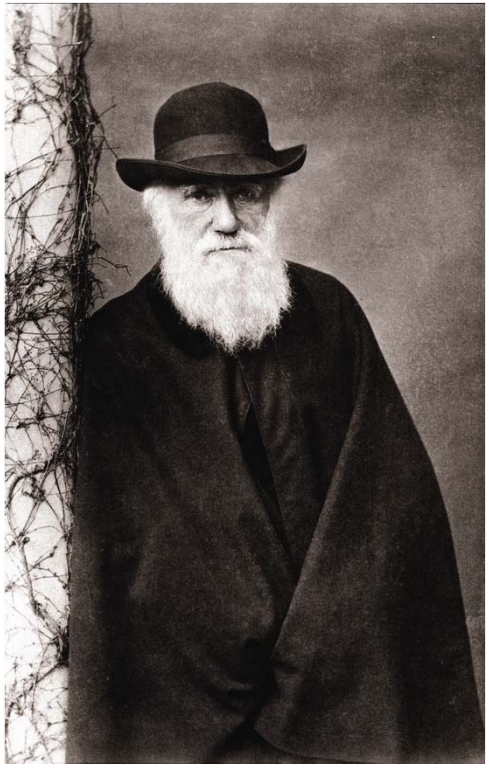
Chapter 01
What and Where Are the Tropics?



(a)

(b)

PLATE 1-1

(a) CHARLES DARWIN
(b) ALFRED RUSSEL WALLACE

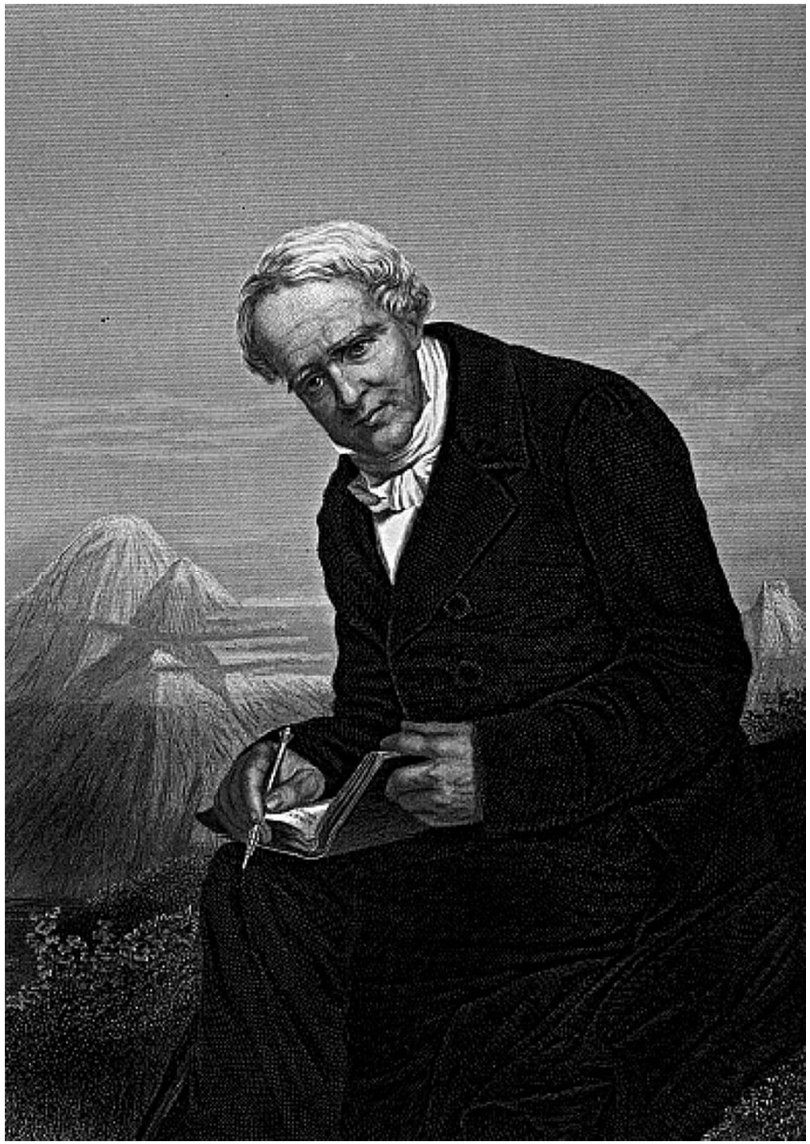


PLATE 1-2

ALEXANDER VON HUMBOLDT

PLATE 1-3

SNOW ON PÁRAMO

Snow is common at high elevations in equatorial regions. Here, bunch grasses of the high páramo life zone are partially snow-covered. From Ecuador.

PLATE 1-4

FOREST CANOPY

The dense canopy of a low-elevation, humid tropical moist forest, such as this one in the Arima Valley in Trinidad, is typically irregular, with some emergent tree species rising above others. Forest gaps created by fallen trees also add to canopy heterogeneity.

(a)

(b)

FIGURE 1–1
(a) Curl-crested toucan. (b) Mobbed by curl-crested toucans.

PLATE 1-5

WILLIAM BEEBE

PLATE 1-6

The OTS 3 eld station at La Selva.

PLATE 1-7

The harpy eagle (*Harpia Harpyja*) released on Barro Colorado Island, Panama, is monitored by radio tracking.

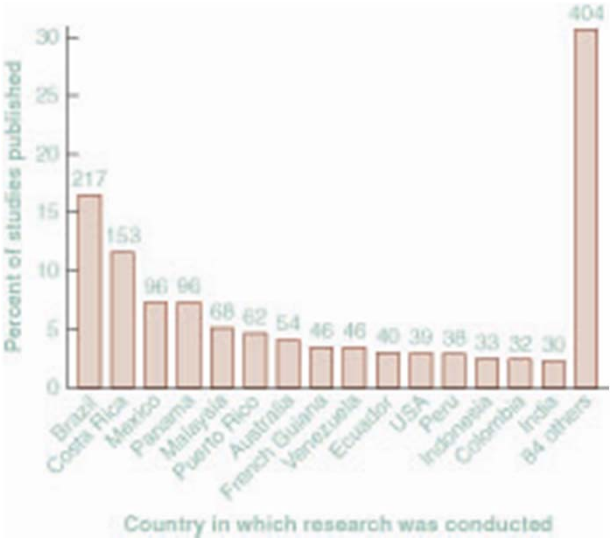


FIGURE 1-2

This graphic depicts the number of studies published in two professional journals, *Biotropica* and *Journal of Tropical Biology,* from 1995 to 2004. It shows how many studies were conducted in each of various countries. Note that most studies are focused in the Neo-tropics. (Numbers on bars are actual numbers of published studies.)

