Chapter 06

A Shifting Mosaic: Rain Forest Development and Dynamics

PLATE 6-1

Landslides such as this along a forested area on an Ecuadorian mountainside sometimes result in soil removal, and this results in slow primary succession. If soil is not severely damaged, the result will be more rapid secondary succession.

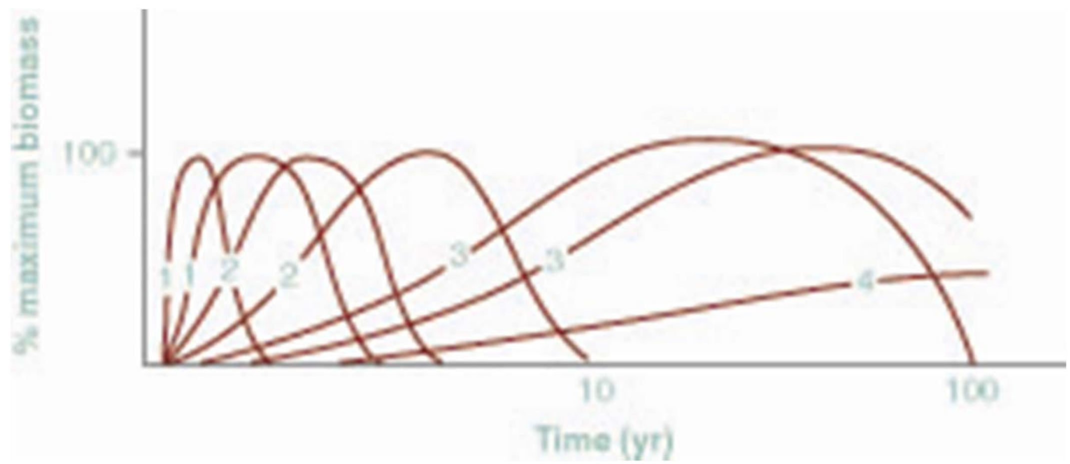


FIGURE 6-1

General description of Neotropical secondary successions. Numbers on curves represent Phases 1-4 (see text).

PLATE 6-2

Early secondary succession in the tropics is characterized by dense cover of sun-demanding species. From Ecuador.

PLATE 6-3

This disturbed gap in Ecuador experiences an abundance of sunlight, ideal for species such as this flowering heliconia.

PLATE 6-4

This field adjacent to a rural village in Belize, now abandoned, is undergoing secondary succession. The large-leaved plants are bananas.

PLATE 6-5

This abandoned house in Belize has become literally vine-covered as secondary succession has reclaimed the abandoned site. Cecropia trees are seen overtopping the house.

PLATE 6–6

This example of secondary succession reflects what the term *jungle* means in the ecological sense. Note how dense the vegetation is. The plant on the right is a tree fern.

PLATE 6-7

Leaf area index measures the density of leaves from ground to canopy. The leaf area index of this well-shaded Amazonian forest would be high.

