

The Temperate Deciduous Forest Biome

In North America, the temperate deciduous forest occurs on the southeast edge of the boreal forest (see Figure 7-16, page 144). This biome is recognized by its temperate (moderate) climate and deciduous trees (Fig. 10-1). Deciduous trees drop their leaves in the winter. In Canada, only the most southern parts of Ontario, Québec, and the Maritimes are in this biome. However, as Figure 7-16 shows, most of the eastern half of the United States is in it.

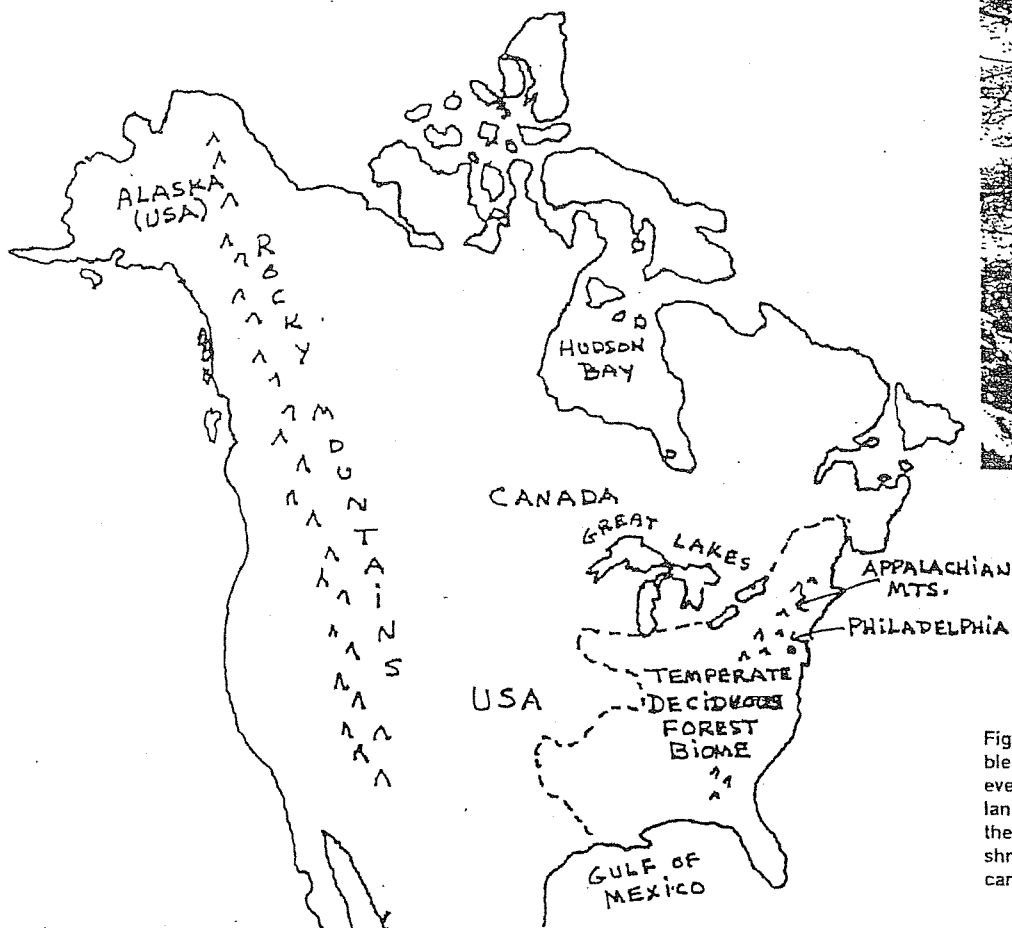
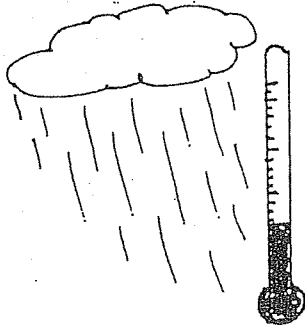


Fig. 10-1 This deciduous forest appears bleak in the winter. The occasional evergreen adds some green to the landscape (A). In the summer, however, the forest has an understory of green shrubs and saplings, shaded by a dense canopy of leaves (B).

Abiotic Factors

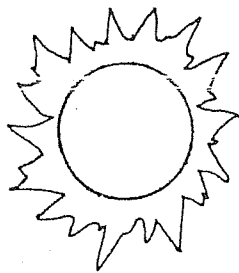
Climate



The temperate deciduous forest is found largely in the eastern half of our continent. There, the climate is moderate. The average annual precipitation varies from 75 to 125 cm. That is, moisture is abundant, but not excessive. (The Gulf states generally receive more precipitation—up to 150 cm a year.) Further, precipitation is fairly evenly distributed throughout the year. The winter snow is not as deep as that of the boreal forest. Nor does it stay as long.

The four seasons are well-developed. And the temperature gradually changes with the seasons. Temperatures are more moderate than those of the boreal forest. Average January temperatures range from -12°C in the north to 15°C in the south. And average July temperatures range from 21°C in the north to 27°C in the south. The growing season ranges from 4 to 6 months. During that time, the relative humidity is usually high.