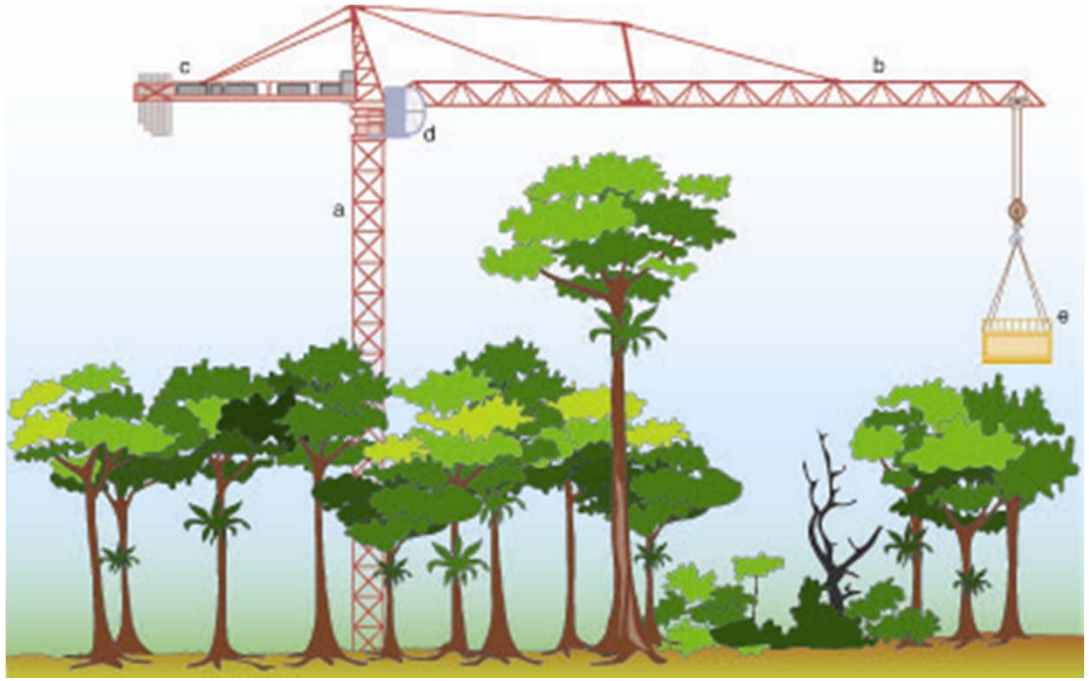


FIGURE 1–3

This sketch illustrates the use of a large industrial crane to examine tropical forest canopies: *a* is the tower, *b* is the counterjib, *c* is the counterweight, *d* is the operator's cab, and *e* is the gondola, where a researcher would be located.

PLATE 1–8

CANOPY WALKWAY AND FOREST

This tall and lengthy canopy walkway at Sacha Lodge in Ecuador provides safe and easy access that permits study of species largely con3 ned to the forest canopy.

PLATE 1-9

HIGH CANOPY WALKWAY

Viewed from the ground, the canopy walkway is seen crossing a major forest gap.

PLATE 1-10

VIEW FROM CANOPY WALKWAY

The expanse and structural complexity of Ecuador's lowland forest is readily evident, as observed from a canopy walkway.

PLATE 1-11

WOODEN CANOPY TOWER

Canopy towers allow more restricted access than walkways but, if strategically placed, afford excellent opportunities for canopy study. Note the broad branching pattern of the tree. The tower is essentially built around the tree. From Sacha Lodge, Ecuador.

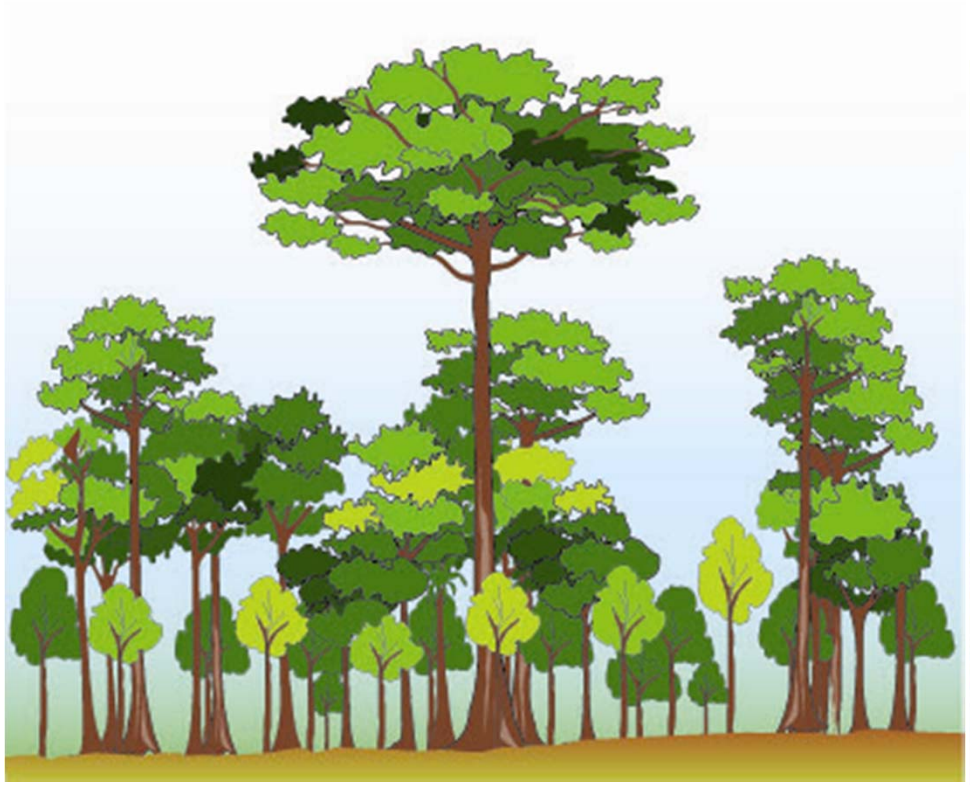


FIGURE 1-4

This is a sketch of a forest pro3 le in what was then British Guiana and is now the independent nation of Guyana. This is adapted from one of several classic forest pro3 les included in Richards's famous book *The Tropical Rain Forest.*

FIGURE 1-5

Also adapted from Richards's classic volume, this is a pro3 le of a mixed Dipterocarp forest in Borneo. Compare this with Figure 1-4. Both forests are structurally similar but contain entirely different tree species.