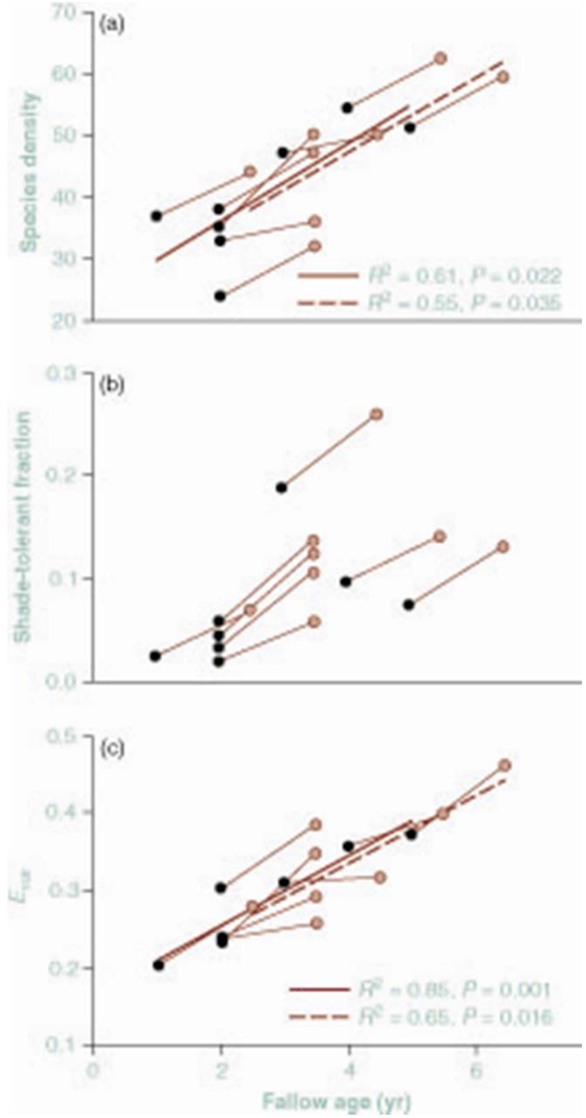


FIGURE 6–2

Early secondary succession trends in community attributes of trees greater than 1.5 meters in height at Marquéz de Comillas, Southern Mexico. (a) Species density (number of species per 500 square meters. (b) Fraction of total number of trees belonging to shade-tolerant species. (c) Smith and Wilson's measure of evenness (E_{var}). Black circles: census 1; brown circles: census 2. The bold continuous and dashed lines give the linear regressions of the variables of census 1 and 2, respectively, on fallow age.

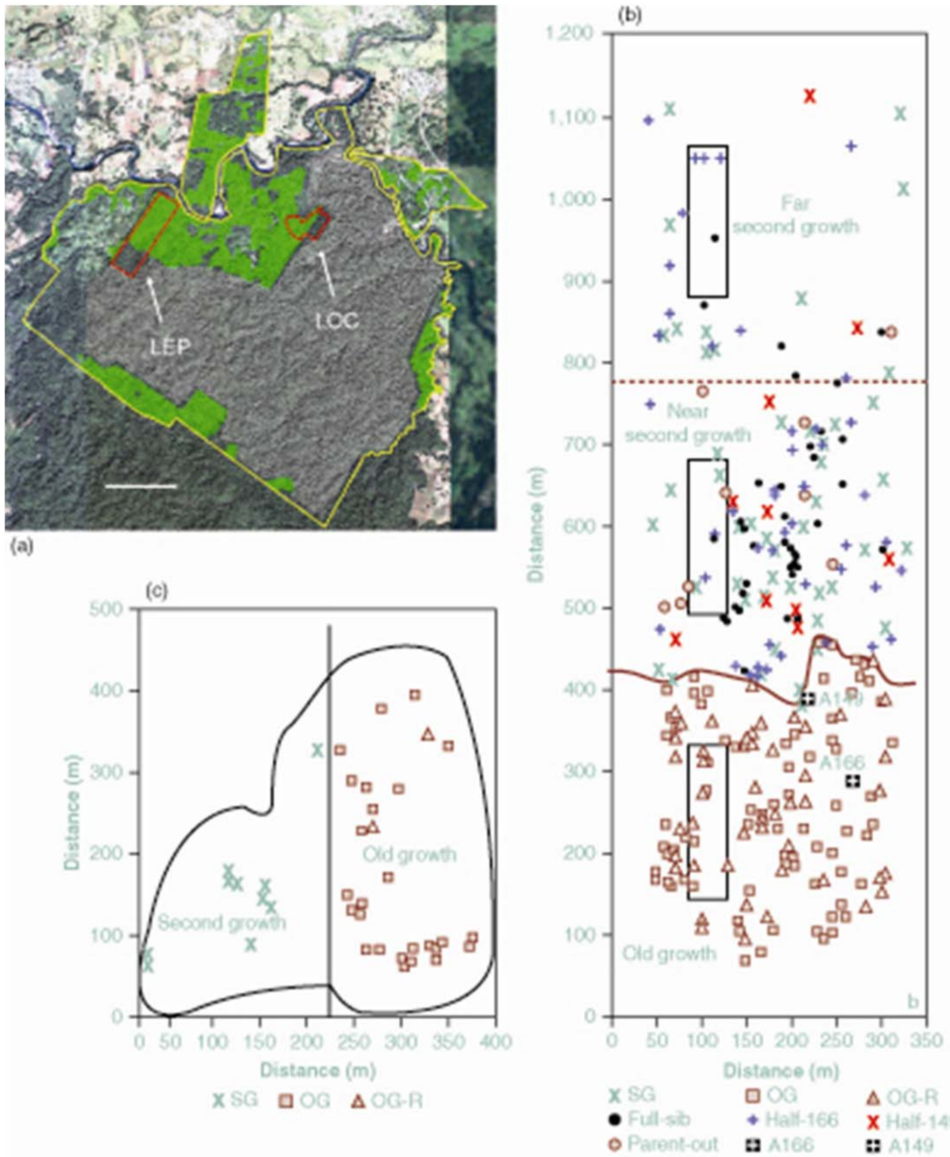


FIGURE 6-3

(a) Quickbird satellite imagery taken in 2004 showing the coverage of second-growth forest (green) and old-growth forest (dark gray) within La Selva Biological Field Station, Costa Rica. The two study sites, Lindero El Peje (LEP) and Lindero Occidental (LOC), are indicated by arrows. The horizontal bar represents 1 kilometer. (b) Map of genotyped trees in the 35-hectare LEP site. The curved line shows the boundary between the old-growth (OG) and the second-growth (SG) forest. The dashed line separates the far and near second-growth forest zones. The two reproductively dominant trees are A166 and A149. Reproductively active trees are labeled OG-R. Map positions of full-sib and half-sib (half-166 or half-149) offspring of the reproductively dominant trees are indicated. (c) Map of genotyped trees in the 8-hectare LOC site.

