Mangroves such as these on Coconut Beach, Samoa, thrive in tough, salty conditions.

MUDDY WATERS

PHOTO: CORBIS

WANTED! PLANTS TO TAKE UP RESIDENCE IN QUESTIONABLE NEIGHBOURHOOD. MUST LOVE MUD, MOSQUITOES, LOW OXYGEN LEVELS, ENDLESS VISITORS AND, MOST IMPORTANTLY, AN OVERDOSE OF SALT.

BY MICHAEL FRANCO

A soggy-looking mangrove forest rooted in sloppy mud is surprisingly tough, even in the face of major forces of nature.

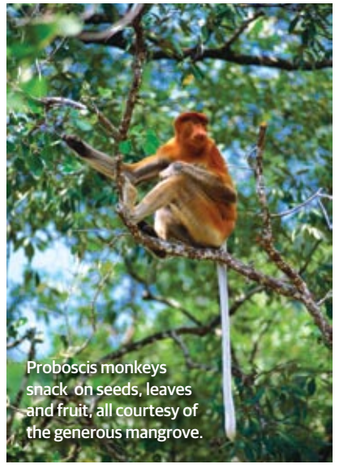
IF MOTHER NATURE RAN AN ADVERTISEMENT LIKE THIS, YOU WOULDN'T EXPECT HER TO GET MANY RESPONSES. YET THERE ARE MORE THAN 110 SPECIES OF PLANTS THAT CHOOSE TO LIVE IN MANGROVE SWAMPS, THE PLACES THAT FIT OUR DESCRIPTION TO A 'T'. CHIEF AMONG THESE IS THE MANGROVE TREE.

Mangroves live in tidal areas regularly flooded by ocean water, so the soil they grow in is extremely salty. Without rain to rinse the soil, mangrove mud can be more saline than the ocean itself.

As a result, mangrove sap is very salty. Dan Alongi, a biologist with the Australian Institute of Marine Science, says it can contain up to ten times more sodium chloride than the sap of non-mangrove plants.

But like most other life forms, mangroves will die if they take in too much salt. So their roots have developed a special ability to suck up seawater, leaving the salt behind. Red mangroves (*Rhizophora mangle*) do this by sending positive ions of magnesium to their roots, which draws water in and salt is kept out by a process of reverse osmosis.

Mangrove roots have also evolved to provide another critical requirement – oxygen. The soil at the base of mangrove trees is often permanently waterlogged, and the little oxygen there is consumed by marauding bacteria. Just one teaspoon of mud from a mangrove swamp in Australia's north Queensland contains more than 10 billion bacteria – among the highest levels found in marine mud anywhere in the world.



Proboscis monkeys snack on seeds, leaves and fruit, all courtesy of the generous mangrove.

PHOTOS: DAVE BULLOCK; GETTY IMAGES

To cope with the bacteria, red mangroves have developed aerial, or prop roots that branch off from the trunk as much as 2 metres above ground, due to which they are called "walking trees" in the US state of Florida. These roots are full of tiny pores called lenticels which breathe in air molecules. Similarly, spongy straws known as pneumatophores around the base of black mangrove trees suck in oxygen from the air at low tide and send it to the roots.

SUCCULENT SALTED LEAVES

The leaves of the mangrove tree also help it survive in its less-than-inviting neighbourhood. They tend to be waxy, thick and succulent, all of which help to prevent the hard-gained water inside from evaporating. Some species, such as the black mangrove (*Avicennia germinans*), are less effective at preventing salt water from entering the roots. But the black mangrove makes up for this by "sweating" out the salt into a crusty layer of crystals on its leaves which is either washed away when it rains, or disposed of when the leaves drop off, according to Alongi.

This smart tree even tackles the tricky business of reproducing in briny conditions. "Most mangroves are viviparous," says Alongi – they "give birth" to embryonic trees that remain on the parent, attached to the branches until seasonal cues, aided by the presence of the hormone abscisic acid, cause them to fall.

Mangroves can't just drop their seeds like other trees do, as they would be destroyed by the salty water. "Root growth is suppressed as long as the embryo remains attached to the parent tree, but once released from the parent there is no dormancy period," says Alongi.

