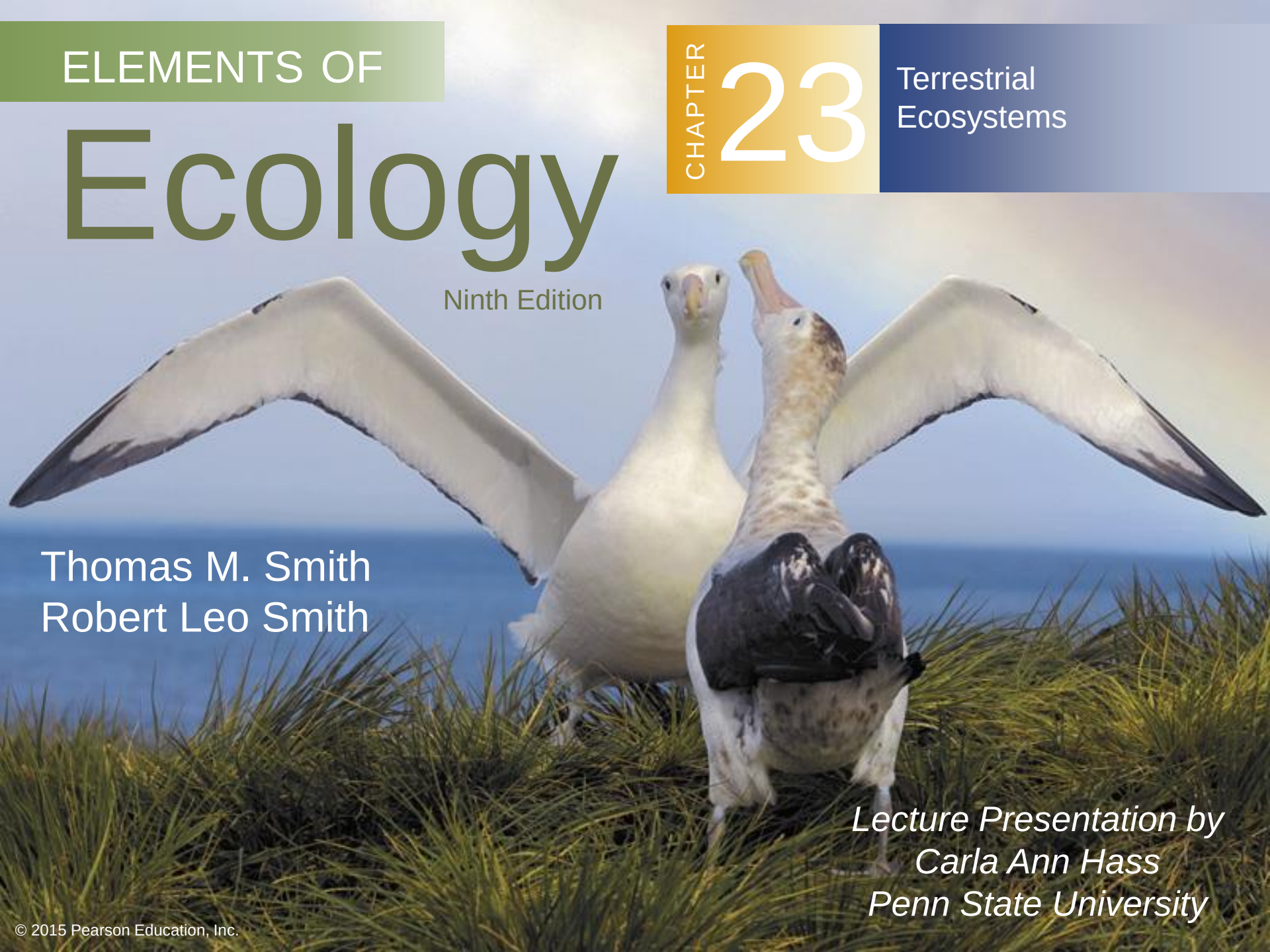
ELEMENTS OF

Ecology

Ninth Edition

CHAPTER 23

Terrestrial Ecosystems

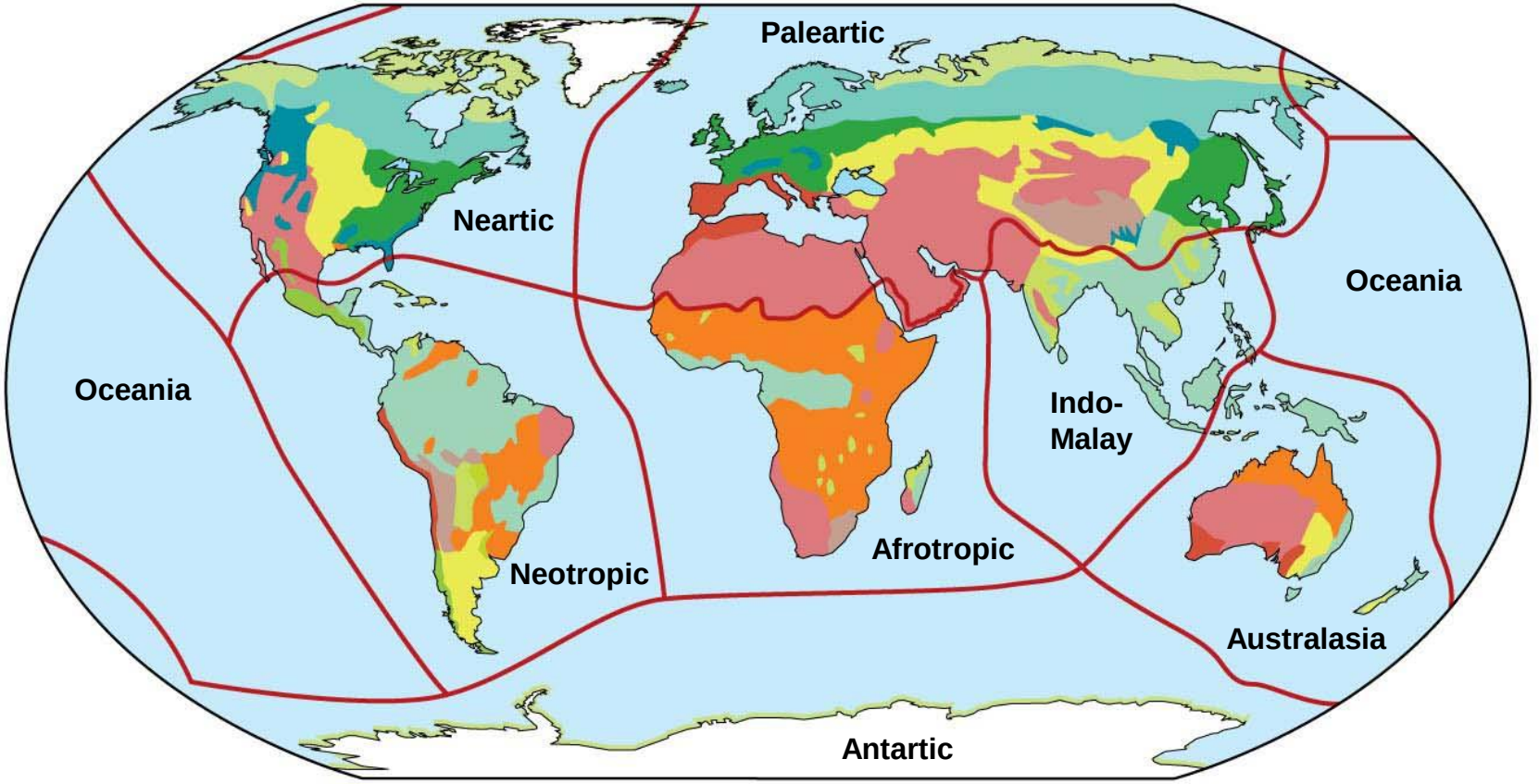


Thomas M. Smith
Robert Leo Smith

Lecture Presentation by
Carla Ann Hass
Penn State University

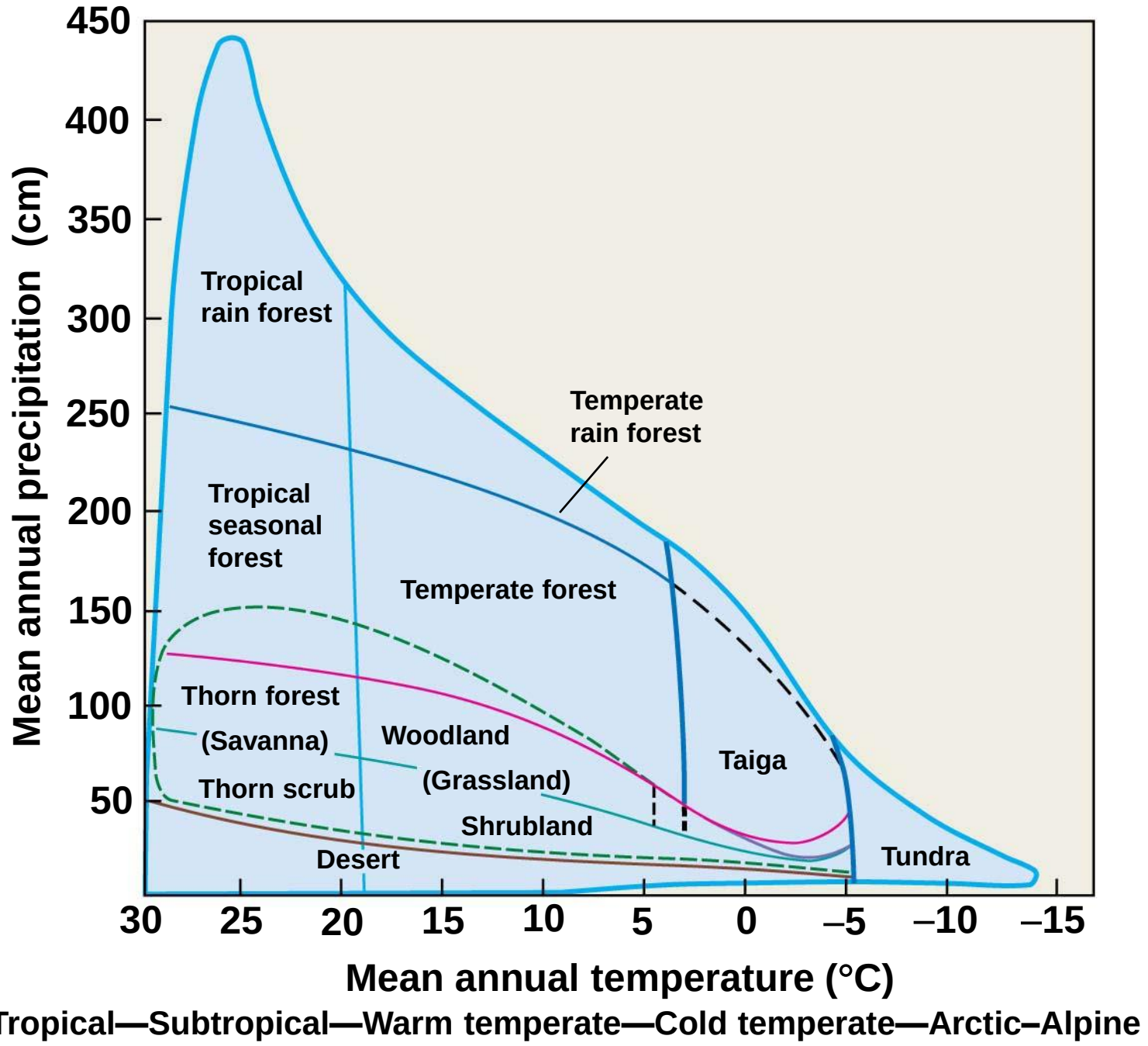
Chapter Opener 23.0

Figure 23.1



- Tropical and subtropical moist broadleaf forests
- Tropical and subtropical dry broadleaf forests
- Tropical and subtropical coniferous forests
- Temperate broadleaf and mixed forests
- Temperate coniferous forests
- Boreal forests/taiga
- Tropical and subtropical grasslands, savannas, and shrublands
- Temperate grasslands, savannas, and shrublands
- Flooded grasslands and savannas
- Montane grasslands and shrublands
- Tundra
- Mediterranean forests, woodlands, and scrub
- Deserts and xeric shrublands
- Mangroves

Figure 23.2



Section 23.1 Terrestrial Ecosystems Reflect Adaptations of the Dominant Plant Life-Forms

- The classification of terrestrial biomes reflects the relative contribution of three plant life-forms
  - trees
  - shrubs
  - grasses
- While each of these represents a diverse range of species and characteristics, they each exhibit fundamentally different patterns of carbon allocation and morphology

Section 23.1 Terrestrial Ecosystems Reflect Adaptations of the Dominant Plant Life-Forms

- Grasses
  - maintain a higher proportion of biomass in photosynthetic tissue (leaves) because little energy is required for support tissues (stems)

Section 23.1 Terrestrial Ecosystems Reflect Adaptations of the Dominant Plant Life-Forms

- Shrubs and trees (woody plants)
  - Shrubs invest fewer resources in stems and other supporting structures than do trees
  - Advantage of woody tissue is increased height and access to light
  - But there is an associated cost of maintenance and respiration
  - As environmental conditions are less favorable for photosynthesis, trees decline in height and density

Section 23.1 Terrestrial Ecosystems Reflect Adaptations of the Dominant Plant Life-Forms

- Leaf form is a plant characteristic used to further classify forest and woodland ecosystems
- Leaf longevity
  - **Deciduous** leaves live for only a single year or growing season; are shed at the end of a growing season and regrown at the beginning of the next
    - **Winter-deciduous** leaves are lost in response to low temperatures – seen in temperate regions
    - **Drought-deciduous** leaves are lost in response to dry conditions

Figure 23.3a

(a)

Examples of winter- and drought-deciduous trees. Temperate deciduous forest in central Virginia during (a) summer and (b) winter seasons. Semiarid savanna/woodland in Zimbabwe, Africa, during (c) rainy and (d) dry seasons.

