Three layers of green in the Madison School Forest.

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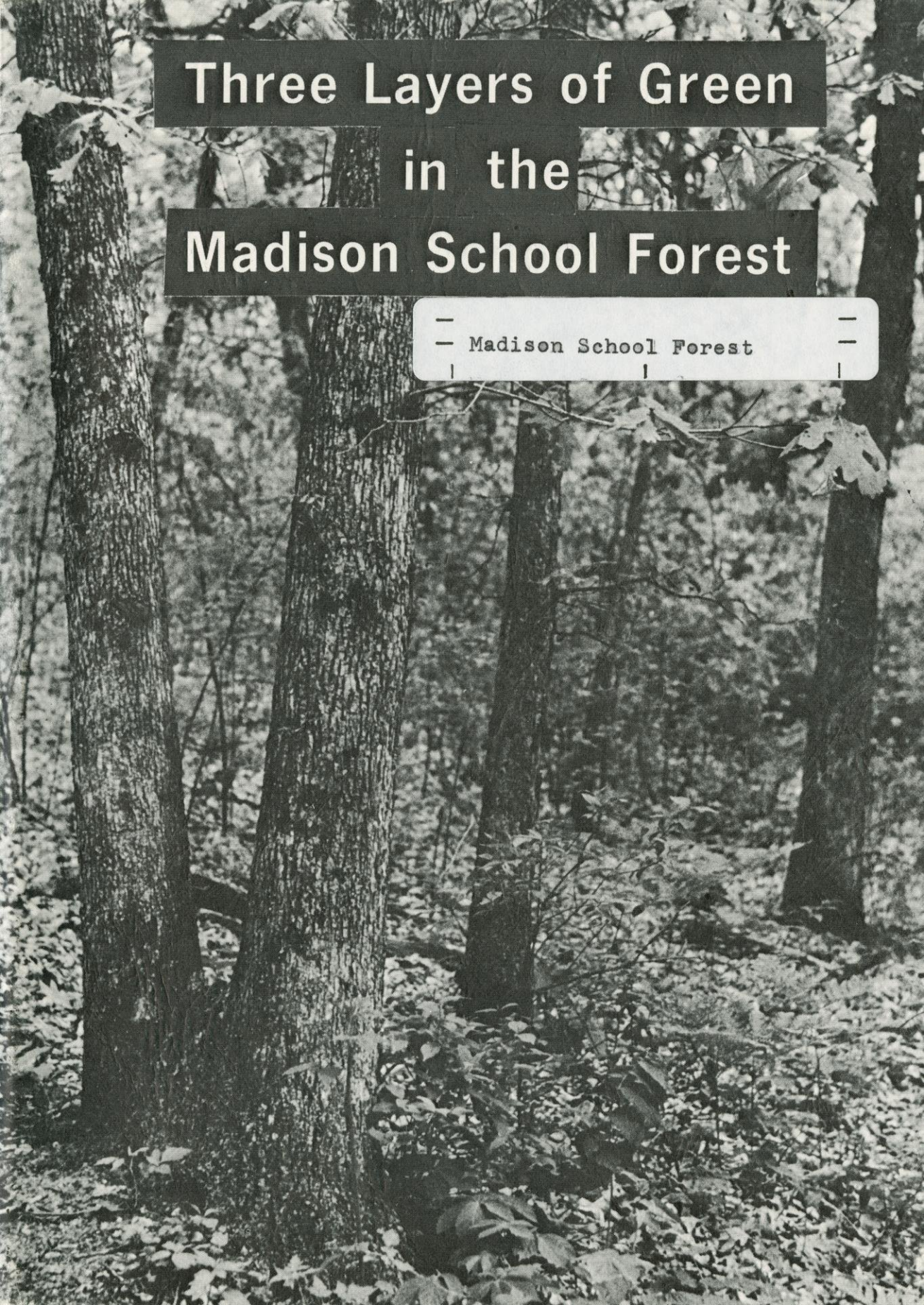
Three Layers of Green
in the
Madison School Forest
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"THREE LAYERS OF GREEN IN THE MADISON SCHOOL FOREST"

SECTION I: Teacher Information

SECTION II: Teacher Reference for Two Filmstrips

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OBJECTIVES OF
"THREE LAYERS OF GREEN IN THE MADISON SCHOOL FOREST"

These materials introduce the student to the idea of a natural community, in this case an oak forest. Important producers (green plants) are identified in each layer of the forest: canopy layer, shrub layer, herb layer. Interrelationships between the plants and animals of the forest are stressed.

It is planned that the student will not only become familiar with the main plants of the forest, but even more important, will develop an awareness of the interdependence of living things.

Increased awareness can lead to greater enjoyment in the out-of-doors as well as to responsible attitudes toward conservation of our natural resources. If our efforts in this area result in a few more young people choosing fields related to ecology, well and good. But of greater importance will be the development of attitudes of environmental awareness and concern in the young people who will choose other fields — the doctors, craftsmen, businessmen, homemakers, teachers, artists, legislators of the future. In their hands will lie the decisions affecting our land. Their attitudes may mean the difference between destruction and preservation, between exploitation and conservation — perhaps between a land barely habitable and a land worth inhabiting.

SUGGESTED USES FOR MATERIALS

The materials will be especially useful to classes planning a trip to the Madison School Forest (or other available oak forest), both as a preview and follow-up activity.

The slides and scripts are divided into Part I (introduction and canopy layer) and Part II (shrub and herb layers). The two parts are best presented on separate days, allowing time for discussion.

The class might also explore a different natural community such as marsh, northern forest, or prairie. While the plants and animals vary in different communities, many of the same interrelationships can be observed, thus reinforcing the idea of the interdependence of living things.

Comparison of a natural community to a man-maintained community is a good discussion topic. Some ideas for such a discussion are listed in this guide, page 45.

Source: Madison School Forest

Chapter 4 - The Natural Area

Half of this forest will be left unmanaged, undisturbed, and reserved for study. The map of the forest on the inside cover shows this area and the trails which have been established so far to guide you through the forest. The idea of keeping some land in a "natural state" is a growing one. Besides the unique recreational value of wilderness, it is now realized that nature was the source of all we know and still has much to teach. To alter the last tiny fragments now remaining of prairie, forest and wetland may be to destroy forever certain clues to the future as well as the past.

The Natural Communities of Southern Wisconsin

A natural community differs from a garden or a zoo, or a farm or a managed woodlot; it is formed and maintained all by itself. It includes those plants and animals which can survive in a certain habitat - that is, that require or at least tolerate its climate, soil and moisture conditions. But these plants and animals must be also able to get along together without the help of a caretaker. In southern Wisconsin most of the wild communities may be grouped under the following nine headings:

A. Lowland Communities

1. Cat-tail - Duck Potato Marsh: quiet shallow water, abundant producer of frogs, waterfowl and muskrats.

2. Sphagnum - Tamarack Bog: fabulous floating gardens with Owls, orchids, insectivorous plants - often ringed with a moat and a hedge of Poison Sumac.

3. Sedge - Bluejoint Meadow; hummocky home of Marsh Hawks and Mice and source of mint-fragrant marsh hay.

4. River floodplain Forest: mosquitoey jungles of Elm and Silver Maple hung with Poison Ivy, our last real wilderness - rich in birds and all wildlife.

B. Upland Communities

5. Prairie: our richest and most colorful flora amid man-tall Bluestem and Indian Grass - now nearly extinct because prairie soil is best for crops.

6. Sugar Maple-Basswood - Elm Forest: stately trees above a dark and shrubless floor - famous for fall color and dense carpets of brief spring wildflowers.

7. Oak Forest: sturdy nut trees, squirrels, brambles and burs. The Madison School Forest is one of the finest and largest Oak stands.

C. Weedy Communities

8. Kentucky Bluegrass: dense sod, as in prairie, but much quicker to get started and with fewer associated plants - lawns, fields, roadsides, pastures and meadows.

9. Short-lived Weeds: still quicker to invade bare ground and just as quickly invaded in turn by grass, but maintained wherever soil disturbance is repeated (cultivation, erosion, etc.) as in our parking lots and paths.

Each of these communities consists of from 50 to 300 kinds of wild plants and their associated birds, mammals, insects and lower forms of life. The first six communities are rare today - having succumbed to plowing, pasturing or changes in drainage. The last three (including our forest) have benefited from man's activities in one way or another and are today more abundant than they were a century ago.

Structure and Composition of an Oak Forest

Because Oaks cast less shade than most trees, Oak Woods have a well developed shrub layer. Thus, the plants may be grouped into three layers or stories:

1. The CANOPY or dominant tree layer including four kinds of Oaks - Bur, White, Red, and Black Oaks. With these Oaks one almost always finds Shagbark Hickory and Wild Black Cherry, and, on the edge, Quaking Aspen.

