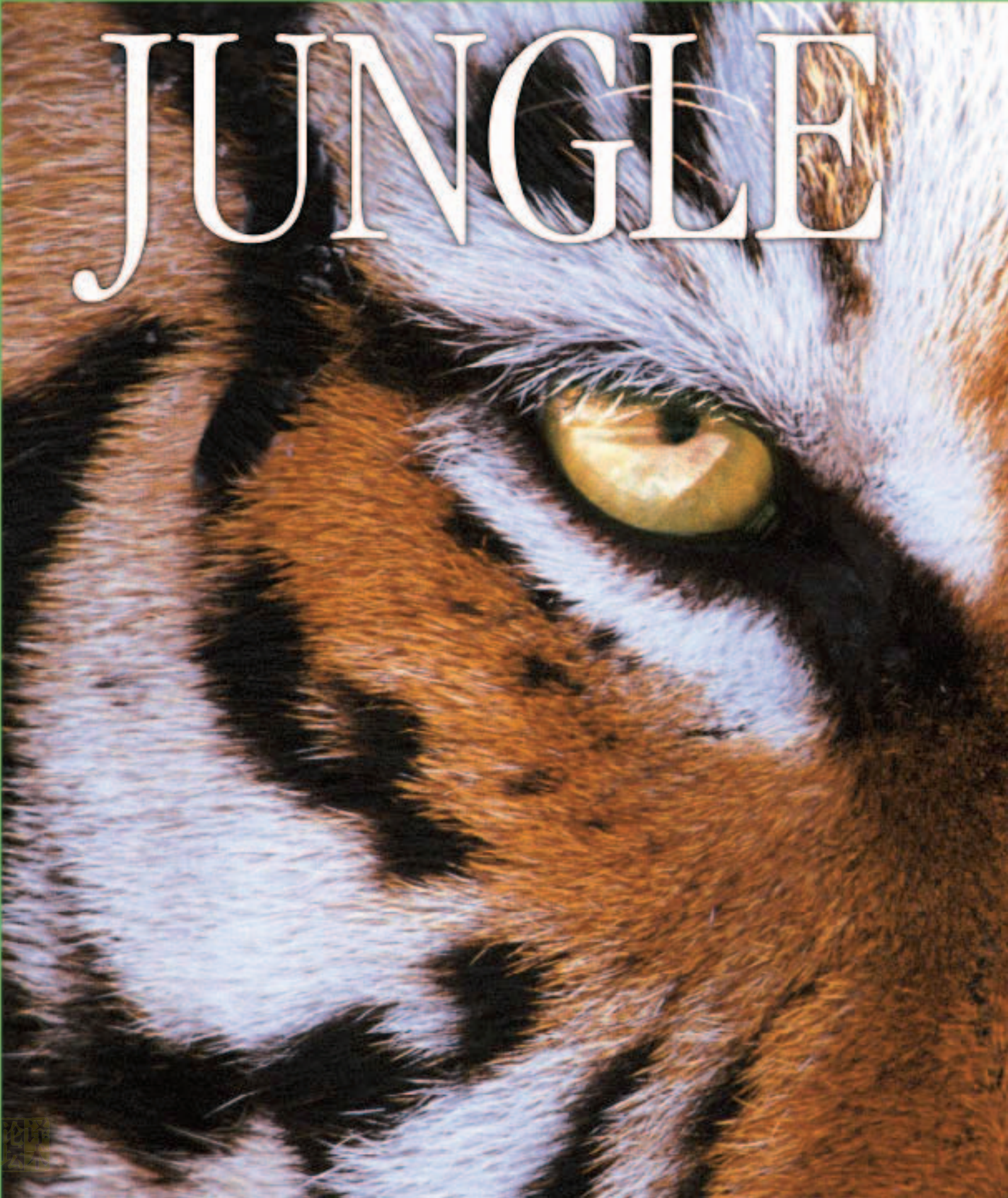




Eyewitness



# JUNGLE



# Eyewitness Jungle





White-lipped  
tree frog  
*Litoria infrafenestrata*



Medicinal  
calabar beans  
*Physostigma  
venenosum*



*Clerodendrum  
splendens*

# Eyewitness Jungle

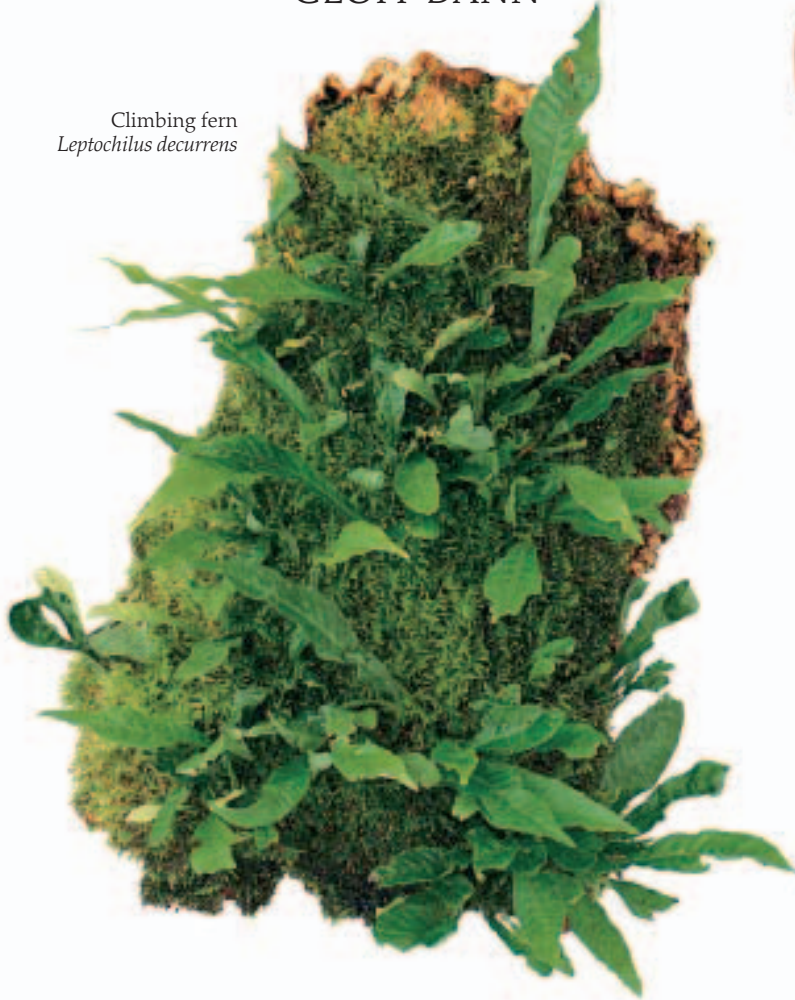
Written by  
THERESA GREENAWAY

Photographed by  
GEOFF DANN



Medicinal  
Heckel  
chewstick  
*Garcinia kola*

Climbing fern  
*Leptochilus decurrens*



Stone ax  
(Guyana)



DK Publishing



Spear (Guyana)



Cassava  
squeezer  
(Guyana)



Serpent carved  
paddle (Papua  
New Guinea)



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Pacu  
*Colossoma oculus*



Passion flower  
*Passiflora sp.*

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Red-kneed tarantula  
*Brachypelma smithi*

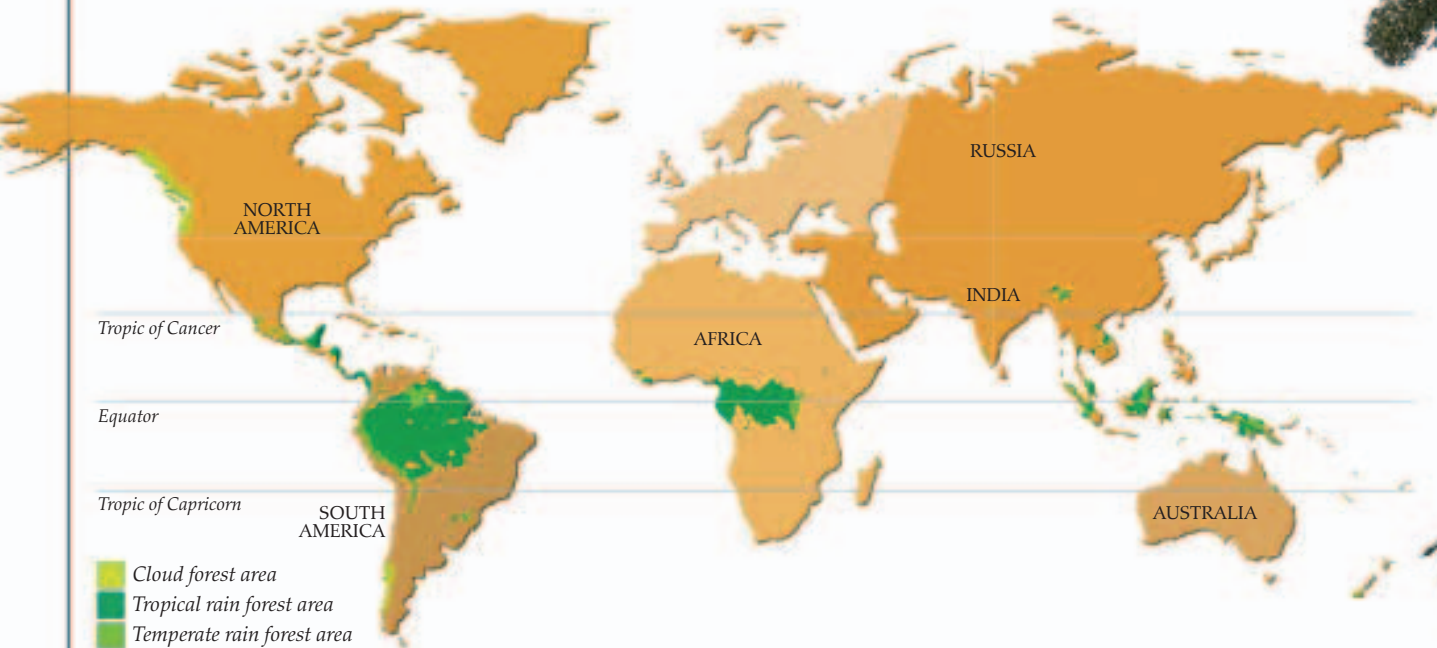
# What is a rain forest?



## COLOR IN THE CANOPY

Splashes of color in the canopy may indicate that a tree has burst into flower. It is just as likely that a flush of red, orange, pink, or white new leaves has unfurled.

**STRUCTURALLY COMPLEX** and ages old, rain forests cover only about six percent of Earth's surface, yet they are extremely diverse, containing over half of all known animal and plant species. Most people associate rain forests with tropical areas but they are also found in temperate coastal regions that have suitable climates. Tropical rain forests are typically found in the lowland areas of river basins, such as the Amazon and Congo. The equatorial climate is ideal for plant growth because it is consistently hot, wet, and humid. Also, because tropical rain forests lie between the Tropics of Cancer and Capricorn they experience about 12 hours of sunlight every day all year round, which means there are no limitations on the growing season. Tropical rain forest is frequently described as being luxuriant and spectacular, but, sadly, today the most apt term to use is "disappearing."



## WARM AND VERY WET

Temperate rain forests are usually found on the western side of land masses where rainfall exceeds 58 in (1,500 mm) a year and air currents carry moist air inland. Like cloud forest, these can be windy and temperatures vary. Tropical forests have a more constant environment with average temperatures of 77°F (25°C) and rain most days.

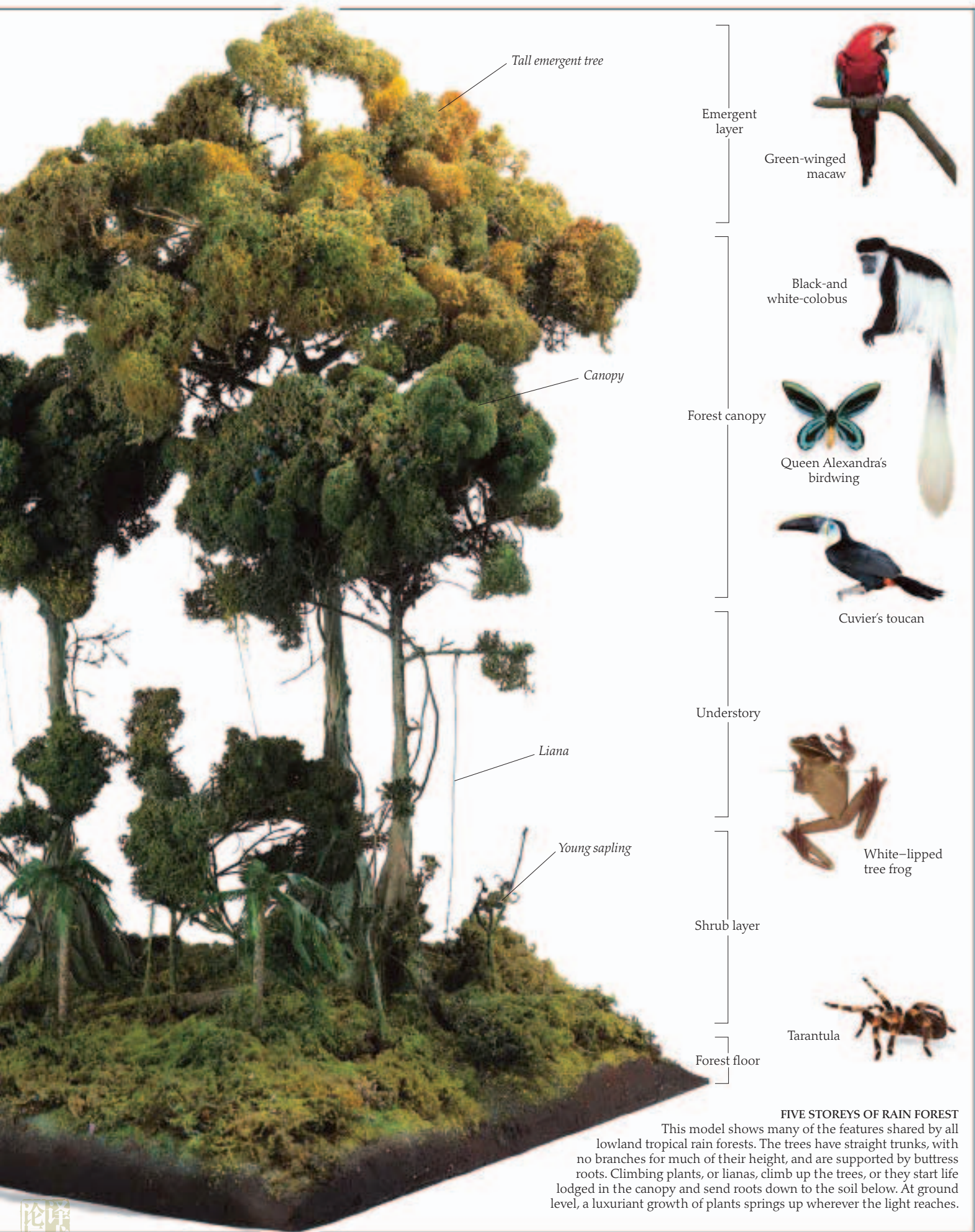
## THE FOREST FLOOR

Swamp forest soils are regularly enriched by silt-laden flood waters. Away from flooded area, much of the lowland forest has surprisingly poor, infertile soils called oxisols. Nutrients are locked up in living plants and animals until released by organisms such as termites and fungi.



Undergrowth

Palm tree



Tall emergent tree

Emergent layer

Green-winged macaw

Canopy

Forest canopy

Black-and white-colobus

Queen Alexandra's birdwing

Cuvier's toucan

Liana

Understory

White-lipped tree frog

Young sapling

Shrub layer

Tarantula

Forest floor

**FIVE STOREYS OF RAIN FOREST**

This model shows many of the features shared by all lowland tropical rain forests. The trees have straight trunks, with no branches for much of their height, and are supported by buttress roots. Climbing plants, or lianas, climb up the trees, or they start life lodged in the canopy and send roots down to the soil below. At ground level, a luxuriant growth of plants springs up wherever the light reaches.

# Types of rain forest



## MONTANE FOREST

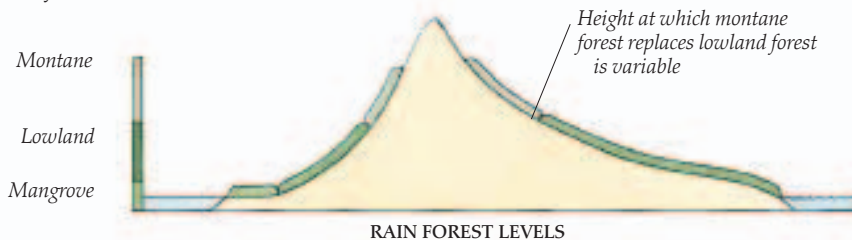
In Malaysia, lowland rain forest gives way to lower montane forest at altitudes of about 3,300 ft (1,000 m). The climate is cooler, but still moist. There is dense tree cover, but the height of the canopy gets lower and lower. The trees have smaller leaves and tree ferns are abundant, as are magnolias, rhododendrons, myrtles, and laurels.

THERE ARE A NUMBER of different types of rain forest. Tropical lowland rain forest is found near the equator and gets about 80 inches (200 cm) of rain a year. Nearer to the Tropics, conditions become more variable, especially in Asia, which has a monsoon climate. Here the rain forest is different because it is subject to seasonal changes, and has only 50 inches (125 cm) of rain a year. In coastal areas, the rain forest species are often replaced by mangroves. Tropical rain forest also changes with increasing altitude. It is richest and most diverse in lowland areas, progressing to montane forest at about 3,300 ft (1,000 m). High montane forest at over 6,600 ft (2,000 m) is often enveloped in cloud and mist—hence, its alternative name of cloud forest. A few temperate coastal regions that have suitable climates and at least 58 in (145 cm) of rain a year also support rain forest but, unlike tropical rain forests, the majority of the trees are evergreen rather than deciduous.



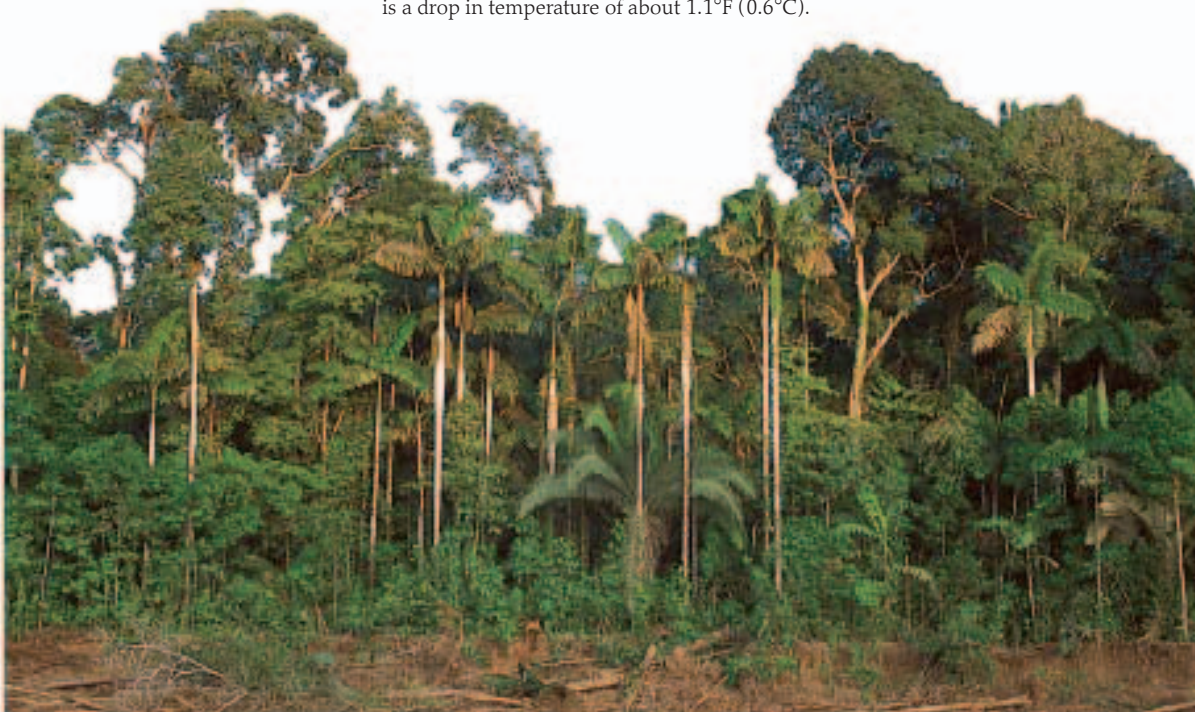
## CLOUD FOREST

At higher altitudes, a permanent heavy mist envelops the forest. The climate of cloud forests, such as the Maquipucuna Reserve in Ecuador, is cool and very damp. Moisture in the mists condenses on the surface of the leaves and constantly drips from them. Mosses and liverworts cover everything with a spongy blanket. Because of the lower temperatures, the leaf litter decomposes very slowly. A thick layer builds up on the ground, eventually turning into peat.



RAIN FOREST LEVELS

Lowland rain forest can reach right down to the coast. Wherever there are the right conditions, mangrove forest extends along the coast and into river estuaries. With every 330 ft (100 m) increase in altitude, there is a drop in temperature of about 1.1°F (0.6°C).



## LOWLAND RAIN FOREST

Viewed from the river, the Rio de Los Amigos, the structure of this lowland rain forest in Peru is clearly visible. In the foreground, young climbers, ferns, and saplings flourish in the increased light levels beside the river. A cycad, a remnant of a truly ancient group of plants, also grows in this clearing. Tall palms make up a large proportion of the canopy. Towering over them are the umbrella-shaped crowns of the rain forest's huge emergent trees.





Scarlet ibis  
*Eudocimus ruber*  
(South America)

#### LIVING IN A SWAMP

Perhaps the most spectacular inhabitant of South American mangrove swamps is the scarlet ibis. It nests and roosts in large colonies. By day, it feeds on tidal mudflats or in the shallow waters of lagoons or beaches, probing for shellfish and worms with its long bill. As dusk approaches, a whole flock wheels and circles against the sky before flying into the mangroves to roost.

#### STILT ROOTS

The palm *Verschaffeltia splendida* is found naturally only in the rain forests that cover the steep hillsides of the Seychelles islands. There, the wet, rocky ground has a thin layer of soil. Thick stilt roots grow out from the lower part of the trunk. They give the palm firmer anchorage on difficult terrain.

Stilt palm  
*Verschaffeltia splendida*  
(Indian Ocean)



#### MANGROVES

Deep layers of mud and silt accumulate along sheltered tropical coastlines and in river estuaries. A number of different kinds of trees, collectively known as mangroves, colonize these muddy shores and form swampy forests. The mud and the warm, shallow seawater that ebbs and flows are very low in oxygen. So that their roots can breathe, mangroves have pneumatophores—roots that stick up above the mud and take in oxygen from the air through large pores or lenticels. The *Rhizophora* pneumatophores (above) grow in a tangle of arches; others are like knobby knees or narrow spikes.

New stilt root growing out from trunk

Splayed out stilt roots improve anchorage



# At the top

ALL EMERGENT TREES tower above the rest of the jungle canopy, a few reaching heights of 200–230 ft (60–70 m). These scattered trees have straight trunks, often buttressed at the base and with a cauliflower-shaped crown. It is hotter and drier at the top of the canopy, with greater changes in temperature and humidity. The trees are also much more windblown, and the fruit or seeds of some species are dispersed by the moving air. Many emergent trees are leafless for short periods of time, but seldom all shed their leaves at once. The epiphytes that live on the boughs of these trees include drought-resistant species of bromeliads, lichens, and cacti.



#### MONKEY BUSINESS

The striking black-and-white colobus monkey lives right at the top of the jungle, feeding on leaves.



Sun conure  
*Aratinga solstitialis*  
(South America)

#### FLYING FORAGER

Conures live in noisy flocks high up in the treetops. They fly restlessly from tree to tree, feeding on flowerbuds, fruits, seeds, and insects. They often eat unripe seeds.

Leaves have a waxy surface



#### PENANG FOREST

Tualang trees (*Koompassia excelsa*) often reach 230 ft (70 m)—but an 285 ft (87 m) tualang holds the record for a broadleaved rain-forest tree. Malaysians believe that spirits live in these trees.

#### GREEN SHADES

The tall canopy tree *Carapa guianensis* belongs to the mahogany family, and is found predominantly in swampy or seasonally flooded parts of the forest. Mature trees may produce 300 or more large, corky fruits that split into four segments, each containing two or three large seeds. Most of these are eaten by animals.

Crabwood  
*Carapa guianensis*  
(Central and South America)



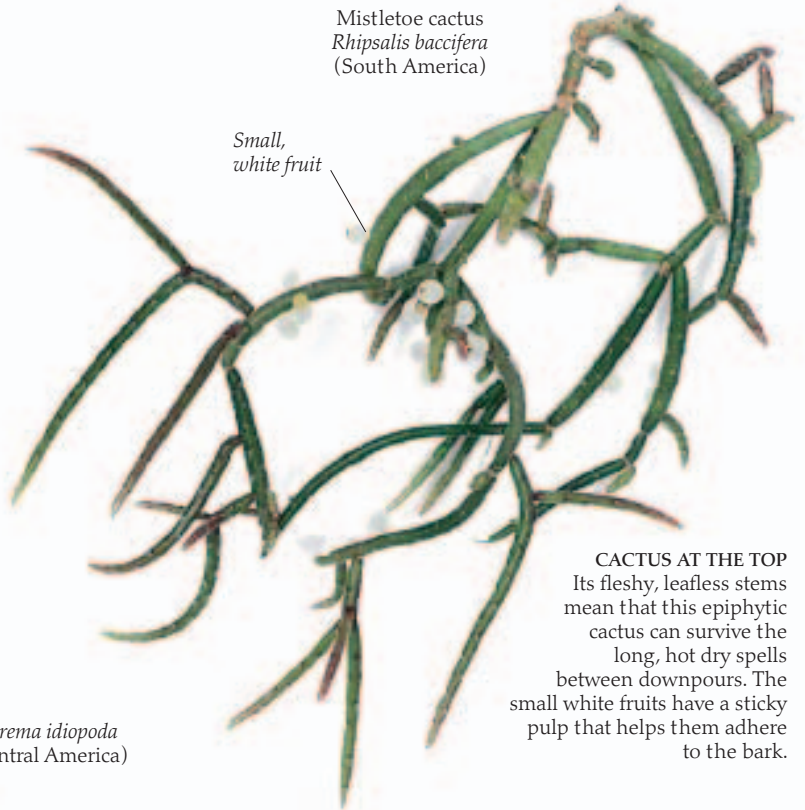
**EAGLE-EYED**

One of the world's largest eagles, the harpy leaves its post in a tall emergent tree to swoop with speed and agility through the canopy. Its exceptionally strong legs and immense talons are used to snatch howler monkeys or sloths, wrenching them free from a tightly grasped branch. Harpy eagles use the same nest site every year. They build a bulky nest of sticks lined with leaves and fur in the boughs of an emergent kapok tree, 165 ft (50 m) or so above the ground.



