ISLANDS

The Illustrated Library of the Earth

CONSULTING EDITORS

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JACKET: *Kuta Bandos beach, Maldives. Photo by* ZEFA/*Australian Picture Library.* JACKET INSET: *A silhouette of a snowy egret at dawn, Florida, USA. Photo by Lynn M. Stone/The Image Bank.* ENDPAPERS: *Gastropods and bivalves washed ashore by a change in tide. Photo by Jean-Paul Ferrero/*AUSCAPE. PAGE 1: *A Huli tribesman, Papua New Guinea. Photo by Kevin Deacon/Dive 2000.* PAGE 2: *Sunset on a tropical island, Praslin, Seychelles. Photo by Hans-Peter Merten/Bruce Coleman Ltd.* PAGE 3: *The Fijian archipelago consists of more than 800 islands and islets, including the coral islet of Malamoto. Photo by Jean-Paul Ferrero/*AUSCAPE. PAGES 4–5: *An island endemic: the chameleon* Chameleon lateralis *of Madagascar.* PAGES 6–7: *Two wandering albatrosses* Diomedea exulans *in courtship display, South Georgia.* PAGE 8: *A brown lemur* Lemur fulvus *stoops to drink, Madagascar. Photo by Frans Lanting/Minden Pictures.* PAGES 10–11: *A New Guinea native in full ceremonial paint and makeup.* PAGES 12–13: *Lord Howe Island in the Tasman Sea is fringed by a thriving coral reef fish community.* PAGES 52–53: *A marine iguana* Amblyrhynchus cristatus *with a Sally Lightfoot crab, Hood Island, Galapagos.* PAGES 108–109: *Chimbu highlanders, Papua New Guinea.*

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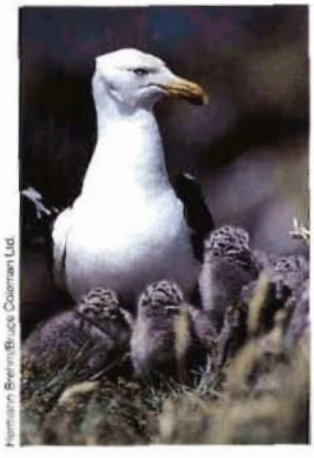
7 Islands of the Atlantic and Indian Oceans

STORRS L. OLSON AND DIANA WALKER

The islands of the Atlantic and Indian oceans are far fewer and more isolated than those of the Pacific. At first glance their plants and animals seem much less exotic, but recent fossil evidence reveals how numerous and diverse the life-forms of the islands once were. Since human habitation, many species have become extinct and many more are endangered.



Hermann Brehm/Black Coleman Ltd.

The Dominican gull Larus dominicanus *breeds on most islands of the subantarctic region, including South Georgia and the Falkland Islands.*

The Atlantic Islands

Atlantic islands such as Newfoundland and Britain were connected to nearby continental landmasses during the ice ages, and the flora and fauna of these continental islands are, thus, remnants of a larger set of species occurring on the adjacent continents. Many Atlantic islands, however, are oceanic islands whose native fauna and flora must have crossed over water to colonize them.

