HUMANS AND INTRODUCED SPECIES
All insular giant tortoise populations evolved and survived on islands free of predators and relatively free of competition until human exploration and invasive species began processes of decline and extinction. Rats escaped sailing ships and ate eggs and hatching tortoises. Goats, brought on ships for meat and milk, became feral and ate vegetation that might have sustained tortoises. And, of course, sailors loaded their ships with tortoises, whose flesh sustained crews during long ocean voyages.

The tortoises of the Indian Ocean were driven extinct by the combined impact of all these factors. And these same factors have been in operation in the Galápagos; why have the tortoises of Galápagos fared better? The difference seems partly due to when disturbances began. In the case of Indian Ocean tortoises, sailing ship visitations, colonization, hunting, and introduced animals occurred several hundred years earlier than in Galápagos. In addition, human visits to the Mascarenes and Seychelles were more frequent than to the Galápagos. Furthermore, permanent settlements were established on Indian Ocean islands long before any settlements were established in Galápagos. Aldabra tortoises avoided extinction because the atoll is remote and outside regular sailing routes, and there is no permanent water.

CONSERVATION
The success of most conservation programs depends on timing and effort. For Cylindraspis, no effort was made because conservation was not a priority in the eighteenth and nineteenth centuries. Aldabrachelys on Madagascar became extinct between 750 and 1250 years before present, well after the first appearance of humans on the island.

Today, active conservation efforts are ongoing in Galápagos and on Aldabra. The Charles Darwin Research Station was built by the Charles Darwin Foundation and inaugurated in 1964. The Station is headquartered on Santa Cruz and manages continuing efforts to help in recovery of Galápagos tortoises. For races rare in their native range, the Station raises hatchlings until they are large enough to be released back to their native habitat. Other activities include the eradication of goats and rats. Financial support comes from organizations and institutions, as well as individuals. The government of Ecuador, which exercises sovereignty over the archipelago, established the Galápagos National Park Service and deserves special praise for the commitment made to preserve Galápagos biodiversity. The work of the Station is one of the success stories in conservation of biodiversity and habitat restoration.

Aldabra has been vigorously protected through a variety of programs and with considerable international participation. Many of the same institutions and organizations that support the activities of the Charles Darwin Research Station also support conservation efforts on Aldabra.

SEE ALSO THE FOLLOWING ARTICLES
Adaptive Radiation / Galápagos Islands, Biology / Gigantism / Madagascar / Seychelles

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TRADE WINDS
SEE CLIMATE ON ISLANDS

TRINIDAD AND TOBAGO

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Trinidad and Tobago are two small islands with a combined land area of about 5100 km², lying just off the northeast edge of the South American continent (Fig. 1) at 10°02′–11°21′ N and 60°31′–66°15′ W. Southwest Trinidad is separated from the mainland by an 11-km strait, whereas in the northwest there are steppingstone islands between Trinidad and the mainland. Tobago is separated from Trinidad by a 36-km strait. Trinidad’s Northern
Range and Tobago are eastern extensions of Venezuela’s long Coastal Range.

**CLIMATE AND TOPOGRAPHY**

The islands are characterized by moderate topography—maximum elevation 940 m for Trinidad, 576 m for Tobago—and by a climate typical of their tropical latitude. Mean annual rainfall varies from about 125 to about 325 cm, according to locality, with a moderately distinct dry season from about mid-January to late May. Mean daily temperature fluctuation is estimated at 10.4 °C, with very little seasonal difference. Trinidad and Tobago lie south of the usual path of Atlantic hurricanes and have not been significantly affected by them in most decades.

**PEOPLE AND GOVERNMENT**

The two islands, together with various associated islets, form the Republic of Trinidad and Tobago. About 80% of the populace of 1.3 million is of Indian and African descent in equal proportions, with small minorities of people of other races and of mixed descent. English is the language of public affairs, and no other language is spoken by large numbers. The government of this former British colony, independent since 1962, is a parliamentary democracy in the British model. The economy is semi-industrialized and is heavily reliant on the petroleum industry (Trinidad) and on tourism (Tobago) and hardly at all on agriculture. Per-capita GDP is variously estimated at US$15,500–17,500. Life expectancy at birth is 74 years for women, 68 years for men.

**ENVIRONMENT**

The tectonic history of Trinidad and Tobago is complex and controversial. However, they appear to have undergone no significant movement or other gross disturbance since the Tertiary. Although it is difficult to plot Quaternary sea-level changes, they are thought to have caused several cycles of isolation and reunification with the mainland. The age of present isolation is generally estimated at 10,000 years for Trinidad and 14,000 years for Tobago, although a minority view holds that a land bridge connected Trinidad to the mainland at least intermittently until much more recently.