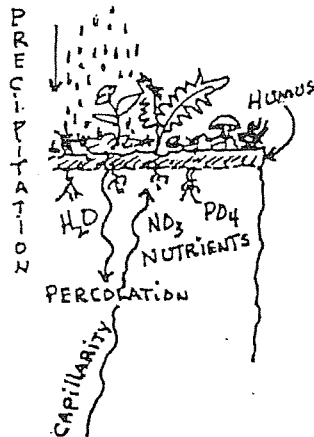
Light



This biome is closer to the equator than the boreal forest is. As a result, the average light intensity is higher. But the average photoperiod (length of daylight) is shorter.

Winters are shorter than in the boreal forest. But they are still long enough to greatly reduce photosynthesis and, as a result, growth rates. Deciduous trees enter a dormant period in the winter. During this period they shed leaves. One hectare of forest floor may be carpeted with more than 25 000 000 leaves each fall! (A hectare is about the area of two football fields.)

Soil



Fallen leaves and other organic matter decay quickly during the warm moist summer. This produces a nutrient-rich layer of soil called humus. Typical deciduous woodland soil is called "brown earth". It is formed where the downward drainage of rain water (percolation) is balanced by the upward movement of water (capillarity). Capillarity brings water to the surface to replace water which evaporates. As it does so, it brings nutrients to the surface. In other words, it brings up those nutrients that percolation tends to leach out of the soil. As a result, nutrients are circulated through the soil. They are not leached from it as they are in boreal soils.

Rocky areas and areas with porous soils tend to be much drier. Precipitation drains off quickly. Such areas do not usually have enough moisture to support deciduous trees. They will, however, grow conifers and shrubs. In some pockets of land, water movement is slow. Bogs may form in these areas.

Biotic Factors: Vegetation

At one time the eastern shore of this continent was a vast forest. It was so dense, legend says, that a squirrel could travel through the treetops from the Atlantic coast to the Mississippi River without ever having to set foot on the ground. But today only patches of that forest remain.

Because the soil is rich, much of this biome has been cleared for farming. And urbanization covers a fair portion of the cleared area. Small animals have adapted to live in small scattered woodlots. And some large herbivores like the whitetail deer thrive in this more open environment. But, generally, large carnivores do not. They have been wiped out or forced to retreat to a few remaining pockets of wilderness. Some, like the timber wolf, have retreated to the boreal forest.

Clearing this biome has greatly affected the nature of the life in it. But a wide and interesting variety of plants and animals still exists. Foremost among these are the trees. Let us first take a look at them.

There are three main types of deciduous forest in the temperate deciduous forest biome:

- northern hardwood forest
- central hardwood forest
- southeast pine-oak forest

The species present in each forest depend on the local climate.

The Northern Hardwood Forest

A northern hardwood forest occurs in the moister and cooler northern regions. It begins in southern Canada (specifically southern parts of Ontario, Québec, and the Maritimes). It extends south into the United States, covering the mountainous regions of New England and following the Appalachian Mountains south to North Carolina and Tennessee. It also spreads west in a belt under the Great Lakes from New York to Minnesota.

In the eastern part of the northern hardwood forest, the dominant species are sugar maple, beech, and yellow birch (Fig. 10-3). Black cherry, white ash, and red oak are also common. Hemlock, a conifer, is co-dominant in wet cool areas. And majestic white pines tower above the hardwoods in drier areas (Fig. 10-4). White pines used to be the most striking feature of this forest. But heavy logging has removed most of the large trees. And you know from your study of succession in Chapter 4 that pine cannot regenerate in the dense shade of trees like maple and beech. Moving west from western New York to southern Indiana, the northern hardwood forest is mainly a maple-beech forest. Maple-beech extends to parts of Illinois and central Minnesota. But from central Wisconsin and Minnesota south to Missouri, it is mainly a maple-basswood forest.



Fig. 10-3 Sugar maple and beech dominate the northern hardwood forest in many areas. The beech tree is the one with the smooth gray bark.



Fig. 10-4 White pine can often be seen towering above the deciduous trees.

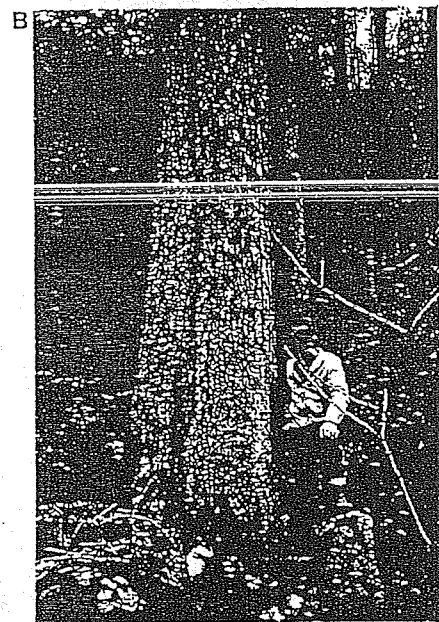


Fig. 10-5 Yellow poplar (A) and buckeye (B) dominate the cove hardwood forest.



