People and wildlife in the Tristan da Cunha islands

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Over 60 years ago, Peter Beighton and I both attended Arnold School, in the Lancashire town of Blackpool – a place, according to a music hall recital, 'famous for fresh air and fun'! From there our professional careers have taken us to many fascinating places, including the remotest inhabited island in the world – Tristan da Cunha, in mid-South Atlantic. I was there in 1955 - 1956, as Senior Scientist and Joint Leader of the Gough Island Scientific Survey; Peter has told me that my book about that expedition[1] stimulated his interest and was one factor that drew him to undertake medical studies there in the 1970s. He has also visited and worked on Easter Island and St Helena. So it seems appropriate for me to contribute an essay on a place that has been professionally important to both of us.

The Tristan da Cunha islands and their wildlife

The Tristan da Cunha islands are oceanic volcanoes in the mid-Atlantic, some 3 000 km west of South Africa and 4 000 km from the nearest point of South America. They rise above a mantle plume or 'hot spot' near where the Walvis Bay Ridge meets the Mid-Atlantic Ridge, and have been constructed by successive phases of volcanicity over a long period. Tristan da Cunha is the largest and youngest of the archipelago, with a surface area of 86 km^2, a height of 2 060 m and a maximum recorded age of under 1 million years. Two other islands, Inaccessible and Nightingale, with areas of 12 km^2 and 4 km^2, respectively, rise close to it. The smallest and most eroded of the group, Nightingale Island, is also the oldest, with rocks dating back some 18 million years, so it is evident that potential habitat for terrestrial plants and animals has existed in the area for at least that period of time. Gough Island, 350 km to the south-east, has a surface area of 57 km^2, a height of 910 m and a maximum age of around 2.6 million years. But despite their varying maximum determined rock ages, all four main islands have clearly exhibited volcanic activity within the past 200 000 years.[2]

Like all such oceanic volcanoes, the Tristan islands have acquired their land flora and fauna by long-range dispersal across a very wide expanse of sea. The biogeographical affinities of the species now present lie overwhelmingly with temperate South America, up-wind in the prevailing atmospheric circulation, although some species with African relationships also occur; two dominant plants, the 'island tree' *Phylica arborea* and the tall tussock grass, *Spartina arundinacea*, also grow on Ile Amsterdam in the mid-Indian Ocean.[3] The build-up is likely to have followed a sequence, with far more species arriving than succeeded in establishing themselves (something that still happens with land birds and insects today). Sea birds and seals are almost certain to have been the first arrivals, only requiring stable ground above storm limits on which to breed and moult. In parallel, a steady drift of the tiny, light spores of fungi, lichens, mosses, ferns and liverworts will have arrived; these can establish on simple rocky substrata provided there is adequate water. As the patches of moss and lichen extended, they would have trapped particles released when lavas or ashes broke down, making soil in which higher plants could root. Wind dispersal is less likely to have brought such plants, but some Tristan species have seeds known to be able to germinate after long periods afloat at sea while others have seeds known to hook onto birds. Small invertebrates such as mites, springtails and young spiders also drift on the air currents, while larger winged insects are blown on the winds – although they could only have survived if suitable food plants had got there first. Likewise, land birds could only survive if seed-bearing plants or insects had already arrived in sufficient numbers. The pyramid of life must have built up slowly, with more arrivals dying than surviving.

Had we been able to witness this process, we would have noticed one striking feature – very few of the species dominant on the world's continents were among the successful transoceanic migrants. The resulting Tristan biota is characterised by four features typical of remote islands:[4,5]

- Impoverishment: the number of species present is much less than on continental islands or mainland areas of similar extent, terrain and climate
- Disharmony: many taxonomic groups dominant on continental mainlands are absent from oceanic islands
- Endemism: many oceanic island species have evolved there and are found nowhere else in the world
- Vulnerability: oceanic island species are liable to extinction in the face of competition or predation from mainland species carried to the islands by human agency.

In addition, oceanic islands are characterised by the presence of very large breeding populations of marine birds and mammals, also vulnerable to predation by humans or by predators imported by human agency.