Harpy eagle  
*Harpia harpyja*  
(Central and South America)

Mistletoe cactus  
*Rhipsalis baccifera*  
(South America)



Small,  
white fruit

**CACTUS AT THE TOP**  
Its fleshy, leafless stems mean that this epiphytic cactus can survive the long, hot dry spells between downpours. The small white fruits have a sticky pulp that helps them adhere to the bark.

*Abarema idiopoda*  
(Central America)

Young  
developing leaf



Bipinnate leaf

**LEAF DIVISION**  
Rain forest trees have large leaves. These are either simple leaves with a waxy surface and a smooth outline, or leaves that are divided into separate leaflets. *Abarema* is bipinnate—its leaves are twice divided and have small leaflets. *Carapa* and *Abarema* are leafless for brief periods, normally when there is a dry spell, or the tree is flowering.



**LIFE IN THE CANOPY**  
This male tawny rajah (*Charaxes bernardus*) is one of many kinds of butterfly that may spend its entire life cycle up in the forest canopy.

# Forest canopy

**I**N THE CANOPY of a rain forest, reaching 80–150 ft (25–45 m) above the ground, it is always green and leafy. The crown of each tree is taller than it is broad, making a sun-speckled layer around 20–23 ft (6–7 m) thick. This leafy roof shields the ground and absorbs most of the sunlight. It also lessens the impact of heavy rainfall and high winds. The teeming life of a jungle canopy is only glimpsed

from below. Some creatures are so well adapted to their treetop existence that they seldom, if ever, descend to the forest floor. It is difficult even to match up fallen fruits or flowers with the surrounding tree trunks. Many species were totally unknown—or their numbers grossly underestimated—before walkways strung up in the canopy allowed biologists to research and find out what life was really like in the treetops.

**REACHING THE HEIGHTS**  
Lianas are plants that need a lot of light, which they have to compete for against tall rain-forest trees. By using these trees for support, the lianas do not invest energy and materials in a thick trunk of their own. Instead, their slender climbing stems reach the canopy, and the light, very quickly. Once up among the branches, they loop through the treetops, growing leaves, flowers, and fruit.

White-lipped tree frog *Litoria infrafrenata* (Australasia)



**SAFE ASLEEP?**  
Canopy-dwelling creatures such as this silky anteater (*Cyclopes didactylus*) need to cling tightly to the branches. Sharp claws and a long, prehensile tail are adaptations shared by completely unrelated canopy animals.



Liana  
*Clerodendrum splendens*  
(Africa)

**STICKY-TOED TREE TRAVELER**  
To avoid the hottest part of the day, thin-skinned tree frogs hide in damp, leafy crevices among canopy epiphytes. The smaller tree frogs may spend their entire lives in the canopy, even breeding in the reservoirs of water trapped by bromeliad leaves. Others, such as this white-lipped tree frog, laboriously make their way down to forest pools to mate and spawn. Long legs and sticky toe pads enable them to climb with consummate ease.

*Cecropia glaziovii*  
(Central and South America)



**CANOPY FOLIAGE**

The large leaves of lowland rain-forest trees may be simple in shape, or divided into leaflets or lobed. The canopy remains leafy all year, but within it, some trees shed their foliage for short intervals—sometimes as little as a few days.

Leaf-fall usually coincides with the driest time of the year, but it is not always synchronized, even in trees of the same species.

Large lobed leaf



Sacred fig  
*Ficus religiosa*  
(Southeast Asia)

**DRIP TIPS**

This typical rain forest leaf has a shiny, waxy surface, and it is drawn out into a narrow point, or drip tip. Both these features are designed to encourage rainwater to run off quickly. This prevents the growth of minute algae and liverworts.

**FLEETING BEAUTY**

Completely invisible from the ground, epiphyte-laden boughs are like treetop gardens. Of all the different plants perched on these branches, orchids are among the most fascinating. The perfect white orchids (right) last just one day.

One-day orchid  
*Sobralia sp.*  
(Central America)



**INSECT LIFE**

Only some canopy insects have been classified and named, like this click beetle (*Chalcolepidius sp.*). Even then, little is known about them.

# The forest floor

IN LOWLAND RAIN FOREST close to the equator, the air near the forest floor is still and sultry. Only about two percent of light reaching the canopy penetrates the thick blanket of foliage. Small plants that do not need much light, such as ferns and mosses, grow here. Only when a tree falls can lianas, saplings, and other herbaceous plants get the light they need to grow and they do so rapidly. Monsoon rain-forest canopies are much more open and because there is more light, there is a vigorous growth of vegetation in the understory and on the forest floor.



**FOREST FUNGI**  
Bacteria, molds, and fungi such as this pink agaric fungus, *Marasmius*, grow very quickly in the humid conditions of the forest floor. A mass of fungal threads called a mycelium takes nutrients from the litter of dead leaves, and spores are produced by the brightly colored toadstools.



**A SPLASH OF COLOR**  
A luxuriant growth springs up wherever there is enough light. Heliconias, with their bright red flowerheads, are widespread in Central American jungles.



**TRAPPING LIGHT**  
The leaves of *Fittonia* contain red pigments that trap light and make good use of the dim conditions. Amerindian tribes use the plant to treat a variety of ailments.

Nerve or mosaic plant  
*Fittonia albivenis*  
(South America)

*Diplazium proliferum*  
(Southeast Asia)

Bulbil

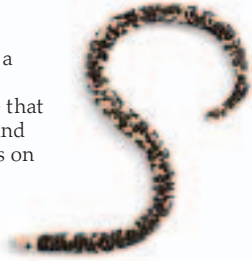
**FLOURISHING**  
Ferns thrive best where it is warm and damp, and many tolerate low light levels, so they are abundant on the jungle floor. This fern produces bulbils on its fronds that will sprout and take root, either when they are knocked off, or when the frond dies.



**SHADE LOVER**  
Each long-stalked leaf of the Elephant's ear plant, *Alocasia thibautiana*, has silvery veins on top, and is purple underneath. Clumps of these shade-loving aroids can grow in the gloomiest parts of Southeast Asian jungles—on the forest floor beside streams, and even in the entrances of limestone caves.

#### BURROWING WORM

The black and white worm-lizard, (*Amphisbaena fuliginosa*) is neither a lizard nor a snake. It is an amphisbaenid—a wormlike reptile that lives in burrows in the damp soil and leaf litter of the forest floor. It feeds on worms and other invertebrates, detecting prey by touch.



Banded pitta  
*Pitta guajana*  
(Malaysia)

#### BROWSING BIRD

The pitta finds invertebrates on the forest floor, using its good eyesight and sense of smell. It breaks snail shells on rocks.

#### BUTTRESS ROOTS

These enormous roots are characteristic of lowland tropical rain forest. The curving shapes rise from lateral roots that run at or near the surface of the ground. Buttress roots may spread up the trunk to 30 ft (9 m), forming supporting wings of particularly hard wood.



# In the water

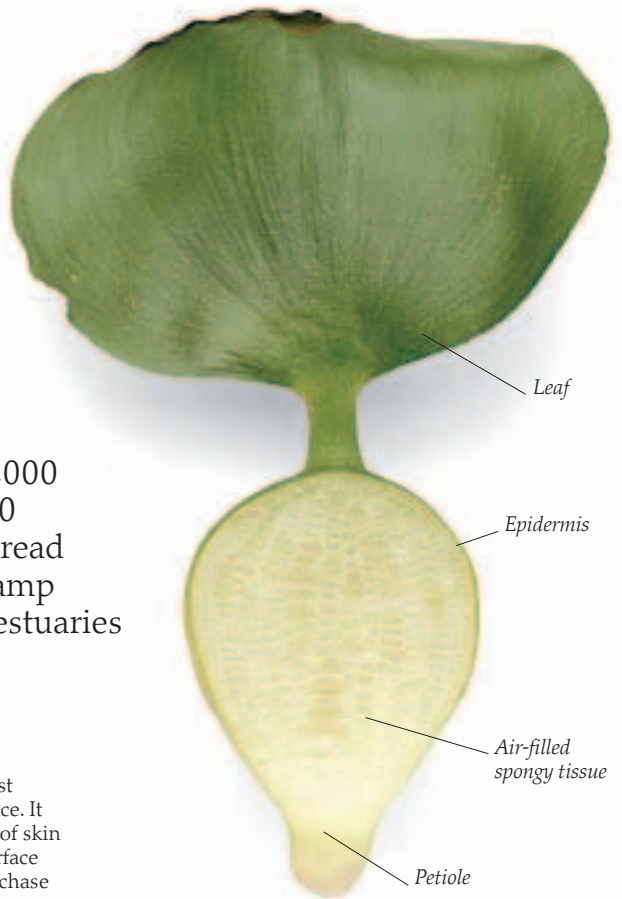


## WELL CAMOUFLAGED

Lurking immobile in shallow water, the craggy carapace of the matamata (*Chelus fimbriatus*) looks like a rock. This Amazonian turtle has nostrils at the tip of its long, upturned snout, which is used like a snorkel as it lies in wait for prey.

THE RAIN FOREST is awash with water. It drips from the leaves, collects in puddles, runs down mountainsides, and eventually drains into huge, meandering rivers. The Amazon is the largest river of all—together with its tributaries,

which number 1,000 or more, it holds two-thirds of the world's freshwater. There is an incredible diversity of life supported by this vast water system. It contains around 5,000 species of freshwater fish, and there may be another 2,000 awaiting discovery. Where rain forest rivers flood, they spread nutrient-rich silts over the surrounding land, creating swamp forests. When they join the sea, more silt is deposited in estuaries and deltas, contributing toward mangrove swamps.



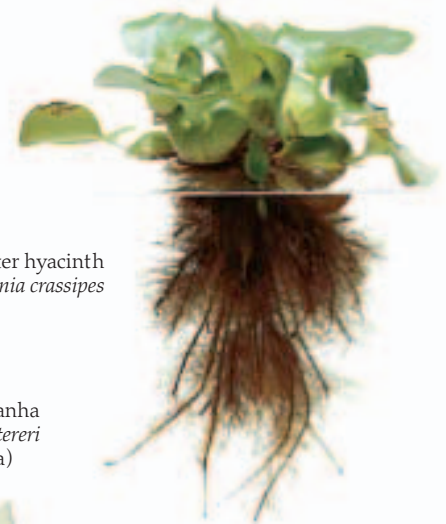
## WATER HYACINTH

To keep the water hyacinth afloat, and the right way up, the base or petiole of each leaf stalk is swollen into an air-filled float. Cutting this in half reveals that each float is made up of a mass of air-filled spongy tissue. The leaf and stem are encased in a smooth, tough skin, or epidermis.



## RUNNING ON WATER

The Jesus Christ lizard runs fast using its tail as a counterbalance. It has flattened scales and a flap of skin on its hind toes to increase surface area, so it can run on water to chase prey or escape danger.



Water hyacinth  
*Eichhornia crassipes*

Pacu  
*Colossoma oculus*  
(South America)

## FRUIT-EATING FISH

The varzea and the igapo are two areas of swamp forest flooded every year by the Amazon. Fruits falling from palms and other trees attract fish such as the pacu.



Red-bellied piranha  
*Serrasalmus nattereri*  
(South America)



## DANGER IN THE WATER

Formidably armed with rows of sharp, triangular teeth, the fiercely predatory piranha is dangerous only in the dry season, when water levels are low and the fish gather in shoals of 20 or more. By feeding collectively, the fish are able to tackle large animals, although their usual prey is other fish, mollusks, fruits, or seeds.

## FLOATING PLANT

The water hyacinth (above) floats with its feathery roots dangling down into the water. The plants grow very quickly, forming large rafts on the surfaces of lakes and slow streams. Smaller clumps are dispersed by the wind, blown along like small, unsinkable sailing ships.



**DANGER ON THE RIVER BANK**

Few carnivores would tackle a large anaconda moving lazily along the river's edge. Anacondas keep close to swamps or streams, but they can also climb trees. Exceptional individuals have been recorded at 30 ft (10 m) or more, but most anacondas are smaller than this. They are excellent swimmers, preying on animals that come to the water to drink, and killing their prey by constriction and drowning. Younger anacondas are more likely to be preyed on, and use their swimming skills to escape. The females give birth to 9 in (23 cm) long live young in the water.

Green anaconda  
*Eunectes murinus gigas*  
(South America)

Smooth, shiny scales keep friction to a minimum when swimming

Underside yellow with black markings

Black blotches break up outline and are a good camouflage

Broad leaves to absorb sunlight



Stolon

Water lettuce  
*Pistia stratiotes*

Finely branched roots



**SWAMP PLANT**

Air spaces in the leaves keep the water lettuce rosette buoyant. Each leaf is covered in a layer of water-repellent hairs and is waterproof. New rosettes sprout from stolons (slender stems) that grow out sideways beneath the surface.

Mudskipper  
*Periophthalmus barbarus*

Large gill chamber fills with water so oxygen from the water can be used to breathe when on land



**LAND CREATURES?**

When the tide goes out, the mudskipper stays behind on the exposed mudflats of mangrove swamps. Using its fins for support and balance, it flips its body rapidly from side to side, skipping across the mud.

**SHOVEL-NOSED CATFISH**

Hiding beneath water plants by day, this fish (right) forages on the riverbed at night. Three pairs of long sensory barbels help it to feel its way around. The catfish pokes its long, flattened snout into mud and debris to scavenge for food, as well as taking live prey such as worms and small fish.

Shovel-nosed catfish  
*Sorubim lima*  
(South America)



# Epiphytes



**PLATYCERIUM**  
The bracket fronds of the large epiphytic elk horn fern, or *Platycerium*, loosely clasp the tree trunk, so that a litter of plant debris collects behind it. This compost is moistened by rainwater trickling down the trunk and a rich humus develops into which the fern grows roots. Hanging clear of the trunk are the fertile, spore-bearing fronds.

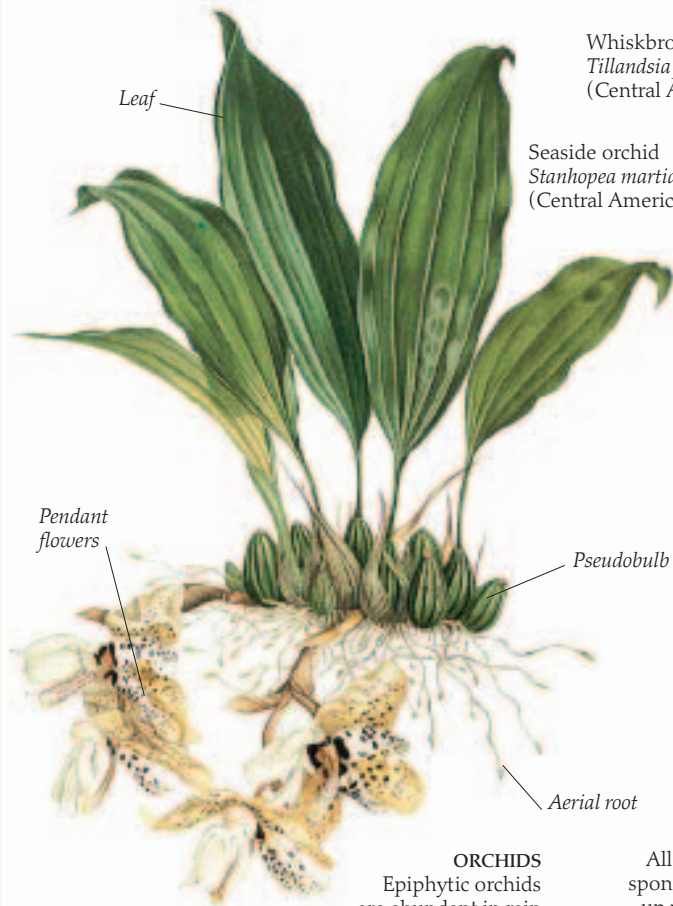
UP IN THE RAIN FOREST treetops, a special group of plants clothe the branches so thickly that the bark is completely hidden. These plants are called epiphytes, or air plants. They anchor themselves to the stems, trunks, branches, and even leaves of other plants. They do not take either water or food from their hosts. Instead, they use them simply as a means of reaching the light. After heavy rain, the combined weight of epiphytes and the water they have trapped can be enough to bring down whole branches. In the wettest forests, up to 25 percent of flowering plants and ferns are epiphytes, and there are many more kinds of mosses, liverworts, and lichens. The highest numbers of epiphytic species are found in Central and South American forests.



Whiskbroom airplant  
*Tillandsia juncea*  
(Central America)

Seaside orchid  
*Stanhopea martiana*  
(Central America)

*Dischidia lanceolata*  
(Asia) has flowers that stick clumps of pollen onto the legs or body of insect pollinators

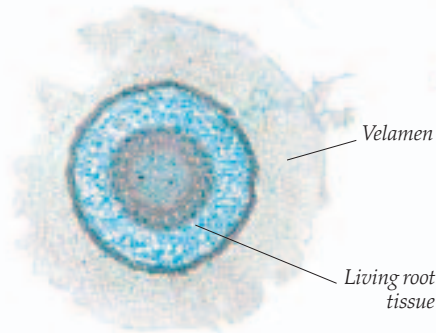


Leaf

Pendant flowers

Pseudobulb

Aerial root



Velamen

Living root tissue

## AERIAL ROOTS

All orchid roots are surrounded by a thick, spongy layer, the velamen. The velamen soaks up water and dissolved nutrients. Although some of this is gradually absorbed, most stops the roots from drying out. Even after the water has evaporated, the white walls of the empty velamen cells reflect light and heat, so protecting the living root tissues.

## ORCHIDS

Epiphytic orchids are abundant in rain forests. Many have pseudobulbs, or "false bulbs."

These are swollen segments of stem in which water is stored. *Stanhopea* orchids have tightly packed clusters of ridged pseudobulbs, each one with a single leaf.

Bird's nest anthurium  
*Anthurium salviniae*  
(Central America)

This aroid has leaves that channel water down to a detritus-catching mat of roots

This plant absorbs water from the air through scales on the leaves

An aroid with silver-veined leaves that have a velvety upper surface

#### WATER TANKS

Epiphytic bromeliads, or urn plants, are found in New World rain forests. Each plant has a rosette of stiff leaves around a short stalk. The tightly overlapping leaf bases form a series of cups that collect rainwater. Plant fragments also become trapped, releasing nutrients into the water as they rot. Both water and dissolved minerals are absorbed by the bromeliad through specialized hairs on the leaf surface. These high-rise pools support an incredible number of aquatic insects and invertebrates. Some frogs even breed in them.



Silver vase bromeliad  
*Aechmea fasciata*  
(South America)

Flamingo flower  
*Anthurium crystallinum*  
(South America)



Hollow oncidium (orchid)  
*Oncidium excavatum*  
(South America)

Spanish moss  
*Tillandsia usneoides*  
(Central America)

Young seedlings like this have anchoring roots; the mature air plants are a tangle of stems and very narrow leaves

## Branching out

Heavy rain soon drains through the canopy, and the sunshine, although patchy, is very hot. This means that water and dissolved nutrients can be in short supply. Because of this, epiphytes share many of the characteristics of plants that grow in arid conditions. The leaves have a thick, waxy, waterproof outer layer to reduce evaporation and are arranged so that rainwater is funneled to the roots. The decomposing organic remains caught in water traps provide a source of fertilizer.

Scarlet star  
*Guzmania lingulata*  
(Central America) is a bromeliad that prefers shade

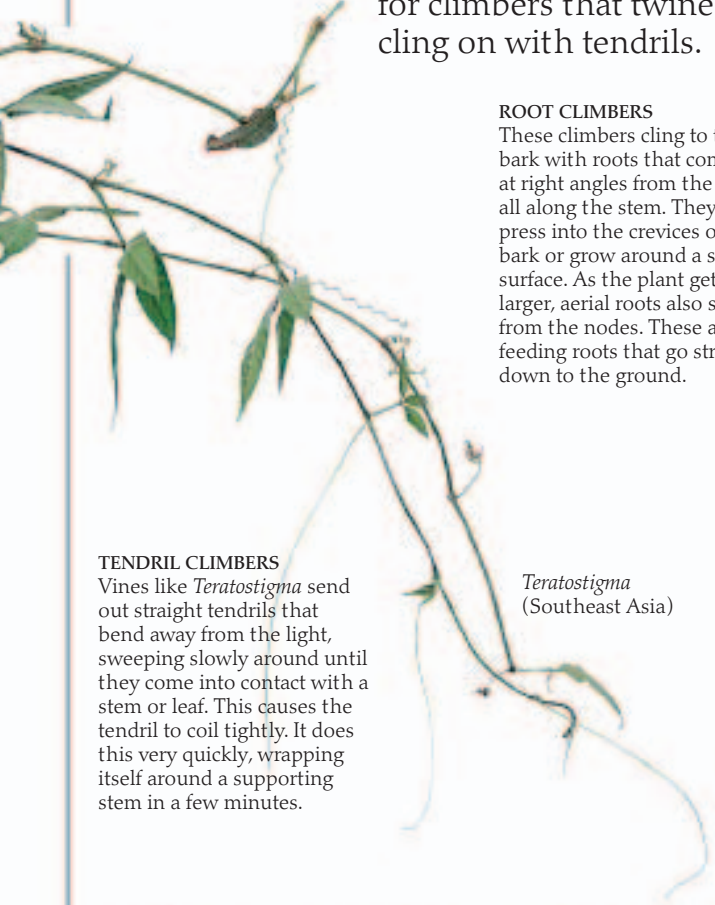
*Aechmea purpurea-rosea* (Brazil)

# Climbers



**BLACK SPIDER MONKEY**  
Spider monkeys spend all their time in the trees, using their long limbs and tail to grip the branches or swing on lianas.

ONE OF THE MOST impressive features of a tropical forest is the abundance of climbing plants, or lianas. Some lianas grow to a huge size, with long stems that climb in search of light to the forest canopy, looping from branch to branch and linking the crowns of trees. Once up in the canopy, they develop branches that bear leaves and flowers. Lianas also send aerial roots down to ground where the roots bury themselves in the soil. These long roots become woody, and in turn act as supports for climbers that twine or cling on with tendrils.



**TENDRIL CLIMBERS**  
Vines like *Teratostigma* send out straight tendrils that bend away from the light, sweeping slowly around until they come into contact with a stem or leaf. This causes the tendril to coil tightly. It does this very quickly, wrapping itself around a supporting stem in a few minutes.

*Teratostigma*  
(Southeast Asia)

*Rhaphidophora decursiva*  
(Southeast Asia)

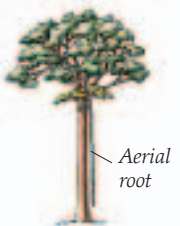


Creeping philodendron  
*Rhaphidophora decursiva*

Node



Rex Begonia  
*Begonia serratifetala*



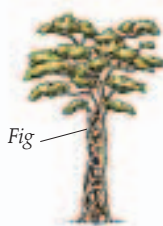
Aerial root

The fig sends aerial roots to the ground, where they spread through the soil



Mesh

Roots grow branches that form a woody mesh around the trunk of the host



Fig

Fig kills the host tree by strangulation and by blocking out its light

**STRANGLERS**  
Strangler figs destroy host trees when they grow. They begin life as epiphytes, and become very tall trees. Eventually the host tree dies, leaving a hollow where the trunk once was.

## GROWING TOGETHER

Strong climbing plants such as *Rhaphidophora decursiva* have juvenile leaves very different from the adult foliage. The young plants have short stems, with closely overlapping "shingle" leaves that press against the bark to prevent loss of water. Later, long-stalked adult leaves develop. In contrast, the climbing *Begonia serratifetala* is delicate and its leaves shrivel if exposed to dry air.



**REACHING THE TOP**

Tall rain-forest trees are festooned with the leafless stems and aerial roots of climbers. These need to be strong but flexible, so that they do not snap when the trees that support them sway in high winds.



Vine  
*Mondia whitei*

**TWINGING PLANTS**

These plants reach the light with stems that twine around a support. Once one stem is secured, others from the same plant twine around it so that a tough, twisted cord is made.



Downward curving stamens

The bare stem, or internode, between nodes gets longer as the plant grows

Flower bud

Three-lobed leaf

Passionflower  
*Passiflora*  
(South America)

Fern scrambling toward light over moss



*Leptochilus decurrens*  
(Southeast Asia)

Young frond

**CLIMBING FERNS**

Ferns such as *Leptochilus decurrens* start life on the damp, shady forest floor. The young fronds are thin and delicate. The older ones are much tougher, with a thick, waxy surface. These climbers reach the light by scrambling over other vegetation.

**PASSIFLORA**

There are about 400 species of passionflower, *Passiflora*, in tropical jungles, most of them in tropical America. The young plant has short stems and no tendrils. It may stay like this for months on the shady forest floor. If a gap appears in the canopy above, the plant begins to grow rapidly up toward the light.



# Central American jungles



**ANCIENT CULTURE**  
The Maya civilization flourished in Belize and Guatemala until 800 CE. They left many examples of intricately decorated pottery showing how they observed animals, such as this jaguar.

ONCE THE CENTERS of the great Maya and Aztec civilizations, the small countries bridging North and South America contain an incredible diversity of plant and animal life. A large number of plants native to the region are found nowhere else, and it is home to many important tropical crops, including pawpaws, allspice, vanilla, and avocado pears. Central America and the Caribbean islands are particularly rich in birdlife. The small country of Panama has more bird species than are found in the whole of North America, including migratory species that winter in the warm rain forests, returning to North America to breed.



Epiphytic orchid  
*Stanhopea wardii*



CENTRAL AMERICA

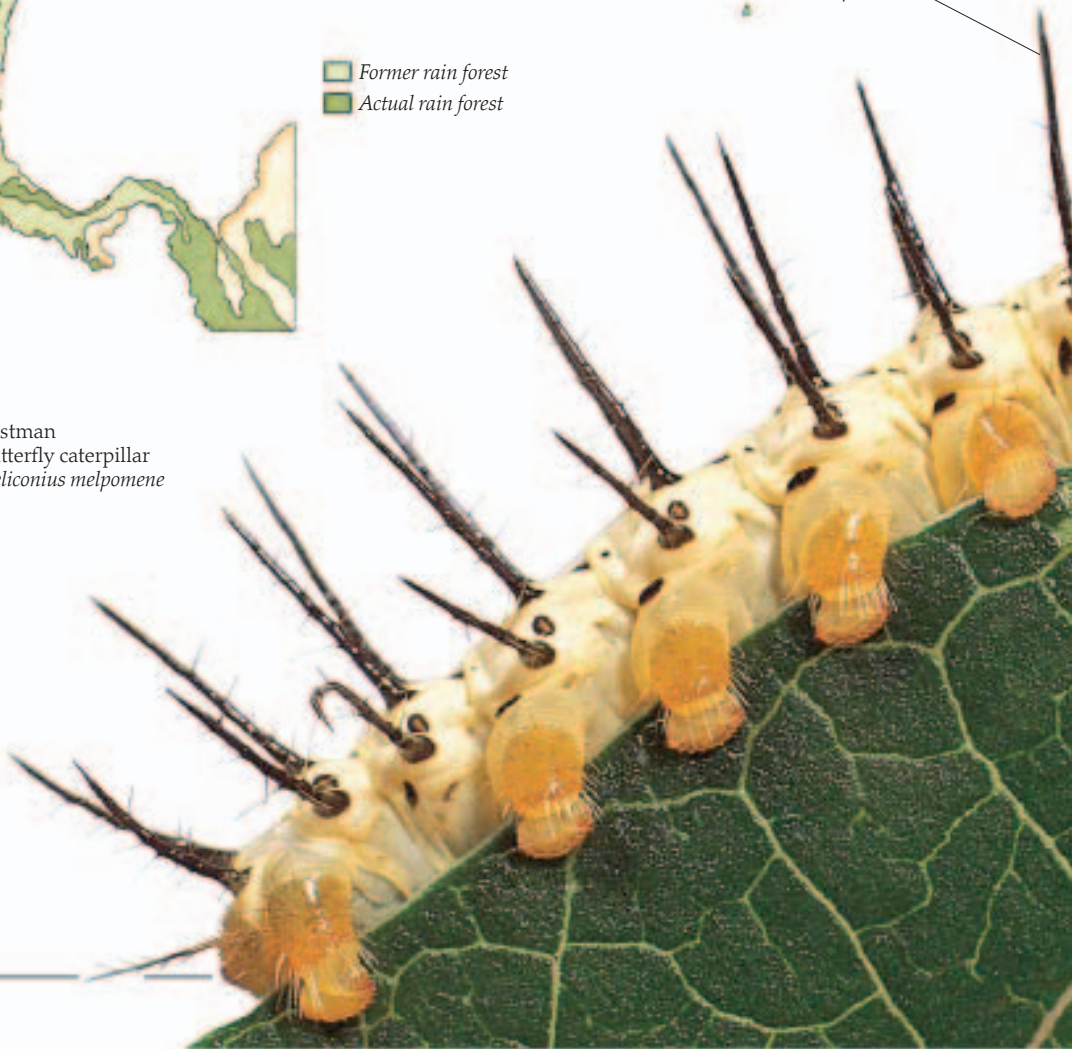
**CENTRAL AMERICA**  
Before the 16th century, the Caribbean islands were almost completely covered with rain forest. Nearly all of this was cleared, island after island, to make way for sugar plantations. The rain forests of mainland Central America now cover only about 40 percent of their original extent, with only Belize retaining as much as 60 percent.