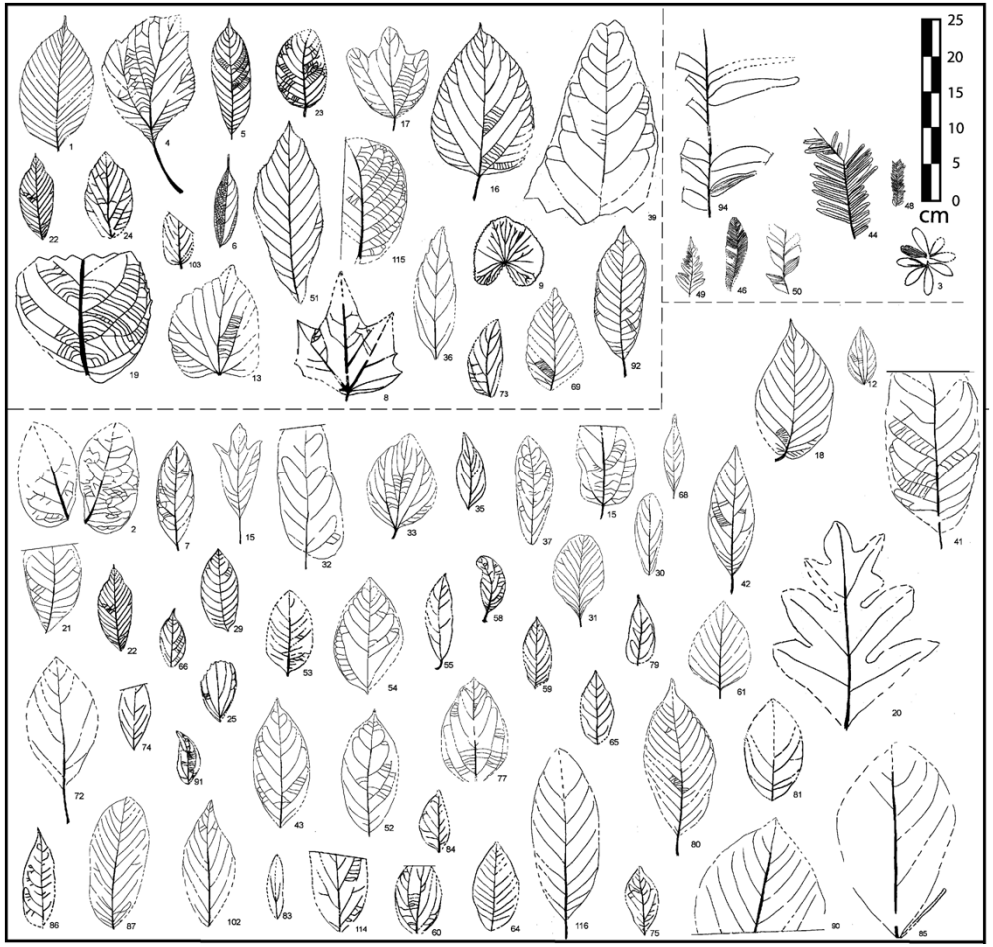


FIGURE 1-6

This drawing illustrates the morphotypes of tropical leaves found near Castle Rock, Denver, dating back 64.1 million years. Only the leaves in the upper right are nondicot leaves. By this time, modern plants, dominated by dicots, dominated terrestrial plant communities.

PLATE 1-12

ANACONDA

PLATE 1-13

CAMPTOSAURUS, APATOSAURUS, STEGOSAURUS, DRYOSAURUS, CAMARASAURUS AND ALLOSAURUS (LEFT TO RIGHT)

Each of these dinosaurs cohabited tropical regions in western North America during the late Jurassic period. The tropics then would bear scant resemblance to the tropics of today.

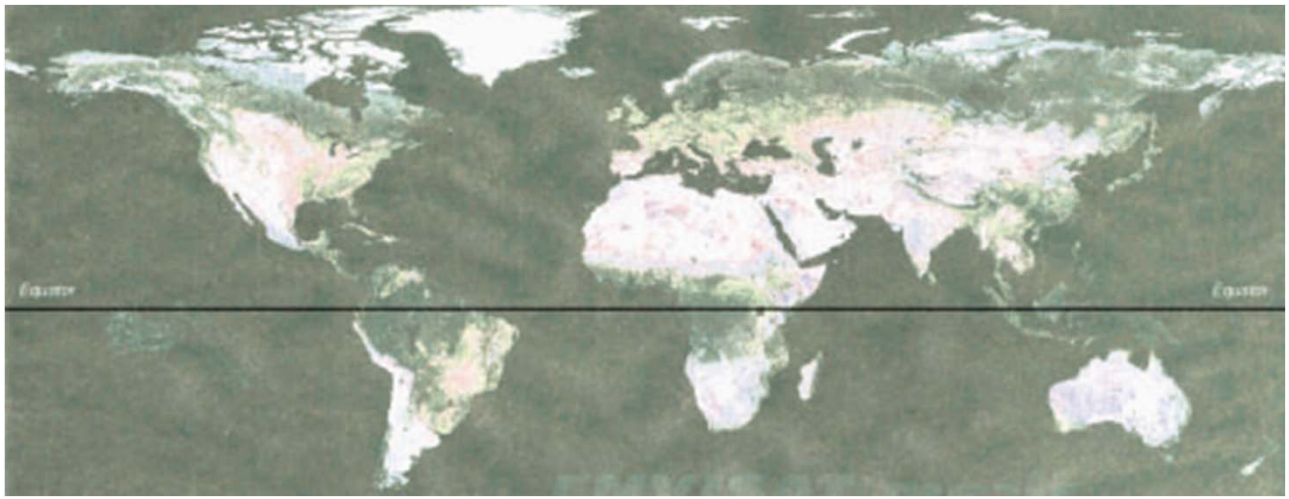


FIGURE 1–7
Satellite image of Earth, showing the band of tropics around the equator.

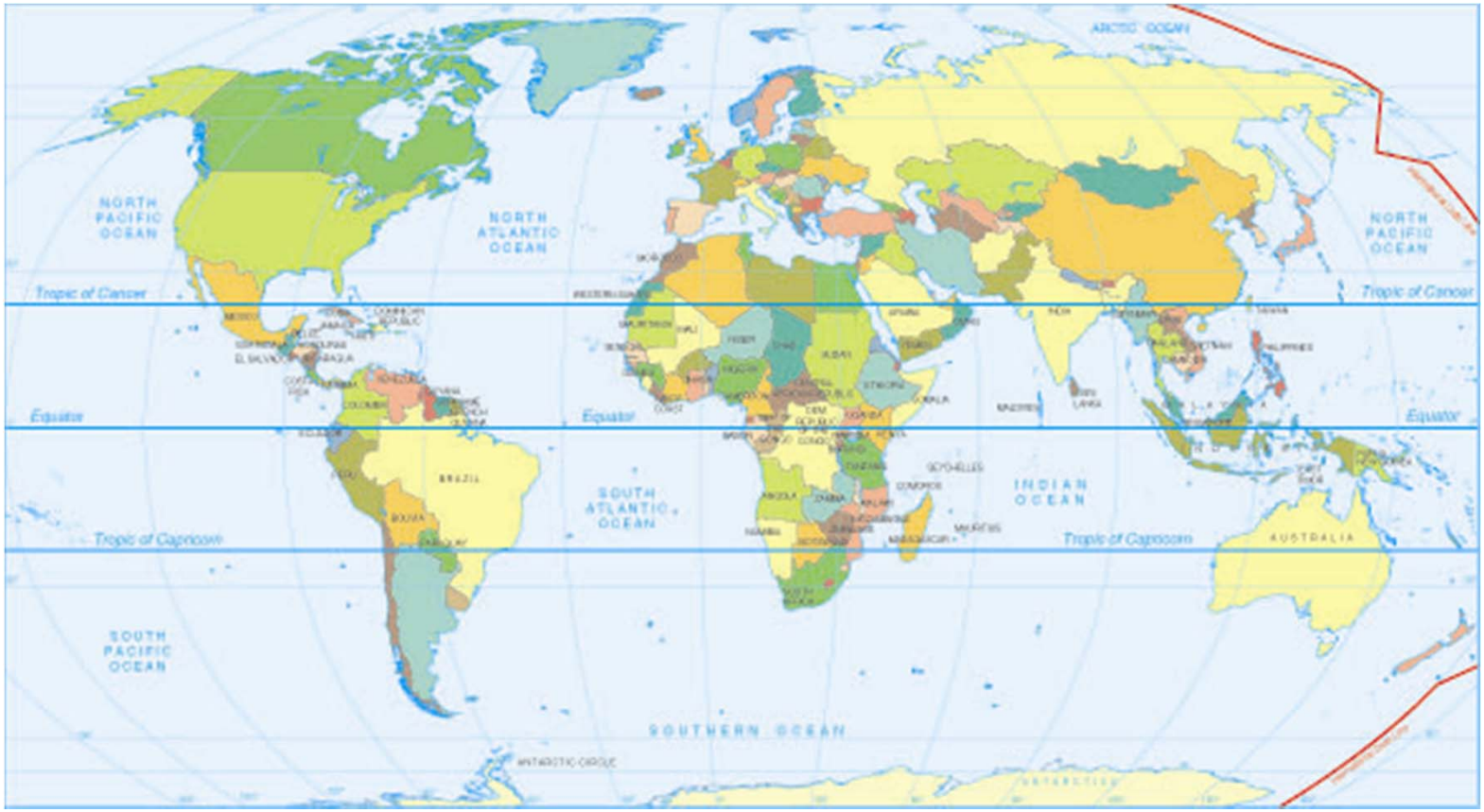


FIGURE 1–8
Political map of Earth, showing nations that occur within the tropics.