The recorded native flora of the Tristan archipelago is certainly impoverished. There are 58 species of native flowering plant and 35 ferns on the total area of 159 km^2, compared with the 216 flowering plants and ferns on the 1 km^2 Welsh coastal island of Skokholm.[3-5] Cryptogams are more abundant – as might be expected from their relatively easy distribution, with 150 species of moss, a comparable number of hepatics, a 100 or more lichens and a considerable diversity of fungi. The land faunas are also impoverished, comprising only 7 species (10 subspecies) of land birds and only 113 definitely native invertebrates (plus some 45 species of avian ectoparasites and some 40 other species of doubtful status). In contrast, there are about 24 species of breeding seabird. Moreover, despite this species impoverishment, the biomass and productivity of the vegetation are clearly comparable with that in continental areas of similar cool-temperate climate, while the seabird and seal biomass is strikingly large. Several seabird populations are numbered in hundreds of thousands or millions, and while the population of southern elephant seal, *Mirounga leonina,* is now small, that of the sub-Antarctic fur seal, *Arctocephalus tropicalis,* totals around 200 000 on Gough Island alone.[6]

Disharmony is evident. None of the trees dominant on southern temperate mainlands occurs on the islands, where the only widespread tree is the so-called 'island tree', *P. arborea*, which rarely exceeds 10 m in height. Overall the flowering plant flora is meagre, with many families missing, although the fern, moss, liverwort and lichen floras are relatively 'normal' in continental terms. Among the fauna, the complete absence of native land mammals, reptiles, amphibians and freshwater fishes is typical of remote temperate islands, and among the insects the lack of Trichoptera, Odonata, Ephemeroptera,

Neuroptera and Mecoptera is also typical. The Hemiptera are represented by a single species of delphacid bug (also present in South America), one endemic nabid and eight alien aphids. Even groups with more species, such as terrestrial gasteropod molluscs, Coleoptera or Diptera, are represented by one or two families.

Endemism on remote islands is commonly ascribed to two factors. First, the founder stocks of island populations are generally small, carrying a reduced sub-set of the genes present in the much larger source populations. Second, those small founder stocks are exposed to new and different selection pressures. In the Tristan group, all the seven species of land birds, around 40% of the plants and 60% of the invertebrates are known only from the islands. As elsewhere, flightlessness is a feature of 2 surviving (and one extinct) endemic landrails, 3 endemic moths, 19 of the 21 native beetles and 4 endemic flies.[4] As elsewhere, some endemics such as the Gough Island bunting, *Rowettia goughensis*, appear to have broadened their food and habitat spectra in the absence of competitors. Others display radiation from the original founder stocks to exploit different ecological niches. This has occurred in the buntings of the genus *Nesocichla*, which have evolved a large-billed species feeding preferentially on the tough fruits of *Phylica* and a slender-billed species feeding on smaller seeds. Radiation is also displayed by 9 species of small gastropods of the genus *Balea*,[7] at least 11 species of listroderine weevil[8] and 9 species of Drosophilid fly.

But there are puzzles. Although Gough and the northern islands are widely separated, they have a number of endemic plant and invertebrate species in common. For example, 52 Gough Island plant species are confined to the Tristan group, but only 11 of them are restricted to Gough alone. Similarly, the native invertebrate faunas are remarkably similar on the four islands. Fifteen of the 30 species recorded as confined to the group are present on both Gough and the northern islands, but of those, 11 cannot fly.[4] The presumption is that there must none the less have been interchange between the islands, maybe using seabirds as vectors.

There have been relatively few modern genetic studies on the relationships of the island biota. However, one study of plastid trnL-F and ribosomal DNA sequences indicates that the genus *Phylica* to which the Tristan island tree, *P. arborea*, belongs, unquestionably evolved on the African mainland and *P. arborea* itself diverged from its nearest ancestor and reached the Tristan-Gough group about 2 million years ago. The species may have dispersed from Gough to Ile Amsterdam as recently as 0.5 million years ago, and birds are the most plausible vector.[9] Rather similarly, mitochondrial DNA sequence data for subunit I of cytochrome oxidase has been used to create a phylogenetic tree for the mollusc genus *Balea*, including five species endemic to the Tristan-Gough group. It seems clear not only that the Tristan-Gough species arose from a single ancestor, but that ancestor shared an ancestral stock with a cluster of species in the Azores and Madeira, the Azorean ancestor itself being derived from Palaearctic stock. Seabirds again emerge as the most plausible vectors.[10] These examples illustrate the scope for substantial future research, with the listroderine curculionid weevils as an obviously promising subject.