2. The UNDERSTORY or shrub layer which includes some saplings and the following characteristic shrubs: Blackberry, Chokecherry, Gooseberry, Hazelnut, Gray Dogwood, Nannyberry and Wild Plum. Others such as Crab and Sumac prefer the edge. Several woody vines are also present such as Grape and Bittersweet.

3. The GROUND COVER or herb layer including many plants. The sixteen most important species on the combined basis of both presence and abundance in Wisconsin Oak stands are:

Pennsylvania Sedge
Enchanter's Nightshade
Woodland Tick-Trefoil
Bedstraws (elegant, sweet-scented, and annual)
Wild Geranium
Sweet Cicely (two varieties)
Hog Peanut
Lopseed
Greater False Solomon's Seal
Wild Sarsaparilla
Bracken Fern
Poison Ivy
Woodbine

Poison Ivy and Woodbine are really woody vines but they seldom climb. Over 40 other herbs - from Arrowleaf Aster to Woodland Blue Violet - are common members of the Oak Forest. Most of these you will find illustrated and discussed in the chapter on plants of the forest.

Animal Life in Relation to the Three Storied Plant Layers

Each plant layer has its special animal life. Cicadas and Flycatchers prefer the treetops, Tree Crickets and Catbirds the shrubs, and oven birds and Ground Beetles prefer the leafy forest floor.

However, most animals use several layers or even several plant communities. Most birds sing higher than they feed, and nest in between. Many insects spend their larval or "eating" stage low and then fly, mate or sing high. Indigo Buntings nest in Blackberries in an opening but sing from high in the trees. Even small animals may use entirely different communities in their life cycle, such as the wood-boring beetles that feed as adults on the flowers of prairie and weed plants. Thus you can see the importance of diversified plant cover (a high ratio of edge to total area) for the maximum production of wildlife. For example, this forest is large enough to demonstrate that fewer kinds of birds nest in its interior than near its margins or openings.

However There is a Need for Large Blocks, Too

On the other hand, wildness is important to certain species. Placing a field in the forest's center would probably increase the Buntings, Thrashers, Flickers, Blue Jays, Cardinals, Catbirds and Towhees but probably decrease the Ruffed Grouse, Vireos, Thrushes, Whip-poor-Wills, oven-birds and Tanagers. These latter birds seem to require the seclusion of large areas of forest. Thus, there are psychological and behavioral requirements of animal species quite independent of plant cover which help to determine suitable habitat and thus abundance.

Ecology of the Oak Forest

Even what little is known about the ecology of the Oak community would fill several books. The following headings, which will be discussed in some detail, suggest a few approaches worth further study in a "natural" forest. These major headings or problems will be:

1. The Problem of Soil Fertility
2. The Problem of Shade
3. The Problem of Erosion
4. The Problem of Seedling Survival
5. The Problem of Community Permanence

Soil Fertility and Tick-Trefoil

Ecologists use the word community because there are some parallels between natural plant and animal groups and our society. For example, the Woodland Tick-Trefoil sells insurance.

But to back up a bit - Nitrogen is an essential component of all living cells. Most of the world's nitrogen is found in the air about us - 80% nitrogen gas. As a free gas in the air nitrogen does little good for plants or animals. Animals can get their nitrogen by eating the protein built by plants, but green plants must get their nitrogen in the form of nitrate ions and sometimes ammonium ions largely in water solution from the soil. These nitrate ions are seldom abundant in the soil because they are readily water-soluble and wash away. Their chief source in the soil is from the gradual decomposition of organic matter - dead leaves, stems, bark, roots, and fecal material - which beetle and worms work into the soil.

Very important in the nitrogen cycle are bacteria which live on organic matter and comprise the nitrogen bank. Plants withdraw nitrate savings each year and by causing its decomposition or decay, release nitrates from this nitrogen bank. But, the bacteria are careless tellers in the nitrogen bank and sometimes hand out more nitrates than are requested. The excess is then leached out by rains.

There are as well occasional large thefts by bank robbers - fires which convert the organic-stored nitrogen back to nitrogen gas. There are also "embezzlers"- bacteria which use up nitrates for themselves or convert some of it back to freely escaping nitrogen gas.

Three Forms of Nitrogen Insurance

Fortunately there are three kinds of insurance companies which operate to restore the nitrogen bank's balance. First, there is the occasional lightning

bolt which converts a little nitrogen gas to nitrates. Secondly, some bacteria in the soil are able to make their living by converting nitrogen gas into nitrates.

Thirdly, another group of bacteria which must live as parasites on the roots of certain plants (usually legumes) can also utilize and convert nitrogen gas directly. These parasites thug give their hosts an added source of nitrogen in exchange for some of the sugar made by the legume plant. Hence, for a given amount of plant body the legumes put back into the soil more nitrogen than they withdraw.

Woodland Tick-Trefoil is the only important perennial legume in the Oak forest. The annual dying back of Tick-Trefoil leaves and rootlets, like plowed-under alfalfa and clover, greatly enriches the nitrogen bank. Similar legumes are common among the weed and prairie communities, but only a few species of legumes have become able to survive the forest's shade.

Hog Peanut, an annual forest legume, is also a very important nitrogen insurance agent. This is especially true because of the mobility of this plant which enables it to invade burns and other openings quite quickly. Also, it releases all of its nitrogen every year and thus in two ways boosts the soil fertility just at the times and places of most rapid forest growth.

Still another nitrogen insurance agent is Naked Tick-Trefoil. This is a much less common legume but it is locally quite abundant in our forest. Because much of our forest has light, sandy soil, it is fortunate that this plant is here to help in the nitrogen supply.

Two of the prairie plants here also harbor the nitrogen-fixing bacteria. Both Lead Plant and New Jersey Tea (which is not a legume) help to add to the nitrogen total but they do poorly in the shade and must be considered unreliable insurance agents in the forest.

The Problem of Shade

Few problems below the canopy of a forest compare with the overwhelming problem of shade. In addition to the building materials for growth - carbon dioxide from the air, water and some 15 minerals from the soil - energy must come from the sky in the form of light.

In the open, productivity of plants may be held back by lack of minerals, or water, or oxygen in the soil, or by the limited amount of carbon dioxide in the air - but light is always sufficient. Under the trees, however, plants are almost always hindered by the extreme scarcity of light.

So serious is this scarcity of light in the forest that seldom will the improving of any other factor alone give much help to any of the plants below the canopy trees. How, then, have forest plants been able to adapt themselves for survival in shade?

Survival in the Shade - Technique 1 - Leaf Size and Exposure

In general, all plants can and do respond to shading by developing broader, thinner, darker green leaves and holding them more horizontally. In so doing they expose a maximum amount of chlorophyll per unit of area to such sunlight as penetrates to them. This response of leaf size and position can be seen by comparing the same plant grown in sun and in shade, or indoors and outdoors, or leaves from the top or bottom branches of the same tree.

Within limits then, this behavior enables every plant to make best use of the available light. There is, however, also a dilemma - the same dilemma that has faced plants ever since they left the sea. The more surface you expose to absorb light and carbon dioxide the more water you will lose to the air through transpiration. Thus, land plants could not be really successful until they developed a waxy coating to conserve water (and incidentally permit pupils to polish apples). But, wax can reduce or keep out the needed carbon dioxide and oxygen too - hence, a further invention, the ingenious valves (stomata) which can be closed when the plant is losing more water than the roots can replenish. Thus, the amount of leaf surface that a plant body can risk to exposure is limited by the fact that some water is always lost to the air through both the "valves" and wax.

"Microclimate"

The silver lining for plants living in the shade is that the "microclimate", the special conditions on the forest floor or at least below the canopy, includes "air-conditioning". That is, because of the shady tree cover it is cooler, more moist and less windy. This permits plants to increase the surface of leaves as well as cut down on light-absorbing devices for protection against too much sunlight. This greater sensitivity which develops in shade-grown leaves may be demonstrated by moving a potted plant out of the shade or by observing the ground plants where trees are cut in the summer. The formerly shaded leaves will now wilt, curl up or may even turn yellow or brown.

Technique No. 2 - "Grow Tall"

The Brambles and such herbs as Woodland Lettuce and Joe-Pye-Weed have another technique - they quickly shoot up and grow taller than other herbs and even some shrubs. So does the huge bush-like Spikenard. Thus, these plants place themselves above other herbs and in a more favorable position to receive what light there is.

The annual Hog Peanut takes the same plan by climbing on other plants and in effect borrows their cellulose for support while putting its own energy into seeds to give its offspring a rapid growth habit next spring. The Bedstraws borrow support by sticking to other plants with their rough hairs.

