

Letter From the Desk of David Challinor
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About 1,000 miles west of the mid-Atlantic Ridge at latitude 32°20' north (roughly Charleston, SC), lies a small, isolated archipelago some 600 miles off the US coast. Bermuda is the only portion of a large, relatively shallow area or bank that reaches the surface. This bank intrudes into the much deeper Northwestern Atlantic Basin, an oceanic depression averaging some 6,000 m deep. A few kilometers off Bermuda's south shore, the depth of the ocean slopes precipitously to several hundred meters. Bermuda's geographic isolation has caused many endemic plants to evolve independently from their close relatives on the US mainland. This month's letter will continue the theme of last month's about Iceland and will illustrate the joys and rewards of longevity that enable us to witness what appears to be the beginnings of landscape changes. In the case of Bermuda, I have watched for more than 40 years a scientist trying to encourage an endemic tree's resistance to an introduced pathogen.

My first Bermuda visit was in the spring of 1931. At that time the archipelago was covered with Bermuda cedar (*Juniperus bermudiana*). This endemic species was extraordinarily well adapted to the limestone soil and sank its roots deep into crevices of the atoll's coral rock foundation. The juniper's relatively low height, (it grows only 50' high in sheltered locations), protected it from "blow down," a frequent risk to trees in this hurricane-prone area. Juniper regenerated easily and its wood was used in construction, furniture, and for centuries in local boat building. The pleasant smell of juniper permeated the islands and its dark green foliage colored the landscape.

During WWII, when agricultural quarantine facilities were stretched thin, juniper nursery stock from California was imported to landscape an estate in Tuckerstown at the western end of the main island. The imports harbored a minute scale insect, barely visible to the naked eye. This insect inserts its proboscis into the base of juniper petioles (leaf stems) and sucks the sap. Although two closely related mainland junipers, Southern red cedar (*J. silicicola*) and Virginia cedar (*J. virginiana*) are quite resistant to this scale insect, the endemic Bermuda species was not. In less than a decade, virtually every Bermuda juniper was infested. Mortality ran to 90% because the local trees could not produce enough extra sap to replace that which had been lost to the scale insect. When the foliage withered, the tree died.

When I was in Bermuda in 1960, whole hillsides of pale grey, skeleton-like dead cedars were a common sight. The naturally rot-resistant wood ensured their ghostly presence for years. The dreary landscape triggered prompt reaction by the local government: they hid the blighted trees and replaced the junipers with many exotic species. Various biological methods were attempted to control the introduced pest, but

none succeeded. For example, vast numbers of lady bugs of several species, all of whose nymphs are scale insect predators, were imported and released but were ineffective, largely because so many were blown out to sea by the normally strong winds blowing across this narrow island. Even though some of the imported ladybug species have survived, they never could control the introduced pest.

In 1970, I photographed several locations where small patches of cedars were still alive, and with my colleague, David Wingate, then with Bermuda's Department of Agriculture and Fisheries, published an article titled "The Struggle for Survival of the Bermuda Cedar," (Biol. Cons. Vol. 3, No. 3, Apr. 1971 pp. 220-222). Since then, I have been monitoring these relict stands on a regular basis—usually every two to four years. A few stands eventually succumbed, but individual trees within other groups are still alive and evidently have sufficient resistance to survive. Most survivors are growing in sites ecologically favorable for junipers.

In the 1980's, the Bermuda government initiated a restocking program by taking cuttings from resistant trees for vegetative propagation. Seeds from these trees were also collected and by the early 1990's saplings were distributed for planting. During the last decade, I have been impressed with the success of this program: some resistant junipers are now 15' high. Young transplants have to be kept free of introduced vines and ideally be exposed to full sun. Under the best conditions and assisted by fertilizer, they can grow half a meter a year on good sites. Somewhere in the gene pool of this juniper, isolated for millennia, is evidently a genetic component that may provide a resistance similar to that of its close relatives on the continent. Prior to 1943, this species had never needed such protection as this particular cedar scale was unknown on Bermuda. Helped by human intervention, the odds are high that cedar may eventually re-establish itself on the island. The process is daunting because there is so little open land left. With a population of 3,000 to the square mile, most of the land is occupied by houses. There are few open areas, but these are golf courses where the cedar planting must be confined to the edges of fairways.