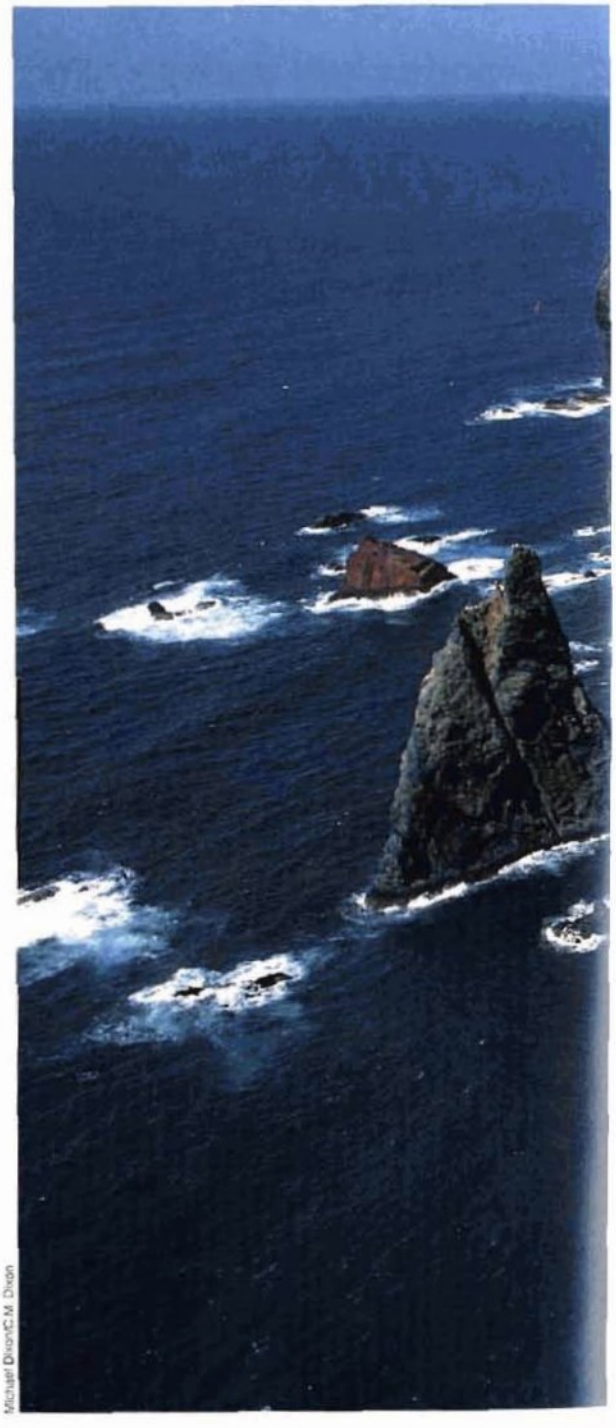
Continental Links

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, or were, formed on the Mid-Atlantic Ridge, the underwater mountain range that marks the zone where North and South America pulled away from Europe and Africa, to begin forming the Atlantic Ocean more than 130 million years ago.

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

A string of volcanoes in the Gulf of Guinea gave rise to the islands of Bioko (Fernando Póo), Príncipe, São



Michael Dick/C.M. Dixon

Tomé, and Annobón (Pagalu). Bioko is continental, but the others are oceanic and support several species that occur nowhere else. These endemic species include a dwarf ibis *Bostrychia bocagei*, a pigeon *Columba thomensis*, a very large weaverbird *Ploceus grandis*, and a grosbeak *Neospiza concolor* 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 that in the British Museum. The overall affinity of the flora and fauna of these islands is overwhelmingly with that of equatorial Africa.

HUMAN SHADOW

In the north Atlantic, with the exception of Bermuda, the oceanic 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 BC and 2000 BC. Most of the other islands and archipelagos were discovered and inhabited during the era of great Portuguese and Spanish exploration in the fifteenth and early sixteenth centuries.

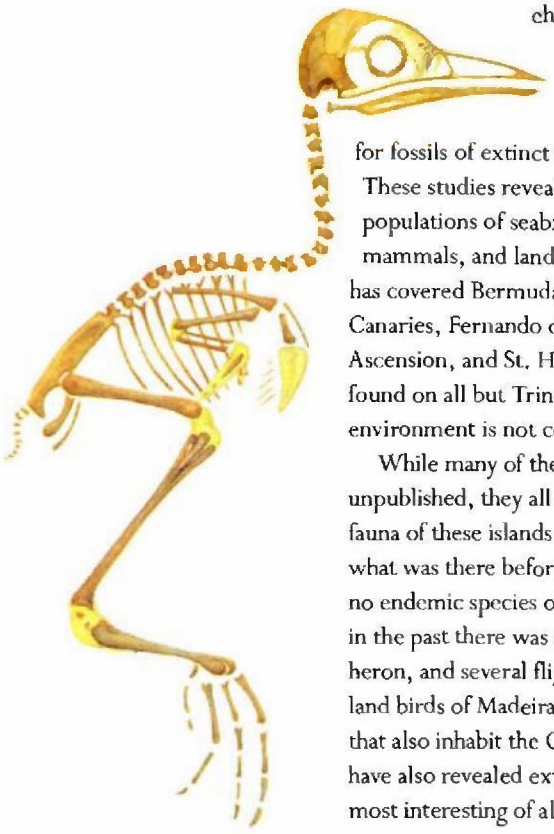
Human settlement has had a similar impact on the ecology of all the Atlantic islands. Historical accounts

The rugged volcanic cliffs of Ponta de Sao Lourenco at the eastern tip of Madeira. Uninhabited and densely wooded when discovered in 1419, the island's forests have been extensively destroyed by fire during subsequent settlement.