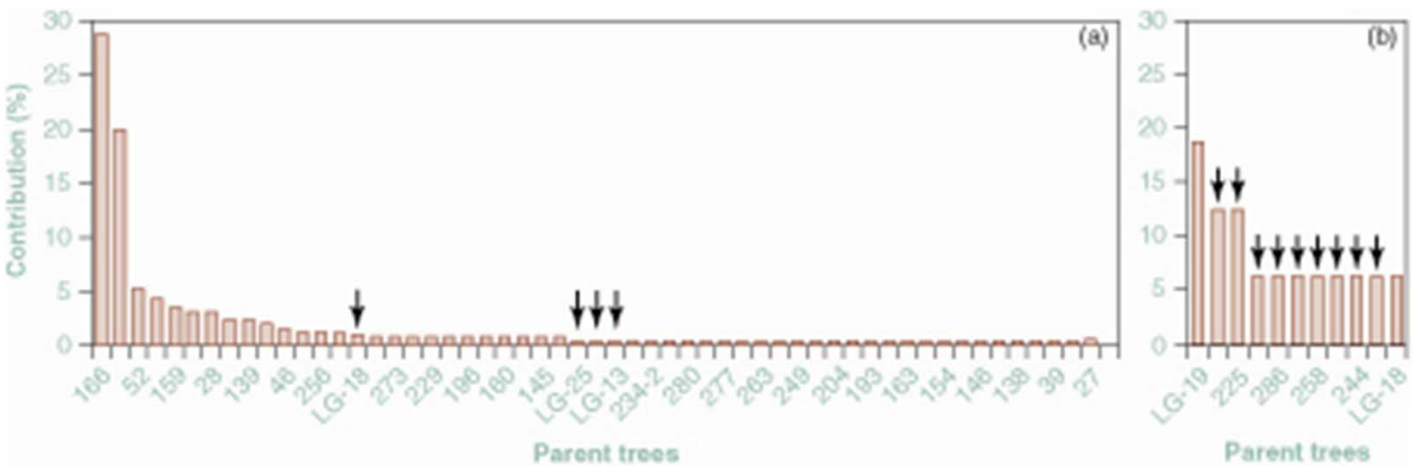


FIGURE 6-4

Reproductive contribution of parental trees to founding adult tree generation of second-growth forest in (a) LEP and (b) LOC sites. Black arrows indicate reciprocal long-distance contributions from (a) four parents found in the LOC site and (b) nine parents in the LEP site. LG represents parents in the old-growth portion of the LOC site.

PLATE 6-8

CHESTNUT-MANDIBLED TOUCAN
(*RAMPHAASTOS SWAINSONII*)

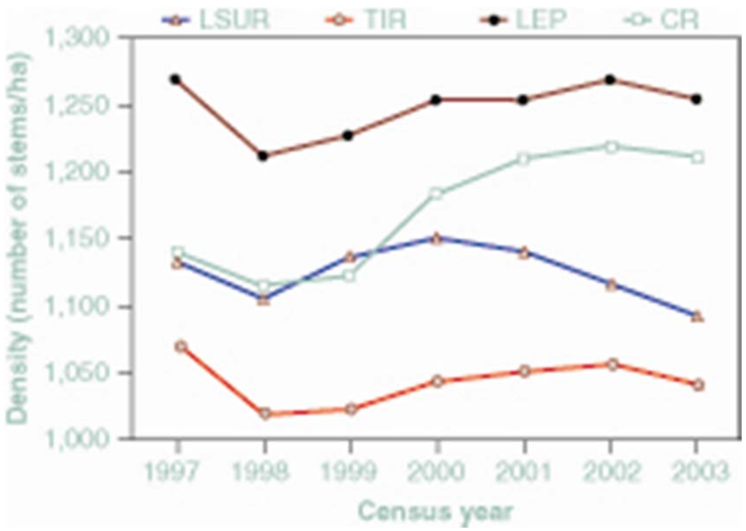


FIGURE 6-5

Absolute changes in total tree density (trees greater than 5 centimeters DBH) in four second-growth permanent sample plots from 1997 to 2003.

