

THE ENCYCLOPEDIA OF THE EARTH

OCEANS AND ISLANDS

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Endpapers: Aerial seascape, Keppel Bay, Queensland,
Australia. (Leo Meier/Weldon Trannies)

Page 1: The beauty and unharnessed power of a breaking wave.
(Frans Lanting/Minden Pictures)

Pages 2-3: Kiritimati, the world's oldest known atoll.

Page 6: The Rarotongan Express, Cook Islands.

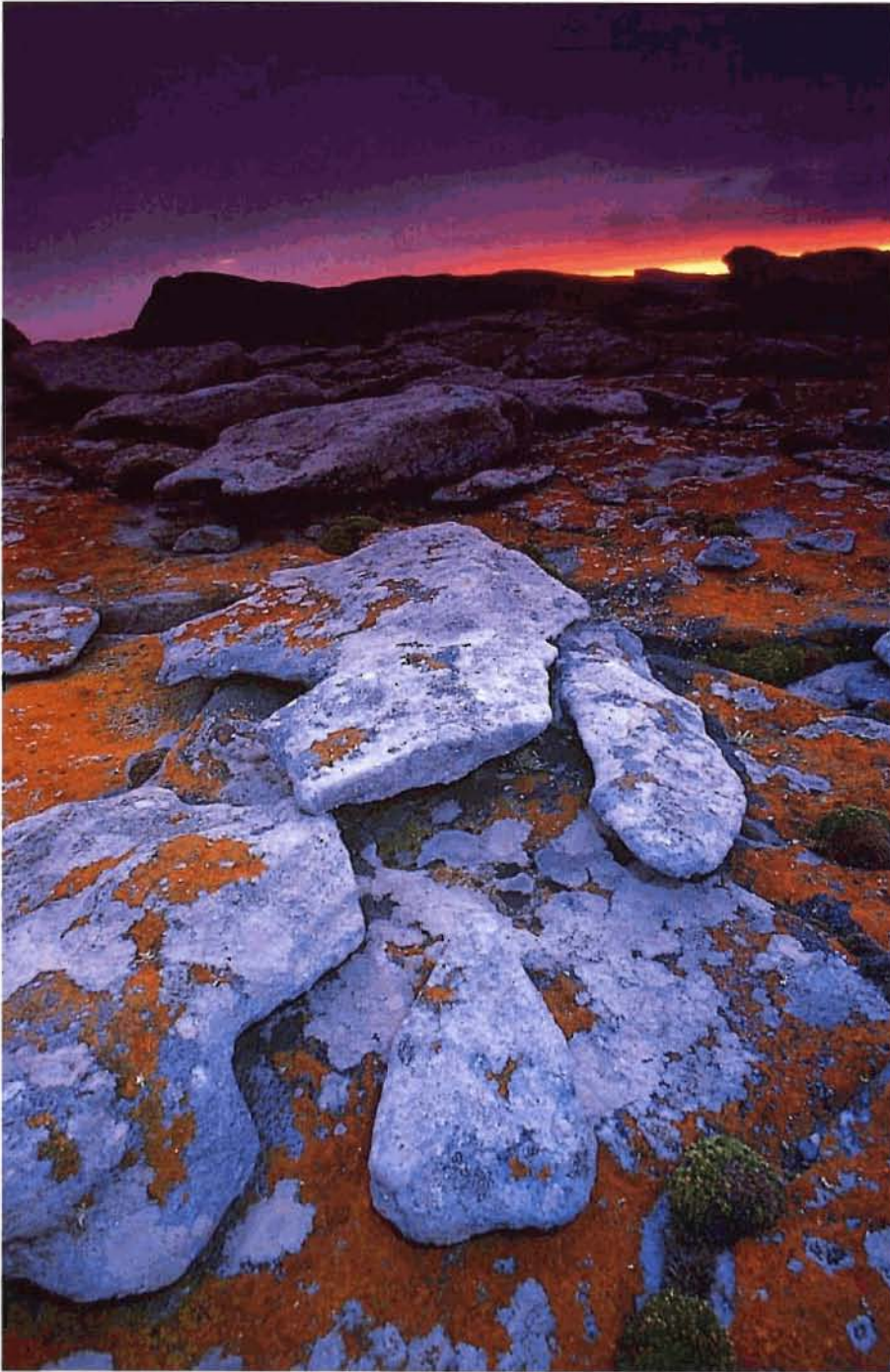
Pages 8-9: Dawn breaks over the Polynesian island of Moorea.

Pages 10-11: Bigeye soldier fish, Seychelles, Indian Ocean.

Right: The island of Raiatea in French Polynesia.