Michael Brooke/Oxford Scientific Films

Few islands are so distant from the nearest land that they have never been colonized by some bird. Even remote Inaccessible Island in the south Atlantic has its unique species, the rail Atlantisia rogersi.

The skeleton of a baby rail, with its relatively tiny wings and feeble breastbone. These structures are far larger in flying adults.



invariably mention the 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 come to study 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 covered Bermuda, Madeira and Porto Santo, the Canaries, Fernando de Noronha, Ilha da Trindãde, Ascension, and St. Helena. Extinct forms have been found on all but Trindãde, where the geological environment is not conducive to fossil deposition.

While many of these studies are still incomplete and unpublished, they all show that the historically known fauna of these islands is 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. The most distinctive land birds of Madeira are a species of pigeon and a pipit that also inhabit the Canaries. But fossils from Madeira have also revealed extinct thrushes, finches, a rail, and most interesting of all, two species of quail that may have been flightless. Extinct rodents, lizards, a tortoise, and a finch have been described from fossils in the Canaries. With this in mind, the absence of any endemic species of bird in the Azores seems 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 here.

FOSSIL EVIDENCE

The realization that recent extinctions have occurred so commonly on islands should make us view anomalous patterns of distribution with skepticism. For example, although there are 10 much larger islands in the Cape Verde archipelago, the lark *Alauda razae* occurs only on the tiny barren islet of Razo, and nowhere else in the world. Likewise, the impressive giant skink *Macroscincus coctei*, a lizard over 30 centimeters (1 foot) long not including the tail, is confined to Razo and the adjacent, even smaller, islet of Branco. These distinctive organisms surely did not evolve in response to the conditions presented by these tiny islets. It is more reasonable to think, given the evidence on extinctions, that they must once have been more widely distributed in the archipelago, but persisted on Razo and Branco only because these islands are barren, waterless, and, therefore, uninhabited by humans.

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 have often quickly evolved 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 (now extinct) and Gough islands, and the tiny flightless rail of Inaccessible Island, all in the Tristan da Cunha 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.

One of the more peculiar discoveries on an Atlantic island were bones of a hoopoe on St. Helena. The hoopoe *Upupa epops* is an odd bird with a long bill and a striking crest that occurs throughout Europe, Africa, and Asia. The bird on St. Helena was, however, a distinct species. It was considerably larger in size and had much smaller

wings than mainland hoopoes. Although it was almost certainly not flightless, it was on its way to becoming so. A flightless hoopoe could scarcely be imagined were it not for the bones that remained on St. Helena.