The Central Hardwood Forest

South of the northern hardwood forest is the vast central hardwood forest. It occupies the central part of the temperate deciduous forest biome. This forest consists of three main types:

- cove hardwood forest
- pine-oak forest
- oak-hickory forest

Cove Hardwood Forest This forest occurs throughout the central region. But it is best developed in the deep mountain coves of the southern Appalachians. In Smoky Mountains National Park (in North Carolina and Tennessee) this forest ranks in majesty and beauty with the best on earth. It contains a wide variety of species, including most of those of the northern hardwood forest. But the dominant trees are towering yellow poplars and yellow buckeyes (Fig. 10-5).

Pine-Oak Forest This forest is found in drier upland regions of the central hardwood forest. It is dominated by a wide variety of oaks and pines. Among the oaks are red, white, chestnut, and scarlet oak. And among the pines are Virginia, pitch, shortleaf, and white pine. Several species of hickory also live here.

One of the most devastating ecological disasters of all time happened in the pine-oak forest. When the European settlers first moved into this area, one of the dominant trees was the American chestnut. It was one of the finest, most common, and most valuable of the native trees. Humans and many animals shared its nuts. And its timber was of top quality. But it was struck by a disease, the chestnut blight. This disease is caused by a parasitic fungus. It entered the United States before plant quarantine laws were enacted. It came from Asia about 1925 on plants closely related to chestnut. As is often the case with disease organisms, the blight was much more virulent in its new home than in its native land. In a matter of a decade or so, almost all the American chestnuts were dead. The last good crops of chestnuts were collected in the early 1930s. Today a few living trees still occur in isolated areas such as Ontario's Niagara Peninsula. But throughout the pine-oak forest, dead trunks still stand as reminders of this disaster (Fig. 10-6). No remedy has been found for chestnut blight. But resistant varieties of chestnut are being developed and planted.

Along streams and in wet valleys throughout both the pine-oak and cove hardwood forests, one finds cottonwoods, sycamore, elm, and willow. Elms are not as common as they used to be. Like the American chestnut, elms have been almost eliminated by a fungus which causes the Dutch elm disease. It, too, is an imported fungus. It has spread to elms throughout most of their range. It is carried from tree to tree by a beetle called the Japanese bark beetle. Specimen trees have been preserved in city parks by expensive treatments. But most trees die two or three years after they are attacked.

Oak-Hickory Forest This forest occurs along the western edge of the central hardwood forest. It dominates the Ozark Mountains of Missouri. And it follows the river valleys through the prairies.

Fig. 10-6 This chestnut has been dead for over 60 years. The high quality wood of this hardwood resists rotting.

The Southeast Pine-Oak Forest

This forest occupies the coastal plain from New Jersey south through the Atlantic states to the Gulf states. It occurs on sandy, well-drained soils. Such soils are nutrient-poor and low in water-holding capacity. Pines thrive in such an environment. As a result, they dominate this forest.

It may seem strange to you that we call this forest a deciduous forest when it is dominated by evergreens. Ecologists agree that the pines are just a successional stage. If cutting and fires are halted, the pines are usually replaced by deciduous trees. Oaks dominate, but hickories and magnolias are found in many areas.

Pitch, Virginia, and shortleaf pine dominate northern areas. Figure 10-7, photographed in the Pine Barrens of New Jersey, includes these species. Further south, shortleaf, longleaf, slash, and loblolly pine dominate (Fig. 10-8). These pines invade as far south as most of Florida and the Mississippi delta. But oaks and magnolias dominate the climax forest in most of the southern region.

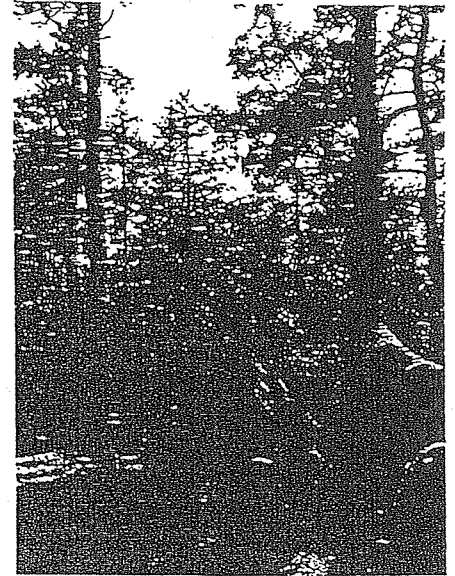


Fig. 10-7 Pines surround this campsite in the Pine Barrens of New Jersey. ...

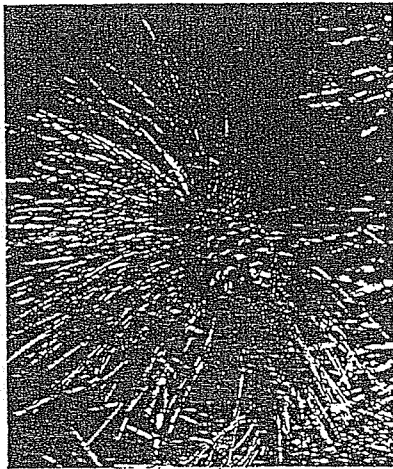


Fig. 10-8 Longleaf pine is easily identified. Its needles are up to 45 cm long! And its cones can reach 25 cm in length.