M. Claye/Explorer





Frans Lanting/Minden Pictures

▲ The stunning lighting from a Falkland sunset lends a primeval beauty to a lichen-covered boulderfield in these otherwise bleak and treeless islands.

THE ATLANTIC ISLANDS

The islands of the Atlantic Ocean are far fewer than those of the Pacific, and their flora and fauna seem much less exotic. Islands such as Newfoundland and the British Isles were connected to nearby continental landmasses during the ice ages, when so much water was tied up in glaciers that sea levels were much lower than at present. The flora and fauna of these continental islands are thus remnants of a larger set of species occurring on the adjacent continents.

Most Atlantic islands, however, are oceanic islands whose native fauna and flora must have crossed over water to colonize them. With the exception of wave-washed St Paul Rocks, home to but three species of seabird and a few insects, all the oceanic islands of the Atlantic are volcanic in origin. Many are on, or were formed on, the Mid-Atlantic Ridge, an underwater mountain range that marks the zone where North and South America pulled away from Europe and Africa to begin forming the Atlantic Ocean some 150 million years ago.

CONTINENTAL LINKS

As a rule, the flora and fauna of the Atlantic islands were derived from the nearest continent. Thus the affinities of Bermuda are with North America; the islands of Macaronesia (Azores, Madeira, Canaries, and Cape Verdes) with southern Europe and northern Africa; Fernando de Noronha and Trindade with Brazil; and Ascension and St Helena with Africa. The exceedingly remote islands of the Tristan da Cunha group and Gough Island are interesting because, although situated rather closer to Africa, their land bird fauna, at least, seems most similar to that of South America. Presumably this is because the prevailing winds are from the west, so that even today most of the vagrant birds arriving in Tristan are of American origin.

The natural history of islands at the northern and southern extremes of the Atlantic reflects their proximity to the poles. The wildlife of Iceland, for example, is like that of northern and Arctic Europe, whereas South Georgia is populated mainly by Antarctic seabirds, and the Falklands by a combination of Antarctic and South American elements, the most intriguing of which was the Falklands fox, renowned for its extreme tameness, such that Charles Darwin once obtained a specimen with a hammer. As might be expected, the Falklands fox is now extinct because of subsequent persecution by fur trappers and stockmen.

Of the string of volcanoes in the Gulf of Guinea that gave rise to the islands of Bioko (Fernando Poo), Principe, Sao Tome, and Annobon, the first is continental, whereas the others are oceanic and support several species that occur nowhere else, such as a dwarf ibis, a pigeon, a very large weaverbird, and a grosbeak with a truly massive bill. This last species is now presumed extinct, and with the destruction of the museum in Lisbon by fire, the only remaining specimen appears to be the one in the British Museum. But, as would be expected, the overall affinity of the flora and fauna of these islands is overwhelmingly like that of equatorial Africa.

The remaining islands in the south Atlantic are for the most part single, small, and very isolated, whereas in the north Atlantic, with the exception

of Bermuda, the islands are all part of larger archipelagos. There is no prehistoric record of human occupation of any of these islands except the Canaries, which were colonized by a people known as the Guanches between 2500 and 2000 BC. Most of the other islands and archipelagos were discovered and inhabited during the great era of Portuguese and Spanish exploration in the 1400s and early 1500s.