Technique No. 3 - "Keep Moving"

The long-runner habit is found in 14 of the 23 shrubs and in 17 of the 64 woodland herbs and also in 10 of the 23 prairie herbs illustrated for this forest. Runners are useful in reproduction anywhere but certainly there is a special value in the ability to explore new areas of the forest floor. Plants with the runner habit are able to move, to seek out bare spots which admit more light, as well as to escape from areas too thickly crowded by other plants.

The runner plants continually play a game of free-for-all tag with each other. For this purpose runners are superior to seeds since seeds have less stored food to draw on in getting through the leaf litter and avoiding other plants. It is also true that seeds do not find favorable moisture conditions every year.

Technique No. 4 - "Escapers"

Another mechanism of living with shade is to escape it - that is to modify the growth pattern to a period before the forest comes into leaf and hence into shade.

Most forest plants come up and flower early in contrast to the late and gradual development of prairie plants (where shade is no problem). The very best shade escapers are those that beat the trees into leaf, like Spring Beauty, Toothwort, Dutchmans Breeches, Fawn Lily, Wild Leek and Floerkea, and then show "fall" color and go underground in late May. These are Maple forest plants called "Spring Ephemerals" but in the Oak forest Wood Anemone and Shooting Star behave similarly and by late summer several others have withered - such as Sweet Cicely and Jack in the Pulpit. The advantage of this habit, shrewdly put: if little food can be made during the shady summer, why bother to feed a full set of leaves?

In addition to Spring growth, some, like Sweet Cicely, Waterleaf, and Honewort send up a second set of leaves in September to catch a little sun shine after the leaves of most trees and shrubs have fallen. Annual Bedstraw, small-flowered Crowfoot and White Avens germinate in September and thus likewise make most of their food in shade-free October and before late May.

How the Escapers Do It

Early Spring development requires rapid growth at low temperatures. This is achieved through (a) pre-formation of leaves and flowers during the previous summer, (b) storing of food for quick growth in enlarged underground stems (bulbs, rhizomes, tubers, and thickened roots) and (c) a considerable use of water rather than cellulose in support. Thus, with water cheap, especially in the spring, and cellulose always more expensive or at least slower from hard-won sugar (made in sunlight), these plants can get an early jump and then quit for the year.

Instead of being thick-walled and rigid bricks, the cells of these plants in the spring are more like balloons, owing their firmness to water pressure within. This is why Spring wildflowers wilt soon after being picked.

A disadvantage to the watery growth is the ease with which forest herbs are crushed by the foot. The need for pre-formation of next year's shoots and the need to store every bit of Spring-made food for these new buds means that the plant cannot afford the additional food needed for regrowth if it is trampled, browzed by cattle or picked. In that event, the plant must simply wait another year when it can only send up a weaker, smaller shoot from its small reserve of food.

Technique No. 5 - Slow Growth or "Take It Easy" - The "Endurers"

All "closed communities", plant groups that live together for long periods in crowded conditions, show slow growth habits.

Compare a weedy type of plant, Corn, with an Enchanter's Nightshade. In 90 days a corn plant may produce 500 starch-packed kernels while in the same time the Nightshade has formed but three white tubers the size of a corn kernel. Each plant is geared to its habitual growth rate - the corn won't form a single kernel in the shade; it is fast or nothing. Forest plants, even when they can get all the light they want, still won't produce much more, setting perhaps ten tubers and twenty seeds per stem. It is not surprising that most forest plants take 3 - 10 years from seed to first flowering. They survive because they refuse to be in a hurry.

Insects Know This Too

The final proof is to look for insects - the second link in the food chain. In grassland you will find them everywhere. In the forest a few are visible on saplings, shrubs and herbs but not very many - there is not much food here. To find forest insects you must go where the bulk of the forest's annual crop is - the treetops, the fallen leaves and the dead wood.

Trees and Shade

Lordly trees have their shade problems too. Even the shade-tolerant species - Sugar Maple, Elm, Basswood, Ash, Yellow Bud Hickory, Butternut, Walnut and Cherry - make best growth in the sun. Some of them may germinate better, however, in the shadier, moister forest conditions. By observing Cherry or Maple saplings you may note that growth in height may be as little as an inch a year in shade and as much as two feet in the sun.

Thus, trees can, if need be, adopt the "no hurry" philosophy of the forest herbs - apparently barely staying alive while waiting for a taller, older tree to die. At that time the trees shift over to the "in a hurry" pattern of the corn plant. This story of sudden, "released" growth can be read in the annual rings

of many a stump of a forest grown tree - first narrow, then suddenly wider. Blackberries and most shrubs likewise show their preference for more light by becoming a veritable jungle where the forest is opened up by cutting.

In contrast to the shade-tolerant trees, the Pines, the Oaks, and Aspens tolerate little shade and suppression. They characterize the early stages of the plant succession, pioneering in open places, for they cannot wait too long - they must have light fairly soon or else. Shagbark Hickory and Wild Black Cherry often invade open grassland as pioneers but they also can tolerate suppression in shade up to a point; they seem to be more versatile than other trees.

The Problem of Erosion

But the forest has other problems besides that of shade - and in fact the problem of erosion is made more difficult in the forest because of shade. Erosion is hard enough to stop anywhere when once started, but in a forest it is next to impossible to control.

Most importantly, no sod-forming plants are shade tolerant. Pennsylvania Sedge is one exception, but even this plant requires considerable light for good growth. For erosion control the forest must depend on a substitute for sod to absorb rain, check run-off and ease penetration. This substitute is the layer of fallen tree leaves. The leaf litter in turn acts further to exclude sod-forming grasses.

We come now to an opportunity to point out the dependence of the trees upon the lowly herbs. Examine a downslope road or trail in the forest and compare the lesser amount of litter present and the greater amount of erosion with the aspect of the adjacent undisturbed forest floor. Or visit a grazed or a burned woodlot. You will note that the denser the ground cover the less the leaves will be blown around or moved by water in fall and spring and hence remain in position to stop erosion.

Trees Alone Are Not Enough

Trees are sometimes planted to prevent or check erosion. But it must be understood that trees alone will not accomplish this objective. In fact, trees may worsen the situation by shading out pre-existent ground cover which had earlier served to anchor the litter and soil.

It is only the entire complex of leaf litter and humus held in place by the low stems and fine shallow roots of the herbs and shrubs, which prevents erosion in a forest. But shade-adapted plants as noted earlier are slow to grow, slow to spread, and have sparse stems, held apart to expose their horizontal leaves.

As a result, forests are very easily abused and degraded. One bridle path or heavily used trail can become a gully in a single year on a slope of sufficient

grade. Sometimes run-off waters from a field above a forest will create too great a problem for the precariously perched litter. Then the forest, which was left on this lower, steeper slope to prevent erosion, will merely enter into the problem!

Herbs and the A_1 Layer

The litter-holding, shade-adapted herbs benefit the trees in still another way, by building a nutrient bank of decaying leaves (the A_1 layer of forest soils discussed in the chapter on Soils)

Tree leaves - forming a large share of the forest's annual crop - contain much of its resources - both minerals and stored energy. These leaves feed countless worms, adult beetles and beetle grubs, sowbugs, millipedes, snails, fungi and bacteria which borrow the mineral nutrients in return for changing the ground litter into humus. Thus, the forest keeps using and re-using its resources and keeps losses outside the community to a minimum.

Burning or grazing woodlots cause many-sided losses. Since forest herbs are among the world's worst forage plants, cows need be given only a corner of the woodlot, for shelter only. (Burning on rare occasions can be a management tool when expertly used for a special purpose, but its bad effect on forest herbs and litter are nonetheless severe.)

The Problem of Seedling Survival

A well-anchored leaf litter does much to solve the forest's problem of erosion but typically one solution helps to create a new one. A germinating seed, having very limited resources, is truly low man on the forest totem pole. Leaf litter obstructs and shades its tiny shoot in addition to the three layers of herbs, shrubs, and canopy above - as well as hungry rodents.

Seeds must have a continuous supply of moisture until they have developed a root and further moisture to develop a shoot with either seed leaves or true leaves exposed above the ground and litter, and an adequate supply of light - all before the stored food runs out.

Seedling Requirements are Very Important Factor in Presence

There are many subtle variations whereby seedlings accomplish this early growth. The distribution, abundance and even presence in the forest of many of the herbs is tied closely to this problem of seedling survival. In older forests (closer to the climax type) even the trees and shrubs share this seedling survival problem.

