the first three hours of a 10-hour chumming session. In contrast, the light morph (and variations) was spread more equally throughout the day. A simple explanation for this behaviour could be that when still close to Trindade Island the petrels disperse onto the ocean to some degree by morph. Perhaps the morphs occupy different feeding areas, though less so where close to where breeding occurs, as a mechanism to maximise the utilisation of feeding areas. This is a most interesting tentative finding from the expedition: *dimorphism related to plumage reflects maximum utilisation of food sources, rather than controlling mating pressures in selecting breeding partners or locations*. Further research required.

***The 'Golden Petrel' – a distinctive plumage type or sub/species*?** Recognition and discussion of plumage variation in Trindade Petrel goes back to the Nineteenth Century (e.g., Giglioli & Salvadori 1869 *Oestrelata arminjoniana* and *Oestrelata trinitatis*, Sharpe 1904 *Oestrelata wilsoni*). Of particular interest is *Oestrelata chionophara* (Murphy 1936), which is regarded by most authorities as an example of leucism (Appendix 5 includes a photograph of the *chionophara* type specimen held at AMNH). However, despite similarities, we report a unique variant among the petrels that demands further attention. The main and striking feature is the predominantly golden buff head that continues onto the upperparts and upperwing-coverts. It appears to be a distinctive plumage variant rather than an aberration as three *chionophara* were observed during the expedition: one 11th May between Martim Vaz rocks and Trindade Island, one 13th May above Pico do Monumento, and one 14th May southwest of Trindade Island (Photo 33). Regular patterning, even among a small number of birds, is unlikely to be an aberration. Furthermore, there are some differences in the underwing pattern characteristic of *chionophara*. Of particular note, there are structural differences, with all three birds appearing larger, more heavily built, and broader-winged than nearby Trindade Petrels. Structural differences were reflected in less agile flight, often low to the surface. Due to this uniqueness, we ascribe the provisional vernacular name 'Golden Petrel', with the hope that it will encourage future observers to look out for this form, which may lead to better understanding. However, the AMNH specimen may well be a leucistic example since the pale area of the plumage is pure white and the bill is partially pinkish. That said, the *chionophara* specimen could be a leucistic example of Golden Petrel, or a hybrid between the latter and an *arminjoniana* affected by leucism. Further research required.

Photo 33 'Golden Petrel', 14 May 2022. *(Photograph courtesy of the Tubenoses Project © H. Shirihai.)*

Trindade Petrels documented, counted, and present 7th–15th of May

As previously mentioned, a total of 1,941 Trindade Petrels were photographed and each was assigned an identity number (TP1 to TP1941). These petrels were photographed as part of the process whereby a total of 3,494 petrels were counted and conservatively estimated from all sessions / sites during the expedition (see Expedition Log). This final total of 3,494 petrels is conservative and was determined by carefully preventing double-counting, using the classification method explained earlier, and high-definition photographs (checking petrels photographed against birds photographed up to two days beforehand and afterwards). Therefore, we can assume that this total is largely free of double-counting. That said, assuming that many of the petrels represent one member of a pair, with the other member either feeding at sea or present at the nest, and even if assuming that only half of the 3,489 petrels counted are one parent of breeders (the other half being maybe solitary nonbreeding immatures), the total number present during these days could exceed 5,000 Trindade Petrels. It is important to note that these numbers mainly consist of petrels attracted to chum at sea or gathering for display flights above the colonies, and not necessarily at the nest. Nonetheless, these counts provide valuable data for assessing population trends. The counts were conducted during the peak period of the austral autumn and winter breeding season and to complete the picture the study should be repeated during the austral spring and summer months (ideally in October or November). The Expedition Log provides detailed observations for each day, at different locations, and during various operations.

Two main breeding colonies of Trindade Petrel

The two main breeding colonies of the Trindade Petrel are located at Ilha do Sul and atop Pico do Monumento. According to the Expedition Log, on May 11th, 227 petrels were counted at Ilha do Sul (arriving late in the day, just off the island), while on 12th and 13th May, estimates reached 410 and 400 petrels, respectively. At the top of Pico do Monumento, gatherings of up to 320 petrels were observed at one time, with a rough estimate of at least 500 petrels. The counts for Ilha do Sul are consistent with the 180 nests reported by Luigi *et al*. (2009). However, Silva (1995) and Luigi *et al*. (2009) only reported 23–30 nests in the vicinity of Pico do Monumento. It is likely that the researchers did not reach the top of Pico do Monumento or missed the large gathering of petrels present there throughout the day, which can only be seen at close range and with good optics. None of these studies mentioned the gathering atop this massive pillar or indicated that there is a large gathering there all day long. Based on the present work, it is clear that the main colony of the species is actually located atop Pico do Monumento and this is one of the key findings of the expedition. It is also clear that before the present expedition, this huge colony was overlooked due to its inaccessibility and the fact that the petrels flying above its summits are almost invisible. Refer to the tips for observers in the Expedition Log (May 13th, Pico do Monumento) on how to approach this matter. Additionally, refer to the example image of such gatherings, with 207 petrels in one view above Pico do Monumento (Photos 18–19, under Method, point 4).


West side


West side; east side


Photos 34–39 Various views of Ilha do Sul. This pyramid-like rock is one of two main locations where Trindade Petrels concentrate. Two interesting points to note: in the bottom-left image, the disconnection of Ilha do Sul from Trindade Island is very narrow and likely would not prevent predators from crossing if they once again invade the main island. In the bottom-right image, Ilha do Sul is full of large white lining marks. It is unlikely that this is seabird excrement (guano) because, at least during this time of year, there were no large numbers of seabirds breeding on the island. The markings most likely are some sort of sedimentary mineral formation. *(Photographs courtesy of the Tubenoses Project © H. Shirihai.)*

Photo 40 The impressive 270 m high pillar known as Pico do Monumento, which is one of the most prominent structures on the western side of Trindade Island. During the current expedition, it was discovered that the top of this pillar is home to one of the largest concentrations of Trindade Petrel, if not the largest. By zooming in on the image, you can see dozens of petrels resembling small dots around the top. For more information, refer to the main text, Expedition Log (13th May), and Photos 18–19 in the methods section. *(Photograph courtesy of the Tubenoses Project © H. Shirihai.)*

Evidence that Trindade Petrel breeds on Martim Vaz rocks

Luigi *et al*. (2009) state that Trindade Petrel does not breed and has never bred on the Martim Vaz rocks. However, on the 10th and 11th May we monitored the rocks from all directions and found good numbers of displaying petrels, indicating that breeding very likely occurs there. See Expedition Log for these dates.

Pelagic behaviour of Trindade Petrel

In calm to moderate wind conditions, Trindade Petrels mainly flew close to the surface, with a few deep wingbeats, long extended glides, and low arcs, negotiating movement of the waves with great ease. Wings typically were held somewhat arched. The flight style enabled effortless, long-distance foraging trips. In stronger winds, birds flew in higher, towering arcs with long wheeling glides. In our experience, Trindade Petrel is among the fastest and most agile of the *Pterodroma* petrels. It is generally solitary at sea. However, it is rather sociable when feeding, tending to form small, loose feeding groups and / or admixed with other seabirds (see Photos 45–46). Two principal foraging and feeding techniques were noted, both in natural conditions and when attracted to chum. First, a petrel scans the surface searching for floating food items; second, a petrel undertakes aerial pursuit of small leaping or flying fish and squid trying to escape predator fish such as tuna. In several instances, mostly during the early morning, Trindade Petrels formed flight circles of normally six to 15 birds at one location, though at several locations at one time involving up to 60 birds. These circling flights are undertaken at great speed, with half flexed and pointy wings, perhaps trying to confuse and round-up fish (see Photos 41–42). Also unrelated to the chumming practices, Trindade Petrels picked-up food items from the surface while hovering with deep wingbeats over the food (see Photos 43a–e). Trindade Petrels also chased South Polar Skua, once forcing a skua to drop food that it had just taken from a Cory's Shearwater *Calonectris borealis* (see Photo 44). Trindade Petrels did not employ other methods to obtain food, used by other members of the genus *Pterodroma*, including sat on the surface with partially open wings, taking prey with rapid beak strokes, nor with partial submersion of the head and neck. The petrels habitually reacted to floating objects in a manner whereby they hang / hover in the air before collecting it. Trindade Petrels are easily attracted to a boat while chumming and thus might be prone to becoming bycatch victims. Their such scavenging behaviour could be repeated for floating pieces of plastic.

Photos 41-42 Circling flights are carried out at great speed, with wings half-flexed and shaped very pointy. It looks as though the birds are attempting to confuse and round-up fish. In the bottom image, the leftmost petrel is in the typical position that we observed during an aerial chase of small leaping fish or flying fish and flying squid. *(Photographs courtesy of the Tubenoses Project © H. Shirihai.)*

Photo 43a–e Flight sequence (a–e) of a Trindade Petrel reacting to a floating object. The bird appears to partially hover before collecting the prey. *(Photographs courtesy of the Tubenoses Project © H. Shirihai.)*

Photo 44 A Trindade Petrel harassing a South Polar Skua (see main text). *(Photograph courtesy of the Tubenoses Project © H. Shirihai.)*

Photo 45 A Trindade Petrel passes a Common/Brown Noddy during joint feeding frenzies of mixed seabirds. *(Photograph courtesy of the Tubenoses Project © H. Shirihai.)*

Photo 46 A Trindade Petrel is captured in a feeding frenzy with Common/Brown Noddies (12th bird from the left, above the horizon). *(Photograph courtesy of the Tubenoses Project © H. Shirihai.)*

Colonial behaviour of Trindade Petrel

The diurnal flight displays of Trindade Petrel are a common behaviour observed around colonies. The two main flight display behaviours mirrored those of Trindade Petrels on Round Island, Indian Ocean. The first, well-documented behaviour involves a pair (male and female) pursuing each other at short distance, the distance decreasing during the course of the pursuit until the pair all but touch each other. The pair performed gliding flights, alternating with vigorous elastic wingbeats, especially as they descended, concluding in an ascending curve, giving the impression of repeated circular circuits. The chasing bird, with its bill constantly open and throat and chest puffed-up, utters the characteristic *kikikiki* song (see Photos 47–53). The sound of multiple pairs in flight pursuit filled the air. The other display frequently observed can be termed as an 'orgy display' (Photos 54–

55). It is partially aerial and involves apparently non-breeder immature petrels with one principal female that attracts a group of displaying males (up to nine of them). In this action, the female perches on the ground while the displaying petrels partially glide and partially hover, mostly around and above her, in a line forming a circle. They return back to the same starting position, doing it repeatedly – see images. This group display is very noisy. It is quite similar to the gaming behaviour observed among other diurnal petrels and even shares the same principles in the social structure of nonbreeding albatrosses, such as the gaming of immature Southern Royal Albatrosses (HS *per. obs*.).

Photos 47–49 Sequence of aerial displays of Trindade Petrels above Ilha do Sul on Trindade Island. *(Photographs courtesy of the Tubenoses Project © H. Shirihai.)*

Photos 50–52 An in-flight display sequence involving a pair of birds chasing each other at close range. The chasing bird was very vocal and shows its open bill. The top bird is of the Light (palest) plumage type, while the bottom one is of the Midway plumage type. *(Photographs courtesy of the Tubenoses Project © H. Shirihai)*.

Photo 53 A pair of Trindade Petrels in flight display, with the bird on the left being of the Light (palest) plumage type and the bird on the right being of the Midway plumage type. *(Photograph courtesy of the Tubenoses Project © H. Shirihai.)*

Photos 54–55 The so-called 'orgy display', featuring one main individual (possibly female) perched on the ground (indicated by the yellow arrow in the right image). This individual attracts a group of displaying petrels, likely mostly males (shown by the red arrows), which glide and hover in a line mostly around and above the perched petrel, repeating this behaviour. This particularly noisy group display can last for hours. *(Photographs courtesy of the Tubenoses Project © H. Shirihai.)*

Another frequently observed colonial behaviour is that many Trindade Petrels seem to perch on open rocky ground, mostly on Ilha do Sul. This behaviour most likely involves nonbreeders or immature petrels. Luigi *et al*. (2009) experiences for Trindade Island and HS' experiences from Round Island concur concerning the preferred nesting sites of Trindade Petrels. Most nests are located in natural cavities formed by irregularities in the terrain, such as caves, crevices, and other types of recesses found on large rocky surfaces with a steep slope,

or sometimes among patchy clusters of scrub. Therefore, most of these perched birds on open rocky ground, with tens of them on Ilha do Sul, presumably are resting nonbreeders. See photos of the perched birds on open rocky ground versus in caves (taken on Ilha do Sul, Photos 56–58).

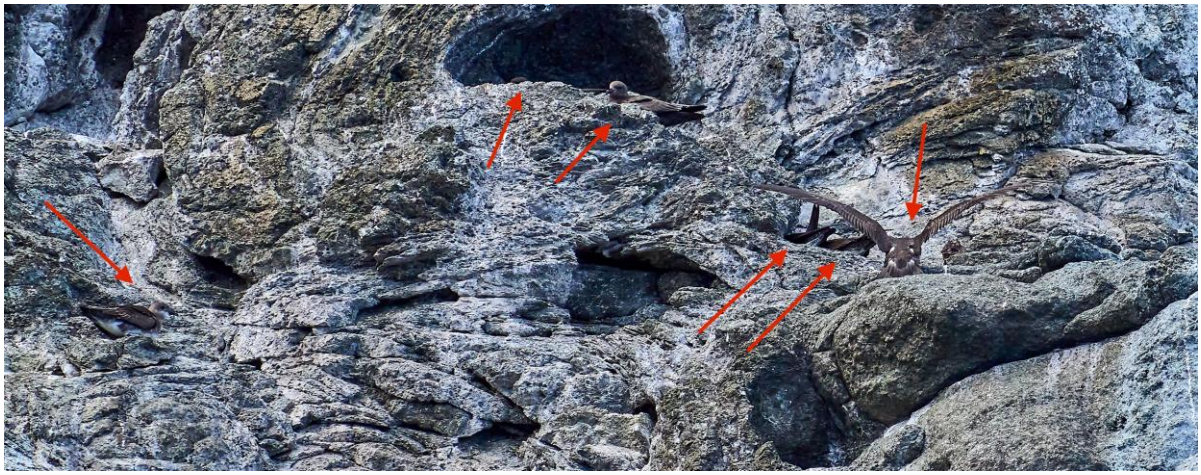


Photo 56 Six Trindade Petrels perched on open rocky ground with some in caves, Ilha do Sul. These birds are most likely resting or engaging in a type of ground display, with some in pairs. They are presumably nonbreeders or petrels that have not found safe and undisturbed breeding sites. *(Photograph courtesy of the Tubenoses Project © H. Shirihai.)*

Photo 57a–g (photo-closure) Seven Trindade Petrels on open rocky ground. Although they appear to be incubating, they are actually resting or engaging in a type of 'grounding display'. *(Photograph courtesy of the Tubenoses Project © H. Shirihai.)*

Photo 58 Nine Trindade Petrels on open rocky ground, likely resting nonbreeders. *(Photograph courtesy of the Tubenoses Project © H. Shirihai.)*

Possible identifiable threats to Trindade Petrels on land

As we did not land on any rocks or islands (to avoid harming breeders), our observations from the boat did not identify any visual threats to the Trindade Petrels on land. For further information on these issues, we point the reader to Luigi *et al*. (2009).

Colonial interrelations of Trindade Petrel with other breeding seabirds

Ilha do Sul is also occupied by large numbers of breeding White Tern and small populations of the two frigatebird species. There was no obvious conflict or competition between White Terns and Trindade Petrels. They breed alongside each other without land or aerial fights. However, the relationship between the two frigatebirds and Trindade Petrel is more complex. Frigatebirds occasionally harassed petrels on land, perhaps trying to force them to leave a nest for predation. This is unlikely to be a major threat to the Trindade Petrel due to the small numbers of frigatebirds and well-hidden nests of petrels. During flight patrols along the cliffs, frigatebird did not attack the petrels, though occasionally petrels hassled the frigatebirds. Presumably, petrels treat frigatebirds as predators (see Photos 59–60).

Photos 59–60 On the left, a Trindade (Lesser) Frigatebird in flight moving towards a Trindade Petrel perched on the ground (possibly incubating) in the top-left corner of the photo. On the right, a Trindade Great Frigatebird on a hunting patrol across the cliff face. It shows interest in a breeding Trindade Petrel in a cave and appears alarmed by a White Tern. *(Photographs courtesy of the Tubenoses Project © H. Shirihai.)*

Endemic Frigatebirds – the rarest seabirds on Earth!

Trindade Island is home to two (neo)endemic, critically endangered taxa of Frigatebirds, the Trindade (Lesser) Frigatebird *Fregata trinitatis* and Atlantic Great Frigatebird *F. [minor] nicolli* (see Olson 2017). Genetic evidence along with morphological analysis make a strong case for full species status for both (see Croxall 2023 and references therein). Special effort was made to monitor and record the small number of the two taxa of Frigatebirds. Careful analysis of photographs, focusing on age-related and sex-related plumage variation, demonstrate just how few birds were present during our visit: 13 Trindade (Lesser) Frigatebirds; 22 Trindade Great Frigatebirds

Images of every individual present during the expedition are given in Appendix 7, categorised as juvenile, immature, subadult, and adult, with females listed first. Each individual of the two frigatebird species has been assigned a code: Trindade (Lesser) Frigatebird TLFB 1 to TLFB 13; Trindade Great Frigatebird TGFB 1 to TGFB 22. Every surviving individual of these highly endangered taxa, the rarest seabirds on earth, is significant!

In brief, of the 13 Trindade (Lesser) Frigatebirds, 11 were juvenile or immature (coded TLFB 1–11), and two were adult female (coded TLFB 12–13). Of the 22 Trindade Great Frigatebirds, eight were juvenile (coded TGFB 1–8), six were immature (coded TGFB 9–14; TGFB 9 immature female, TGFB 10–13 immature males, TGFB 14 older immature or near adult male), and eight were adult (coded TGFB 15–22; three females TGFB 15–17, and five males TGFB 18–22).

Port *et al*. (2016) is the only published comparative source of a recent past census: six Trindade (Lesser) Frigatebirds (two adult males, two adult females, two juveniles), and four Trindade Great Frigatebirds (two adult males, one adult female, one juvenile). Notwithstanding that the methods of the latter and the current works differ, the numerical differences suggest significant population increases: over 100% in Trindade (Lesser) Frigatebird and over 550% in Trindade Great Frigatebird. For interest, Olson (2017) speculates that fewer than 20 breeding pairs of Trindade (Lesser) Frigatebird remain.

The main concern is the absence of the two adult-male Trindade (Lesser) Frigatebirds reported by Port *et al*. (2016). It is possible that they were foraging at sea or resting on obscured ledges on or nearby Ilha do Sul, though they may have perished. Virtually all of the activities of the frigatebird species were focused around Ilha do Sul; aerial activities, resting on favoured ledges on the islet, or on an artificial stand made for the frigatebirds

on Trindade Island, opposite Ilha do Sul. The two frigatebird species did not compete or fight with each other. Rather, they sometimes grouped together in flight, and once on a rocky ledge.

A main attraction around the Ilha do Sul for the frigatebirds is an ample supply of fish gained by kleptoparasitism on the White Terns. Both frigatebird species attack incoming White Terns carrying fish for their chicks. Most attacks involved persistent chases until a tern dropped its fish, or occasionally escaped from the frigatebird. Trindade (Lesser) Frigatebird only fed by kleptoparasitism on the White Terns, whereas Trindade Great Frigatebird also spent time searching for nests of other seabirds, including of petrels and terns, with intent to rob them.

Since Ilha do Sul is the only safe place for the frigatebirds, despite lacking trees, they have no other choice but to carry out their everyday life based on or around the islet, including nesting on the ground. Ground nesting is unusual among frigatebirds that tend to breed on trees and bushes. The Ascension Frigatebird *Fregata aquila* of South Atlantic is the other notable exception.

Olson (2017) elevated Trindade (Lesser) Frigatebird, otherwise known as Atlantic Lesser Frigatebird, to species level, with the scientific name *Fregata trinitatis*, split from Lesser Frigatebird *F. ariel* of the Indo-Pacific, based on plumage differences and greater robustness of the rostrum and wing bones. Our studies concur with Olson (2017). This involves comparison of plumage variation of *F. ariel* with all individuals on the current expedition and the *trinitatis* specimens, including the Holotype held at the National Museum in Rio de Janeiro (see Appendix 6).

Immature plumages of *F. trinitatis* maintain the characteristic rufous-brown head/neck for at least the first two/three years of life, with some birds superficially resembling young Ascension Frigatebirds. Remarkably, Olson (2017) also found *F. trinitatis* fossils on St. Helena, geographically a step closer to the Ascension Island. The fact that 11 of the 13 Trindade (Lesser) Frigatebirds were recorded as juvenile or immature may support the notion that immature plumages are carried over numerous moult cycles. However, further work is required to elucidate the age-related and sex-related plumage maturation of this frigatebird.

Great Frigatebird exhibits significant geographical variation and accordingly there is a case that the discrete population on Trindade Island should be elevated to sub/species level, or at least to be regarded as a significant Conservation Unit, affording it a higher level of preservation along with Trindade (Lesser) Frigatebird. Both frigatebirds now occur only on Trindade Island where they are restricted to Ilha do Sul, probably are the rarest seabirds on Earth, and are on the verge of extinction.