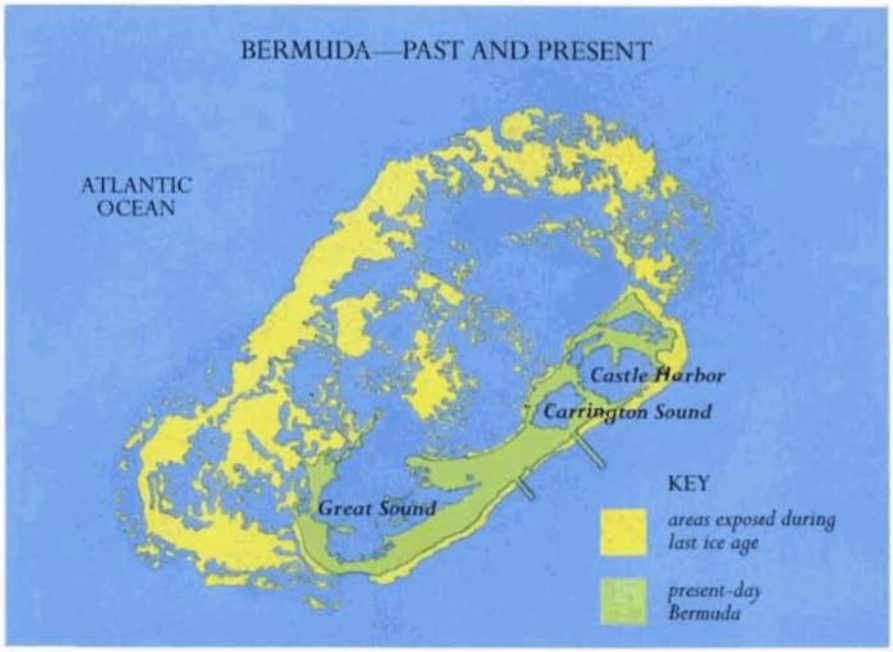
FLIGHTLESSNESS

Because the evolution of flight was the key adaptation that allowed birds to diverge and radiate from their reptilian ancestors, it is important to ask how and why birds so often become flightless in island environments. In the Atlantic this condition is confined almost entirely to rails, but elsewhere we know of flightless ducks, geese, ibises, pigeons (the dodo of Mauritius), the kagu of New Caledonia, and other groups of insular birds that have become flightless. One of the principal factors that allows flightlessness to evolve on islands is the almost invariable absence of mammalian predators. It is thought that very simple changes in the process of development explain the evolutionary rapidity with which flightlessness occurs. At hatching, all rails, for example, have large, well-developed legs and feet, but tiny wings and a very reduced breastbone. Only later in development does the flight apparatus increase in relative size to permit the bird to fly. By arresting the development of the flight apparatus and retaining the proportions of a chick into adulthood, a bird would thus remain flightless.

This explains how a bird may become flightless. But why? The answer lies in the conservation of energy. Flight has a great energy cost. It requires large breast muscles and an elevated metabolic rate for those muscles to function properly. Therefore, when conditions permit it, if large breast muscles and a higher metabolic rate can be eliminated, a bird will have greatly reduced energy requirements. Less food would be needed to sustain the individual and, therefore, more energy would be available for egg-laying and other reproductive activity. Recent studies have confirmed that flightless rails do indeed have lower metabolic rates than their closest flying relatives. Thus, the evolutionary advantages of flightlessness in an insular situation are very important, and we find that flightlessness has evolved repeatedly in different kinds of birds the world over. Flightless birds, however, are immediately at an extreme disadvantage once humans introduce unnatural predators into their untroubled homes. Thus, the true prevalence of this adaptation has been revealed only recently through the fossil record.

CLIMATE CHANGE

Not all extinctions on islands are attributable to humankind. The repeated advances and retreats of glaciers in the past million years or so caused wide fluctuations in sea levels and profound changes in marine environments. Bermuda, for example, shrank to around a tenth its present size when the seas rose to their maximum extent some hundreds of thousands of years ago, but at the height of the last glaciation, about 18,000 years ago, when sea levels dropped precipitously, Bermuda was 10 times larger than it is now. At that time, we know from fossils, a crane, a duck, and four different species of flightless rails existed on Bermuda that have since disappeared. A few of these doubtless survived the subsequent reduction in land area, but the inundation that reduced Bermuda to its present size would surely have eliminated all the habitat available for a crane.



A map of Bermuda showing the present and past extent of the island. During the last ice age, the central lagoon was probably a large marshy area suitable for cranes, which once inhabited the islands but became extinct when sea levels rose.

On St. Helena, a pigeon and a shearwater related to the Indo-Pacific wedge-tailed shearwater *Puffinus pacificus* are known only from the oldest deposits on the island. These birds presumably disappeared due to natural changes in the environment, before the arrival of humans. Nevertheless, these documented instances of "turnover" unrelated to human activity are very rare.

Like many related seabirds, the soft-plumaged petrel Pterodroma mollis *lays a single egg at the end of a burrow dug in the soil, which it visits only at night. This species breeds commonly on Gough Island, south Atlantic Ocean.*

Graham Robertson/AUSCAPE

L.A. Fuertes/Robert Harding Picture Library

The last recorded specimen of the Labrador duck Camptorhynchus labradorius *was shot on Long Island, New York, in 1875. Although the reasons for its extinction remain somewhat mysterious, human persecution is unlikely to have been a direct cause, as the bird was notoriously shy and not particularly good to eat.*

DISAPPEARING SEABIRDS

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 *Pinguinus impennis*, an ecological counterpart to the flightless penguins of the Southern Hemisphere. This bird 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 it for food and oil. The last known pair was killed in 1844.