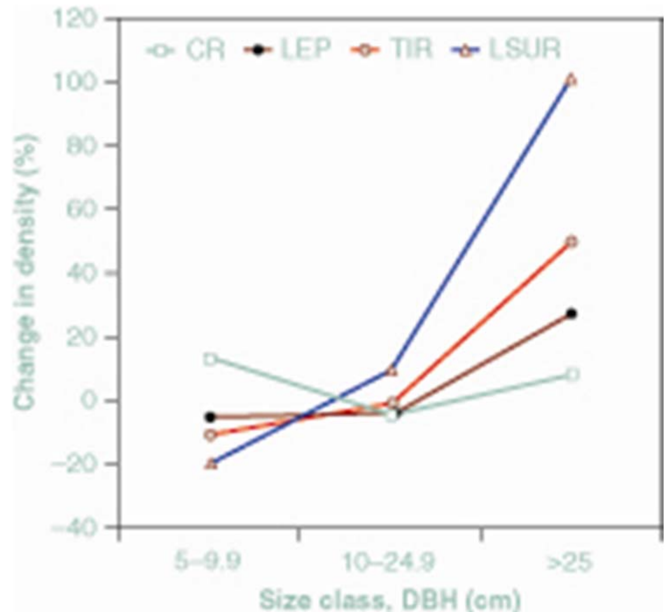


FIGURE 6-6

Percentage change in density of three diameter size classes from 1997 to 2003 in four second-growth permanent sample plots.

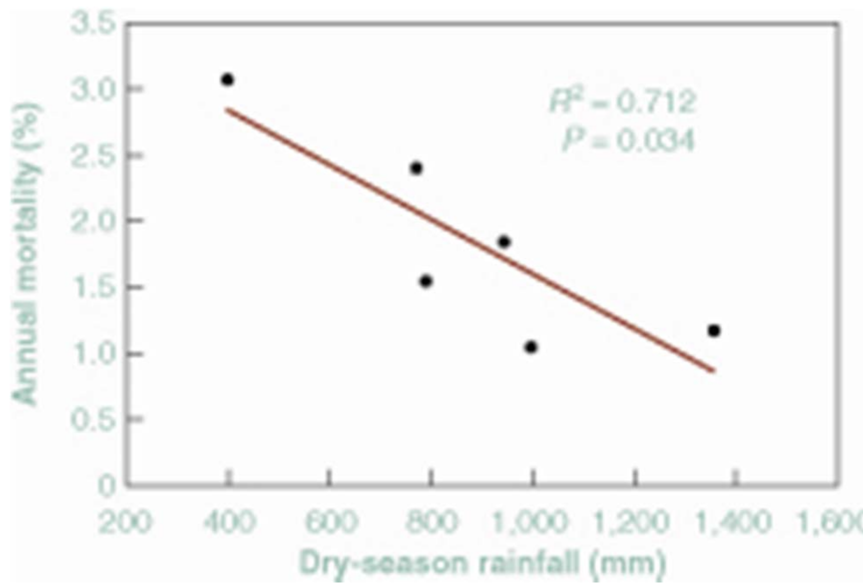


FIGURE 6-7

Regression of mean annual mortality rate of trees greater than 10 centimeters DBH on dry-season rainfall (total rainfall between January and April) across six years. Data are means for four second-growth plots.

PLATE 6-9

Flowering heliconia in the understory of an Ecuadorian rain forest. Note the colorful bracts. The flower is barely visible within the second bract from the bottom.

PLATE 6-10

This cluster of *Piper* in Belize is ready for a nocturnal visit by piperphile bats.

PLATE 6-11

MIMOSA PIGRA

PLATE 6-12

Clusters of cecropia trees are a common sight in sunny areas throughout the Neotropics.

PLATE 6-13

Cecropias have large palmate leaves and flowers and fruits that dangle like fingers below the leaves, attracting numerous bird species.

PLATE 6-14

Azteca ants on the bole of a cecropia. The brown bodies beneath the leaf axils supply the food for the ants.

PLATE 6-15

Ceiba pentandra, the kapok or silk-cotton tree, is one of the most striking tropical trees.

PLATE 6-16

Pastures such as this one in Panama have the capacity to undergo secondary succession and return to forest. The bird perched atop the cow is a smooth-billed ani (*Crotophaga ani*).

PLATE 6-17

Tikal as it appears today.