Sharp, poisonous spines to protect caterpillar from predators



Postman butterfly caterpillar  
*Heliconius melpomene*

**JUNGLE COLOR**  
Different kinds of *Heliconia* grow in shady conditions beside streams or in overgrown clearings. The striking flowerheads are made up of brightly colored bracts, each one enclosing a number of small flowers.





Winged central column

**BRIEF BEAUTY**  
Hanging in fragrant sprays, the large waxy flowers of this lowland, epiphytic orchid are short-lived, withering after pollination. At the center of its petals, each flower has a winged central column with fleshy lips, designed to attach the clumps of pollen firmly onto its euglossine bee pollinator.

**WELL NOURISHED**  
These butterflies are able to live for six to nine months because they feed on protein-rich pollen as well as nectar. They squirt enzymes onto the pollen, which turns it into a "soup" that can be sucked up. Their longer life span means that they can lay more eggs.



Postman butterfly  
*Heliconius melpomene*



Scarlet macaw  
*Ara macao*

**WINGS IN THE TREETOPS**  
Raucous calls reveal the presence of these macaws in the treetops. These brightly colored and gregarious birds squabble over nesting sites, tree holes at least 100 ft (30 m) above the ground. Their diet consists mostly of seeds, many of which are protected by a hard shell. The macaw positions a seed in the upper part of its beak with its tongue, and cracks it with the lower pair of mandible—just like a pair of pincers.



**PROGRAMMED TO EAT**  
The postman butterfly caterpillar eats enormous numbers of leaves in the short time before it metamorphoses into a butterfly. Many different postman butterfly caterpillars feed on passionflower (*Passiflora*) vines. The female butterfly always selects young shoots or tendrils that do not already have eggs on them, as the first caterpillars to hatch will devour any younger ones.

**JUNGLE GOLD**  
The golden beetle *Plusiotis resplendens* is just over 1 in (3 cm) long and is only found in Costa Rica. The adult beetles eat leaves, but the larvae feed on soft, rotting plants.



Slipper orchid  
*Paphiopedilum callosum*  
(Southeast Asia)

# Sweet success

A FLOWER HAS TO BE POLLINATED before seeds can develop. Flowers are made up of petals around the male (stamens) and female (carpels) reproductive parts that produce its seeds. During pollination, pollen is transferred from the stamens to the stigma at the tip of a carpel. Pollination almost always happens between plants of the same species, and stamens and carpels are often arranged so that self-pollination is not possible. Most jungle plants are pollinated by insects, birds, or animals. In order to attract their pollinators, flowers offer sugary nectar or protein-rich pollen as food. They draw attention to themselves with brightly colored petals or strong scents.

Line acting as nectar guide

Pouched petal

## EXOTIC ORCHID

Tropical slipper orchids are often pollinated by a single species of bee or hoverfly. The insect is guided to the center of the flower, where it is slippery, so it falls into a pouch. The only way out is to climb up hairs at the back of the pouch, a route that takes it past the stigma and pollen sacs. Pollen sticks to the insect and is carried to the female stigma of the next flower.

## BAT POLLINATION

Bat-pollinated flowers such as *Pachira aquatica* open at dusk, just as the bats wake up. The bats are attracted to the flowers by a pungent or sour smell, and the flowers are arranged so that bats can reach them easily. As a bat drinks the nectar, its furry head is dusted with pollen from the long stamens.

Long stamens

Geoffroy's tailless bat carrying baby  
*Anoura geoffroyi*  
(South America)

## NECTAR-SIPPER

Bats that feed exclusively on nectar have long tongues with a brushlike tip which quickly mops up pollen as well as droplets of nectar. These bats can hover while feeding.

Shaving brush tree  
*Pachira aquatica*  
(South America)





Rattan palm  
*Steriphoma paradoxum*  
(South America)

**THE LONG AND THE SHORT OF IT**  
Most flowers are insect pollinated. Short-tongued bees, flies, and beetles pollinate flat or cup-shaped flowers as they gather pollen and nectar. Only insects with longer tongues can reach nectar hidden in tubular flowers. This *Steriphoma* has long stamens that ripen before the stigma, in order to prevent self-pollination. It is pollinated by long-tongued insects such as hawkmoths.

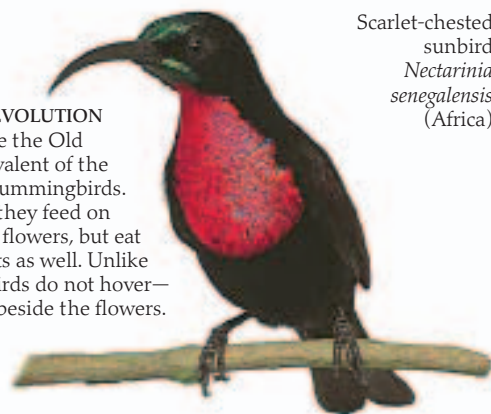


Orchid bee  
*Euglossa asarophora*  
(South America)



Orchid bee  
*Euglossa intersecta*  
(South America)

**EUGLOSSINE BEES**  
Male euglossine bees, known as orchid bees, pollinate the orchids when they visit them, to scrape aromatic substances from parts of the flower. Female euglossine bees forage over a large area, pollinating a wide variety of plants at all levels of the forest.



Scarlet-chested sunbird  
*Nectarinia senegalensis*  
(Africa)

**PARALLEL EVOLUTION**  
Sunbirds are the Old World equivalent of the American hummingbirds. Like them, they feed on nectar from flowers, but eat many insects as well. Unlike them, sunbirds do not hover—they perch beside the flowers.

Wings flap at least 90 times per second



Brown violet-ear  
*Colibri delphinea*  
(Central America)

Hummingbird sucks up nectar with the long tongue inside its beak



**QUICK AS A FLASH**

Hummingbirds hover in front of flowers, their wings making a figure-eight movement that allows them to maneuver easily. Bird-pollinated flowers are usually red or bright orange. Nectar, though sweet and sugary, is watery and low in protein, so nectar-eating birds need a constant supply of flowers to get enough energy for flight. The pollen eaten with the nectar is a valuable source of protein.

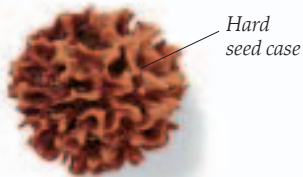


Hotlips  
*Cephaelis elata*  
(Central America)

# Seed dispersal



**HEALTHY APPETITE**  
The Asian great hornbill (*Buceros bicornis*) is an avid fruit-eater. Seeds germinate from its droppings.



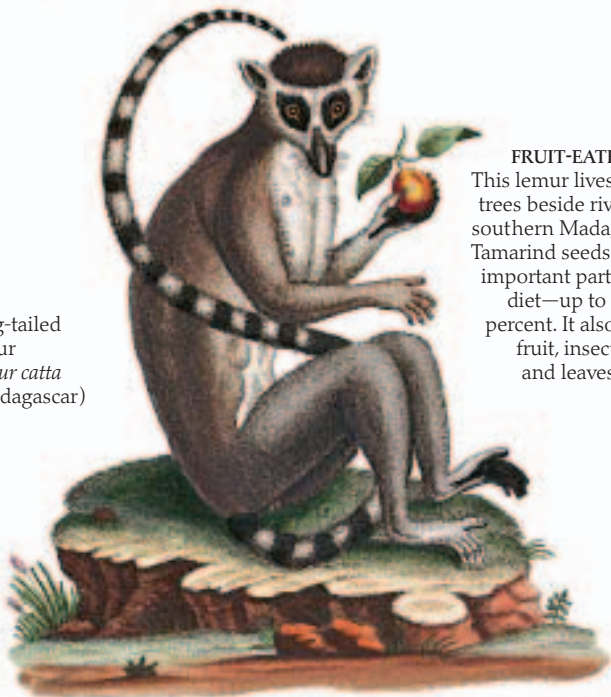
Hard seed case

**ATTRACTIVE MORSEL**  
This blue quandong (*Elaeocarpus angustifolia*) seed was inside a fruit with oily purple flesh. Hornbills and other birds swallow the fruit whole.



**BURIED AND FORGOTTEN**  
Inside the fibrous case of the *Loxococcus rupicola* is a hard nutty seed that is dispersed by rodents. These gnawing animals bury seeds for future feasts. Forgotten caches germinate and grow.

Ring-tailed lemur  
*Lemur catta*  
(Madagascar)



**FRUIT-EATER**  
This lemur lives in tall trees beside rivers in southern Madagascar. Tamarind seeds are an important part of its diet—up to 50 percent. It also eats fruit, insects and leaves.

PLANTS NEED to spread their seeds so that they have room to grow. Because they cannot move around, they rely on wind, animals, water, or explosive pods to scatter their seeds. The fruit wall is part of a plant's dispersal mechanism. Some fruits are winged or cottony to help the seeds become airborne. Some are air-filled and float on water. More familiar are the juicy, brightly colored fruits that spread their seeds by enticing animals, including people, to eat their succulent flesh. These seeds are spread when animals spit them out, let them fall, or pass them out in droppings deposited some distance away.

**RATTAN PALMS**  
Rattan palms produce clusters of fruits. These usually contain a single seed enveloped in a fleshy layer that is eaten by birds and animals. As hard shelled seeds pass through the digestive tract of an animal, their outer wall is eaten away by digestive juices. This means that water absorption and germination are easier.



Fruit is in clusters at base of frond



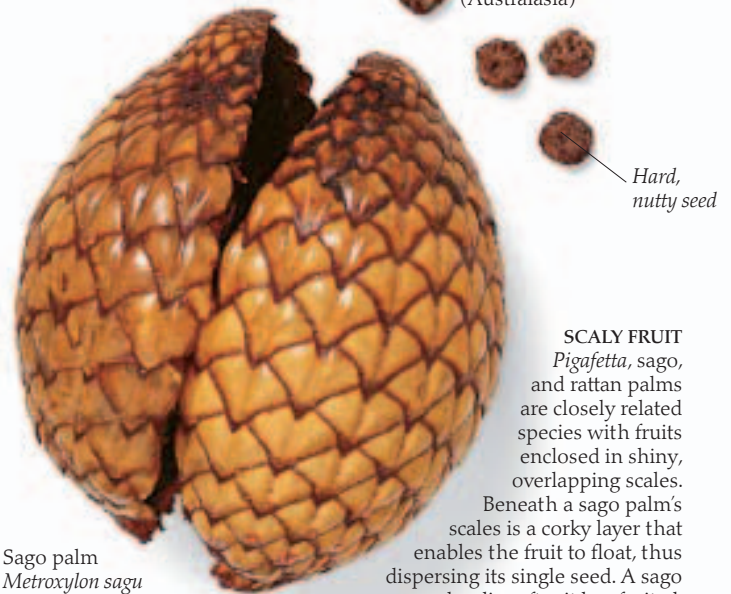
Rattan seeds  
*Calamus paspalanthus*  
(Southeast Asia)



Red lemur palm fruit  
*Lemurophoenix halleuxii*  
(Madagascar)

**A CASE THAT IS HARD TO CRACK?**  
Larger animals and fruit-eating bats often carry fruit to a safe place before eating it. Some seeds are then spat out or discarded, especially if they are too hard to crack.

Wanga palm  
*Pigafetta filaris*  
(Australasia)



Hard, nutty seed

Sago palm  
*Metroxylon sagu*  
(Australasia)

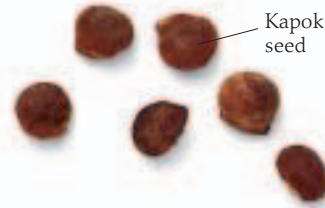
**SCALY FRUIT**  
*Pigafetta*, sago, and rattan palms are closely related species with fruits enclosed in shiny, overlapping scales. Beneath a sago palm's scales is a corky layer that enables the fruit to float, thus dispersing its single seed. A sago palm dies after it has fruited.



Epauletted fruit bat eating wild fig  
*Epomophorus wahlbergi*  
(Africa)

**FRUITFUL FIGS**

Figs are found in all tropical rain forests. They are a significant part of the diet of many animals, including birds, bats, and monkeys. To stop the small fig seeds from being destroyed by digestive juices, the fig flesh contains a laxative that ensures the seeds pass through quickly.



Kapok seed

Kapok pod  
*Ceiba pentandra*

**BLOWING IN THE WIND**  
Towering above the forest canopy, the kapok tree employs the wind to disperse its seeds. Each fruit pod is up to 7 in (18 cm) long. As it ripens, the pod wall dries and eventually splits, releasing a mass of shiny floss in which the seeds are embedded. As this is blown far and wide by the winds, the seeds fall out.

Pod bursts open to disperse seeds

Nypa palm seed  
*Nypa fruticans*  
(Southeast Asia)

Fibrous wall



**SEEDS AFLOAT**  
Seeds that are spread by water need a waterproof layer to prevent them becoming waterlogged. They also need an air-filled fruit wall to keep them afloat. Nypa palms grow in the brackish mud of mangrove swamps. Their fruits have a thick fibrous wall that enables them to float for several months, during which time the seed inside may start to germinate.

# Dusk to dawn

NIGHT COMES SWIFTLY in the tropics. At about 6 p.m., darkness falls—there are no lingering hours of twilight. As the Sun sinks toward the horizon, daytime creatures return to their roosts or nests, and a new group of animals awakens. By dividing into day and night shifts, different species of animals that would otherwise compete for food and space are separated. The cooler night air brings out insects and amphibians with thin, moist skins, while small mammals and rodents hunt on the forest floor. Nocturnal animals are specially adapted, and many have huge eyes, or acutely sensitive ears and noses. Yet the jungle is never completely dark. The Moon shines on clear nights. Fireflies flash through the trees, and on the forest floor, phosphorescent fungi glow eerily, until they are devoured by beetles.

## NIGHT FEEDER

By day, Franquet's epauletted bats roost in small groups, hanging from thin branches usually 13–20 ft (4–6 m) above the ground. As night falls, they fly off to feed on fruit, large numbers often gathering in a heavily laden tree. Fruit bats have large eyes with good vision, but they locate ripe fruit with their keen sense of smell.

Franquet's epauletted bat  
*Epomops franqueti*  
(Africa)

Wings folded  
when roosting

## FLYING HOME TO ROOST

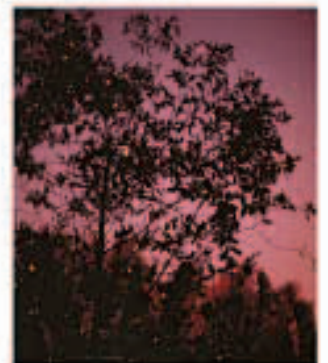
Just before darkness falls, parties of toucans fly off to roost in selected trees. They look ungainly in flight, but although large, their colorful bills are very light in weight, and they fly strongly across clearings and over the treetops. As dawn breaks, the flock once more takes to the air, to search for ripe fruit.

Large curved  
beak for picking  
and eating fruit

Red billed toucan  
*Rhamphastos tucanus*  
(South America)

## NIGHTLIGHTS

Fireflies are actually different species of beetles. Males of "roving" fireflies, such as *Pyrophorus* from tropical America, fly among the trees flashing in special sequences that are only answered by females of the right species.





African moon moth  
*Argema mimosae*  
(Africa)

**NECTAR-SIPPERS**

Night-flying moths feed on the nectar of sweetly-scented, pale-colored flowers, many of which are open only for a single night. This African moon moth is one of the largest species, with a wingspan of 4 in (12 cm). The feathery antennae of the male are so sensitive that they can pick up the slightest trace of the pheromone—sex hormone—wafting from a female moth.

**BIG EYES**

The vertical pupils of the red-eyed tree frog *Agalychnis callidryas* open up at night to help them see in the very low light levels. By day, the pupils become slits. The frogs live and feed up in the canopy, only coming down to streams for the female to absorb water before she lays her eggs.

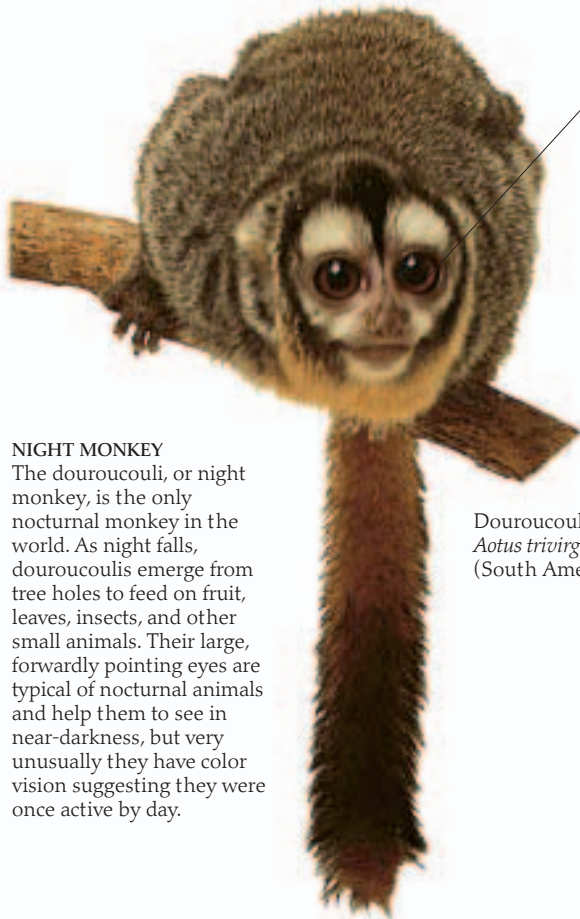


**DAWN CHORUS**

Just before dawn breaks, howler monkeys set up a noisy chorus. The deafening howls can be heard several miles away and are produced in a large larynx by air passing over the hyoid bone. Mature males, such as this one, make the loudest howl, amplified by the position they hold themselves in while calling. This loud early morning symphony is a warning to other groups of howlers not to come too close and safeguards their food supply.



Red howler monkey  
*Alouatta seniculus*  
(South America)



Douroucouli  
*Aotus trivirgatus*  
(South America)

Large eyes for night vision

**NIGHT MONKEY**

The douroucouli, or night monkey, is the only nocturnal monkey in the world. As night falls, douroucoulis emerge from tree holes to feed on fruit, leaves, insects, and other small animals. Their large, forwardly pointing eyes are typical of nocturnal animals and help them to see in near-darkness, but very unusually they have color vision suggesting they were once active by day.

**DIGGING DOWN**

The scaly Indian pangolin *Manis crassicaudata* digs a burrow in which it spends the day, emerging at night to forage on the forest floor. Though its sight is weak, it has an acute sense of smell that it uses to locate ant and termite mounds. Breaking in with the long powerful claws on its forelimbs, the pangolin flicks its very long sticky tongue into chambers full of insects, eggs, and pupae. It is toothless, and the swallowed insects are ground up in the lower part of its stomach.



# South American jungles



THE AMAZON BASIN covers a vast area, nearly 2.5 million sq miles (6 million sq km) and is covered by the world's largest expanse of tropical rain forest. This jungle supports more species of plants and animals than anywhere else—about one-fifth of the world's bird and flowering plant species, and about one-tenth of all mammal species. No definite figure can be put on the number of different insects, because many have yet to be identified—or even discovered—by scientists. Indigenous people have lived in these forests for about 12,000 years, during which time they have built up a detailed and valuable knowledge of the rain forest plants, many of which are used to make medicine.

## SOUTH AMERICA

The Amazonian rain forest is still the largest in the world but, like all tropical forests, it is being overexploited. Twenty percent of it has been lost already, much of it transformed into pasture for cattle. Only small pockets of Atlantic coastal forest remain today.



## BODY PAINTING

These Yanomamo girls belong to one of 143 tribal groups remaining in Amazonia. Body painting is popular, using a plant known as urucu or achiote in South America and annatto in Europe. The seeds are wiped directly onto the skin or boiled to make a paste. Each tribe has its traditional patterns.



Annatto  
*Bixa orellana*

## A WAXY SURFACE

Growing naturally beside rivers and around the edges of swampy areas, the Brazilian wax palm *Copernicia prunifera* is also cultivated in Brazil for the carnauba wax that covers the surface of its leaves. Carnauba is a top quality wax with a high melting-point of 161°F (70°C). It is used chiefly in the cosmetic and polish industries. The wax flakes off leaves that have been picked and dried in the sun. That taken from the young leaves is known as "prime yellow," and about 1,300 leaves are needed to obtain just over 2 lb (1 kg) of wax.



**ONE OF MANY**  
The malachite butterfly is one of more than 2,000 species of butterfly in the Amazonian jungles. They fly during the day, pausing to suck up juices from overripe fruit fermenting on the forest floor.



Malachite butterfly  
*Metamorpha stelenes*

**GOLD IN THE FOREST**  
This beautiful golden monkey is found only in Atlantic coastal rain forests. Golden lion tamarins live in mature forest, where they forage for invertebrates, small animals, and fruit 10–30 ft (3–10 m) up in the liana-covered trees. They came near to extinction in the 1960s, because their habitat was being destroyed and hundreds were being exported as pets every year. Since then, captive breeding programs established in Europe and the United States have resulted in the release of golden lion tamarins back into the wild.

Golden lion tamarin  
*Leontopithecus rosalia*

Long tail for balancing



Buriti palm  
*Mauritia flexuosa*

**THE TREE OF LIFE**  
Nothing of this tall palm goes to waste. The local people use it as a source of food, fibres, wood, cork, and thatching. Wine made from the fruit, rich in vitamin C, is given to the elderly and sick.

**NOT SO LAZY**  
Despite its name, the three-toed sloth *Bradypus tridactylus* is not lazy. It is perfectly adapted to its life up in the canopy. It eats from only a few trees. There is little protein in its diet, but its digestion is very slow, and by hanging upside down, it saves energy. Its strong claws lock tightly onto branches so it does not fall off even when asleep.



Amazon lily  
*Eucharis amazonica*

**MYSTERIOUS POWERS**  
The Amazon lily grows on the lower slopes of the Andes. The Kofan tribes of western Colombia and northern Ecuador boil the whole plant, including its bulb, to make a tea. This is drunk by men before they hunt monkeys, in the belief that it will make them more accurate with the blowpipe.

# Beside the water

THE RIVERBANK IS THE DOMAIN of animals that live both on land and in water. The vegetation here is particularly dense, as the open expanse of water allows extra light to reach the ground. This mosaic of water, overhanging branches, and tangle of waterside ferns, sedges, and saplings provides an ideal environment for animals that live and breed on land but enter the water to hunt and feed. However, heavy rains sometimes cause a river to burst its banks, and this puts those animals nesting close to the water's edge at risk.



**JAWS OF THE RIVERBANK**  
The saltwater crocodile *Crocodilus porosus* is the world's largest crocodile. It can reach 20 ft (6 m) in length and weigh as much as 3 tons.



**UMBRELLA GRASS**  
The sedge *Cyperus alternifolia* has leaves that radiate from the top of its tall stems like the spokes of an umbrella—hence its common name of umbrella plant. Under water, the roots grow into an impenetrable tangle that helps to stabilize the edges of the swamps where it grows.

**WARY WATER LIZARD**  
Water dragons are agamid lizards that live beside water in the forests of Southeast Asia and Australia. Although they are mainly tree-dwellers, they can run quickly over the ground on their two hind legs, usually aiming for the next tree. When not searching for invertebrates, eggs, and nestlings to eat, they spend most of their time resting along a branch overhanging the water. They are extremely wary and, at the slightest disturbance, will drop off into the water, which may be as much as 30 ft (9 m) below.

Crested water dragon  
*Physignathus cocincinus*  
(Asia)

**WATERSIDE PLANT**  
The waterside plant fire flag (*Thalia geniculata*) is abundant in marshes and seasonally flooded ground near rivers. It has large, waxy leaves and spreads by means of tuberous roots.

An alert crested water dragon stands on all four feet, watching for danger





**GIANT OTTER**

Each family group of giant otters has its own territory. Ungainly on land, these creatures are excellent swimmers, using their large, webbed feet as paddles and their muscular tails as rudders. They catch fish and carry it to the surface to eat.

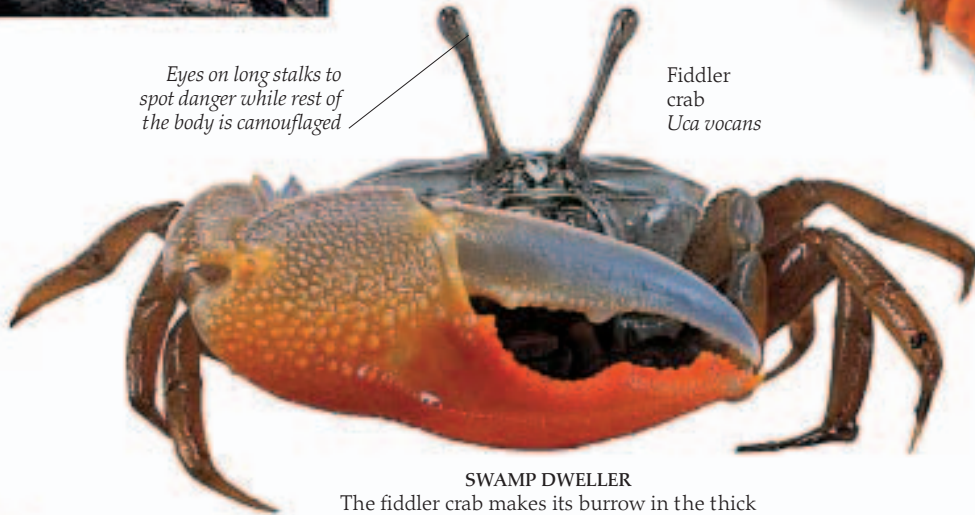


**FROGS IN DANGER**

Originally inhabitants of Madagascan rain forests, these endangered tomato frogs, *Dyscophus antongili*, are now adapting to other habitats, as the forests dwindle in size.