Fig. 10-9 How many strata (levels of vegetation) can you see in this deciduous forest?

Other Vegetation in the Deciduous Forest

The temperate deciduous forest has a long, warm growing season. It also has abundant moisture and rich soil. As a result, it supports a wide variety of other plant species in addition to trees. These species usually live in levels, or strata, in the forest (Fig. 10-9). The taller trees form the first stratum, or upper canopy. This canopy receives full exposure to the sun. The broad leaves permit maximum absorption of light energy. A small oak tree with a trunk diameter of 60 cm has more than 100 000 leaves. Their total surface area is about the size of two tennis courts!

Some sunlight filters through to the second stratum. This layer contains smaller "understory trees". Beneath these is the third stratum, a shrub layer. This layer includes shrubs and saplings. Saplings are young trees up to 3 or 4 m tall. And, finally, at ground level, the fourth stratum occurs. This ground layer consists of mosses, ferns, tree seedlings, and a wide variety of flowering plants.

When the sun is overhead, the ground layer in an oak forest receives only about 6% of the sunlight that strikes the upper canopy. At other times of day, it receives even less. As a result, the plants of the ground layer show many adaptations to low light intensity. Their leaves are generally quite broad. This allows them to capture extra energy. And the leaves are densely packed with chloroplasts. (You may have noticed that plants of the forest floor are dark green.) These extra chloroplasts promote additional photosynthesis.

If you have ever walked through the woods in the spring, you have seen another adaptation to low light intensity. While the trees are still dormant and leafless, the ground layer plants resume activity. They leaf out and begin to photosynthesize. While abundant light still reaches them, they store food in roots or underground stems. Much of their photosynthesis and flowering occurs in the short days of early spring. Once they have formed seeds, these plants become dormant until the following spring.

Why Deciduous Trees Drop Their Leaves

The Reason for Loss of Leaves Deciduous leaves are usually thin and delicate. They are easily injured by frost. Furthermore, they are easily dried out by winter winds. Therefore, even if they could remain on the trees undamaged during the winter, the frozen soil could not replace lost water. As a result, the leaves are shed in the fall. Photosynthesis ceases. And the trees live on food stored in roots, trunks, and branches.

How Loss of Leaves Occurs The falling temperatures and shorter days of autumn cause chemical changes in the leaves. These changes cause certain cells at the bases of the leaf petioles to separate from each other. (The separation takes place where the leaf petiole joins the leaf to the twig.) The leaves are now attached to the twigs only by their veins. They are easily knocked off by wind or rain. Where the petiole falls off, a layer of cork forms over the exposed stem. The cork prevents water loss. These corky areas form leaf scars. You have likely seen these on twigs in the winter (Fig. 10-12).

Spring Returns When the air gets warm enough, the trees resume activity. All deciduous trees are flowering plants. Some, like the maple, beech, and oak, form inconspicuous flowers. These trees depend on the wind to carry pollen from one tree to another. As a result, they usually flower before the trees completely leaf out. Then the wind can spread the pollen around more effectively. Other trees such as the yellow poplar and black cherry have brightly coloured fragrant flowers. These trees depend largely on insects for pollination.

The flowering of deciduous trees usually produces a bounty of seeds and fruits. As a result, a deciduous forest can support a wide variety of mammals and birds.

Why Leaves Change Colour

Deciduous trees in temperate climates often become brightly coloured before they drop their leaves. Why does this occur?

A leaf usually has many pigments, or colours, in it. Table 10-1 lists the names and colours of the main ones. Fall colours are caused partly by a loss of chlorophyll. This loss is triggered by falling temperatures. The cold nights of early autumn break down the chlorophyll. Now you can see the yellow and orange pigments which were masked by the green of the chlorophyll. They are responsible for the beauty of poplar (cottonwood), beech, and white birch

Table 10-1 Leaf Pigments

PIGMENT:	COLOR:
CHLOROPHYLL	GREEN
XANTHOPHYLLS	YELLOW
CAROTENES	ORANGE
ANTHOCYANIN	RED

leaves. The production of anthocyanin, a red pigment, is triggered by low temperatures. And it is greater when there are many cool sunny days. The leaves of maples, sumac, and poison ivy often turn brilliant red. This colour is due to an abundance of anthocyanin in the vacuoles of their leaf cells.

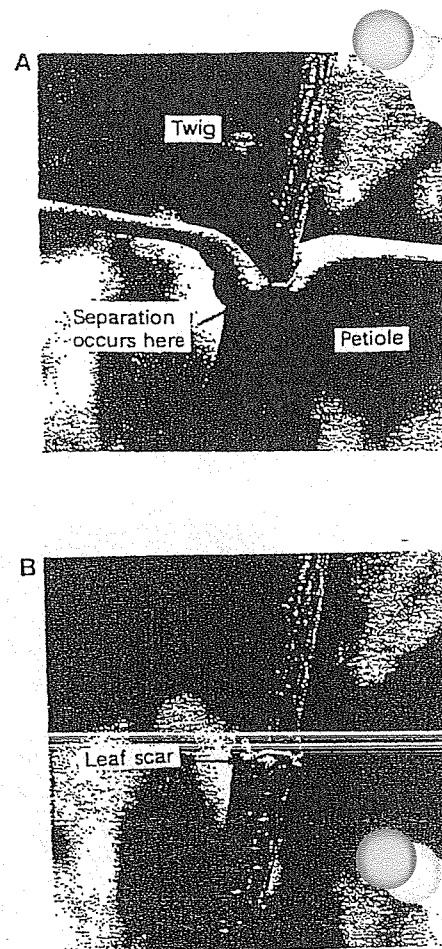


Fig. 10-12 When the petiole separates from a twig (A), a leaf scar forms (B).