The Frigatebirds of Trindade Island: taxonomic status and identification

Trindade Island is the only current nesting site for two taxa of Frigatebirds, *Fregata trinitatis* Miranda Ribeiro,1919) and *F. [minor] nicolli* Mathews, 1914 (hereafter *F. nicolli*). Olson (2017) argued for specific status of *F. trinitatis* from *F. ariel* based on immature plumage differences, a considerably stouter bill and bill lengths of males being significantly smaller than in *F. ariel*. The ulnae, and especially the humeri, are markedly more robust than in *F. ariel*. *Fregata nicolli* has remained unstudied and lumped with the Great Frigatebird *F. minor*.

Recent genetic work (Martins *et al*. 2022) has provided the first robust phylogeny for Frigatebirds and evidence for full species status for several taxa, including *F. trinitatis* and *F. nicolli* (see Croxall 2023 for a review). Briefly, genetic data show strong support for *F. trinitatis* to be treated as the sister taxon of all Indo-Pacific taxa now grouped under *F. ariel*, while *F. nicolli* is sister (with moderate – 0.79 – support) to a clade comprising both *F. aldabrensis* (W Indian Ocean), *F. palmerstoni* (most of the Pacific) and *F. ridgwayi* (Galapagos, Cocos and Revillagigedo Is.).

Morphologically (summary in Olson 2017), the main difference between *F. trinitatis* and the Indo-Pacific *F. ariel* group is that *F. trinitatis* has an immature plumage with brown head and white from the flanks extending well into the axilla. This brown-headed plumage was first recognised by Lowe (1924) who pointed out that "whatever they are, the brown head phase is either peculiar to the South Trinidad ariel or it so happens that this phase has never been noted or collected before throughout the whole range of the species".

Olson (2017) recognised that the "subadult plumage, in which the top of the head and hindneck are dark brownish and the throat a smoky grey, is distinctive". He also remarked that, contrary to Indo-Pacific birds, "the only indication so far that rufous may be present in *F. trinitatis* was my observation, at considerable distance, of a nestling juvenile with a rufous head. If this is typical of juveniles of the species, then the rufous must be a very evanescent plumage, because none of the available specimens of *F. trinitatis* is in juvenile plumage or retains any portion of such plumage". As colour perception varies among humans Olson's "rufous" should be read as tawny (as used by Harrison *et al*. 2021) while Orta *et al*. (2020) used apricot to tawny-brown to describe the juvenile head colour of *F. ariel*.

F. minor nicolli was described based on its large bill and very broad pale wing band (Mathews & Iredale 1921), with Murphy (1936) adding its bill to be "horn-colour but very rosy on the latericorn and the sides of the mandible; orbital ring is red". No detailed description of its juvenile or immature plumages have been made although Olson (2017) mentions a juvenile specimen with a chestnut stripe in the lower throat and upper breast.

Port *et al*. (2016) has a picture of a Juvenile Stage 1 (based on Harrison *et al*. 2021) with an all-white head with no cinnamon wash, white oval belly patch with axillary tabs and, most importantly, a tawny-tinged chocolate breast band making it look like a Juvenile Stage 1 Ascension Frigatebird *F. aquila*.

The limited number of specimens and publicly available photographs has resulted in the plumage data in Olson (2017) to be considered insufficiently precise to allow consistent critical comparison of *F. trinitatis* with the four plumage cycles now recognised in other frigatebird taxa (Croxall 2023), while no comparison has ever been made between *F. nicolli* and its sister taxa. On *F. nicolli*, no proposal for its full-species status has been made so far.

Although present genetic data are robust enough to grant full species status to both taxa and hopefully highlight a Critically Endangered status that has been ignored because of taxonomic constipation (Pacheco 2018), the records made during this expedition help to clarify the plumage sequence of both *F. trinitatis* and *F. nicolli*, how they compare to their sister taxa and their uniqueness. Larger samples, if they ever become available, are needed to understand the plumage sequence in both Trindade taxa. What follows is a preliminary attempt to describe a complex pattern that ideally should be based on progression of primary molt to allow accurate ages (Howell, 2010), something not possible at this stage. Further research on this topic including good samples for different populations of Indo-Pacific birds is also be needed for meaningful comparisons with these Atlantic birds and to be encouraged.

The plumage sequence in Howell (1994) and Harrison *et al*. (2021) were used as the benchmark to name plumage stages and make comparisons alongside the descriptions of Indo-Pacific Frigatebirds in James (2004) although we chose not to strictly adhere to them. Frigatebirds apparently have a wave moult per cycle or year but this is protracted, not necessarily tightly synchronised to season or between individuals, often progresses in an irregular and asymmetrical manner, and may be punctuated by periodic interruptions, making ageing difficult.

James (2004) provides a simple system, using only the gross head and ventral patterns, for ageing Oriental Region frigatebirds. Juveniles of both sexes have tawny-coloured heads (which bleach rapidly), broad blackish breast-bands, and clean white bellies. Second-year birds lose the breast-band gradually from the centre outwards (often showing blackish tabs or blotches on the sides of the breast) to show extensively white underparts and a pale head. They cannot be sexed in most cases.

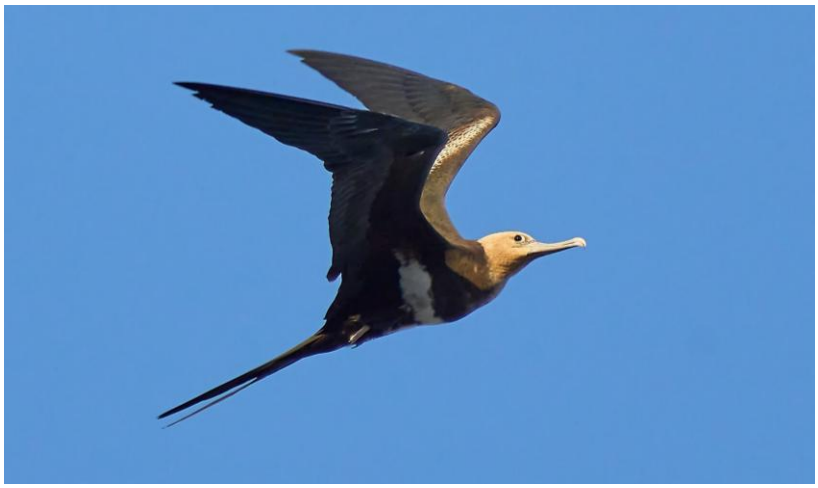
In the third year (or cycle), males and females begin to differ. Areas of the head and ventral surfaces that are white in juveniles and black in adults become increasingly flecked and mottled with black. At this stage, females are typically white, mottled with black on the head and belly while the breast remains cleanly white. Meanwhile, males start to show black mottling on the head and belly, but also on the breast. This replacement of white with black continues gradually, and fourth-year birds show an adult-like plumage of their respective sex except for tell-tale signs of immaturity such as white mottling on the head and underparts. By this stage, adult bare part colours are evident, including the red inflatable gular pouches of males. Adults have cleanly demarcated black and white areas on the underparts, usually without mottling. Adult males are mostly black, although the Lesser Frigates have small white areas on the underparts. Adult females are more extensively white below.

What follows is a provisional attempt to make sense of the plumage sequence of both *F. trinitatis* and *F. nicolli*, based on the limited data available, thereby to encourage seabirders to check their pictures as valuable information may be hidden in misidentified photos. We assume fledglings of both frigatebird taxa have reddish (as described by Olson for *F. trinitatis*) or apricot / cinnamon heads, as have their sister taxa.

TRINDADE FRIGATEBIRD *FREGATA TRINITATIS*

JUVENILE STAGE 1 (TLFB 9) – Apricot head, throat and neck contrasting with brown chest and upperparts. There is a mid-body white belly band linking the white axillary spurs, with white feathers spreading from it to the vent forming a fuzzy inverted triangle. Upper secondary coverts whitish peppered with dark centres forming a striking upper wing panel. This plumage is very similar to the one in Harrison *et al*. (2021) although *F. trinitatis* looks definitively cocoa-brown under strong light.

TLFB9



Older birds (TLFB2, TLFB3, TLFB7) have apricot head a bit paler, neck cocoa brown from the nape and throat down, with mixed white feathers on the breast reaching up the throat and sides of the neck suggesting where the white collar of the female plumage will be. The inverted white triangle on the belly and connected white axillary spurs remain evident but with dark feathers speckled on the belly. The bill is light blue with a light pink unguis and remains so through the juvenile-immature stage, and the eye-ring is light blue.

TLFB2

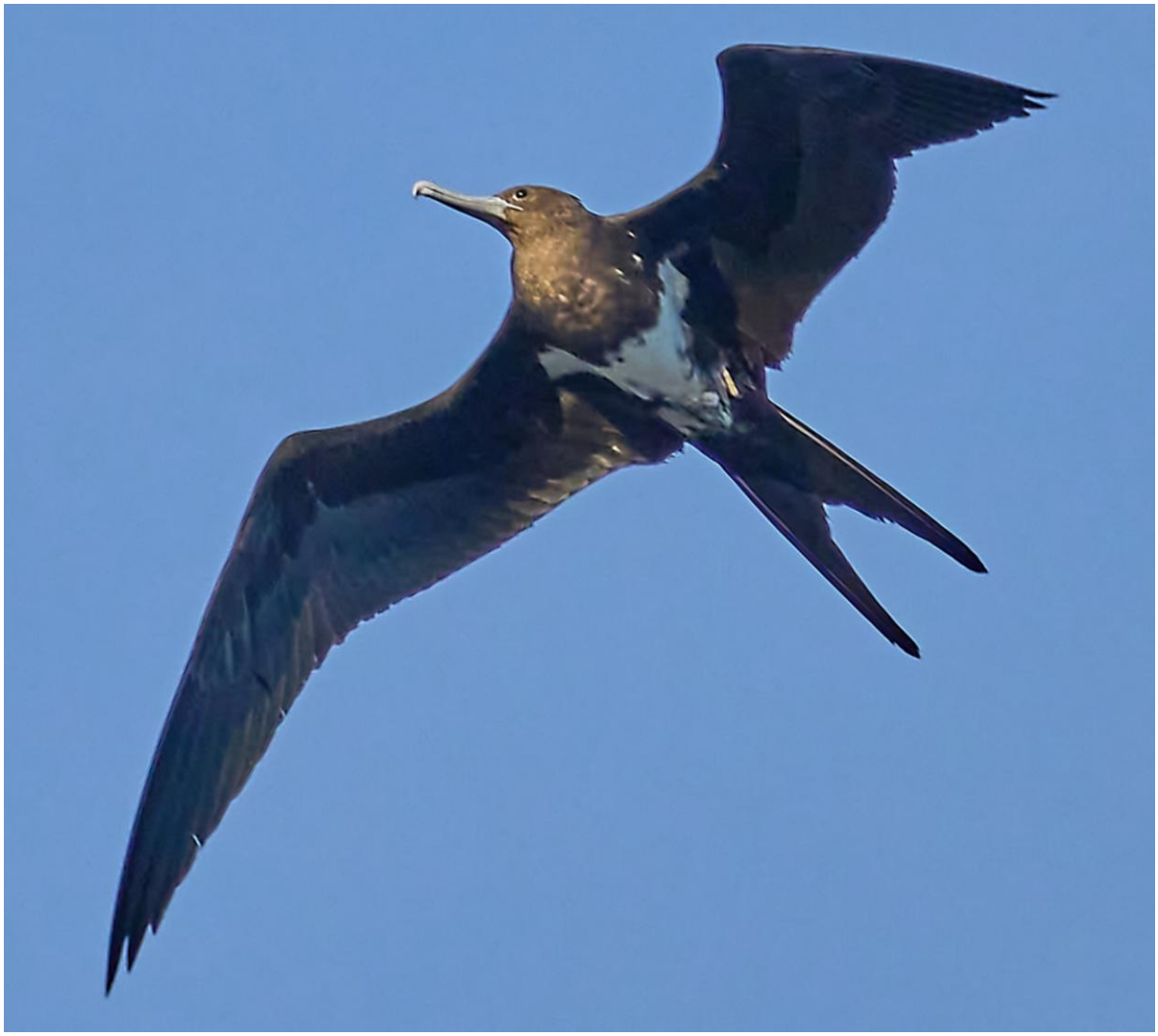
TFLB3 **TFLB7**

JUVENILE STAGE 2 (TLFB1, TLFB4, TLFB5, TLFB8, TLFB11) – The head is solid brown, looking cocoa-brown depending on the light, and may contrast with blacker body feathers, although some look concolorous. Inverted triangular belly patch and axillary spurs are well marked and fuzzy white feathers extend into the vent. Bill is light blue with pink unguis, eye-ring light blue, and feet pink. This is the distinctive brown headed plumage considered exclusive of *F. trinitatis* and is unlike any other plumage in the Indo-Pacific sister taxa. Trawling through 2,121 photos of *F. ariel* in eBird failed to show any similar bird.

TLFB1

TLFB4

TLFB5



TLFB8

TLFB11

IMMATURE FEMALE (TLFB6) – Like Juvenile Stage 3 with a brown head but body feathers start moulting into blackish and the breast ones into white. Bill is bluish with pink unguis, eye-ring bluish, and feet pale pink.

TLFB 6

SUBADULT FEMALE – Not recorded during the expedition. Brown-headed with grey-throat and white collar (pictured in Olson 2017).

ADULT FEMALE (TLFB12 and TLFB13) – Blackish with salmon-pink eye-ring, bill and feet that may look brighter depending on the breeding cycle. The bird looks hooded; a broad white neck collar connects to the white breast and upper belly, neatly demarcating the all-black head, including nape and throat. The photos suggest that *F. trinitatis* females may lack the belly-pointing central peak seen in Indo-Pacific birds (James 2004), but a skin (MN 39145) shows that feature. Upper wing lesser secondary coverts are white peppered with dark contrasting with the blackish upper wing and back both in flight and when the bird is at rest. The white axillary spurs are not as neat as in the males and look fuzzy, peppered with dark feathers. Bill and eye-ring are salmon-pink and feet are pink. MN 39145 had a wingspan of 1,820 mm and weighed 1,150 g.

TLFB 12

TLFB 13

IMMATURE MALE – Unknown, probably unlike the subadult male in Harrison *et al*. (2021); see below.

SUBADULT MALE – MN 39077 is a male bird prepared with its gular sac inflated. It is all blackish apart from a single feather on the chest and its mid belly, which is white (the feathers are tinged yellow from preparation) with some scattered black feathers, mostly in the mid-belly and connects with the white flanks. This bird had a wingspan of 1,830 mm, weighed 1,050 g, and had pale pink (front) and pale orange (back) tarsi with black feet and pale orange soles.

ADULT MALE - No adult male was recorded during the expedition. Available specimens at MN and pictures (Port *et al*. 2016) show that *F. trinitatis* adult males are probably indistinguishable from Indo-Pacific birds, with black plumage that has a green, bluish and purplish gloss on the upper body, and no upper-wing panel and white crescent over central axillaries and anterior flanks. The bill is dark grey.

TRINDADE GREAT FRIGATEBIRD *FREGATA NICOLLI*

JUVENILE STAGE 1 (TGFB1, TGFB2, TGFB3, TGFB4, TGFB5, TGFB6, TGFB7, TGFB8) – Head is tawny to cinnamon, becoming partially white on some birds (TGFB1) with the throat and ventral side of the neck retaining the tawny colour and connecting to a broad cocoa brown breast band that may have a strong tawny tinge in its centre (TGFB3), fading into black on the sides (TGFB2). No bird had the broad pure tawny breast band and white head shown by some juveniles in the Galapagos and elsewhere.

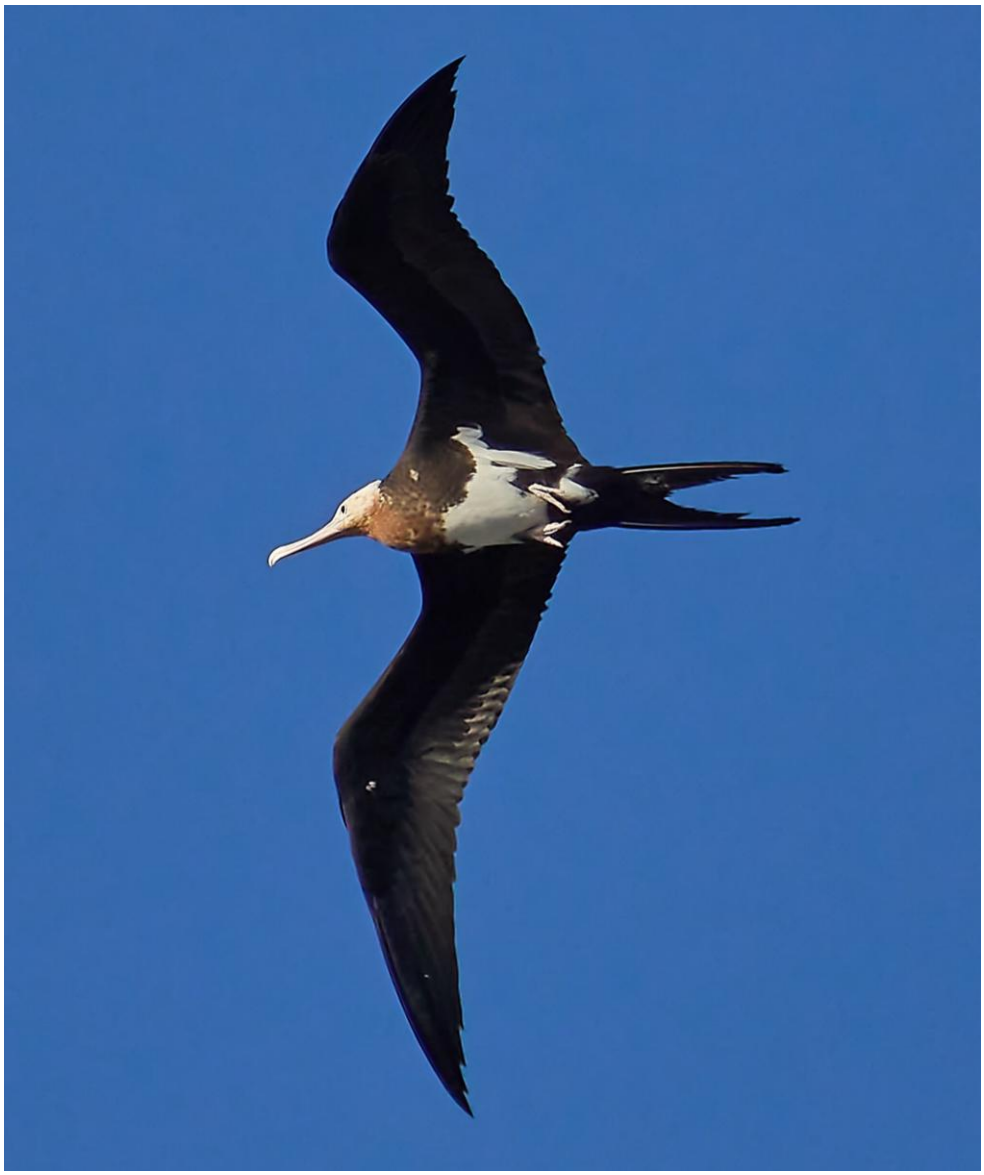
TGFB1

TGFB 2

TGFB 3

White belly patch egg-shaped with parallel-sided, square-tipped spurs coming from the middle up the flanks but not much farther into the axillaries. The spurs can be asymmetrical, sometimes with long white bands spreading backwards (TGFB4) or even altogether lacking (TGFB5, also see Silva e Silva & Carlos 2019). When present (7:1 of birds in this age group had spurs), the spurs look more developed and conspicuous compared to birds in the Oriental Region (James 2004) and elsewhere (Harrison *et al*. 2021). Bill pale whitish pink, but some birds have a pale grey-blue upper bill, pink being restricted to the unguis, cutting edge and mandible. Feet pale pink, vent dark, conspicuous upper wing alar bar with white dark-centred feathers forming a mottled pattern. Depending on the light, white-headed juveniles may look like juvenile Ascension Frigatebirds with a broad brown breast band (see Port *et al*. 2016).

TGFB4



TGFB5

JUVENILE STAGE 2 – unknown.

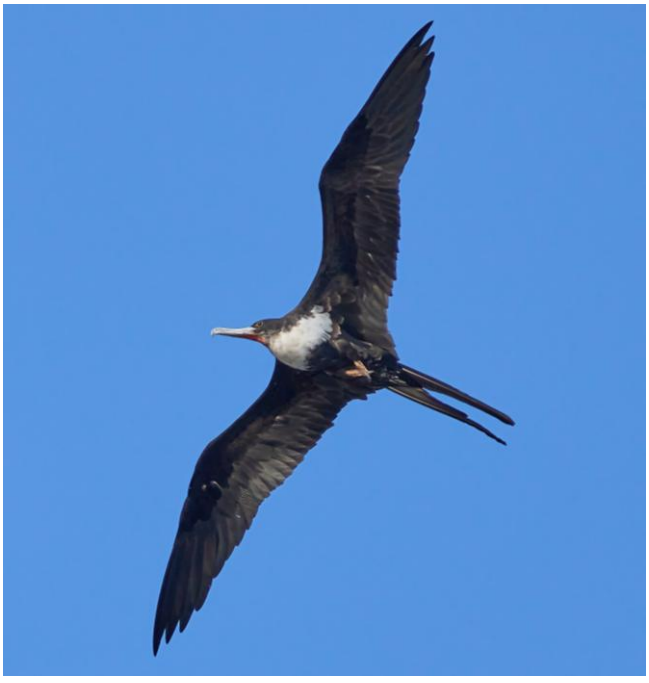
IMMATURE FEMALE – unknown. Presumably has a whitish belly mottled with dark feathers, white breast and tawny or white head, but retaining tawny along the throat down to the upper breast.