Special seed requirements account for the absence of many shade-intolerant plants. These plants would not do well under forest conditions and oddly many of them then refuse even to germinate. This is not really so odd, since

there is survival value in not starting to grow if the situation is hopeless anyway. Most weeds and probably most prairie plants require the conditions found in a bare, sunny mineral soil to trigger germination. It may be light, oxygen, heat, or the absence of chemicals found in decaying leaves, but be it what it may, shade intolerant seeds do not germinate well in a forest. The vast majority of such seeds simply remain dormant in the soil waiting for the day the forest burns, or is opened up by grazing, or is ravaged by erosion. After such occurences the appearance of these seemingly endless new plants can be spectacular.

Seed Behavior Roughly Follows Size

The behavior of forest plants roughly follows seed size. Nuts must be buried by rodents and sometimes it takes a whole year or two to soften the hard shells of Hickories and Butternuts to allow germination. A month or two is enough for acorns which sprout the first spring. White Oak acorns behave somewhat exceptionally and frequently sprout immediately in a wet fall even before burial and occasionally may get their tap root anchored in that same fall.

Supplied with abundant food, nut seedlings and acorns can easily get above litter and ground herbs. It is this feature which when added to the carrying and burying habits of squirrels enable Oaks and Hickories to invade the dense sod of the grasslands. Deep tap roots give these pioneer trees drought and fire resistance as well, which are useful qualities in such an invasion.

Medium Sized Seeds

Climax trees like Basswoods, Maples, and Elms, on the other hand, have medium sized seeds and belong with the litter-piercing herbs. Such trees require moist soil to germinate and have shallow roots even when mature. Hence, they seldom invade undisturbed grassland.

By litter-piercing is meant sending up a long shoot or long leaf-stalks which get above the fallen leaves. This habit is especially characteristic of herbs with shade-escaping seedlings which come up in early spring when the leaf litter is densest - Virginia Waterleaf, Hog Peanut, and especially Sweet Cicely and Jewelweed.

The rest have adopted the slow growth habit of their parents whose own shade they must tolerate. Many are so slow that they send down only a root the first year and their first leafy shoot appears the second (Solomon's Seals, Bellworts). In the shade-endurers, the seed leaves often remain below ground, furnishing only stored food. In the shade-escapers these seed leaves have a dual role for they form the first green leaves to help make hay while the sun shines.

Small Seeds

The really small seeds must of necessity be litter-avoiders and, like the sun-loving weeds, prefer a bare spot for germination. Arrowleaf Aster, White Snakeroot, Small-flowered Crowfoot and Charming Sedge are examples here. Because such plants are "weedy" in regard to germination and yet are adapted for the forest's shady, cool, moist environment as adults, these plants are good indicators of local litter disturbances in the forest.

So, too, is the presence of mosses and ferns, whose spores have even less stored food than the smallest seeds. Notice how mosses and ferns tend to get started along paths, rocks and logs, places where litter is absent. Ferns, being long-lived, will, of course, continue for decades to indicate where once the litter was lacking. Mosses would too if the litter did not later kill them out.

Most annuals and biennials of the forest belong to the litter-avoiders - Clearweed, Pellitory and Woodland Lettuce. White Avens uses still another trick in escaping the litter: its seeds germinate in late summer by which time the earth worms have cleaned up most of the leaves and bare spots are more available. By October White Avens has formed a large enough rosette not to be "snowed under" by the newly falling leaves.

Dormancy Period

Summer and fall germination in seeds is rare, however. Perhaps because there is more moisture in the spring, and also because a full season equips the plant with more root and stored food for survival, spring germination is the rule. Most wild seeds do not sprout in fall because they first require a month or more of cold treatment in moist soil. Individual seeds of the same plant vary in the length of this dormancy period and many will not grow the first year even if conditions are favorable but remain stored in the soil. There is much survival value in not putting all your eggs in the same basket.

And After the Seedling is Up

Once the seedling is up the fun has only begun. The forest is a closed community - one already well occupied by a close mosaic of well established plants which usurp just about all of the light, water, minerals, and space available. Seedling establishment is therefore an annual game of musical chairs.

As the mature plants struggle together occasionally one will be eaten, succumb to disease, or be knocked down. Any seedling lucky enough to be on the spot when this happens has a brief chance to attain some size before the opening closes again. The rest of that year's seedling crop dies. In trees this is known as "gap-phase" reproduction and forms the basis for selective cutting procedures.

The Problems of Community Permanence

After all these pages we come to the question, "Where does the Oak forest fit?" In an earlier chapter it was pointed out that theoretically such a forest was a "sub-climax". What does our natural area have to say to this theory?

What the Herbs Say

Perhaps the herbs are the best indicators because they have the least to say concerning the forest environment. One group of herbs was given earlier on these pages - those found in all Oak stands. But, a second group of herbs discussed in the chapter on plants of the forest are prairie plants and a third group are found as well in the climax Sugar Maple forest.

SOME PRAIRIE PLANTS PRESENT IN THIS FOREST

Prairie Willow*
Pussytoes
Starry False Solomon's Seal
Shooting Star
Wild Strawberry
Five Finger
Wild Rose*
Spiderwort
Comandra
Krigia
Black Raspberry*
Upright Bindweed
Alum Root
Spreading Dogbane
New Jersey Tea*
Lead Plant*
Flowering Spurge
Lance-leaved Loosestrife
Spiked Lobelia
Tickseed
Sumac*
Canada Tick-trefoil
Cone Flower
Culver's Root
Big Bluestem Grass
Early Goldenrod
Smooth Aster
(* are shrubs)

SOME HERBS FOUND HERE AND ALSO IN MAPLE FOREST

Sweet Cicely
Bellwort
Annual Bedstraw
Yellow Violet
Early Meadowrue
Wild Sarsaparilla
Dwarf Carrion Flower
Greater False Solomon's Seal
Honewort
Jack-in-the-pulpit
Virginia Creeper*
Wild Yam Root
Alternate Dogwood*
Enchanter's Nightshade
Wild Leek
Bottlebrush Grass
Hog Peanut
Maidenhair Fern
Spinulose Wood Fern
(* are woody plants)

Our conclusion is that the Oak Forest environment is a hybrid between the Prairie and Maple communities - both climax in their own right in their respective goegraphic regions - with Oak occupying an intermediate stage in light and moisture between the two. This may be expected when we see that Southern Wisconsin is located on the prairie-forest border.

What the Trees Say

The trees tell us something further, for their size and growth-form give clues to past history and future events in this place. To see what the trees say, take a swing along one of the trails and make an actual count of the trees on either side within 100 feet of the trail. We think your chart would look much like the following one:

AGE COMPOSITION OF TREES IN THE FOREST

Species of Tree	Old, Open-Grown	Straight, Forest-Grown	Saplings 1/2-grown 6-30 ft.	Small Saplings 1-3 ft.	Seedlings 1-12 in. ***
White Oak	Some	Many	Some	Some	Some
Red & Black Oak	Few	Some*	Some	Some	Some
Wild Black Cherry	---	Few*	Few	Few	Few
Shagbark Hickory	Few	Few	Some	Some	Few
Slippery Elm	----	----	Few	----	----
Ironwood	----	Few	Some	----	----
Sugar Maple	----	----	Few	----	----
Other Trees**	?	?	?	?	?

NOTES:

* Some of the big cherries and red oaks were cut in 1951.

** Other trees found in the forest include Aspen, Bur Oak, Red Maple, Yellowbud Hickory, Walnut, Basswood, American Elm, Hackberry, Box Elder, Russian Mulberry, and Black Locust.

*** The number of seedlings will vary greatly from place to place and from year to year, since conditions for starting and survival are not always favorable, and seed crops occur very irregularly. The first seeding of Slippery Elms and Sugar Maples was noticed in 1962; the possible absence of local seed supply previously would account for the lack of seedlings of these trees in 1962 when this table was made.

This is a picture of forest succession in progress. Can you tell what is happening and why?

First, notice that the oldest trees (about 200-250 years old) are mostly open-grown White Oaks. Refer to the two center trees shown on the front cover of this book to see what is meant by open-grown. Compare this shape with the forest-grown shape of the trees in the right and left foreground. Open-grown trees had no near neighbors to shade out their side branches; hence the low branches remained and grew large. We can conclude that this is a young forest, for this must have been open country (hence, grassland) when the oldest trees present today were young. This conclusion is supported by the persistence of a few prairie plants in the forest; they are the last relic grassland plants which the forest has not yet shaded out.

Second, look at the forest-grown Oaks more closely. They are even-aged (about 120 years old) and some have two or three trunks, an unusual situation for Oaks. The even age corroborates the cessation-of-fire theory related in the chapter on the past century. These Oaks all sprang up simultaneously as soon as fires ceased to burn them down. The open-grown Oaks were the few that had escaped the repeated fires and got an earlier start, scattered widely like an open orchard. Between them the inflammable prairie grasses flourished.