Eyes on long stalks to spot danger while rest of the body is camouflaged

Fiddler crab  
*Uca vocans*



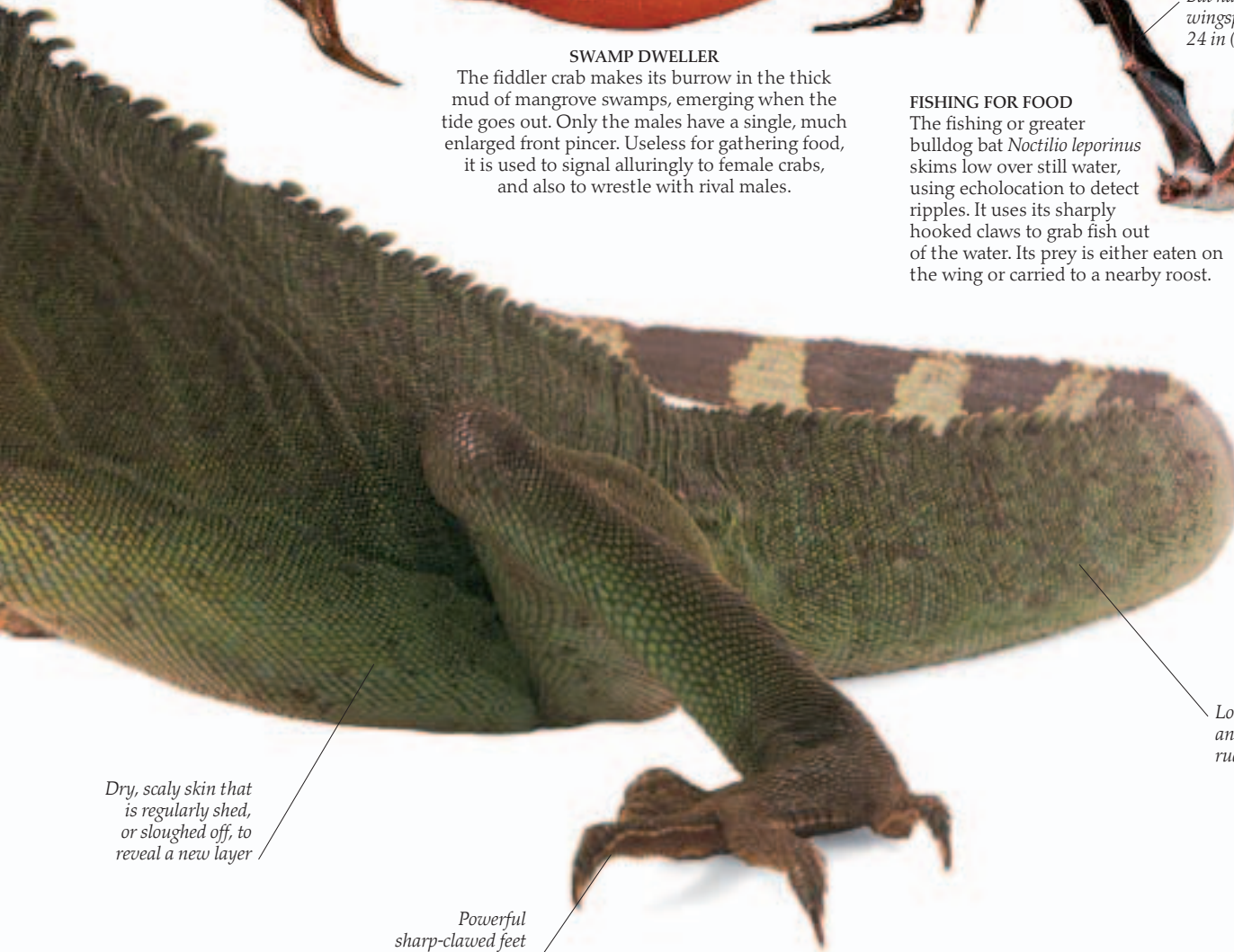
**SWAMP DWELLER**

The fiddler crab makes its burrow in the thick mud of mangrove swamps, emerging when the tide goes out. Only the males have a single, much enlarged front pincer. Useless for gathering food, it is used to signal alluringly to female crabs, and also to wrestle with rival males.

Bat has a wingspan of 24 in (60 cm)

**FISHING FOR FOOD**

The fishing or greater bulldog bat *Noctilio leporinus* skims low over still water, using echolocation to detect ripples. It uses its sharply hooked claws to grab fish out of the water. Its prey is either eaten on the wing or carried to a nearby roost.



Dry, scaly skin that is regularly shed, or sloughed off, to reveal a new layer

Powerful sharp-clawed feet for climbing

Long tail for balance and to use as a rudder in water

# Hidden dangers

## CURARE

The rough bark or roots of some *Strychnos* vines are ingredients of curare, used as an arrow poison by some tribesmen. In the past, each tribe had its own closely guarded secret recipe for making the poison.



Solid lump of prepared curare

LURKING IN THE DEPTHS of the jungle are animals and plants equipped with a lethal battery of foul-tasting poisons. They either manufacture the poisons themselves, or use those that were in their food, advertising their hidden armory with their bright colors.

Venomous creatures such as snakes and spiders need powerful toxins to subdue prey that might inflict injury during a struggle. Plants contain poisons to prevent herbivores from eating all their foliage. The only indications that their green leaves are unpleasant are the smell and taste. They can afford to lose a few leaves, and animals soon learn to avoid them.



## TAKING AIM

This Penan hunter in Borneo uses darts tipped with poisons. Different tribes use a variety of plant poisons to kill their catch quickly.

## POTTED POISON

After the ingredients for curare are pounded together, the mixture is boiled or mixed with cold water. The thick liquid is strained off and kept in hollow gourds.



Arrow tipped with coating of curare

## Living with poisons

The poisonous nature of animals and plants is understood by the tribes who live in the jungle. Many highly toxic plants are in everyday use, both for hunting and, in far smaller doses, as medicines. Concoctions are used to tip arrows so that animals fall from the canopy close to the hunter. Poisonous leaves or sap are used to contaminate stretches of water so that many fish die at the same time.



Arrows used to hunt monkeys and other mammals

Bamboo quiver

## SAFETY TIPS

South American hunters tie their arrows together with cord and keep them securely in a bamboo quiver for safety. They have to be careful that they do not accidentally prick themselves with a poisoned tip.



**IMMUNE TO DANGER**

A female postman butterfly, also known as the red passion flower butterfly, lays her eggs on the youngest *Passiflora* leaves, because these contain the least poison. The larvae absorb the poison into their bodies.



Small postman butterfly  
*Heliconius erato*  
(South America)

Blue poison dart frog  
*Dendrobates azureus*  
(South America)



**POISON DART FROG**

This forest floor frog exudes very nasty poisons from all over its skin if anything tampers with it. Local hunters use the poison to coat their blowpipe darts.

**POISONOUS PLANT**

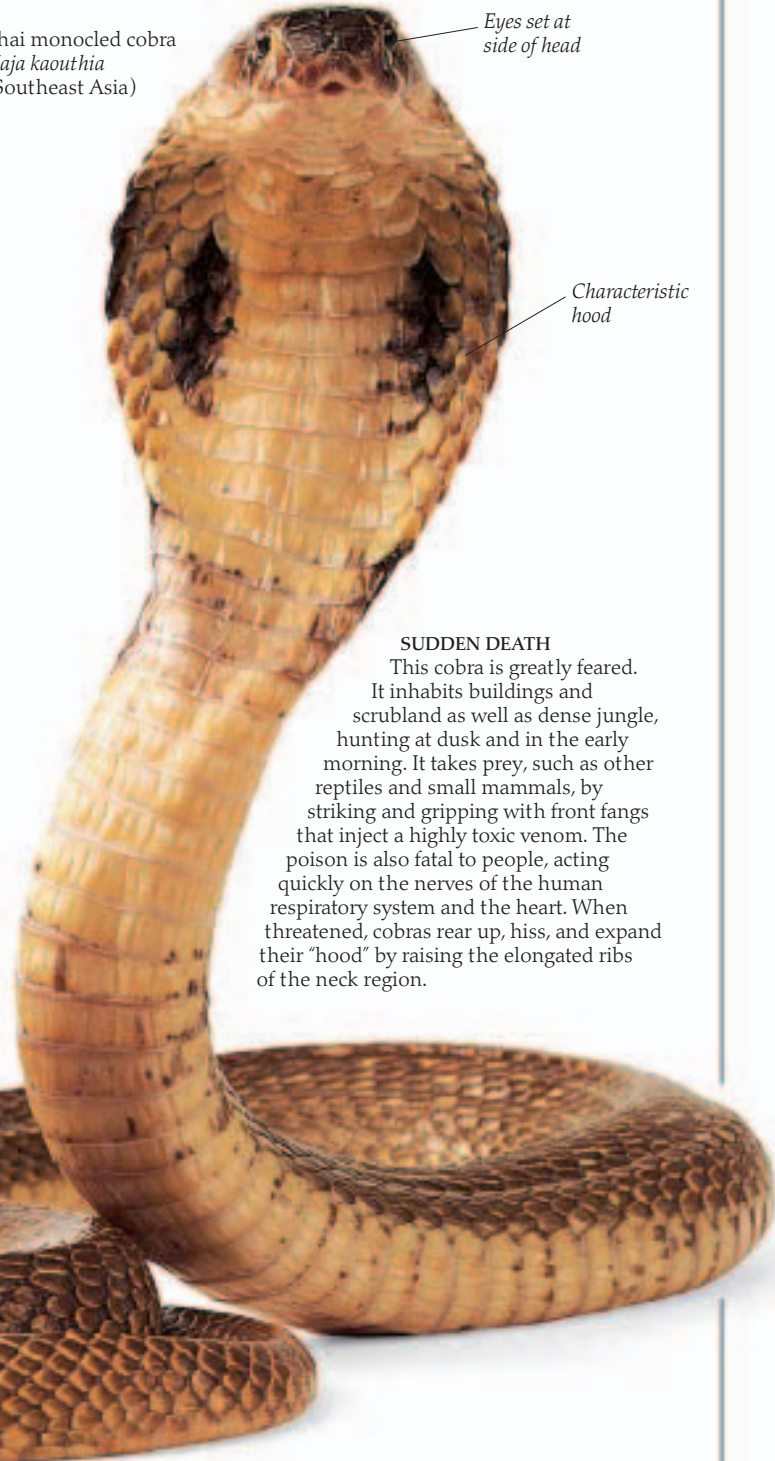
If a plant loses most or all of its leaves, its ability to take in carbon dioxide and manufacture sugars is greatly reduced. The foliage of this large *Passiflora* climber, the red passionflower, contains a complex cocktail of chemicals including bitter-tasting alkaloids and compounds that contain cyanide. Mammals will not eat it, and only a few leaf-eating insects such as postman butterflies and some species of beetles have evolved ways of overcoming its toxicity.



Thai monocled cobra  
*Naja kaouthia*  
(Southeast Asia)

Eyes set at side of head

Characteristic hood



**SUDDEN DEATH**

This cobra is greatly feared. It inhabits buildings and scrubland as well as dense jungle, hunting at dusk and in the early morning. It takes prey, such as other reptiles and small mammals, by striking and gripping with front fangs that inject a highly toxic venom. The poison is also fatal to people, acting quickly on the nerves of the human respiratory system and the heart. When threatened, cobras rear up, hiss, and expand their "hood" by raising the elongated ribs of the neck region.

Giant tiger centipede  
*Scolopendra gigantea*  
(Africa)



**FATAL FEET**

Dramatic orange and black stripes warn of this centipede's toxicity. It injects its prey with poisonous venom, using the first pair of its many legs, which have sharply tipped claws.

# Nature's architects

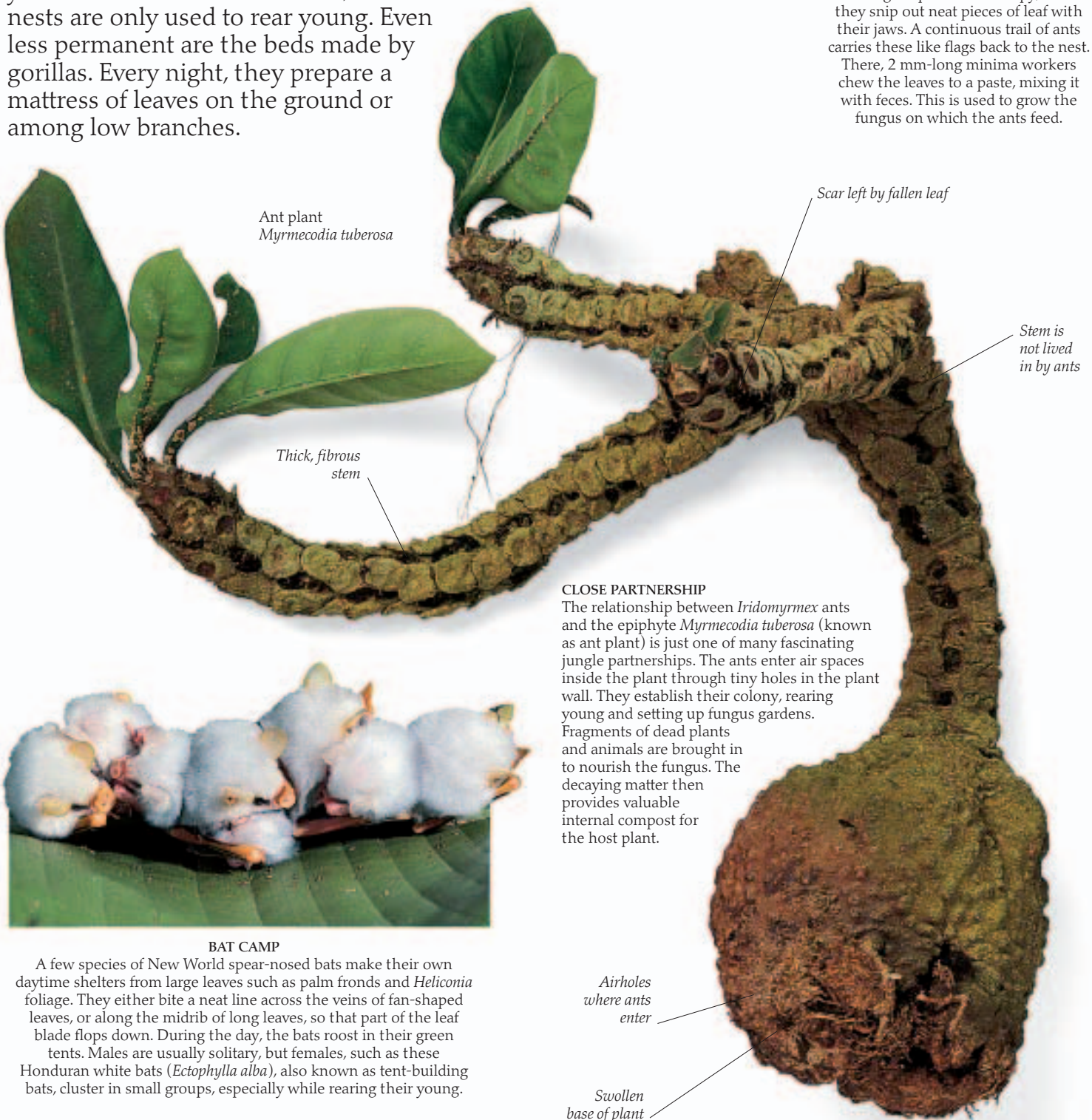
THE RAIN FOREST PROVIDES tree holes, tangles of lianas, and plenty of other hideaways. In spite of this, numerous creatures build custom-made homes from forest materials. Social insects such as bees, wasps, ants, and termites construct elaborate nests where a teeming mass of insects live and tend their larvae. These large colonies need well-protected structures to keep predators out. Some structures last for years. Birds are master weavers, but their nests are only used to rear young. Even less permanent are the beds made by gorillas. Every night, they prepare a mattress of leaves on the ground or among low branches.



Media ant

## THE CUTTING EDGE

Leaf-cutter ants live in underground nests in colonies of up to five million. There are four groups of worker ants—minima, minor, media, and major. Media workers, only 10 mm long, travel right up into the canopy, where they snip out neat pieces of leaf with their jaws. A continuous trail of ants carries these like flags back to the nest. There, 2 mm-long minima workers chew the leaves to a paste, mixing it with feces. This is used to grow the fungus on which the ants feed.



Ant plant  
*Myrmecodia tuberosa*

Scar left by fallen leaf

Stem is not lived in by ants

Thick, fibrous stem

## CLOSE PARTNERSHIP

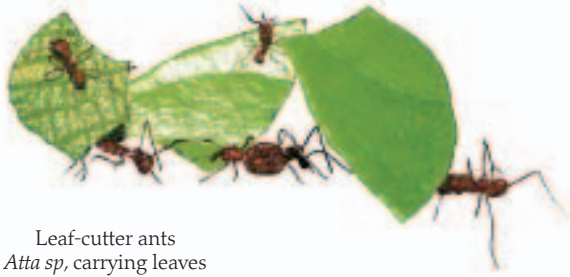
The relationship between *Iridomyrmex* ants and the epiphyte *Myrmecodia tuberosa* (known as ant plant) is just one of many fascinating jungle partnerships. The ants enter air spaces inside the plant through tiny holes in the plant wall. They establish their colony, rearing young and setting up fungus gardens. Fragments of dead plants and animals are brought in to nourish the fungus. The decaying matter then provides valuable internal compost for the host plant.

Airholes where ants enter

Swollen base of plant

## BAT CAMP

A few species of New World spear-nosed bats make their own daytime shelters from large leaves such as palm fronds and *Heliconia* foliage. They either bite a neat line across the veins of fan-shaped leaves, or along the midrib of long leaves, so that part of the leaf blade flops down. During the day, the bats roost in their green tents. Males are usually solitary, but females, such as these Honduran white bats (*Ectophylla alba*), also known as tent-building bats, cluster in small groups, especially while rearing their young.



Leaf-cutter ants  
*Atta* sp, carrying leaves  
back to nest

Paper wasps  
*Polistes* sp.  
(Central America)



**BOWER BUILDER**

Male satin bowerbirds (*Ptilonorhynchus violaceus*) build their bowers on the forest floor to attract mates. They make them in low-growing vegetation and arrange colored feathers, fruits, and flowers in the bower to tempt the female. Different species often favor particular colors.

Adult emerging  
from cell



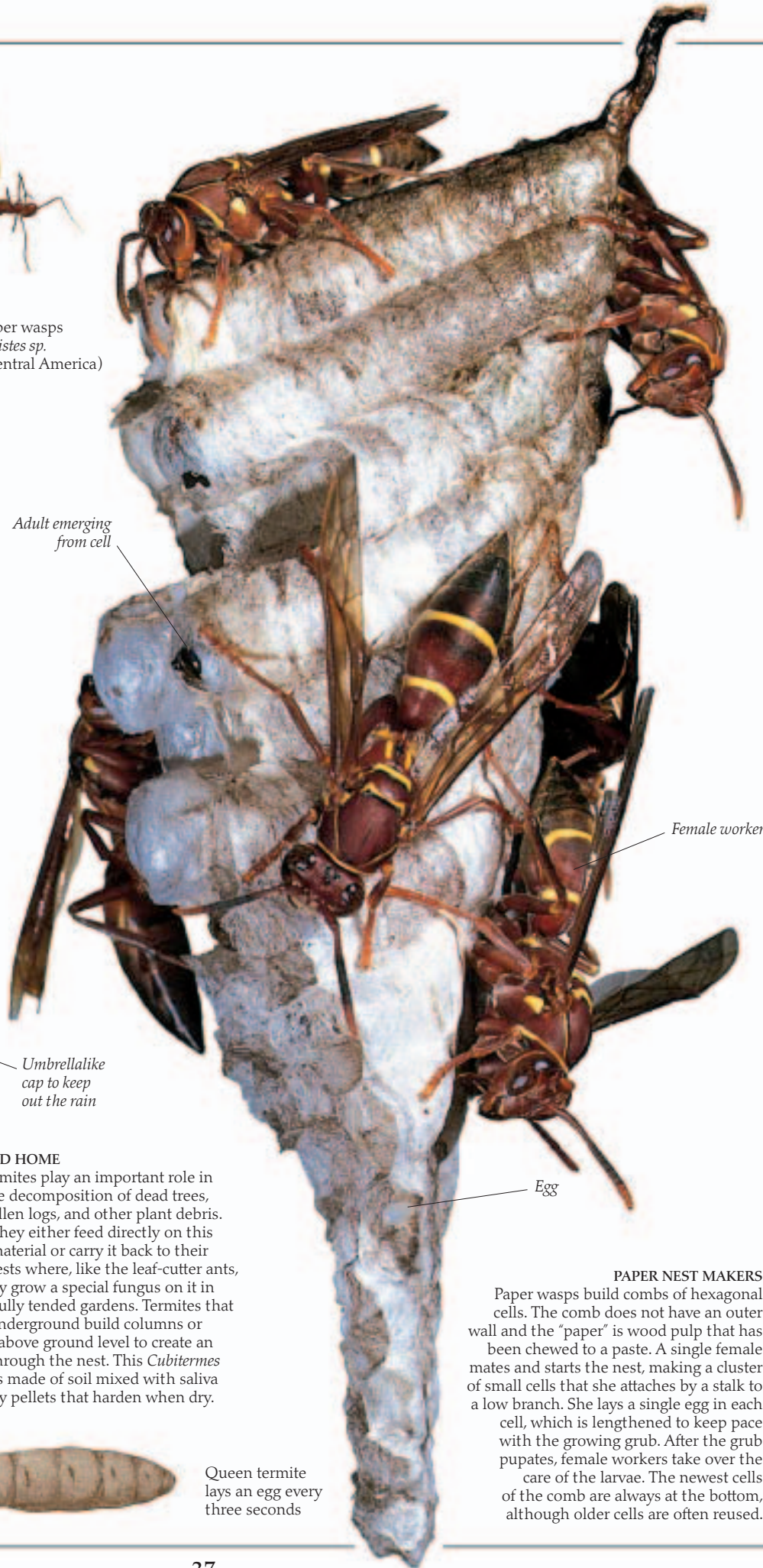
Umbrellalike  
cap to keep  
out the rain

**MUD HOME**

Termites play an important role in the decomposition of dead trees, fallen logs, and other plant debris. They either feed directly on this material or carry it back to their nests where, like the leaf-cutter ants, they grow a special fungus on it in carefully tended gardens. Termites that nest underground build columns or mounds above ground level to create an airflow through the nest. This *Cubitermes* column is made of soil mixed with saliva into sticky pellets that harden when dry.



Queen termite  
lays an egg every  
three seconds



Female worker

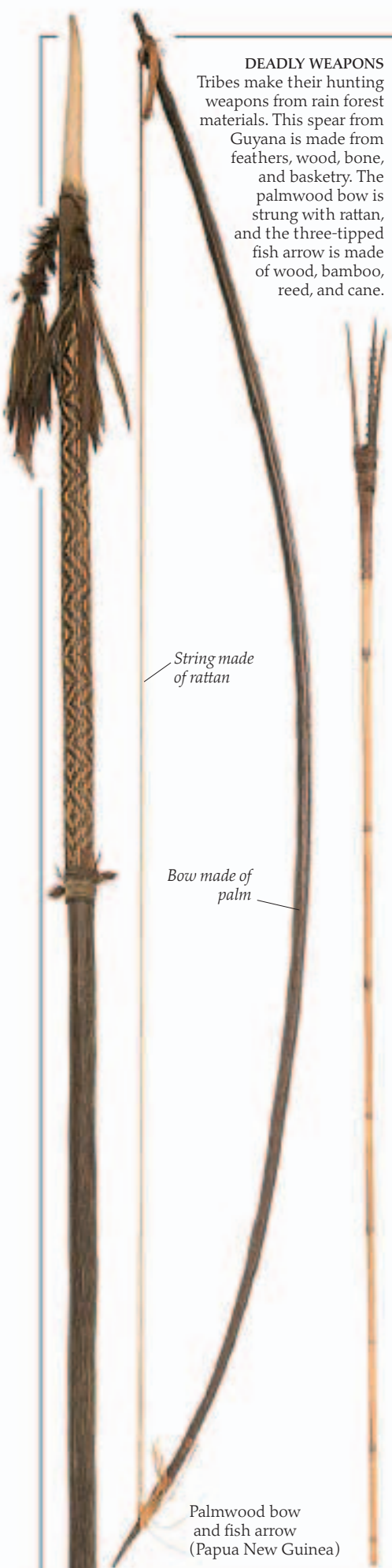
Egg

**PAPER NEST MAKERS**

Paper wasps build combs of hexagonal cells. The comb does not have an outer wall and the "paper" is wood pulp that has been chewed to a paste. A single female mates and starts the nest, making a cluster of small cells that she attaches by a stalk to a low branch. She lays a single egg in each cell, which is lengthened to keep pace with the growing grub. After the grub pupates, female workers take over the care of the larvae. The newest cells of the comb are always at the bottom, although older cells are often reused.

# House and home

**DEADLY WEAPONS**  
Tribes make their hunting weapons from rain forest materials. This spear from Guyana is made from feathers, wood, bone, and basketry. The palmwood bow is strung with rattan, and the three-tipped fish arrow is made of wood, bamboo, reed, and cane.



String made of rattan

Bow made of palm

Palmwood bow and fish arrow (Papua New Guinea)

**WHEN PEOPLE NEED** shelter, there is no shortage of building materials in the jungle. Slender tree trunks are felled for use as walls, palm fronds are cut for thatching, and tough cording is prepared from lianas. Some tribes build separate family homes grouped together in a forest clearing. Others favor one enormous structure that houses the whole community, and inside which each family has its own hearth. Styles vary, but the houses share some features, such as an overhanging thatched roof to keep out the rain. Inside, each dwelling contains everyday utensils and weapons, made skillfully from natural materials such as bamboo and cane.



**POTTER'S ART**  
The neolithic Kintampo culture brought pottery to the African rain forests. Containers such as this part-glazed pot from lower Zaire are still made today.

Model of a rain forest house without walls (South America)



Sturdy tree trunks form basic structure

**WELL SHIELDED**  
Warring tribesmen held shields to parry blows from spears or arrows. Today, many use them more often for ceremonial purposes. This colorful shield from Borneo is decorated on the front with human hair. The reverse depicts mythical creatures, symbols of strength and invincibility.



Human hairs

Dyak shield (Borneo)





**HIGH AND DRY**

This hill tribe house in northern Thailand has central living quarters. It is well screened from the rain by thatching that sweeps down on all sides. The house is set on poles above the ground to keep the floor dry. Outside, there is plenty of shelter beneath the roof for outdoor tasks.



**NATIVE HOUSE AT DORERI**

Traveling by water is the easiest way to get around much of New Guinea because of the dense jungle vegetation. Many settlements are therefore built on the riverside or by the coast. This large house has been built on stilts over the water probably in order to escape destructive insects such as termites.



