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Mangrove islands

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understanding the evolutionary history of mammalian radiations, as well as new information on how we may conserve these remarkable fauna.

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MANGROVE ISLANDS
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Mangrove islands are islands composed entirely or partially of mangrove vegetation and comprise microcosms of generally high productivity, high biodiversity, and structurally complex habitats in the nearshore environment. Such mangrove islands are largely confined to the tropics, with their latitudinal limits occurring in those regions where water temperatures never exceed 24 °C throughout the year. In comparison to shoreline mangroves, the vegetation of mangrove islands is subjected to much greater fluctuations in hydrological and meteorological conditions, resulting in its high dynamism and leading to its enhanced susceptibility to drastic change.

MANGROVE ISLAND TYPES
Mangrove islands can be subdivided into two broad types: islands consisting only of mangroves and islands where mangroves form a part of the island vegetation. Those mangrove islands consisting only of mangroves commonly occur where sediments have built up sufficiently to form an island at low tide, which has then been colonized by mangroves (Fig. 1). These are known as overwash mangroves as the islands are completely submerged at high tide, and only the mangroves are visible. Such overwash forests are commonly associated with deltas of rivers carrying high terrigenous silt loads (e.g., the Meghna–Brahmaputra delta of Bangladesh or the Fly River delta of Papua New Guinea) or in shallow waters where abundant sediments of biogenic carbonates accumulate (e.g., the overwash mangrove islands of the Florida Keys). Clearly, however, the mangrove vegetation will differ structurally and functionally in the deltaic, ter- rigenous setting from that of the carbonate setting.
intervening mangroves in the lee of the shingle. These are referred to as “low wooded islands” and occur commonly in northeastern Queensland, north of 15° S. Low wooded islands display a complex range of features, which occupy around 30–50% of the reef flat. The windward shingle banks are often partially colonized by mangrove scrub (e.g., Avicennia marina, Aegialitis annulata, Pemphis caroliniana) and other halophytes (e.g., Sarcocornia, Sesuvium, Suaeda), and moats form to the leeward of the shingle ramparts, which retain water at low tide and allow micro-atoll growth (commonly of Porites andrewsi) to occur. The micro-atolls grow upward to mean low water level, and provide a convenient platform for the anchoring of drifting propagules and the subsequent growth of mangroves, which ultimately cover the entire moat with a closed canopy mangrove forest. On the Great Barrier Reef, the primary colonizing species is Rhizophora stylosa, although other species, such as Avicennia marina and Lumnitzera racemosa, quickly follow. In the northern Great Barrier Reef, closed canopy mangroves on low wooded islands consist of around 15 species. Because of the small catchment areas of these islands, freshwater availability is restricted, and mangrove communities on low wooded islands are restricted to regions where the annual rainfall exceeds 1200 mm. Low Isles, off Cooktown in North Queensland, is the most studied low wooded island on the Great Barrier Reef, being originally surveyed by the 1928–1929 Great Barrier Reef Expedition, which spent a year surveying the biota of this island. The island and its mangroves have been surveyed in 1945, 1954, 1965, and 1973, and over that period, the Rhizophora woodland has increased markedly. Some, but not all, other low wooded islands also showed mangrove expansion, and it seems that reef-top topography and the extent of micro-atoll formation appear to be the major factors in the extent of mangrove development. Cyclones are an annual occurrence in this area, and destructive winds can arrest or even reverse mangrove expansion on low wooded islands for considerable periods.

ENVIRONMENTAL SETTINGS OF MANGROVE ISLANDS

As outlined above, mangrove islands occur in two contrasting settings: in river mouth deltas and on reefal platforms. Clearly, the deltaic setting is river-dominated, and the reefal setting is tide-dominated. These dominating factors result in significant differences in the structure and functioning of mangrove islands.

In the deltaic setting, mangrove islands are flooded by river water as well as by tides, so salinity remains moderate. Silt and nutrients are carried by the river water, but they flocculate and are deposited when mixed with seawater. As a result, nutrient-rich sediments are deposited around mangrove pneumatophores and stiltroots on mangrove islands, and luxuriant and diverse mangrove communities rapidly develop. Organic-matter production is generally washed out of the system (strongly outwelling) and replenished by the river-borne nutrient supply. In turn, the outwelling of organic matter trophically supports nearshore food webs, particularly for molluscs, penaeid shrimp, and juvenile fish.