PLATE 1-14

The Komodo dragon, which sometimes reaches a length of nearly 3 meters (9.8 feet), is endemic to the Lesser Sunda Islands of Indonesia.

FIGURE 1–9

These graphs contrast the climate in tropical Brazil with that of temperate Canada. Note the strong seasonality of the tropics with regard to precipitation but the steady temperature that prevails in the tropics. The opposite pattern characterizes the temperate zone.

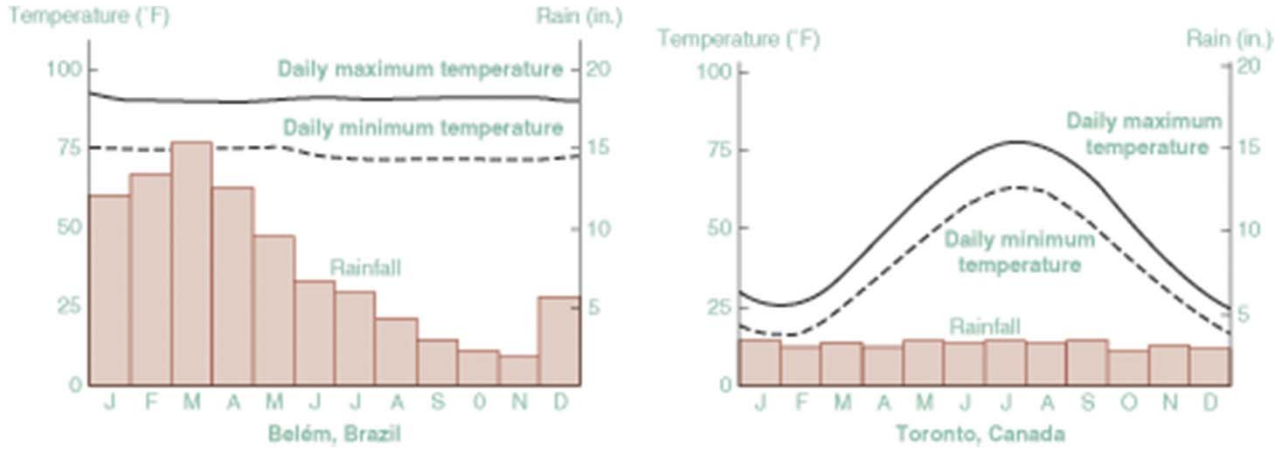
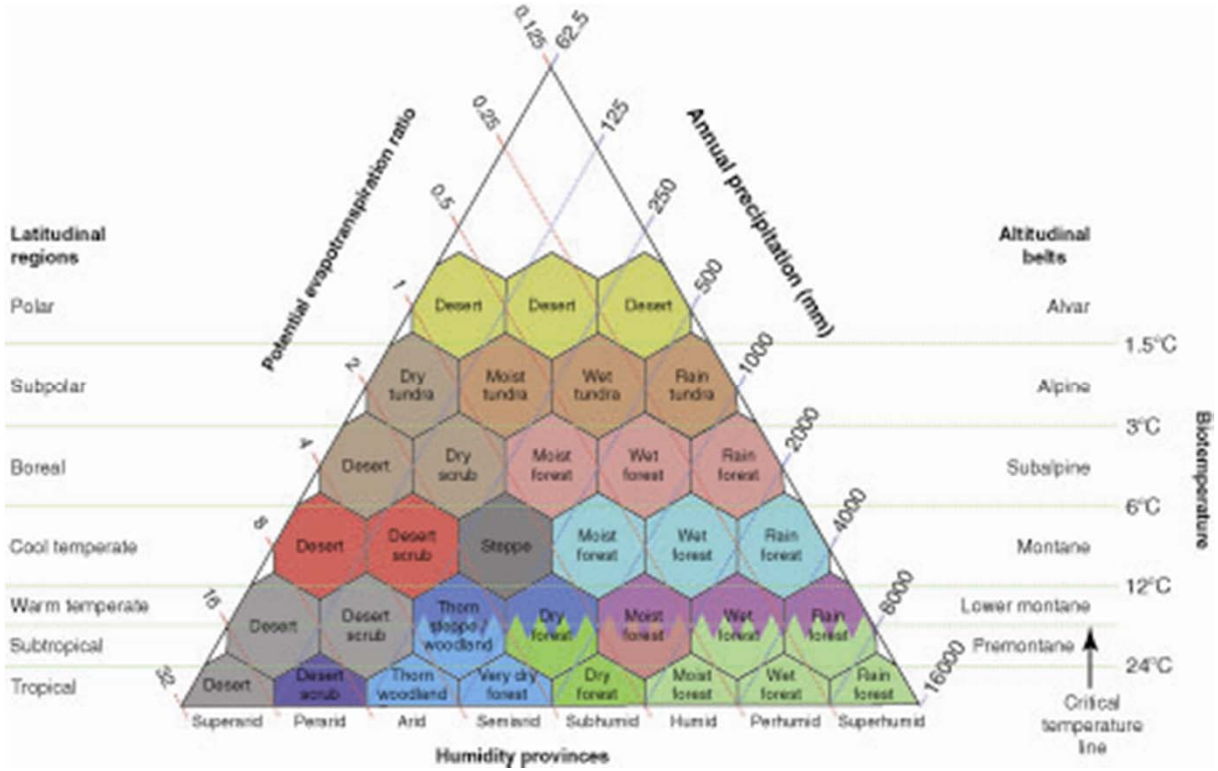


FIGURE 1–10

This is the famous Holdridge diagram that illustrates the relationship between ecosystem types as determined by latitude, elevation, and combination of precipitation and temperature.