SUBADULT FEMALE (TGFB 9) – full dark belly, breast is white but for the centre which remains tawny/cinnamon, this colour running up the neck to the throat. Head with a dark hood contrasting with the tawny throat but merging neatly with the dorsal side of the neck and back. Bill is pale greyish blue, feet and eye-ring are pink.

TGFB 9

ADULT FEMALE (TGFB10, TGFB15, TGFB16, TGFB17) – dark belly, white breast with a few scattered dark feathers, mouse grey throat reaching the base of the neck. Some females show an orange-pink or pale pink small gular sac (TGFB10, MN 39089, MN 39098). Eye-ring colour is salmon-pink, sometimes quite bright, and iris dark brown (MN 39089). The bill is grey, sometimes with pinkish unguis, sometimes also base and cutting edge, a feature seen in some female Christmas Frigatebirds; extent and brightness of pink depends on breeding condition (TGFB16 pinker than the basically all-grey bill of TGFB15). Feet pale orangey pink to pink. MN 39089 had a wingspan of 2.125 m and weighed 1,550 g; MN 39098 2,170 mm and 1,500 g.

TGFB10



TGFB15

TGFB16

TGFB17

IMMATURE MALE (TGFB11, TGFB12, TGFB13) – dark belly, white breast peppered with dark feathers, dark throat. Bill and eye-ring bluish grey or pale pink (TGFB10, TGFB11), feet pink. Red gular sac becomes visible and birds in this stage do display with fully inflated gular sac. Axillary spurs may be present. Conspicuous upper wing whitish alar bar with dark-centred feathers, and green shine to elongated dorsal feathers. Bill is blackish with horny unguis (MN 39018), eye-ring black, iris dark brown, and feet light pinkish-yellow. MN 39078 had a white breast, full gular sac and weighed 1,250 g.

TGFB 11

TGFB 12

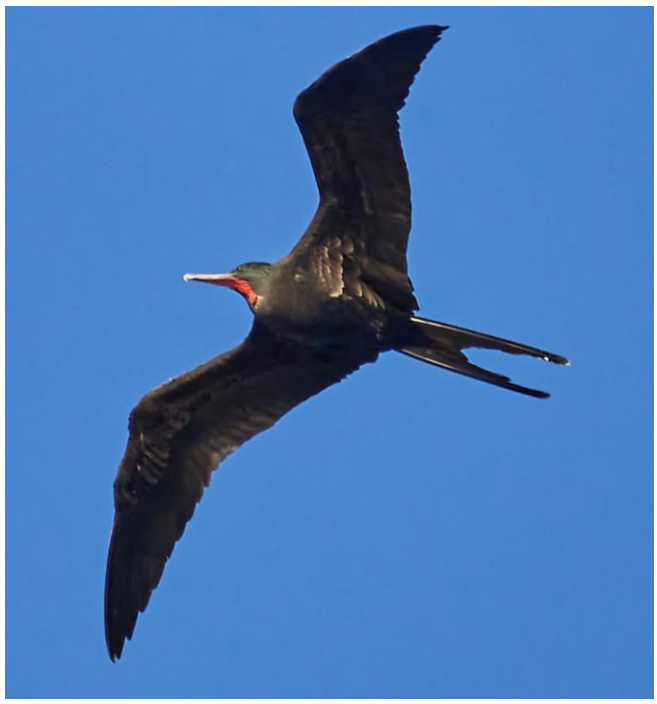
TGFB 13

SUBADULT MALE (TGFB14, MN 39083) – the breast becomes dark with few white speckles, with some white on the breast and in the axillaries giving them a scalloped effect. Red gular sac fully developed. Elongated feathers on the back with a purple and green sheen. Eye-ring is black, iris dark brown, and feet pale pink.

TGFB14

ADULT MALE (TGFB18, TGFB19, TGFB21, TGFB22) – The white breast becomes dark, the conspicuous pale upperwing alar bar can be seen in all black males but seems to turn browner without pale feathers over time (MN 35946). Axillaries show pale edges giving them a scalloped effect. Bill is light bluish grey, but may look whitish depending on the light. Feet are pale pinkish-orange, while toes may be pale orange (MN 39083). MN 39083 had a wingspan of 2,050 mm and weighed 1,600 g.

TGFB 18



TGFB 19

TGFB 21

TGFB 22

REMARKS ON FRIGATEBIRDS

Olson (2016) suggested *F. trinitatis* had only a very transitional juvenile plumage with a "reddish head" changing into white, but this seems not to be the case.

In short, *F. trinitatis* shows has a distinctive juvenile brown morph unlike any other taxon in the group. The single subadult male skin suggests the chest turns black first, followed by the belly, the opposite of Lesser Frigatebirds.

It is possible not all birds transition to the brown plumage. TLFB 10 shows a pale apricot head bleaching into white, belly patch and throat with fresh black feathers and breast black mottled with white, suggesting a step leading a plumage similar to Juvenile Stage 2 in Harrison *et al*. (2021) and white-headed birds photographed by Port *et al*. 2016 and in https://ebird.org/checklist/S96892661.

F. nicolli shows a similar plumage to other pink/red eye-ring populations except: 1) Axillary spurs seem more common among juveniles than the 1/3 figure for Oriental Region birds from James (2004). 2) Axillary spurs are present up to the immature stage, while Indo-Pacific birds lose them with the breast band in their second cycle (James 2004). 3) The alar bar is more developed in all plumages but for older males compared to Indo-Pacific sister taxa. The presence of a small gular sac in adult females may also be particular to this taxon.

All plumages of *F. trinitatis* are distinctive from *F. nicolli* and *F magnificens* and there should be little risk of misidentification if key field marks such as the belly patch of juveniles are visible.

Confusion arises when comparing adult males of *F. nicolli* and *F. magnificens*, as adult males look identical if the brown (and sometimes faint) alar bar of *F. nicolli* is not visible (*F. magnificens* lacks one), and adult females may look similar when birds are flying with tucked heads, hiding the white collar of *F. magnificens*, and light conditions obscure the grey (not black) throat of *F. nicolli* and its pink eye-ring (bluish-grey in Atlantic *F. magnificens*).

One interesting comparison pair is white-headed looking juvenile *F. nicolli* with a mostly brown breast-band and juvenile *F. aquila*. Both share a whitish head and most *F. nicolli* will show axillary spurs, but the breast-band in *F. aquila* lacks the tawny seen in *F. nicolli* and its centre tends to have a gap (see also Howell 2010). Besides, *F. aquila* lacks tawny from its throat to upper breast seen in *F. nicolli* and its bill is bluish while most *F. nicolli* will have at least some pink.

The present status of *F. trinitatis* as an endemic breeder to Trindade is an artifact from the human impact on the oceanic islands of the South Atlantic as subfossil remains show *F. trinitatis* also occurred in Saint Helena (Olson 2017) and, apparently, Fernando de Noronha (Olson 1982). The same is likely true of *F. nicolli*, which has been recorded alive in Fernando de Noronha (Silva e Silva & Carlos 2019) while subfossil material from Fernando de Noronha (including an extinct flightless rail) remains to be fully described (Olson 1982).

Sightings of *F. nicolli* and *F. trinitatis* in Fernando de Noronha raise the question if those species may be present there amid the more common *F. magnificens*. Directed searches for those species, as well for *F. aquila* (recently photographed there; see https://macaulaylibrary.org/asset/385219581) might yield some surprises.

Photos 61 Trindade (Lesser) Frigatebirds in aerial acrobatics above Ilha do Sul, 13th May 2022. *(Photograph courtesy of the Tubenoses Project © H. Shirihai.)*

Photos 62–63 Trindade Great Frigatebird (left) and Trindade (Lesser) Frigatebird in aerial acrobatics above Ilha do Sul, 13th May 2022. *(Photographs courtesy of the Tubenoses Project © H. Shirihai.)*

Photos 64–65 Trindade Great Frigatebirds in aerial acrobatics above Ilha do Sul, 13th May 2022. *(Photographs courtesy of the Tubenoses Project © H. Shirihai.)*

Seabirds Around the Archipelago

In addition to the Trindade Petrel and the two frigatebirds, a main interest for census work was the **White Tern** *Gygis alba kleptoparasitic*. On Trindade Island, breeding localities largely overlap with colonies of Trindade Petrel, possibly because both require similar predator-free breeding locations. White Terns breed on exposed ground surfaces, mostly in cavities in rocks and cliffs, rather than on trees, as on many Pacific islands. The species is highly visible around its breeding localities as it frequently flies around the nest sites, performing various social behaviours, including group displays, and returning with fish to feed chicks.

The largest count was 230 on the 13th and 14th May, of which 130 were seen on the southwest side around Ilha do Sul, with the remainder around the north side of the island, from Ponta do Norte to Praia do Noroeste, and along the west shore, around Pico do Monumento. The other large breeding gathering was around the Martim Vaz rocks with nearly 100 White Terns on 10th May.

On Trindade Island, White Terns mostly associate with colonies of Trindade Petrel, while in the Martim Vaz rocks, where fewer petrels presumably breed, White Terns associate with the largest colonies of Masked Booby. Mancini *et al*. (2016) state that on Martim Vaz rocks about 40 adults and eggs of at least 15 pairs were found in early April 2007. They give no details for Trindade Island. A side benefit, monitoring breeding White Terns may provide insights into the conservation state of the other breeding seabirds. For example, the kleptoparasitic frigatebirds are largely dependent on White Terns. White Terns feed in association with feeding frenzies, involving shearwaters, boobies and noddies, mostly in the shallow waters between Trindade Island and the Martim Vaz rocks, and east of Martim Vaz rocks.

Other breeding species seen in good numbers around the Trindade archipelago include **Masked Booby** *Sula dactylatra*, with 10s breeding on Martim Vaz rocks (10th May), which correspondence with Mancini *et al*. (2016). Good numbers of **Red-footed Booby** *Sula sula* were logged at sea around the archipelago, with the highest count of 23 on 10th May, involving the full range of age variation. Some adult Red-footed Boobies were among the breeding Masked Boobies on the Martim Vaz rocks, suggesting that the species breeds there. Mancini *et al*. (2016) note that Red-footed Booby once bred on Trindade Island, but is now presumed extinct on the island. The expedition observations are possibly the first evidence that Red-footed Booby still breeds in the archipelago. A scattering of **Brown Booby** *Sula leucogaster* was observed during the expedition. Good numbers of **Common/Brown Noddy** *Anous stolidus stolidus* were observed most days at sea, especially in the shallow waters between Trindade Island and the Martim Vaz rocks. On 10th May, up to 20 **Lesser/Black Noddy** *Anous minutus americanus* were among feeding frenzies, not far from the Martim Vaz rocks, which corresponds with Mancini *et al*. (2016) who report that a relict population persists on Martim Vaz rocks, where about 10 nests were photographed on an inaccessible cliff in April 2007. The **Sooty Tern** *Onychoprion/Sterna fuscata* is a prominent breeder on Trindade Island and the Martim Vaz rocks, but few birds were seen as the expedition period occurred outside its breeding season.

Photo 66: White Terns, an essential seabird of Trindade Island for the survival of the two endemic frigatebirds *(Photograph courtesy of the Tubenoses Project © H. Shirihai.)*

Photos 67-68 Above, Common/Brown Noddy, in profile (top-left) and feeding (top-right), off Trindade Island. *(Photographs courtesy of the Tubenoses Project © H. Shirihai.)*

Photo 69 Left, one of the few Lesser/Black Noddy seen during the expedition, off Martim Vaz rocks. *(Photograph courtesy of the Tubenoses Project © H. Shirihai.)*

Photo 70 Masked Booby off Martim Vaz rocks. *(Photograph courtesy of the Tubenoses Project © H. Shirihai.)*

Photo 71 Red-footed Booby (dark morph). Although thought to be extinct as a breeder in the archipelago, good numbers were seen during the expedition, including juveniles. *(Photograph courtesy of the Tubenoses Project © H. Shirihai.)*

Seabirds Between Trindade Island and Mainland Brazil

Numerous other seabirds, nonbreeding and migratory, were recorded during the expedition, 2nd–19th May 2022 (18 days), as summarised below. Of particular note is the strong passage of Great Shearwater. This illustrates the global importance of the region for seabird conservation. The following summary by species includes the number of days a species was recorded and the maximum daily count.

Great Shearwater *Ardenna gravis* Observed on most days. On 5th May, over 10,000 birds were recorded on northeast passage, crossing the Jaseur Seamount (coordinates in Expedition Log). Up to 520 was the maximum single count between 06.00 to 10.00. Passage was noted throughout the day as we sailed eastward, parallel to the Vitória-Trindade Seamount Chain. We also encountered large rafts and feeding frenzies. Adults were moulting inner primaries while juveniles were in fresh plumage.
Cory's Shearwater *Calonectris borealis* Observed on 10 days, with up to 40 recorded on 5th May, though not in association with the Great Shearwater movement.
Cape Verde Shearwater *Calonectris edwardsii* Two birds on the 10th May.
Sooty Shearwater *Ardenna grisea* Observed on 10 days, with up to 15 recorded on 5th May.
Short-tailed Shearwater *Ardenna tenuirostris* One on 5th May.
Manx Shearwater *Puffinus puffinus* Three birds on 19th May off the Brazilian coast.
Spectacled Petrel *Procellaria conspicillata* Individuals on 10th and 16th May.
Soft-plumaged Petrel *Pterodroma mollis* One on 11th May.
Tristan Albatross *Diomedea dabbenena* One on 19th May.
Atlantic Yellow-nosed Albatross *Thalassarche chlororhynchos* One on 19th May.
Wilson's Storm-petrel *Oceanites oceanicus* Observed most days, commonest nearer the mainland, with a maximum of 20 on 3rd May.
Black-bellied Storm-petrel *Fregetta tropica* Observed on 12 days, with six recorded on 17th May.
Band-rumped Storm-petrel *Thalobata castro* One on 2nd May.
South Polar Skua *Catharacta maccormicki* Observed on five days, with 10 recorded on 5th May.
Pomarine Jaeger (Skua) *Stercorarius pomarinus* One on 3rd May.
Magnificent Frigatebird *Fregata magnificens* One on 19th May.

Photo 72: Spectacled Petrel. *(Photograph courtesy of the Tubenoses Project © H. Shirihai.)*

Photos 73–74: Great Shearwaters. *(Photographs courtesy of the Tubenoses Project © H. Shirihai.)*

Photo 75: Cory's Shearwater. *(Photograph courtesy of the Tubenoses Project © H. Shirihai.)*

Photo 76: Cape Verde Shearwater. *(Photograph courtesy of the Tubenoses Project © H. Shirihai.)*

Photo 77: Black-bellied Storm-Petrel. *(Photograph courtesy of the Tubenoses Project © H. Shirihai.)*

Photo 78: Wilson's Storm-Petrel. *(Photograph courtesy of the Tubenoses Project © H. Shirihai.)*

Cetaceans

Surprisingly, there were very few sightings, despite the calm weather and visiting many seamounts on 10th May:
Blainville's Beaked Whale *Mesoplodon densirostris* Female and calf photographed on 8th May.
Beaked Whale sp. Immature male photographed on 10th May (Photos 79–81).
Oceanic Bottlenose Dolphin *Tursiops truncatus* Six on 10th May.

Photos 79-81 Unidentified beaked whale sp., off the Martim Vaz rocks. Experts in the field of cetacean identification advised this is probably a Blainville's Beaked Whale *Mesopolodon densirostris (Photographs courtesy of the Tubenoses Project © H. Shirihai.)*

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APPENDIX 1

Expedition Log

The following Expedition Log was recorded and written in full during the nights of the expeditions by HS. It contains a lot of basic information that formed the report. It was a very time-consuming process, as every night HS processed all photos from the day and ran the double-counting control with the photos to ensure that only new petrels were counted in every counting and parallel photographic session. Sometimes, Roberto, the skipper, would wake up to say, "Hadoram, you need time to sleep and recover... your computer is using too much electricity." Further details of the *'Cyclone Escape of May 17th–19th*' are given in Appendix 2.

1st May*:* Departed the Brazilian mainland from Vitoria at around midnight between the 1st and 2nd of May, exactly on HS' birthday! Just two days earlier, on April 29th, HS celebrated the one-year anniversary of his marriage to Reut!
Coordinates: 20°19'20.97"S, 40°17'25.57"W

2nd May*:* At sea, moving eastward for another six days or so to Trindade Island.
Coordinates: 19°54.066' S, 38°48.295 W to 19°52.881' S, 38°33.087 W.
Wind/ocean: 10–15 N to NNW.
Chumming technique: Oil-dripping.
Species recorded:
Wilson's Storm-Petrel *Oceanites oceanicus* 3.
Band-rumped Storm-Petrel *Thalobata castro* 1.
South Polar Skua *Catharacta maccormicki* 1.

3rd May*:* At sea, moving eastward for another five days to Trindade Island.
Coordinates: 19°50.228' S, 37°53.255 W to 20°2.670' S, 37°12.357 W.
Wind/ocean: 8–12 NE.
Chumming technique: Oil-dripping.
Species recorded:
Wilson's Storm-Petrel *Oceanites oceanicus* 20 (up to 5 together).

Black-bellied Storm-Petrel *Fregetta tropica* 2.
South Polar Skua *Catharacta maccormicki* 1.
Pomarine Jaeger (Skua) *Stercorarius pomarinus* 1.

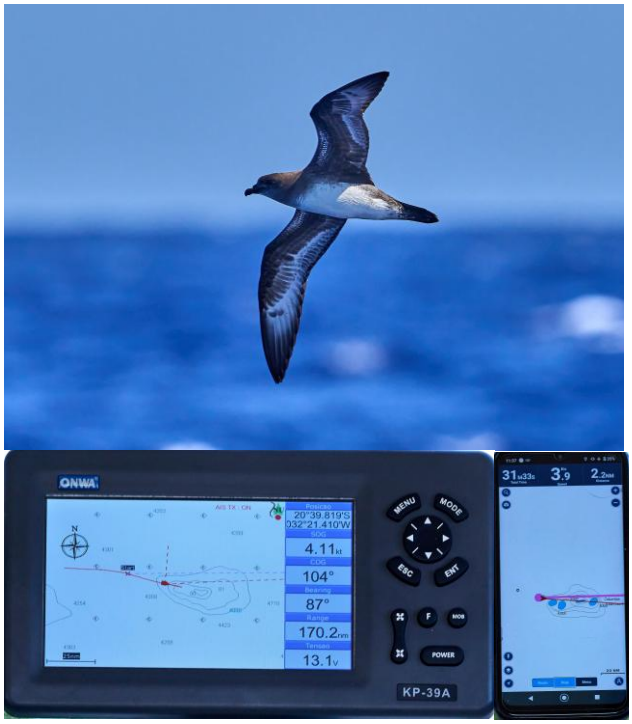
4th May*:* At sea, still moving eastward for another four days to Trindade Island.
Coordinates: 20°7.753' S, 36°39.653 W to 20°18.689' S, 35°31.037 W.
Wind/ocean: 12–20 NE.
Chumming technique: Oil-dripping.
Species recorded:
Wilson's Storm-Petrel *Oceanites oceanicus* 3 (up to 2 together).
South Polar Skua *Catharacta maccormicki* 1.
Great Shearwater *Ardenna gravis* 12.
Cory's Shearwater *Calonectris borealis* 1.
Masked Booby *Sula dactylatra* 1.

5th May*:* At sea, still moving eastward for another three days to Trindade Island.
Coordinates: 20°21.504' S, 34°28.204 W to 20°29.478' S, 33°27.648 W.
Wind/ocean: 15–22 NE.
Chumming technique: Oil-dripping
Species recorded:
Wilson's Storm-Petrel *Oceanites oceanicus* 5 (up to 2 together).
South Polar Skua *Catharacta maccormicki* 10 (up to 3 together).
Great Shearwater *Ardenna gravis* 4,600 counted, but a rough estimate of over 10,000 (up to 520 together in one view / one count; all moving north or northeast; most between 06.00 to 10.00 between 20°21.504' S, 34°28.204 W to 20°22.665' S, 34°6.808 W, but all day long there was movement of shearwaters, and with resting rafts of tens of birds); mixed fresh juvenile and moulting adult (inner primaries in moult).
Cory's Shearwater *Calonectris borealis* 40, not in association with Great Shearwaters, usually single birds, but up to three birds at once (on average, every 15 minutes one bird or so); and habitually avoided the boat unlike the Great Shearwaters.
Sooty Shearwater *Ardenna grisea* 15, on migration with the Great Shearwaters.
Short-tailed Shearwater *Ardenna tenuirostris* 1 (identification based on jizz, short stubbier bill, rounded head profile, clear feet projection, and wider / diffuser greyish pale underwing panel, classic individual. In international waters at around 10.00 at 20°22.665' S, 34°6.808 W).

Photo 82: Sooty Shearwater. *(Photograph courtesy of the Tubenoses Project © H. Shirihai.)*

6th May*:* At sea, still moving eastward for another two days towards Trindade Island.
Coordinates: 20°33.931' S, 32°43.845 W to 20°42.792' S, 31°55.521 W.
Wind/ocean: 5–12 E.
Chumming technique: Oil-dripping.
Species recorded:

Trindade Petrel *Pterodroma arminjoniana* 3, 12.00–15.30:
1 (1 white-bellied), at TP-LOCATION1 20°39.833' S, 32°21.971 W.
1 (1 light), at TP-LOCATION2 20°41.605' S, 32°13.311 W.
1 (1 light), at TP-LOCATION3 20°42.046' S, 32°8.777 W.