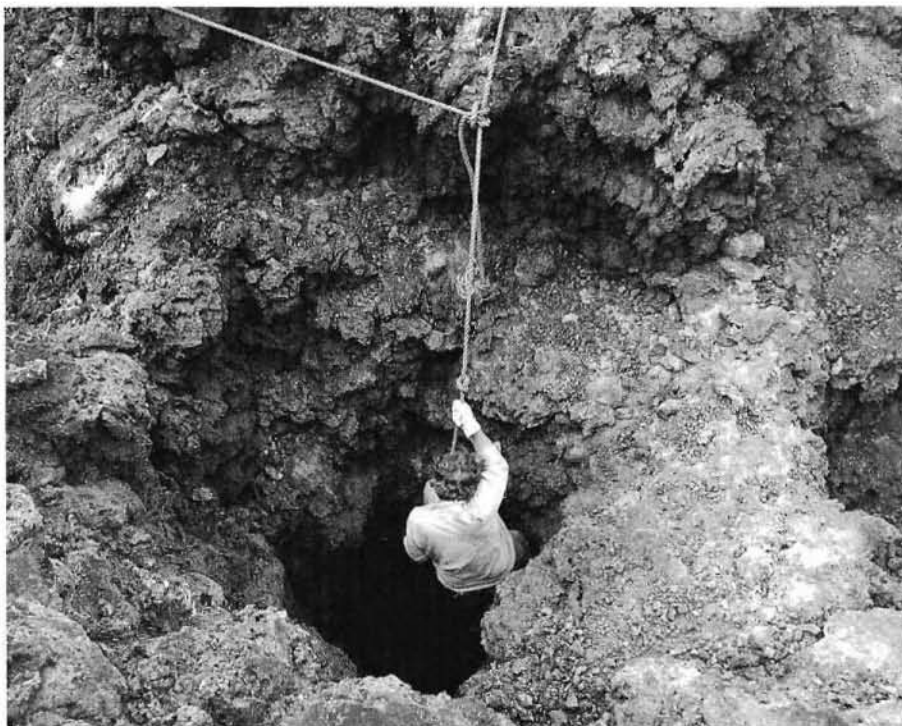
THE HUMAN IMPACT

Human settlement has had a depressingly similar impact on the ecology of all the Atlantic islands. Historical accounts invariably mention the early release of destructive domesticated animals. Goats and rats were among the first, and were usually followed by pigs, dogs, cats, mice, and other pests that either killed native animals directly, or destroyed the vegetation on which they depended. On those islands that were settled by Europeans, habitat destruction continued through burning, clearing for agriculture, and the introduction of noxious plants and insects.

Biologists did not arrive in the islands until long after these perturbations had altered the character of native ecosystems. Thus, the full extent of human impact was not appreciated until systematic searches were made for fossils of extinct vertebrates, beginning in the 1970s. These studies revealed many extinct or extirpated populations of seabirds, land birds, a few reptiles and mammals, and land snails. So far, the search for fossils has included Bermuda, Madeira and Porto Santo, the Canaries, the Cape Verdes, Fernando de Noronha, Trindade, Ascension, and St Helena. Extinct forms have been found on all but Trindade, where the geological environment is not at all conducive to fossil deposition.

Many of these studies are still incomplete and unpublished. All show, however, that the historically known faunas of these islands are often only a pitiful remnant of what was there before the arrival of humans. There are no endemic species of land birds on Bermuda now, yet in the past there was a finch, a woodpecker, an owl, a heron, and several flightless rails, among others. The most distinctive land birds of Madeira are a species of pigeon and a pipit, both shared with the Canaries. But fossils reveal extinct thrushes, finches, a rail, and two species of quail that may have been flightless. Extinct rodents, lizards, a tortoise, and a finch have been described from fossils in the Canary Islands. With these facts in mind the absence of any endemic species of birds in the Azores is quite improbable. These islands are older and more remote than the Galapagos and it is hardly conceivable that no differentiation of birds beyond the level of subspecies took place there.

Rails and gallinules are somewhat chicken-like marsh birds that disperse widely and are often



found as vagrants far out of their normal range. For this reason they are very successful at colonizing remote oceanic islands, where they quickly evolve flightlessness. This condition unfortunately renders them extremely susceptible to introduced predators. The only flightless members of this group known historically in the Atlantic are gallinules from Tristan da Cunha (now extinct) and Gough Island, and the tiny flightless rail of Inaccessible Island in the Tristan island group.

But fossils show that there were probably flightless rails on all the islands of the Atlantic, for in addition to those mentioned above from the north Atlantic, we now know of a flightless rail from Fernando de Noronha, two from St Helena, and one from the harsh and inhospitable island of Ascension, which is hardly more than a giant cinder. This rail was observed alive and accurately described in 1656 by the astute traveler and diarist Peter Mundy. It is thought to have been dependent on carrion and associated insects found in seabird colonies, and indicates the extreme adaptability of rails to various island environments.

SEABIRDS PAST AND PRESENT

Although terrestrial organisms were hard hit by the arrival of humans, seabirds were dealt perhaps a more devastating blow. Even the most oceanic of birds must come to land to nest. Thus for seabirds, the few tiny islands of the Atlantic were of inestimable importance, far out of proportion to their total land area.

The most renowned of seabirds dependent upon Atlantic islands was the flightless great auk

▲ A scientist descends into a dormant fumarole (vapor hole near a volcano) in search of the fossilized bones of an extinct rail on Ascension Island. Detailed searches such as this have shown that the extant fauna on many Atlantic islands is but a small subset of the variety of species in pre-European times.



P. Morris/Ardea London

▲ A nineteenth-century engraving from John Gould's *Birds of Britain* shows the extinct great auk. Once common in the north Atlantic, this peculiar flightless bird (related to razorbills and guillemots) was slaughtered for its oil and as a food source for sailors. By about 1844 it had been wiped out.