Another extinction in the north Atlantic that has never been satisfactorily explained is that of the Labrador duck *Camptorhynchus labradorius*. This beautiful sea-duck was known only on its wintering grounds from New Brunswick to New Jersey in North America. It was never common, and although shot for the market, it was not considered good to eat, so hunting was probably not a factor in its initial rarity. The species is known from fewer than 50 specimens, and disappeared about 1875. Perhaps this duck also nested only on islands, where prehistoric exploitation may have reduced its numbers long before the species was discovered and named by naturalists.

Since it surfaced some 30 million years ago, Bermuda probably has been 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 few dozen individuals by colonists, who used it as food, and by pigs, cats, dogs, and rats. Fossils show that St. Helena, too, was once home to vast numbers of seabirds, at least six species of which were exterminated after 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 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.

Erwin & Peggy Bauer/Bruce Coleman Ltd.

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Common across North America, the yellow-crowned night heron (far left) has recently been reintroduced to Bermuda in an attempt to restore a vanished natural system of checks and balances: once the night heron was the chief predator of a local land crab Gecarcinus *(left), which preys heavily on chicks of the now critically endangered Bermuda cahow.*

RESTORING THE BALANCE

The extent of previous destruction, coupled with the remoteness of many of the Atlantic islands, would at first seem to make conservation measures a dismal enterprise. There are some reasons for hope, however. Heightened environmental awareness, especially on the more populated islands such as Madeira and the Canaries, should help with efforts to preserve what remains of the fauna and flora. More tangibly, on St. Helena there has been a vigorous effort to identify and preserve, through propagation and reintroduction, the nearly vanished native vegetation, which includes many highly peculiar plants that are thought to be of relatively ancient origin.

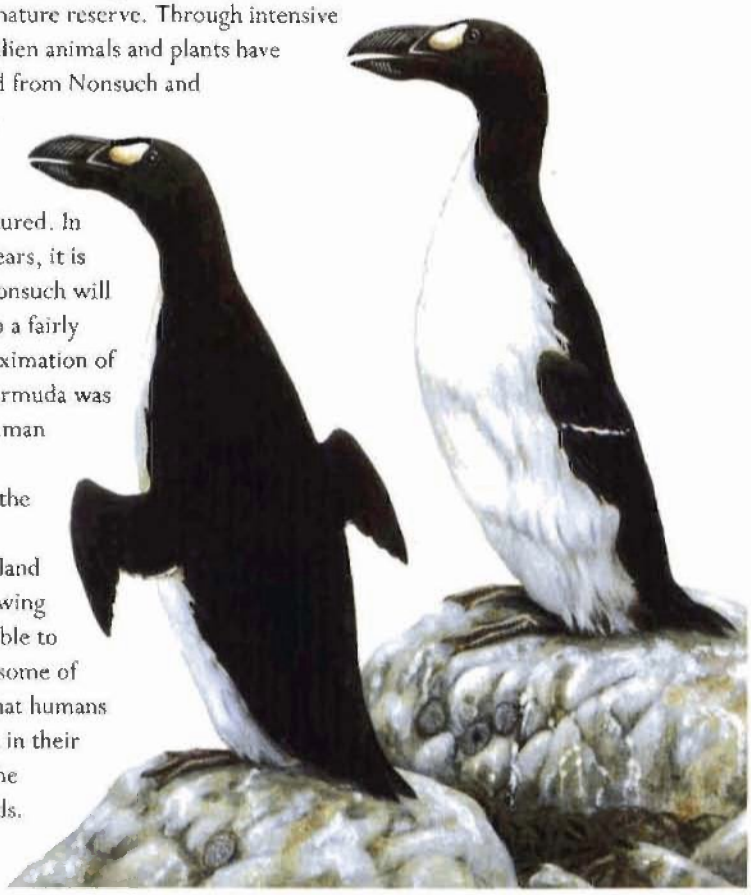
Finally, the determined efforts of David Wingate, Conservation Officer on Bermuda, should stand as an example of the effect of individual perseverance and optimism in the face of the bleakest of prospects. Bermuda is one of the most densely populated islands in the world, besides having more than 7 percent of its land area taken up in golf courses. By the first part of this century, very little remained of its native vegetation and what did was dealt a devastating blow by the introduction of a scale blight from California in 1942, which denuded the landscape of cedar forests within a few years.