So the baby tree, which is encased in a pod and known as a propagule, can float off and send out a root as soon as the opportunity presents itself. According to Alongi, it is best for the entire mangrove forest if new

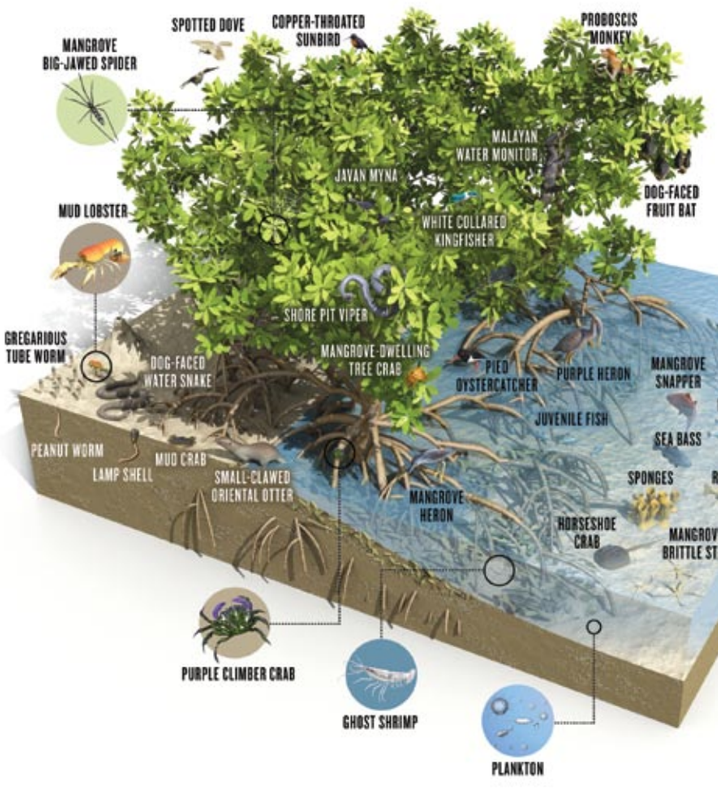
ILLUSTRATION: EMILY COOPER

LIFE AND FOOD IN THE MANGROVES

The mangrove habitat is a superb example of a natural food chain at work, starting from the bottom – literally. The silty mud harbours millions of bacteria, algae and diatoms, all of which use sunlight to photosynthesise sugars that keep them alive. They also consume oxygen.

Next up the food chain are the krill, or tiny shrimps. They hang about in the mangrove roots, eat bacteria and algae, and get munched on by small fish, crustaceans and worms. These in turn are food for crabs, lobsters, mudskippers and medium-sized fish (bass, snapper, catfish), who get preyed on by the big ones – herons, otters, vipers and lizards.

In the vegetarian section of the mangrove forest, bats, spiders, birds and monkeys thrive on leaves and seeds. It's fast food heaven.



MANGROVE MARVELS

- **70:** *species of mangrove trees worldwide*
- **51:** *mangrove species in Asia*
- **25:** *percent of the world's mangroves found in Indonesia*
- **541,176:** *number of mangrove saplings planted in one day in Pakistan in July this year, a world record*
- **22:30 minutes**: *world record for a mangrove swamp run (100-metre)*

The rich diversity and social importance of the Sundarbans delta led to UNESCO World Heritage Site recognition.

trees put down roots some distance from their parents to help the forest spread, so most propagules float considerable distances via tides and currents. At first they drift like little boats in a horizontal position, but become vertical after a month or so. "This makes it more likely that the tip will anchor into mud and be stranded as the tide recedes," says Alongi. Amazingly, the pods can remain viable for up to a year even if they fail to root quickly.