Hammock

Fishing basket



**CHIEF'S YAM HOUSE**

Yams are an important staple food. On the Trobriand Islands off the coast of New Guinea, yams are also a central part of complicated rituals that maintain goodwill and kinship between clans related by marriage. After the yam harvest, the chief's yam house is filled first. This brightly decorated house is thatched and has well-ventilated walls. This allows air to circulate, so that the yams do not get moldy.

# African jungles

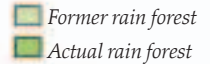


**OIL PALM**  
This 33–65 ft (10–20 m) palm (*Elaeis guineensis*) yields two valuable oils—palm oil from the red, fibrous fruit pulp, and palm kernel oil from the seeds.

ALTHOUGH THEY CONTAIN an impressive 17,000 species of flowering plants, African rain forests have fewer species than those of either America or Asia. There are also fewer different kinds of ferns. This is because the climate of Africa became much drier during the last Ice Age, which ended about 12,000 years ago. Many animals and insects, as well as plants, died out during this period, surviving only in three well-separated pockets of forest that remained moist. As the ice retreated from the lands farther north, the climate became wetter, and the surviving rain forest species spread out from their isolated refuges.



**STICKY FEET**  
The Madagascar day gecko (*Phelsuma madagascariensis*) has velcrolike toe pads so it can cling to branches—even running along underneath.

 Former rain forest  
Actual rain forest



**AFRICA**  
Africa's rain forest once covered most of central and west Africa. Today only about 10 percent of the West African forest remains and much of the rest is threatened. Preservation of the forest and the animals that live in it is difficult due to political instability and pressure from growing populations.



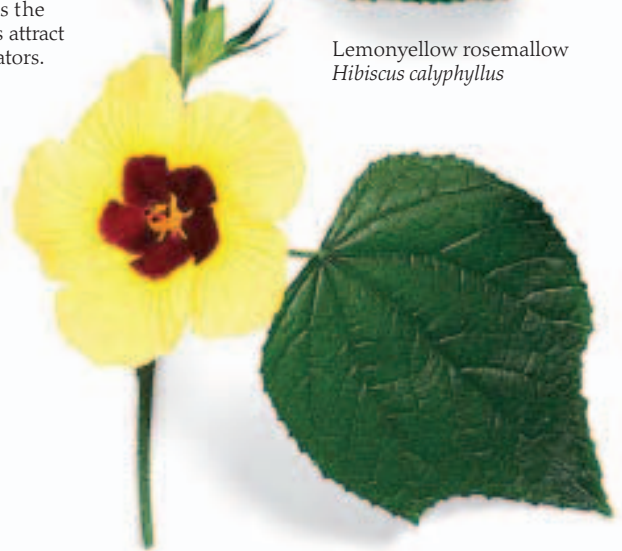
**FLOWERS IN THE CANOPY**  
Of all the epiphytic flowering plants and ferns that grow in African jungles, over 60 percent are different kinds of orchids and little is known about their life histories. *Polystachya galeata* comes from Sierra Leone, where new reserves will help to safeguard its future and that of other vulnerable species.



**FAST GROWTH**  
These large-flowered shrubs grow quickly up to 7 ft (2 m) tall. They flourish along the edges of the forest, where there is the most light. Their flowers attract bee and butterfly pollinators.



Lemonyellow rosemallow  
*Hibiscus calyphyllus*



**GOOD APPETITES**  
African forest elephants *Loxodonta cyclotis* prefer to browse the dense vegetation of clearings and forest margins. Over half of their diet is foliage from trees and large climbers, but they will travel far into the depths of the jungle to reach their favorite tree fruits.







Black-and-white colobus monkey *Colobus guereza* (Africa)

**FAMILY GROUP**

The guereza is one of four kinds of black-and-white colobus monkey that live in family groups in the treetops. It is found in central and eastern Africa. Because these monkeys eat a wide range of readily available leaves, they do not need a very large home range.



Senegal parrot *Poicephalus senegalensis* (Africa)

**FLASH OF COLOR**

The green and gold Senegal parrots migrate across savanna grassland into the forest to take advantage of ripening crops of fruits and seeds. They nest in unlined tree holes.

Only males have a silver back



Large, powerful hands

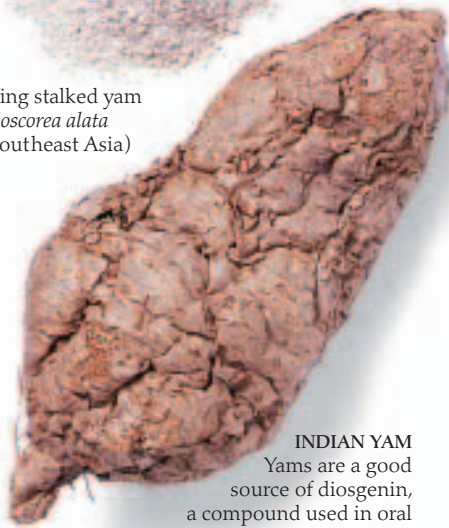
**HEAD OF THE TRIBE**

This silverback lowland gorilla (*Gorilla gorilla*) is a mature male. He is the dominant head of a social group that also contains mature females and young gorillas. Silverbacks are gentle with their young, but as their sons reach maturity, they have to leave and form their own social group. Gorillas travel slowly through the forest, eating leaves, stems, and shoots, and resting.

# Medicines

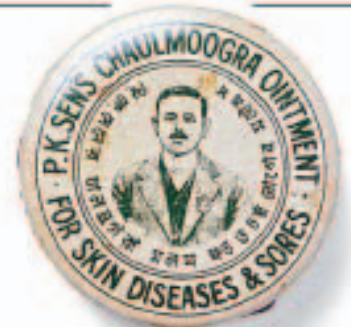
Wing stalked yam powder

Wing stalked yam  
*Dioscorea alata*  
(Southeast Asia)



**INDIAN YAM**  
Yams are a good source of diosgenin, a compound used in oral contraceptives. It is also used in treatments for rheumatoid arthritis and rheumatic fever.

**MOST OF THESE PLANTS** are very poisonous. Yet, at the right dosage, they help to alleviate suffering or save lives. A rain forest can be compared to a giant pharmacy where tribespeople can find remedies for all their ills. It is becoming increasingly important to screen the plants and learn from the tribespeople before either the plants become extinct, or the tribes, with their accumulated knowledge, disappear. Many plants are known to contain beneficial compounds. Others have a more spiritual importance. Some tribespeople think if a plant looks like a bodily organ, it will cure that organ of all ailments.



**SKIN MEDICINE**  
Chaulmoogra ointment is a Hindu preparation rubbed onto the skin to treat leprosy and skin infections.



Hydnocarpus fruit and seeds  
*Hydnocarpus kurzii*  
(Southeast Asia)

Red cinchona bark  
*Cinchona succirubra*  
(South America)



Quinine stored in the bark

**PRECIOUS PLANT**  
The red cinchona tree is one of four commercial kinds of *Cinchona*. The quinine extracted from the bark and roots is an important part of the treatment of malaria, although synthetic drugs are also available today.

Dried tongue of arapaima fish  
(South America)



Guarana bark  
*Paullinia cupana*  
(South America)



**STIMULATING DRINKS**  
Guarana plants contain caffeine and are made into tonic drinks all over Brazil. Tribes grate the seeds (above) or bark into water with the rough, dried tongue of the pirarucu fish. Strong, bitter doses are used to get rid of intestinal worms. The seeds are used commercially in carbonated drinks.



**HARD MEDICINE**  
This hard fruit comes from the *Hydnocarpus* tree, grown in Burma, Thailand, and India for its medicinal properties.



Heckel chew stick  
*Garcinia kola*  
(Africa)





Rosy periwinkle  
*Catharanthus rosea*  
(Africa)

**A ROSY FUTURE**

This one small plant gave hope to cancer sufferers when compounds were isolated from its leaves in the 1950s. Two alkaloids taken from its leaves—vincristine and vinblastine—are now used particularly in the treatment of Hodgkin's disease and childhood leukemia.



Carved handle  
of chew stick

**CHEW IT AND SEE**

For centuries, in parts of Africa, tribespeople have used chew sticks to keep their teeth clean. Woods such as *Garcinia* and the toothbrush tree (*Salvadora persica*) release juices when chewed. These appear to act against bacteria in the mouth, cleaning teeth and preventing infection.



Entire seed

Moreton Bay chestnut  
*Castanospermum australe*  
(Australasia)



Seed with seed  
coat removed

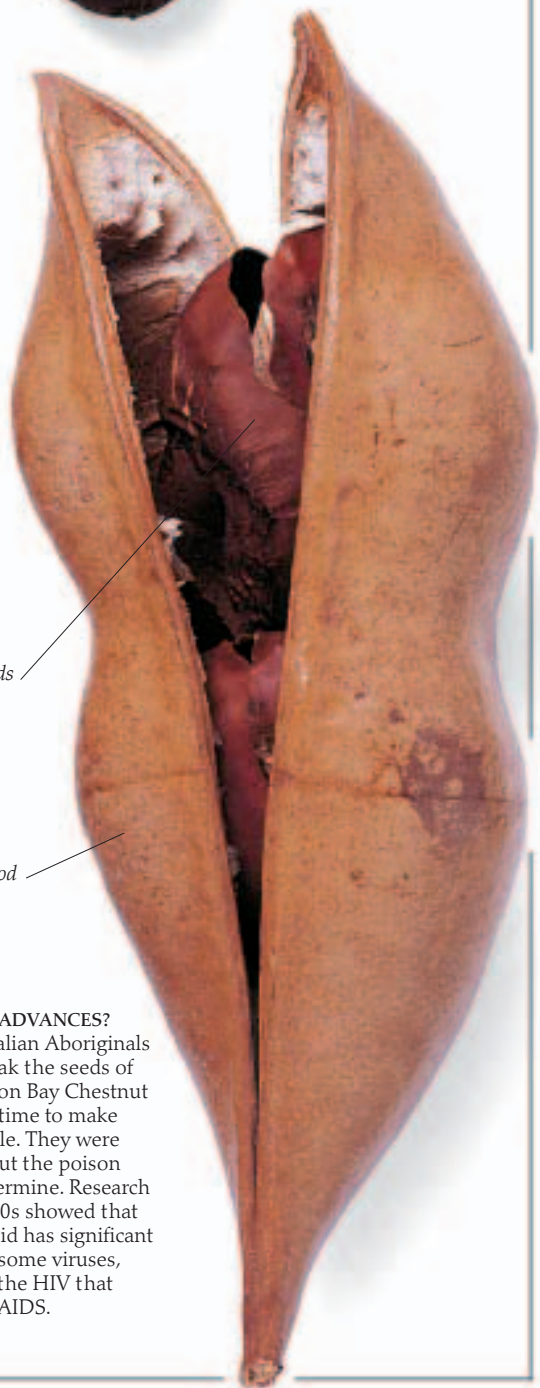


Seed pod of ouabain  
*Strophanthus hispidus*  
(Africa)

**TAKING HEART**

Ouabain was once used by African tribes as an arrow poison. Today, strophanthidin and sarmentogenin are extracted from the seeds of this plant. Strophanthidin is used to treat heart conditions. Sarmentogenin is the chemical starting point for the manufacture of treatments for rheumatoid arthritis.

Seeds are  
wind  
dispersed



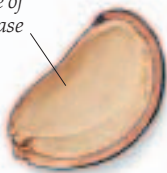
Seeds

Seedpod

**MEDICAL ADVANCES?**

The Australian Aboriginals used to soak the seeds of the Moreton Bay Chestnut for a long time to make them edible. They were washing out the poison castanospermine. Research in the 1980s showed that this alkaloid has significant effects on some viruses, including the HIV that can cause AIDS.

Inside of  
seed case

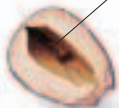


Calabar bean  
*Physostigma venenosum*  
(Africa)

Outside of  
seed case



Seed kernel

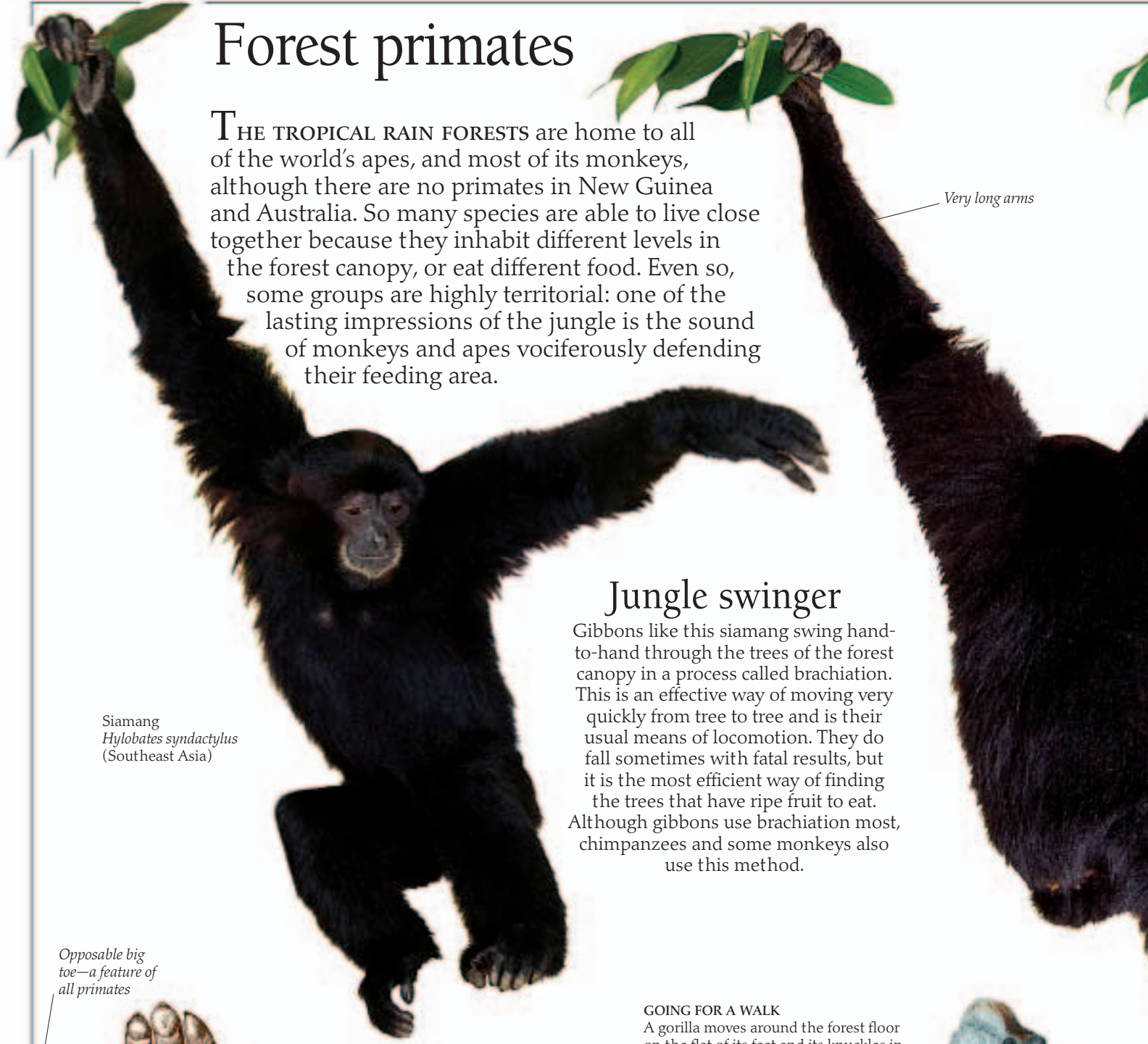


**KILL OR CURE?**

The exceedingly poisonous seeds of the calabar bean were also known as ordeal beans, because they were used by Africans to decide the guilt of a person. If the eater survived, he or she was innocent. Extracts from the seeds are now used to treat glaucoma (a form of blindness) and high blood pressure.

# Forest primates

THE TROPICAL RAIN FORESTS are home to all of the world's apes, and most of its monkeys, although there are no primates in New Guinea and Australia. So many species are able to live close together because they inhabit different levels in the forest canopy, or eat different food. Even so, some groups are highly territorial: one of the lasting impressions of the jungle is the sound of monkeys and apes vociferously defending their feeding area.



Very long arms

Siamang  
*Hylobates syndactylus*  
(Southeast Asia)

## Jungle swinger

Gibbons like this siamang swing hand-to-hand through the trees of the forest canopy in a process called brachiation. This is an effective way of moving very quickly from tree to tree and is their usual means of locomotion. They do fall sometimes with fatal results, but it is the most efficient way of finding the trees that have ripe fruit to eat. Although gibbons use brachiation most, chimpanzees and some monkeys also use this method.

Opposable big toe—a feature of all primates



Gorillas have broad feet; their big toes are opposable so they can curl around to grip



Chimpanzees walk and climb in lower canopy, using both hands and feet



Gibbons spend all their time up in trees so have narrow feet

### GOING FOR A WALK

A gorilla moves around the forest floor on the flat of its feet and its knuckles in quest of the vast quantities of vegetation that it needs to eat every day. Although normally slow-moving, it is capable of bursts of speed when necessary, for example, when seeing off a rival.



Gorilla  
*Gorilla gorilla*  
(Africa)

**JUNGLE CHORUS**

The siamang is the largest of the gibbons. Each pair lives in the treetops with their offspring. They guard their territory and its vital food supply from neighboring siamangs with a morning and afternoon duet of ear-splitting shrieks and barks. The loud calls, which can be heard over half a mile away, are given extra resonance by their inflated throat sacs.



Long, narrow hands with thumb cleft almost to the wrist

Forearm that can rotate 180°

Shoulder joint will rotate 360°

Powerful shoulder muscles

Broad chest

Leg outstretched to maximize forward movement

Legs curled up to increase upward stroke of swing

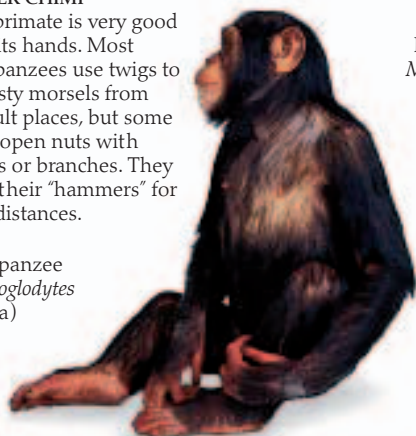
Legs shorter than arms

Big toe long and opposable

**CLEVER CHIMP**

This primate is very good with its hands. Most chimpanzees use twigs to get tasty morsels from difficult places, but some crack open nuts with stones or branches. They carry their "hammers" for long distances.

Chimpanzee  
*Pan troglodytes*  
(Africa)



Mandrill  
*Mandrillus sphinx*  
(Africa)



Humboldt's monkey  
*Lagothrix lagotricha*  
(South America)



**MONKEY ON THE MARCH**

The male mandrill lives mostly on the forest floor. Females and young climb up into low undergrowth.

**TAIL GRIP**

Tree-dwelling woolly monkeys use their prehensile tails to grip slippery branches in the canopy.

# Hunters and killers



## AMBUSHED!

The solitary leopard *Panthera pardus* watches out for prey. It stalks its victim, killing it with a bite to the throat or neck.

**PREDATORS HAVE TO CATCH** and kill other animals if they are to survive. They need to detect their prey before it sees them, to stalk, ambush, or outrun it before it escapes and incapacitate it before it can do them harm. To do all this, they must have acute senses. Daytime hunters often rely on their keen eyesight to find prey. Nocturnal hunters need other skills—a highly developed sense of hearing or smell, or an ability to detect vibrations made by an approaching animal. Prey animals have their own defenses and means of avoiding capture, such as camouflage, so an incompetent hunter goes hungry.



Irritant hairs are kicked into face of assailant

## DANGER ON EIGHT LEGS

As well as dry rocky places, the red-kneed tarantula lives in humid forests. During the day, it stays in its silk-lined burrow. After dark, it emerges to hunt for large insects or small vertebrates. It injects prey with a venom that quickly causes paralysis.

Tarantula  
*Brachypelma smithi*  
(Central America)

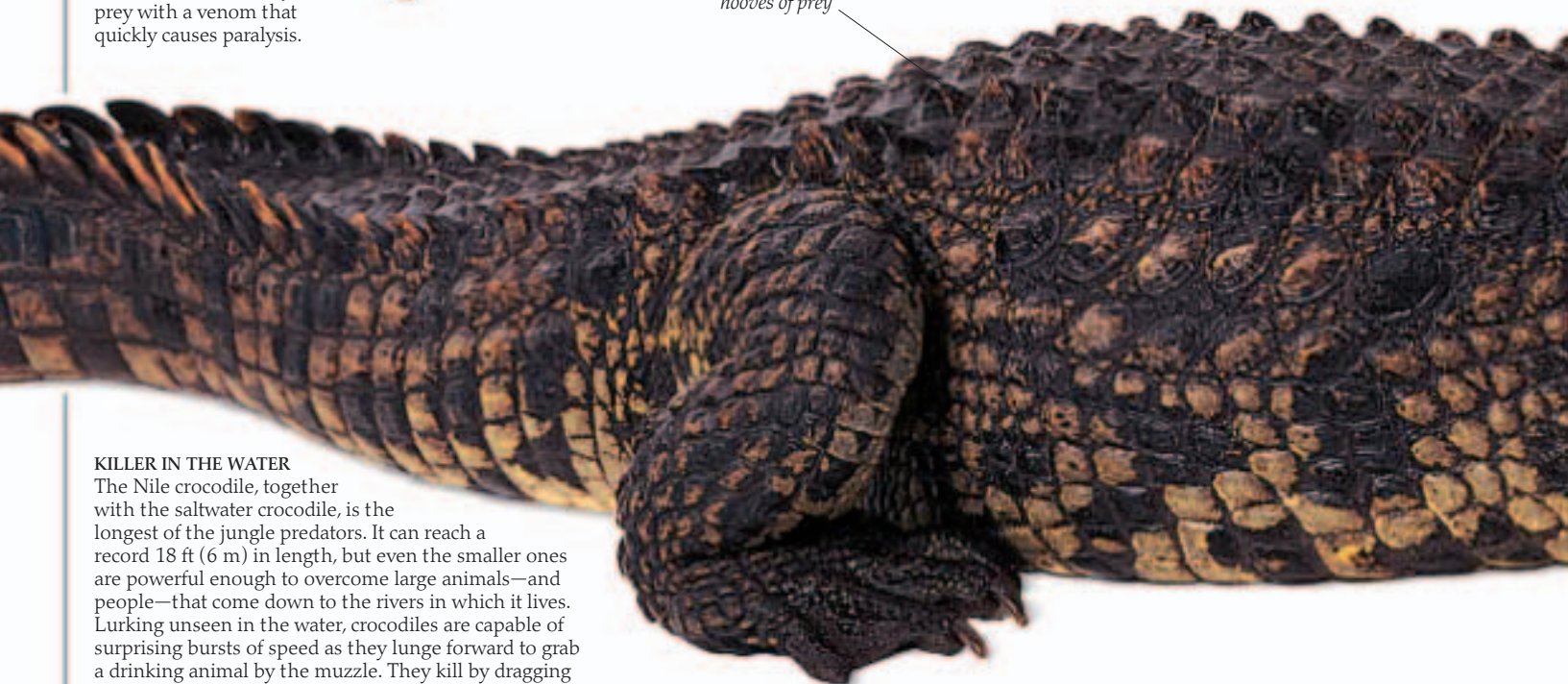
Tough scaly skin protects the crocodile from flying hooves of prey



Changeable hawk eagle  
*Spizaetus cirrhatus*  
(Southeast Asia)

## HUNTER IN THE SKY

The changeable hawk eagle has superb eyesight so it can focus on an animal or bird on the distant ground. From its vantage point, hidden in the foliage of a tall tree, this young bird of prey swoops down swiftly and silently, snatching up its victim with powerful talons.



## KILLER IN THE WATER

The Nile crocodile, together with the saltwater crocodile, is the longest of the jungle predators. It can reach a record 18 ft (6 m) in length, but even the smaller ones are powerful enough to overcome large animals—and people—that come down to the rivers in which it lives. Lurking unseen in the water, crocodiles are capable of surprising bursts of speed as they lunge forward to grab a drinking animal by the muzzle. They kill by dragging their catch under water until it drowns.

Juvenile lures prey with yellow tail



Common lancehead  
*Bothrops atrox*  
(South America)

**SMALL BUT DEADLY**

The small common lancehead is nocturnal, locating warm-blooded prey with heat-sensitive pits between its eyes and nostrils. When a victim is in range, the snake gapes open its mouth, and two long front fangs swing forward. As the snake strikes, these fangs stab, injecting a lethal venom. Most human deaths from snake bites in South America are due to this species.

Boa constrictor  
*Boa constrictor*  
(Central and South America)



**SQUEEZED TO DEATH**

The boa constrictor waits motionless until its prey comes close enough, its airborne scent picked up by the snake's tongue and transferred to the highly sensitive Jacobson's organs on the roof of its mouth. The snake strikes open-mouthed, gripping its catch with its fangs and coiling around the animal's body. Each time the animal breathes out, the snake tightens its coils a little more, until the prey is suffocated.

Formidable array of sharp teeth that are replaced continuously throughout the crocodile's life

Expandable jaws to swallow large prey



Nile crocodile  
*Crocodilus niloticus*  
(Africa)

Strong claws to climb quickly up slippery riverbanks

**TOOTH AND CLAW**

The tiger *Panthera tigris* is a solitary animal that hunts by day or night. It stalks or ambushes, pouncing on its kill when it comes in range. Tigers can bring down deer or cattle with their formidably clawed forepaws, and kill by biting. Although deer and goats are their usual diet, some tigers, particularly old or injured animals, take people.



# Tropical Asia

THE TERM "JUNGLE" is derived from a Hindi word *jangal*, meaning impenetrable forest and undergrowth around settlements. Tropical Asia includes many countries and encompasses an enormous area. Part of this is continental mainland, but stretching southeast of this are the archipelagos of Indonesia and Malaysia, some large, others tiny. It is a diverse and complex region, with many different peoples and histories. Much of the land is covered with tropical forest, including montane forests, and the evergreen and monsoon forests of the lowlands, all of which are rich in animal and plant life. With so much coastline, it is not surprising that most of the world's mangrove swamps are found here.



Prominent eyes with vertical pupils for seeing in low light

## TREE SNAKE

The nocturnal green cat snake (*Boiga cyanea*) lives almost exclusively in trees, often near water. It preys on other arboreal creatures, such as tree frogs and lizards. It subdues its prey with venom from fangs at the back of its mouth, before swallowing it whole.



**WORKING WITH PLANTS**  
Palm trees provide a plentiful raw material for many local industries. This Sarawak girl is splitting palm leaves into strips to be woven into matting or baskets.



Malayan tapir  
*Tapirus indicus*



Strong legs for swimming

## BROWSER

The tapir is a solitary animal that is most active at night. It browses with its long, mobile snout on leaves, fruits, and seeds in the thick jungle growth bordering water.