The one endemic species of bird on Bermuda, the cahow (once thought to be extinct), persisted only as a few pairs on tiny offshore islets. But through Wingate's constant monitoring and creative environmental manipulation since the 1960s, the cahow has slowly been brought back from the brink of extinction. Its numbers have continued to increase despite setbacks such as the appearance of a vagrant snowy owl that killed several breeding birds. One factor that had kept numbers low was the insufficiency of suitable nesting sites, but Wingate cut artificial nest burrows out of solid limestone, and the birds readily adopted them. Another limiting factor is predation on chicks by land crabs. Although land crabs occur naturally in Bermuda, we know from fossils that one of their chief predators, a form of yellow-crowned night heron with an exceptionally large bill, had been exterminated. As a remedy, yellow-crowned night herons were introduced from the North American mainland and have started breeding on Bermuda, where it is hoped they will keep the number of land crabs in check.

One of Bermuda's larger islets, Nonsuch, has been set aside as a nature reserve. Through intensive effort, most alien animals and plants have been removed from Nonsuch and native plants, including cedar, carefully nurtured. In a few more years, it is hoped that Nonsuch will be restored to a fairly faithful approximation of what all of Bermuda was like before human settlement. Perhaps then the cahow will reclaim the island for itself, showing that it is possible to undo at least some of the damage that humans have wrought in their conquest of the Atlantic islands.

STORRS L. OLSON

A large flightless seabird, the extinct great auk Pinguinus impennis *inhabited islands off northern Europe, Greenland, and northeastern Canada. The last were killed by a fisherman on 3 June 1844.*



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STORRS L. OLSON
Dr. Olson is Curator of Birds, Department of Vertebrate Zoology, National Museum of Natural History, Smithsonian Institution, Washington DC. His research interests lie in systematics and the evolution of recent and fossil birds of the world, and in human-caused extinctions of birds on oceanic islands. His special focus has been on the islands of Hawaii, the West Indies, and the Atlantic. An authority on fossil birds in general, his first expedition was 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.

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Dr. Rowley-Conwy is a lecturer in archeology at the University of Durham in the UK, focusing on the prehistory of Europe and southwest Asia. From 1988 to 1989, he taught at the Memorial University of Newfoundland, Canada. After reading archeology at Cambridge University, Dr Rowley-Conwy completed his PhD in 1980 on the prehistory of Denmark, and has specialized in the analysis of prehistoric animal bones and plant remains. Since 1980 he has carried out post-doctoral work in Syria and has conducted research in Portugal, Italy, Egypt, and Sweden.

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Dr. Talbot is Director of the National Museum of Natural History/National Museum of Man, Smithsonian Institution, Washington DC. A marine biologist who has specialized in coral reef fish ecology, he has studied reef fish communities off the east coast of Africa and off Australia's Great Barrier Reef. He has lived and studied on a Caribbean coral reef in the Tecktite II underwater habitat program, and sailed on a small yacht with his wife and youngest child across the Indian Ocean from Australia to Africa, returning via the Southern Ocean. Dr. Talbot has been Professor of Biology and Environmental Studies at Macquarie University, Sydney, Director of the Australian Museum in Sydney, and Executive Director of the California Academy of Sciences.

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Dr. Yaldwyn retired as Director of the National Museum of New Zealand in 1990, where he was based for 23 years. A specialist in marine biology, he worked at the University of Southern California's Allan Hancock Foundation in Los Angeles, and at the Australia Museum, Sydney. He has researched the biology and ecology of many islands, including New Zealand subantarctic islands, Great Barrier Reef and Coral Sea islands, and the raised coral atoll of Niue in the South Pacific. His publications include *Australian Seashores in Colour* and *Australian Crustaceans in Colour*, and he is now an honorary research associate of the National Museum of New Zealand.

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