Nonsuch island, a biological reserve of 14.9 acres, established by the government of Bermuda in 1961, now has scores of resistant junipers and even the beginning of some natural regeneration. This island, located a scant 1/4 mile from Bermuda's airport, has had limited access to the public while government workers and volunteers clear the exotic plants and poison the introduced rats. Casuarina trees from Australia still cover some areas as wind protection for the young juniper, but as the latter become established, the casuarina are girdled to allow the favored juniper to grow through their dead crowns. Much of the success of rehabilitating Nonsuch, which school groups now visit, is due to David Wingate, recently retired from government service. He and a warden live in two small houses on Nonsuch to ensure protection and continue their work of restoring the native vegetation.

In the world of birds, Wingate is recognized as the savior of the Bermuda petrel or cahow. This nocturnal, hole-dwelling seabird once nested all over the archipelago. When the Europeans arrived in the early XVI century, the bird rapidly disappeared and was believed extinct by the 1650's. Its easily harvested young were eaten by hungry settlers and finished off by human-introduced rats and pigs. Amazingly, in the 1930's two or three dead birds turned up and experts confirmed their identity. Finally, in 1951 their breeding grounds were discovered on rocky islets surrounding Nonsuch. Wingate, a teenager at the time, accompanied Robert Cushman Murphy, the famed seabird expert from New York's American Museum of Natural History, and Louis Mowbray of the Bermuda Aquarium, when they found the nesting holes. Cahows had escaped detection for 300 years because it was their habit to return to their nest holes only at night. The approximately 10 pairs of these pigeon-sized seabirds found in the 1950's have grown to more than 30 breeding pairs this year (2001). Another 150 or more young non-breeding birds remain at sea until old enough to pair and breed themselves. Wingate accomplished this triumph over extinction by excavating shallow nest holes about a meter long with a chamber at the end. A heavy lid over the chamber allowed him to monitor the progress of the single chick. Each entrance had to be protected by a wooden baffle with a precisely cut oval hole, large enough to allow the cahow to enter, but small enough to keep out the slightly larger diurnal white-tailed tropic bird. This larger bird would otherwise occupy the nesting hole during the day while the petrel parents were at sea getting food for their young, and thus prevent the parents from feeding their young.

Despite the three-fold increase in the cahow population, their existence remains tenuous. A current threat is commercial development of Cooper's Island, adjacent to Nonsuch. Cooper's has been used as a NASA tracking station since the early days of the space program. NASA has no further need for it, but retains its lease. A proposed large resort hotel complex would impinge on the cahows nesting on the rocky islets adjacent to Cooper's attractive sandy beach. The government eventually will have to decide between a public park with controlled night time access to protect the birds during their breeding season, or a major development thought to be locally beneficial economically—not an unusual trade off.

Meanwhile, Wingate is ready to adapt a procedure borrowed to help the cahow. This procedure, successful in Maine, lured puffins back to re-establish nesting colonies on coastal islands. Financed by the Audubon Society, artificial nest holes were excavated and scores of puffin decoys were staked at sites believed suitable for puffin nesting. For almost a decade, puffin chicks were flown in from Canada, put in nest holes, and fed by volunteers. Competing nesting colonies of Great black-backed gulls were eradicated and puffin chick survival to fledging was an impressive 75%. Finally, in 1985 the first four-year-old birds fledged there returned to breed. Other puffins, lured by tapes and decoys, also returned to establish a new colony. Can the same technique be successful with another hole-nesting sea bird in Bermuda? Wingate thinks it is worth trying. It will be a daunting task, not only to raise the necessary funds, but to man the

selected nesting areas on Nonsuch all night long to monitor the sound equipment and to observe the cahows' behavior.

The encouraging indications of insect resistance developing in Bermuda cedar and the three-fold increase in breeding pairs of cahows are but two examples of what can be accomplished by the dedicated work of one man. Over time, David Wingate, and his colleagues revived two characteristic and even charismatic components of Bermuda's biological heritage. The threats to maintain these extraordinary reversals in two declining populations are still present, but there is reason for optimism. The chances seem good that the sounds that Shakespeare had Caliban describe for the audience in *The Tempest* can once again be heard in selected Bermuda cedar forests:

"...the isle is full of noises,
Sounds, and sweet airs, that give delight and hurt not.
Sometimes a thousand twangling instruments
Will hum about mine ears; and sometime voices,
That if I then had wak'd after long sleep,
Will make me sleep again..."¹

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¹ The "noises" and "voices" are thought to be the calls of myriad cahows returning to their holes.