Figure 23.3b

(b)

Examples of winter- and drought-deciduous trees. Temperate deciduous forest in central Virginia during (a) summer and (b) winter seasons. Semiarid savanna/woodland in Zimbabwe, Africa, during (c) rainy and (d) dry seasons.

Figure 23.3c

(c)

Examples of winter- and drought-deciduous trees. Temperate deciduous forest in central Virginia during (a) summer and (b) winter seasons. Semiarid savanna/woodland in Zimbabwe, Africa, during (c) rainy and (d) dry seasons.

Figure 23.3d

(d)

Examples of winter- and drought-deciduous trees. Temperate deciduous forest in central Virginia during (a) summer and (b) winter seasons. Semiarid savanna/woodland in Zimbabwe, Africa, during (c) rainy and (d) dry seasons.

Figure 23.4a

(a)

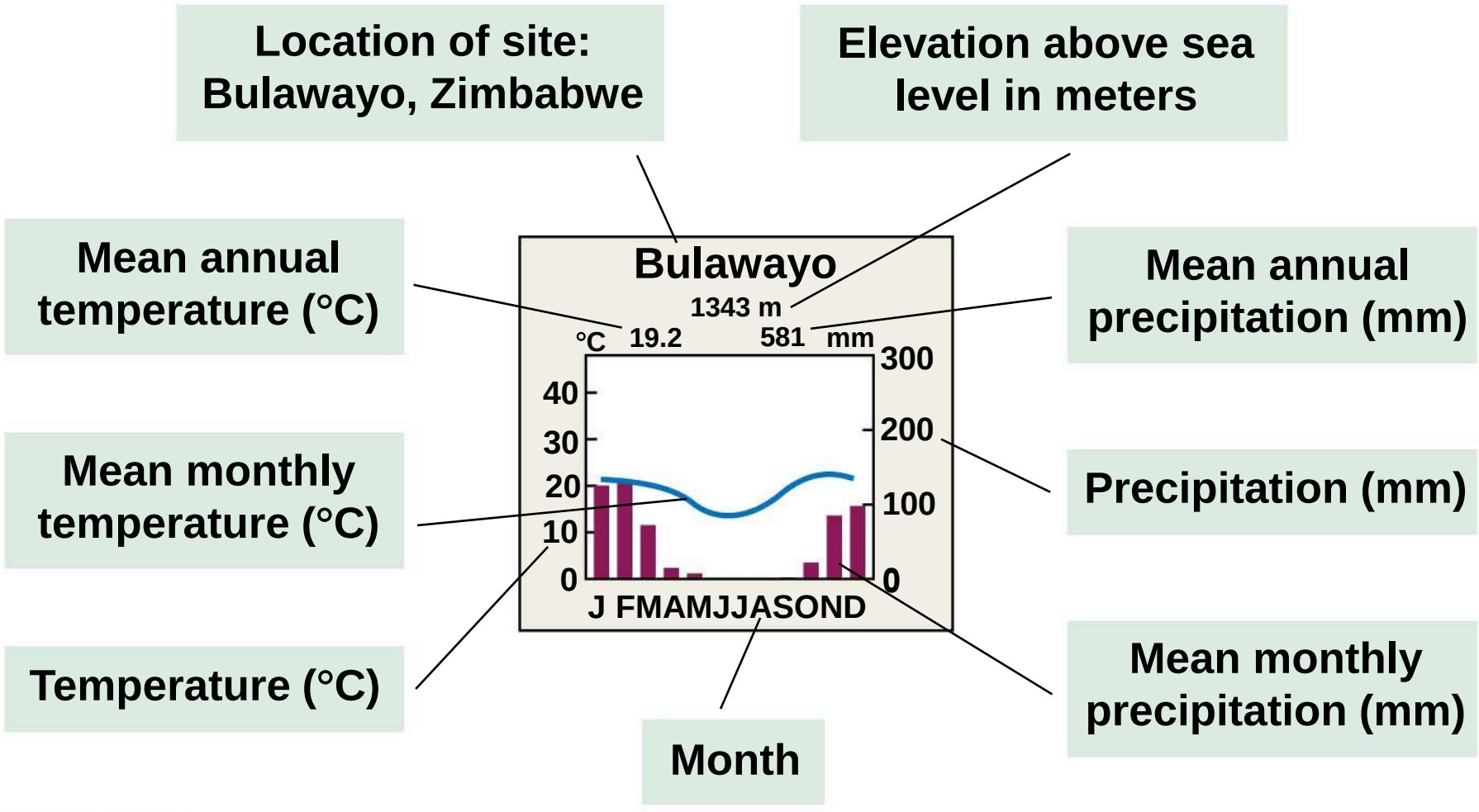
Examples of evergreen trees. (a) Broadleaf evergreen trees dominate the canopy of this tropical rain forest in Queensland, Australia. (b) Needle-leaf evergreen trees (foxtail pine) inhabit the high-altitude zone of the Sierra Nevada in western North America.

Figure 23.4b

(b)

Examples of evergreen trees. (a) Broadleaf evergreen trees dominate the canopy of this tropical rain forest in Queensland, Australia. (b) Needle-leaf evergreen trees (foxtail pine) inhabit the high-altitude zone of the Sierra Nevada in western North America.

Quantifying Ecology Box Figure 1



Climate diagram for Bulawayo, Zimbabwe. This city is in the Southern Hemisphere, where the cooler winter season occurs during the period of May–August. Note the distinct dry season during the winter months, with the rainy season beginning in October (spring) and lasting through the summer months.

Figure 23.5

Geographic distribution of Earth's tropical forest ecosystems

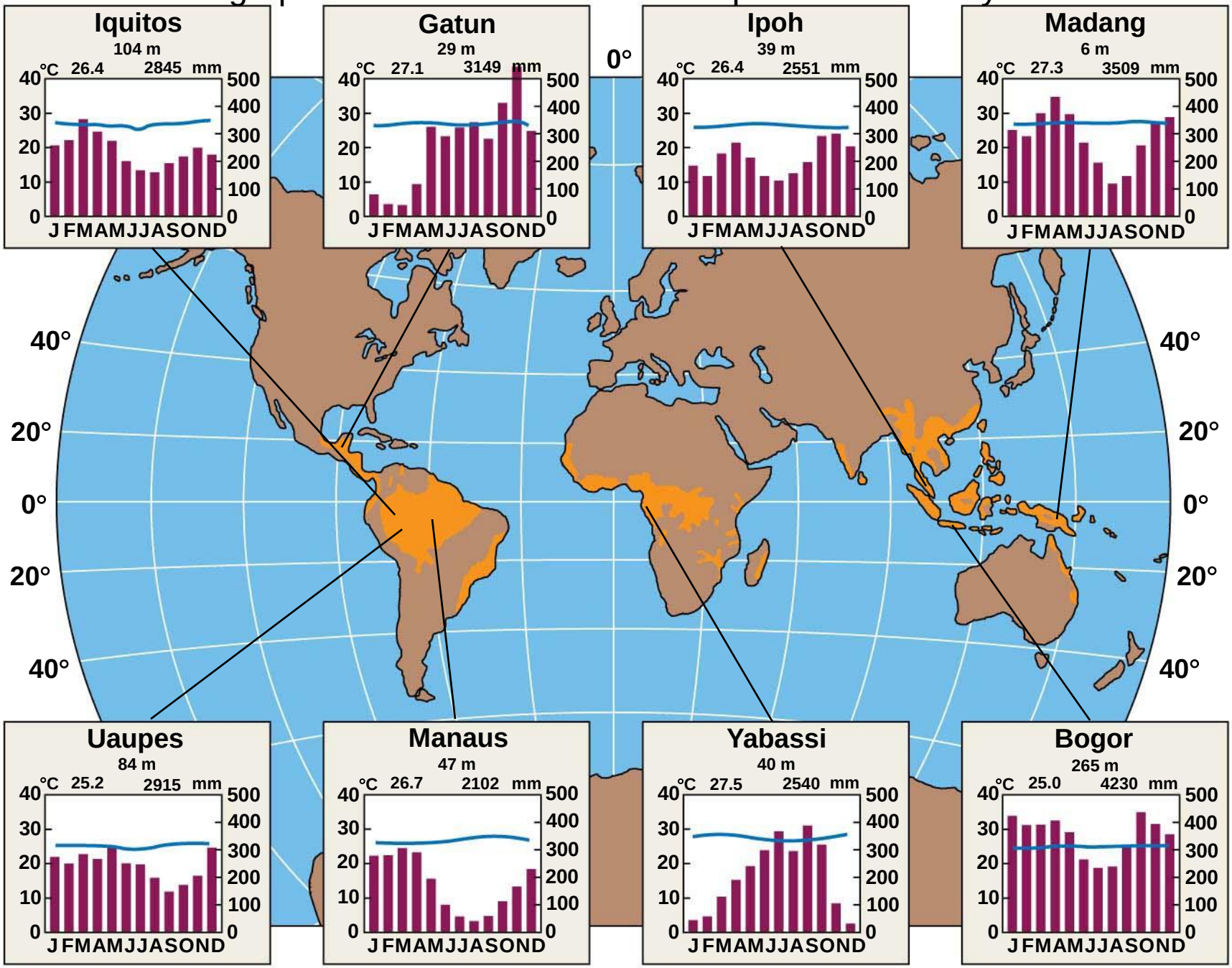


Figure 23.6a

(a)

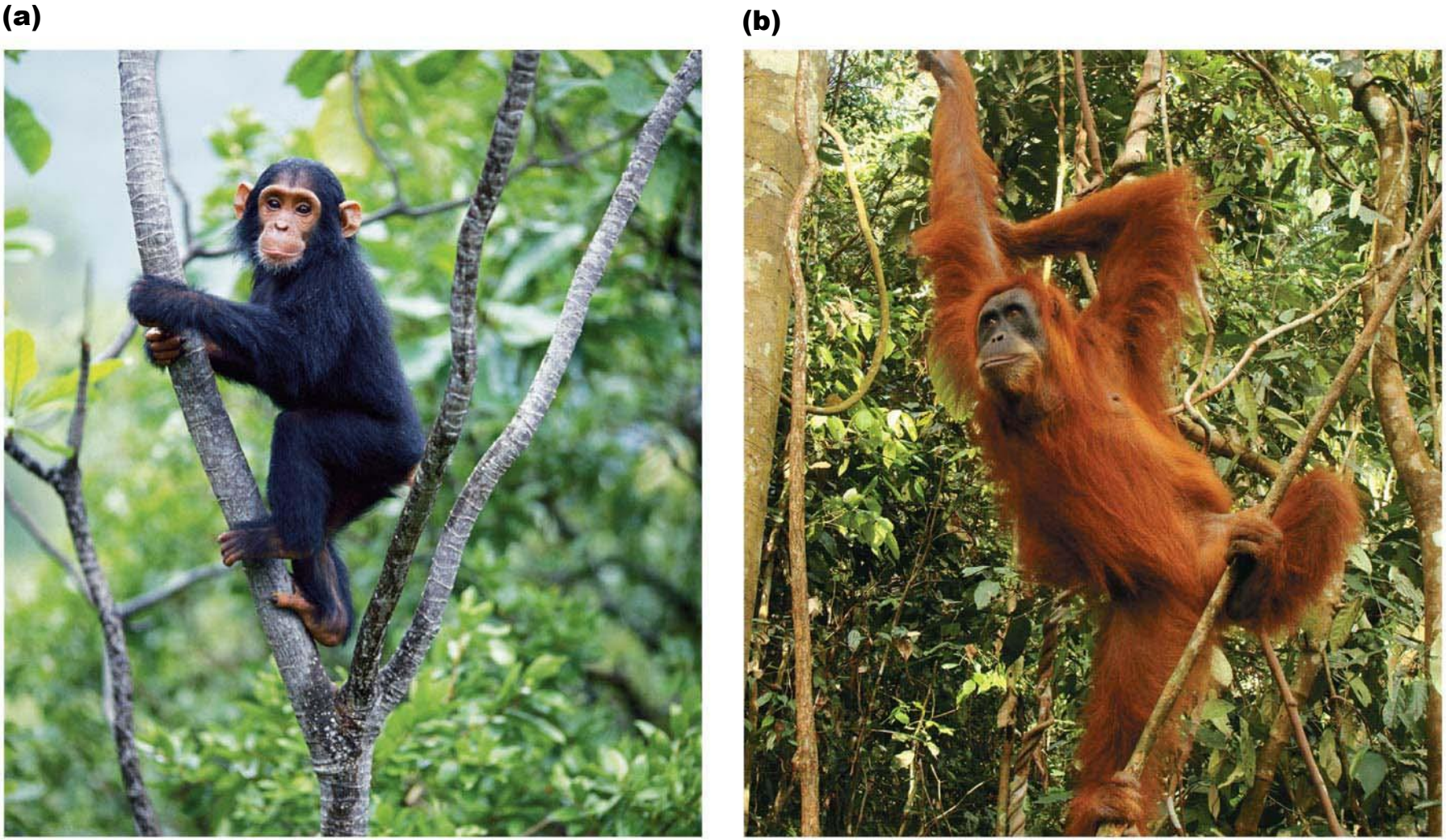
Tropical rain forests in (a) Amazon Basin (South America) and (b) Malaysia (Southeast Asia). Despite being taxonomically distinct, these two tropical rain forest regions are dominated by broadleaf evergreen trees and support vigorous plant growth year-round. Tropical rain forests represent the most diverse and productive terrestrial ecosystems on our planet.