The Low and High of Forest Activity

The bounty of food disappears with the coming of winter. Some birds, such as chickadees and nuthatches, remain in the forest. They eat insect pupas, insect eggs, and, in some cases, seeds. Specialized food preferences allow several wintering species to share the same area without competition.

Most birds, however, migrate to regions of insect activity. Amphibians and reptiles lapse into a hibernating coma. The tiny shrew, however, cannot afford to sleep through a single winter day. It must constantly find dormant insects in the soil litter to survive.

Forest activity reaches a peak during the spring and early summer. Most of the animals breed then. However, some, such as deer and bats, mate in the fall. Owls and some squirrels wait until winter. But at any time of year life is diverse and abundant in the deciduous forest. The interrelationships are complex. But the same principles which govern a simple biome like the tundra also govern this biome. We can use our knowledge of those principles to understand and protect the deciduous forest.

Human Impact on the Deciduous Forest

Present State of the Deciduous Forest

In the United States and Canada, large tracts of deciduous forest still exist. It is more common, however, to see this forest in countless small woodlots. Almost every farm has a woodlot. Logging removed most of the virgin forest long ago. Fires and clearing for agriculture and settlements destroyed still more forest. In fact, much of this biome looks more like a grasslands (Fig. 10-33). In many prime agricultural areas, less than 5% of the land remains forested.

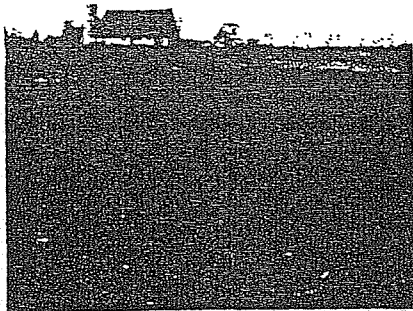


Fig. 10-33 A dense forest of deciduous trees once covered this land. Today, the rich soil formed by generations of trees grows food.

The rich soil formed by generations of trees makes this biome a prime agricultural area. However, large-scale agriculture has moved west. And agriculture in the east has gone into a slight decline. The best land in the east remains under cultivation. But the poorer land is being taken out of agriculture. Gradually this land is reverting back to forest. Close to urban areas, urbanites are buying up this land. Many plant trees on the land. Often, however, these trees are not native species. Therefore the forests may be a long time returning to their former state, if they ever do. But at least trees are being planted.

You learned in Chapter 9 that the demands for timber and other wood products will soon exceed the supply. This trend is encouraging the development of tree farms on abandoned farmland. These tree farms are under intensive management. In most cases, the objective of the owner is to make money. As a result, tree farms are often planted to a monoculture (one species). And they often specialize in fast-growing hybrid species. Again, this type of reforestation may not bring the deciduous forest back. But it is better than leaving marginal agricultural land bare.

Because of planting programs, forest is returning in parts of the deciduous forest biome. But urban sprawl and highways still destroy countless hectares each year. Clearing for agriculture still occurs. And strip mining threatens vast tracts of some of the most beautiful and diverse forest on earth—the southern Appalachians.

Importance of Woodlots

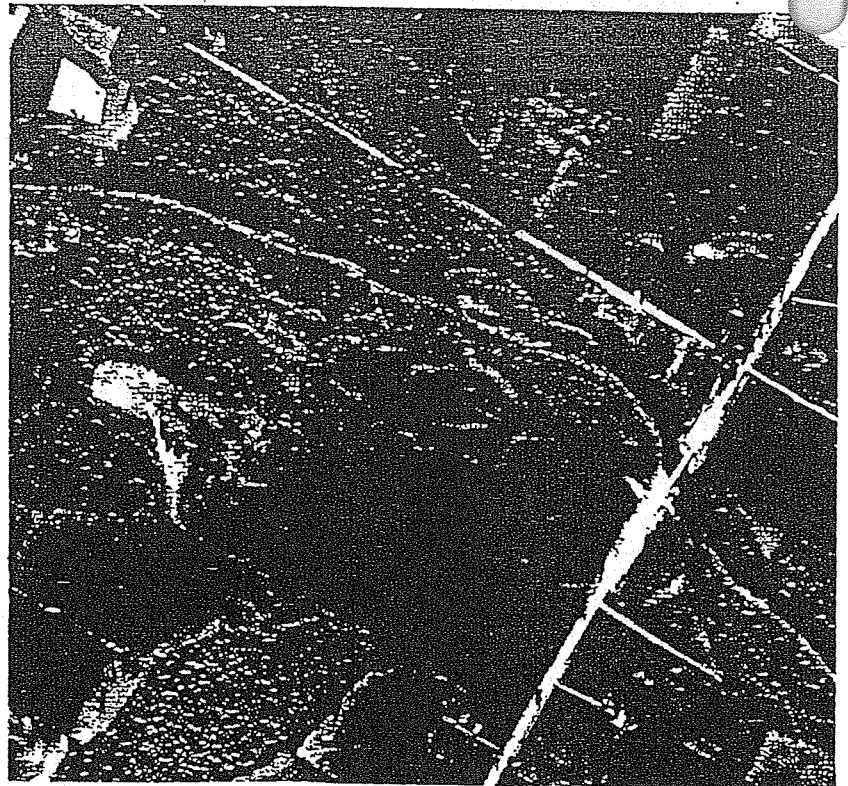
Numerous woodlots dot the deciduous forest biome. They are of great importance ecologically, economically, and socially. They provide wildlife habitat and soil protection. They act as ground water recharge areas. They help moderate climatic extremes. They are sources of wood and wood products. They are prime sites for recreation. And they add greatly to the beauty of the countryside. For these and other reasons, these woodlots must be protected and improved.