Human settlement in the Tristan da Cunha islands

It is clear is that when Portuguese navigators discovered Gough Island in 1505 and the three northern Tristan islands in 1506, the terrestrial biota was distinctive and typical of such remote archipelagos. But there are no records of landings by passing Portuguese seafarers. However, in 1643 the abundance of seals, penguins, seabirds and fish was reported to the Dutch East India Company, whose ships visited in 1655, 1669 and 1696. In that period Tristan lay on a major sea route for sailing vessels, which headed south-west across the south-east trade winds until they picked up the westerlies off Brazil, heading back south-east to the Cape. By the late 18th century some such vessels almost certainly stopped for water, and goats and pigs had been released on Tristan as a food resource. The abundance of fur seals, valuable for their pelts, and elephant seals, whose thick subcutaneous blubber was rendered for oil, drew many sealing vessels to the South Atlantic following the discovery of South Georgia by Cook in 1775, and one American sealing gang took 5 600 fur seal pelts during 9 months on Tristan in 1790.[2] Sealing gangs also lived on Gough Island in the late 18th and early 19th centuries, and again between 1860 and 1890, and were probably responsible for introducing house mice, *Mus musculus*. Whalers, especially from the United States, also began to visit the South Atlantic and called at Tristan.

The first attempt at permanent settlement on Tristan was made by three men, led by Jonathan Lambert of Salem, Massachusetts, in 1810. His plan was to establish a victualling station for passing ships and also to export sealskins and oil, and he brought pigs, geese, poultry, potatoes and various vegetables, cultivated on about 12 acres of cleared ground on the north-western coastal plain. The group also caught and penned some of the wild pigs, fished, and ate the then-abundant endemic flightless moorhen. Wildlife was clearly important as a food resource, as Lambert recorded, writing that 'all this stock, together with ourselves, live at present on the flesh of the (sea) elephant', and that although the pigs could subsist on the herbage 'we give then an elephant once in 10 - 15 days to keep them in heart.'[1,2]

Lambert and a companion were drowned in 1813, but in 1816 a British garrison arrived. When it was withdrawn a year later, Corporal William Glass (or Glasgow) and his South African wife, Mary Magdalena Lambers, together with two single men, stayed behind. From this scanty beginning the community grew steadily. In a sense the human population paralleled that of wild species in being descended from a small founder stock, but the humans differed in two important respects. Wild species seem likely to have originated from single invasions with restricted genetic diversity, subsequently isolated from genetic reinforcement. The initial human population of Tristan, in contrast, was reinforced during the 19th century several times, and its male members had a wide diversity of origins, coming from Scotland, England, the USA, the Netherlands and Italy, while the women came from South Africa and St Helena, and subsequently from the USA and Ireland.[11-13]

Tristan in the 19th century lay on a trade route and was far from cut-off. There was a steady stream of passing ships, and island men often shipped as seamen in American whalers. There was considerable human interchange with New England and St Helena. In 1826, five women were brought from St Helena at the earnest request of five bachelor Tristanians; their ancestors may well have included liberated slaves from West Africa and Angola. Hence, although the Tristan community descends from a relatively small founder stock, its ethnic diversity is considerable. Allegations of damaging inbreeding by resident missionaries in the 1850s and 1880s seem to have been based more on theory than observation.[2,11-13]

Although the early population certainly had a diet rich in fish, seabirds and their eggs and seal meat, during much of the 19th century farming and trade both flourished. By 1837 there were 100 head of cattle, 100 sheep, 50 pigs and numerous poultry at the settlement, while by 1842 nearly 150 acres of ground were under cultivation, supplying the 73 residents (in ten families) with potatoes, apples, strawberries, onions, cabbages and other vegetables. Trade with passing ships and visiting American whalers also flourished. However, commerce declined in the middle of the 19th century.