		MEAN ANNUAL BIOTEMPERATURE (°C)	POTENTIAL EVAPORATION RATIO	HUMIDITY PROVINCE	AVERAGE TOTAL ANNUAL PRECIPITATION (CM)
Polar		<1.5	0.125–1.5		6.25–75
Subpolar (alpine)	Tundra				
	Dry	1.5–3	1–2	Subhumid	6.25–12.5
	Moist	1.5–3	0.5–1	Humid	12.5–25
	Wet	1.5–3	0.25–0.50	Perhumid	25–50
	Rain	1.5–3	0.125–0.25	Superhumid	50–100
Boreal (subalpine)	Desert	3–6	2–4	Semiarid	6.25–12.5
Boreal	Dry scrub	3–6	1–2	Subhumid	12.5–25
Boreal	Forest				
	Moist Puna	3–6	0.50–1	Humid	25–50
	Wet páramo	3–6	0.25–0.50	Perhumid	50–100
	Rain páramo	3–6	0.125–0.25	Superhumid	100–200
Cool temperate	Desert	6–12	4–8	Arid	6.25–12.5
Cool temperate	Desert scrub	6–12	2–4	Semiarid	12.5–50
Cool temperate	Tundra dry	6–12	1–2	Subhumid	25–50
Cool temperate	Forest				
	Moist	6–12	0.5–1	Humid	50–100
	Wet	6–12	0.25–0.5	Perhumid	100–200
	Rain	6–12	0.125–0.25	Superhumid	200–400
Subtropical	Desert	12–24	8–16	Perarid	6.25–12
Subtropical	Desert scrub	12–24	4–8	Arid	12–25
Subtropical	Thorn woodland	12–24	2–4	Semiarid	25–50
Subtropical	Forest				
	Dry	12–24	1–2	Subhumid	50–100
	Moist	12–24	0.5–1	Humid	100–200
	Wet	12–24	0.25–0.5	Perhumid	200–400
	Rain	12–24	0.125–0.25	Superhumid	400–800
Tropical	Desert	>24	16–32	Superarid	6.25–12
	Desert scrub	>24	8–16	Perarid	12–25
Tropical	Thorn woodland	>24	4–8	Arid	25–50
Tropical	Forest				
	Very dry	>24	2–4	Semiarid	50–100
	Dry	>24	1–2	Subhumid	100–200
	Moist	>24	0.5–1	Humid	200–400
	Wet	>24	0.25–0.5	Perhumid	400–800
	Rain	>24	0.125–0.25	Superhumid	>800

FIGURE 1–10
(continued)

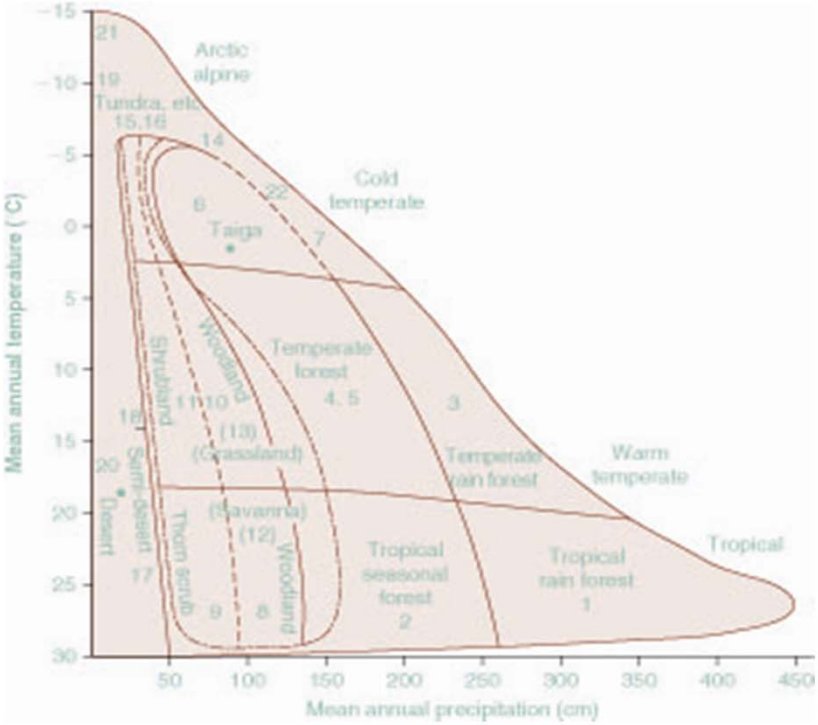


FIGURE 1–11

Diagram showing the relationship between ecosystem type, mean annual temperature (ºC), and mean annual precipitation (centimeters). Note that tropical rain forest occurs where both climatic variables are highest.

PLATE 1–15

Where rainfall is highly seasonal, tropical ecosystems are often dry forest, with many species of deciduous trees. Forest stature is generally small, and trees are usually widely spaced. From Venezuela.

PLATE 1-16

Northern Australia is an area of vast dry forest with tall, scattered termite mounds. This is the ecosystem typically called *outback*

PLATE 1-17

Rapidly growing tree species such as Cecropia trees, shown here in the foreground, typify the forest edge, where vegetation structure is dense. This would be considered tropical moist forest in the Holdridge classification. From Trinidad.

PLATE 1-18

Herds of wildebeest move with rainfall patterns in a vast seasonal migration on the East African savanna. From Tanzania.

PLATE 1-19

Savannas are open areas dominated by grasses and scattered trees, particularly in the genus *Acacia*. Here giraffes are feeding on acacia leaves on the East African savanna. From Tanzania.

PLATE 1-20

Australia has many endemic plant species, including hundreds of Eucalyptus species and grasses such as *Spinifex*. This image shows dry forest with *Spinifex* in south central Australia.

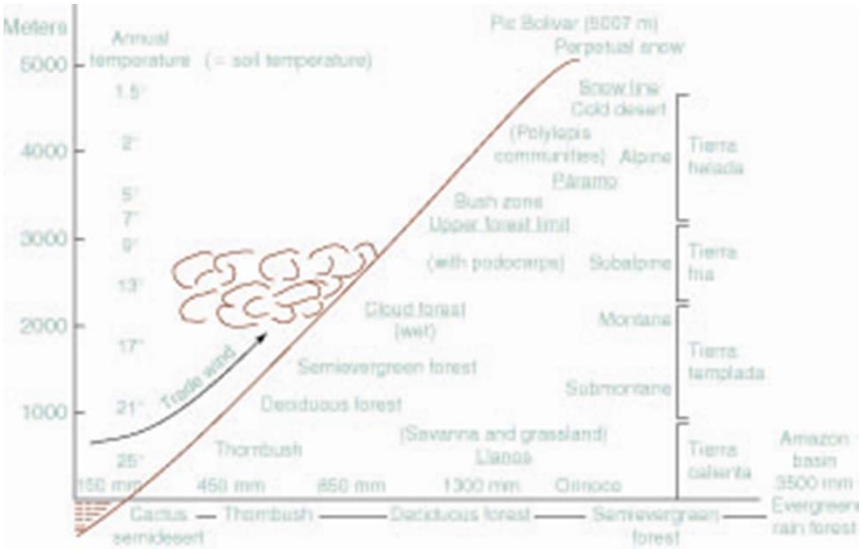


FIGURE 1–12

This diagram shows the distribution of ecosystem types in Venezuela as they relate to elevation and climatic variables.

PLATE 1–21

Members of the Composite family, *Espeletias* are unique shrubs of the high páramo of the Andes Mountains. Several hummingbird species specialize on feeding on *Espeletia* nectar. From Venezuela.

PLATE 1–22

At high elevations in the Andes Mountains where moisture is normally abundant, gnarled forests of *Polylepis* trees are supported. From Ecuador.

PLATE 1-23

Clouds shroud much of the mountainsides along the east slope of the Andes Mountains in parts of South America, supporting dense, species-rich ecosystems called *cloud forests*. From Ecuador.