Because of poor management (often no management), these woodlots are not making the contribution they could make. Proper thinning could greatly increase timber production from these woodlots. In many areas, the woodlots need to be expanded to make a noticeable contribution. Extensive replanting needs to take place. For example, trees need to be planted along fencelines to protect crops and soil from the winds. And trees should be planted along all creeks and rivers to reduce erosion and increase water quality.

Modern forestry practices can create forests which benefit an area ecologically, economically, and socially. We simply need enough vision as a society to plan a few decades into the future.



This area has more forest than most parts of the deciduous forest biome. Trees still remain along the river and in farm woodlots. The rest, however, were cut many decades ago to create farmland.



SUPPLEMENTARY INFO FOR BOOKLET: "THE TEMPERATE DECIDUOUS FOREST"

CLIMATE

_____ and _____ determine the major types of terrestrial ecosystems, or _____.

	AVG. TEMPERATURES	Northern Region	Southern Region
* TEMP. CONVERSION:			
JAN		$^{\circ}\text{F} / -12^{\circ}\text{C}$	$^{\circ}\text{F} / 15^{\circ}\text{C}$
JUL		$^{\circ}\text{F} / 21^{\circ}\text{C}$	$^{\circ}\text{F} / 27^{\circ}\text{C}$
$^{\circ}\text{C} = (^{\circ}\text{F} - 32) \div 1.8$			
$^{\circ}\text{F} = (^{\circ}\text{C} \times 1.8) + 32$			
	AVG. TOTAL RAINFALL PER YEAR	_____ in.	Entire Biome
		_____ in.	Locally (S.E. Penna.)

* 1.0 in. = 2.54 cm.

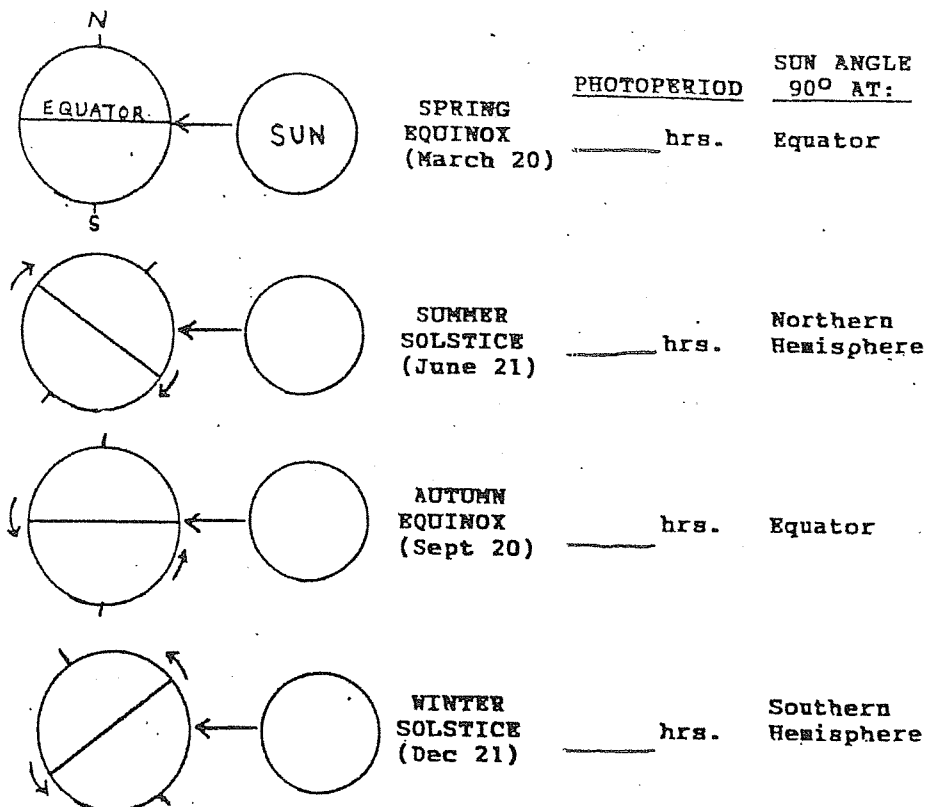
NOTE: The total amount of rainfall in this is distributed _____ throughout the year.