Sealing collapsed and the American whaling fleet declined. In 1856, 25 people (including William Glass's widow) left for the USA. Thirty-five more went with a missionary, the Reverend W F Taylor, to South Africa in 1857. Visits from sailing ships declined in the late 19th century, following the advent of steamships and the opening of the Suez Canal in 1869. The arrival of rats from a shipwreck in 1882 and the loss of 15 men in a boating disaster in 1885 made matters worse, though it was not until the early 20th century that Tristan passed into near-complete isolation. By then, under the leadership of a Dutchman, Pieter Willem Groen (better known as Peter William Green), matters had stabilised. In 1892 the population stood at 50, and was reinforced by two Italian seamen in that year and then in 1908 by 17 people – three returning islanders with their wives (two of them Irish) and families.[11-13]

Human biology on Tristan da Cunha

It is clear from all this that although the Tristan population is relatively isolated and inbred, it has experienced far less genetic isolation than the native flora and fauna. Medical officers aboard visiting ships generally reported that despite their restricted diet, the islanders were very healthy and fit, that their teeth were exceptionally good, that disease was rare (apart from the epidemic of colds that usually followed the visit of a ship) and that most individuals died either of accident or old age! These observations were broadly confirmed by S Dick Henriksen, Per Oeding and Reidar Sognnaess of the Norwegian Scientific Expedition to Tristan da Cunha, which spent 4 months on the island in 1937 - 1938.[14] They found that both men and women were of robust physique (the men commonly with a bursa mucosa over the seventh cervical vertebra as a consequence of load carrying); their general state of health was better than in most developed countries; tuberculosis was unknown and there were no cases of serious infectious, or venereal or other major diseases; the people were apparently free from bacterial pathogens; and the only frequent conditions were allergic (especially asthma, affecting over 10% of the population). Subsequent investigations of bone and joint disorders have likewise concluded that the prevalence of rheumatoid arthritis and osteo-arthritis was more or less comparable with what would be expected in a similar community in Europe.[15] Likewise, dentist Sognaess confirmed the generally excellent state of the islanders' teeth – with caries relatively rare and occurring most frequently in pregnant mothers. He did notice – an observation ahead of its time, perhaps – that the only case of caries in milk teeth was in a family of children with unusual access to refined sugar!

However, some genetically controlled conditions that could be related to isolation and inbreeding have been identified. In 1937, Henriksen established that the prevalent asthmatic condition could be traced back to two of the original immigrant women from St Helena.[14] Three cases of polydactyly have also been recorded in three different generations of descendants of one of those women and her (English) husband, together with several cases of slight external deformity of the outer ear.[11-13] Two or three cases of retinitis pigmentosa have also been recorded, possibly also traceable to the founder members from St Helena since the autosomal recessive form of that condition is known to exist there.[16]

Research has also explored whether the historically high proportion of fish, wild birds' eggs and seabird meat and oil in the islanders' diet had physiological consequences. The early settlers certainly consumed quantities of seal meat and killed the wandering albatross, *Diomedea dabbenena,* and other seabirds that originally bred on the Peak, as well as the endemic moorhen, *Gallinula nesiotis.*[2,11-13] Although consumption of wildlife probably eased (and the diet became more balanced) as farming improved in the mid-19th century, agriculture seems to have declined thereafter and serious problems of overgrazing and deaths of livestock from starvation in winter were reported in the 1900s.[17] This almost certainly led to resumed pressure on wildlife. When the Norwegian Scientific Expedition was at Tristan in 1937 - 1938, the population numbered over 200, agriculture was in decline, and fish and potatoes predominated in the diet – with penguin eggs and juvenile great shearwaters, *Ardenna gravis,* collected from nearby Nightingale and Inaccessible islands as important supplements.[14] The juvenile 'petrels' were also rendered down as a source of cooking oil, imparting a distinctive flavour to roast potatoes!

A commercial fishery based on the endemic rock lobster *Jasus tristani* was established by a Cape Town company in 1949. Revenue and wages, boosted further by revenues from the sale of the island's distinctive postage stamps, brought new prosperity but fish and wildlife remained important in the island diet. In the 1950s and 1960s, yellow-nosed albatross, *Thalassarche chlororhyncos,* continued to be taken for food on Tristan (although the take was regulated and some areas were designated as sanctuaries). But by then the main source of predation was on Nightingale Island, where eggs of the northern rockhopper penguin, *Eudyptes chrysocome moseleyi,* eggs and juvenile yellow-nosed albatross and eggs and juvenile greater shearwater, *A. gravis,* were all collected. Estimates of annual tolls vary but for penguin eggs range from 12 500 to 41 000 between 1951 and 1974, with 4 500 - 5 500 yellow-nosed albatross eggs and chicks taken in 1949 - 1963 and between 15 000 and 30 000 eggs and 15 000 - 20 000 young great shearwaters in 1950 - 1953.[2] In the 1970s a toll of between 37 000 and 63 000 young of the latter species was stated to have been taken but this figure may combine eggs and young.[18] Studies of serum cholesterol and triglyceride patterns in 1973 - 1974 revealed differences between human males and females, possibly related to the higher obesity in women, who were less active. Whether genetic factors related to the special features of the island population are involved was not clear.[18] Since the 1970s the harvest of wildlife has certainly declined, but follow-up studies on lipid levels have not been made.