**INDIA AND SOUTHEAST ASIA**  
The rain forests of Asia are thought to be the oldest and most diverse of all the rain forests but they are also the most affected by human activities. None remain in the Philippines and the recent demand for biofuels has led to felling of large areas throughout Southeast Asia to make way for palm oil plantations.



Rattan palm  
*Calamus caesius*

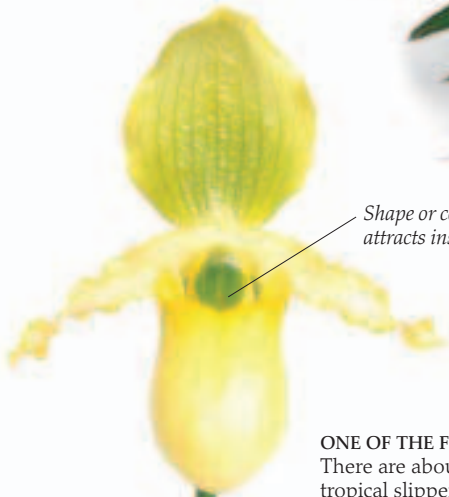


Stem can reach  
over 660 ft  
(200 m) in length

**RATTAN PALMS**

There are about 600 species of rattan. These are climbing palms that reach the canopy by means of whips on the tips of the fronds that are clothed with hooked spikes. Rattan canes are commercially important for making furniture that is exported all around the world.

Shape or color of petals  
attracts insects



Flower bud

**ONE OF THE FEW**

There are about 70 species of tropical slipper orchid, all of which are found in Southeast Asia. Most of them grow on the ground, but a few grow on trees or rocks. Many slipper orchids are naturally rare because they have specific habitat requirements. Since 1964, 20 new species have been described, and *Paphiopedilum primulinum* itself was only discovered in 1972.

Slipper orchid  
*Paphiopedilum  
primulinum*

Leaf sheath covered  
in hooked spines



**THE GINGER LILY**

Many ginger lilies (*Hedychium spp.*) have fragrant, attractive flowers, and their thick underground stems often contain aromatic oils. After the tubular flower, a fruit capsule develops, which when ripe splits to reveal three rows of seeds.

# Disguise and warning

ANIMALS AND INSECTS use camouflage in an effort to keep from being eaten. Color and shape either make an animal indistinguishable from its background, or trick a predator into thinking that they are dealing with something bigger or more dangerous. Animals with cryptic coloration have colors or patterns that closely match their background. Some patterns seem bold and conspicuous, but actually break up an animal's outline, making it impossible to see against a mosaic of leaves, twigs, sunshine, and shadow. Mimicry takes this kind of camouflage a stage further, with insects looking like leaves, bark, or twigs. The disguise of many insects is so good that, rather than waste time looking for them, flocks of mixed species of birds

move noisily through the forest like a wave. What small creatures one bird dislodges or disturbs, the bird behind snaps up.



## STARTLE DISPLAY

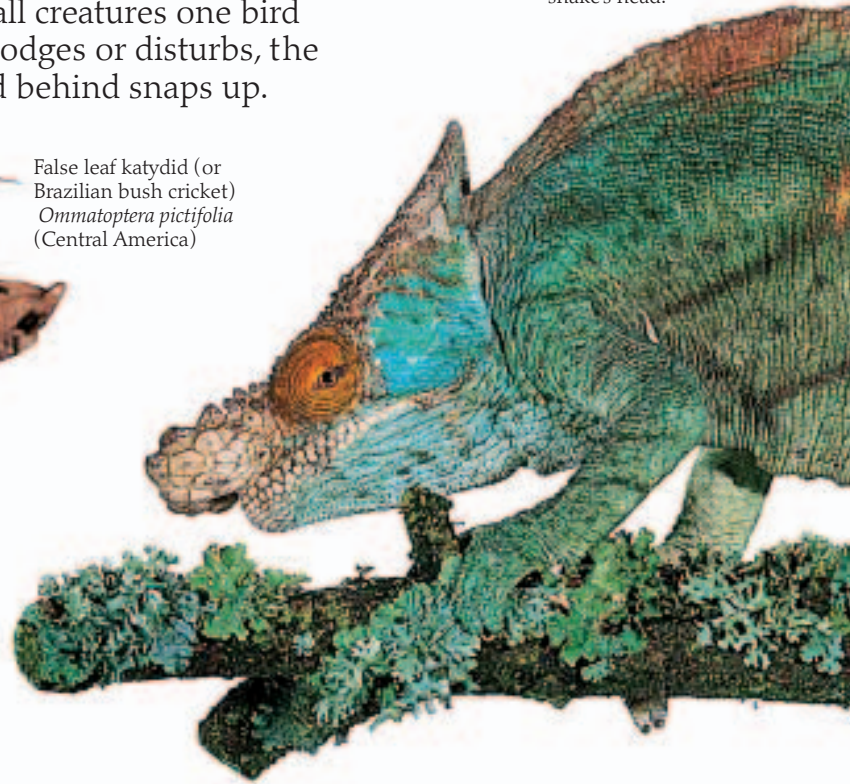
The forewings of the false leaf katydid are near-perfect replicas of dead leaves. When motionless, it blends in well with low-growing vegetation. However, if it is discovered, this katydid has a second line of defense. In one quick movement, the forewings part to reveal a startling display of eye spots. This should scare a predator long enough for the katydid to escape.

False leaf katydid (or Brazilian bush cricket)  
*Ommatoptera pictifolia*  
(Central America)



## MIMICKING A SNAKE

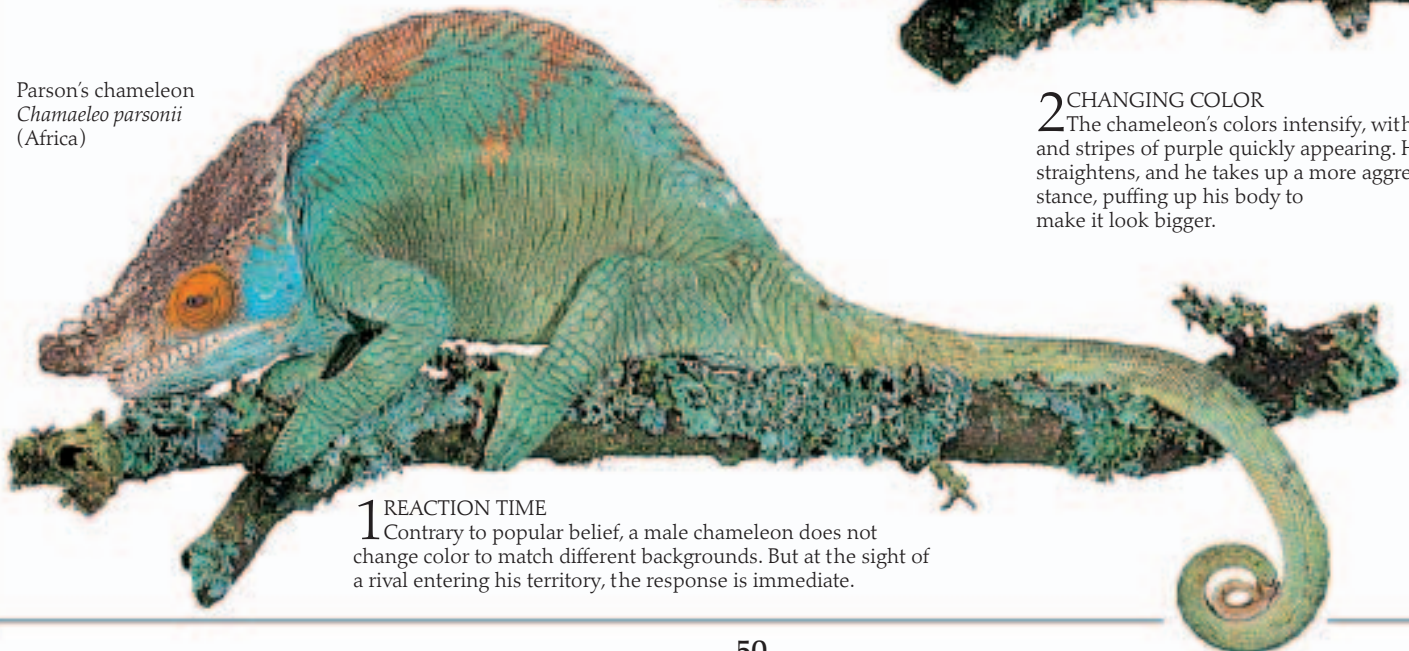
When disturbed, the caterpillar of the hawkmoth *Leucorampha ornatus* mimics a small, venomous pit-viper. It does this by swinging the front part of its body upside down, inflating its thorax to look like a snake's head.



## 2 CHANGING COLOR

The chameleon's colors intensify, with spots and stripes of purple quickly appearing. His tail straightens, and he takes up a more aggressive stance, puffing up his body to make it look bigger.

Parson's chameleon  
*Chamaeleo parsonii*  
(Africa)



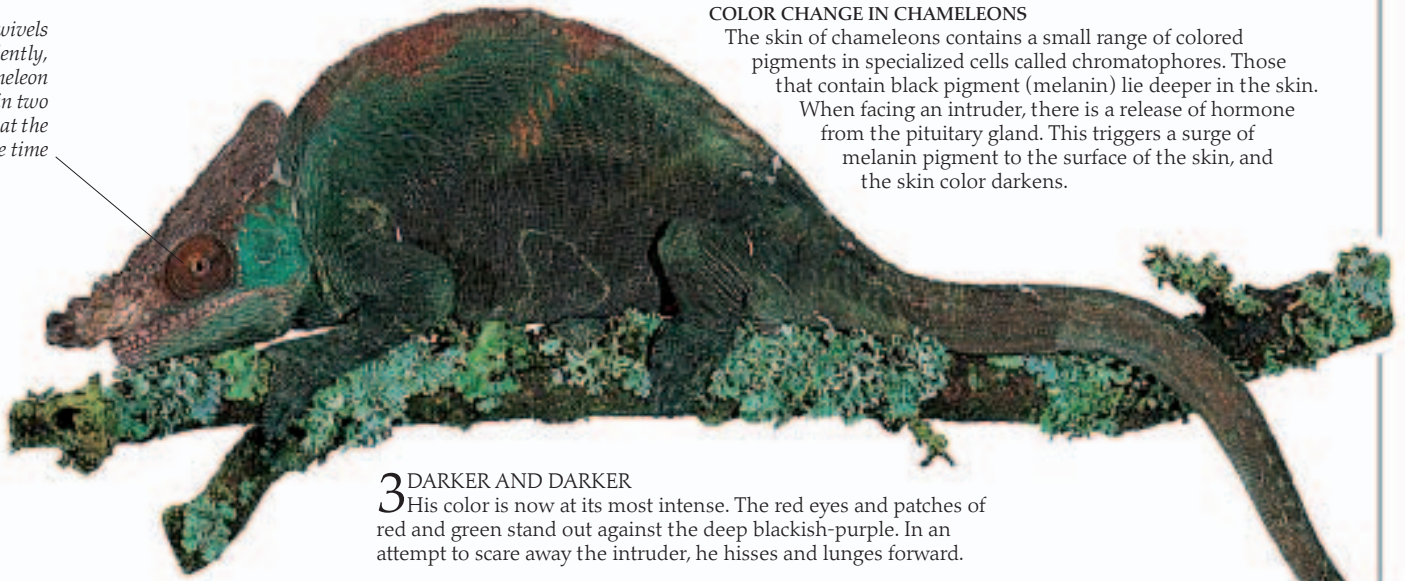
## 1 REACTION TIME

Contrary to popular belief, a male chameleon does not change color to match different backgrounds. But at the sight of a rival entering his territory, the response is immediate.

Each eye swivels independently, so the chameleon can look in two directions at the same time

#### COLOR CHANGE IN CHAMELEONS

The skin of chameleons contains a small range of colored pigments in specialized cells called chromatophores. Those that contain black pigment (melanin) lie deeper in the skin. When facing an intruder, there is a release of hormone from the pituitary gland. This triggers a surge of melanin pigment to the surface of the skin, and the skin color darkens.

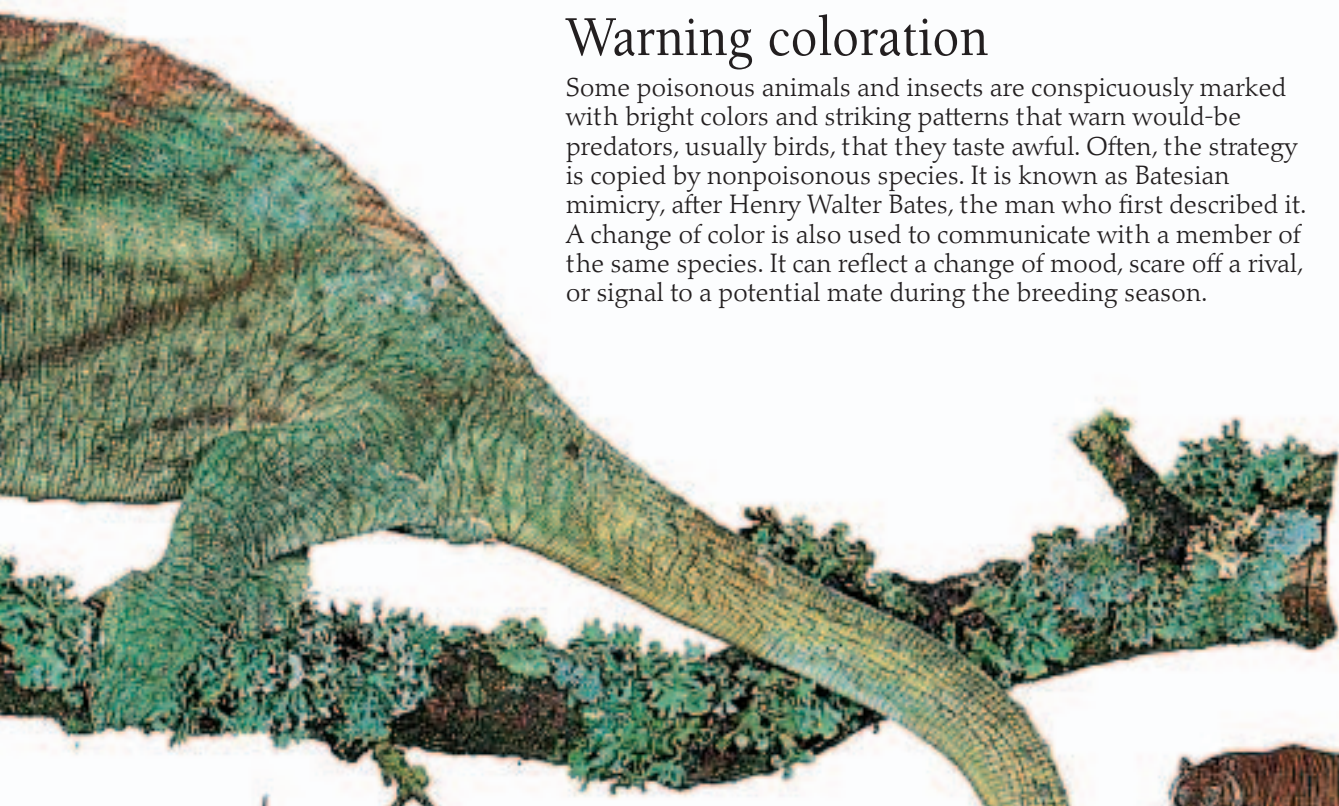


#### 3 DARKER AND DARKER

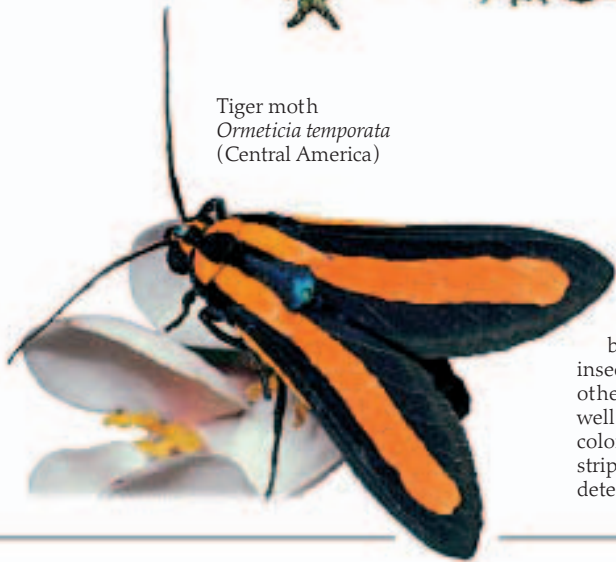
His color is now at its most intense. The red eyes and patches of red and green stand out against the deep blackish-purple. In an attempt to scare away the intruder, he hisses and lunges forward.

## Warning coloration

Some poisonous animals and insects are conspicuously marked with bright colors and striking patterns that warn would-be predators, usually birds, that they taste awful. Often, the strategy is copied by nonpoisonous species. It is known as Batesian mimicry, after Henry Walter Bates, the man who first described it. A change of color is also used to communicate with a member of the same species. It can reflect a change of mood, scare off a rival, or signal to a potential mate during the breeding season.



Tiger moth  
*Orneticia temporata*  
(Central America)



**ALTERNATIVE DEFENSE**  
Moths and butterflies cannot sting attackers, or defend themselves by biting, unlike many other insects. Instead, they have to adopt other strategies. This tiger moth is well protected by its bold warning coloration. The bright yellow stripes on the wings act as a deterrent to any predators.



#### CAMOUFLAGED CAT

Light-colored fur with dark stripes, spots, or blotches imitates the dappled effect of sunlight in the dense vegetation of the rain forest. It makes an effective camouflage for jungle cats. Tigers rely on their ability to remain unseen as they stalk an intended victim, until they are close enough to pounce.

# Tricks and traps

AT ALL LEVELS of the rain forest, there is a host of alert, wary creatures with a strong instinct for their own survival. A predator always has to outsmart its prey if it is to catch enough to eat. Some hunters combine trickery and deception with patience and the ability to move at lightning speed. Plants have a few mean tricks of their own. Sap-sucking insects may have their mouthparts gummed up by an unexpected flow of sticky latex. Other plants, that grow on poor or peaty soils, cannot get enough nutrients. In order to survive, these gain additional nutrients by trapping small animals.



## NETTED

Instead of waiting for an insect to fly into its web, the fishing-net spider (*Deinopis sp*) nets its prey. Suspended from lines of silk attached to a twig, the spider spins a small web of stretchy silk. Picking this up with its four front legs, it hangs upside down and waits. When an unsuspecting insect comes close, the spider drops the net over it.

## SLIPPERY SLOPE

The rim of the pitcher plant is very slippery, so that small vertebrates and insects lose their footing and fall in. They are digested by enzymes in the liquid.



Pitcher develops at tip of leaf

## HUNGRY PLANT

Insects are attracted by the color of the pitcher plants, and by nectar secreted around the rim. They are not aware, until it is too late, that it is a trap. They are digested by enzymes in the water half-filling each pitcher and are absorbed into the plant. The largest pitcher plants have pitchers 12 in (30 cm) long that hold 4 pints (2 liters) of liquid.

## DEADLY LEAVES

The gaboon viper (*Bitis gabonica rhinoceros*) is patterned just like the sun-flecked leaves on the forest floor. It remains motionless and invisible until a small mammal or bird strays too close. Its 2 in (5 cm) long fangs inject a venom that is almost instantly fatal.

Nectar-secreting gland

Leaf blade

Monkey cup  
*Nepenthes mirabilis*

Partly digested insects

Digestive gland



Orchid mantis  
*Hymenopus coronatus*

Compound eyes

Folded front legs in  
"praying" position



**A NASTY SHOCK**  
Any insectivorous predator that tries to sample this tasty morsel will receive a painful surprise. This spiky leaf insect has sharp spines all over its body—enough to make a predator drop it. This female is an immature nymph. After its final molt the wings will be fully formed.

Nectar-sweet  
orchid flower

Folded  
wings

Flap on back leg

**LADY IN WAITING**

With her pale creamy color and the petal-like flaps on her legs, this female orchid mantis seems to be part of the spray of blooms. She has two large compound eyes at the corners of a triangular head that swivel around while the rest of her body stays still. When an insect visits the orchid, the mantis takes deadly aim and strikes out with her front legs.

# Flying high

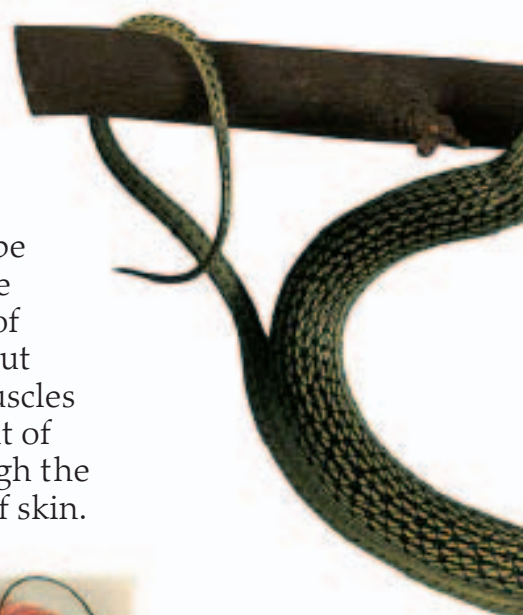


**FROG BEETLE**  
A Malayan frog beetle (*Sagra buqueti*) covers its hind wings with elytra—modified forewings.



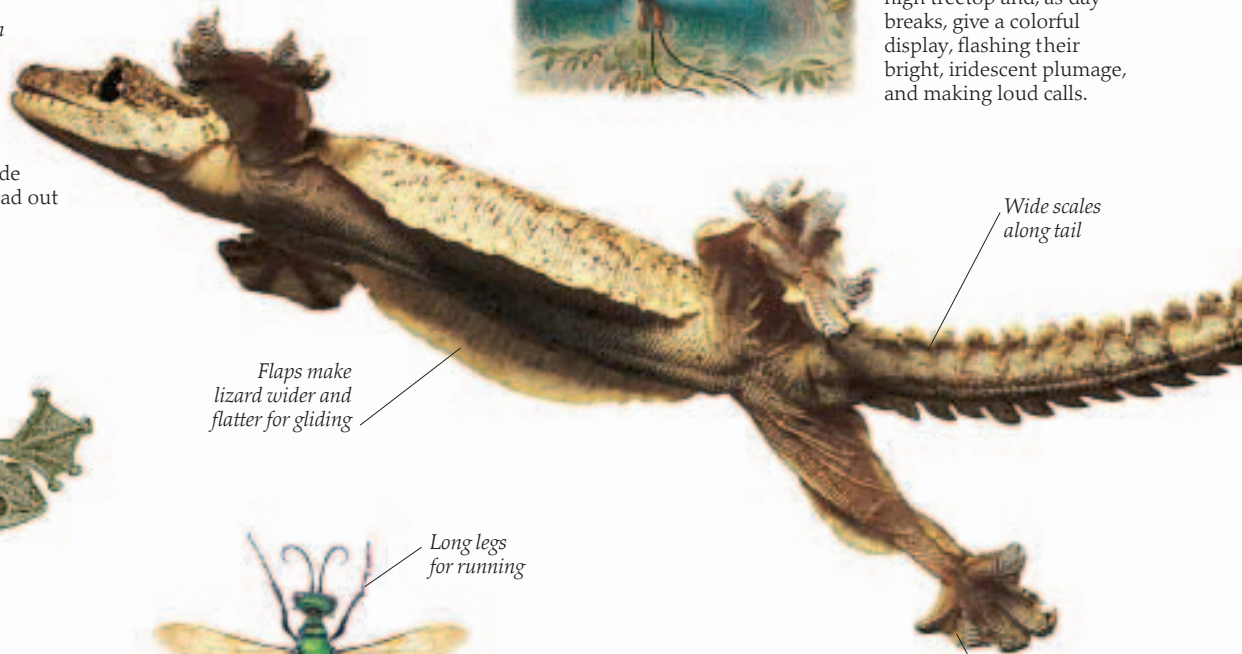
**BEETLING ABOUT**  
Before flying, this leaf beetle (*Doryphorella langsdorffii*) opens its elytra and spreads out its membranous wings.

LIVING IN THE CANOPY many yards above the ground is fine until an animal needs to travel from one treetop to the next in search of food or to escape a predator. Running down one tree trunk, along the ground, and up the next is hazardous and a waste of energy. Traveling through the air overcomes this, but only birds, bats, and insects have the wings and muscles that permit powered flight. However, an assortment of other creatures have evolved ways of gliding through the air by increasing their body area, often with flaps of skin. When airborne, these flaps spread out like parachutes, increasing their wind resistance and slowing down the rate of descent. They glide from tree to tree, landing slightly lower down on the next tree trunk, and then they climb up from there. Many of these gliders can alter direction in midair by moving their legs, tail, or body, and some travel remarkable distances.



**BIRDS OF PARADISE**  
The splendid plumage of male birds of paradise is used simply to attract a mate. Males gather in groups called leks in order to display. Some choose a high treetop and, as day breaks, give a colorful display, flashing their bright, iridescent plumage, and making loud calls.

**FLYING GECKO**  
This nocturnal gecko (*Ptychozoon kuhli*) lives in trees and relies on camouflage to conceal it from predators. If it is spotted, it escapes by launching itself into the air and gliding to safety. Loose flaps of skin along each side and smaller flaps on its legs spread out and fill with air.

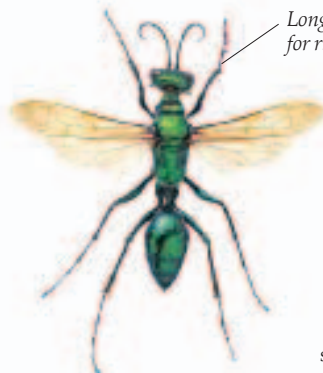


Flaps make lizard wider and flutter for gliding

Wide scales along tail



**FLYING FROG**  
Reinwardt's flying frog (*Rhacophorus reinwardtii*) is one of a small number of rain-forest tree frogs that leap out of a tree to escape from a pursuer. The digits of their very large hands and feet are connected by webs of skin. During long, gliding leaps, these act like parachutes.



Long legs for running

**HUNTING WASP**  
The electric blue female hunting wasp (*Chlorion lobatum*) cruises low over the forest floor, hunting for crickets. It grips its prey with powerful jaws and paralyzes it with venom injected by its sting. It drags the insect into a burrow and lays a single egg in it, so that, on hatching, the larva has food until it pupates.

Webbing between toes

Blue-and-yellow macaw  
*Ara ararauna* (South  
America)



**EXPERT PILOTS**

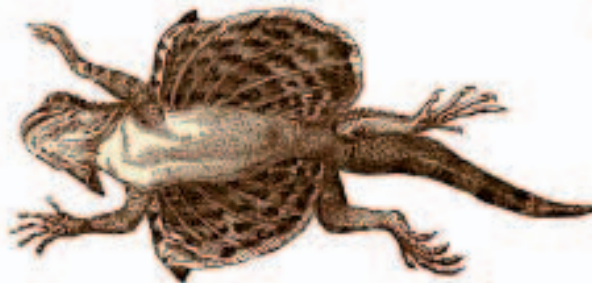
Macaws have short, broad wings so that they can fly skillfully between the leafy branches of the forest canopy. They fly considerable distances in search of trees bearing ripe fruits. By changing the position of their wings and tail feathers, they are also able to glide and brake before landing on a branch or at a tree hole nesting site.