GROWING SEASON (Locally) _____ Last Frost _____ First Frost _____
 (*6 months/approx. 180 days)

SEASONAL CHANGE

The 4 distinct seasons in the temperate deciduous forest are the result of the changing _____ throughout the year in relation to the earth's surface, causing temperatures to increase and decrease seasonally. During its yearly journey around the sun, the earth is tipped _____ toward and away from the direct rays.

FILL IN NORTH + SOUTH AXIS ON EACH EARTH & NOTE POSITION



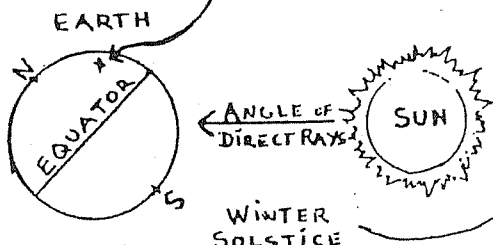
PHOTOPERIOD RECORD

DEC 1997--JAN 1998
(Phila., PA)

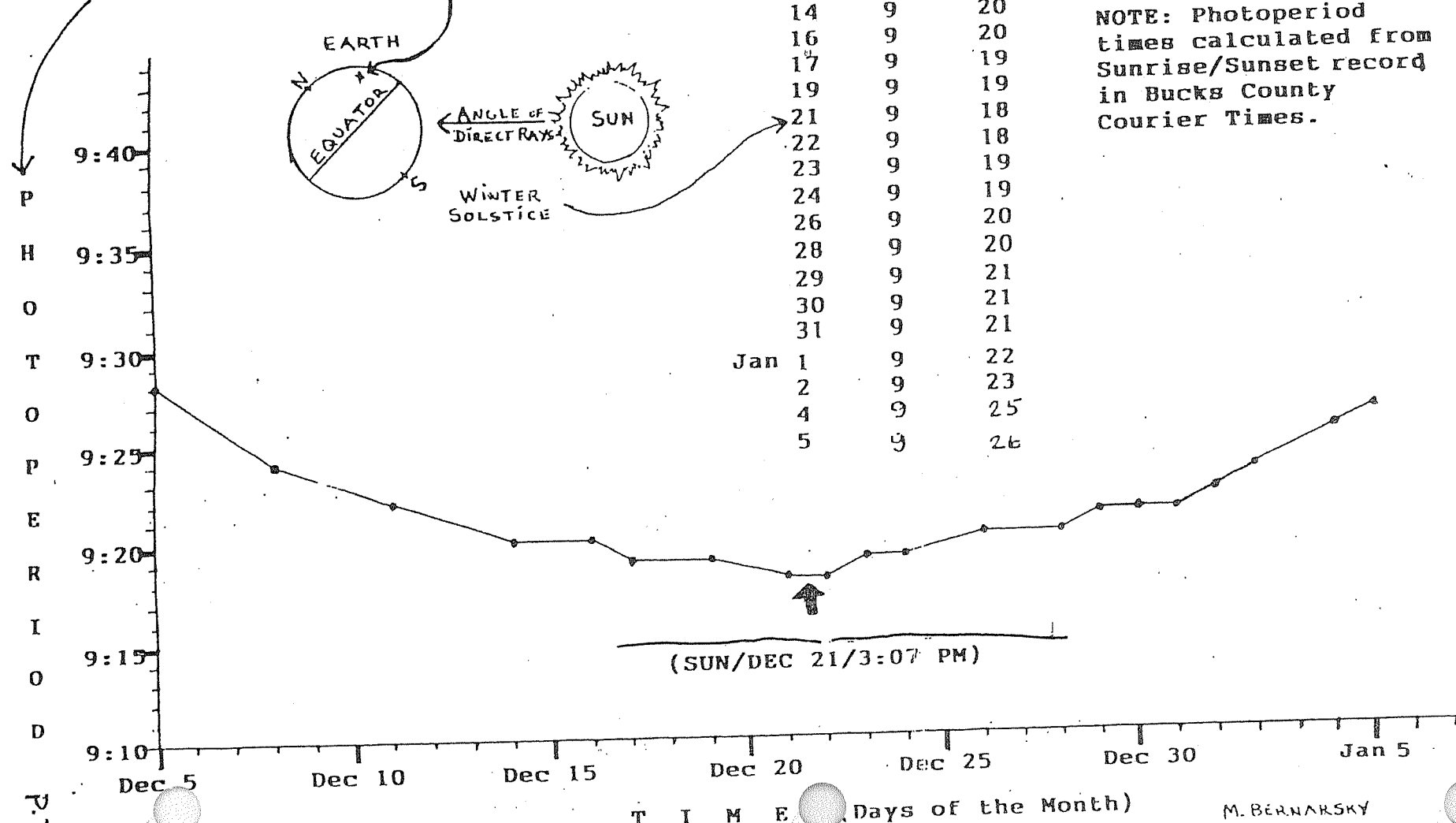
DATE PHOTOPERIOD
Hours Minutes

Dec 5	9	28
8	9	24
11	9	22
14	9	20
16	9	20
17	9	19
19	9	19
21	9	18
22	9	18
23	9	19
24	9	19
26	9	20
28	9	20
29	9	21
30	9	21
31	9	21
Jan 1	9	22
2	9	23
4	9	25
5	9	26

NOTE: Photoperiod times calculated from Sunrise/Sunset record in Bucks County Courier Times.