← **Photo 83a–c (cluster of three)** The first Trindade Petrel documented on the Trindade Expedition, May 6th (TP1), approximately 430 nautical miles off the mainland of Brazil, and around 170 nautical miles from Trindade Island (see GPS screen). *(Photographs courtesy of the Tubenoses Project © H. Shirihai.)*

Of the expedition's first three Trindade Petrels observed today, two were photographically documented (individually coded TP 1 to 2) and placed into plumage types:
Light (palest) – L, 1 petrel.
Midway – M, 1 petrel.
Wilson's Storm-Petrel *Oceanites oceanicus* 3 (up to 2 together).
Great Shearwater *Ardenna gravis* 33.
Cory's Shearwater *Calonectris borealis* 4, habitually avoided the boat.
Sooty Shearwater *Ardenna grisea* 3, on migration.
Masked Booby *Sula dactylatra* 3.

7th May*:* At sea, moving eastward to Trindade Island.
Coordinates: 20°38.701' S, 31°5.284 W to 20°37.320' S, 30°16.718 W.
Wind/ocean: 3–6 E.
Chumming technique: Oil-dripping during the morning; from 11.00–17.00 dropped some frozen chum blocks and worked the chum slick.
Species recorded:
Trindade Petrel *Pterodroma arminjoniana* 46 (amazing number away / west of the island, 11.00–17.00):
1, at TP-LOCATION4 20°37.980' S, 30°35.875 W.
1, at TP-LOCATION5 20°38.028' S, 30°32.327 W.
1, at TP-LOCATION6 20°37.120' S, 30°29.964 W.
4, at TP-LOCATION7 20°37.880' S, 30°23.229 W.
7, at TP-LOCATION8 20°37.870' S, 30°23.612 W.
2, at TP-LOCATION9 20°37.870' S, 30°25.225 W.
1, at TP-LOCATION10 20°37.871' S, 30°23.670 W.
2, at TP-LOCATION11 20°37.876' S, 30°22.650 W.
2, at TP-LOCATION12 20°37.853' S, 30°20.661 W.
1, at TP-LOCATION13 20°37.804' S, 30°19.266 W.
22, during 2.5 h chumming at TP-LOCATION14 20°37.320' S, 30°16.718 W.

Of the 46 estimated Trindade Petrels, 36 were photographically documented (individually coded TP 3 to 39) and were assigned to plumage type:
Light (palest) – L, 7 petrels.
Midway – M, 4 petrels.
White-bellied – Wb, 8 petrels.
Darkest (max-dark) – D, 17 petrels.

Two interesting feeding-related behaviours were observed among the Trindade Petrels. Unrelated to the chumming, several petrels lifted food items from the surface while in the air, rather than sitting on the water with partially open wings. They hovered with deep wingbeats to stay over one location above the food. I also photographed a Trindade Petrel aggressively harassing a South Polar Skua, forcing it to drop food that it had taken from a Cory's Shearwater.
Wilson's Storm-Petrel *Oceanites oceanicus* 3 (up to 2 together).
Black-bellied Storm-Petrel *Fregetta tropica* 1.
Great Shearwater *Ardenna gravis* 9.
Sooty Shearwater *Ardenna grisea* 12, on migration.
Cory's Shearwater *Calonectris borealis* 3.
Masked Booby *Sula dactylatra* 2.
South Polar Skua *Catharacta maccormicki* 1.
White Tern *Gygis alba alba* 2.

8th May*:* Chumming all day long approximately six miles southwest off Trindade Island.
Coordinates: TP-LOCATION15 20°38.319' S, 29°18.936 W
Wind/ocean: Max 6 E.
Chumming technique: A long session of stationary chumming (see coordinates above, times recorded below), using frozen chum blocks and fish oil. When on the move, we constantly ran the oil-drip.
Species recorded:
Trindade Petrel *Pterodroma arminjoniana* At least 400. This total included 250 petrels counted 06:00–12:00. During this time, a quick count was made every 15 minutes, observing the birds that were visible in a one-minute view in the direction of the chum slick, as well as within a 180° range to the west. The result was 12 to 83 birds per minute in 19 counts throughout the six-hour session. After midday counting ceased. Despite decreasing numbers, birds continued to pass through constantly until 17:00. Therefore, the daily total must have exceeded 400 petrels, probably a conservative estimate!

Choice of the chumming location six miles southwest off Trindade Island was based on previous experience that petrels usually approach breeding islands from the southwest in the southern latitudes. There is no obvious explanation for the mass gatherings of petrels this morning, which included circling groups of tens of birds in one area. It seemed as if they were socialising while waiting for something to happen or waiting for the wind to develop, as there was a long stretch of windless conditions prevailing in the area.

Of the 400+ estimated Trindade Petrels, 365 were photographically documented (individually coded TP 40 to 404) and were assigned to plumage type:
Light (palest) – L, 143 petrels.
Light (barred variant), 5 petrels.
Midway – M, 120 petrels.
White-bellied – Wb, 43 petrels.
L/M, L/M/Wb & M/Wb, 12 petrels.
Flecked – F, 5 petrels.
Dark-brown – Db, 3 petrels.
Dark-grey – Dg, 2 petrels.
Darkest (max-dark) – D, 32 petrels.
Other species:
Wilson's Storm-Petrel *Oceanites oceanicus* 3 (up to 2 together).
Black-bellied Storm-Petrel *Fregetta tropica* 2.
Great Shearwater *Ardenna gravis* 5.
Sooty Shearwater *Ardenna grisea* 2, on migration.
Cory's Shearwater *Calonectris borealis* 5.
Masked Booby *Sula dactylatra* 12.
Red-footed Booby *Sula sula* 6.
White Tern *Gygis alba alba* 20.

Common Brown Noddy *Anous stolidus stolidus* 5.
Blainville's Beaked Whale *Mesoplodon densirostris* 2, a female and calf (photographed).

9th May*:* Chumming much of the day approximately 6–10 miles southwest off Trindade Island.
Coordinates: TP-LOCATION16 20°37.371' S, 29°23.122 W (all morning till midday) & TP-LOCATION15 20°38.319' S, 29°18.936 W (from 14.00 to 17.00).
Wind/ocean: Max 6 SE.
Chumming technique: Two extended sessions of stationary chumming (see above), using frozen chum blocks and fish oil. When on the move, constantly ran the oil drip.
Species recorded:
Trindade Petrel *Pterodroma arminjoniana* – 120, a conservative daily total, as the petrels were spread out in small numbers and constantly passing throughout the day, making it difficult to count accurately! It was not the same glorious petrel day as the previous day, but still nice to have constant views of up to eight petrels on the chum slick every few minutes.

Of the 120 estimated Trindade Petrels, 81 were photographically documented (individually coded TP 405 to 485) and were assigned to plumage type:
Light (palest) – L, 27 petrels.
Midway – M, 31 petrels.
White-bellied – Wb, 10 petrels.
M/Wb: 1 petrel.
Flacked – F, 2 petrels.
Darkest (max-dark) – D, 10 petrels, 6 during the morning session and 4 in the afternoon–evening.
Wilson's Storm-Petrel *Oceanites oceanicus* 3 (up to 2 together).
Black-bellied Storm-Petrel *Fregetta tropica* 4.
Great Shearwater *Ardenna gravis* 10.
Sooty Shearwater *Ardenna grisea* 4, on migration.
Cory's Shearwater *Calonectris borealis* 3.
Masked Booby *Sula dactylatra* 7.
Red-footed Booby *Sula sula* 2.
White Tern *Gygis alba alba* 30.
Common Brown Noddy *Anous stolidus stolidus* 3.
Sooty Tern *Onychoprion (Sterna) fuscata* 1.

10th May*:* A long day that began by seeking out the 'submerged atoll', only to discover that while it is on the map, it is actually deeply submerged. The presence of a large number of seabirds above the area confirmed its existence. We then crossed the water to the east toward the Martim Vaz rocks, where we encountered many feeding frenzies of noddies and boobies, along with other shearwaters and petrels. We stayed there for about two hours until just after midday. Afterward, we scanned the area for breeding seabirds and were fortunate to spot a female of the near-extinct endemic race of the Great Trindade Frigatebird perched atop the southern rock, Ilha do Sul, in the Martim Vaz rocks. We also found evidence of possible breeding Trindade Petrels on the main Martim Vaz rock. We then chummed three miles east off Martim Vaz rocks and conducted about two hours of night listening and spotlighting observations on the south side of the rock, but nothing nocturnal was detected, likely due to strong rain and half-moon lighting.
Coordinates: TP-LOCATION17 20°37.107' S, 29°13.213 W (05.30–0630 at the 'submerged atoll'), sailing Martim Vaz rocks, and stopping at TP-LOCATION18 20°31.540' S, 28°56.279 W (at the feeding frenzy, from 12.00 to 13.30); TP-LOCATION19 20°29.122' S, 29°51.185 W (at the Martim Vaz rocks, from 13.30 to 15.00); TP-LOCATION20 20°28.942' S, 28°47.736 W (chum east off Martim Vaz rocks from 15.30 to 17.00).
Wind/ocean: Max 10 SE.
Chumming technique: Mostly on the move, with constant oil-dripping, stationary chumming later in the day (see above), using frozen chum blocks and fish oil.
Species recorded:
Trindade Petrel *Pterodroma arminjoniana* 464 + 30 + 32; giving a total of 526. The first number (464 petrels) is the number of petrels counted mostly closer to TP-LOCATION17 and during the sail to about TP-LOCATION18, of petrels seen passing through or in large gatherings of up to 60 birds, some in impressive feeding behaviours, as well as in feeding association with other seabirds. The second number (30 petrels) involves petrels in display flight above the cliffs and tops of the main Martim Vaz rocks, TP-LOCATION19. The third number (32 petrels) includes petrels on the chumming session three miles to the east off Martim Vaz rocks.

Of the 526+ estimated Trindade Petrels, 108 were photographically documented (individually coded TP 486 to 594) and were assigned to plumage type:
Light (palest) – L, 20 petrels.
Midway – M, 37 petrels.
White-bellied – Wb, 13 petrels.
L/M, L/M/Wb & M/Wb, 14 petrels.
Flecked – F, 1 petrel.
Dark-brown – Db, 4 petrels.
Dark-grey – Dg, 2 petrels.
Darkest (max-dark) – D, 17 petrels.

Notes on the feeding behaviours of Trindade Petrel: During the morning, the birds formed flight circles of normally not more than six to 15 birds. Several such gatherings across 90° of the horizon involved up to three circling groups at once, totalling 60 birds. These circling flights were very impressive as they were performed at great speed with half-flexed very pointy wings, giving the appearance that the birds were attempting to 'confuse', group and trap fish. Also observed today was a good number of Trindade Petrels associated with the feeding frenzies of terns, noddies, and boobies in shallow waters between Trindade Island and the Martim Vaz rocks. This involved aerial pursuit of leaping or flying small fish and squid, mostly in response to predator fish such as tuna beneath the surface. In such chases and pursuits, the Trindade Petrels were seen to accelerate their flight speed enormously and outpace all other seabirds.

Notes on possible breeding on Martim Vaz rocks: A good number of displaying petrels were observed atop and along the cliffs of the main rock of the group, suggesting that breeding is likely to occur there. Some of the petrels were seen landing close to the edge of the cliffs and the grass at the top, indicating that these displayers mostly likely are breeders. At least 30 petrels were involved in the display flights.

Photo 84 Trindade Petrel *Pterodroma arminjoniana*, with two birds displaying atop and along the cliffs of Martim Vaz rocks. *(Photograph courtesy of the Tubenoses Project © H. Shirihai.)*

Wilson's Storm-Petrel *Oceanites oceanicus* 1.
Black-bellied Storm-Petrel *Fregetta tropica* 2.
Great Shearwater *Ardenna gravis* 30.
Sooty Shearwater *Ardenna grisea* 3, on migration.
Cory's Shearwater *Calonectris borealis* 20.
Cape Vere Shearwater *Calonectris edwardsii* 2.
Spectacled Petrel *Procellaria conspicillata* 1.
Great Frigatebird *Fregata minor nicolli* 1 female.
Masked Booby *Sula dactylatra* 15 at sea; plus some clusters of 10s of breeding birds on the Martim Vaz rocks.
Red-footed Booby *Sula sula* 23 at sea; plus some among breeding Masked Boobies on the Martim Vaz rocks.
White Tern *Gygis alba alba* 50 at sea; plus some colonies of 10s of breeding birds on the Martim Vaz rocks.
Common Brown Noddy *Anous stolidus stolidus* 470 involving some large feeding frenzies.
Sooty Tern *Onychoprion (Sterna) fuscata* 5.
South Polar Skua *Catharacta maccormicki* 1.
Unidentified beaked Whale 1 immature male.
Oceanic Bottlenose Dolphin *Tursiops truncatus* 6.

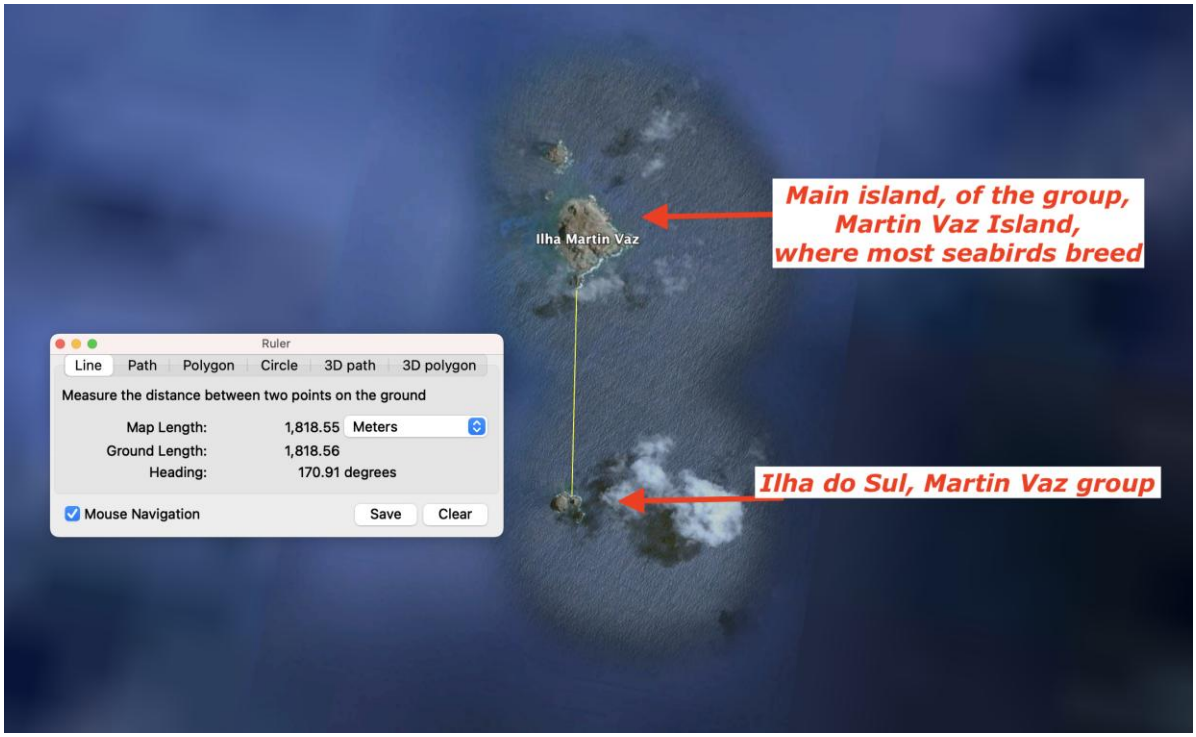


Photo 85 The Martim Vaz rocks. *(Photograph courtesy of the Tubenoses Project © H. Shirihai.)*

Photo 86 Female Trindade Great Frigatebird (TGFB 15), the only frigatebird seen in the Martim Vaz rocks. *(Photograph courtesy of the Tubenoses Project © H. Shirihai.)*

11th May*:* Some chumming undertaken during the first half of the day west of Martim Vaz rocks; in the late afternoon and evening we returned to the southwest corner of Trindade Island, to Ilha do Sul.
Coordinates: TP-LOCATION21 20°31.180' S, 28°55.552 W (morning session).
Wind/ocean: Max 5 SE.

Chumming technique: Some short sessions of stationary chumming in the morning; otherwise, constant oil-dripping when on the move.
Species recorded:
Trindade Petrel *Pterodroma arminjoniana* 240 + 227; due to the calm ocean, both the chum slick and the petrels were spread out throughout the day, making counting difficult!

Out of the 467 counted Trindade Petrels, 114 were photographically documented (individually coded TP 595 to 708) and were assigned to plumage type:
Light (palest) – L, 38 petrels.
Midway – M, 32 petrels.
White-bellied – Wb, 26 petrels.
L/M, L/M/Wb & M/Wb, 7 petrels.
Dark-brown – Db, 1 petrel.
Dark-grey – Dg, 3 petrels.
Darkest (max-dark) – D, 7 petrels.
The petrels documented during the day (mostly feeding) west off Martim Vaz rocks were referred to as TP 595 to TP 693, while those that were photographed closer to Trindade Island (on the return to the island) were referred to as TP 694 to TP 708.
Soft-plumaged Petrel *Pterodroma mollis* 1.
Wilson's Storm-Petrel *Oceanites oceanicus* 5.
Black-bellied Storm-Petrel *Fregetta tropica* 3.
Great Shearwater *Ardenna gravis* 10.
Cory's Shearwater *Calonectris borealis* 10.
Masked Booby *Sula dactylatra* 2.
Red-footed Booby *Sula sula* 12.
White Tern *Gygis alba alba* 14.
Common Brown Noddy *Anous stolidus stolidus* 300.
Black Noddy *Anous [minutus] americanus* 20.
Sooty Tern *Onychoprion (Sterna) fuscata* 1.

12th May*:* Ilha do Sul (often regarded as part of the 'Ponta do Sul'), at the isolated (disconnected) 'pyramid rock' is located off the south shore of Trindade Island. We arrived with limited expectations of what we might find here in terms of breeding petrels and frigatebirds, but it turned out to be incredible and one of the best days of the expedition so far! We found both species of frigatebirds, documented most age / sex classes, and above all, discovered a large colony of Trindade Petrels. It was fascinating to learn and collect data on the social behaviours of the latter and other seabirds, both intraspecific and interspecies. We checked the eastern side of the rock first thing in the morning, and as the sun moved to the west, we relocated to its western side 06:00–15:00. We then moved a mile to the south to count the incoming petrels from the ocean to the colony.
Coordinates: TP-LOCATION22 20°31.600' S, 29°19.510 W.
Wind/ocean: Max 5 S.
Chumming technique: Oil-dripping from 15.00 onwards (see above).
Species recorded:
Trindade Petrel *Pterodroma arminjoniana* 246 + 410; giving a total of 656. The daily total, a conservative count, involved counting the birds every half-hour throughout the day (with up to 48 counted in one view at 09:00, up to 95 at 14:00, and up to 72 at 17:00, totalling 246 petrels. The evening count of incoming birds included 410, a stream of incoming petrels, with up to 39 birds per minute.

Of the 656 estimated Trindade Petrels, 358 were photographically documented (individually coded TP 709 to 1066) and were assigned to plumage type:
Light (palest) – L, 119 petrels.
Light (barred variant) – LF, 2 petrels.
Midway – M, 116 petrels.
White-bellied – Wb, 57 petrels.
L/M, L/M/Wb & M/Wb: 39 + 3 petrels.
Flecked – F, 4 petrels.
Dark-brown – Db, 2 petrels.
Dark-grey – Dg, 3 petrels.
Darkest (max-dark) – D, 12 petrels.

Photo 87: Trindade Petrel, Trindade (Lesser) Frigatebird and White Tern, the 'prime story' of the ilha do Sul, Trindade Island. *(Photograph courtesy of the Tubenoses Project © H. Shirihai.)*

Wilson's Storm-Petrel *Oceanites oceanicus* 5.
Trindade Frigatebird *Fregata [ariel] trinitatis* 4, with one adult female and rest young birds (tentative total).
Great Frigatebird *Fregata minor nicolli* 6, with 1 adult male, 2 adult females, and three juveniles and immatures (tentative total).
Masked Booby *Sula dactylatra* 20.
Red-footed Booby *Sula sula* 3.
White Tern *Gygis alba alba* 130.
Common Brown Noddy *Anous stolidus stolidus* 30.

Photo 88 Trindade Frigatebird during the evening moonrise of the 13th May. *(Photograph courtesy of the Tubenoses Project © H. Shirihai.)*

13th May*:* We began at 06:30 at Ilha do Sul to continue studying the breeding petrels and frigatebirds (refer to the previous day). From about 08:30 until midday, we circumnavigated Trindade Island to check the petrels' activities above known historical breeding sites (see list below). After these observations, we are now certain that the colony on Ilha do Sul is still one of the most important of the species on Trindade Island. However, we also discovered a much larger concentration of petrels around and above Pico do Monumento. From midday, we returned to Ilha do Sul to continue working there until the end of the day (we also continued counting the number of petrels around Pico do Monumento from a distance, which gave us a wider angle of view).
Coordinates: see below.
Wind/ocean: Max 5 SE.
Chumming technique: No chumming today.
Species recorded:
Trindade Petrel *Pterodroma arminjoniana* 993; involved flying and displaying petrels in various-sized gatherings above their breeding localities. This is a conservative count, as 722 individuals were photographed to eliminate double-counting. This was done by comparing individual plumage types and patterns. The high rate of documented and individually recognised birds (993/722, approximately 73%) indicates a conservative approach to counting. The circumnavigation and counting were undertaken anticlockwise (from south to southeast, along the east coast to the north, and southwards along the west coast, with 11 main sites checked around Trindade Island, as marked on the map below.