Human impact on Tristan wildlife

Commercial exploitation by sealers and whalers clearly affected the Tristan fauna. Fur seals, *Arctocephalus tropicalis,* were virtually exterminated by 1890 and the present resurgence is almost certainly based on a small remnant, breeding on the almost inaccessible western shores of Gough Island. The elephant seal, *Mirounga leonina,* remains relatively scarce even there, for reasons that are not clear.[5] Southern right whales, *Eubalaena glacialis australis,* were doubtless exploited by whalers but remained frequent around Tristan in the 1950s: the population was, however, almost eliminated during the period when the island was depopulated in 1961 - 1963.[2] Non-commercial consumption and also habitat change following settlement obviously also had its impact. Human predation (augmented by that of rats, feral cats and dogs and perhaps mice) eliminated the Tristan wandering albatross, *Diomedea dabbenena,* and many other ground-nesting seabirds from the main island of Tristan, and also contributed to the extinction of the endemic moorhen, *Gallinula nesiotis.* Habitat change was probably a main factor in the extinction of the Tristan subspecies of bunting, *Nesospiza acunhae acunhae.* Feral pigs may have contributed to the near elimination of wandering albatross from Inaccessible Island.

The species introduced by human agency, which now substantially outnumber the native species, have had substantial impact. Vulnerability is one of the basic characteristics of island biotas, alongside impoverishment, disharmony and endemism. There are many instances of continental species, carried by

human agency across the oceanic barriers that protect remote islands, becoming invasive dominants there. A high proportion of the recorded extinctions of species over the past 300 years are island endemics. Conversely, there is no proven case of an island endemic becoming invasive on a continent. In the Tristan islands, invasive invertebrate animals now greatly outnumber native species, and the ratios are highest on Tristan itself, occupied by people for 200 years, and Gough Island, continuously occupied for 60 years. Recent research has estimated that about one human landing in four can be expected to introduce an alien invertebrate and, on that basis, the influx to the Tristan islands is bound to continue unless strict biosanitary measures are introduced.[19]

Many of these introduced species fill vacant niches in the ecosystem alongside native ones (although rarely if ever to their benefit). This appears to be the case with the introduced earthworms, a European millipede *Cylindroiulus latestriatus*, and an isopod, *Porcellio scaber*, on Gough Island, where they may accelerate the decomposition of the peaty soil in which seabirds burrow.[4,19] However, some are obviously threatening, and one striking recent example is provided by the house mouse, *M. musculus*, on Gough Island. It is believed that mice were introduced to Gough and Tristan by sealers, probably over 200 years ago. Races of small rodent on islands are commonly larger than those of the same species on mainlands, and the Gough house mice are the largest known in the world. In 1955 - 1956 they were not observed as having a damaging impact on the island's birds, but in recent years it is evident that they have become serious predators on juvenile Tristan wandering albatross and Atlantic petrel, *Pterodroma incerta*.[20] The mice attack the body fat over the dorsal region of the chick, at the stage where they are abandoned by their parents and are drawing on these reserves during fledging. The breeding success of both bird species is now low (27.38% and 19.9%, respectively) and, combined with mortality of adults drowned when ingesting baited hooks deployed by long-line fishing boats, poses a serious threat to the species, almost all of whose world populations breed on Gough Island.[19] Plans are now afoot to eliminate the mice by deploying poisoned bait from helicopters – a method used successfully in the New Zealand subantarctic islands. It may also be needed on Marion and Prince Edward Islands, where similar predation has been discovered. But we live in an era of recombinant biogeography and the erosion of the distinctive biota of these unique islands seems likely to continue.

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