The multiple trunks also point to the fire theory. Acorn production is too irregular to have been likely to result in even-aged saplings over the entire area the year the fires stopped, and indeed, all over Dane County where the forest-grown Oaks are approximately the same age. So we must presuppose that these Oaks were already present for some time, being repeatedly burned down but not killed by the grass fires, each time sending up a new crop of sprouts from the burned stumps. Such trees, called Oak grubs, are still found where railroads burn their grassy banks to control brush. Since the roots are old and large, the sprouts grow rapidly; when fires ceased, there was a good chance for several sprouts from one grub to attain considerable height before one or another began to shade out and dominate the rest. In some cases, none became dominant, and all attained full tree height. These are the "two-legged" and "three-legged" Oaks we see today. Thus the roots of the forest-grown Oaks may be as old as the open-grown trees.

As the forest-grown Oaks crowded around the open-grown Oaks, the latter lost their large lower limbs in the denser shade, leaving knobs where the bark grew out over the rotting stubs, and cavities where animals kept the bark from growing by chewing on the entrances to their dens.

Third, notice that climax forest trees are present here as saplings or young trees (hence can grow here now all right) but not as mature trees (hence must have come in only recently). We can conclude that they are sensitive to fire and drouth, and were kept out until this Oak forest had become dense enough to create a shady, humid environment in which the small Elm, Maple, Basswood and Ironwood seeds that occasionally blow in from afar could begin to grow.

The Sugar Maple near the sink hole, whose age was guessed to be about 30 years in 1962, got started, curiously enough, in the dry period of the 1930's. But it is located in a moist hollow with deep rich soil. Most of the elms are similarly situated in moist pockets.

Fourth, look at the various saplings more closely. Notice that where the shading is uniform, the young Elms, Ironwoods, Basswoods, Yellowbud Hickories, Maples and Walnuts are growing faster than the young Oaks of similar size. This difference in growth rates can have but one result: the Oaks are doomed in competition with these climax trees. The Cherries, Shagbark Hickories, and Red Maples, often seen with Oaks, seem to be intermediate, having come in later than the Oaks and tolerating shade somewhat better than the Oaks in general. The Red Oak can be classed with them and apart from the more drouth-tolerant and shade-intolerant White and Black Oaks. But even the Red Oak will eventually lose out to the Elms, Maples, Basswoods and Ironwoods, in whose very dense shade nothing can reproduce except climax trees. Even now, under the groups of Ironwoods, no Blackberries and no Oaks grow.

A Dynamic Forest

Our conclusion must be that our Oak forest is dynamic in contrast to the more static condition of climax forest or treeless prairie. Not only is it intermediate, but it is steadily changing. It is a self-extinguishing community - but the process is so gradual that we can study in detail its road to suicide. Here in Wisconsin two great empires meet - the prairie and the forest - and our Oak woods represents the meeting grounds. The climate of Southern Wisconsin now favors the forest, but it only barely does so. The prairie could not invade the forest without the aid of repeated fire. But the Maple flora cannot reclaim the grasslands except through the previous suicidal invasion of the Oaks. Thus, Oak forests are important in the transition from Prairie to Maple climax forest.

Relics or Invaders?

How can we tell that the prairie plants seen in the forest are relics and not invaders? If any are reproducing satisfactorily from seed, they could be coming in rather than going out. This needs study, but in general the prairie plants in the shade show weak growth and few or no flowers. If even the well-established adult plants are doing poorly, the seedlings can have but little chance.

On the other hand, the Maple herbs listed above seem to be thriving. The complete absence here of such characteristic Maple herbs as Baneberry, Bloodroot, Blue Cohosh, Dutchman's Breeches, Woods Phlox, Spring Beauty, Toothwort, Fawn Lily and Trillium may be ascribed to the youth of this forest and its isolation from Maple woods. The climax forest herbs, protected from wind and with fewer mammals to hitch rides on than in the Oak forest whose berries and nuts attract furbearers, must depend for seed dispersal on such small animals

as shrews, mice and ants whose "home range" is very limited.

Our Forest is Part of a Gradient in Time and Space

Some Oak stands show more Prairie flora than ours, some less; the same is true of the Maple flora present, but in reverse order. Oak communities, then, are really a series of plant groupings along a continuous gradient, with Prairie species most abundant at one end and Maple herb and shrub species at the other. Oak shrubs like Gray Dogwood, Hazel and Blackberry reach their peak near the Prairie end, often acting as invaders of Prairie, while the Red Oak and Black Cherry tend to peak towards the Maple side, where very few shrubs occur. This plant gradient is really an expression of four gradients: in site (soil and exposure), in plant adaptations (light and moisture requirements), in plant influences (light interception), moisture retention and nutrient accumulation), and in time (plant succession which has resulted from or been influenced by the three previous gradients).

Plants as Indicators of Site

Because the rock varies here from sandstone to limestone, and the slope and soil drainage is anything but uniform, there are many "micro-environments" within this forest. Succession is fastest in the deep moist hollows and ravines having deposits of silt. It is slowest on steep sandstone areas whose soil is dry, thin, poor and acid. An abundance of the drouth-tolerant Black Oaks tells you where the sandstone is. On the southwest-facing sandy slopes, even the Black Oaks are small and stunted. Since the Black intercepts the least light of all the Oaks, the Black Oak islands support the majority of the Prairie relics.

It is under Black Oaks (and stunted White Oaks) on sandstone that you are most likely to find seedlings and saplings of Oaks. This oak reproduction is usually White and Red Oak, indicating that the shade is too dense for young Blacks but not quite dense enough to kill Whites and Reds.

Since sand contains little lime to counteract the acids produced by decaying leaves, the sandstone areas also support acid-loving plants such as Haircap Moss, Rattlesnake Plantain Orchid, Canada Mayflower, Pipsissewa, Blueberry and Bush Honeysuckle. Most of these are much commoner in Northern Wisconsin, and it is possible that these long-lived plants are actually relics of a time thousands of years ago when the climate here was cooler and pine forests grew here. Some sandstone bluffs in this region do still support stands of red or white pine, and even hemlock. The smaller plants may have survived the fires and drouths in more places than have the northern trees. Sandy sites also support certain loose-soil-lovers like bristly Hawkweed, Lupine and Lyre-leaved Rock Cress, and are avoided by lime-lovers like Shooting Star and Bur Oak.

Sites having poor drainage support indicator plants too - Bluejoint Grass, Marsh Nettle, Elderberry, Manna Grass, Graceful Sedge, and Sensitive Fern. These marsh plants are found not only in hollows or in ruts by the road, but also occur on the highest ridge in the forest. Here the loess and clay are so successful in water retention that the soil stays wet all summer even though the land slopes away in all directions.

A final indicator plant tells you where litter is continually removed - the weed. Notice that only along the trails do you find Burdock, Broad-leaved Dock, Self-heal, Plantain, Yard Rush, annual bluegrass and Virginia Stickweed.

Natural Areas Tell Many Stories

Land managed for a crop - food or timber - can be a good teacher; but so can a land not managed, like this area. Comparing the two yields still more information. The foregoing examples in this chapter show that the herbs and trees, when left alone, can tell us much by their presence or absence, distribution, abundance, age, vigor and growth shape. They indicate local site or microclimate because each species has its own adaptations and requirements. They tell the history and future of the community, because relics of cool climates lag behind climatic shifts and the Prairie plants are evicted with difficulty by the Oaks while the Maple plants are slow to invade even though the environment now favors them.

Another story was interdependence; trees and herbs benefit each other and keep the soil fertile and in place. But there are numerous other examples. Natural damage to trees, which the forest manager tries to keep to a minimum, makes the natural community richer in wildlife. The exposed dead wood of an unpruned or half dead tree supports whole chains of interdependent organisms, such as fungi and insects, on which feed other insects and birds, and in which woodpeckers carve nest-holes which when abandoned are used by Flying Squirrels, Chickadees and Crested Flycatchers for their nests. Hollow, gnarled open-grown Oaks are "wolf trees", taking up valuable space from the forester's view, but they provide essential housing for many of the forest's mammals. Fallen logs support fungi, insects, and mosses which cannot live elsewhere, and they are essential drumming sites for grouse. Finally, Oak Wilt, the forest's deadly enemy, creates openings and edge cover required by buntings, and dead wood required by woodpeckers. The fact that the wilt fungus does not spread to all black and red oaks may lead to knowledge useful in its control.