Figure 23.6b

(b)

Tropical rain forests in (a) Amazon Basin (South America) and (b) Malaysia (Southeast Asia). Despite being taxonomically distinct, these two tropical rain forest regions are dominated by broadleaf evergreen trees and support vigorous plant growth year-round. Tropical rain forests represent the most diverse and productive terrestrial ecosystems on our planet.

Figure 23.7



Primate species that inhabit the tropical rain forests of the world: (a) the chimpanzee (*Pan troglodytes*) inhabits the tropical rain forests of Central Africa, and (b) the orangutan (*Pongo pygmaeus*) inhabits the tropical rain forests of Borneo (Southeast Asia).

Figure 23.8

Figure 23.8 Vertical stratification of a tropical rain forest.

Figure 23.9

Figure 23.9 Plank-like buttresses help to support tall rain forest trees.

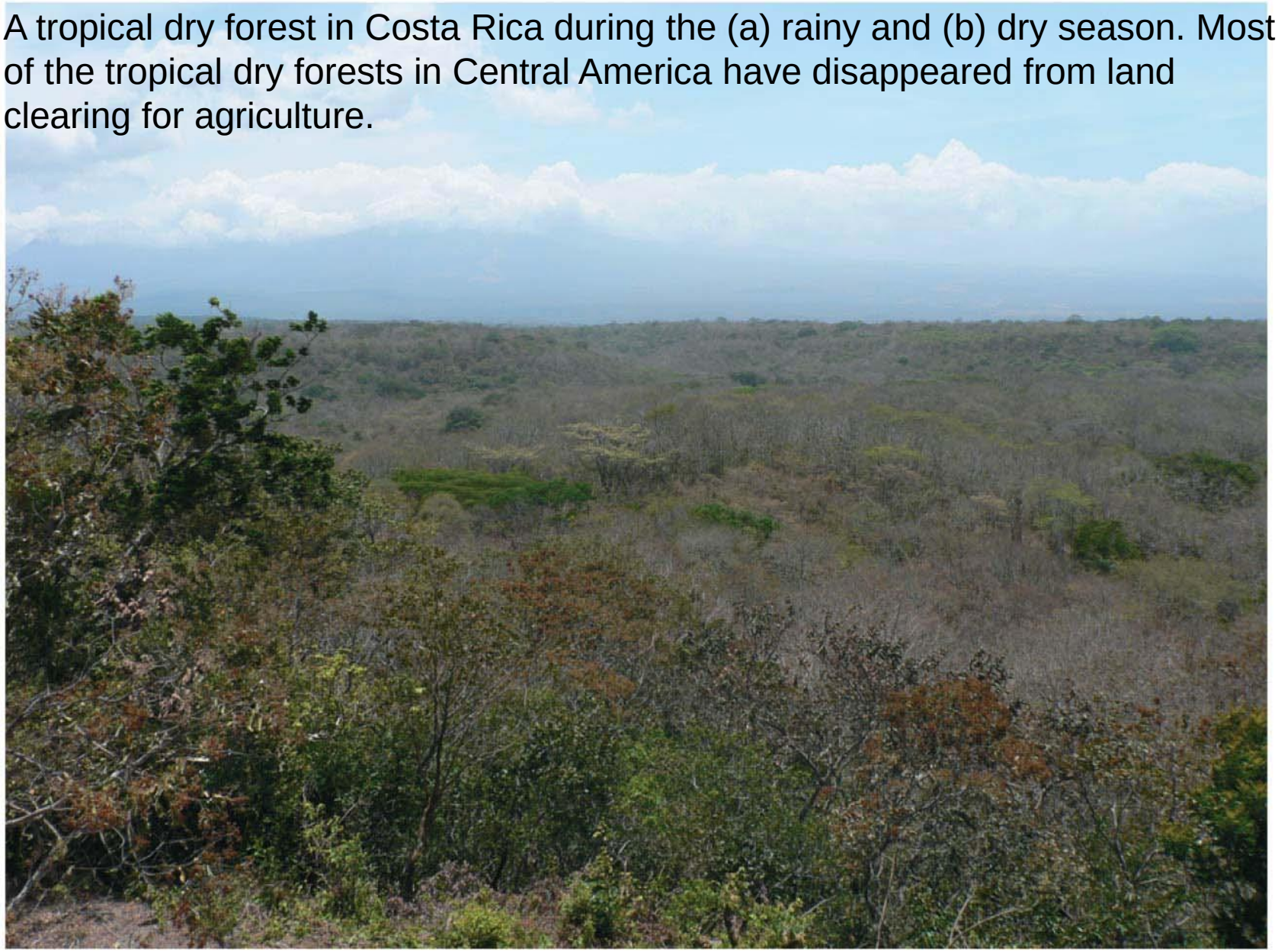
Figure 23.10a

A tropical dry forest in Costa Rica during the (a) rainy and (b) dry season. Most of the tropical dry forests in Central America have disappeared from land clearing for agriculture.

(a)

Figure 23.10b

A tropical dry forest in Costa Rica during the (a) rainy and (b) dry season. Most of the tropical dry forests in Central America have disappeared from land clearing for agriculture.



(b)

Figure 23.11a

(a)

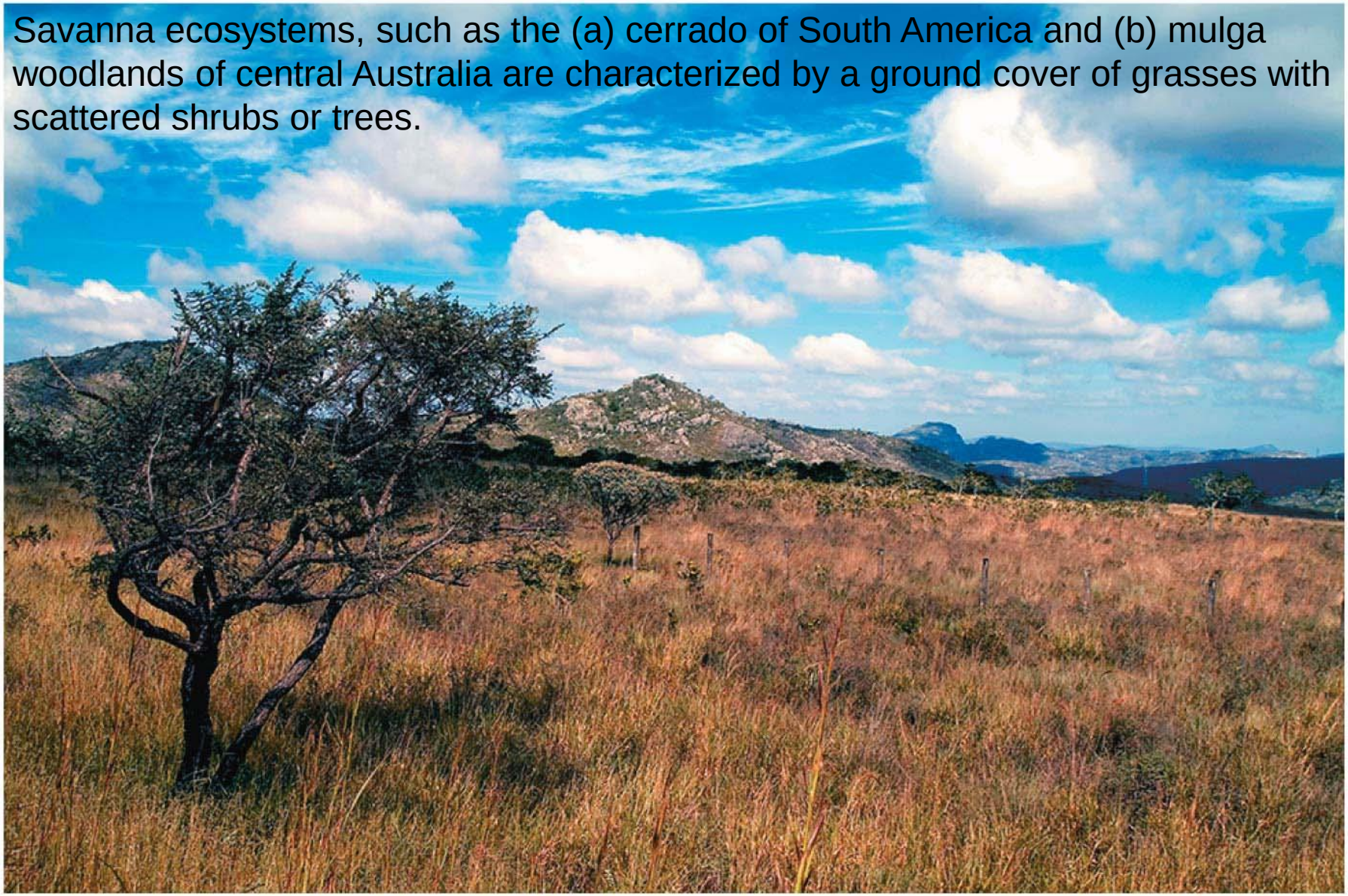


Figure 23.11b

(b)

Savanna ecosystems, such as the (a) cerrado of South America and (b) mulga woodlands of central Australia are characterized by a ground cover of grasses with scattered shrubs or trees.

Figure 23.12

Geographic distribution of Earth's tropical savanna ecosystems

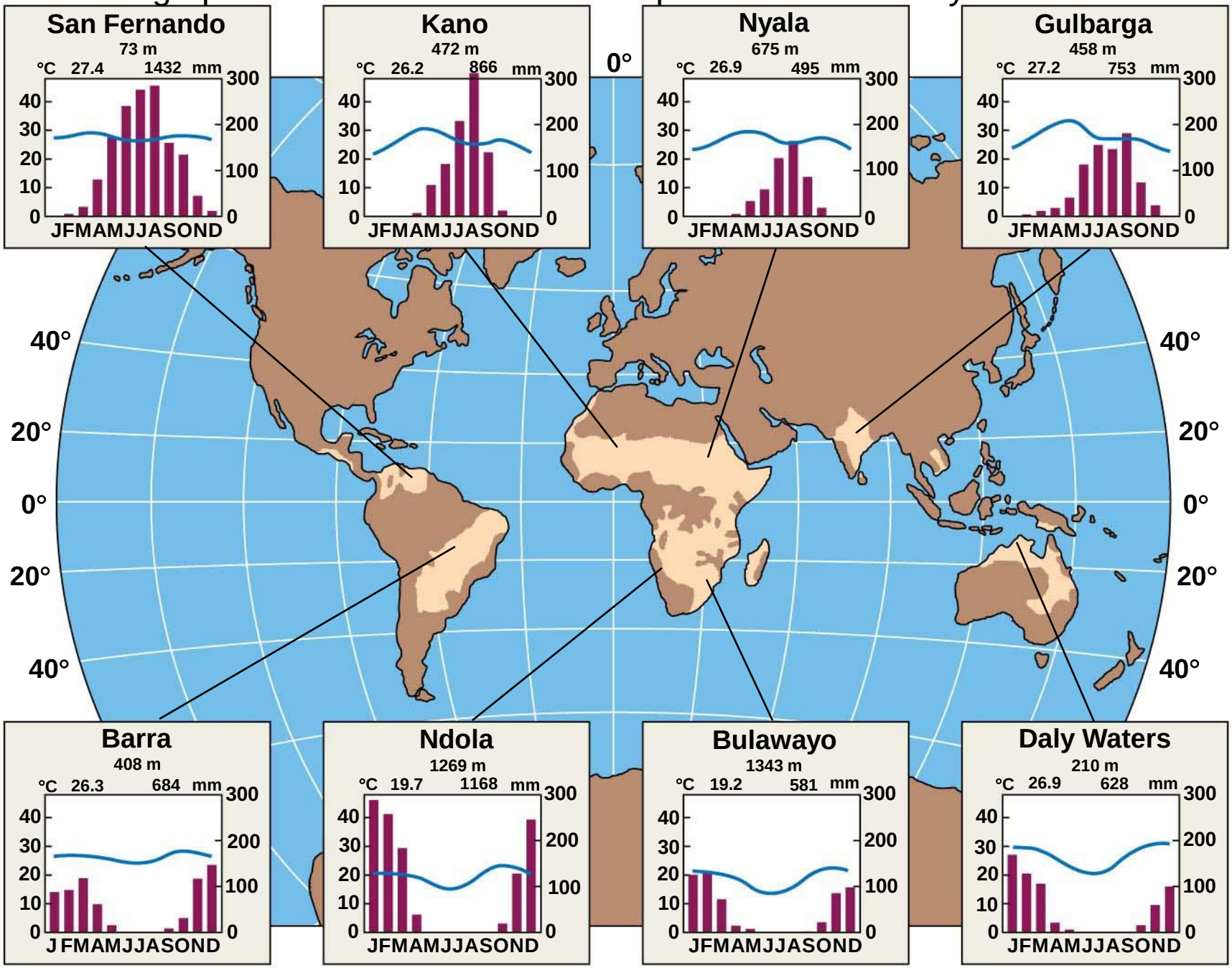


Diagram showing the interaction between annual precipitation and soil texture in defining the transition from woodland to savanna and grassland in southern Africa. Plants have more limited access to soil moisture on the heavily textured soils (clays) than on the coarser sands, so annually more precipitation is needed to support the woody plants.