**FLYING SNAKE**

The twin-barred tree snake (*Chrysopelea pelias*) is one of five species from Southeast Asia that can glide through the air. By raising its ribs upward and outward, the snake flattens its body and so manages to travel distances of up to 165 ft (50 m) from one tree to another. When it lands on the ground it resumes its usual shape.



Flying  
dragon  
*Draco spp.*



**FLYING LIZARD**

Flying dragons have six or seven pairs of elongated ribs covered with a membrane of skin. These "wings" are usually folded against the lizard's body, but open out so it can glide long distances.

Wing pattern  
and colors  
help males  
and females  
find each  
other



**GIANT MOTH**

The Atlas moth (*Attacus atlas*) is the world's largest moth, with a wingspan of 12 in (30 cm). Unlike other insects, the wings of moths and butterflies are covered with minute, overlapping scales. These are richly colored, some because they contain colored pigments, others because of the way that they scatter the light that falls on them.

# Australasian rain forests

ONE HUNDRED MILLION years ago, Australia was part of Antarctica, and rain forest covered the moist coastal regions of this vast southern continent. As Australia separated and drifted north, it became drier, and Antarctica colder. Australia's rain forests are all that is left of this ancient jungle, and contain some primitive flowering plants and conifers. Aside from the bats, all the native animals are pouch-bearing marsupials. New Guinea is to the north, a heavily forested island with a mixture of Asian and Australian plants and animals.



## GREEN AND RED

The tiny flowers of this fig (*Ficus racemosa*) are contained in the fleshy green swellings that will eventually become sweet fruits. When the figs ripen, they turn red.

## RARE AND BEAUTIFUL

Living only in a small area of the extreme southeast of Papua New Guinea, this is one of the world's rarest butterflies. It is also the largest, the female having a wingspan of up to 11 in (28 cm). These butterflies are found in the forest margins, but little is known about them.



The male is smaller than the female

Queen Alexandra's birdwing  
*Ornithoptera alexandrae*

## IN THE SHADE

This fleshy-stemmed fern lives beside water in shady forests. There is little strengthening tissue in the leaf stalks, and they soon wilt in dry conditions. Turnip (*Angiopteris*) ferns are very similar to the primitive ferns and tree ferns that were alive 325 to 280 million years ago, in the Upper Carboniferous period.



Long, arching leaf stalk

Turnip fern  
*Angiopteris lygodiiifolia*



## DANGER UNDERFOOT

The marbled scorpion (*Lychas marmoreus*) is found under bark and among leaf litter, where it hunts for small invertebrates. These are usually overpowered by the front claws and jaws. The venomous sting in the tail is used primarily for defense.



## SOGERI SING-SING

In Papua New Guinea elaborate rituals and ceremonies such as the sing-sings have always been an important part of tribal life. New Guinea men adorn themselves with brightly colored body paints, feathers, shells, and beads. Headdresses made with bird of paradise feathers are especially prestigious.



Doria's tree kangaroo  
*Dendrolagus dorianus*

#### UP A TREE

Tree kangaroos have evolved from ground-dwelling ancestors. Doria's tree kangaroo is the most arboreal. It has strong forelegs, broad hind feet, and sharp claws. Its limbs are almost the same length, allowing it to climb trees to browse on foliage, but because of this it can no longer hop along on the ground like other kangaroos. It lives in the cooler forests of the New Guinea highlands and has a thick fur coat to keep it warm.

Sharp claws  
for climbing



#### AUSTRALASIA

New Guinea contains the largest expanse of rain forest to be found in Southeast Asia. Most of it is still undisturbed, and many remote regions have yet to be explored. In contrast, Australian tropical rain forests are limited to patches in three main areas along the northeast coastal region.

#### FRIENDLY FROG

White's tree frog (*Litoria caerulea*) has round toe-pads that are sticky with mucus. It lives in forests, although it is familiar to many Australians because it also lives in water barrels and lavatories. It is 2–4 in (6–11 cm) long, and feeds on any moving creature small enough to swallow. These frogs spawn in still water, producing 200–2,000 eggs.



#### STICKY MEDICINE

The small bitter bark tree (*Ervatamia orientalis*) grows in clearings and the edges of Australian rain forests. When broken, the stems ooze a white, milky latex that some Australian Aboriginals use to treat wounds and sores.

# Jungle produce



**NUTMEG PLANT**

The red aril that covers the nutmeg seed is also used as a spice, called mace.



**A POPULAR FLAVOR**

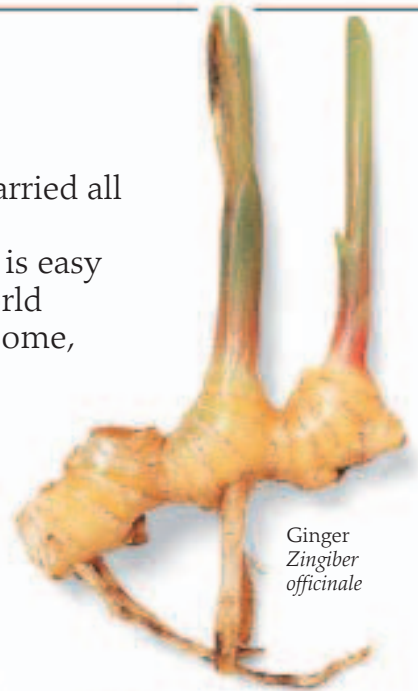
More than 1,350,000 tons (1,227,000 metric tons) of cocoa beans are produced every year to manufacture chocolate, cocoa, drinking chocolate, and cocoa butter.

FOR MANY CENTURIES, jungle products have been carried all around the world. A few, such as rubber, sugar, and chocolate, are now so much a part of everyday life, it is easy to forget their rain forest origins. Products with a world market are mostly grown on plantations. However, some, such as Brazil nuts, are still gathered from the forest.

Many of the fruits and seeds that the tribespeople have enjoyed for a long time are only now beginning to find new markets in North America and Europe. In the future, we may be enjoying ice creams and using cosmetics that contain ever more exotic ingredients from the jungle.

**SPICING IT UP**

Strongly flavored spices such as pepper, ginger, cloves, and nutmeg were highly prized and very expensive in Europe in the Middle Ages. They were used to hide the tainted flavor of bad meat. Today, they are used to enhance the flavor of food, and to make medicines and toothpastes taste better. Spices are prepared from different parts of plants. For example, nutmeg is a seed, cloves are unopened flower buds, cinnamon comes from bark, and ginger is a root. They are dried and can be ground into a powder.



Ginger  
*Zingiber officinale*



Cloves  
*Syzygium aromaticum*



Nutmeg  
*Myristica fragrans*



Cinnamon  
*Cinnamomum zeylanicum*



Cocoa pod  
*Theobroma cacao*



Pulp



Rows of 20–60 oval seeds are embedded in a sweet pulp

**COCOA BEANS**

Cocoa trees have been cultivated for over 2,000 years in Central America. The Aztecs called the pods "cacahual," and believed that Quetzalcoatl, the plumed serpent god, dined on them. When ripe, cocoa pods are cut and split open by hand. The wet, pulpy mass of seeds is piled into baskets and allowed to ferment to lose unwanted pulp and develop the flavor. Then the seeds—the cocoa beans—are dried, cleaned, and polished, ready for export.

Starfruit  
*Averrhoa carambola*



**STARFRUIT**  
Starfruits grow wild in Indonesian forests, but are planted widely in tropical Asia. They are an attractive garnish on food, as well as a source of vitamin C and iron.



**RUBBER**

Over 1,000 kinds of plants produce the white, sticky latex that can be made into rubber. The para rubber tree (*Hevea brasiliensis*) is by far the most important.

Pineapple  
*Ananas comosus*



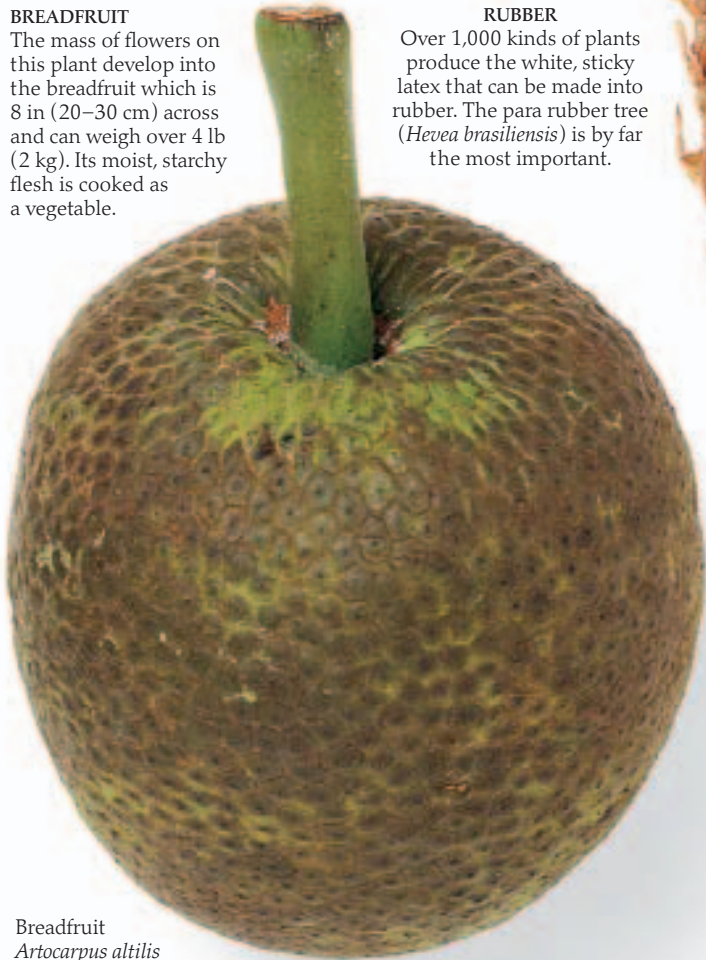
Pineapple cloth or piña

**PINEAPPLE**  
Originating in South America, pineapples are now grown in many tropical countries. Both fresh and canned pineapples are popular foods, but the leaves have a different use. In the Philippines, thin fibers are extracted, prepared, spun, and woven by hand to make a fine sheer cloth called piña. Piña shirts are part of the national costume.



**SWEET POTATO**  
This starchy *Ipomoea batatas* originated in tropical America and contains sugars, so it is pleasantly sweet. Sweet potatoes are boiled, roasted, or dried and ground into flour.

**BREADFRUIT**  
The mass of flowers on this plant develop into the breadfruit which is 8 in (20–30 cm) across and can weigh over 4 lb (2 kg). Its moist, starchy flesh is cooked as a vegetable.



Breadfruit  
*Artocarpus altilis*

Large, sturdy prehensile tail

# Explorers

THE LUCRATIVE spice market drew Portuguese, English, and Dutch explorers to the forested islands of Southeast Asia in the 15th, 16th, and 17th centuries. At the same time, Spanish conquistadors were exploring Central America and Peru, interested more in ransacking Aztec and Inca gold than in the jungles. From the 16th century onward, rival European nations fought to extend their empires in tropical regions. The 18th and 19th centuries saw a steady rise in scientific curiosity about these areas, with explorers such as Darwin and Wallace evolving the theories that have shaped modern thinking.



## WILLIAM BLIGH (1754–1817)

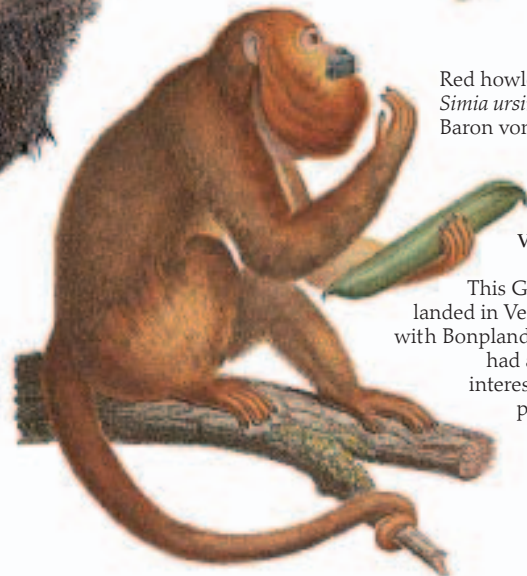
For explorers who sailed the seas in bygone days conditions were harsh. In 1789, Captain Bligh was skipper of the *Bounty*, commissioned to transport young breadfruit trees from the tropical islands of Tahiti to the West Indies. His crew, who wanted to stay on Tahiti, rebelled and the famous mutiny took place. A second attempt succeeded and one of the trees planted by Bligh on St. Vincent is still standing.



## AIMÉ BONPLAND (1773–1858)

With von Humboldt, the Frenchman Aimé Bonpland explored both montane and lowland rain forests. Bonpland was a gifted artist and botanist and recorded over 3,000 new species of plants, such as this *Melastoma coccinea*, in a splendid series of paintings.

Red howler monkey, *Simia ursula*, painted by Baron von Humboldt



## ALEXANDER VON HUMBOLDT (1769–1859)

This German naturalist landed in Venezuela in 1799, with Bonpland. Von Humboldt had an avid scientific interest in the animals, plants, and places he discovered.

### IT'S ALL IN THE NAME

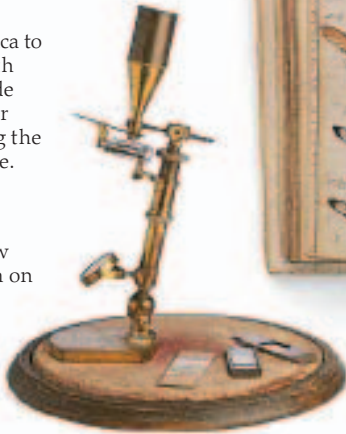
This woolly monkey, *Lagothrix lagotricha* (left), comes from the Orinoco and Upper Amazon basins. It is often called Humboldt's monkey to commemorate that intrepid explorer who had to put up with swarms of biting insects and fevers in this very humid region.



Livingstone's compass

**DAVID LIVINGSTONE (1813–1873)**  
Livingstone, a Scot, traveled to Africa to combine his missionary calling with exploration of the interior. He made three expeditions, traveling by river through dense forest, and mapping the Zambezi River and parts of the Nile.

**CHARLES DARWIN (1809–1882)**  
Abandoning medicine and the priesthood, Darwin joined the crew of the *Beagle* in 1831. He was taken on to record the wildlife found during this small naval ship's mission to chart the South American coastline. The observations he made formed the basis for his theory of evolution.



Darwin's microscope

Pages from one of Bates's notebooks



**HENRY BATES (1825–1892)**

In 1848, Henry Bates and his friend Alfred Wallace left safe jobs in England to explore the Amazon. In 11 years, Bates collected 14,000 specimens, mostly insects, of which 8,000 were new to science. He described how some harmless species mimic other poisonous ones; this is now known as Batesian mimicry.

Glass roof-like greenhouse



**BRINGING IT HOME**

Transporting specimens back from the rain forests has always been difficult. This early 20th-century Wardian case (left) is a portable greenhouse used to carry plants safely back to the Royal Botanic Gardens at Kew, England. Plant specimens were also preserved by being pressed flat between sheets of absorbent paper. Succulent plants and fruits were preserved in spirits to stop them becoming moldy.



**YOUNG VENTURER**

Since the 1970s, Colonel John Blashford-Snell has probably done most to enable biologists and young people to investigate the canopy. First in the Operation Drake, and then in the Operation Raleigh expeditions, they studied plants and animals from lightweight aluminum walkways many yards above the ground.



#### CLEARANCE FOR CATTLE RANCHING

In South and Central America, cleared tropical rain forest provides pasture for beef cattle. When ranchers move into the forest, they burn trees to clear the land for farming. After five years, each animal needs 12.5 acres (50,000 sq m) to graze. After 10 years the land is useless. Overgrazing, the impact of the animals' hooves, and the loss of the trees lead to soil erosion.

#### ENVIRONMENTAL INFLUENCES

Rain forests influence the carbon cycle and have a profound effect on rainfall. The uneven surface of treetops causes air turbulence that increases the amount of water evaporating from the forest. This forms clouds that fall as rain. If the forests disappear, less rain will fall, it will drain more quickly, and air and soil temperatures will rise.



#### PLANTATION PROBLEMS

Palm oil is big business in Riau Province, Indonesia, but the palm tree plantations are proving costly for the environment. Like most of the region, less than 40 percent of the original rain forest remains, and this is having a detrimental effect on both the wildlife and on the carbon cycle. Since 2007, the Indonesian government has promised to try and reduce carbon emissions, which are partly caused by the burning of vast areas of forest to clear it for these plantations, but the demand for biofuels is increasing.

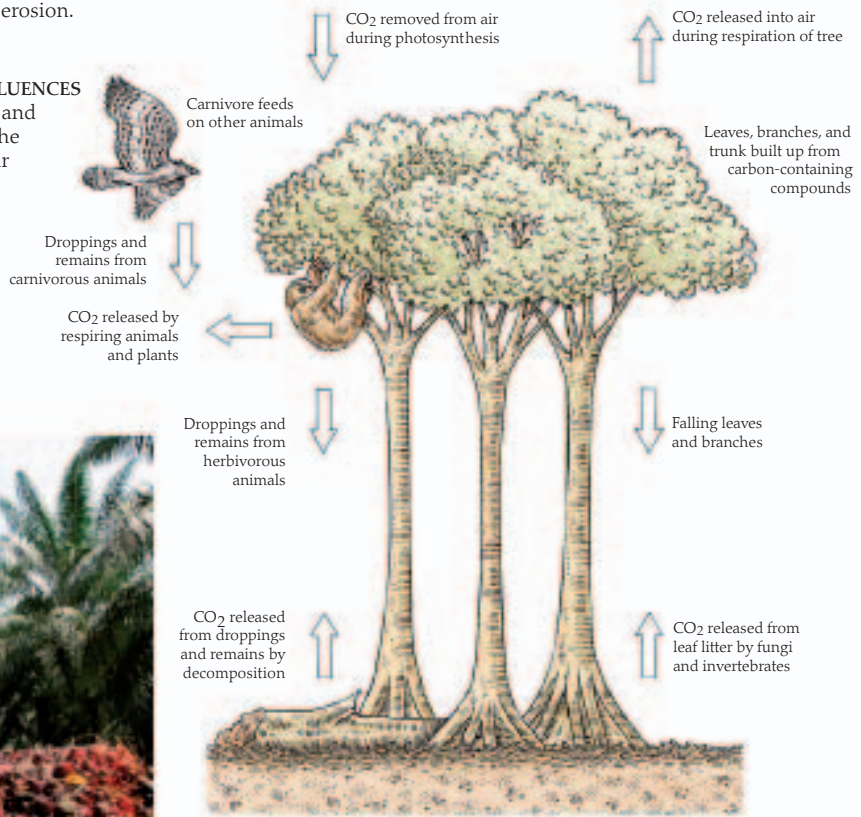


#### THE OLD AND THE NEW

This beautiful Dutch mahogany armoire is an antique. Today, most of the mahogany that comes from Amazonia is poached, felled illegally at the expense of the lives and livelihood of the indigenous tribespeople.

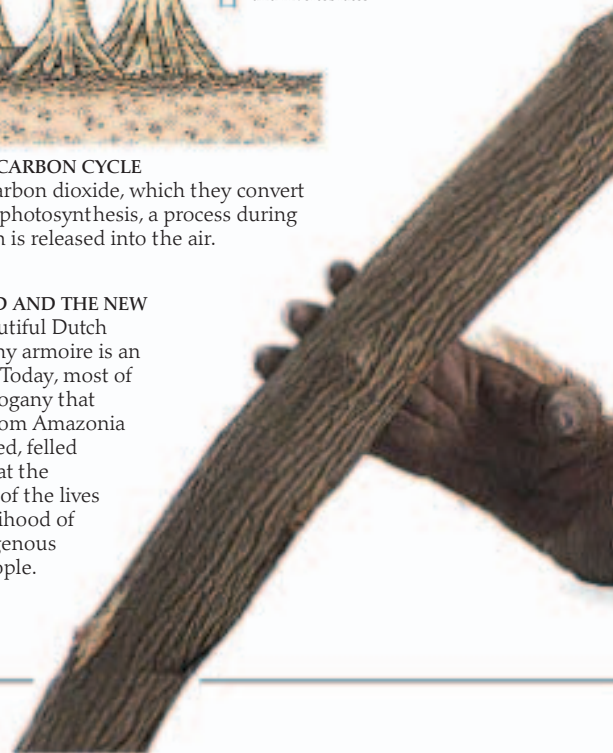
# Under threat

EVERY SINGLE SECOND an area of rain forest the size of a football field disappears—this rate of loss is unsustainable and if it continues, by 2060 there will be none left. Conserving rain forests is one of the biggest challenges we face today, but demand for farmland, efficient communication networks, and mining licenses, in addition to illegal logging and the bushmeat trade are all taking their toll. More recently, the demand for biofuels (fuel made from crops) has led to massive deforestation, particularly in Indonesia, to make way for palm oil plantations.



#### THE CARBON CYCLE

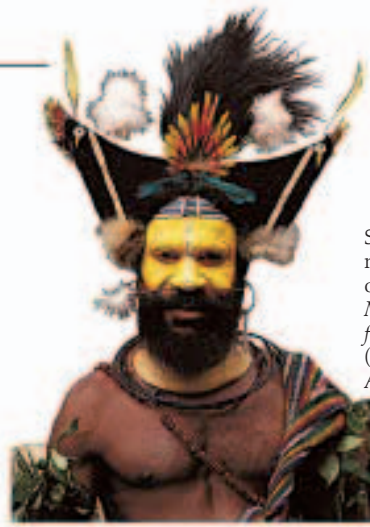
Green plants take up carbon dioxide, which they convert to sugars by means of photosynthesis, a process during which oxygen is released into the air.





**EMBROIDERED CLOTH, NILGIRI HILLS**

In the Nilgiri Hills in India a large area of forest has been made into a Biosphere Reserve. Tribal groups are encouraged to live there in a traditional way and supplement their livelihood by making items for export.



Shiny  
maxillaria  
orchid  
*Maxillaria  
fulgens*  
(Central  
America)



**OBSESSIVE COLLECTION**  
Many of the estimated 18,000 species of orchids are found in rain forests. Their exotic blooms attract collectors, and the trade in these flowers, although frequently illegal, is worth a lot of money. Orchids are highly susceptible to over-collection and some face extinction in the wild.

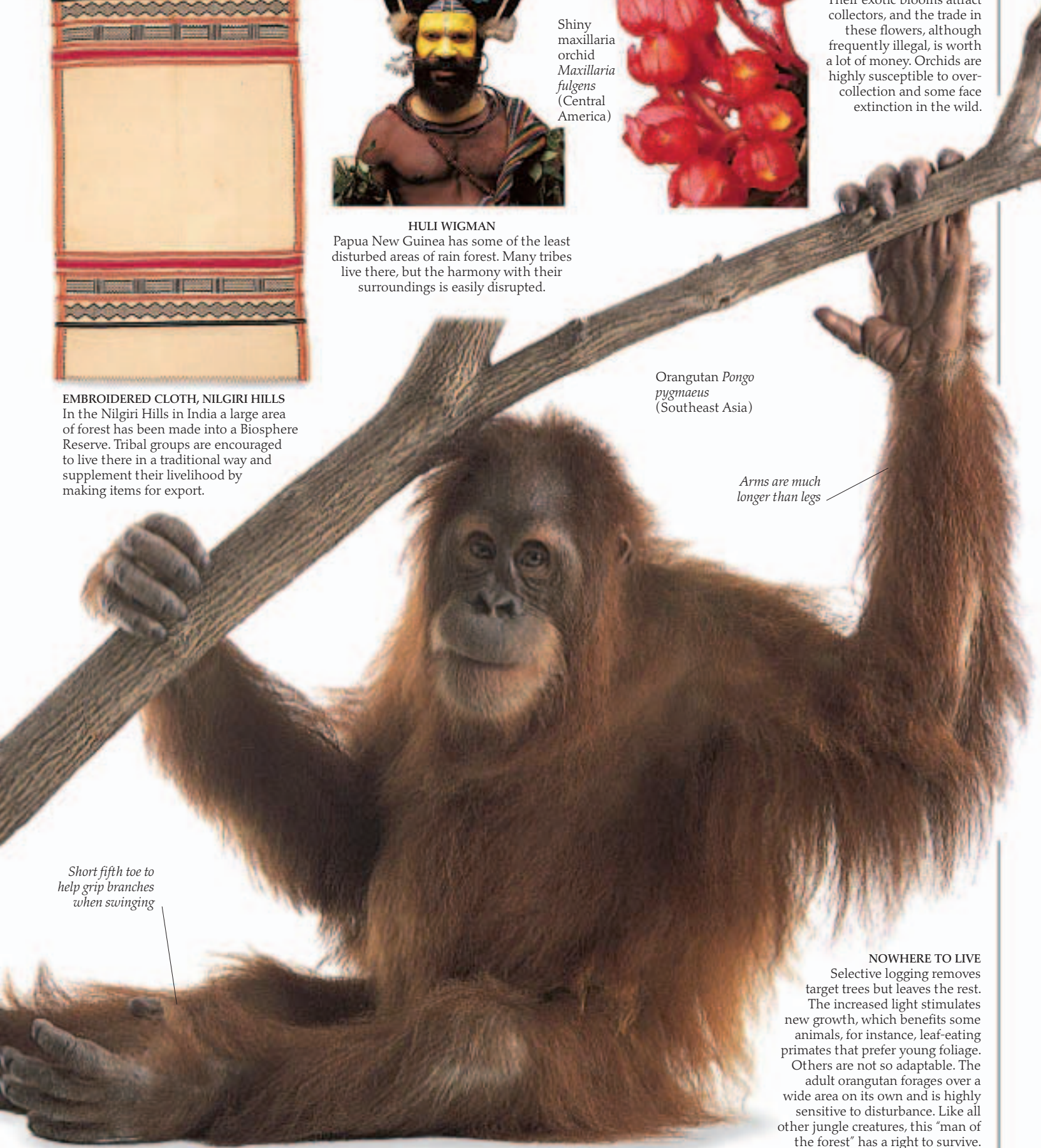
**HULI WIGMAN**

Papua New Guinea has some of the least disturbed areas of rain forest. Many tribes live there, but the harmony with their surroundings is easily disrupted.

Orangutan *Pongo  
pygmaeus*  
(Southeast Asia)

Arms are much longer than legs

Short fifth toe to help grip branches when swinging



**NOWHERE TO LIVE**  
Selective logging removes target trees but leaves the rest. The increased light stimulates new growth, which benefits some animals, for instance, leaf-eating primates that prefer young foliage. Others are not so adaptable. The adult orangutan forages over a wide area on its own and is highly sensitive to disturbance. Like all other jungle creatures, this "man of the forest" has a right to survive.

# Did you know?

## AMAZING FACTS



Amazon

\* Rain forests cover 6 percent of Earth's total land area, yet are home to over half of its plant and animal species.

\* Half of the world's rain forests are within the borders of three countries—Brazil in South America, Indonesia in Southeast Asia, and the Democratic Republic of the Congo in Africa.

\* Tropical rain forests have an average temperature of around 77°F (25°C).