Pinguinus impennis, an ecological counterpart to the flightless penguins of the Southern Hemisphere. It is known to have nested in historic times on islands from the Gulf of St Lawrence to the British Isles. In prehistoric times it was known from Florida to the Mediterranean, so the species had probably been adversely affected by prehistoric people before Europeans exterminated the species for food and oil: the last known pair was killed in 1844.

Since it surfaced some 30 million years ago, Bermuda was probably an important breeding locality for seabirds. The petrel known as the cahow *Pterodroma cahow* once occurred there by the millions, but the species was reduced to a pitiful remnant of a few dozen individuals by colonists who used it as food and by pigs, cats, dogs, and rats. Fossils show that St Helena was once home to vast numbers of seabirds, at least six species of which have been exterminated since human settlement. The few remaining species exist only in very low numbers on small offshore rocks.

With seabirds, the story is not so much one of complete eradication of species, although this did happen, but of reduction of population sizes by

► The flightless rail of Ascension Island was observed alive by Peter Mundy while visiting this inhospitable place (in the south Atlantic Ocean) in 1656. Mundy's observations and his drawing of the rail, together with fossilized bones, are all that remain of this bird.



Hakluyt Society

several orders of magnitude. Millions of petrels, terns, frigatebirds, boobies, and other efficient surface predators were removed from the oceanic environment. What the effect may have been on the fish and squid that were their prey, or on nutrient recycling in the waters around the islands where they nested, has never been calculated. Humans have long wrought profound and deleterious changes in the terrestrial ecosystems of Atlantic islands. We must now entertain the possibility that these changes had a significant effect on the oceans themselves.

STORRS L. OLSON

ISLANDS OF THE INDIAN OCEAN

Although the islands of the Indian Ocean are not as numerous as those of the Pacific, they are geologically and biologically more varied. Relatively few of them are inhabited. Unlike the Pacific Ocean, archipelagos made up of many small coral atolls are rare—the Maldives and the Laccadives, and the Chagos Archipelago, are the two main groups. However there are many single coral atolls, as well as much larger islands such as Madagascar and Sri Lanka.

CORAL ATOLLS

Off the northern coast of Western Australia are several uninhabited and isolated coral atolls such as the Rowley Shoals, composed of three atolls, and Scott, Ashmore, and Seringapatam reefs. Although they have little landmass above the water and limited terrestrial scenery, their subtidal environments are often spectacular, with extensive coral reefs, steep drop-offs, and large territorial reef fish. The northern reefs support very dense sea-snake populations, making diving an interesting experience!

Cocos (Keeling) Islands, a group of a few small coral atolls, are roughly equidistant from Australia, Sri Lanka, and Chagos, but their marine fauna is most similar to that of Indonesia. The islands have been inhabited since 1826 and until the 1980s the basis of their economy was the production and export of copra. Human activity has led to vastly reduced populations of turtles, and the bird life too has been heavily affected. The uninhabited island of North Keeling is a world-renowned seabird rookery, with colonies of red-footed, brown and masked boobies, frigatebirds, red- and white-tailed tropicbirds, white, sooty and common noddy terns, and Cocos buff-banded rails.

In contrast, the main island, only 24 kilometers (15 miles) away, is almost devoid of birds. This may have resulted from the felling of hardwood trees for timber, which destroyed the birds' habitat. Birds and their eggs, as well as turtles and

KNOWLES KERRY

Knowles Kerry is a senior research scientist with the Australian Antarctic Division. Since joining the Australian National Antarctic Research Expeditions in 1966 as a biologist, he has wintered on Macquarie Island and spent many summers there and in Antarctica conducting biological research, and has led numerous expeditions to Antarctica, including his work as chief scientist on marine science cruises. As a permanent member of the scientific staff of the Australian Antarctic Division he established in 1972 the Australian biological research program in Antarctica and in 1979 the marine biology program. He served on the Australian delegation which negotiated the Convention for the Conservation of Antarctic Marine Living Resources and represented Australia at meetings of the scientific committee of the commission. He has recently edited *Antarctic Ecosystems: Ecological Change and Conservation*.

G. L. KESTEVEN

G. L. Kesteven was educated at the University of Sydney, and has worked as a fisheries investigation officer with the New South Wales Department of Fisheries; a fisheries biologist with the CSIR; Deputy Controller of Fisheries in the Department of War Organization of Industry; and an advisor on fisheries to the South Pacific office of UNRRA. In 1947 he joined the Food and Agriculture Organization and was stationed in Singapore, Bangkok, and Rome until 1960 when he returned to Australia to become assistant chief of the CSIRO Division of Fisheries and Oceanography. In 1967 he rejoined FAO, undertaking fieldwork in Mexico, Peru, and other Latin American countries. He has since retired, but continues to act as a consultant to fishery companies.