These fluctuations in land area were presumably accompanied by cyclical changes in gross habitat type, as throughout northern South America. The greatest extent of savanna, relative to forest, occurred during glacial maxima (most recently about 20,000 years ago), and it is estimated that seasonal evergreen forest came to cover about 75% of the land surface by 10,000 years ago and to remain at about that figure through pre-Columbian times. Forest cover is now reduced to about 20–30%, depending on

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**FIGURE 1** Trinidad and Tobago, position and topography. The present -125-m line approximates the coastline at the height of the most recent glaciation about 20,000 years ago. Map by Bheshem Ramlal.
definition, although the decline of agriculture over about the last century has slowed the pace of deforestation.

The predominant natural land habitat is evergreen seasonal forest, found in wetter areas up to about 250 m. Other habitats of note include swamp forest (most notably on the east coast of Trinidad), mangrove (on the east and west coasts of Trinidad and in southwest Tobago), savanna (in central and southwest Trinidad), and lower montane forest (above about 250 m on both islands), with some elements of montane forest in the highest parts of Trinidad’s Northern Range. Coastal habitats include many sand beaches, the major Buccoo Reef at the southwest end of Tobago, and several lesser coral reefs in Tobago and northeast Trinidad. Each island has a great many streams, but no significant rivers or natural lakes.

BIOTA

Whereas the rest of the West Indies—the Antilles—are oceanic islands, Trinidad and Tobago are typical continental islands. That is, they show only slight endemism, and they closely resemble comparable nearby mainland habitats in their (harmonic) biotic composition and diversity (Fig. 2). In addition, they are relatively resistant to invasive species and their effects. Endemism among the approximately 6600 species of seed plants, for example, is estimated at 2.1%. To cite some other well-studied examples, the corresponding figure for land vertebrates is 2 of 521 species (0.4%) (Fig. 3), for butterflies (sensu stricto, excluding Hesperiidae) is 5 of 387 species (1.3%), and none of the 42 known species of freshwater fishes is endemic. In line with this trend, no family of plants or animals with strong representation in the Guianas or eastern Venezuela appears to be absent from Trinidad and Tobago. As rough estimates, these islands harbour about 3% of the world’s land and freshwater animal species and about 2% of plant species.

It is expected that over an extended period of time, a continental island will increasingly partake of the biotic features of an oceanic island: decreased diversity, increased disharmony, and increased endemism. We can refer to these outcomes col-

FIGURE 2 Like much of Trinidad and Tobago’s biota, the social wasp Mischocyttarus alkeni is very broadly distributed in South America. It nests in a variety of lowland habitats on many different substrates. Photograph by Allan W. Hook.

FIGURE 3 The golden treefrog, Phyllodytes auratus (A), one of Trinidad and Tobago’s very few putative endemic species, known only from the upper reaches of Trinidad’s two highest peaks. It breeds in the water that accumulates among the bracts of Glomeropitcairnia erectiflora (B). This tank bromeliad, although not rare, is known only from high elevations in Trinidad and nearby parts of Venezuela. Photographs by Daniel G. Thornham.
lectively as the “island effect.” The earliest of these features to appear is likely to be the first, a lowering of diversity as a result of uncompensated local extinction, or “relaxation,” which may be the engine of the island effect as a whole.

To what extent is an island effect manifest in Trinidad and Tobago? This question is only now coming to be addressed, by way of floristic and faunistic comparisons between Trinidad’s Northern Range and similar habitat in Venezuela’s Paria Peninsula. After some 10,000 years of separation, it is predicted that the magnitude of Trinidad’s island effect will vary in a meaningful way among taxa. Preliminary results suggest, for example, that the diversity of social wasps (Polistinae) is much the same in Trinidad as in comparable habitats on the mainland, whereas that of stingless bees (Meliponini) is markedly lower.

CONSERVATION ISSUES

Trinidad and Tobago are a signatory of several international agreements relating conservation and the environment, including CITES, the Convention on Wetlands (Ramsar), the Convention on Biological Diversity, and the Cartagena Convention. Furthermore, a relatively high proportion of land area is under public ownership, and much of this remains in a natural or semi-natural state. A contributing factor here is undoubtedly the heavy dependence of the national economy on petroleum and, to a lesser extent, tourism, which limits pressure on the land for agricultural purposes.

At the same time, legal protection remains weak. Much of the country’s conservation policy and infrastructure dates back to colonial times. There is still no formal system of national parks and protected areas that meets today’s international standards, and the few designated conservation areas enjoy little real protection. Even in these areas, poaching and logging are relatively unchecked.

However, the growth of ecotourism, together with the presence of a number of active conservation-related NGOs federated under a national umbrella body, are promising signs. Allied with this latter factor is a perceptible, ongoing shift in government toward an increased local participation in management of the national environment.

The most striking conservation success story of recent times is the rise of community-based patrolling of sea-turtle nesting beaches in both Trinidad and Tobago. This earns substantial revenue from both domestic and foreign ecotourism and has reduced poaching of adult turtles and eggs to a fraction of its former level. Another promising development is a move toward formal designation of a well-preserved, 90-km² forested area in northeastern Trinidad as the Matura National Park, again with community involvement.

SEE ALSO THE FOLLOWING ARTICLES

Antilles, Biology / Endemism / Island Biogeography, Theory of / Relaxation / Sea-Level Change

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