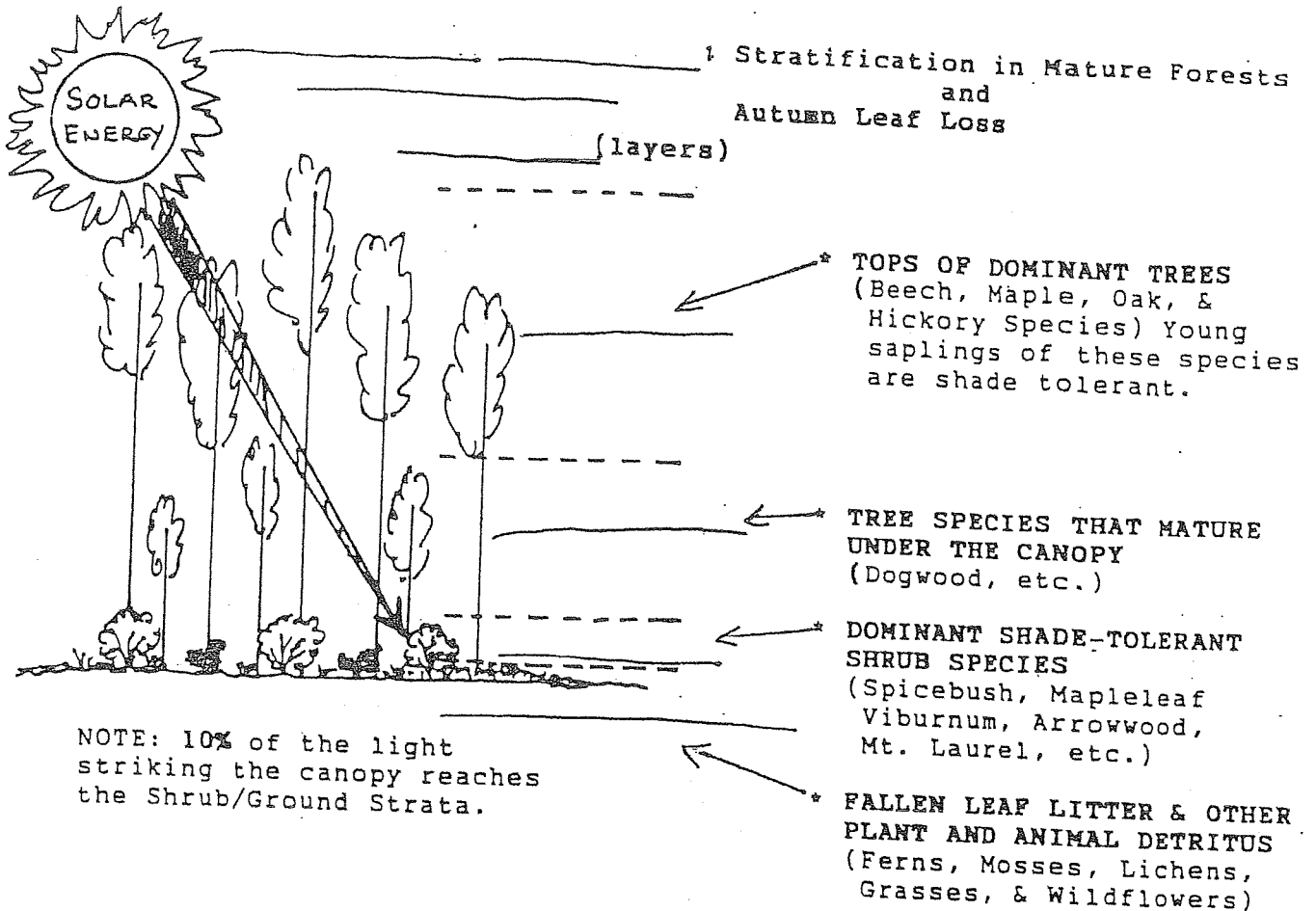


OF HRS./MIN.
OF SUNLIGHT



T I M E Days of the Month)

M. BERNARSKY



Deciduous trees lose their leaves in Autumn in response to the shortening length of the daylight period, or **PHOTOPERIOD**. In early fall, a corky layer (abscission layer) forms where the leaf stalk meets the branch. This blocks the materials needed for the production of chlorophyll in the leaf. The chlorophyll fades and the fall colors appear (carotenoids & xanthophylls).

The reason for leaf loss is because trees in Spring and Summer draw water from the soil, and lose it to the atmosphere by a process called **TRANSPIRATION**. Water is unavailable to the tree in winter due to frozen soil. Thus the leaves are dropped to prevent dehydration in the tree during the winter "drought" period, and the trees enter a period of **DORMANCY**.

NOTE: Woodland flowers bloom in Spring before light is blocked by the canopy.)