Oaks and Fire

Groups of Aspen in this forest tell still another story - occurrence of forest fire. Aspen seeds, being very tiny, are litter-avoiders; hence Aspen stands originate where litter is temporarily destroyed. Basal fire scars on many of the forest-grown oaks are now partly healed over with bark which left rings of wood that date the fire to 1921. The location of the scars on the trees' west side tells us that the fire moved in the leaf litter from east to west, indicating a gentle

east wind during a very dry fall or spring when the litter was vulnerable to fire. The west sides of the trees, sheltered from the breeze, became hot enough to kill the protective bark and permit rot-causing fungi to work up into the heartwood. Though not killing the trees, the rot weakens the wood, making the trees vulnerable to windthrow and the lower portions useless as timber. The presence of these rotting trees in our natural area shows how fire is the forest's enemy; yet we must also remember, from other evidence found here, that fire was important in creating this Oak forest in the first place - just as important as acorn-planting squirrels!

Comparing the managed and natural areas of this forest can tell us much - not only the effect of management on wildlife and succession, but also the requirements of oak reproduction. Two facts are puzzling. (a) Why did the forest-grown oaks sprout readily from fire-burned stumps and, for the most part, escape heartrot until the 1921 fire damaged them, whereas the 1951 logging and the present logging in the managed area result in sprouts on only a few stumps and these subject to heartrot? (b) Why is third-generation oak reproduction so irregular? For an example of the latter puzzle, compare the dense stand of oak saplings along the beginning of the Prairie trail and adjacent road with the total absence of Oak saplings in large areas of the forest, and the presence of Oak seedlings near the sink hole. What factors are responsible for these differences? Moisture? Soil type? Amount of blackberries? Amount of tree shade? Chance coincidence of good seed crop, few squirrels, and good germination conditions at an earlier date near the Prairie trail than near the Sink Hole? How will the young oaks fare at these two places and how will they fare in the opened-up parts of the managed area? Clues abound in this forest to tricks for successful Oak forestry which may have economic value as well as being a fascinating subject for research - which is another word for education. Because the natural area of this forest has been altered little by man - there having been little cutting, grazing, fire or erosion in the past century - it is an ideal place to become aware of and to study the push and pull of natural forces within a self-sufficient community.

Source: Madison School Forest
Chapter 7
The Animals of Madison School Forest

As a result of work in the forest during 1959-1962, we have begun to meet a few of its "owners" - or its inhabitants if you prefer. Who and what lives here? What eats the plants and what eats the plant-eaters? Where can you find them? When? Here is what we have found so far; you will no doubt be able to add to this list if you are "sharp" and come here often.

I. BIRDS

The birds are the easiest animals to find; they move mostly by day, they move often and fast, and they have a lot to say.

Most birds migrate in fall and spring. Some actually winter in Florida like some people. But to others, southern Wisconsin is "Florida;" these spend their summers much farther north. These last are called winter visitors, and they include the tiny brown creeper, who hunts tiny insects in tree bark, always climbing upward, then flying to the bottom of the next tree. In winter you will also find some of the sparrows and finches, particularly the slate-colored junco or snow bird. He is dark gray, has an ivory bill, and shows two white tail feathers when he flies. Like the junco, the tree sparrow is as often found in fields as in the trees, for both eat seeds that fall on the snow after winter storms. The tree sparrow is brown, with a reddish cap and a single tiny spot on the breast. Some of the winter birds appear to be permanent residents, being seen here both winter and summer. However, some, like blue jays and goldfinches, probably include two populations, one of which moves in from the south in spring and replaces the other which goes farther north to breed. (How could you find out if this is really the case?)

But it is the summer birds we are most interested in. Their singing supplies much of the forest's sound. They are the easiest birds to learn because they nest here. About the nest the male sets up a "territory" from which he excludes other males of his species by warning them with his advertising song. This advertising usually prevents actual fighting, but that may occur too. Because each pair of birds remains close to its nest, within the territory, the birds are easy to find; if you wait a while, the male who went into hiding at your approach is sure to come out again and show himself and sing for you (actually of course, for the benefit of other male birds of his species, who might otherwise invade his territory.) This "staying put" on territories of less than an acre for a month or more makes it possible for you to return several times to the same place in the forest and see the very same birds and learn their songs. It is important to learn the calls and songs of forest birds; for then you can spot them when they are only partly hidden in the foliage, before they have spotted you and sneaked out of sight.

A few of the summer birds live here all year round. These permanent residents include the cardinal, chickadee, nuthatch, titmouse, most of the woodpeckers, owls, hawks, and the ruffed grouse. The rest are summer residents only. Here are the nesting birds of the School Forest that everyone should know:

Blue Jay. This rather large, noisy, blue-and-white bird with a crest flies and swoops about far and wide and does not stay as close to the nest as most birds. The rather twiggy and coarse nest may actually be within reach in a low tree crotch or junction of branches. Woe be to one who finds the nest or unfledged young; for the parents will attack! Jays eat most anything, from acorns to caterpillars to fruits; but their egg-stealing habits have probably been exaggerated. Bluejay feathers are commonly found during the molting season (late summer).

Cardinal. This is the all-red bird with a long tail and a crest. The female is olive but has a red bill. Cardinals have several loud whistled songs. They nest in brushy places and like to hunt caterpillars in rather low tangles of grapes and other vines. In winter they eat seeds. The cardinal has evidently moved north since settlement by white man; in 1840 cardinals were very rare in southern Wisconsin.

Scarlet tanager. Tanagers are much brighter red than cardinals, and smaller, shorter-tailed, and have black wings and no crest. They prefer the tree-tops, but the male is easy to spot when the sun strikes him. The female is olive-colored. The nest is often just out of reach on a low branch, and so flimsy that the eggs can be seen from below! Insects form the diet of this tropical beauty. Cowbirds often parasitize tanagers. Learn the tanager's call ("tick-grrr") and his song (like a robin with a sore throat).

Rose-breasted grosbeak. Another beauty, black and white with a bright cerise triangle on the breast below the black head. The female, brown and white can be recognized easily by the grosbeak's big, powerful ivory-colored beak which can crush large seeds and hard-shelled insects. Rosebreasts like to sing in full view, not too high up, in spring; but after their young are fledged, they are shy birds, hard to see. The nest is usually out of reach in the tree branches. The song is longer and sweeter than a robin's; the call is a characteristic "sheeek".

Woodpeckers. These are important forest birds. (Why?) Notice their upright posture as they brace themselves against a trunk with stiff tail-feathers, hammering away at dead wood to find insects or to carve out a nesting hole with their chisel-like bill. (What other birds depend on abandoned woodpecker nest holes for nest-sites?) Most woodpeckers have several calls, and they also can signal by a rapid drumming, this drumming being different for each kind of woodpecker.

The little downy woodpecker, the tamest, is mostly black above, with white

markings and, in the male, a tiny red spot on top of the head. The larger, shyer hairy woodpecker prefers the treetops; its markings are very similar to the downy. The flashy red-headed woodpecker exhibits big white patches in the wings as he flies about after insects in the fashion of flycatchers. In both male and female redheads the entire adult head is red; the young have gray heads. Redheads prefer areas of dead timber or the edge of the woods or a telephone pole. Much shyer is the red-bellied woodpecker, whose belly isn't red! (It is slightly pinkish.) Adults of both sexes do have a beautiful red patch on the back of the head; and the fine speckling of black and white all over the back is very handsome. Redbellies are more often heard than seen. Finally, one finds an occasional flicker in the forest, usually where there is an opening or grassy area. Flickers feed largely on ants. It is a sight to see this large bird sitting on the ground, running his long tongue right down the ant-hill. When he flies up, the flicker exhibits a white rump and golden undersides of the wings.

Nuthatch and Chickadee. These tiny bark-dwellers, like the woodpeckers, seek insects in tree bark and dead wood; they may even travel from tree to tree with woodpeckers, feeding together; and both nest in holes, often those made by woodpeckers. The lively black-capped chickadee can give a wo-toned musical whistle as well as say its name. Families of chickadees often travel about together. The white-breasted nuthatch is a stiff gray wooden toy on long legs who inches his way down the trunk head first!

Flycatchers. These are often seen flying about, but their colors are so drab that one must depend on their calls for identification. The flycatcher posture is characteristic: sitting still, unusually erect for a bird, on a dead branch, turning the head quickly this way and that to locate flying insects, then deashing off, manoeuvering expertly in mid-aid and snatching at the prey with a distinctly audible snap of the beak. All summer and all day long one hears the plaintive rising or falling whistles of the wood pewee. Pewee nests are high up, camouflaged with lichens plucked from the bark. Less often seen is the crested flycatcher, whose strong "wheep" call and throaty croaks come from a treetop. Crested flycatchers use an old woodpecker hole and line their nest with a snake's skin (when they can find one). The phoebe is similar to the pewee but constantly wags its tail and occasionally says its name in an almost conversational tone. Phoebes nest on cliffs or buildings.

Catbird. This common inhabitant of the blackberry and dogwood brush is about robin-size but slimmer and all gray. It is related to the mockingbird and gives many kinds of calls as well as "mewing" like a cat. The bright bluegreen eggs are laid in a low nest in the bushes. Many insects fall prey to the catbird's incessant searching.