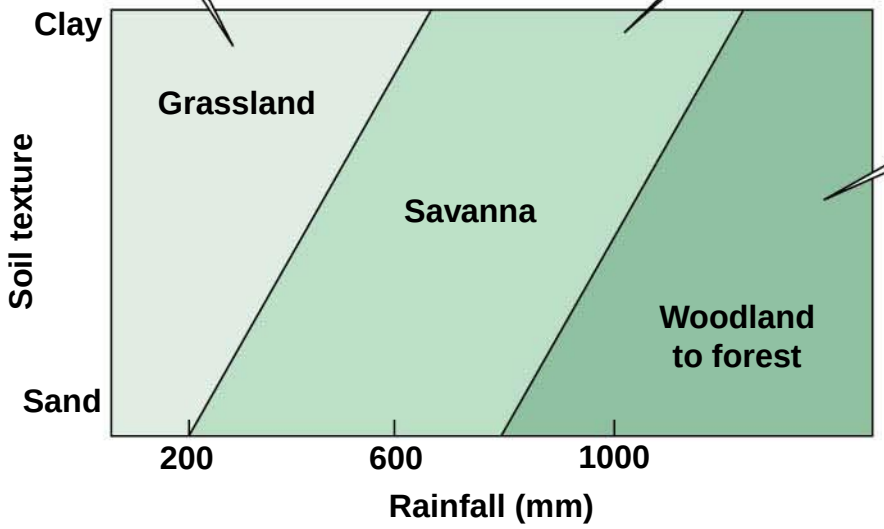


Figure 23.13

Figure 23.14 Geographic distribution of Earth's temperate grassland ecosystems

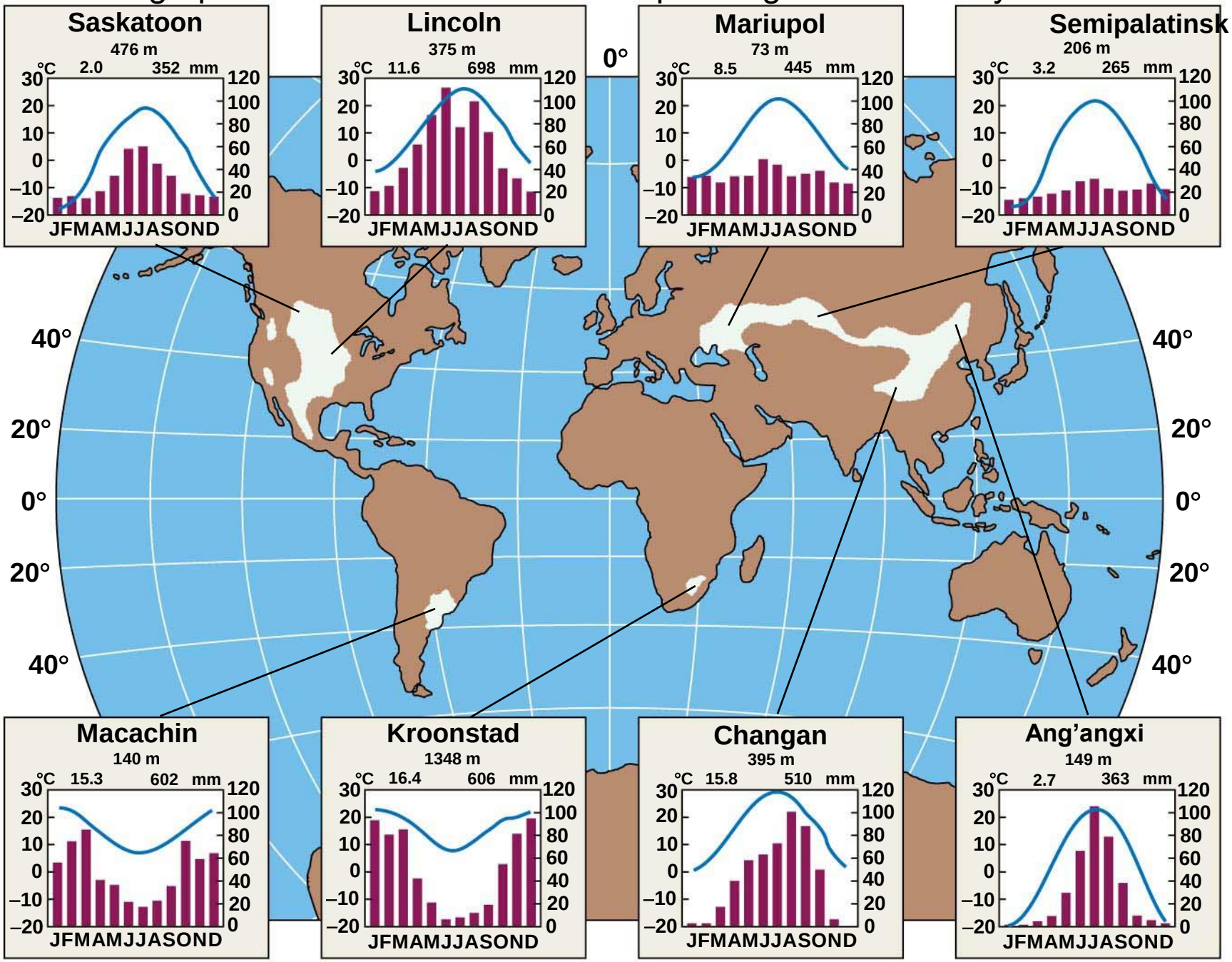
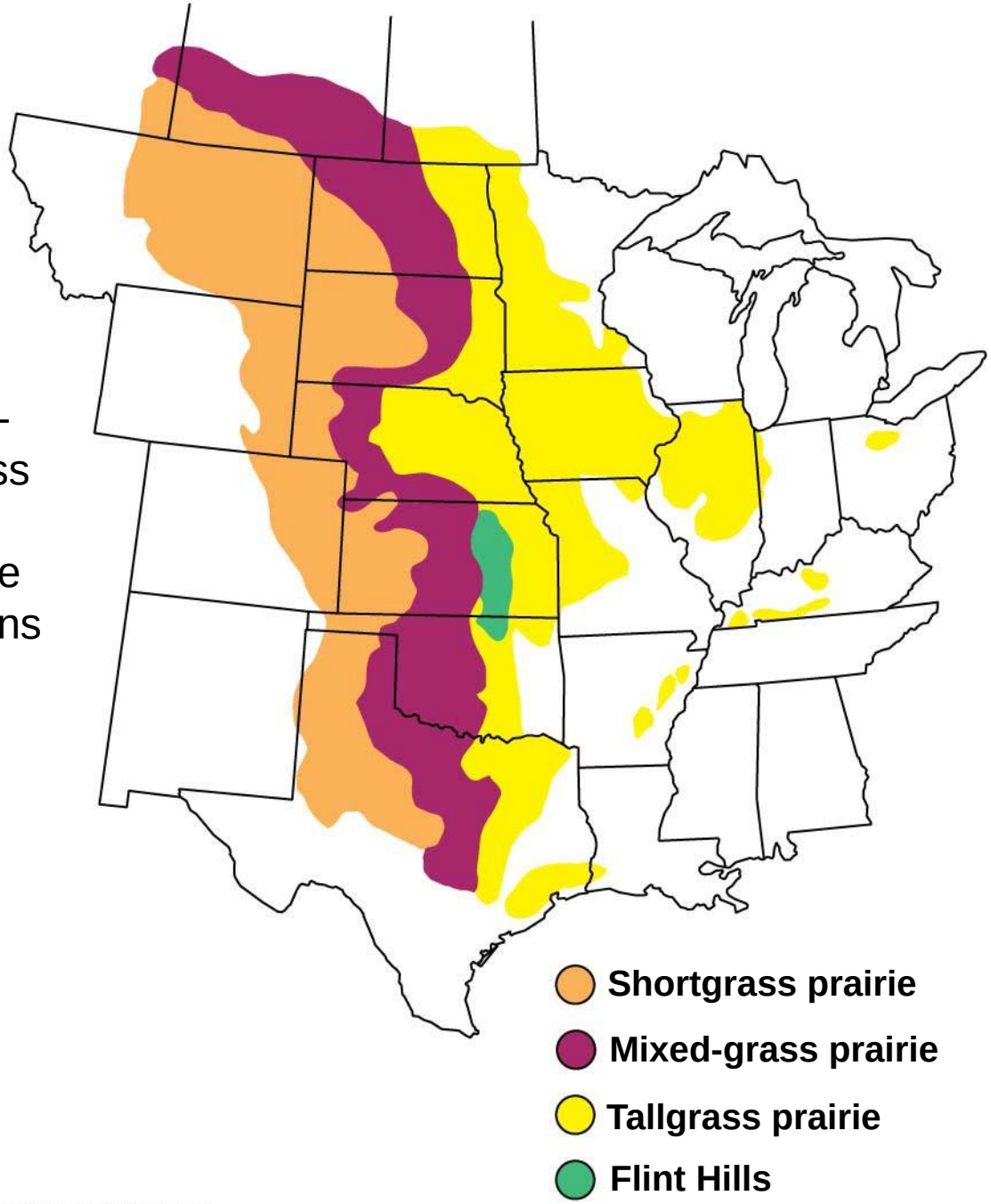
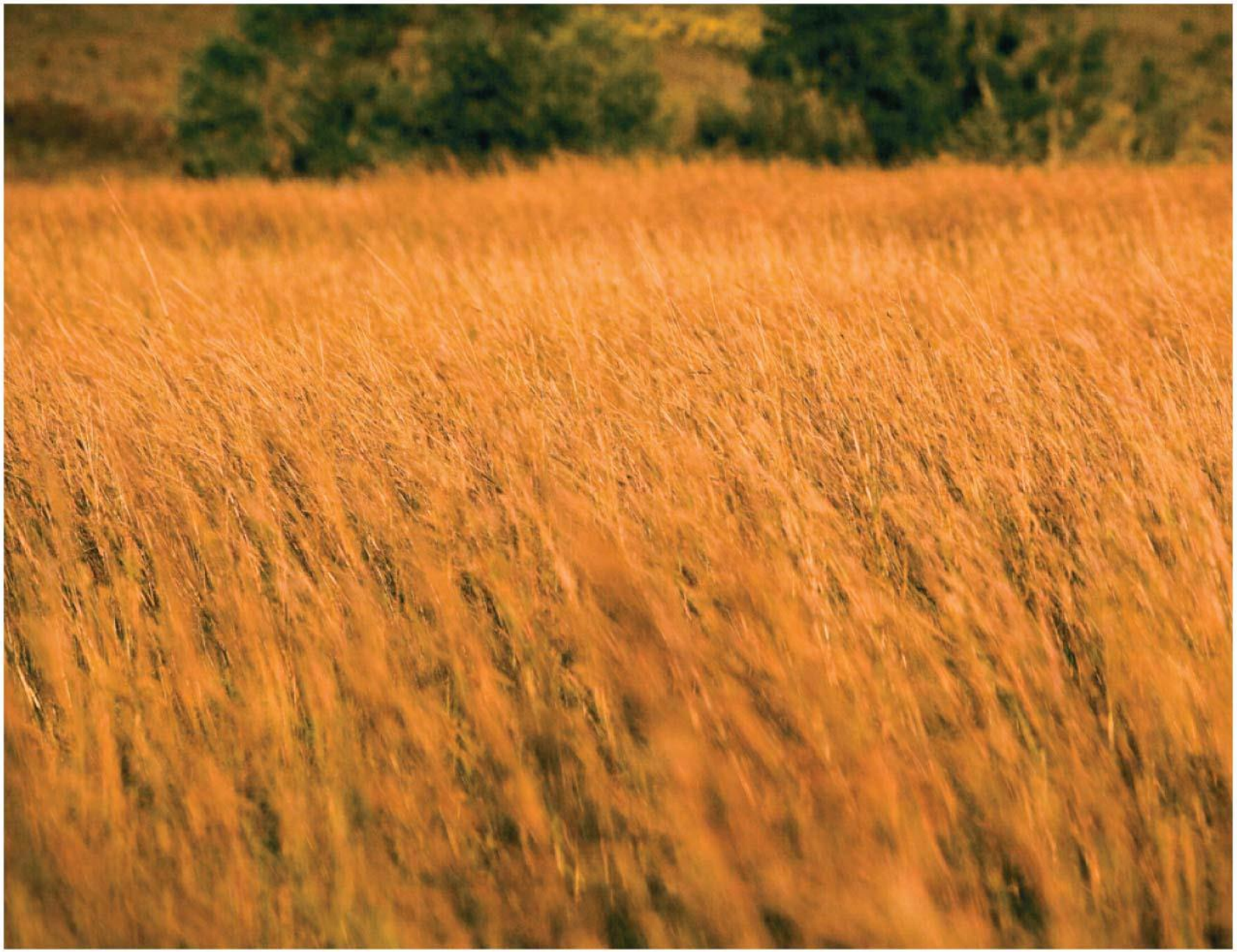


Figure 23.15



Map showing the original extent of shortgrass, mixed-grass, and tallgrass prairies in North America before the arrival of Europeans

Figure 23.16a



(a)

North American grasslands. (a) A remnant tallgrass prairie in Iowa; (b) the mixed-grass prairie has been called “daisyland” for the diversity of its wildflowers; (c) shortgrass steppe in western Wyoming.