It is this durability that has allowed mangroves to survive for millions of years. "Mangroves with modern-day characteristics first appear in the fossil record in the Late Cretaceous Era, about 80 million years ago," according to Dr Aaron Ellison, senior research fellow in organismic and evolutionary biology at Harvard University. It is theorised that the plants which managed to live in or near brackish water evolved into today's mangroves, in an area of ocean near today's Mediterranean Sea called the Tethys Sea. They spread from there and can now be found around the globe between the balmy latitudes of 32˚N and 38˚S. They cover approximately 180,000 square kilometres of the Earth's surface, with the greatest number of different species found in Southeast Asia.

MANGROVES ACT AS SHELTERED NURSERIES. IT IS ESTIMATED THAT 75 PERCENT OF ALL COMMERCIAL TROPICAL FISH SPECIES SPEND AT LEAST A PART OF THEIR LIVES IN MANGROVES.

FOOD FINDER

Mangroves have long been a source of food for indigenous people around the world. Aboriginal tribes in Australia rely on mangroves to provide a variety of fruit, nectar, worms, mussels and oysters, and mud crabs are enjoyed by cultures throughout the Asia-Pacific region.

PHOTOS: CORBIS; GETTY IMAGES

TOUGH LOW LIFE

A stunning variety of life is hidden among the maze-like root systems of the mangrove trees, beginning with bacteria that eat the decaying leaves and other plant matter that falls to the soggy swamp floor. Mangrove swamps are also home to various algae including a type known as diatoms, which secrete mucus that helps bind the soil together. Mangroves slow down water moving through the inter-tidal area, trap sediment, reduce coastal erosion and attenuate wind energy from hurricanes and cyclones. "They may help in dissipating energy and water flow during storms and tsunamis," says Ellison.

All this muddy interaction helps break down plant matter into a form that can be eaten by mangrove-dwelling animals, like the crustaceans found in abundance - in particular fiddler crabs (*Uca pugnax*), perhaps the most visible occupants. With one large and one small claw, these jolly-looking tenants play a critical role in mangrove ecology - their foraging and burrowing helps aerate the earth, keeping microbes and plants healthy. Other animals found in mangroves include a multitude of snails; the upside-down jellyfish (*Cassiopeia xamachana*); mudskippers that can climb trees and "walk" across the mud; and mangrove snakes, sometimes called cat snakes due to their feline eyes.

COAST GUARDS

On May 2, 2008, with winds over 200 kilometres per hour, Cyclone Nargis slammed into Myanmar and tore up the Irawaddy Delta, the country's main rice growing region. It left in its wake enormous swathes of destruction, both in terms of lives and livelihoods, as well as ecological damage. Sadly, according to a report by the Food and Agriculture Organization, if the country had not cleared so much of its mangroves, the destruction by Nargis would have been less. The report states: "Healthy mangrove forests are particularly good at reducing the force of waves because of the resistance provided by stilt roots as well as the trees' trunks and branches." It goes on to note that the Sundarbans mangrove forest in southern Bangladesh helped that area survive the onslaught of Cyclone Sidr in 2007.

PHOTOS: CORBIS

The FAO says 20 percent of the world's mangroves have been destroyed since 1980: bad news for the life forms which they sustain, such as these barnacles growing on roots in a Florida swamp.

MANGROVE MATTERS

But mangroves are in danger. The Food and Agriculture Organization (FAO) of the United Nations estimates that in the past 25 years, 3.6 million hectares have been lost, cut down to make way for farmland, shrimp breeding and wood. Mangroves' most deadly enemy is not challenging locations, atmosphere or parasites - it is man. The number one reason for the downward spiral in Asia is clearing for agriculture, followed by appropriation for aquaculture and urban development. Unless these trends are reversed, mangrove forests look set to decline at the rate of around 1 percent per year, albeit a slower rate than in years past.

But hope lies in the tough nature of mangroves themselves. As Alongi says: "Living in a comparatively harsh environment has prepared most mangrove forests to survive well into the future." If current rates of deforestation can be reduced, that is. And that's our job. ■

25: *maximum height in metres to which mangroves can grow*

6,000: *number of rare Irawaddy dolphins recently found in the mangrove swamps of Bangladesh*

66: *number of days the mangrove killifish can live out of water*

20,400: *size in square kilometres of world's largest mangrove forest, the Sundarbans*