By way of contrast, reefal settings bear the brunt of the tides, which are generally full-strength seawater. Only biogenic sediments are available, brought in by daily tides (bidirectional flux), and nutrients are generally deficient. As a consequence, mangroves are slowed in terms of their organic-matter production, nutrient coupling is usually tight, and organic matter tends to accumulate amongst the vegetation. Reefal mangrove islands are susceptible to erosion, particularly around their periphery, and tend to have less luxuriant mangrove vegetation, often wind-pruned and limited in species richness to those species capable of growing in full-strength seawater. The tendency toward erosion, however, may be offset in this setting, as root material does not break down as rapidly as in deltaic systems and may accumulate as mangrove peat, which facilitates vertical accretion and habitat stability. In Central America, in particular, wherever coring of reefal mangrove islands has been undertaken, peat layers of up to 10 m in depth have been found, and carbon dating suggests that the mangrove communities were initiated through rising sea levels around 8000 years ago and have accumulated peat at a rate that allowed them to keep pace with the rising sea levels of the late Holocene. On the Great Barrier Reef, the mangrove communities of low wooded islands, less reliant on peat accumulation than on micro-atoll growth, were initiated around 6000 years ago.

ECOLOGICAL SERVICES PROVIDED BY MANGROVE ISLANDS

Mangrove islands play an important role in stabilizing and protecting shoaling sand and mud flats. Their roots bind the sediments, and their stiltroots and pneumatophores reduce the water velocity around them, leading to the further deposition of sediments.

Mangrove islands, particularly those associated with deltas, tend to be strongly outwelling. Organic matter is broken down by various biotic and physical process into small particles, and this detritus supports a range of dependent
nearshore species, including penaeid shrimp (prawns) and detritivorous fish, such as mullet (family Mugilidae) and bream (family Sparidae). Many commercial and subsistence fisheries are focused in and around such mangrove islands.

Finally, mangrove islands constitute structurally complex habitats that provide roosting and nesting sites, particularly for bats and seabirds. The surrounding waters, the mangrove vegetation, and the mangrove-associated invertebrates provide a diverse source of food for such nesting and roosting aggregations. On the Great Barrier Reef, around 30 species of seabirds nest on low wooded islands; one species, the Torres Strait pigeon (Myristicivora spilorhoa), relies on such mangrove islands in its annual migrations between Australia and Papua New Guinea. Although such nesting aggregations in the reefal setting bring much needed nutrients, this comes at a physical cost in that dense aggregations of seabirds damage the mangroves (Fig. 2).

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Climate on Islands / Coral / Great Barrier Reef Islands, Biology / Hurricanes and Typhoons / Hydrology / Tides

**FURTHER READING**

**MARIANAS, BIOLOGY**

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The Mariana archipelago is a line of small oceanic islands in the tropical northern Pacific Ocean about 1800 km east of the Philippine Islands. Because of its remoteness from Melanesian and Asian source areas, its small land area, its limited elevational range, and the sparse opportunities for faunal exchange among islands, the native biota of the Mariana Islands is relatively depauperate (species-poor), and native vertebrates are limited to species that can fly (birds, bats) or raft on floating vegetation and withstand contact with seawater (small lizards). Many of these vertebrates have been extirpated, and all but one of the Mariana endemic vertebrates have experienced range reductions consequent to the arrival of humans and human-introduced species.

**BIOGEOGRAPHY**

The Mariana island chain consists of 15 primary islands stretching 920 km from north to south and ranging in size from 541-km² Guam (33.5° N) to 2-km² Farallon de Pajaros (20.5° N). Guam is more than four times the size of the next larger Mariana island (Saipan, at 123 km²) and by itself makes up over half the land area of the Marianas. Guam is also the largest island in Micronesia, the cluster of mostly tiny islands (hence the “micro” in Micronesia) stretching more than 5000 km east–west across the vast area of tropical northern Pacific Ocean west of the International Date Line.

The Mariana Islands arose from the depths of the ocean, in response to melting of the Pacific plate as it pushed under the Philippine plate. Accordingly, none of the islands has ever been connected to a continental land mass or to its neighboring islands. The southern arc of islands (Guam to Farallon de Medinilla) arose at about the same time, during a land-building period that occurred from 42 to 8 million years ago. Although seismically active, the southern arc has experienced no volcanism in the modern era.