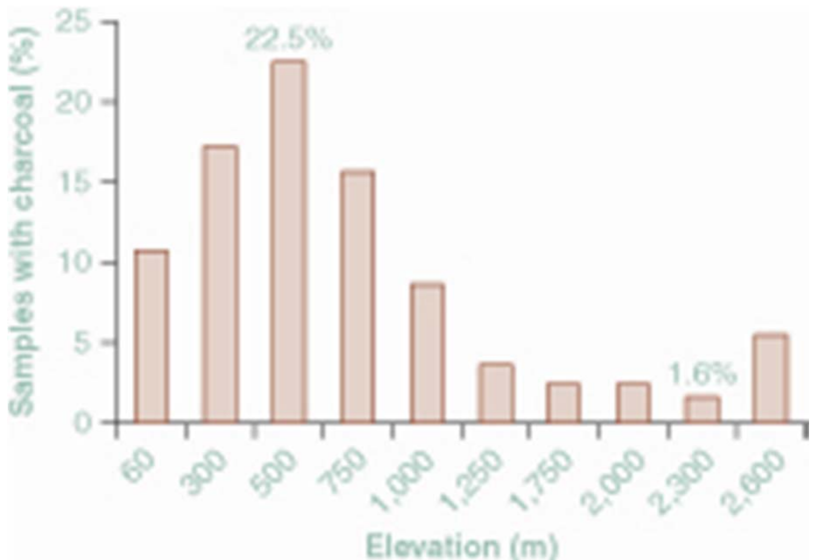


FIGURE 6–8

Charcoal mass (in grams per square meter) of soil charcoal summed for all depths (0 to 150 centimeters) and all subplots at 11 plots along the elevational gradient (240 per plot, means ± 2SE). Site 60-meter data are average of two separate sites at each elevation.

PLATE 6-18

Peat fire in Borneo in summer 2009.

PLATE 6-19

The invasive grass *Saccharum spontaneum*.

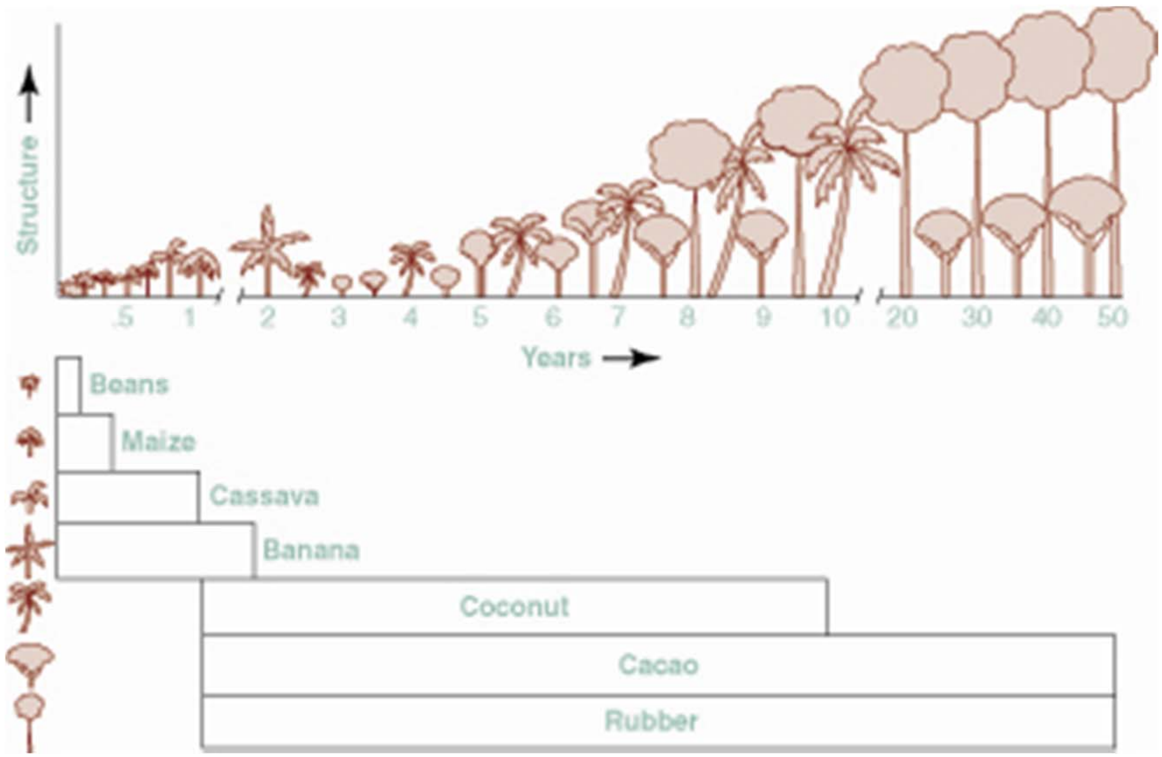


FIGURE 6-9

Sequence of crops that would mimic successional patterns. See text for explanation.

(a)

(b)

PLATE 6-20

(a) Manioc and (b) bananas are common components of the plots described earlier.

PLATE 6-21

Fallen trees such as this former member of the canopy are the main cause of gaps.