PLATE 1-24

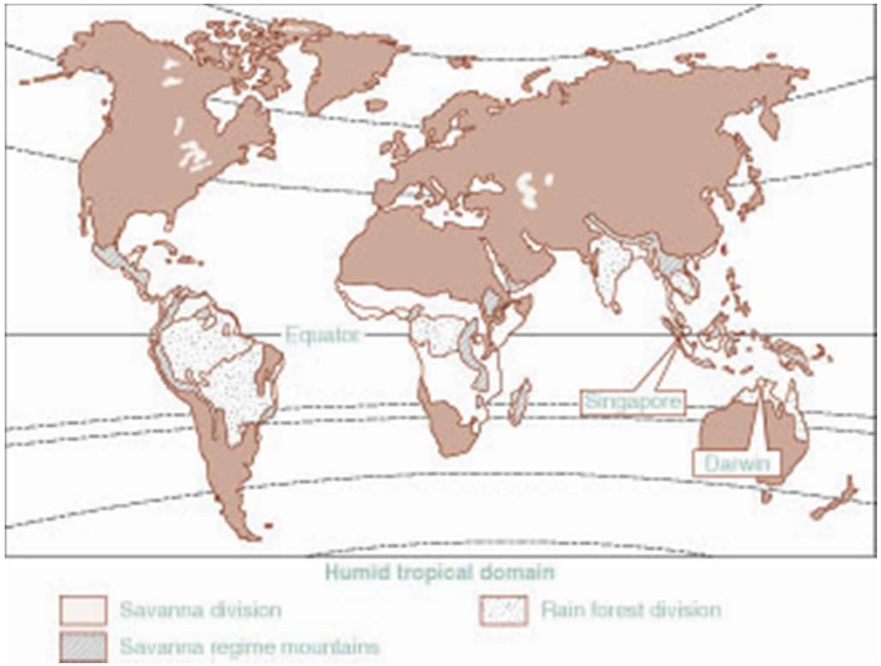
Many tree species are found in cloud forests, along with numerous epiphytes such as orchids, cacti, bromeliads, and various vines. The ecosystem is normally cloud-covered for at least part of each day. From Ecuador.

PLATE 1-25

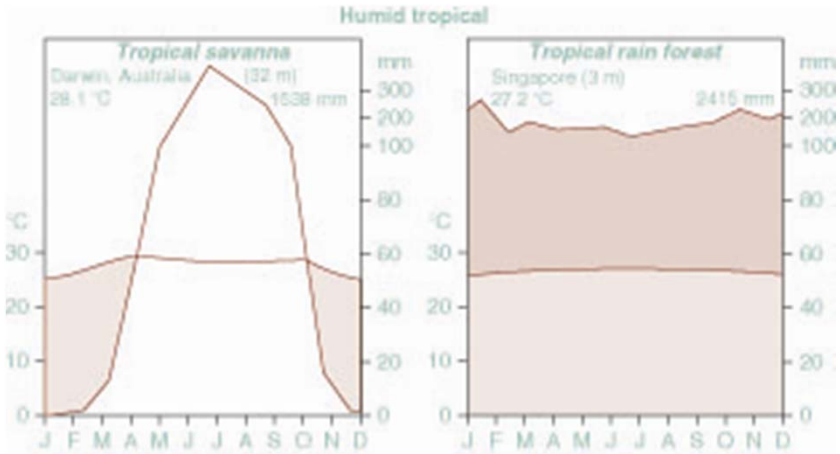
The complexity of structure and diversity of species characterizes tropical moist, wet, and rain forests throughout the world. This forest is in central Brazil.

PLATE 1-26

The term *jungle* refers to a disturbed area where an abundance of sunlight results in a dense array of many plant species, often so thick that it is difficult to penetrate without the use of a machete. Jungles typify areas of moist forest. From Ecuador.



(a)



(b)

FIGURE 1–13

These climate diagrams from (a) Darwin, Australia, and (b) Singapore illustrate the extreme contrast between savanna and rain forest. But note that temperature is about the same, and relatively constant in both places. What varies is the seasonality of precipitation.

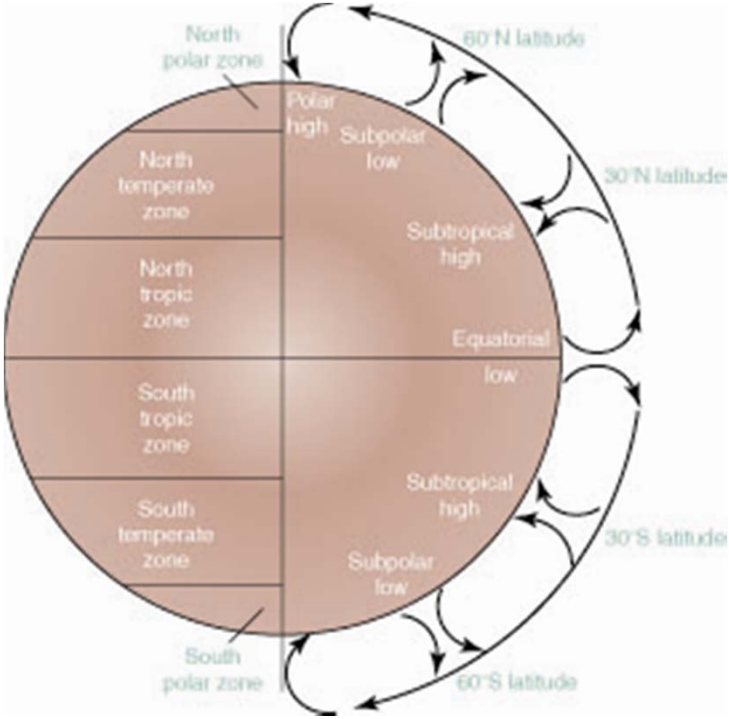


FIGURE 1–14

If Earth were not rotating, this would be the distribution of primary and secondary air movement of the planet.

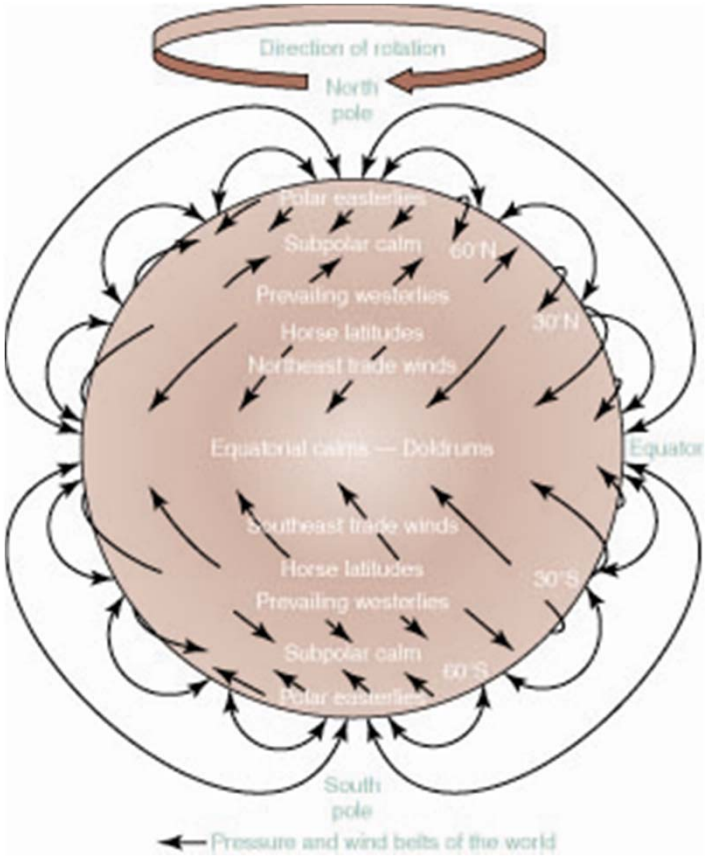


FIGURE 1–15

Earth's daily rotation deflects the Hadley cell currents and creates the trade wind belts. Note the lack of wind at the equator.

