13 ♦ BIOCLIMATIC TRANSECTS

[**INSTRUCTOR NOTE**: MAT for Kugluktuk in Table 13.5 should read –11.33. The equations in questions 5a, 5b, 7a, 7b, 13a, and 13b should have parentheses around the numerator contents and around the denominator contents. In addition, the vertical bars in the numerators and denominators should be minus signs.]

1. See Table 13.5.

TABLE 13.5 MID-CONTINENTAL LATITUDINAL TRANSECT BIOCLIMATIC CHARACTERISTICS

	Kugluktuk, Nunavut	Hay River, Northwest Territories	Williston, North Dakota	Concordia, Kansas	New Orleans, Louisiana	Merida, Yucatan
Latitude	68°N	61°N	48°N	40°N	30°N	21°N
Altitude (m)	22	166	549	454	1	22
MAT (°C)	–11.33	–3.92	4.83	12.00	20.58	25.83
P (mm)	238	326	358	677	1518	1586
T_B (°C)	2.08	4.50	8.08	12.25	20.58	25.83
PE (mm)	121.53	262.94	472.11	715.77	1202.49	1509.25
Holdridge ratio PE/P	0.51	0.81	1.32	1.06	0.79	0.95
Life Zone	tundra	forest	grassland	savanna	forest	forest or savanna
Map Community	tundra	forest	grassland	grassland	forest	savanna
Photograph Community	tundra	forest	grassland	grassland	forest	forest

2. a. West Coast 3 Mid-Continent 4

   b. West Coast: Manzanillo, Vancouver, Eureka (Figure 13.1 distinguishes forest from temperate rainforest).

   Mid-Continent: Concordia; Merida is borderline on the triangle, and it isn't clear from the map or photograph whether it's savanna or forest.

   c. Most of these sites fall at marginal life zone triangle positions near vegetation community boundaries.

3. a. Savanna, to desert beneath the subtropical high, to temperate rainforest, to forest.

   b. Savanna, to forest, to grassland, to forest, to tundra.

4. a. See Figure 13.5.

   b. See Figure 13.6.

FIGURE 13.5 RELATIONSHIP BETWEEN BIOTEMPERATURE AND LATITUDE

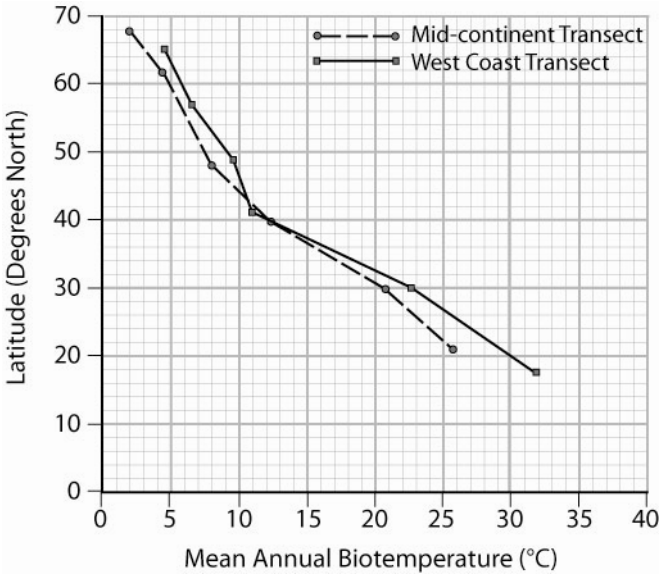
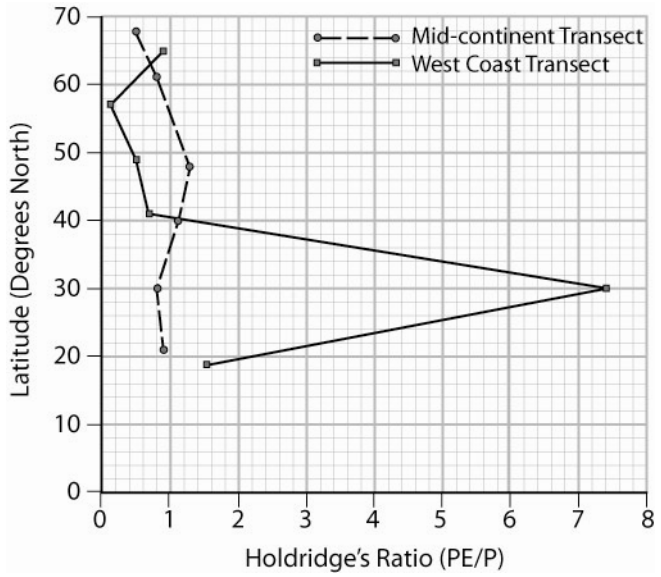


FIGURE 13.6 RELATIONSHIP BETWEEN HOLDRIDGE'S RATIO AND LATITUDE



5. a. $\frac{(2.08°C - 25.83°C)}{(68°lat - 21°lat)} = -0.51°C$ per 1°latitude

   b. $\frac{(4.92°C - 26.48°C)}{(65°lat - 19°lat)} = -0.47°C$ per 1°latitude

c. To the nearest 0.1, the T_B gradients decline identically for both latitudinal transects, so therefore we might conclude that continentality has no effect on T_B gradients. To the nearest 0.01, however, the mid-continent gradient is about 1/20 steeper than the west coast, so we might conclude that climatic moderation of marine west coasts slightly retards the gradient.