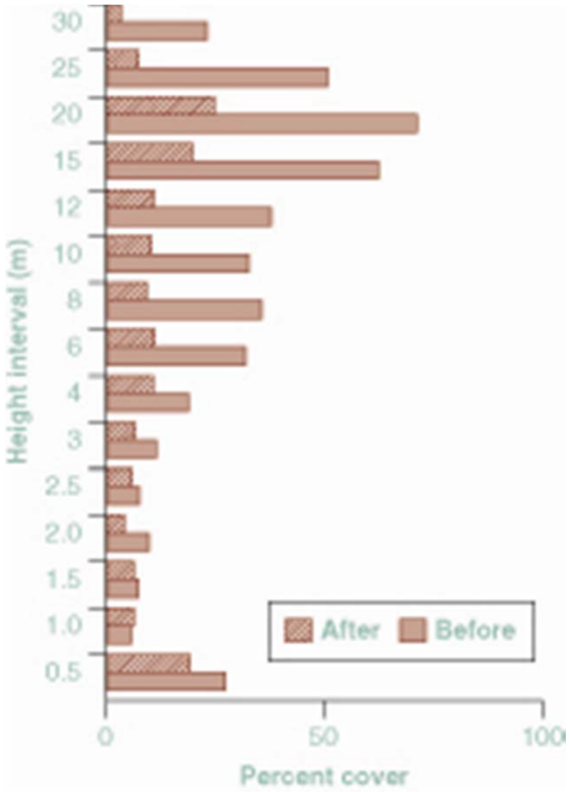


FIGURE 6-10

This figure shows vegetation height profiles for forest plots at El Verde, Puerto Rico, before and after Hurricane Hugo. Note how the hurricane reduced percent cover, opening a huge gap in the forest.

PLATE 6-22

Gaps open the forest to high levels of sunlight, stimulating both germination of seeds in the soil bank as well as growth spurts of saplings already present.

PLATE 6-23

Trema micrantha, a rapid gap colonizer.

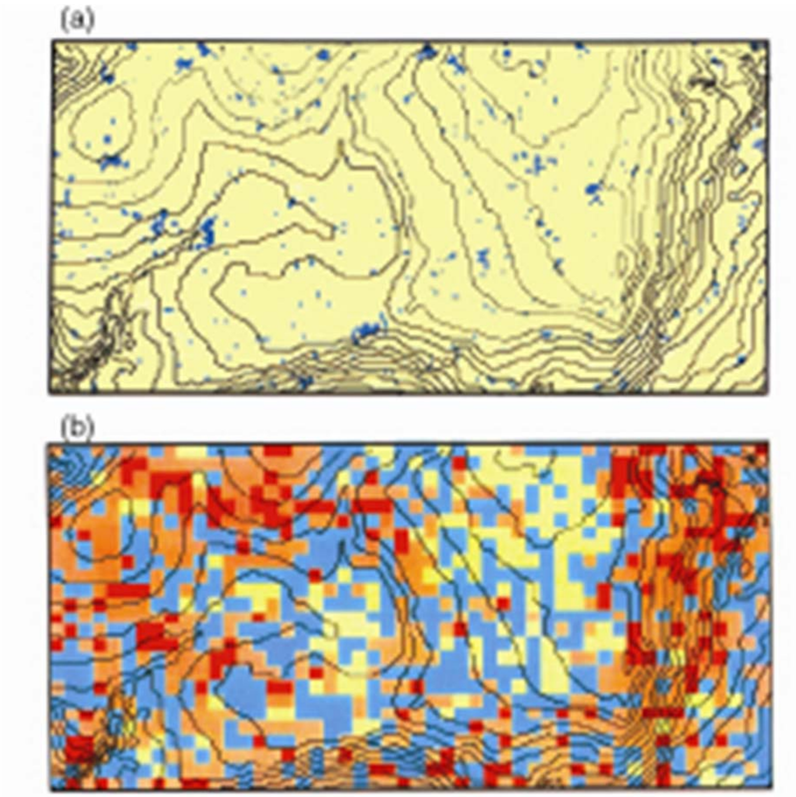
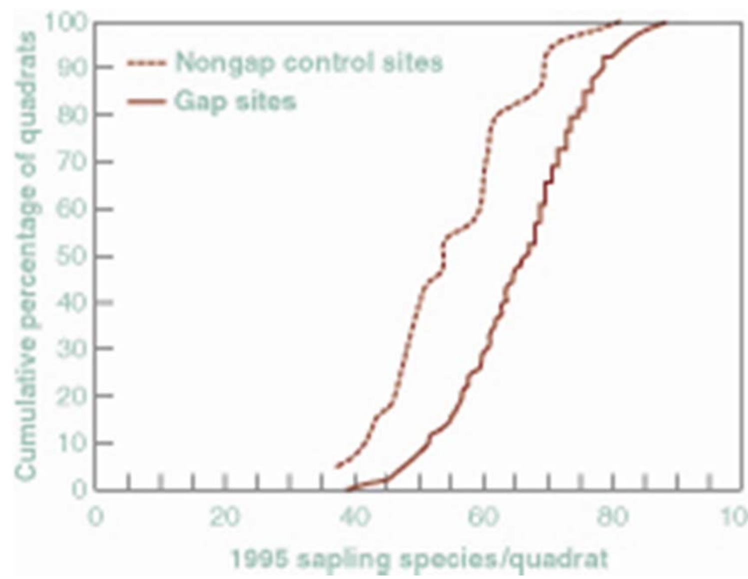