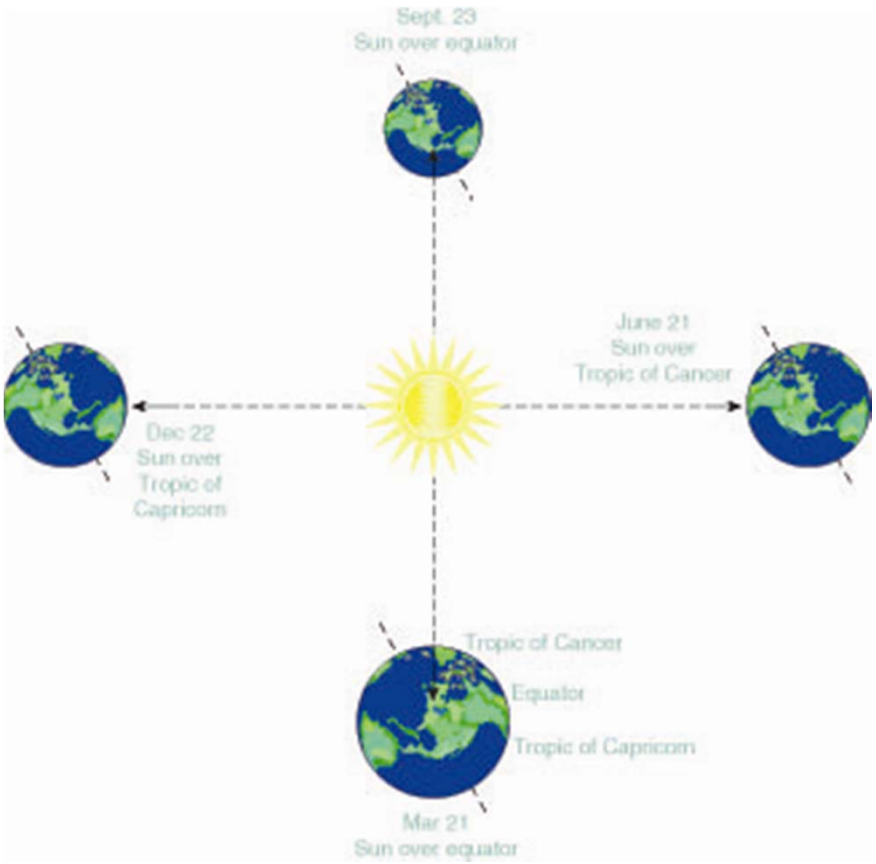


FIGURE 1–16

The angle of the Earth relative to the sun varies during the course of Earth's annual orbit, creating the seasonality that characterizes Earth.

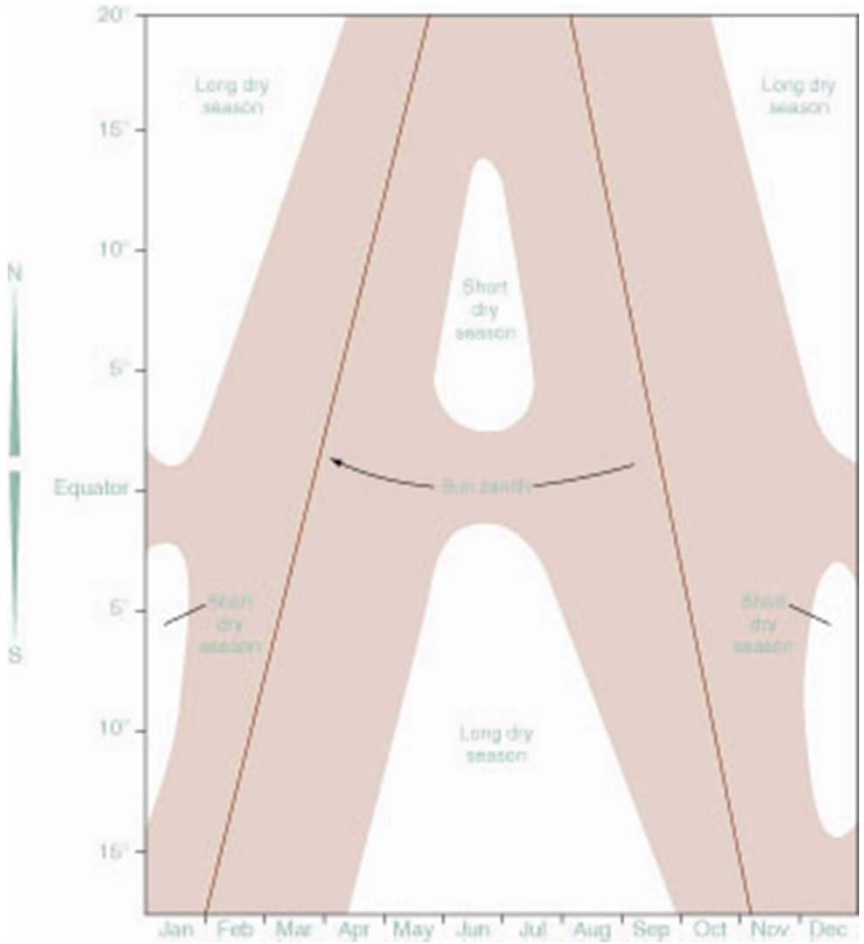
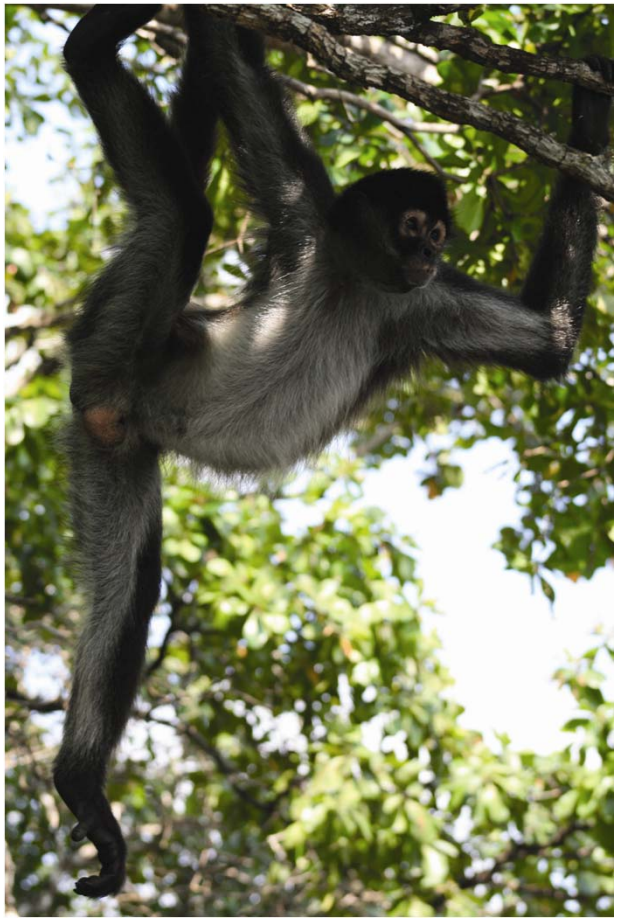


FIGURE 1–17

This diagram shows how climate varies in the tropics. Note the absence of seasonality at the equator.