Towhee. This large handsome finch is robin-sized and has the robin's rusty-red color on the sides (but not center) of the breast; the back is blacker than the robin's, and the long tail has some white-tipped feathers. Females are brown-backed. Like cardinals and other finches, towhees stay near the

ground except when singing. "Drink your tea" (with a trill on the end) is the song; a sharp "zhrink" gives it another name, chewink. Towhees nest in brushy woods and edges, on or near the ground, and look for food by jumping forward and back suddenly with both feet simultaneously, causing the leaves to fly noisily. Towhees, unlike many birds, call and sing conspicuously rather late in the summer, when the young leave the nest.

Wood thrush. Especially in the vening, you can't miss the stately silvery carolling of the thrush. When you do see him, he will be fat, robin-sized, brown-backed, with large brown spots all over the breast. He sings rather high, but the nest may be within reach on a low branch or in a tall bush. The nest is very conspicuously placed, with some large leaves fastened on the outside. Thrushes prefer the darkest parts of the woods and hunt insects (on the ground and in the trees) so efficiently that you seldom see them eating.

Oven-bird. Though a member of the "warbler" family he is almost as big as a thrush and looks thrush-like, brown-olive above, with rows of brown spots on the breast. The tiny orange crown is hard to see. In fact, the oven-bird himself is hard to see, for he slinks furtively along the ground or a low branch just out of sight. However, near his domain, on ridges and steep slopes which are not too brushy, you will hear his song suddenly ringing through the forest: teach-teach-teach teach-teach-teach-TEACH; appropriately enough for the school forest! The name comes from the ground nest, which has a roof and side entrance, carefully concealed among the dead leaves. Oven-birds, eat insects.

Indigo bunting. This small insect-eating finch usually looks like a dark-colored English sparrow, but if you can see him with bright light coming directly from your side, he glows with irridescent indigo blue! The female really does look like an English sparrow; but she has the bunting's sharp "chip" call. Buntings nest in blackberries in clearings or on the forest's edge. The male sings from a perch quite high up in a tree, and his song continues very late in the season compared to most birds. Learn to recognize the pairing of phrases in the song; a rather loud "sweet-sweet, sibi-sibi, see-see, churr-churr, tee-tee."

Redstart. This small warbler is the butterfly of the bird world, flitting about incessantly from bushes and tree branches, spreading and flashing a pink tail with a black "T". The female is pale yellow where the male is pale red, and not so black elsewhere. Both sexes can sing various rapid songs: "tseea-tseea-tsee" and "tse-tse-tsee-er." Redstarts nest in shrubs in clearings. The constant activity has a purpose; by moving about, the bird can view stationary insects from all sides and so can locate them in spite of their protective coloring.

Vireos. Vireo means green, but olive and gray would be better; in any event, vireos are extremely difficult to see, for they like to sit still in the densest tree-top. They are almost as small as warblers, but instead of moving quickly, they watch and wait until the insect moves and reveals himself. While waiting, they talk and talk, and you are seldom out of earshot of a vireo. The chatter

of the red-eyed vireo resembles a robin's voice but is weaker and colorless. It is heard in the darkest forest, in the hottest weather, and all day long. The yellow-throated vireo has a richer, more throaty voice and speaks less often; one phrase sounds like "three-eight."

House wren. The wren probably originally nested in old woodpecker holes; now man builds additional houses for him! On the forest edge you are sure to find a wren sooner or later. Many bluebird houses placed too near the forest or brushy places will be taken over by wrens, which will fill the house up almost entirely with big twigs, leaving only a small corner for the nest. Large families (as many as seven) are raised in this tiny space. (What do wrens eat? How would you describe the wren's song?) Notice that the tail cocked over the back distinguishes wrens from other small birds.

Tufted titmouse. This busy and noisy chickadee relative is gray with a crest on the head. Curiously, although he is tame enough when you do see him, he is seldom seen. But his loud series of cardinal-like whistles carry far through the forest; and a person who can whistle at a high pitch can call a titmouse over from far away by whistling "peter-peter-peter-peter." Titmice nest in holes.

Mourning dove. Our wild pigeon prefers more open woods, but our forest always has at least one pair. The owl-like series of mournful coos appears to come from farther away than the bird is. The nests are so flimsy that they often dump the contents; but doves make up for accidents by re-nesting several times during the long season from March to September. Notice the audible whickering of the wings when a dove flies. Doves pick up seeds on bare ground outside the forest.

Whip-poor-will. In large wild patches of woods like this one can be heard a whip-poor-will or two in the evening just after the last wood pewee has gone to sleep. He sings from the treetops, catches flying insects, and nests and rests by day on the ground.

Hummingbird. This smallest of birds will attack other birds that get too near its nest, which is camouflaged on a tree limb. If you are sharp, you will sooner or later see a hummingbird sit still for a minute on a dead twig high up, silhouetted against the sky. No doubt hummingbirds fly far afield to bring nectar and tiny insects to the young; for forest flowers are not abundant in summer. Hummingbirds' calls are tiny faint squeaks. A real treat is to see the aerial pendulum dance, in which the bird buzzes audibly at the end of each turn. Our hummingbird is well-named the ruby-throated, for the male is just that.

Baltimore oriole. The orange-and-black bird with the hanging gourd-shaped nest is more often found in roadside and streamside trees, but one or two pairs nests in the school forest, for example near the parking lot. This bird has one of the shortest song-periods; his rich, variable whistled songs are heard in May and parts of June, and only occasionally after. The wren-like scold call and

other calls are clues to the presence of orioles throughout the summer. Orioles live entirely in trees, eating insects and sometimes fruit.

Cowbird. No discussion of birds is complete without mention of the cowbird, the small blackbird with the brown head (in good light). The male gurgles, squeaks, and bows in competition with other males for the favor of a female. Later, the gray female lurks about in the forest looking for other birds' nests in which to lay her eggs. Her duty done, she joins the males for a carefree vagabond life while the parasitized birds raise the cowbird young, often to the exclusion of their own. It should be said, however, that the parasitism is not extreme, else the victims would have long since become extinct, and so then the cowbirds! Part of nature's balance is good adjustment between parasite and host, even as it is between predator and prey. One reason for the good adjustment is the large number of bird species which share the burden of raising the annual crop of cowbirds. The cowbirds' unusual habit is thought by some to have arisen when the cowbirds followed the buffalo, eventually becoming dependent upon them to stir up or uncover insects on which the birds fed. Since it was impossible to commute between the nest and the moving herd, only the eggs laid by mistake in the wrong nests were hatched and raised. Eventually cowbirds lost the ability to build their own nests.

Ruffed grouse. Grouse or partridge live here, but they are not abundant. In spring you will hear the faint accelerating series of thumps as the cock whacks his wings on his body while standing on a resounding hollow log. When you surprise a grouse in the woods, he will surprise you with an explosive whir of wings as he escapes. Lucky is the visitor who witnesses the broken-wing act given by the hen to distract your attention from the chicks! Grouse eat tree-buds in winter, insects in summer.

Hawks and Owls. The common bird of prey here is the red-tailed hawk, is seen soaring over the forest almost every day. The bulky nest is placed high up in a big tree and may be used for several years. (Notice that the leafy nests of squirrels are more abundant than the twiggy nests of hawks, owls and crows.) While red-tails hunt in the fields for mice, the swifter, less-often-seen cooper's hawk darts through the trees in search of birds. A great horned owl has been seen in our forest. The commoner barred owl and screech owl have not been seen here yet, perhaps because owls like open ground on which to hunt mice; but you may expect to find them in the forest now and then, seeking refuge from crows and jays. The clamor of the latter is the best way to locate an owl or hawk resting in the forest.

Five very common birds are very rare in the school forest: English sparrow, rock dove (common pigeon), starling, grackle, and robin. Here are some possible reasons; perhaps you can think of others. Sparrows, pigeons and starlings like to feed in farm yards and fields, and tend to stay near farm buildings where nest-sites are abundant. Grackles like to nest in evergreen trees, especially near water; we have neither evergreens nor water here. Robins hunt worms by looking for the worm castings on the surface of the

ground, which they can see in short grass (lawns and pastures) but not under the litter of fallen leaves that covers the forest floor. Besides, this particular forest has few earth worms anyway!

The birds mentioned so far are important to know and relatively easy to identify. Many others are present, but they are either rare here or hard to see or identify. Some of these are listed below for the serious student.

Other Summer Forest Birds.