FIGURE 6-11

Distribution of light gaps and sapling species richness superimposed on a topographic map of the 50-hectare permanent forest plot on Barro Colorado Island (BCI), Panama. Contour intervals are 2 meters. (a) Distribution of light gaps in the 1983 canopy census. Each small square represents an area of 5 meters by 5 meters, the smallest gap censused. A *c*2 analysis between habitat type and gap abundance showed no correlation between gaps and topographic features of the plot in 1983 or in any later year. (b) Distribution of sapling species richness in the 20-meter by 20-meter quadrats in the 50-hectare BCI plot (1,250 total quadrats), showing the relationship between topography and species richness. Yellow: < 29 species per 400 square meters. Blue: 30 to 39 species per 400 square meters. Orange: 40 to 49 species per 400 square meters. Reddish orange: > 50 species per 400 square meters. The central plateau and the small seasonal swamp (center and left, respectively) have 22% to 64% fewer species than slope areas to the east, south, and west. Note the lack of correlation with the 1983 gap sites in (a). A similar lack of correlation between species richness and gap disturbances also exists in the other years.

FIGURE 6-12

Distribution of species richness per quadrat for all 20- by 20-meter quadrats containing 1983 gaps after 13 years (solid line) and for quadrats in nongap control areas that remained in mature, high-canopy forest over the entire 13-year period of the study (dashed line).



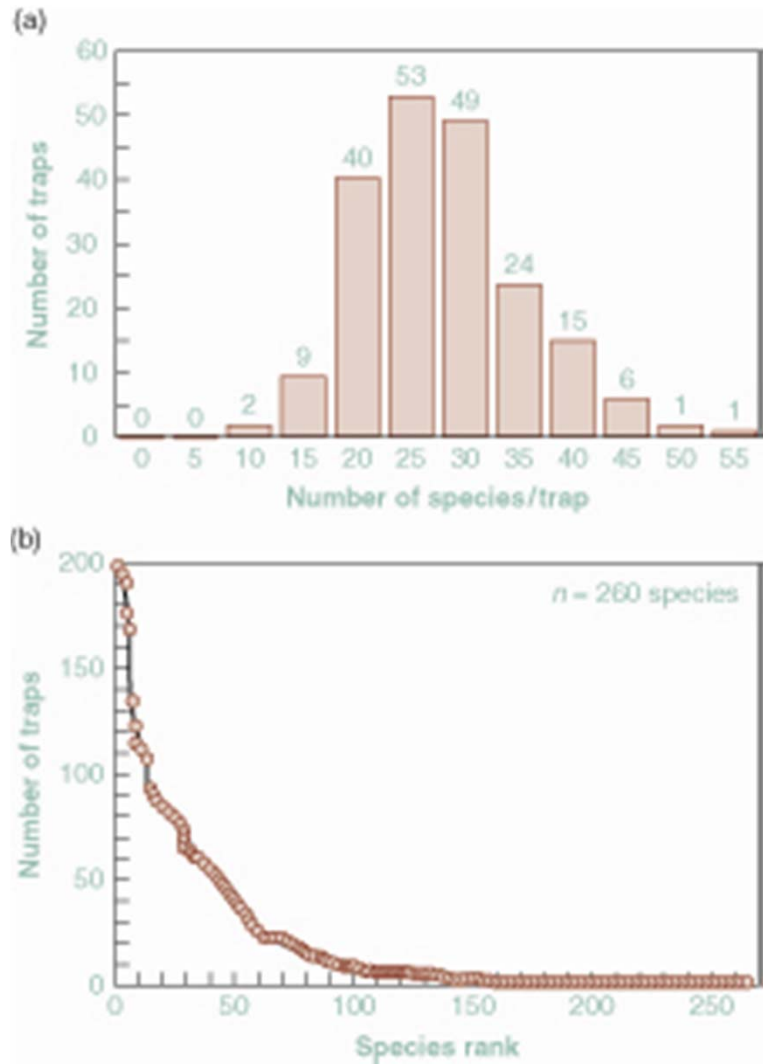


FIGURE 6-13

Evidence for dispersal limitation in BCI trees from a 10-year seed trap study using 200 traps in the 50-hectare plot. Seeds of a total of 260 species of the 314 species in the plot census were collected at least once. (a) Frequency distribution of the number of species captured per trap during the 10-year trapping period (1987–1996). The average number of species per trap was 30.8 ± 7.5 SD. (b) The total number of traps into which each species dispersed at least one seed during the 10-year trapping period.