Figure 23.16b

(b)

North American grasslands. (a) A remnant tallgrass prairie in Iowa; (b) the mixed-grass prairie has been called “daisyland” for the diversity of its wildflowers; (c) shortgrass steppe in western Wyoming.

Figure 23.16c

North American grasslands. (a) A remnant tallgrass prairie in Iowa; (b) the mixed-grass prairie has been called “daisyland” for the diversity of its wildflowers; (c) shortgrass steppe in western Wyoming.

(c)

Figure 23.17a

North American grasslands were once dominated by (a) large grazing ungulates such as bison and (b) burrowing mammals such as the prairie dog.

(a)

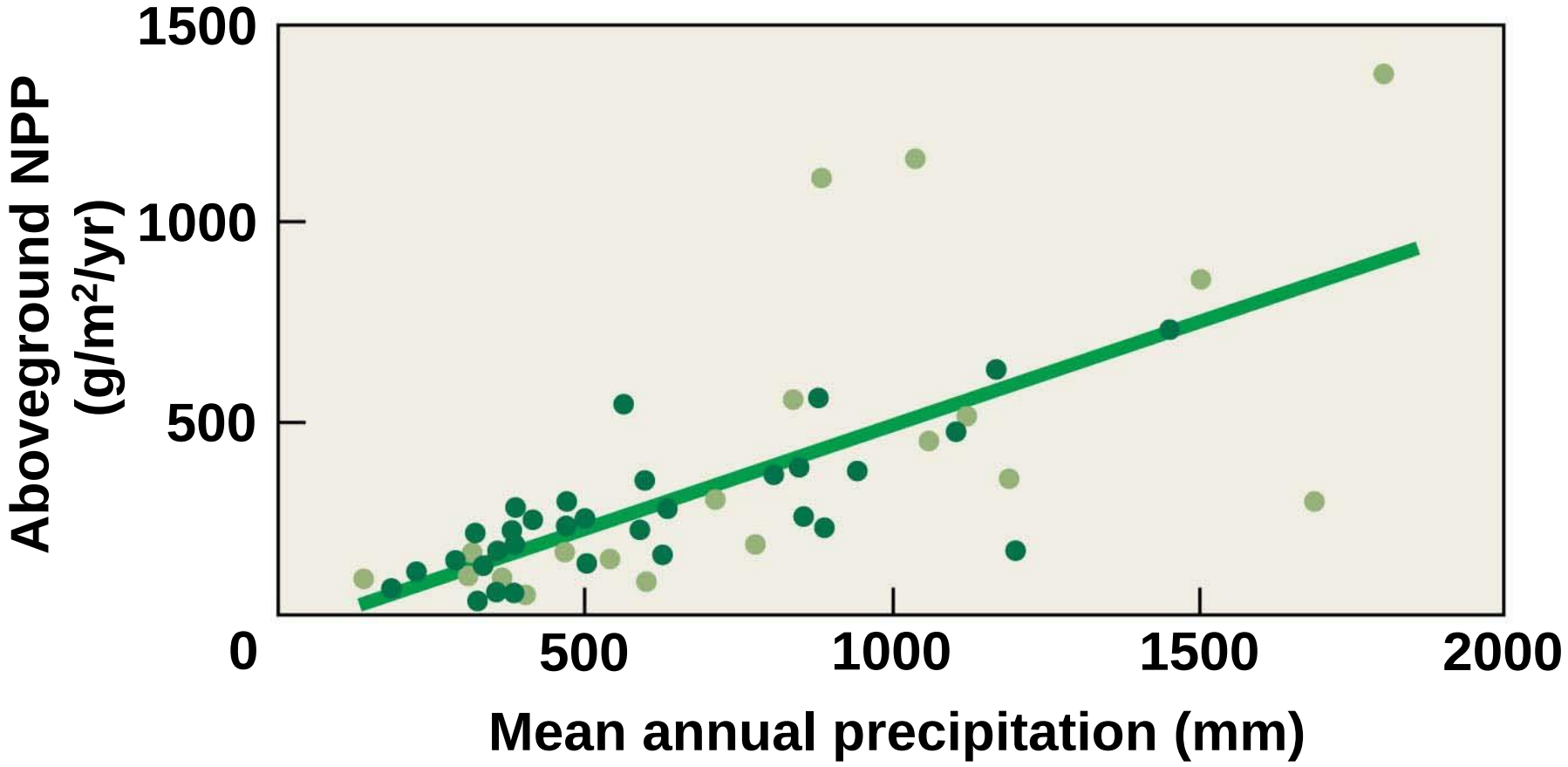
Figure 23.17b

North American grasslands were once dominated by (a) large grazing ungulates such as bison and (b) burrowing mammals such as the prairie dog.

(b)

Figure 23.18

Relationship between aboveground net primary production (NPP) and mean annual precipitation for 52 grassland sites around the world. Each point represents a different grassland site. North American grasslands are indicated by dark-green dots.



(Adapted from Lauenroth 1979.)

Figure 23.19

Geographic distribution of Earth's desert (arid) ecosystems

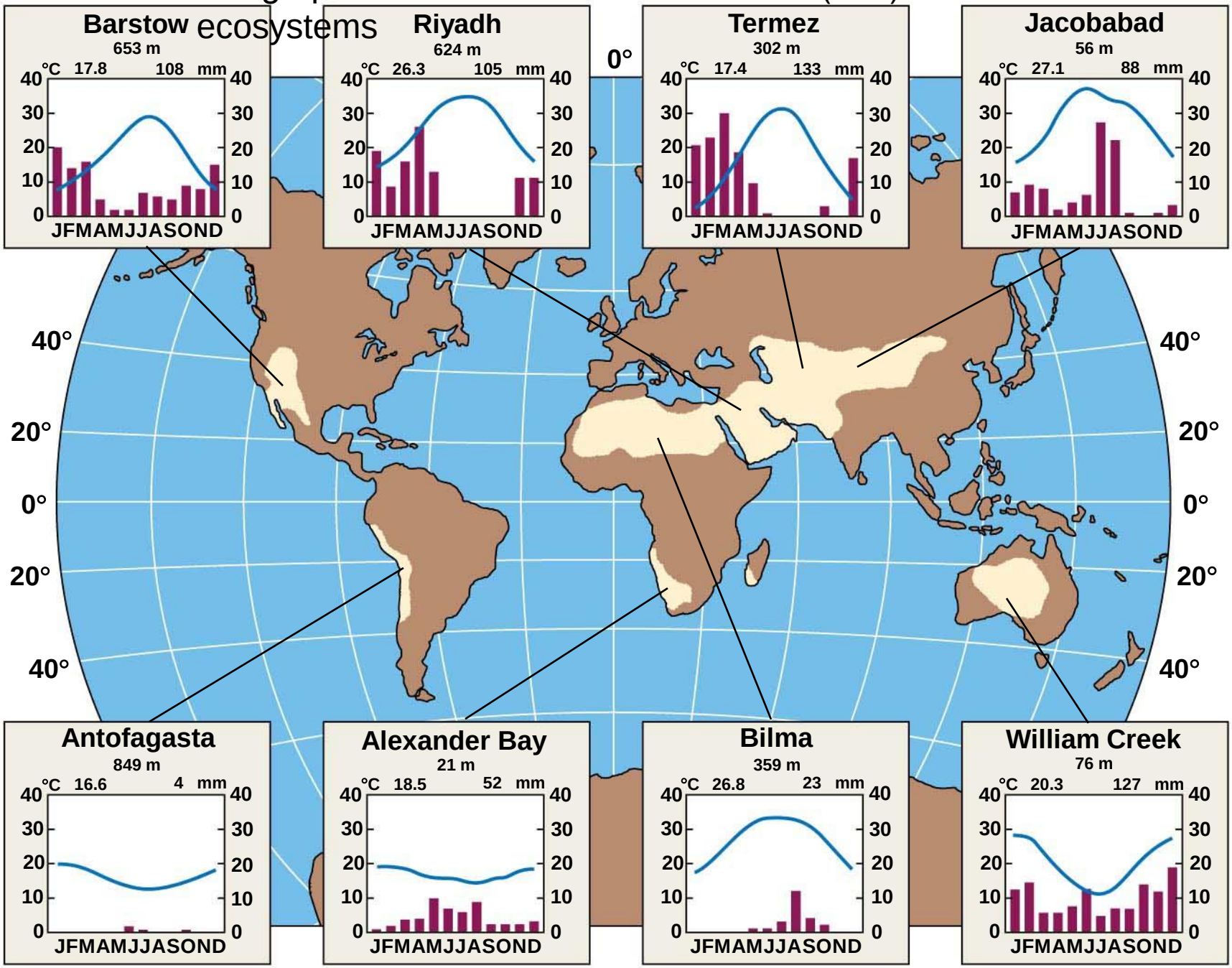
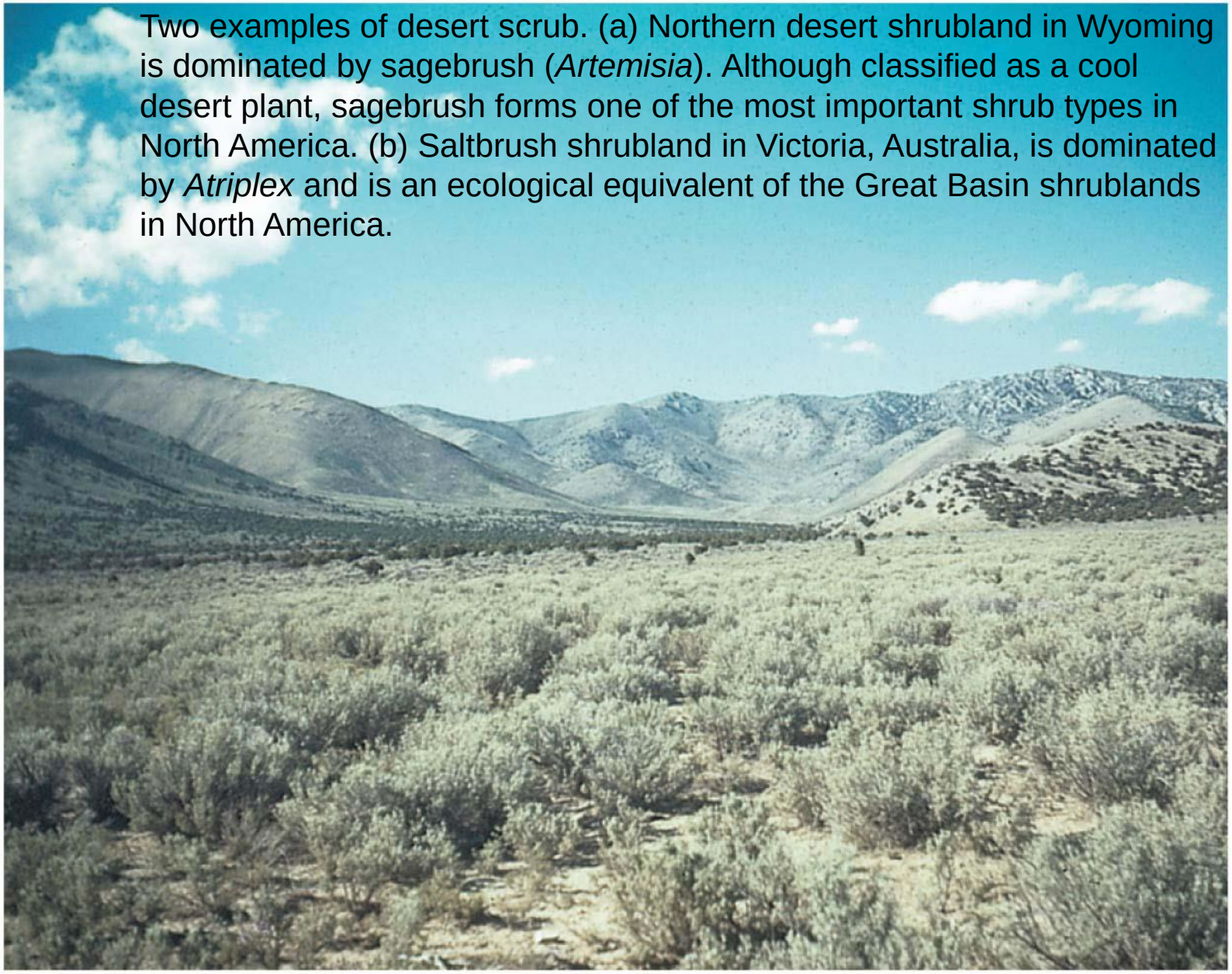