6. a. The west coast has warmer and/or longer growing seasons than do inland sites at comparable latitudes.

   b. In general, warmer and wetter conditions along the west coast results in more luxuriant vegetation than in the interior. The west coast exception is associated with the combination of subtropical high pressure cells and cold ocean currents (e.g. Rosario) which in combination with warmer biotemperatures produce drier conditions than in the mid-continent.

   c. Continentality – the mid-continental region is warmer in the summer than the west coast due to differences in heat capacity of land and water. In addition, greater cloudiness on the west coast decreases growing season temperatures, whereas less cloudy conditions at interior sites allow higher growing season temperatures.

7. a. $\frac{(-11.33°C - 25.83°C)}{(68°lat - 21°lat)} = -0.79°C$ per 1° latitude

   b. $\frac{(-3.21°C - 26.48°C)}{(65°lat - 19°lat)} = -0.63°C$ per 1° latitude

   c. The west coast has a smaller temperature gradient then the continental interior.

   d. Both T_B gradients are substantially less than the MAT gradients. As latitude increases, the annual temperature range increases, causing the MAT gradients to be larger than T_B gradients, which use only warm growing-season temperatures.

8. a. West coast locations are generally moister.

   b. West coast locations are generally drier.

   c. Wetter conditions at higher latitudes result from the westerlies bringing moist air, cyclones and fronts onshore, and from orographic uplift. Drier conditions at lower latitudes result from more stable atmospheric conditions due to the subtropical high pressure cells and cold ocean currents.

   d. Moisture doesn't vary much with latitude; it hovers around a ratio of 1.0, the boundary between wet and dry.

9. a. Holdridge's Ratio (PE/P)

   b. Biotemperature (T_B)

10. a. The west coast biotemperature is several degrees higher than the interior biotemperature at all locations except Eureka. Both transects show a similar inverse biotemperature gradient with latitude.

    b. The west coast Holdridge ratio generally shows moister conditions above 40°N compared to the mid-continent, and drier conditions below 40°N. The mid-continent transect has less variability and is drier than the west coast between 40°N and 60°N. Above 60°N the west coast transect is drier than the mid-continent.

c. Compared to the mid-continent, the west coast has denser forest vegetation above 30ºN, but sparser desert and savanna vegetation below 30ºN. The mid-continent transect shows greater variability in vegetation with latitude than the west coast transect.

11. a. 4

b. Boulder, Longmont

c. Marginal position in life zone graph; non-precipitation water sources, urban heat island. Possibly climatic change, but most likely human modifications. Humans have artificially diverted water from the nearby mountains onto the plains, and this supplement to the natural plains precipitation sustains the trees in Boulder and maintains the lake at Longmont. An additional factor might be "urban heat island" effect at Boulder, a city >100,000. Note that its MAT and T_B are warmer than Longmont's, despite a higher elevation.

12. a. Grassland up to about 1600 m elevation, forest between 1600 m and 3400 m, tundra above 3400 m.

b. Grassland – forest – forest – forest – forest – tundra

c. Yes. Presumably, temperature and growing season reduction with increasing latitude have a similar effect with gains of altitude, provided the changes in moisture are also consistent. [Note to instructor: Growing season day lengths ("photoperiod") lengthen as latitude increases but remain constant with altitude gains at a single latitude. Many plant species are quite sensitive to photoperiod triggers of growth functions, so we could expect some dissimilarity between higher latitudes and altitudes of biome composition and diversity.]

13. a. $\frac{-3.8ºC - 9.3ºC}{3743m - 1509m} = -0.0059ºC$ per 1 m altitude

b. $\frac{2.25ºC - 9.75ºC}{3743m - 1509m} = -0.0034ºC$ per 1 m altitude

14. a. $\frac{-0.79ºC/1ºlat}{-0.0059ºC/1m} = 134$ m/1ºlat

b. $\frac{-0.51ºC/1ºlat}{-0.0034ºC/1m} = 150$ m/1ºlat

c. Colorado latitude = 40ºN; Williston latitude = 48ºN; latitude difference = –8º
Tundra in Colorado occurs at ~3400 m. Since Williston is 8º north of Colorado, tundra will occur at a lower elevation than in Colorado. The elevation difference can be calculated using either MAT or T_B:
MAT = 134m/1ºlat × –8ºlat = –1072 m; tundra would be found at 3400m – 1072m = 2328 m
T_B = 150m/1ºlat × –8ºlat = –1200 m; tundra would be found at 3400m – 1200m = 2200 m.