Photo 89 Trindade Island, with main surveying locations for breeding colonies of the Trindade Petrel. *(Photograph courtesy of the Tubenoses Project © H. Shirihai.)*

The 722 Trindade Petrels that were photographically documented (individually coded TP 1067 to 1789) today (out of the daily counted total 993) were assigned to plumage type:
Light (palest) – L, 262 petrels.
Midway – M, 220 petrels.
White-bellied – Wb, 70 petrels.
L/M, L/M/Wb & M/Wb, 133 petrels.
Flecked – F, 6 petrels.

Dark-brown – Db, 6 petrels.
Dark-grey – Dg, 3 petrels.
Darkest (max-dark) – D, 12 petrels.
Darkest/ Flecked – 1 petrel.
Golden –1 petrel.
Light/Golden –1 petrel.
Unrecognised (only seen/photographed from above) – 7 petrels.

***By the 10 main localities*:**

***The west side*:**
Ilha do Sul 20°31.600' S, 29°19.510 W: during the early morning checks of the flight gatherings, including many displaying birds, the numbers were low to moderate, reaching up to 35 per count. However, late in the day, from 14.30, numbers gradually increased to a constant presence of 28–130 petrels per count, in every 15-minute count until dusk. Furthermore, at around 17.00, at one time something made the birds suddenly excited and highly vocal, all rising from the island to the sky, when 380 petrels were counted! Thus, a rough estimate (and conservative!) from the morning and the afternoon-evening counts together is 400 petrels.

Pico do Monumento 20°30.086' S, 29°20.608 W: during the late morning from around 10.30 over one-hour (with counts every 15 minutes) there were up to 93 circling and displaying petrels per count atop this impressive 270m high pillar, giving a rough (highly conservative) total of 200 petrels! However, later in the day, the gatherings became larger, reaching up to 320 per count, suggesting a rough estimate of around 500 petrels, at least! Highly impressive! See the photos of 207 petrels together from that count (Photos 18–19)! (See also next day for counts of the gathering atop Pico do Monumento, while chumming from the southwest and west of the Island.) **One point for future visits**: circling and displaying petrels atop Pico do Monumento are not easy to see because the birds are very high. Scan with binoculars to locate them. The radius of the circling and displaying petrels is mostly concentrated just above and around the top of Pico do Monumento, but when at peak numbers the range spreads to around 500 meters radius and tens of meters higher, like a huge and thick flying wheel of circling petrels! Thus, a rough estimate from the late morning to the afternoon-evening counts on the 13th May alone, and the mean number of both session-counts, is 350 petrels, being highly conservative, once again!

Ilha da Racha 20°30.408' S, 29°20.786 W: not more than 18 petrels, most busy in flight-display.

Vale do "M" 20°30'49.90"S, 29°20'16.59"W: the cliffs and gorges above this stretch were occupied by small groups in flight-display, or single pairs or individuals, some seen entering caves. However, later in the day, the same area was occupied by up to 37 petrels in one count (across an extended area counting mostly from a distance). Estimate of not more than 50 petrels for that area.

Vale dos Farilhões 20°31'31.33"S, 29°19'52.70"W: the cliffs and peaks above the shore of this area were occupied by small groups or individuals during much of the day, but later in the day, the same area was occupied by up to 50 petrels in one count. Estimate of not more than the latter figure for that area, too.

***The north side*:**
Ponta do Norte to Praia do Noroeste 20°29.242' S, 29°20.256 W, and 20°29.616' S, 29°20.518 W, respectively: obviously, there is a lot of activity of petrels above the cliffs and peaks of this highly ragged area, but when we passed this area around mid-morning, the number of petrels per count reached a maximum of 58. No estimate as little time spent here.

***The SE side*:**
Morro do Paredão (red rock) 20°31.440' S, 29°18.145 W: maximum 34 petrels counted, most busy in flight-display, some seen investigating or entering caves.

Morro do Pão de Acucar 20°31'19.69"S, 29°18'32.26"W: the cliffs around this area were occupied by small groups or individuals during much of the day, but later in the day the same area was occupied by up to 22 petrels per count. Estimate of not more than 30 petrels for that area.

***The central summits*:**

Pico de Nossa Senhora de Lourdes & Pico do Vigia 20°30'57.48"S, 29°18'21.34"W and 20°31'7.41"S, 29°18'38.09"W, respectively: at distance (from the boat / ocean) and by photographing these summits, we detected only single birds during the morning, but in the afternoon-evening the same area was occupied by up to 36 petrels per count. Estimate of not more than 30 petrels for that area.

Enseada dos Portugueses 20°30'23.04"S, 29°19'28.22"W: involving the summit from east to west, roughly above the naval base. At distance (from the boat / ocean) and by photographing these summits, we were surprised by the scant number of petrels during the morning, normally not more than two birds at a time, but in the afternoon-evening the same area was occupied by up to 20 petrels per count. Estimate of not more than 20 petrels for that area.

Wilson's Storm-Petrel *Oceanites oceanicus* 1.

Trindade Frigatebird *Fregata [ariel] trinitatis* 13, which includes 11 juveniles and immatures, and two adult females (these include the same individuals seen yesterday).

Great Frigatebird *Fregata minor nicolli* 21, which includes eight juveniles and six immatures, and with only seven adults, of which two were females and five were males (this includes the same individuals seen yesterday).

Photo 90: A group comprising five Trindade (Lesser) Frigatebirds and three Trindade Great Frigatebirds. *(Photograph courtesy of the Tubenoses Project © H. Shirihai.)*

Notes on the two frigatebirds: much of the total population of the Trindade (Lesser) Frigatebird were documented today: 13 birds, and 21 out of the total 22 seen during the expedition of the Trindade Great Frigatebird. From about 17.00, both species of the frigatebirds made evening glides above and around the western cliffs of Ilha do Sul, and at one stage up to 14 frigatebirds were counted together in the air in one group, and photos of up to nine birds in one frame were taken (see photo). Each individual was photographed well enough for ageing and sexing, which is summarised in the opening pages of the expedition report. Notes were taken on the social and feeding behaviours of the two frigatebirds as well as their relationships especially to the White Terns and the Trindade Petrels.

Photos 91–93 Trindade (Lesser) Frigatebird acrobatically chasing a White Tern, with a Trindade Petrel also visible in the same view (left image). *(Photograph courtesy of the Tubenoses Project © H. Shirihai.)*

Masked Booby *Sula dactylatra* 13.
Red-footed Booby *Sula sula* 2.
Brown Booby *Sula leucogaster* 1.
White Tern *Gygis alba alba* 360; main colonies were clearly around the north side of the island, Ponta do Norte to Praia do Noroeste, and down the west side around the Pico do Monumento, and in the southwest side around the Ilha do Sul.
Common Brown Noddy *Anous stolidus stolidus* 45.

14th May*:* Chumming close to the southwest corner of the island 06:00–14:00, then started to sail back to the west to mainland Brazil, but with a slow drift westward on sails along a 20-mile track while chumming until dusk.
Coordinates: TP-LOCATION23 20°25.780' S, 29°26.342 W.
Wind/ocean: Max 10–25 SE and finally the wind returned!
Chumming technique: One extended session of stationary chumming slicks, using the last frozen chum blocks with fish oil. While on the move we constantly ran the oil-drip.
Species recorded:
Trindade Petrel *Pterodroma arminjoniana* 278 (on the chumming slick).

Of the 278 Trindade Petrels counted, 163 were photographically documented (individually coded TP 1790–1952) and assigned to plumage type:
Light (palest) – L, 58 petrels.
Midway – M, 51 petrels.
White-bellied – Wb, 17 petrels.
L/M, L/M/Wb & M/Wb & L-D, 10 + 3 petrels.
Flecked – F, 4 petrels.
Dark-brown – Db, 5 petrels.
Dark-grey – Dg, 2 petrels.
Darkest (max-dark) – D, 12 petrels.
Golden 1 petrel.

Also photographed was the tentatively named Golden-type petrel (or 'Golden Petrel'), which looked similar to Robert Cushman Murphy's mysterious 'Snowy-mantled Petrel' *'Aestrelata chionophara*' described in Murphy (1914, *Auk*, 31, p. 13, pi. 2), and based on Holotype AMNH 132499, an adult female, collected by himself at Trindade Island on 8th April 1913 – 109 years earlier! Unlike *chionophara*, which has been suggested by some as leucistic or as a "sport" as Murphy later termed it when being self-critical (Murphy & Pennoyer 1952), this golden type is a striking-looking plumage. This was the first photographed out of a total of three similar petrels seen on the expedition: the two earlier, with one on the 11th of May between Martim Vaz rocks and Trindade Island, and one above Pico do Monumento on the 13th May, which was too far to secure reasonable images.

Further, while chumming from the southwest and west of the island, the top of Pico do Monumento reached a constant 35–50 birds circling and displaying per count, in every one-hour check from 07:00 to 14:00!
Wilson's Storm-Petrel *Oceanites oceanicus* 1.
Black-bellied Storm-Petrel *Fregetta tropica* 3.
Sooty Shearwater *Ardenna grisea* 5.
Great Shearwater *Ardenna gravis* 30.

Cory's Shearwater *Calonectris borealis* 10.
Masked Booby *Sula dactylatra* 22.
Red-footed Booby *Sula sula* 2.
Brown Booby *Sula leucogaster* 1.
White Tern *Gygis alba alba* 40.
Common Brown Noddy *Anous stolidus stolidus* 20.

15th May*:* The first full day sailing back west to mainland Brazil. The wind was not in our favour, coming from the south and light, so we had to use the motor. This, combined with the use of sails when possible, meant our route shifted a bit NWW. Thus, we also ended up moving a little to the north of the seamount line.
Coordinates: 20°10.051' S, 30°57.344 W to 20°8.687' S, 31°52.289 W.
Wind/ocean: Max 7–15 SE and S.
Chumming technique: Constant oil-dripping.
Species recorded:
Trindade Petrel *Pterodroma arminjoniana* 5; at TP-LOCATION24, 20°8.491' S, 31°5.934 W.
Wilson's Storm-Petrel *Oceanites oceanicus* 1.
Black-bellied Storm-Petrel *Fregetta tropica* 4.
Sooty Shearwater *Ardenna grisea* 4.
Great Shearwater *Ardenna gravis* 15.
Cory's Shearwater *Calonectris borealis* 3.
Masked Booby *Sula dactylatra* 3.
White Tern *Gygis alba alba* 2.

16th May*:* Second full day sailing west to mainland Brazil. Finally, some favourable wind for sailing, coming from the north and north-east, but still moving a bit to the north of the seamount line, hence limited birds despite constant oil-dripping.
Coordinates: 20°9.512' S, 32°56.614 W to 20°9.473' S, 34°1.757 W.
Wind/ocean: 10–20 NE and N.
Chumming technique: Constant oil-dripping.
Species recorded:
Black-bellied Storm-Petrel *Fregetta tropica* 5.
Sooty Shearwater *Ardenna grisea* 1.
Great Shearwater *Ardenna gravis* 30.
Cory's Shearwater *Calonectris borealis* 2.
Spectacled Petrel *Procellaria conspicillata* 1, followed the boat much of the day!

17th May*:* Third full day sailing west to mainland Brazil. Still moving a bit to the north of the seamount line, hence limited birds despite constant oil-dripping.
Coordinates: 20°7.747' S, 34°54.523 W to 20°14.147' S, 35°48.423 W.
Wind/ocean: 12–15 NW.
Chumming technique: Constant oil-dripping.
Species recorded:
Wilson's Storm-Petrel *Oceanites oceanicus* 12.
Black-bellied Storm-Petrel *Fregetta tropica* 6.
Manx Shearwater *Puffinus puffinus* 1.
Sooty Shearwater *Ardenna grisea* 1.
Great Shearwater *Ardenna gravis* 50.
Cory's Shearwater *Calonectris borealis* 3.

18th May*:* Fourth full day sailing west towards mainland Brazil. At times, we were close to or on the seamount line, which resulted in more birds due to the constant oil-dripping. During the last night, a strong wind developed into a storm with lightning all around. In the early hours of the morning, the wind speeds reached 30+ knots. Contact with the mainland suggested that we were starting to feel the effects of the cyclone system 'Yakecan' south of us. It was predicted to develop in our area to over 50+ knots, possibly making Vitoria unable to receive us. We decided to shift to the north-northwest with the wind and head approximately 500 km north to Caravelas. This decision would extend our journey but ensure a safe return to land. At the point of changing direction, we were still approximately 190 miles from land at 20°31.120' S, 37°20.720 W.

Coordinates: 19°02.973' S, 38°30.489 W to 18°28.820' S, 38°47.424 W.
Wind/ocean: 25 increasing to 30+ SW, with wind gust to almost 40.
Chumming technique: Constant oil-dripping.
Species recorded:
Wilson's Storm-Petrel *Oceanites oceanicus* 5.
Black-bellied Storm-Petrel *Fregetta tropica* 4.
Sooty Shearwater *Ardenna grisea* 1.
Great Shearwater *Ardenna gravis* 700.
Cory's Shearwater *Calonectris borealis* 40.
Masked Booby *Sula dactylatra* 2.

19th May*:* Fifth and final full day sailing west towards mainland Brazil, still approximately 100 miles from land after escaping the cyclone. What a day at sea, the largely birdless day of the expedition, but filled with albatrosses, bats and insects. In the morning, the strong wind and high waves continued with virtually no seabirds in sight. However, there was an occurrence of thousands of bats of all sizes, as if the cyclone had shaken and scattered the entire forest biomass into the ocean somewhere along the coast of Brazil. Among the bats were two small insect-eating bats that circled the boat before landing to rest on the sails.
Coordinates: 20°7.747' S, 34°54.523 W to 20°14.147' S, 35°48.423 W.
Wind/ocean: 25 dropping to 10 SW.
Chumming technique: Constant oil-dripping.
Species recorded:
Tristan Albatross 1 adult at 18°46.532' S, 38°34.674 W.
Atlantic Yellow-nosed Albatross 2 juveniles at 18°46.532' S, 38°34.674 W.
Wilson's Storm-Petrel *Oceanites oceanicus* 6.
Black-bellied Storm-Petrel *Fregetta tropica* 3.
Manx Shearwater *Puffinus puffinus* 3.
Great Shearwater *Ardenna gravis* 1.
Masked Booby *Sula dactylatra* 20.
Magnificent Frigatebird *Fregata magnificens* 1.

20th May*:* After an overnight sail, it was the sixth and final day sailing west towards mainland Brazil. We arrived at Caravelas after almost 20 days at sea, and what a cyclone escape that was!
Coordinates: 17°44'1.97"S, 39°15'53.52"W (Caravelas).
Wind/ocean: Up to 10 SW.

APPENDIX 2

The Cyclone Escape 17th–19th May

On the night of 17th–18th May, still 200–300 miles from land, strong winds began to develop into a storm. The ocean was illuminated by lightning. We were already experiencing 30+ knot winds as Cyclone 'Yakecan' headed towards us. By the early morning of 18th May, the cyclone had intensified to over 50+ knot wind speeds. In radio communication, we were informed that Vitoria would be unable to receive us. Our only option was to sail north-northwest with the wind, aiming to reach Caravelas, approximately 500 km to the north.

On 19th May, still escaping the cyclone, the aftermath of 'Yakecan' along the Brazilian coast was evident in the ocean. Despite the strong winds and high waves, that morning was the first time we could briefly check the masts and folded sails for damage. I also had a moment to observe the birds in the area. There were virtually no seabirds that morning, but there was a rain of thousands of bats of all sizes, as if the cyclone had blown the full forest biomass into the ocean somewhere along the Brazilian coast. Among them were two small insect-eating bats that circled the boat before landing on the sails. Later in the day, as the wind subsided closer to the continental shelf, we began to see seabirds, including Tristan and Atlantic Yellow-nosed Albatrosses. The fall of bats and a few songbirds pushed into the ocean by the cyclone is an example of the general phenomenon of the spread of insects and birds around the world, and how it relates to evolutionary history, island endemism, and the biodiversity we see today.

Early on 20th May, we finally reached land in Caravelas, entering a magnificent forest river from the sea. From there, we had a long journey along the coast to reach Vitoria the next day for my flight to Rio.

APPENDIX 3

Example of One Day (8th May) of individual ID, Plumage Scoring, and Coding of Trindade Petrel

8th May*:*

Of the 400+ estimated Trindade Petrels, 365 were photographically documented (individually coded TP 40 to 404) and assigned to plumage type:

Light (palest) – L, 143 petrels:

Trindade Petrel Pterodroma arminjoniana - plumage sequence: L p5, c5, c4, 8 May 2022 (TP171), IM-ID: 2552; new --> arminjoniana - plumage sequence: L, p?, c?, c?, 8 May 2022 (TP139), IM-ID: 2405-2406edV; new --> arminjoniana - plumage sequence: L, p?, c?, c?, 8 May 2022 (TP213), IM-ID: 2759-2764edV; new --> arminjoniana - plumage sequence: L, p1, c3, c3, 8 May 2022 (TP97), IM-ID: 2173-2184edV; new --> arminjoniana - plumage sequence: L, p2, c3, c5, 8 May 2022 (TP131), IM-ID: 2388-edV; new --> arminjoniana - plumage sequence: L, p2, c5, c3, 8 May 2022 (TP236), IM-ID: 2913-2931edV; new --> arminjoniana - plumage sequence: L, p3, c?, c?, 8 May 2022 (TP176), IM-ID: 2567-edV; new --> arminjoniana - plumage sequence: L, p3, c?, c?, 8 May 2022 (TP290), IM-ID: 3486-edV; new --> arminjoniana - plumage sequence: L, p3, c?, c?, 8 May 2022 (TP294), IM-ID: 3538-edV; new --> arminjoniana - plumage sequence: L, p3, c?, c?, 8 May 2022 (TP340) IM-ID: 4090-edV; new --> arminjoniana - plumage sequence: L, p3, c?, c?, 8 May 2022 (TP369) IM-ID: 4367-4368edV; new --> arminjoniana - plumage sequence: L, p3, c3, c4, 8 May 2022 (TP175), IM-ID: 2563-2566edV; new --> arminjoniana - plumage sequence: L, p3, c3, c5, 8 May 2022 (TP189), IM-ID: 2617-2621edV; new --> arminjoniana - plumage sequence: L, p3, c3, c5, 8 May 2022 (TP266), IM-ID: 3179-3185edV; new --> arminjoniana - plumage sequence: L, p3, c4, c3, 8 May 2022 (TP145), IM-ID: 2443-edV; new --> arminjoniana - plumage sequence: L, p3, c4, c4, 8 May 2022 (TP144), IM-ID: 2439-2442edV; new --> arminjoniana - plumage sequence: L, p3, c4, c4, 8 May 2022 (TP174), IM-ID: 2560-2563edV; new --> arminjoniana - plumage sequence: L, p3, c4, c4, 8 May 2022 (TP200), IM-ID: 2672-2673edV; new --> arminjoniana - plumage sequence: L, p3, c4, c5, 8 May 2022 (TP75), IM-ID: 1901-1913edV; new --> arminjoniana - plumage sequence: L, p3, c4, c5, 8 May 2022 (TP80), IM-ID: 2015-2024edV; new --> arminjoniana - plumage sequence: L, p3, c4, c5, 8 May 2022 (TP115), IM-ID: 2317-2322edV; new --> arminjoniana - plumage sequence: L, p3, c4, c5, 8 May 2022 (TP116), IM-ID: 2323-2324edV; new --> arminjoniana - plumage sequence: L, p3, c4, c5, 8 May 2022 (TP170), IM-ID: 2549-edV; new --> arminjoniana - plumage sequence: L, p3, c4, c5, 8 May 2022 (TP188), IM-ID: 2615-edV; new --> arminjoniana - plumage sequence: L, p3, c4, c5, 8 May 2022 (TP190), IM-ID: 2624-2625edV; new --> arminjoniana - plumage sequence: L, p3, c4, c5, 8 May 2022 (TP191), IM-ID: 2628-2630edV; new --> arminjoniana - plumage sequence: L, p3, c4, c5, 8 May 2022 (TP255), IM-ID: 3110-3113edV; new --> arminjoniana - plumage sequence: L, p3, c4, c5, 8 May 2022 (TP293), IM-ID: 3526-3552edV; new --> arminjoniana - plumage sequence: L, p3, c4, c5, 8 May 2022 (TP392) IM-ID: 4514-4519edV; new --> arminjoniana - plumage sequence: L, p3, c5, c2, 8 May 2022 (TP242), IM-ID: 2969-2982edV; new --> arminjoniana - plumage sequence: L, p3, c5, c3, 8 May 2022 (TP102), IM-ID: 2224-edV; new --> arminjoniana - plumage sequence: L, p3, c5, c3, 8 May 2022 (TP104), IM-ID: 2235-edV; new --> arminjoniana - plumage sequence: L, p3, c5, c3, 8 May 2022 (TP127), IM-ID: 2366-edV; new --> arminjoniana - plumage sequence: L, p3, c5, c3, 8 May 2022 (TP220), IM-ID: 2832-2834edV; new --> arminjoniana - plumage sequence: L, p3, c5, c3, 8 May 2022 (TP321), IM-ID: 3905-3916edV; new --> arminjoniana - plumage sequence: L, p3, c5, c3, 8 May 2022 (TP330), IM-ID: 3983-3987edV; new --> arminjoniana - plumage sequence: L, p3, c5, c4, 8 May 2022 (TP133), IM-ID: 2394-2395edV; new --> arminjoniana - plumage sequence: L, p3, c5, c4, 8 May 2022 (TP197), IM-ID: 2662-edV; new --> arminjoniana - plumage sequence: L, p3, c5, c4, 8 May 2022 (TP218), IM-ID: 2804-2813edV; new --> arminjoniana - plumage sequence: L, p3, c5, c4, 8 May 2022 (TP233), IM-ID: 2896-2898edV; new --> arminjoniana - plumage sequence: L, p3, c5, c4, 8 May 2022 (TP245), IM-ID: 3000-3001edV; new --> arminjoniana - plumage sequence: L, p3, c5, c4, 8 May 2022 (TP366) IM-ID: 4334-4344edV; new --> arminjoniana - plumage sequence: L, p3, c5, c4, 8 May 2022 (TP376, 3rd bird from left) IM-ID: 2517-edV; new --> arminjoniana - plumage sequence: L, p3, c5, c4, 8 May 2022 (TP395) IM-ID: 4525-4527edV; new --> arminjoniana - plumage sequence: L, p3, c5, c5, 8 May 2022 (TP77), IM-ID: 1964-1968edV; new --> arminjoniana - plumage sequence: L, p3, c5, c5, 8 May 2022 (TP101), IM-ID: 2207-2214edV; new --> arminjoniana - plumage sequence: L, p3, c5, c5, 8 May 2022 (TP103), IM-ID: 2232-2234edV; new --> arminjoniana - plumage sequence: L, p3, c5, c5, 8 May 2022 (TP216), IM-ID: 2782-edV; new --> arminjoniana - plumage sequence: L, p3, c5, c5, 8 May 2022 (TP221), IM-ID: 2835-2840edV; new --> arminjoniana - plumage sequence: L, p3, c5, c5, 8 May 2022 (TP302), IM-ID: 3667-3669edV; new --> arminjoniana - plumage sequence: L, p3, c5, c5, 8 May 2022 (TP307), IM-ID: 3779-3780edV; new --> arminjoniana - plumage sequence: L, p3, c5, c5, 8 May 2022 (TP308), IM-ID: 3792-3796edV; new --> arminjoniana - plumage sequence: L, p3, c5, c5, 8 May 2022 (TP345) IM-ID: 4150-4154edV; new --> arminjoniana - plumage sequence: L, p4, c?, c?, 8 May 2022 (TP203), IM-ID: 2691-2705edV; new --> arminjoniana - plumage sequence: L, p4, c?, c?, 8 May 2022 (TP322), IM-ID: 3918-3921edV; new --> arminjoniana - plumage sequence: L, p4, c?, c?, 8 May 2022 (TP347) IM-ID: 4159-4167edV; new --> arminjoniana - plumage sequence: L, p4, c1, c5, 8 May 2022 (TP273), IM-ID: 3248-edV; new --> arminjoniana - plumage sequence: L, p4, c3, c5, 8 May 2022 (TP70), IM-ID: 1872-1873edV; new --> arminjoniana - plumage sequence: L, p4, c3, c5, 8 May 2022 (TP305), IM-ID: 3757-edV; new --> arminjoniana - plumage sequence: L, p4, c4, c3, 8 May 2022 (TP67), IM-ID: 1840-1851edV; new --> arminjoniana - plumage sequence: L, p4, c4, c3, 8 May 2022 (TP162), IM-ID: 2501-2502edV; new --> arminjoniana - plumage sequence: L, p4, c4, c4, 8 May 2022 (TP69), IM-ID: 1863-1864edV; new --> arminjoniana - plumage sequence: L, p4, c4, c4, 8 May 2022 (TP168), IM-ID: 2532-edV; new --> arminjoniana - plumage sequence: L, p4, c4, c4, 8 May 2022 (TP356) IM-ID: 4241-4243edV; new --> arminjoniana - plumage sequence: L, p4, c4, c5, 8 May 2022 (TP84), IM-ID: 2085-edV; new --> arminjoniana - plumage sequence: L, p4, c4, c5, 8 May 2022 (TP141), IM-ID: 2411-2422edV; new --> arminjoniana - plumage sequence: L, p4, c4, c5, 8 May 2022 (TP157), IM-ID: 2485-edV; new --> arminjoniana - plumage sequence: L, p4, c4, c5, 8 May 2022 (TP161), IM-ID: 2498-2499edV; new --> arminjoniana - plumage sequence: L, p4, c4, c5, 8 May 2022 (TP210), IM-ID: 2751-edV; new --> arminjoniana - plumage sequence: L, p4, c4, c5, 8 May 2022 (TP298), IM-ID: 3599-3609edV; new --> arminjoniana - plumage sequence: L, p4, c4, c5, 8 May 2022 (TP338), IM-ID: 4071-4079edV; new --> arminjoniana - plumage sequence: L, p4, c4, c5, 8 May 2022 (TP367) IM-ID: 4349-4354edV; new --> arminjoniana - plumage sequence: L, p4, c5, c1, 8 May 2022 (TP179), IM-ID: 2576-edV; new --> arminjoniana - plumage sequence: L, p4, c5, c2, 8 May 2022 (TP205), IM-ID: 2715-2716edV; new --> arminjoniana - plumage sequence: L, p4, c5, c2, 8 May 2022 (TP323), IM-ID: 3932-3940edV; new --> arminjoniana - plumage sequence: L, p4, c5, c2, 8 May 2022 (TP325), bottom-most central petrel, IM-ID: 3967-edV; new --> arminjoniana - plumage sequence: L, p4, c5, c3, 8 May 2022 (TP81), IM-ID: 2042-edV; new --> arminjoniana - plumage sequence: L, p4, c5, c3, 8 May 2022 (TP128), IM-ID: 2377-edV; new --> arminjoniana - plumage sequence: L, p4, c5, c3, 8 May 2022 (TP152), IM-ID: 2465-edV; new --> arminjoniana - plumage sequence: L, p4, c5, c3, 8 May 2022 (TP173), IM-ID: 2557-2558edV; new --> arminjoniana - plumage sequence: L, p4, c5, c3, 8 May 2022 (TP180), IM-ID: 2585-2591edV; new --> arminjoniana - plumage sequence: L, p4, c5, c3, 8 May 2022 (TP186), IM-ID: 2606-2608edV; new --> arminjoniana - plumage sequence: L, p4, c5, c3, 8 May 2022 (TP196), IM-ID: 2650-2658edV; new --> arminjoniana - plumage sequence: L, p4, c5, c3, 8 May 2022 (TP206), IM-ID: 2717-2723edV; new --> arminjoniana - plumage sequence: L, p4, c5, c3, 8 May 2022 (TP227), IM-ID: 2873-edV; new --> arminjoniana - plumage sequence: L, p4, c5, c3, 8 May 2022 (TP261), IM-ID: 3150-edV; new --> arminjoniana - plumage sequence: L, p4, c5, c3, 8 May 2022 (TP300), IM-ID: 3646-3663edV; new --> arminjoniana - plumage sequence: L, p4, c5, c3, 8 May 2022 (TP319), IM-ID: 3891-3949edV; new --> arminjoniana - plumage sequence: L, p4, c5, c3, 8 May 2022 (TP320), IM-ID: 3903-edV; new --> arminjoniana - plumage sequence: L, p4, c5, c3, 8 May 2022 (TP331), IM-ID: 3989-edV; new --> arminjoniana - plumage sequence: L, p4, c5, c3, 8 May 2022 (TP377, 2nd bird from left) IM-ID: 2516; new --> arminjoniana - plumage sequence: L, p4, c5, c3, 8 May 2022 (TP379) IM-ID: 4858-edV; new --> arminjoniana - plumage sequence: L, p4, c5, c3, 8 May 2022 (TP386) IM-ID: 4458-4459edV; new --> arminjoniana - plumage sequence: L, p4, c5, c3, 8 May 2022 (TP400) IM-ID: 4791-4803edV; new --> arminjoniana - plumage sequence: L, p4, c5, c3, 8 May 2022 (TP402) IM-ID: 4814-4817edV; new --> arminjoniana - plumage sequence: L, p4, c5, c4, 8 May 2022 (TP91), IM-ID: 2126-2128edV; new --> arminjoniana - plumage sequence: L, p4, c5, c4, 8 May 2022 (TP93), IM-ID: 2145-2146edV; new --> arminjoniana - plumage sequence: L, p4, c5, c4, 8 May 2022 (TP154), IM-ID: 2472-2473edV; new --> arminjoniana - plumage sequence: L, p4, c5, c4, 8 May 2022 (TP159), IM-ID: 2490-2491edV; new --> arminjoniana - plumage sequence: L, p4, c5, c4, 8 May 2022 (TP164), IM-ID: 2511-2512edV; new --> arminjoniana - plumage sequence: L, p4, c5, c4, 8 May 2022 (TP169), IM-ID: 2543-edV; new --> arminjoniana - plumage sequence: L, p4, c5, c4, 8 May 2022 (TP178), IM-ID: 2572-2573edV; new --> arminjoniana - plumage sequence: L, p4, c5, c4, 8 May 2022 (TP181), IM-ID: 2577-2581edV; new --> arminjoniana - plumage sequence: L, p4, c5, c4, 8 May 2022 (TP184), IM-ID: 2593-2594edV; new --> arminjoniana - plumage sequence: L, p4, c5, c4, 8 May 2022 (TP192), IM-ID: 2631-2633edV; new --> arminjoniana - plumage sequence: L, p4, c5, c4, 8 May 2022 (TP193), IM-ID: 2635-edV; new --> arminjoniana - plumage sequence: L, p4, c5, c4, 8 May 2022 (TP198), IM-ID: 2664-2667edV; new --> arminjoniana - plumage sequence: L, p4, c5, c4, 8 May 2022 (TP208), IM-ID: 2739-2740edV; new --> arminjoniana - plumage sequence: L, p4, c5, c4, 8 May 2022 (TP249), IM-ID: 3022-3028edV; new --> arminjoniana - plumage sequence: L, p4, c5, c4, 8 May 2022 (TP262), IM-ID: 3157-3159edV; new --> arminjoniana - plumage sequence: L, p4, c5, c4, 8 May 2022 (TP265), IM-ID: 3175-edV; new --> arminjoniana - plumage sequence: L, p4, c5, c4, 8 May 2022 (TP275), IM-ID: 3300-3316edV; new --> arminjoniana - plumage sequence: L, p4, c5, c4, 8 May 2022 (TP332), IM-ID: 3993-3996edV; new --> arminjoniana - plumage sequence: L, p4, c5, c4, 8 May 2022 (TP358) IM-ID: 4255-4279edV; new --> arminjoniana - plumage sequence: L, p4, c5, c4, 8 May 2022 (TP370) IM-ID: 4371-4375edV; new --> arminjoniana - plumage sequence: L, p4, c5, c4, 8 May 2022 (TP387) IM-ID: 4469-edV; new --> arminjoniana - plumage sequence: L, p4, c5, c4, 8 May 2022 (TP397) IM-ID: 4589-4591edV; new --> arminjoniana - plumage sequence: L, p4, c5, c4, 8 May 2022 (TP398) IM-ID: 4592-edV; new --> arminjoniana - plumage sequence: L, p4, c5, c5, 8 May 2022 (TP98), IM-ID: 2186-edV; new --> arminjoniana - plumage sequence: L, p4, c5, c5, 8 May 2022 (TP137), IM-ID: 2400-2401edV; new --> arminjoniana - plumage sequence: L, p4, c5, c5, 8 May 2022 (TP160), IM-ID: 2493-2494edV; new --> arminjoniana - plumage sequence: L, p4, c5, c5, 8 May 2022 (TP172), IM-ID: 2554-2556edV; new --> arminjoniana - plumage sequence: L, p4, c5, c5, 8 May 2022 (TP187), IM-ID: 2609-2612edV; new --> arminjoniana - plumage sequence: L, p4, c5, c5, 8 May 2022 (TP212), IM-ID: 2749-2750edV; new --> arminjoniana - plumage sequence: L, p4, c5, c5, 8 May 2022 (TP260), IM-ID: 3142-3144edV; new --> arminjoniana - plumage sequence: L, p4, c5, c5, 8 May 2022 (TP285), IM-ID: 3439-3444edV; new --> arminjoniana - plumage sequence: L, p4, c5, c5, 8 May 2022 (TP288), IM-ID: 3461-3467edV; new --> arminjoniana - plumage sequence: L, p4, c5, c5, 8 May 2022 (TP333), IM-ID: 4000-edV; new --> arminjoniana - plumage sequence: L, p5, c4, c5, 8 May 2022 (TP234), IM-ID: 2899-2901edV; new --> arminjoniana - plumage sequence: L, p5, c5, c2, 8 May 2022 (TP326), distant-most (un-sharp) petrel, IM-ID: 3967edV; new --> arminjoniana - plumage sequence: L, p5, c5, c2, 8 May 2022 (TP339), IM-ID: 4081-4083edV; new --> arminjoniana - plumage sequence: L, p5, c5, c2, 8 May 2022 (TP350) IM-ID: 4183-4184edV; new --> arminjoniana - plumage sequence: L, p5, c5, c3, 8 May 2022 (TP153), IM-ID: 2468-2469edV; new --> arminjoniana - plumage sequence: L, p5, c5, c3, 8 May 2022 (TP336), IM-ID: 4061-edV; new --> arminjoniana - plumage sequence: L, p5, c5, c4, 8 May 2022 (TP99), IM-ID: 2195-2198edV; new --> arminjoniana - plumage sequence: L, p5, c5, c4, 8 May 2022 (TP100), IM-ID: 2201-2206edV; new --> arminjoniana - plumage sequence: L, p5, c5, c4, 8 May 2022 (TP171), IM-ID: 2551-2553edV; new --> arminjoniana - plumage sequence: L, p5, c5, c4, 8 May 2022 (TP279), IM-ID: 3363-3382edV; new --> arminjoniana - plumage sequence: L, p5, c5, c4, 8 May 2022 (TP281), IM-ID: 3394-3400edV; new --> arminjoniana - plumage sequence: L, p5, c5, c5, 8 May 2022 (TP86), IM-ID: 2092-edV; new --> arminjoniana - plumage sequence: L, p5, c5, c5, 8 May 2022 (TP239), IM-ID: 2947-2948edV; new --> arminjoniana - plumage sequence: L, p5, c5, c5, 8 May 2022 (TP256), IM-ID: 3115-edV; new --> arminjoniana - plumage sequence: L, p5, c5, c5, 8 May 2022 (TP306), IM-ID: 3769-edV; new --> arminjoniana - plumage sequence: L, p5, c5, c5, 8 May 2022 (TP378, 1st bird from left) IM-ID: 2516-edV;

Light (barred variant): 5 petrels:

Trindade Petrel Pterodroma arminjoniana - plumage sequence: Lf, p?, c?, c?, 8 May 2022 (TP351) IM-ID: 4189 to 4198edV; new --> arminjoniana - plumage sequence: Lf, p1, c2, c5, 8 May 2022 (TP342) IM-ID: 4100-4121edV; new --> arminjoniana - plumage sequence: Lf, p1, c2, c5, 8 May 2022 (TP368) IM-ID: 4355-4361edV; new --> arminjoniana - plumage sequence: Lf, p1, c3, c5, 8 May 2022 (TP355) IM-ID: 4233-4239edV; new --> arminjoniana - plumage sequence: Lf, p2, c2, c5, 8 May 2022 (TP373) IM-ID: 4403-4425edV;

Midway – M, 120 petrels:

Trindade Petrel Pterodroma arminjoniana - plumage sequence: M, p?, c?, c?, 8 May 2022 (TP122), IM-ID: 2341-2343edV; new --> arminjoniana - plumage sequence: M, p?, c?, c?, 8 May 2022 (TP123), IM-ID: 2349-2350edV; new --> arminjoniana - plumage sequence: M, p?, c?, c?, 8 May 2022 (TP272), IM-ID: 3243-edV; new --> arminjoniana - plumage sequence: M, p?, c3, c5, 8 May 2022 (TP87), IM-ID: 2105-2106edV; new --> arminjoniana - plumage sequence: M, p1, c1, c5, 8 May 2022 (TP403) IM-ID: 4833-4843edV; new --> arminjoniana - plumage sequence: M, p1, c4, c5, 8 May 2022 (TP251), IM-ID: 3072-edV; new --> arminjoniana - plumage sequence: M, p2, c1, c5, 8 May 2022 (TP72), IM-ID: 1879-1888edV; new --> arminjoniana - plumage sequence: M, p2, c1, c5, 8 May 2022 (TP244), IM-ID: 2998-edV; new --> arminjoniana - plumage sequence: M, p2, c1, c5, 8 May 2022 (TP404) IM-ID: 4827-4828edV; new --> arminjoniana - plumage sequence: M, p2, c2, c4, 8 May 2022 (TP90), IM-ID: 2122-edV; new --> arminjoniana - plumage sequence: M, p2, c2, c5, 8 May 2022 (TP110), IM-ID: 2290-edV; new --> arminjoniana - plumage sequence: M, p2, c2, c5, 8 May 2022 (TP113), IM-ID: 2303-2304edV; new --> arminjoniana - plumage sequence: M, p2, c2, c5, 8 May 2022 (TP117, at the back), IM-ID: 2634-edV; new --> arminjoniana - plumage sequence: M, p2, c2, c5, 8 May 2022 (TP119), IM-ID: 2330-edV; new --> arminjoniana - plumage sequence: M, p2, c2, c5, 8 May 2022 (TP120), IM-ID: 2333-edV; new --> arminjoniana - plumage sequence: M, p2, c2, c5, 8 May 2022 (TP140), IM-ID: 2408-2410edV; new --> arminjoniana - plumage sequence: M, p2, c2, c5, 8 May 2022 (TP224), IM-ID: 2861-2863edV; new --> arminjoniana - plumage sequence: M, p2, c2, c5, 8 May 2022 (TP252), IM-ID: 3073-3074edV; new --> arminjoniana - plumage sequence: M, p2, c2, c5, 8 May 2022 (TP267), IM-ID: 3190-3194edV; new --> arminjoniana - plumage sequence: M, p2, c2, c5, 8 May 2022 (TP292), IM-ID: 3522-3537edV; new --> arminjoniana - plumage sequence: M, p2, c2, c5, 8 May 2022 (TP334), IM-ID: 4020-4025edV; new --> arminjoniana - plumage sequence: M, p2, c3, c4, 8 May 2022 (TP381), IM-ID: 2392-edV; new --> arminjoniana - plumage sequence: M, p2, c3, c5, 8 May 2022 (TP74), IM-ID: 1899-edV; new --> arminjoniana - plumage sequence: M, p2, c3, c5, 8 May 2022 (TP85), IM-ID: 2090-edV; new --> arminjoniana - plumage sequence: M, p2, c3, c5, 8 May 2022 (TP271), IM-ID: 3229-edV; new --> arminjoniana - plumage sequence: M, p2, c3, c5, 8 May 2022 (TP353) IM-ID: 4222-4225edV; new --> arminjoniana - plumage sequence: M, p2, c4, c4, 8 May 2022 (TP106), IM-ID: 2246-edV; new --> arminjoniana - plumage sequence: M, p2, c4, c4, 8 May 2022 (TP349) IM-ID: 4181-edV; new --> arminjoniana - plumage sequence: M, p2, c4, c5, 8 May 2022 (TP76), IM-ID: 1949-1950edV; new --> arminjoniana - plumage sequence: M, p2, c4, c5, 8 May 2022 (TP95), IM-ID: 2154-2156edV; new --> arminjoniana - plumage sequence: M, p2, c4, c5, 8 May 2022 (TP150), IM-ID: 2456-edV; new --> arminjoniana - plumage sequence: M, p2, c4, c5, 8 May 2022 (TP166), IM-ID: 2521-2522edV; new --> arminjoniana - plumage sequence: M, p2, c4, c5, 8 May 2022 (TP229), IM-ID: 2881-edV; new --> arminjoniana - plumage sequence: M, p2, c4, c5, 8 May 2022 (TP259), IM-ID: 3136-3140edV; new --> arminjoniana - plumage sequence: M, p2, c4, c5, 8 May 2022 (TP283), IM-ID: 3410-3416edV; new --> arminjoniana - plumage sequence: M, p2, c4, c5, 8 May 2022 (TP362) IM-ID: 4299-4303edV; new --> arminjoniana - plumage sequence: M, p2, c4, c5, 8 May 2022 (TP365) IM-ID: 4314-4326edV; new --> arminjoniana - plumage sequence: M, p2, c4, c5, 8 May 2022 (TP375, 4th bird from left) IM-ID: 2517; new --> arminjoniana - plumage sequence: M, p2, c5, c4, 8 May 2022 (TP107), IM-ID: 2250-2251edV; new --> arminjoniana - plumage sequence: M, p2, c5, c4, 8 May 2022 (TP363) IM-ID: 4306-4310edV; new --> arminjoniana - plumage sequence: M, p2, c5, c5, 8 May 2022 (TP280), IM-ID: 3368-edV; new --> arminjoniana - plumage sequence: M, p3, c?, c?, 8 May 2022 (TP143), IM-ID: 2437-edV; new --> arminjoniana - plumage sequence: M, p3, c?, c?, 8 May 2022 (TP268), IM-ID: 3197-edV; new --> arminjoniana - plumage sequence: M, p3, c?, c?, 8 May 2022 (TP289), IM-ID: 3472-3477edV; new --> arminjoniana - plumage sequence: M, p3, c?, c?, 8 May 2022 (TP313), IM-ID: 3846-edV; new --> arminjoniana - plumage sequence: M, p3, c?, c?, 8 May 2022 (TP328), bottom getting away petrel, IM-ID: 3968edV; new --> arminjoniana - plumage sequence: M, p3, c1, c5, 8 May 2022 (TP68), IM-ID: 1854-edV; new --> arminjoniana - plumage sequence: M, p3, c1, c5, 8 May 2022 (TP390) IM-ID: 4496-4498edV; new --> arminjoniana - plumage sequence: M, p3, c2, c5, 8 May 2022 (TP111), IM-ID: 2292-2293edV; new --> arminjoniana - plumage sequence: M, p3, c2, c5, 8 May 2022 (TP146), IM-ID: 2752-2754edV; new --> arminjoniana - plumage sequence: M, p3, c2, c5, 8 May 2022 (TP235), IM-ID: 2902-edV; new --> arminjoniana - plumage sequence: M, p3, c2, c5, 8 May 2022 (TP240), IM-ID: 2951-2953edV; new --> arminjoniana - plumage sequence: M, p3, c2, c5, 8 May 2022 (TP248), IM-ID: 3017-3018edV; new --> arminjoniana - plumage sequence: M, p3, c2, c5, 8 May 2022 (TP250), IM-ID: 3067-3070edV; new --> arminjoniana - plumage sequence: M, p3, c2, c5, 8 May 2022 (TP382) IM-ID: 4429-edV; new --> arminjoniana - plumage sequence: M, p3, c2, c5, 8 May 2022 (TP388) IM-ID: 4483-edV; new --> arminjoniana - plumage sequence: M, p3, c2, c5, 8 May 2022 (TP389) IM-ID: 4486-4488edV; new --> arminjoniana - plumage sequence: M, p3, c3, c4, 8 May 2022 (TP156), IM-ID: 2481-edV; new --> arminjoniana - plumage sequence: M, p3, c3, c4, 8 May 2022 (TP108), IM-ID: 2258-edV; new --> arminjoniana - plumage sequence: M, p3, c3, c4, 8 May 2022 (TP177), IM-ID: 2570-edV; new --> arminjoniana - plumage sequence: M, p3, c3, c5, 8 May 2022 (TP82), IM-ID: 2050-edV; new --> arminjoniana - plumage sequence: M, p3, c3, c5, 8 May 2022 (TP83), IM-ID: 2056-2067edV; new --> arminjoniana - plumage sequence: M, p3, c3, c5, 8 May 2022 (TP88), IM-ID: 2115-2121edV; new --> arminjoniana - plumage sequence: M, p3, c3, c5, 8 May 2022 (TP109), IM-ID: 2262-2268edV; new --> arminjoniana - plumage sequence: M, p3, c3, c5, 8 May 2022 (TP134), IM-ID: 2755-edV; new --> arminjoniana - plumage sequence: M, p3, c3, c5, 8 May 2022 (TP134), IM-ID: 2756-edV; new --> arminjoniana - plumage sequence: M, p3, c3, c5, 8 May 2022 (TP185), IM-ID: 2603-edV; new --> arminjoniana - plumage sequence: M, p3, c3, c5, 8 May 2022 (TP232), IM-ID: 2890-edV; new --> arminjoniana - plumage sequence: M, p3, c3, c5, 8 May 2022 (TP246), IM-ID: 3006-edV; new --> arminjoniana - plumage sequence: M, p3, c3, c5, 8 May 2022 (TP311), IM-ID: 3827-3841edV; new --> arminjoniana - plumage sequence: M, p3, c3, c5, 8 May 2022 (TP318), IM-ID: 3880-edV; new --> arminjoniana - plumage sequence: M, p3, c3, c5, 8 May 2022 (TP329), IM-ID: 3970-3975edV; new --> arminjoniana - plumage sequence: M, p3, c4, c4, 8 May 2022 (TP66), IM-ID: 1826-2373edV; new --> arminjoniana - plumage sequence: M, p3, c4, c4, 8 May 2022 (TP151), IM-ID: 2460-edV; new --> arminjoniana - plumage sequence: M, p3, c4, c4, 8 May 2022 (TP284), IM-ID: 3411-3412edV; New --> arminjoniana - plumage sequence: M, p3, c4, c4, 8 May 2022 (TP393) IM-ID: 4522-edV; new --> arminjoniana - plumage sequence: M, p3, c4, c5, 8 May 2022 (TP71), IM-ID: 1875-1876edV; new --> arminjoniana - plumage sequence: M, p3, c4, c5, 8 May 2022 (TP79), IM-ID: 2003-2008edV; new --> arminjoniana - plumage sequence: M, p3, c4, c5, 8 May 2022 (TP124), IM-ID: 2344-2347edV; new --> arminjoniana - plumage sequence: M, p3, c4, c5, 8 May 2022 (TP126), IM-ID: 2359-edV; new --> arminjoniana - plumage sequence: M, p3, c4, c5, 8 May 2022 (TP147), IM-ID: 2446-edV; new --> arminjoniana - plumage sequence: M, p3, c4, c5, 8 May 2022 (TP148), IM-ID: 2450-edV; new --> arminjoniana - plumage sequence: M, p3, c4, c5, 8 May 2022 (TP149), IM-ID: 2453-edV; new --> arminjoniana - plumage sequence: M, p3, c4, c5, 8 May 2022 (TP158), IM-ID: 2489-edV; new --> arminjoniana - plumage sequence: M, p3, c4, c5, 8 May 2022 (TP163), IM-ID: 2506-edV; new --> arminjoniana - plumage sequence: M, p3, c4, c5, 8 May 2022 (TP228), IM-ID: 2875-2876edV; new --> arminjoniana - plumage sequence: M, p3, c4, c5, 8 May 2022 (TP253), IM-ID: 3078-3083edV; new --> arminjoniana - plumage sequence: M, p3, c4, c5, 8 May 2022 (TP257), IM-ID: 3118-3131edV; new --> arminjoniana - plumage sequence: M, p3, c4, c5, 8 May 2022 (TP269), IM-ID: 3206-edV; new --> arminjoniana - plumage sequence: M, p3, c4, c5, 8 May 2022 (TP270), IM-ID: 3211-3223edV; new --> arminjoniana - plumage sequence: M, p3, c4, c5, 8 May 2022 (TP278), IM-ID: 3358-3360edV; new --> arminjoniana - plumage sequence: M, p3, c4, c5, 8 May 2022 (TP295), IM-ID: 3556-3580edV; new --> arminjoniana - plumage sequence: M, p3, c4, c5, 8 May 2022 (TP296), IM-ID: 3582-edV; new --> arminjoniana - plumage sequence:

M, p3, c4, c5, 8 May 2022 (TP301), IM-ID: 3651-3655edV; new --> arminjoniana - plumage sequence: M, p3, c4, c5, 8 May 2022 (TP304), IM-ID: 3677-edV; new --> arminjoniana - plumage sequence: M, p3, c4, c5, 8 May 2022 (TP317), IM-ID: 3867-edV; new --> arminjoniana - plumage sequence: M, p3, c4, c5, 8 May 2022 (TP327), left-most petrel, IM-ID: 3968-edV; new --> arminjoniana - plumage sequence: M, p3, c4, c5, 8 May 2022 (TP344) IM-ID: 4134-edV; new --> arminjoniana - plumage sequence: M, p3, c4, c5, 8 May 2022 (TP391) IM-ID: 4510-4511edV; new --> arminjoniana - plumage sequence: M, p3, c4, c5, 8 May 2022 (TP394) IM-ID: 4523-4524edV; new --> arminjoniana - plumage sequence: M, p3, c5, c?, 8 May 2022 (TP207), IM-ID: 2735-edV; new --> arminjoniana - plumage sequence: M, p3, c5, c3, 8 May 2022 (TP209), IM-ID: 2743-edV; new --> arminjoniana - plumage sequence: M, p3, c5, c4, 8 May 2022 (TP276), IM-ID: 3349-3350edV; new --> arminjoniana - plumage sequence: M, p3, c5, c4, 8 May 2022 (TP341) IM-ID: 4095-edV; new --> arminjoniana - plumage sequence: M, p3, c5, c4, 8 May 2022 (TP364) IM-ID: 4311-4313edV; new --> arminjoniana - plumage sequence: M, p3, c5, c5, 8 May 2022 (TP155), IM-ID: 2475-2476edV; new --> arminjoniana - plumage sequence: M, p3, c5, c5, 8 May 2022 (TP204), IM-ID: 2713-2768edV; new --> arminjoniana - plumage sequence: M, p3, c5, c5, 8 May 2022 (TP291), IM-ID: 3491-3508edV; new --> arminjoniana - plumage sequence: M, p3, c5, c5, 8 May 2022 (TP335), IM-ID: 4032-edV; new --> arminjoniana - plumage sequence: M, p3, c5, c5, 8 May 2022 (TP352) IM-ID: 4202-4210edV; new --> arminjoniana - plumage sequence: M, p3, c5, c5, 8 May 2022 (TP357) IM-ID: 4249-edV; new --> arminjoniana - plumage sequence: M, p4, c1, c5, 8 May 2022 (TP254), IM-ID: 3101-edV; new --> arminjoniana - plumage sequence: M, p4, c2, c5, 8 May 2022 (TP223), IM-ID: 2858-2860edV; new --> arminjoniana - plumage sequence: M, p4, c3, c4, 8 May 2022 (TP399) IM-ID: 4771-4786edV; new --> arminjoniana - plumage sequence: M, p4, c3, c5, 8 May 2022 (TP337), IM-ID: 4065-4070edV; new --> arminjoniana - plumage sequence: M, p4, c5, c4, 8 May 2022 (TP312), IM-ID: 3843-3845edV; new --> arminjoniana - plumage sequence: M, p4, c5, c5, 8 May 2022 (TP277), IM-ID: 3351-3357edV; new --> arminjoniana - plumage sequence: M, p4, c5, c5, 8 May 2022 (TP374) IM-ID: 4329-4333edV; new --> arminjoniana - plumage sequence: M, p5, c?, c?, 8 May 2022 (TP359) IM-ID: 4282-4284edV;

White-bellied – Wb, 43 petrels:

Trindade Petrel Pterodroma arminjoniana - plumage sequence: Wb p1, c1, c5, 8 May 2022 (TP92), IM-ID: 2131-edV; new --> arminjoniana - plumage sequence: Wb, p?, c?, c?, 8 May 2022 (TP138), IM-ID: 2402-edV; new --> arminjoniana - plumage sequence: Wb, p1 c1, c5, 8 May 2022 (TP135), IM-ID: 2397-edV; new --> arminjoniana - plumage sequence: Wb, p1 c1, c5, 8 May 2022 (TP136), IM-ID: 2398-edV; new --> arminjoniana - plumage sequence: Wb, p1, c1, c5, 8 May 2022 (TP73), IM-ID: 1891-1895edV; new --> arminjoniana - plumage sequence: Wb, p1, c1, c5, 8 May 2022 (TP94), IM-ID: 2149-edV; new --> arminjoniana - plumage sequence: Wb, p1, c1, c5, 8 May 2022 (TP96), IM-ID: 2167-2169edV; new --> arminjoniana - plumage sequence: Wb, p1, c1, c5, 8 May 2022 (TP105), IM-ID: 2239-2247edV; new --> arminjoniana - plumage sequence: Wb, p1, c1, c5, 8 May 2022 (TP118), IM-ID: 2327-edV; new --> arminjoniana - plumage sequence: Wb, p1, c1, c5, 8 May 2022 (TP121), IM-ID: 2336-2337edV; new --> arminjoniana - plumage sequence: Wb, p1, c1, c5, 8 May 2022 (TP125), IM-ID: 2351-2355edV; new --> arminjoniana - plumage sequence: Wb, p1, c1, c5, 8 May 2022 (TP129), IM-ID: 2380-2382edV; new --> arminjoniana - plumage sequence: Wb, p1, c1, c5, 8 May 2022 (TP142), IM-ID: 2433-2434edV; new --> arminjoniana - plumage sequence: Wb, p1, c1, c5, 8 May 2022 (TP182), IM-ID: 2584-edV; new --> arminjoniana - plumage sequence: Wb, p1, c1, c5, 8 May 2022 (TP183), IM-ID: 2592-edV; new --> arminjoniana - plumage sequence: Wb, p1, c1, c5, 8 May 2022 (TP211), IM-ID: 2757-edV; new --> arminjoniana - plumage sequence: Wb, p1, c1, c5, 8 May 2022 (TP215), IM-ID: 2770-2866edV; new --> arminjoniana - plumage sequence: Wb, p1, c1, c5, 8 May 2022 (TP225), IM-ID: 2865-edV; new --> arminjoniana - plumage sequence: Wb, p1, c1, c5, 8 May 2022 (TP226), IM-ID: 2869edV; new --> arminjoniana - plumage sequence: Wb, p1, c1, c5, 8 May 2022 (TP230), IM-ID: 2884-2886edV; new --> arminjoniana - plumage sequence: Wb, p1, c1, c5, 8 May 2022 (TP231), IM-ID: 2887edV; new --> arminjoniana - plumage sequence: Wb, p1, c1, c5, 8 May 2022 (TP237), IM-ID: 2935-edV; new --> arminjoniana - plumage sequence: Wb, p1, c1, c5, 8 May 2022 (TP238), IM-ID: 2938-2943edV; new --> arminjoniana - plumage sequence: Wb, p1, c1, c5, 8 May 2022 (TP241), IM-ID: 2957-2959edV; new --> arminjoniana - plumage sequence: Wb, p1, c1, c5, 8 May 2022 (TP247), IM-ID: 3011-edV; new --> arminjoniana - plumage sequence: Wb, p1, c1, c5, 8 May 2022 (TP264), IM-ID: 3166-edV; new --> arminjoniana - plumage sequence: Wb, p1, c1, c5, 8 May 2022 (TP282), IM-ID: 3406-3407edV; new --> arminjoniana - plumage sequence: Wb, p1, c1, c5, 8 May 2022 (TP287), IM-ID: 3446-3449edV; new --> arminjoniana - plumage sequence: Wb, p1, c1, c5, 8 May 2022 (TP310), IM-ID: 3805-edV; new --> arminjoniana - plumage sequence: Wb, p1, c1, c5, 8 May 2022 (TP316), IM-ID: 3864-edV; new --> arminjoniana - plumage sequence: Wb, p1, c1, c5, 8 May 2022 (TP324), right-most petrel, IM-ID: 3963-3965edV; new --> arminjoniana - plumage sequence: Wb, p1, c1, c5, 8 May 2022 (TP372) IM-ID: 4393-4397edV; new --> arminjoniana - plumage sequence: Wb, p1, c2, c5, 8 May 2022 (TP360) IM-ID: 4289-4298edV; new --> arminjoniana - plumage sequence: Wb, p1, c4, c5, 8 May 2022 (TP167), IM-ID: 2524-2525edV; new --> arminjoniana - plumage sequence: Wb, p2, c?, c?, 8 May 2022 (TP194), IM-ID: 2644-2645edV; new --> arminjoniana - plumage sequence: Wb, p2, c1, c5, 8 May 2022 (TP112), IM-ID: 2297-edV; new --> arminjoniana - plumage sequence: Wb, p2, c1, c5, 8 May 2022 (TP201), IM-ID: 2674-2675edV; new --> arminjoniana - plumage sequence: Wb, p2, c1, c5, 8 May 2022 (TP202), IM-ID: 2690-2699edV; new --> arminjoniana - plumage sequence: Wb, p2, c2, c5, 8 May 2022 (TP114), IM-ID: 2305-2314edV; new --> arminjoniana - plumage sequence: Wb, p2, c2, c5, 8 May 2022 (TP132), IM-ID: 2390-edV; new --> arminjoniana - plumage sequence: Wb, p2, c2, c5, 8 May 2022 (TP195), IM-ID: 2646-2647edV; new --> arminjoniana - plumage sequence: Wb, p2, c2, c5, 8 May 2022 (TP258), IM-ID: 3133-3134edV; new --> arminjoniana - plumage sequence: Wb, p2, c2, c5, 8 May 2022 (TP380) IM-ID: 4412-4420edV; new --> arminjoniana - plumage sequence: Wb, p3, c4, c4, 8 May 2022 (TP396) IM-ID: 4581-4583edV

L/M, L/M/Wb & M/Wb: 12 petrels:

Trindade Petrel Pterodroma arminjoniana - plumage sequence: L/M, p?, c?, c?, 8 May 2022 (TP297), IM-ID: 3591-edV; new --> arminjoniana - plumage sequence: L/M, p?, c?, c?, 8 May 2022 (TP303), IM-ID: 3672-edV; new --> arminjoniana - plumage sequence: L/M, p?, c?, c?, 8 May 2022 (TP343) IM-ID: 4125-edV; new --> arminjoniana - plumage sequence: L/M, p?, c?, c?, 8 May 2022 (TP371) IM-ID: 4389-edV; new --> arminjoniana - plumage sequence: L/M, p?, c?, c?, 8 May 2022 (TP384) IM-ID: 4441-edV; new --> arminjoniana - plumage sequence: L/M, p?, c?, c?, 8 May 2022 (TP401) IM-ID: 4810-edV; new --> arminjoniana - plumage sequence: L/M/Wb, p?, c?, c?, 8 May 2022 (TP243), IM-ID: 2994-2995edV; new --> arminjoniana - plumage sequence: L/M/Wb, p?, c?, c?, 8 May 2022 (TP286), IM-ID: 3435-3438edV; new --> arminjoniana - plumage sequence: L/M/Wb, p?, c?, c?, 8 May 2022 (TP346) IM-ID: 4158-edV; new --> arminjoniana - plumage sequence: L/M/Wb, p?, c?, c?, 8 May 2022 (TP348) IM-ID: 4168-edV; new --> arminjoniana - plumage sequence: L/M/Wb, p?, c?, c?, 8 May 2022 (TP348) IM-ID: 4172-edV; new --> arminjoniana - plumage sequence: M/Wb, p?, c?, c?, 8 May 2022 (TP309), IM-ID: 3800-edV; new --> arminjoniana - plumage sequence: M/Wb, p1, c?, c?, 8 May 2022 (TP354) IM-ID: 4228-4230edV;

Flecked – F, 5 petrels:

Trindade Petrel Pterodroma arminjoniana - plumage sequence: F, p?, c?, c?, 8 May 2022 (TP361) IM-ID: 4294-edV; new --> arminjoniana - plumage sequence: F, p1, c1, c5, 8 May 2022 (TP89), IM-ID: 2111-2114edV; new --> arminjoniana - plumage sequence: F, p4, c1, c5, 8 May 2022 (TP219), IM-ID: 2815-2822edV; new --> arminjoniana - plumage sequence: F, p4, c1, c5, 8 May 2022 (TP222), IM-ID: 2841-2855edV; new --> arminjoniana - plumage sequence: F, p5, c2, c4, 8 May 2022 (TP217), IM-ID: 2796-2803edV;

Dark-brown – Db, 3 petrels:

Trindade Petrel Pterodroma arminjoniana - plumage sequence: Db, p2, c1, c5, 8 May 2022 (TP315), IM-ID: 3853 to 38621edV; new --> arminjoniana - plumage sequence: Db, p3, c4, c4, 8 May 2022 (TP383) IM-ID: 4437-4440edV; new --> arminjoniana - plumage sequence: Db, p4, c4, c4, 8 May 2022 (TP165), IM-ID: 2519-edV;

Dark-grey – Dg, 2 petrels;

Trindade Petrel Pterodroma arminjoniana - plumage sequence: Dg, p2, c1, c5, 8 May 2022 (TP78), IM-ID: 2424-2431edV; new --> arminjoniana - plumage sequence: Dg, p3, c2, c5, 8 May 2022 (TP274), IM-ID: 3255-3343edV;

Darkest (max-dark) – D, 32 petrels:

Trindade Petrel Pterodroma arminjoniana - plumage sequence: p?, c?, c?, 8 May 2022 (TP263), IM-ID: 3162-edV; new --> arminjoniana - plumage sequence: D, p1, c1, c5, 8 May 2022 (TP40), IM-ID: 1814 to 1817-edV; new --> arminjoniana - plumage sequence: D, p1, c1, c5, 8 May 2022 (TP41), IM-ID: 1974-1997-edV; new --> arminjoniana - plumage sequence: D, p1, c1, c5, 8 May 2022 (TP43), IM-ID: 3691-3700-edV; new --> arminjoniana - plumage sequence: D, p1, c1, c5, 8 May 2022 (TP44), IM-ID: 3706-edV; new --> arminjoniana - plumage sequence: D, p1, c1, c5, 8 May 2022 (TP45), IM-ID: 3708-3714edV; new --> arminjoniana - plumage sequence: D, p1, c1, c5, 8 May 2022 (TP46), IM-ID: 3715-3744edV; new --> arminjoniana - plumage sequence: D, p1, c1, c5, 8 May 2022 (TP47), IM-ID: 3231-3241edV; new --> arminjoniana - plumage sequence: D, p1, c1, c5, 8 May 2022 (TP50), IM-ID: 2237-2238edV; new --> arminjoniana - plumage sequence: D, p1, c1, c5, 8 May 2022 (TP51), IM-ID: 2157-edV; new --> arminjoniana - plumage sequence: D, p1, c1, c5, 8 May 2022 (TP53), IM-ID: 2879-2880edV; new --> arminjoniana - plumage sequence: D, p1, c1, c5, 8 May 2022 (TP57), IM-ID: 2677-2686edV; new --> arminjoniana - plumage sequence: D, p1, c1, c5, 8 May 2022 (TP60), IM-ID: 3424-edV; new --> arminjoniana - plumage sequence: D, p2, c1, c4, 8 May 2022 (TP52), IM-ID: 2904-2910edV; new --> arminjoniana - plumage sequence: D, p2, c1, c5, 8 May 2022 (TP48), IM-ID: 3145-3149edV; new --> arminjoniana - plumage sequence: D, p2, c1, c5, 8 May 2022 (TP55), IM-ID: 2219-2227edV; new --> arminjoniana - plumage sequence: D, p2, c1, c5, 8 May 2022 (TP56), IM-ID: 2011-edV; new --> arminjoniana - plumage sequence: D, p2, c1, c5, 8 May 2022 (TP58), IM-ID: 3034-3050edV; new --> arminjoniana - plumage sequence: D, p2, c1, c5, 8 May 2022 (TP59), IM-ID: 3091-3107edV; new --> arminjoniana - plumage sequence: D, p2, c1, c5, 8 May 2022 (TP60), IM-ID: 3419-3433edV; new --> arminjoniana - plumage sequence: D, p2, c1, c5, 8 May 2022 (TP61), IM-ID: 3817-3820edV; new --> arminjoniana - plumage sequence: D, p2, c1, c5, 8 May 2022 (TP62), IM-ID: 4027-4030edV; new --> arminjoniana - plumage sequence: D, p2, c1, c5, 8 May 2022 (TP63), IM-ID: 4254-4276edV; new --> arminjoniana - plumage sequence: D, p2, c1, c5, 8 May 2022 (TP64), IM-ID: 4662-4756edV; new --> arminjoniana - plumage sequence: D, p2, c1, c5, 8 May 2022 (TP65), IM-ID: 2074-2080edV; new --> arminjoniana - plumage sequence: D, p2, c1, c5, 8 May 2022 (TP130), IM-ID: 2383-2385edV; new --> arminjoniana - plumage sequence: D, p2, c1, c5, 8 May 2022 (TP299), IM-ID: 3622-3627edV; new --> arminjoniana - plumage sequence: D, p2, c2, c5, 8 May 2022 (TP42), IM-ID: 4376-4383edV; new --> arminjoniana - plumage sequence: D, p3, c1, c5, 8 May 2022 (TP49), IM-ID: 2252-2256edV; new --> arminjoniana - plumage sequence: D, p3, c1, c5, 8 May 2022 (TP54), IM-ID: 2640-2642edV; new --> arminjoniana - plumage sequence: D, p3, c2, c5, 8 May 2022 (TP385) IM-ID: 4451-edV; new --> arminjoniana - plumage sequence: D, p4, c1, c5, 8 May 2022 (TP199), IM-ID: 2671-edV;

APPENDIX 4

Measured and Scored Specimens of Trindade Petrel at Rio de Janeiro Museum, Brazil, the World's Largest Collection of the Species

skin number	plumage-c	age
6th Aug to 8th Dec >>>		
MN35993	max dark	adult
MN39087	max dark	adult
MN39149	max dark	f-g chick
MN39128	max dark	0.5 grown
chick		
MN35994	max dark	adult
MN35274	max dark	adult
MN39140	max dark	adult
MN39161	max dark	f-g chick
MN39139	max dark	adult
MN39125	max dark	adult
MN39156	max dark	adult
MN39152	max dark	f-g chick
MN39131	max dark	adult
MN35276	max dark	adult
MN39150	max dark	0.5 grown
chick		
MN39159	dark brown	adult
MN39134	dark brown	adult
MN39088	dark brown	adult
MN39142	dark brown	adult
MN39158	dark brown	adult
MN39121	dark gray	adult
MN39122	dark gray	adult
MN39097	dark gray	adult
MN35273	dark gray	adult
MN2592	dark gray	adult
MN39123	gray flackel	adult
MN39124	gray flackel	adult
MN35991	gray flackel	adult
MN35990	gray flackel	adult
MN39144	gray flackel	adult
MN39143	gray flackel	adult
MN39155	gray flackel	adult
MN39069	white bellied	adult
MN35275	white bellied	adult
MN35995	white bellied	adult
MN2584	white bellied	adult
MN39074	white bellied	adult
MN39157	white bellied	adult
MN38501	white bellied	adult
MN35279	white bellied	adult
MN39154	white bellied	adult
MN35988	white bellied	adult
MN35277	white bellied	adult
MN2573	white bellied	adult
MN35989	white bellied	adult
MN2576	midway	adult
MN35278	midway	adult
MN2582	palest	adult
MN2575	palest	adult
MN39126	palest	adult
MN39141	palest	adult
MN35613	palest	adult
MN39135	palest	adult
MN39090	palest	adult
MN39151		half sized
chick		
MN39127		chick
MN39153		chick
MN39129		chick
MN39133		chick
MN39132		half sized
chick		
MN18978		chick

skin number	plumage-c	age
5th Feb to 24th Jun >>>		
MN38508	max dark	adult
MN35941	max dark	adult
MN2590	dark brown	adult
MN35944	dark gray	adult
MN35614	dark gray	adult
MN35612	dark gray	adult
MN35605	grey flackel	adult
MN35942	gray flackel	adult
MN38506	white bellied	adult
MN38509	White bellied	adult
MN25113	white bellied	adult
MN25117	white bellied	adult
MN38524	white bellied	adult
MN25114	white bellied	adult
MN38515	white bellied	adult
MN2585	white bellied	adult
MN38511	white bellied	adult
MN2581	white bellied	adult
MN36712	white bellied	adult
MN35943	white bellied	adult
MN38507	white bellied	adult
MN38520	white bellied	f-g chick
MN38499	white bellied	adult
MN2574	midway	adult
MN25115	midway	adult
MN2580	midway	adult
MN39763	midway	adult
MN2579	palest	adult
MN2578	palest	adult
MN25112	palest	adult
MN38522	palest	adult
MN39764	palest	adult
MN35945	Palest	adult
MN2577	palest	adult
MN38519		tufted chick
MN38518		tufted chick
MN38516		half grown chick
MN38517		half grown chick
MN38514		half grown chick
MN38513		chick
MN38512		small chick
MN38521		small chick
MN38528		chick
MN38527		chick
MN38526		chick
MN38529		small chick
MN38523		small chick
MN38525		small chick
outside season >>>		
MN2591	dark grey	adult
MN2587	max dark	adult

Photo 94 Indoor work, post expedition, May 2023. *(Photograph courtesy of the Tubenoses Project © H. Shirihai.)*

APPENDIX 5

Measured and Scored Specimens of Trindade Petrel at American Museum of Natural History, New York, including image of the '*Aestrelata chionophara*' type

skin number	plumage-c.	age
6th Aug to 8th Dec >>>		
269140	max dark	A
269138	Dark-grey	A
269139	Dark-grey	A
269137	Dark-grey	A
269142	Dark-grey	A
528147	palest-barred	A
269147	palest	A
269148	palest	A

skin number	plumage-c.	age
5th Feb to 24th Jun >>>		
436003	max dark	A
528149	Dark-brown	A
269660	Dark-grey	
436002	midway	A
132502	midway	A
528148	palest-barred	A
269663	palest	A
132501	palest	A

Photo 95 The *'chionophara'* type, which has been suggested by some as leucistic. *(Photograph courtesy of the Tubenoses Project © H. Shirihai.)*

APPENDIX 6

Museum Material of the Trindade [Lesser] Frigatebird *Fregata [ariel] trinitatis*

The type of the Trindade [Lesser] Frigatebird *Fregata [ariel] trinitatis* and another three males and one adult female – in Rio de Janeiro Museum, Brazil:

Photos 96-97 The *trinitatis* type specimen. *(Photographs courtesy of the Tubenoses Project © H. Shirihai.)*

Photo 98 Three *trinitatis* adult males.

Photos 99–100 Adult female *trinitatis*

(Photographs courtesy of the Tubenoses Project © H. Shirihai.)

APPENDIX 7

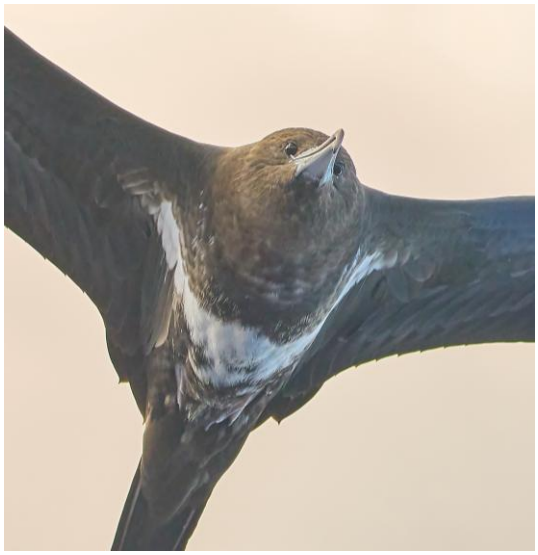
The World's Rarest Seabirds! Full Set of Individual ID Images

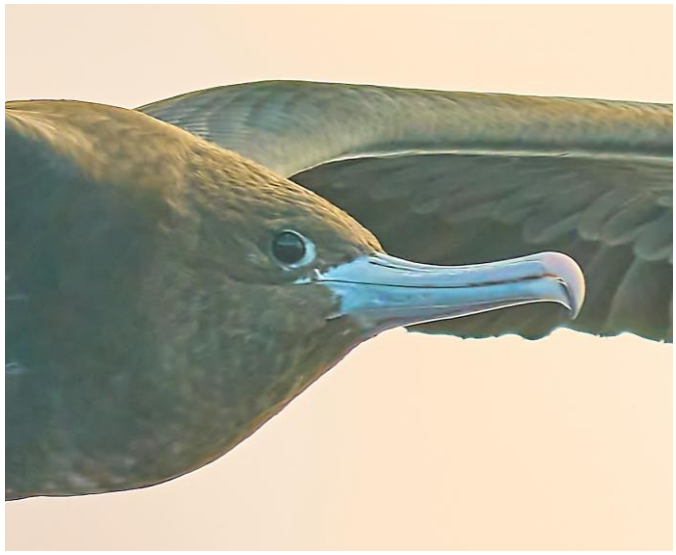
Each of the two species ordered separately by juveniles, immatures, subadults and adults, with the females first. Every surviving individual of these highly endangered taxa present in May 2022 was photographed, being the rarest seabirds on earth.

Trindade (Lesser) Frigatebird *Fregata [ariel] trinitatis* (photos 101-138)

Thirteen individuals of the taxon *trinitatis* (= TLFB 1 to TLFB 13) Trindade Island, May 2022. Documented with photographs by HS, on behalf of the Tubenoses Project. For details see main text.

TLFB 1





TLFB 2

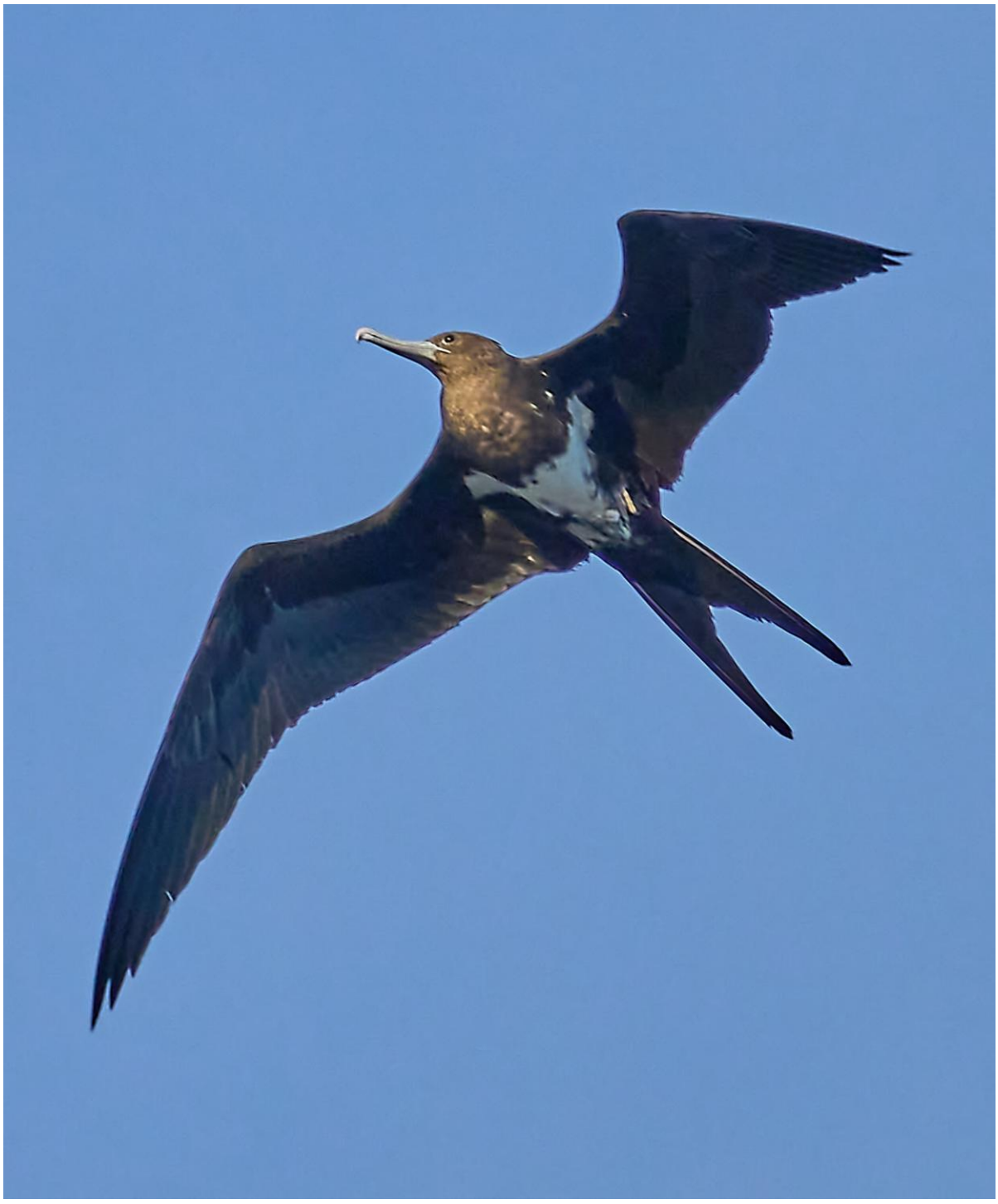
TLFB 3

TLFB 3 with TGFB 13

TLFB 4

TLFB 5

TLFB 5 interacting with TGFB 13



TLFB 5 with TLFB 1 (top bird)

TLFB 6

TLFB 7

TLFB 7 with TLFB 5

TLFB 8

TLFB 8 (right) interacting with TLFB 1

TLFB 9

TLFB 10

TLFB 11

TLFB 12

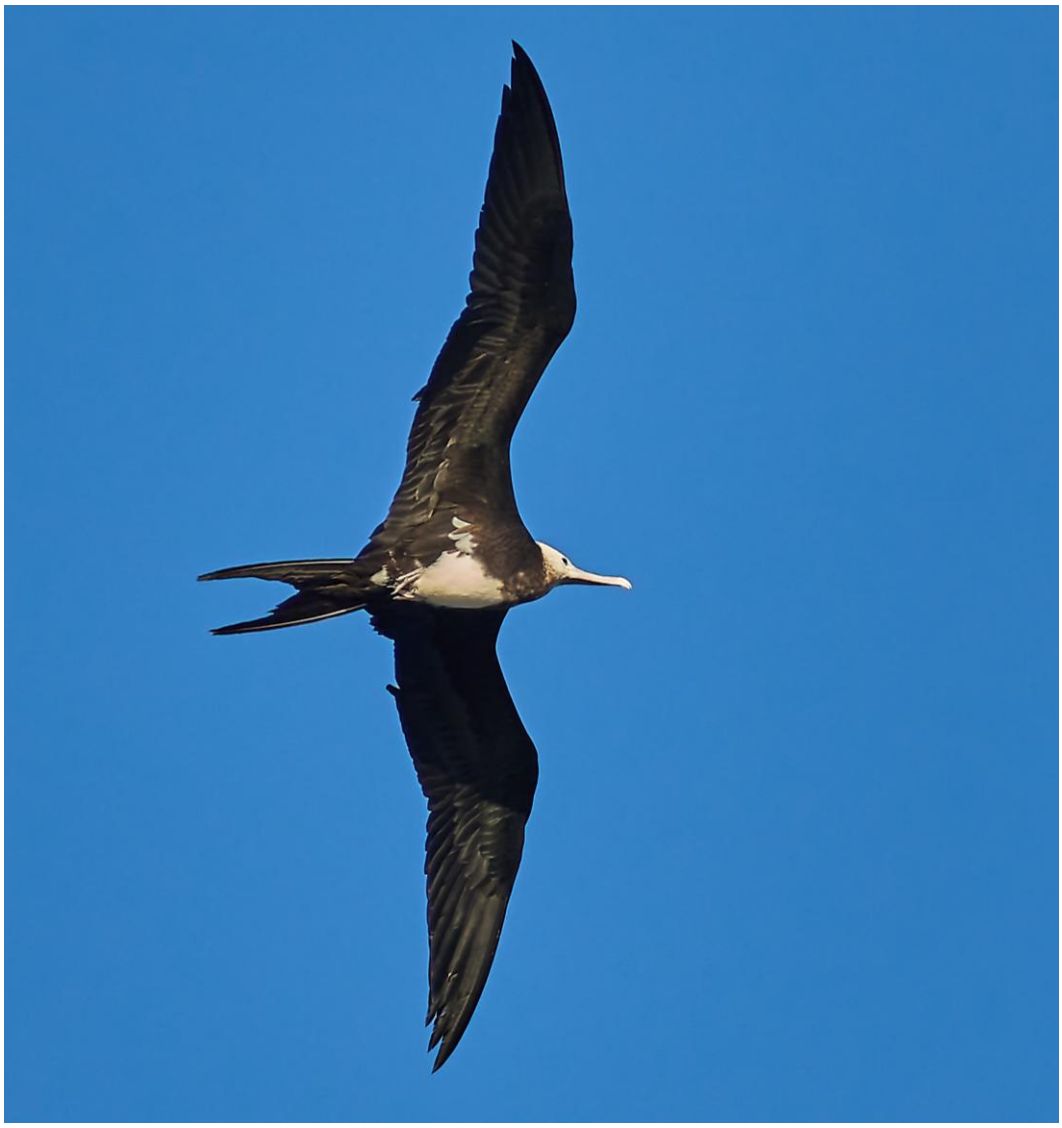
TLFB 13

TLFB 12 with TGFB 14

Trindade Great Frigatebird *Fregata minor nicolli* **(photos 139–192)**

Twenty-two individuals of the taxon *nicolli* (= TGFB 1 to TGFB 22) Trindade Island, May 2022. Documented with photographs by HS, on behalf of the Tubenoses Project. For details see main text.

TGFB 1



TGFB 1 with TGFB 20

TGFB 2

TGFB 2 with TGFB 20

TGFB 3

TGFB 4

TGFB 5

TGFB 6

TGFB 7

TGFB 8

TGFB 9

TGFB 9 with TGFB 2 and with TLFB 2

TGFB 10

TGFB 11

TGFB 12

TGFB 13

TGFB 13 with TGFB 1

TGFB 14

TGFB 15

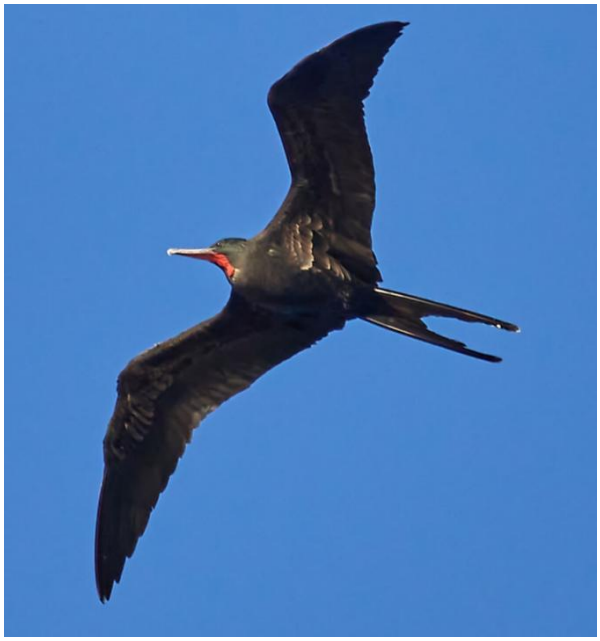
TGFB 16

TGFB 17

TGFB 17 with TGFB 12

TGFB 17 with TLFB 12

TGFB 18



TGFB 19

TGFB 20

TGFB 21

TGFB 22

APPENDIX 8

Expedition Team





Photos 193–197 The team on the Trindade Petrel Expedition, 22nd May 2022, with Roberto Bruno Fabiano (the Skipper), Ivan Nachtigall Marques and HS. *(Photographs courtesy of the Tubenoses Project © H. Shirihai.)*