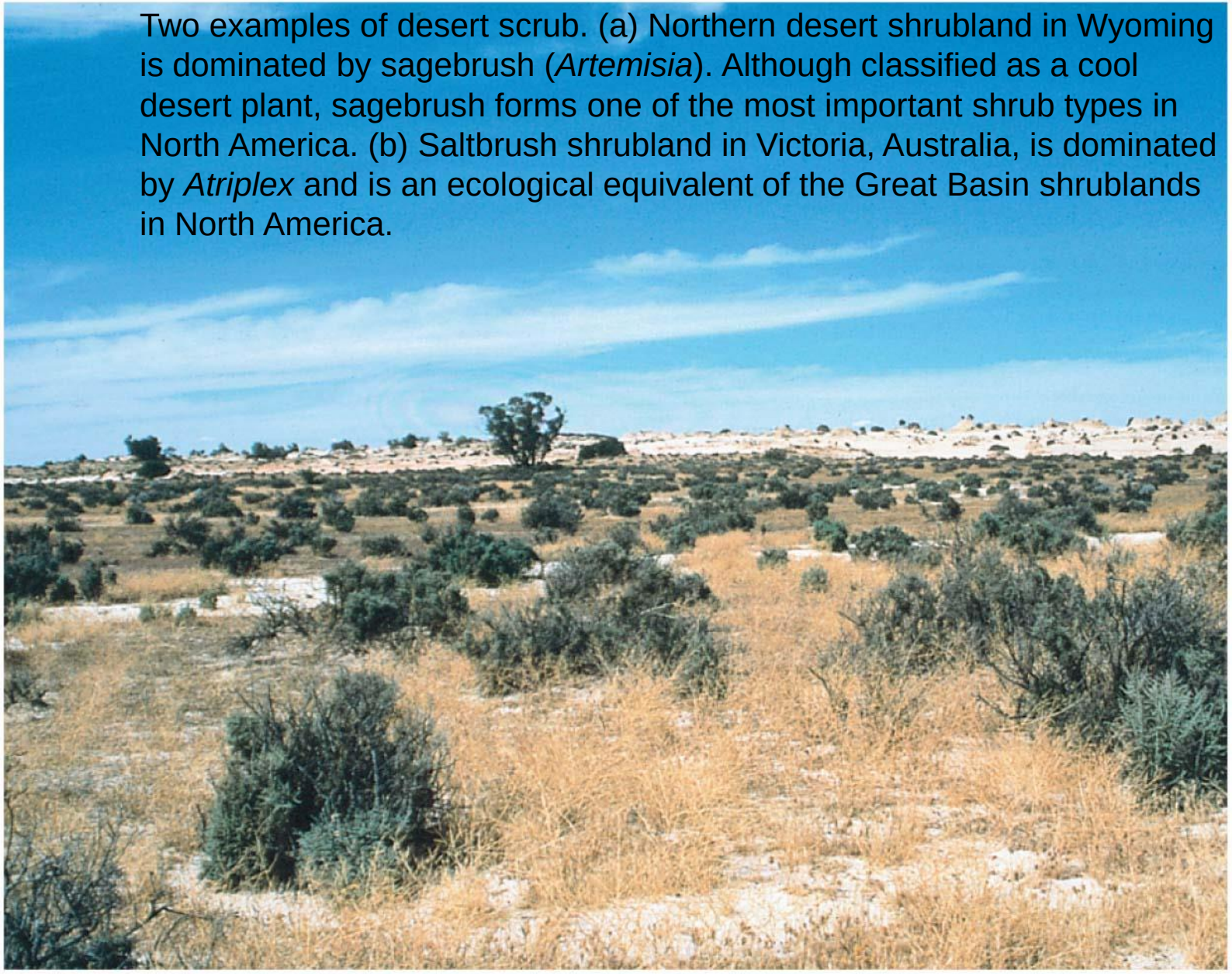
Figure 23.20a



Two examples of desert scrub. (a) Northern desert shrubland in Wyoming is dominated by sagebrush (*Artemisia*). Although classified as a cool desert plant, sagebrush forms one of the most important shrub types in North America. (b) Saltbrush shrubland in Victoria, Australia, is dominated by *Atriplex* and is an ecological equivalent of the Great Basin shrublands in North America.

(a)

Figure 23.20b



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(b)

Figure 23.21a

Two examples of hot deserts. (a) The Chihuahuan Desert in Nuevo Leon, Mexico. The substrate of this desert is sand-sized particles of gypsum. (b) Dunes in the Saudi Arabian desert near Riyadh. Note the extreme sparseness of vegetation.

(a)

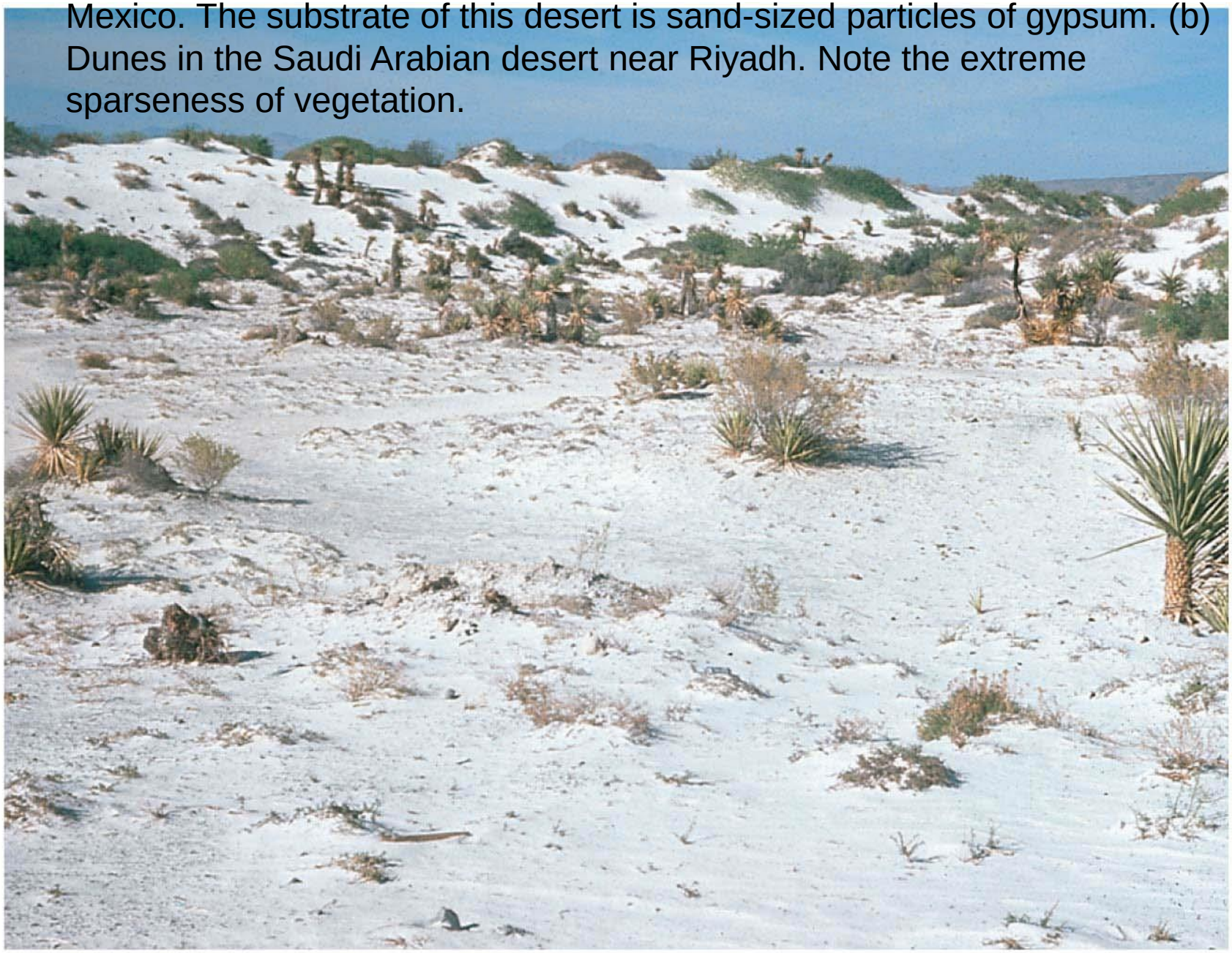

Figure 23.21b

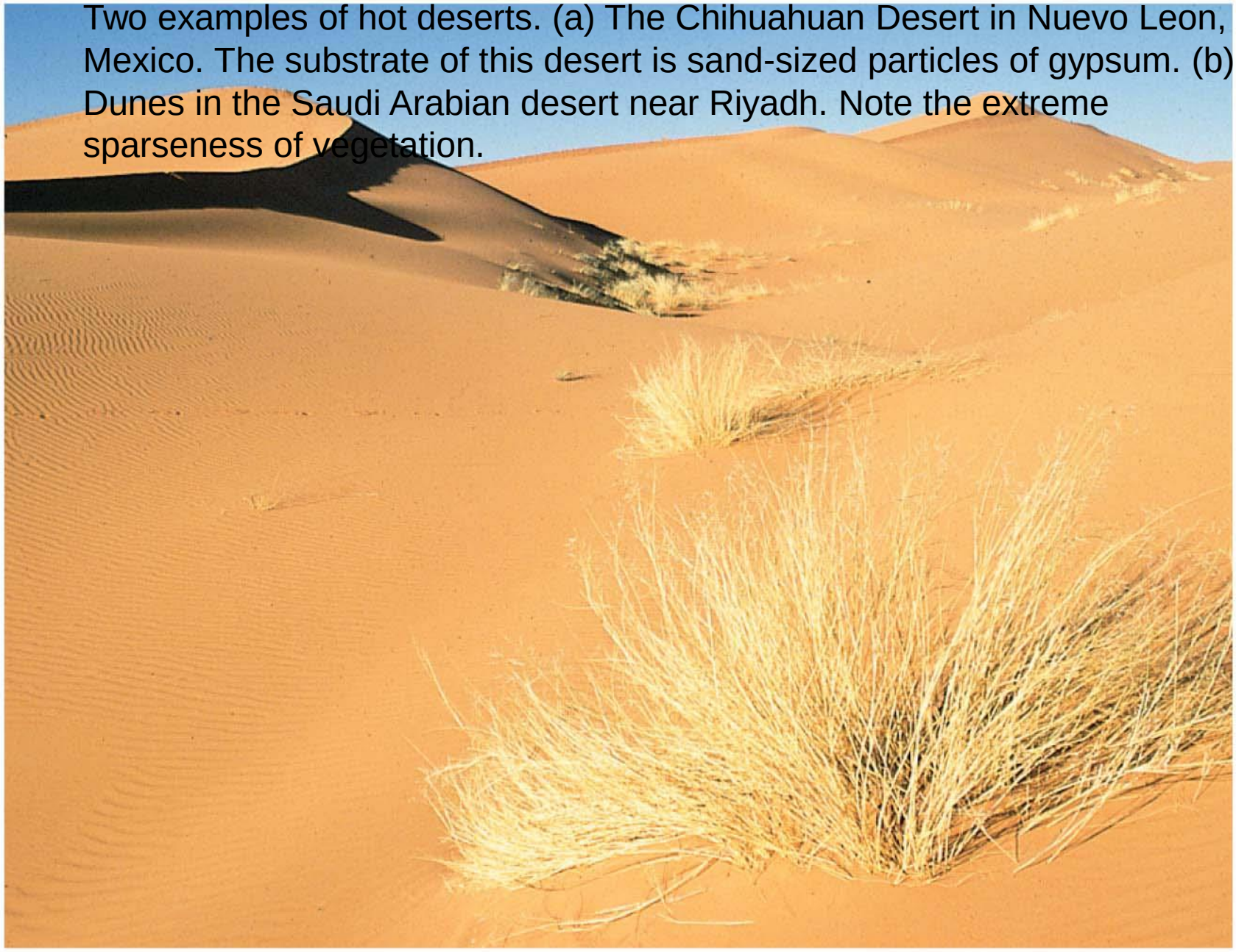

Figure 23.22 A spadefoot toad, named for the black, sharp-edged “spades” on its hind feet, emerges from its desert burrow to breed when the rains come.