M. J. KINGSFORD

M. J. Kingsford was born in Hastings, New Zealand. After a first degree at Canterbury University, he undertook research for MSc and PhD projects from the University of Auckland's Leigh Marine Laboratory. He then carried out contract work for New Zealand fisheries and took up a postdoctoral fellowship at the University of Sydney, where in 1988 he obtained a lecturing position in the School of Biological Sciences. Other teaching activities include presenting adult education lectures on fish and marine ecology. His research has focused on reef-associated juvenile and adult fish as well as the early life history stages of fish. He has a major research interest in the importance of oceanographic features for influencing the distribution, movements, and survival of small fish and plankton. He has published 15 research articles on fish and plankton, and has contributed to educational books.

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John E. McCosker has been Director of the Steinhart Aquarium, a division of the California Academy of Sciences, since 1973. Although trained as an evolutionary biologist, his research activities have subsequently broadened to include such diverse topics as the symbiotic behavior of bioluminescent fishes, the behavior of venomous sea snakes, the predatory behavior of the great white shark, the biology of penguins, the biology of the coelacanth, and dispersed and renewable energy sources as alternatives to national vulnerability and war. His shark research has been summarized in BBC, NOVA, and National Geographic television specials.

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Kenneth McPherson is Executive Director of the Center for Indian Ocean Peace Studies at Curtin University and the University of Western Australia. He established the *Indian Ocean Review* in 1980, the Center for Indian Ocean Regional Studies in 1987, and the Peace Studies Center in 1990. He is the author of numerous articles on Indian Ocean history and is currently working on a major history of the region.

ALEXANDER MALAHOFF

Alexander Malahoff is Professor of Geological Oceanography, Department of Oceanography, University of Hawaii; and Director of NOAA's National Undersea Research Center at the University of Hawaii (Hawaii Undersea Research Laboratory). His research over the past 25 years has been focused on the geology and geophysics of the ocean floor and of volcanoes and volcanic islands, using ships, airplanes, and submarines in order to conduct these studies. He is the author of more than 70 scientific papers and has undertaken over 150 dives in a number of submersibles including those

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Colin Martin is Reader in the Department of Scottish History at the University of St Andrews, Scotland. He worked as a flying instructor and army officer before becoming a freelance journalist specializing in archeological subjects. Between 1968 and 1983 he was Archeological Director on the excavation of three Spanish Armada wrecks in Irish and Scottish waters. He established the Scottish Institute of Maritime Studies at St Andrews in 1973. He is a frequent broadcaster on radio and television, president of the Nautical Archeology Society, and author of two books on the Spanish Armada and numerous papers and chapters on maritime topics.

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STORRS L. OLSON

Storrs L. Olson is Curator of Birds, Department of Vertebrate Zoology, National Museum of Natural History, Smithsonian Institution, with research interests in systematics and the evolution of recent and fossil birds of the world, particularly human-caused extinctions of birds on oceanic islands, especially the Hawaiian Islands, West Indies, and Atlantic. Dr Olson has been associated with the Smithsonian Institution since 1968 and has maintained an office in the National Museum of Natural History since 1971. An authority on fossil birds in general, he has for many years specialized in extinctions of birds on islands, beginning with his first expedition to Ascension Island in 1970. He has collected fossils on four other islands in the Atlantic, and on several islands in the West Indies. With his wife, Helen James, he has also discovered and described dozens of new species of fossil birds in the Hawaiian Islands.

JOHN R. PAXTON

John R. Paxton is a senior research scientist at the Australian Museum, Sydney. He was born in Hollywood and received his degrees from the University of Southern California, working on deep sea fishes at the Allan Hancock Foundation. He joined the Australian Museum in 1968 as curator of fishes. He has conducted fieldwork in many south Pacific countries and has taken part in numerous deep-sea expeditions. He and coauthors have recently published the first fish volume of the *Zoological Catalogue of Australia*. His current work involves attempts to unravel the mysteries of the biology and evolutionary relationships of the deep-sea whalefishes. He has served as foundation secretary and president of the Australian Society for Fish Biology, and has written more than 60 scientific papers and popular articles.

VICTOR PRESCOTT

Victor Prescott is a political geographer whose first appointment was in Nigeria, at University College Ibadan. While lecturing there for five years he completed his doctoral thesis on Nigeria's international and regional boundaries. Since 1961 he has been on the staff of the Department of Geography at the University of Melbourne. He was appointed to a personal chair in that department in 1986. He is author of *Maritime Political Boundaries of the World* (1986) and *Political Frontiers and Boundaries* (1987).

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