(a)



(b)

PLATE 1-27

(a) KINKAJOU AND (b) SPIDER MONKEY

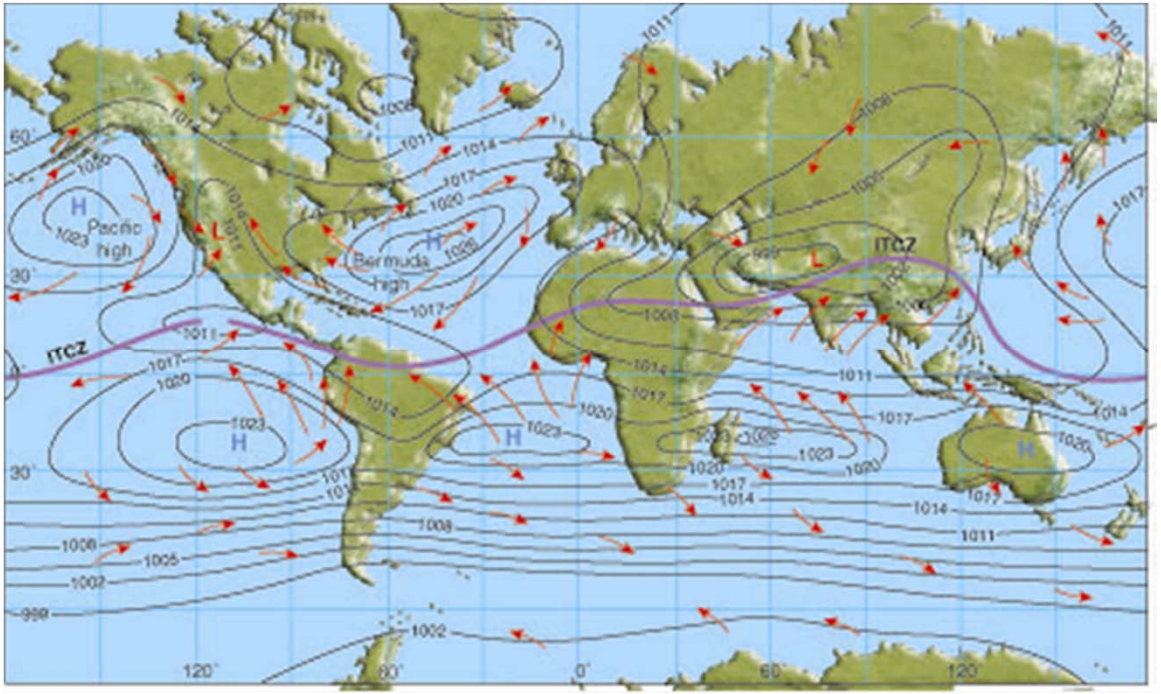


FIGURE 1–18

This map shows the general location of the ITCZ.

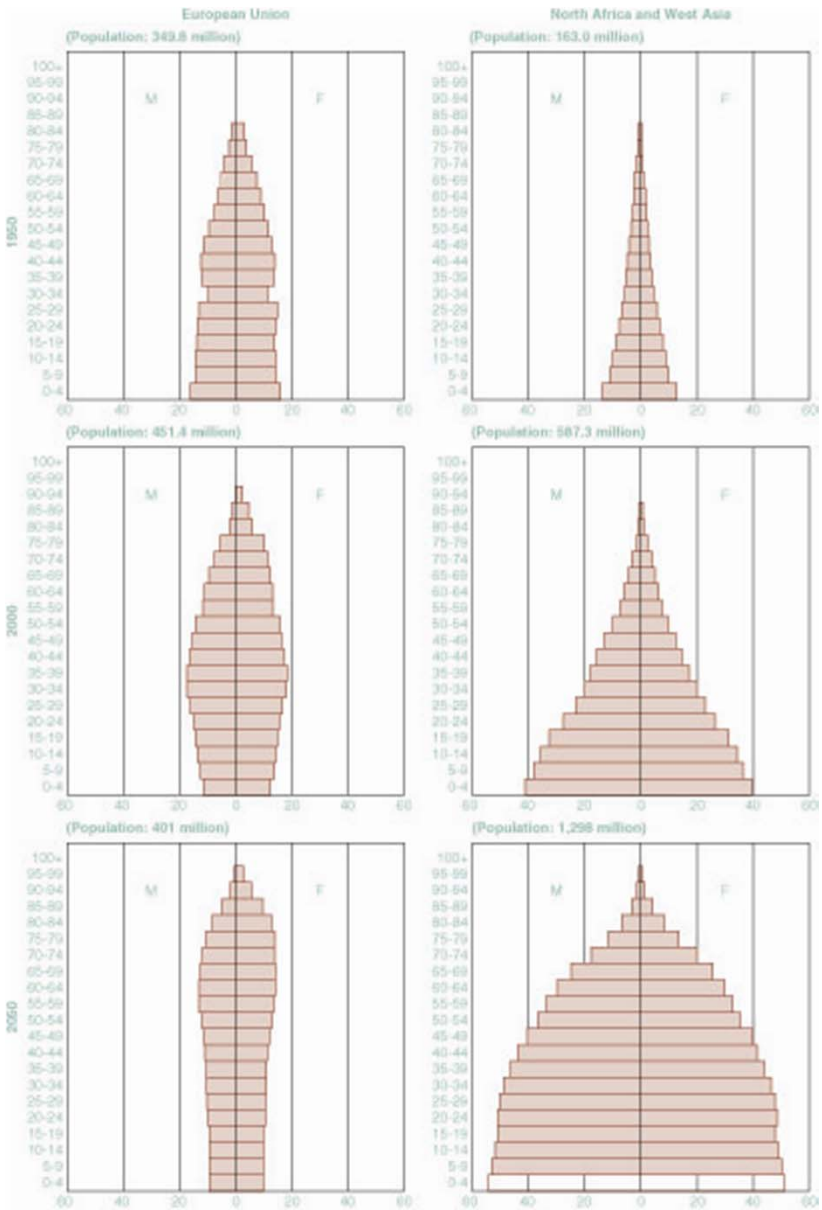


FIGURE 1–19

Human population size and age distribution contrasted between developed and underdeveloped nations, with projections to 2050.

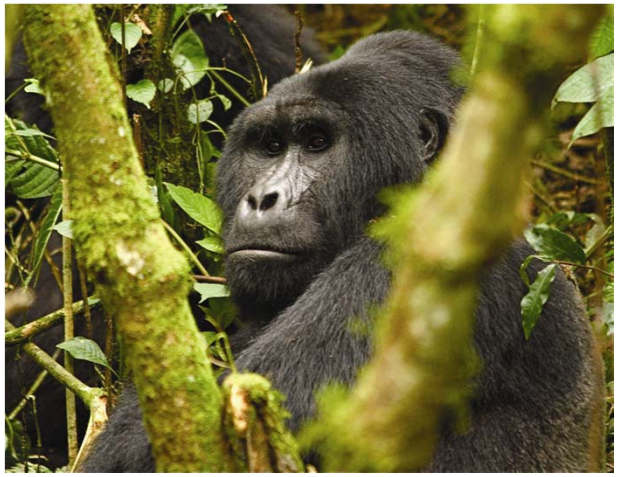


PLATE 1-28

GORILLA