Figure 23.23

Earth's mediterranean ecosystems

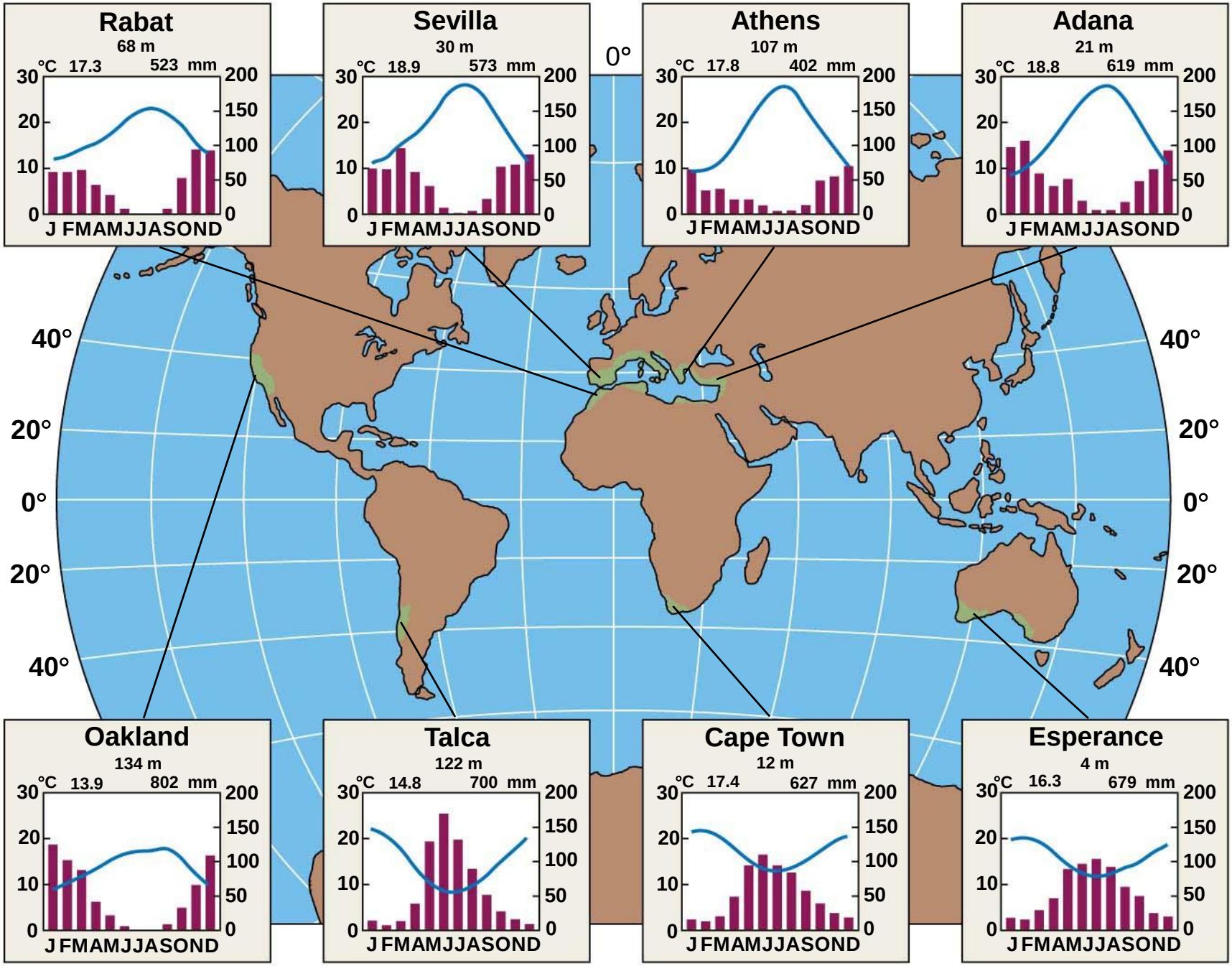

Figure 23.24

Sclerophyllous leaves of some tree and shrub species inhabiting mediterranean shrublands (chaparral) of California: (a) chamise (*Adenostoma fasciculatum*), (b) scrub oak (*Quercus dumosa*), and (c) chinquapin (*Chrysolepis sempervirens*).

(a)

(b)

(c)

Figure 23.24a

(a)

Sclerophyllous leaves of some tree and shrub species inhabiting mediterranean shrublands (chaparral) of California: (a) chamise (*Adenostoma fasciculatum*), (b) scrub oak (*Quercus dumosa*), and (c) chinquapin (*Chrysolepis sempervirens*).

Figure 23.24b

(b)

Sclerophyllous leaves of some tree and shrub species inhabiting mediterranean shrublands (chaparral) of California: (a) chamise (*Adenostoma fasciculatum*), (b) scrub oak (*Quercus dumosa*), and (c) chinquapin (*Chrysolepis sempervirens*).

Figure 23.24c

(c)

Sclerophyllous leaves of some tree and shrub species inhabiting mediterranean shrublands (chaparral) of California: (a) chamise (*Adenostoma fasciculatum*), (b) scrub oak (*Quercus dumosa*), and (c) chinquapin (*Chrysolepis sempervirens*).

Figure 23.25

Mediterranean vegetation (fynbos) of the Western Cape region of South Africa.

Figure 23.26

Chaparral is the dominant mediterranean shrub vegetation of southern California.

Figure 23.27

Earth's temperate forest ecosystems

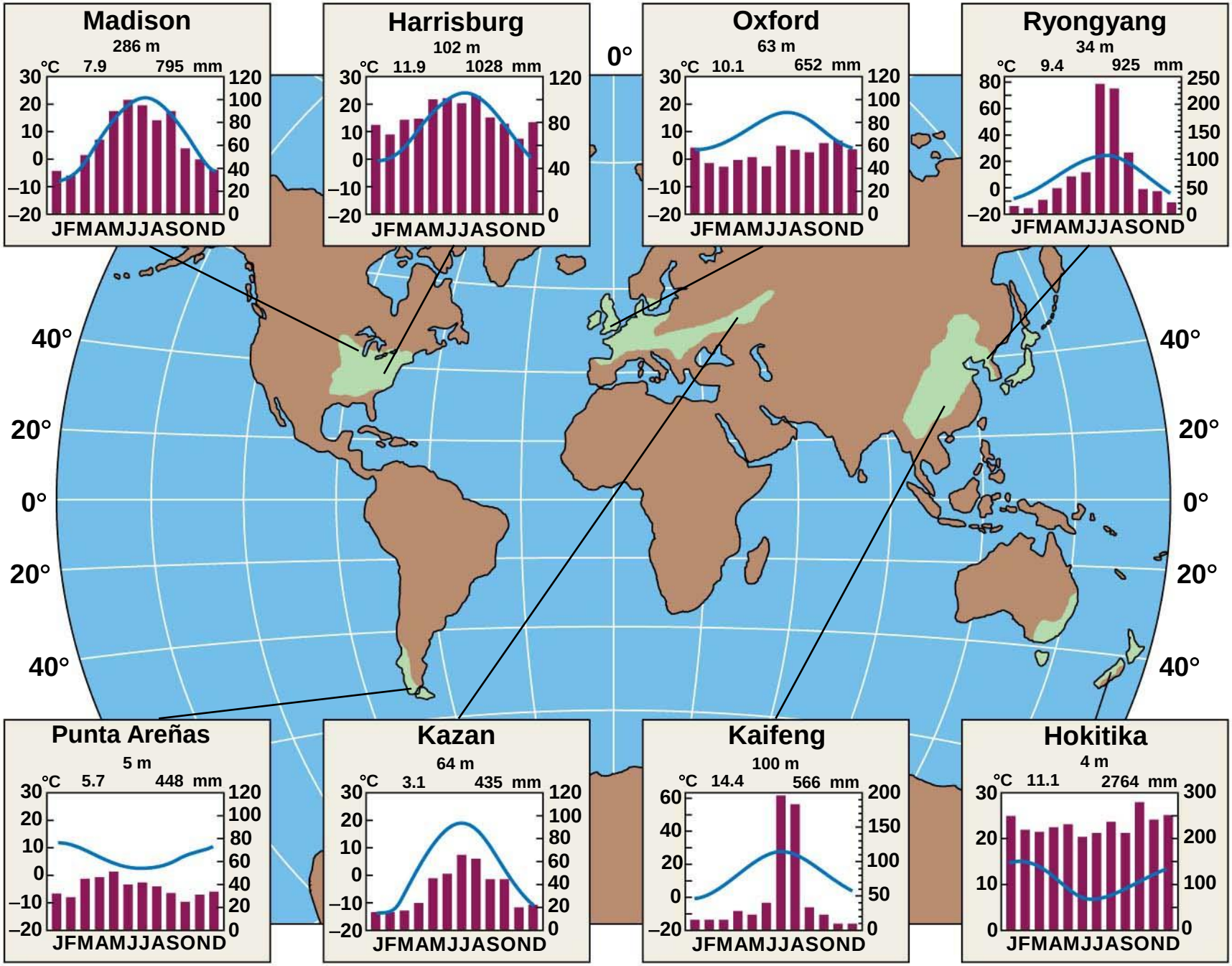

Figure 23.28

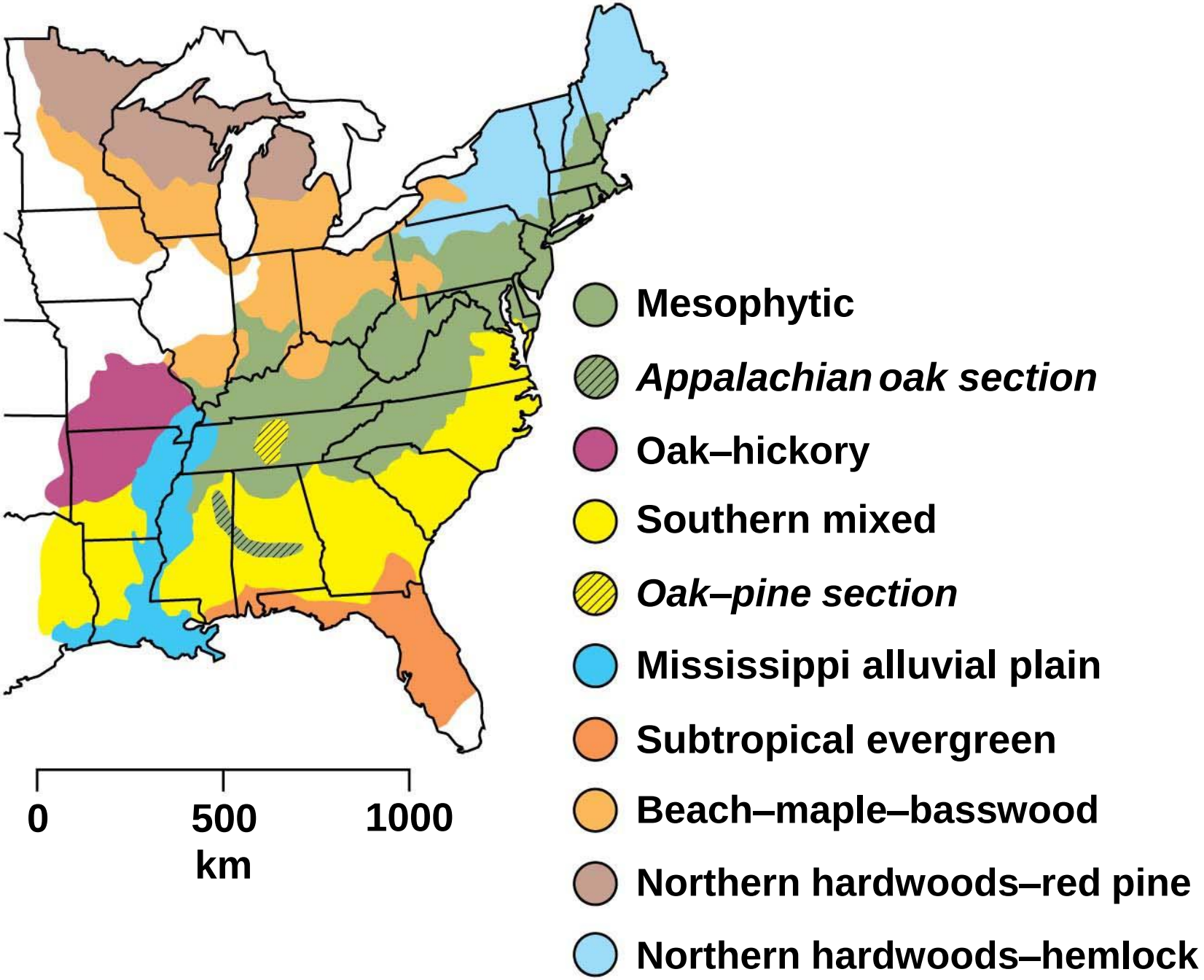

Figure 23.29

A temperate forest of the Appalachian region: (a) the canopy during autumn, and (b) interior of the forest during spring. The forest is dominated by oaks (Quercus spp.) and yellow poplar (Liriodendron tulipifera), with an understory of redbud (Cercis canadensis) in bloom.

(a)

(b)

Figure 23.29a

(a)

A temperate forest of the Appalachian region: (a) the canopy during autumn, and (b) interior of the forest during spring. The forest is dominated by oaks (*Quercus* spp.) and yellow poplar (*Liriodendron tulipifera*), with an understory of redbud (*Cercis canadensis*) in bloom.