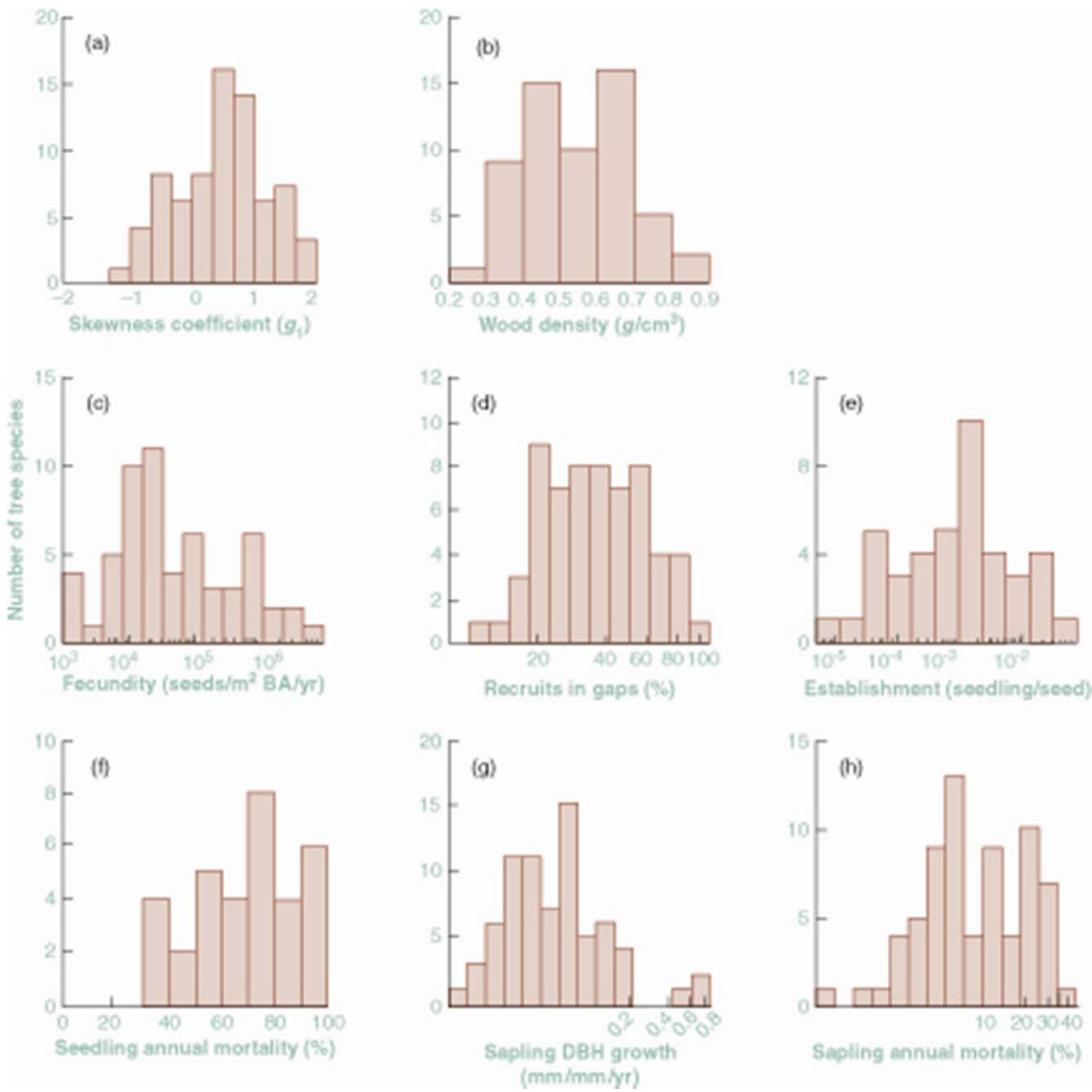


FIGURE 6–14

Frequency histograms for (a) the coefficient of skewness of the logarithm of DBH ($g1$); (b) wood density; (c) fecundity quantified as the number of seeds produced per square meter of basal area per year; (d) percentage of sapling recruits located in tree-fall gaps; (e) seed establishment probability; (f) first-year seedling mortality; (g) relative sapling DBH growth; and (h) sapling mortality for large canopy tree species from Barro Colorado Island, Panama. The distributions are approximately normal or log-normal. Note the *x*-axis log scales in panels c to e, g, and h.

PLATE 6-24

Palms are a common component of gaps in many tropical areas.

PLATE 6-25
DIPTERYX PANAMENSIS

PLATE 6-26

WHITE-LIPPED PECCARIES