Camouflaged potoo

*Motionless potoo guarding single egg in nest*

\* Two and a half acres (1 hectare) of jungle can support around 100 different kinds of tree. Some tropical forests may have more than 750.

\* In the South American rain forest, one scientist discovered around 50 species of ant in three square feet (1 sq meter) of leaf litter.

\* A rain forest's canopy is so dense that it blocks out about 98 percent of the Sun's light. Most animals live in this part of the forest.

\* A sloth's fur has a green tinge because of the algae growing on it. Because it spends most of its time hanging upside

down, its fur is parted along its stomach rather than its back (as on other animals), helping rainwater to run off.

\* The golden arrow poison frog found in the South American rain forest has enough venom in its skin to kill around 950 people.

\* During the day, the common potoo of Central and South America camouflages itself by sitting in an upright posture, often on a broken branch or tree stump, with its head and bill pointing to the sky so it looks like part of the tree. It hunts at night.

\* Some treetop bromeliads can hold up to 12 gallons (55 liters) of water (about 8 sink-fulls!), providing a home to frogs, snakes, spiders, and even small mammals.

\* Up to 80 different species of plant may live on a single emergent rain-forest tree.

\* Most of the world's 18,000–20,000 species of orchid live in tropical forests.



Golden arrow poison frog

\* More than 150 acres (60 hectares) of rain forest are lost every minute. About 78 million acres (30 million hectares) of rain forest are lost every year—that's larger than the United Kingdom.

\* One-quarter of medicines used today are derived from plants. Drugs used to treat cancer, Hodgkin's disease, and other forms of leukemia all come from rain forest plants.

Rain forest orchid *Odontoglossum laeve*





# QUESTIONS AND ANSWERS

**Q** Why are rain forest trees important to Earth's climate?

**A** Rain forest trees—like all green plants—use carbon dioxide and produce oxygen when they make food from sunlight through photosynthesis. It is estimated that rain forests produce 50 percent of Earth's oxygen. However, the main reason they affect our climate is that they hold vast stores of carbon in their leaves, stems, and roots. When they are burned or cut down and left to rot to clear land, the stored carbon is released into the atmosphere as carbon dioxide gas, contributing to the Greenhouse Effect.

**Q** Will the rain forest trees regrow if they are cut down?

**A** If left undisturbed, rain forests will gradually regrow. However, it is doubtful that they will ever support the same variety of plants and animals. Regrowth happens naturally in forests when large trees die and fall to the ground, often taking smaller trees with them. As light pours into the "gap," fast-growing seeds and saplings grow upward, with one tree eventually outgrowing the rest. If huge areas of rain forest are cut down, however, the unprotected soil is eroded through rain. Although new plants take root, tall trees are unlikely to have the soil and nutrients to grow into giants, and since species composition is different, some animals and trees do not return.



Cassowary of the Australasian rain forest



**Q** What is sustainable farming and can it help save the rain forests?

**A** Sustainable use of the forest is the harvesting of rain forest products without affecting the rain forest's delicate balance of nature. For example, the Brazilian government has set aside land in which Brazil nuts can be harvested from the wild in a way that does not require deforestation. Similarly, latex can be collected from rubber trees without mass deforestation. These programs not only help to save rain forest trees, but they also provide an income for indigenous peoples. However, much more needs to be done. Wood is a renewable resource and many environmental groups now back programs for the sustainable use of the world's forests.

Collecting latex

**Q** Why do more types of animal live in rain forests than in any other habitat?

**A** Rain forests have existed for millions of years—some in Southeast Asia are around 100 million years old—so animals have had time to evolve. There are more habitats than elsewhere within the rain forest, both horizontally and vertically within the stories. With constant temperatures and plenty of rainfall, conditions are ideal for sustaining a variety of life. Animals do not face cold winters or hot sun, and they always have water.

Rain forest in Ecuador, cleared for oil exploration

## Record Breakers



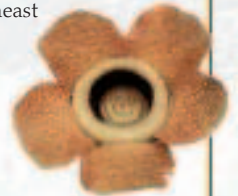
### LARGEST JUNGLE BIRD

The cassowary of the Australasian rain forest grows up to 5 ft (1.5 m) tall.



### LARGEST JUNGLE FLOWER

The giant rafflesia of Southeast Asia can grow around 3 ft (1 m) wide and weigh up to 15 lb (7 kg).



Rafflesia



### LARGEST BUTTERFLY

The Queen Alexandra's birdwing has a wingspan of up to 11 in (28 cm).



### LONGEST JUNGLE SNAKE

The anaconda of South America grows to an average length of 18 ft (5.5 m).



# Endangered jungle animals

HERE ARE JUST A FEW RAIN FOREST ANIMALS that are endangered because of poaching and loss of habitat. Some are now critically endangered, meaning they face an extremely high risk of extinction in the wild\*.



Common gibbon

## JAVAN SILVERY GIBBON

### *Hylobates moloch*

**Habitat and range:** Rain forest of western and central Java in Southeast Asia

**Status:** Critically endangered

**Numbers:** There are thought to be just 1,000 Javan gibbons in fragmented populations in the wild. Other species of gibbon, such as the common (or lars) gibbon, are currently considered low risk because there are around 300,000 remaining in their native habitat. However, if current rates of deforestation continue, they may also become vulnerable and even endangered.

**Reasons for decline:** Loss of habitat through deforestation for farming, logging, and mining, and because juveniles are taken for the pet trade.

Sumatran tiger



## AYE AYE

### *Daubentonia madagascariensis*

**Habitat and range:** Protected rain forest on the African island of Madagascar

**Status:** Endangered

**Numbers:** Estimated population of less than 2,000; numbers are expected to halve over the next 10 years based on current rate of habitat loss.

**Reasons for decline:** Habitat loss through logging and conversion to agriculture; the aye aye has also often been killed since it is considered a pest for feeding on crops, and a sighting of the animal is thought by local people to be a harbinger of misfortune.



Aye aye

Long arms for swinging and reaching fruit

## SUMATRAN ORANGUTAN

### *Pongo abelii*

**Habitat and range:** Northern rain forest of Sumatra

**Status:** Critically endangered

**Numbers:** There are thought to be just 7,500 orangutans (*Pongo pygmaeus* and *Pongo abelii*) left. Unless something is done quickly it is thought both species will be extinct in the wild in less than five years.

**Reasons for decline:** Poaching, loss of habitats and pet trade. Forest fires in 1990s may have killed a third of the population.

## SUMATRAN TIGER

### *Panthera tigris sumatrae*

**Habitat and range:** Sumatran forest, including tropical forest

**Status:** Endangered

**Numbers:** There are thought to be less than 400 animals remaining in the wild, in Sumatra's five national parks.

**Reasons for decline:** Loss of habitat, poaching, and the illegal trade in tiger parts for use in traditional Chinese medicine. The other four remaining subspecies of tiger are also endangered.



Philippine eagle

## PHILIPPINE EAGLE

### *Pithecophaga jefferyi*

**Habitat and range:** Luzon, Samar, Leyte, and Mindanao islands of the Philippines (the eagle is the national bird of the Philippines)

**Status:** Critically endangered

**Numbers:** There are fewer than 250 mature birds in the wild; attempts are now being made to breed the eagle in captivity and return it to its natural habitat.

**Reasons for decline:** Erosion of habitat through logging, mining, and clearing land for agriculture, and also poisoning through accumulation of pesticides.



Adult orangutans are solitary animals, ranging over several miles of rain forest

Sumatran orangutan

\*Based on data from the 2008 Red List of Threatened Species™. For up-to-date information, log on to [www.redlist.org/](http://www.redlist.org/)



Bonobo

**BONOBO (PYGMY CHIMPANZEE)**  
*Pan paniscus*

**Habitat and range:** Rain forest in the Democratic Republic of Congo, Africa  
**Status:** Endangered (along with other kinds of chimpanzee, such as the western chimpanzee)  
**Numbers:** Numbers unknown; estimates vary from 60,000 to less than 5,000.  
**Reasons for decline:** Bush meat trade, loss of habitat, and the sale of young as pets.

**GORILLA**  
*Gorilla gorilla*

**Habitat:** Central Africa, in small areas of wild forest and reserves  
**Status:** All gorillas (eastern, western, and mountain) are now endangered.  
**Numbers:** There are thought to be around 40,000 western lowland gorillas remaining in the wild. The eastern lowland gorilla, now found only in the Democratic Republic of Congo, is thought to have a population of less than 5,000. The mountain gorilla is the most endangered, with only 650 animals remaining in the wild. Half of this number live in protected areas of the Virunga volcanic region of Rwanda, Uganda, and the Democratic Republic of Congo. The rest live in Bwindi National Park in Uganda.  
**Reasons for decline:** Loss of forest home due to logging or clearing land for ranches, farms, and plantations. They are also very susceptible to disease—especially the Ebola virus—and poaching. Civil unrest in some African countries has made it difficult to patrol reserves and safeguard animals from poachers, who hunt gorillas for their meat and skins. Hunting gorillas and other wild animals in the forests of the Congo Basin in Africa is so excessive that poaching is considered to be more of a threat to animal conservation than deforestation.

Mountain gorilla from Rwanda



Hyacinth macaw

**HYACINTH MACAW**  
*Anodorhynchus hyacinthinus*

**Habitat and range:** Southern Brazil, northeastern Paraguay, eastern Bolivia.  
**Status:** Endangered  
**Numbers:** Around 2,500 birds in three distinct populations.  
**Reasons for decline:** Trade (considered a prized pet), hunting, and deforestation.

## Hunted to extinction



Rhino horns

Many countries have passed laws banning the hunting of endangered animals, and have set aside national parks and reserves to preserve what remains of their habitats. However, even though it is illegal, many endangered animals, such as the orangutan, tiger, and rhinoceros, are still poached for their meat, hides, or horns. Sometimes mothers are killed so that their young can be captured and sold as pets.

Young primates are also caught and sold for medical research. Many endangered animals are also hunted because their body parts are thought to have healing powers in traditional Chinese medicine. For example, a tiger's whiskers, are sold to ease toothache, its tail is used to treat skin diseases, and its bones are thought to help cure rheumatism.

**SUMATRAN RHINOCEROS**  
*Dicerorhinus sumatrensis*  
**Habitat and range:** Lowland rain forests of Southeast Asia  
**Status:** Critically endangered  
**Numbers:** It is estimated that there are less than 250 animals in the wild, a few in Sabah and small populations on the Malaysian peninsula and Sumatra. The Javan rhinoceros is also critically endangered, with just 50 animals left in the lowland rain forests of Ujung Kulon National Park on Java, Indonesia, and Cat Tien National Park in Vietnam.  
**Reasons for decline:** Deforestation and poaching for its highly priced horn, which is thought to have medicinal properties.

Sumatran rhinoceros



# Find out more

**T**HERE IS A WEALTH OF INFORMATION AVAILABLE about the world's jungles. Maybe one day you will be fortunate enough to explore a rain forest. Until then, see jungle animals up close in local zoos and wildlife centers, and find out about their captive breeding programs and other important conservation work. You can also watch wildlife programs on television, get online to access information over the internet, join a conservation group, or visit a botanical garden.



Golden lion tamarin

## ZOOS AND WILDLIFE CENTERS

Find out about your nearest zoo's conservation work. It may be involved in breeding and raising endangered animals. In the 1970s, the golden lion tamarin was thought to be the world's most endangered primate, with only around 100 animals left in the wild. Since then, captive breeding programs in zoos worldwide and the setting up of forest reserves have increased populations, and the golden lion tamarin now has a much greater chance of survival.

## ECOTOURISM

It is now easier to visit some of the world's rain forests through ecotourism. Ecotourism means to visit a place to sightsee or learn about its natural environment without, for example, staying in a fancy hotel and using up valuable water resources. While ecotourism in the world's rain forests does not directly help to save the forests, money spent by tourists can be used for conservation work, reforestation, management of reserves, and so on. However, care must be taken not to upset the ecosystem's delicate balance of nature, so tourism must be carefully managed, and visitor numbers limited.



Ecotourism in Malaysian rain forest



Ecotourists in Rwanda, Africa

## ADOPT AN ANIMAL

Many zoos and conservation organizations enable you to adopt an animal by making a contribution toward its upkeep. For example, through the Dian Fossey Gorilla Fund International (an organization that continues the work of Dian Fossey, a scientist who dedicated her life to saving mountain gorillas), you can adopt a gorilla from the Karisoke Research Center in Rwanda. When you adopt an animal, you receive a photo and adoption papers and can keep track of the animal on the website (<http://www.gorillafund.org/>).



## Places to visit

### JUNGLE GARDENS AND BIRD SACTUARY, AVERY ISLAND, LOUISIANA

Jungle Gardens showcases tropical plants, and enormous flocks of herons and egrets rest here in its bird sanctuary in early spring and summer:

### SAN DIEGO ZOO, SAN DIEGO, CALIFORNIA

The San Diego Zoo is active in world conservation efforts. Many endangered jungle animals are on display at the zoo and its wild animal park:

### BRONX ZOO, BRONX, NEW YORK

The Bronx Zoo is also active in conservation. Visit its indoor Asian rain forest—almost a full acre in size—and its Congo Gorilla habitat.

### NATIONAL ZOOLOGICAL PARK, WASHINGTON, D.C.

Exhibits at the National Zoo, which works with the Conservation and Research Center Foundation, allow visitors to get close to rare animals.

### AMERICAN MUSEUM OF NATIONAL HISTORY, NEW YORK, NEW YORK

A re-creation of the Dzanga-Sangha rain forest takes visitors into the jungle, with tangled vines and branches above and leaf litter concealing insects, reptiles and ground mammals below.



Rattan palm

### LONDON ZOO, REGENT'S PARK, LONDON, ENGLAND

Find out about the zoo's work in animal conversation and see

- Sumatran tigers, which are part of a European captive breeding program
- the Macaw Aviary, including endangered Hyacinth macaws

### WHIPSNADE WILD ANIMAL PARK, BEDFORDSHIRE, ENGLAND

This wildlife park has over 2,500 animals living in open paddocks or roaming free in parkland. Look for the three species of rhinoceros (Black, White, and Asian) threatened with extinction, now bred in the park.

### CONSERVATION MATTERS

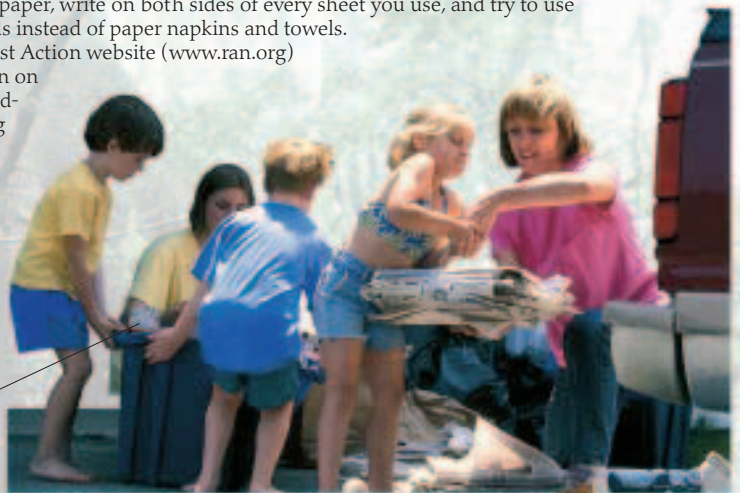
Contact an environmental group to see what it is doing to try to save and protect the world's rain forests and find out how you can help. Many of these groups have websites (see box below) and produce information such as factsheets, films, and brochures. They also raise money and campaign for stricter environmental laws. Help to save rain forest trees by using less paper.

In addition to recycling paper, write on both sides of every sheet you use, and try to use cloth napkins and towels instead of paper napkins and towels.

Check out the Rain forest Action website ([www.ran.org](http://www.ran.org))

for plenty of information on recycling as well as wood-free paper options using waste straw, kenaf, or hemp.

Recycling newspapers and magazines



### USEFUL WEBSITES

- Homepage of the World Wildlife Fund, with information on where to join and other WWF sites: [www.wwf.org/](http://www.wwf.org/)
- Learn about the Save-an-Acre program and more from the Tropical Rainforest Coalition: [www.rainforest.org](http://www.rainforest.org)
- Rainforest Alliance's site offers an Adopt-a-Rainforest program and features rain-forest photographs and art: [www.therainforestsite.com](http://www.therainforestsite.com)
- See photographs from a Smithsonian photographer's six-year documentary of the Panamanian jungle: [www.photo2.si.edu/crane/craneport.html](http://www.photo2.si.edu/crane/craneport.html)



Queen Alexandra birdwing butterfly

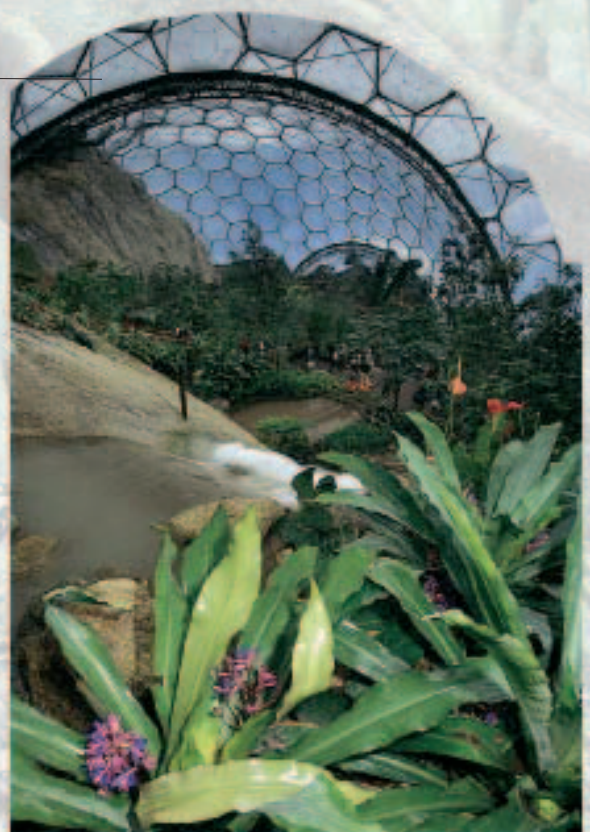
### BUTTERFLY GARDENS

Large butterfly gardens often have a tropical hothouse where you can see colorful rain-forest species flitting through the trees.

Hexagons in domed roof made up of layers of inflated transparent foil, each 6 ft (2 m) deep

### EDEN PROJECT

The Humid Tropics Biome at the Eden Project in Cornwall, England, is the largest conservatory in the world, containing over 1,000 plant species from the jungles of Malaysia, West Africa, the islands of Oceania, and South America. Mist and waterfalls inside the dome keep the air moist, and the air is regulated so it is between 64.4°–95°F (18°–35°C), re-creating the heat and humidity of a tropical forest. In addition to experiencing what it is like to walk through jungle plants, you can also learn about the hundreds of uses of plants in our everyday lives. More information about the Eden Project and news about current exhibits and workshops can be found on its website ([www.edenproject.com](http://www.edenproject.com)).



Inside the Humid Tropics Biome at the Eden Project

# Glossary

**ADAPTATION** Process by which a living organism gradually changes genetically so that it becomes better suited to a particular environment.

**AMPHIBIAN** Ectothermic (cold-blooded) vertebrate such as a frog, whose young uses gills to breathe during its early stages of life.

**BIODIVERSITY** (or biological diversity) The wide variety of living organisms, including plant and animal life.

**BIOME** Large ecological unit broadly corresponding to one of the world's major climatic regions, such as a tropical forest, desert, and so on.

**BIOSPHERE** that part of Earth and the atmosphere in which organisms live.

**BROMELIAD** Member of a family of plants, many of which are epiphytes that live on the boughs of trees. (*see also* EPIPHYTE)

**BUTTRESS ROOT** Supporting structure that grows from the base of a tree's trunk, helping to support its weight.

**CAMOUFLAGE** An animal's color or pattern that enables it to blend in with its surroundings in order to hide from predators or lie in wait for prey.

**CANOPY** Layer in a forest that is made up of the leafy crowns of most trees.

**CARBON DIOXIDE** Colorless, odorless gas given out by animals and plants during respiration; it is absorbed by plants during photosynthesis. Too much carbon dioxide gas in the atmosphere results in global warming. (*see* GLOBAL WARMING)



Bromeliad

**CARNAUBA** Type of high-quality wax taken from wax palms, used mainly in the cosmetics and polish industries.

**CINCHONA** Plant from which quinine is obtained, which is sometimes used in the treatment of malaria.

**CLIMATE** The pattern of weather in a particular place over a long period of time.

**CLOUD FOREST** Type of rain forest growing at high altitudes where trees are often enveloped in mist. There are many moss and lichens which even cover tree branches.

**CONSERVATION** Protecting, preserving, and managing Earth's natural resources and its environment.

**CURARE** Type of poison used by some South American tribespeople to coat their arrow tips when hunting prey.

**CYCAD** Palmlike, seed-bearing plant with long fernlike leaves.

**DEFORESTATION** When forest is felled and cleared as a result of human activity.

**ECOLOGY** The scientific study of plants and animals in relation to their environment, or ecosystem.

**ECOSYSTEM** A community of living organisms in their natural habitat, forming an interdependent food chain. (*see also* BIOME)

**EMERGENT** Very tall tree that towers above the rest of the rain forest canopy. (*see also* CANOPY)

**ENDANGERED** In danger of extinction.

**EPIPHYTE** Plant that grows on another plant (often a tree) for support, and often to reach the light. Epiphytes absorb nutrients from rain and debris lodged on the bark of the tree.

**EXTINCTION** The dying out of a plant or animal species.

Kapok fiber



Kapok pod

**FOOD CHAIN** Series of plants and animals linked by their feeding relationships.

**GERMINATION** Process in which a seed starts to grow.

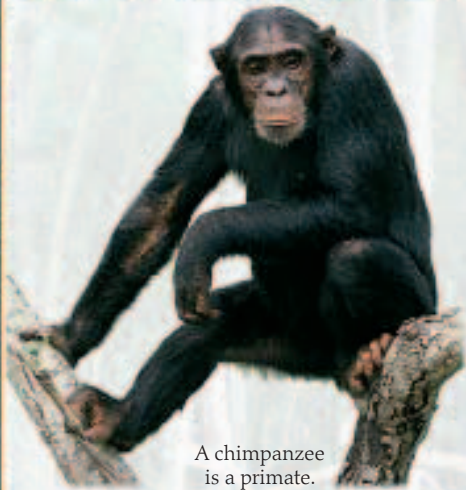
**GLOBAL WARMING** Warming of Earth's atmosphere caused by a buildup of greenhouse gases. (*see also* CARBON DIOXIDE, GREENHOUSE EFFECT)

**GREENHOUSE EFFECT** The accumulation of gases such as carbon dioxide in the atmosphere, which allows sunlight to reach Earth's surface but prevents heat from leaving.

**HABITAT** Environment or surroundings in which an organism (plant or animal) lives.



Emergent tree breaking through the canopy



A chimpanzee is a primate.

**HUMIDITY** The amount of water vapor in the air. A tropical rain forest has an average humidity of around 82 percent.

**HUMUS** Decomposed organic matter.

**KAPOK** Light, waterproof, oily fiber covering the seeds of some species of silk-cotton tree; often used for stuffing pillows.

**LATEX** Thick, milky juice produced by some plants, including the rubber tree, whose sap is used in the manufacture of rubber products.

**LIANA** Plant with a long, slender stem that climbs up jungle trees or dangles down from the canopy so its leaves can reach light.

**LICHEN** Plantlike organism formed from a partnership between a fungus and an alga or cyanobacterium, which forms crusts and tufts on trees, rocks, or soil.

**LITTER** Dead leaves, twigs, and branches that fall to, and carpet, the forest floor.

**LIVERWORT** Plant related to moss; some have a lobed plant-body that resembles a liver; once used to treat liver diseases.

**MAMMAL** Endothermic (warm-blooded), hairy vertebrate that suckles its young.

**MANGROVE** Tree that grows in muddy swamps covered at high tide, or on tropical coasts and the shores of estuaries; characterized by long, tangled roots.

**MARSUPIAL** Animal in which the young is usually carried in a pouch by the female.

**MIMICRY** Copying the behavior, coloring, or markings of another more dangerous animal to escape from predators.

**MONSOON** Wind that changes direction according to the seasons; also used to mean the heavy seasonal rains it brings to parts of the world.

**MOSS** Small plant with simply constructed leaves, attaching itself to ground, trees, or rock by short, rootlike hairs.

**NOCTURNAL** Active by night rather than by day (diurnal).

**NUTRIENT** Food needed by plants and animals to live and grow.

**POACHER** Hunter who kills an animal illegally. Some commercial poachers use shotguns, rifles, or even machine guns to kill their prey. Others use more traditional weapons, such as spears or arrows.

**PHOTOSYNTHESIS** The process by which green plants produce food by using the energy from sunlight to build simple sugars from carbon dioxide and water.

**PREHENSILE** Flexible part of the body (usually the tail) that is able to grip. For example, some monkeys have prehensile tails, which are used like another hand, to hold on to branches.

**PRESERVATION** Keeping something from harm or decay.

**PRIMATE** An order in the animal kingdom, including monkeys, apes, and human beings.



Liana

**REPTILE** Ectothermic (cold-blooded) scaly vertebrate (animal with a backbone) that reproduces by laying eggs or giving birth on land. Living reptiles include lizards, snakes, turtles, and crocodiles.

**SLASH AND BURN AGRICULTURE** When land is cleared by slashing trees and bushes then burning them to release nutrients into the soil. The cleared land is usually used for farming or for raising cattle.

**SPECIES** A distinct group of plants or animals that can breed successfully with a member of the same group to produce fertile offspring.

**STILT ROOT** Long root growing from the lower part of a trunk, giving a plant support on difficult terrain, such as steep slopes.

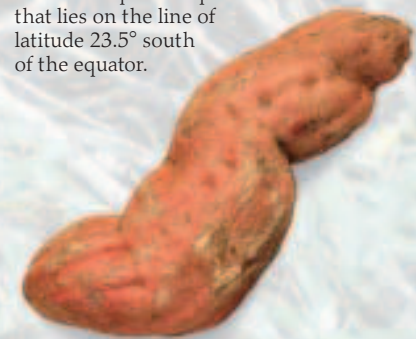
**STRANGLER FIG** Type of plant that starts life as an epiphyte, growing on a treetop branch. Its long aerial roots eventually grow down to the ground, covering the tree until the tree dies and rots away.

**SUBSPECIES** A subdivision of a species, usually based on geographic distribution. The subspecies name is written after the species name.

**TENDRIL** Coil-like shoot from a climbing plant that enables it to cling to another plant and climb toward the light.

**TRANSPIRATION** Release of water into the air from green plants during the process of photosynthesis (making food from sunlight).

**TROPICAL** To do with the tropics—the hot, wet regions lying on or near the equator, between the Tropic of Cancer that lies on the line of latitude 23.5° north of the equator, and the Tropic of Capricorn that lies on the line of latitude 23.5° south of the equator.



Tuber of a sweet potato

**TUBER** Swollen root or underground stem tip that contains a reserve of food (usually sugars and starches).

**UNDERSTORY** Layer of vegetation below the rain forest canopy where limited sunlight penetrates.

**VENOM** Toxic liquid used by an animal to paralyze or kill its prey.

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