Figure 23.29b

(b)

A temperate forest of the Appalachian region: (a) the canopy during autumn, and (b) interior of the forest during spring. The forest is dominated by oaks (*Quercus* spp.) and yellow poplar (*Liriodendron tulipifera*), with an understory of redbud (*Cercis canadensis*) in bloom.

Figure 23.30

Earth's conifer forest ecosystems

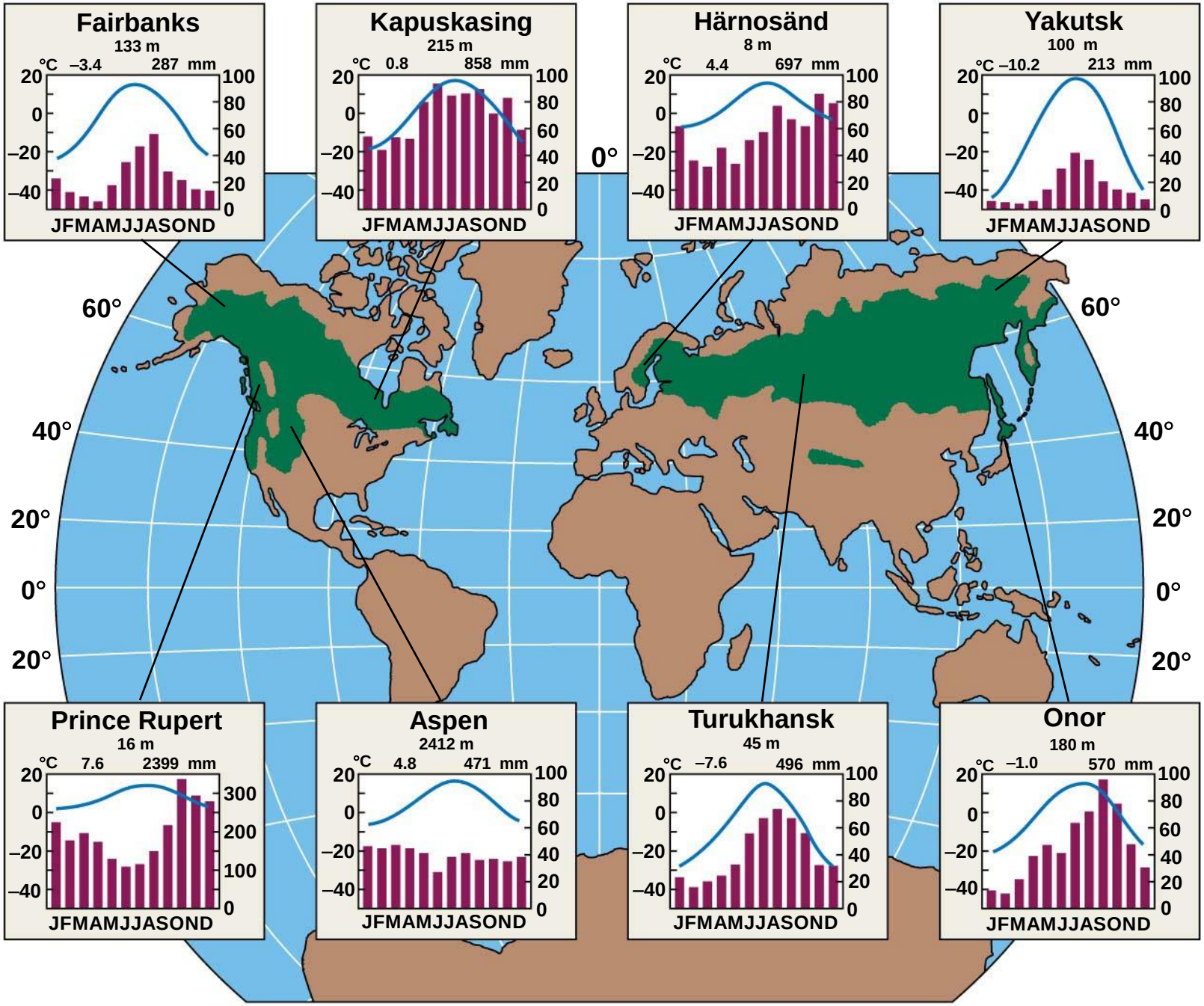

Figure 23.31

Two coniferous forest types. (a) A Norway spruce in the Tarvisio region of Italy. (b) A montane coniferous forest in the Rocky Mountains. The dry, lower slopes support ponderosa pine; the upper slopes are cloaked with Douglas fir.

(a)

(b)

Figure 23.32

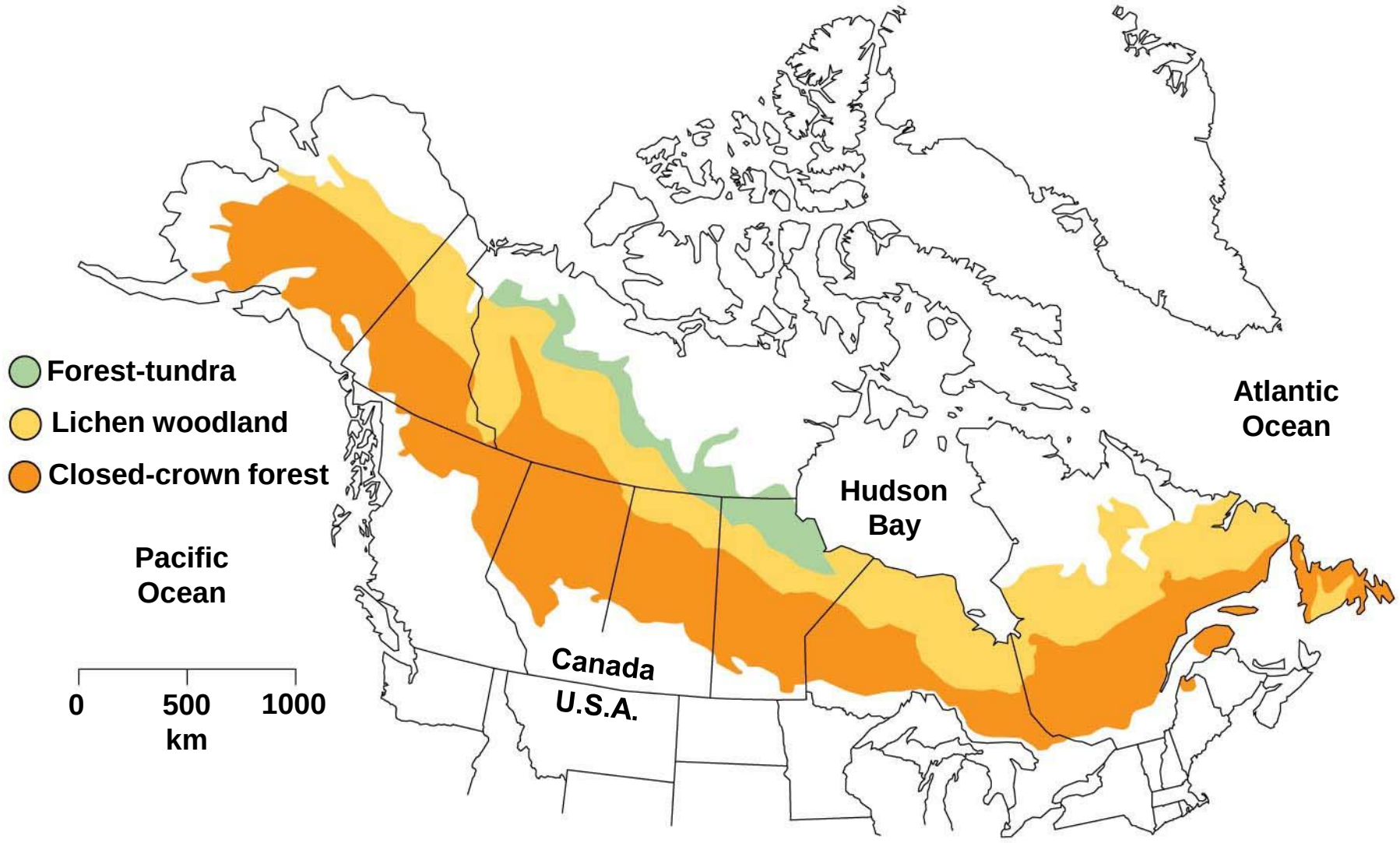

Figure 23.33

Figure 23.34

Earth's tundra ecosystems

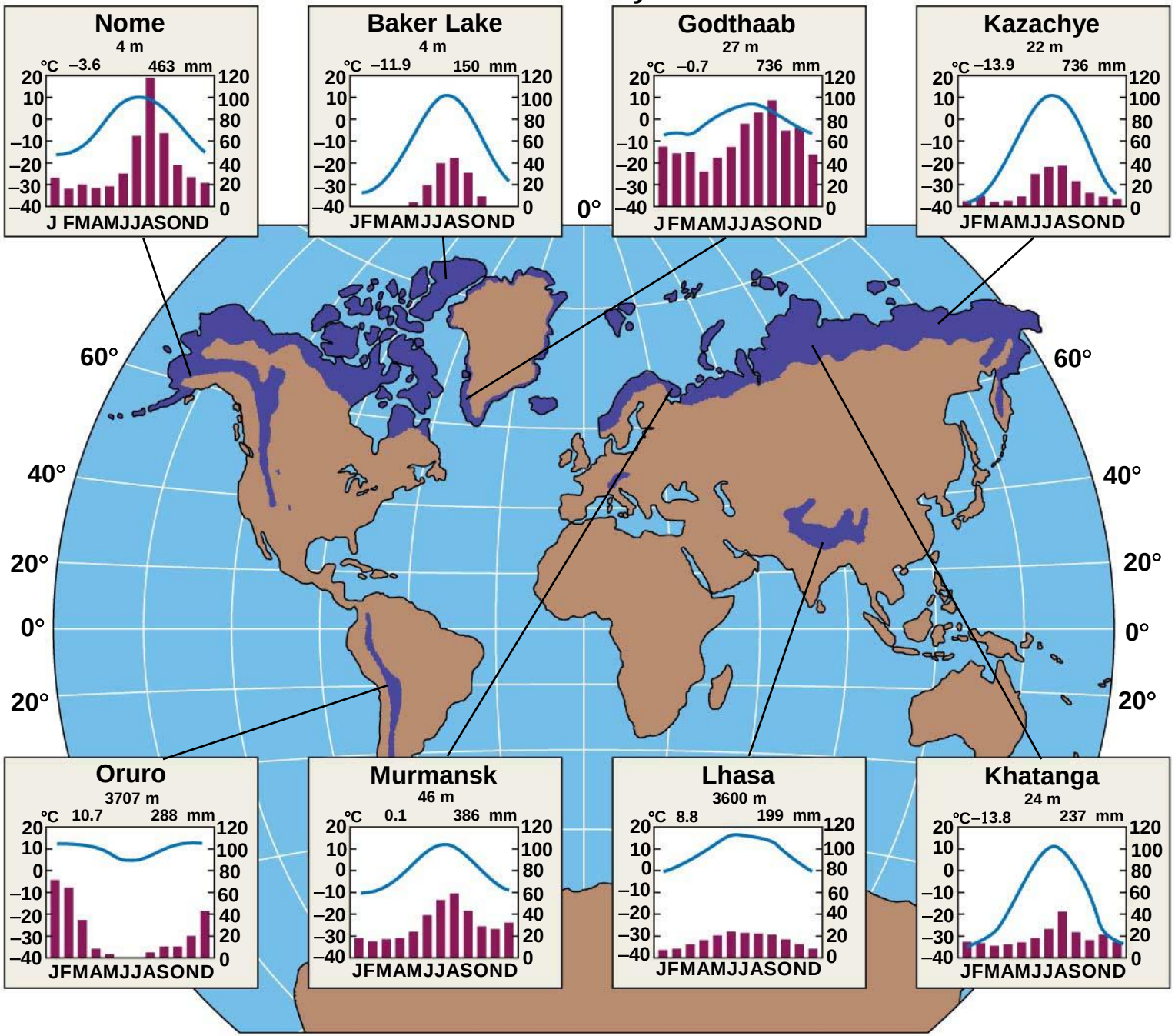

Figure 23.35a

(a) The plant cover that characterizes the wide expanse of the Arctic tundra in the Northwest Territories of Canada presents a stark contrast to (b) the polar desert that is characterized by dry soils and sparse plant cover.

(a)

Figure 23.35b

(a) The plant cover that characterizes the wide expanse of the Arctic tundra in the Northwest Territories of Canada presents a stark contrast to (b) the polar desert that is characterized by dry soils and sparse plant cover.

(b)

Figure 23.36a

(a)

Patterned landforms typical of the tundra region: (a) frost hummocks, and (b) polygons. Alternate freezing and thawing of the upper layer of soil creates the symmetrically patterned landforms

Figure 23.36b

(b) Patterned landforms typical of the tundra region: (a) frost hummocks, and (b) polygons. Alternate freezing and thawing of the upper layer of soil creates the symmetrically patterned landforms

Figure 23.37

Rocky Mountains alpine tundra.