Chestnut-sided warblers are as abundant as redstarts, and similar, but shyer. Another warbler, the yellowthroat, nests along the forest edge. Two other warblers sometimes found in the forest are the Kentucky and the cerulean. An occasional gnatcatcher and acadian flycatcher is seen or heard. Both kinds of cuckoos (yellow-billed and black-billed) are heard in the forest, usually in late summer. The veery, an unspotted thrush, sings its eerie song in evenings and early mornings in the deep forest. Brown thrashers, longer-tailed than thrushes, occasionally nest and sing along forest edges, and make the ground's leaves fly, throwing them over their shoulder, in search of grubs and other food. Woodcock are sometimes seen in low moist hollows in the forest. Crows occasionally nest in the trees. One year five great blue heron nests were successful; perhaps the noise and activity caused by class work has scared the shy herons away. In the sky may be seen nighthawks, swifts, and various swallows feeding on flying insects.

Migrants in the forest. Almost any bird that occurs in Wisconsin forests may be seen here during the spring and fall migration periods, especially most of the warblers, vireos, thrushes and sparrows. Many of these species are neither summer nor winter residents of the forest but transients, nesting farther north and wintering farther south. Among the common transients here are cedar waxwings, robins, and yellow-bellied sapsuckers. The sapsuckers make horizontal rows of holes and return next day to drink the oozing sap and feed on insects attracted to the sap. In this forest, the hickories are the sapsuckers' favorite tree in the absence of their preferred apples, basswoods and conifers. In early spring and late fall the most conspicuous transients in this forest are myrtle warblers, hermit thrushes, kinglets, and white-throated sparrows.

Open-country birds. In the fields adjacent to the forest many prairie birds make their home. Those found in the alfalfa fields just west of the school forest in summer include marsh hawk, sparrow hawk, pheasant, kingbird, horned lark, bluebird, eastern and western meadowlarks, bobolink, redwinged blackbird, dickcissel, gold finch and six kinds of sparrows (savannah, grasshopper, Henslow's, vesper, field and song).

How to observe Birds. To observe birds at close range, one must walk slowly and very quietly. Avoid quick motions or speaking or shuffling feet. Look and listen very intently. Keep the sun at your back and concentrate on birds at your eye level as much as possible; birds seen against sky or sun will be mere silhouettes with no color. Stop frequently for several minutes, especially near openings in the forest where there is more light and more "edge" cover which attracts more kinds of birds. A good 6-power binocular glass helps tremendously, but a good stalker with lots of time can do without a glass and will learn the calls and songs faster. Peterson's Field Guide to the Birds is an excellent guide to identification.

Birds are most easy to observe in morning and late afternoon, partly because they are most active then, and partly because less human disturbance is likely to be occurring. On windy days, birds will concentrate on the forest's leeward side and in well-sheltered spots. Sitting still for an hour on a cliff edge or in a tree can be very rewarding. During spring and fall migration, it pays to pick a good brushy spot and sit down or stand still, letting moving birds flit from bushes and trees right past you. Wearing dark clothes helps conceal you. Squeaking with the lips can arouse small birds' curiosity and bring them over into view.

If a large class visits the forest, it is wise to split the group into smaller groups; the smaller, the better. Stay on trails to keep scuffling noise to a minimum. Two groups slowly working toward each other will chase drifting birds into view.

Some of the best spots in the forest to see birds are the parking lot, the southwest ravine, the blueberry cliff, the sinkhole region, and the shelter house. But some birds will be found at any point in the forest if one is quiet, patient, and alert.

II. MAMMALS

The fur-bearing animals are in general too shy and quiet to be notified; moreover, most of them sleep by day. The exceptions are the squirrels and chipmunks. Chipmunks either "chip" or "chunk" by the hour nearly every day, rain or shine. They live in holes in the ground but may climb to the treetops. Both Gray Squirrels and Fox Squirrels are present, but they tend to stay out of sight on the far side of a trunk. Hunting in the country may be the reason the forest's squirrels are so much shyer than city squirrels. (In mating season, there is no difference!) Fox squirrels differ from gray squirrels in being buffy underneath and larger. Squirrel sign abound in the forest: Look for leafy nests in the trees, chewed hickory nut hulls on the ground in summer, and tracks in mud and snow. Squirrels can prevent a hollow tree from growing over a hole by gnawing on the growing edges of the bark. They also may be heard gnawing on the growing edges of the bark. They also may be heard gnawing on a bone to keep their teeth from growing too long. Since cats cause squirrels to scold furiously, a good way to locate squirrels and learn the different voices of fox

and gray squirrels would be to take a leashed cat along when strolling the trails. (What do chipmunks and squirrels eat at each season of the year?

Flying squirrels inhabit hollow trunks and old woodpecker holes in dead timber. They can be glimpsed gliding swiftly about just as it gets too dark for you to see things well; their eyes are far bigger for their size than yours are for yours! Flying squirrels' squeaks are piercing but almost too high-pitched to hear. Bats of several kinds squeak and fly about at dusk, too. (Where do bats spend the day? What do bats eat?)

Three other small mammals are abundant in the forest but hard to find. White-footed mice (deermice) inhabit hollow trunks and logs or build nests in crannies of cliffs. A curious habit of mice, heard in buildings but seldom in the wild, is a rapid drumming of the forefeet on a piece of wood. Short-tailed shrews make runways just under the leaves on the forest floor and traverse these tunnels over and over again, day and night, looking for seeds, insects and other prey. They may store seeds in certain places, as may mice. Shrews have very small eyes and shorter tails than the woodland mice. Their teeth are all sharp-pointed, whereas mice, being rodents like the squirrels, have chisel-like incisors in front and flad molars for grinding behind. Moles make conspicuous runways under the ground's surface by pushing up the soil with their shovel-shaped forefeet and strong "football player" shoulders. Look for mole tunnels crossing the foot trails in the forest. Moles, along with shrews, belong to the "insectivora", but like the shrews often eat plant matter even though their sharp teeth are not made for grinding up cellulose.

Cottontail rabbits are rarely seen in this forest. More important evidence of their scarcity here is the lack of rabbit sign, such as cut-off blackberry canes. In winter, rabbit tracks are like squirrel tracks but the forefeet are placed one before the other instead of nearly side by side. Aside from brush browzed near the snow line, look for other sign of rabbits such as round pellets and reddish urine in the snow. Have we just experienced a "low" in local rabbit abundance or are rabbits perennialy scarce here because of resident foxes and owls and too few brush piles offering refuge from predators? Those who can read sign will someday know.

Sign of White-tailed deer are quite abundant, especially along the muddier trails in the lower parts of the forest's northwest and southeast corners. The cloven-hoof marks occur in several sizes. (What does this tell you?). Deer like to eat woodland wild lettuce and jewelweeds, leaving knee-high hollow stubs. Deer probably use the school forest more for day shelter than for food, for neither summer nor winter browzing is heavy. In winter, deer, like rabbits, eat twigs. (Why doesn't a forester like to have a high winter deer and rabbit population? Although squirrels eat tree seeds, the forester doesn't mind so much having them around; why doesn't he?)

Several carnivores use the forest. Carnivores, like the other mammal groups (rodents, insectivores, bats, ungulates or hooved animals, etc.), are so named for purposes of classification; the name does not always indicate the situation for all members of the group. Some carnivores eat plant foods as well as meat, and these include several that use our forest. No doubt raccoons live in some of the large dens provided by the hollow open-grown veteran oaks, even if they do some of their hunting down along the Sugar River. Look for coon tracks in muddy spots of the trails. Foxes probably wander in the forest now and then; sooner or later we will find out whether they are red or gray foxes. Some dens need to be investigated; are they fox dens or woodchuck burrows? Skunks are seen in the forest and may be its most frequent carnivore. They eat fruits as well as bird's eggs and insects. Wandering dogs and cats from neighboring farms will be seen, or their tracks found. The famous "black panther" of the school forest has never been seen!

Excrement as well as tracks are important mammal sign. If the "scats" or droppings consist entirely of feathers, hair, bones and teeth, they are not scats but owl and hawk pellets - the undigested regurgitated remains of the prey. More likely to be found in our forest are the true scats of coons, foxes, and skunks, as well as those of dogs and horses. It is guessed that most of the scats are of skunks, but more study is needed. These scats often contain many cherry pits and insect remains. They probably explain the curious occurrence here and there of clusters of a dozen or more seedlings of cherry trees, raspberries, gooseberries and shadbushes, sometimes several of these species in one cluster. These probably grew from disintegrated skunk scats; but another possibility is that shrews or mice stored these seeds and later abandoned their cache, perhaps because an owl or fox caught them! (Incidentally, why don't rodent scats contain live seeds?) Some hard seeds do survive the grinding that occurs in birds' gizzards, and this is of course another possibility for the cause of the clusters of seedlings of berried shrubs and cherries.

What other mammals occur in the forest? Do we have any woodchucks, opossums, or badgers here? For small mammals, look at the scats and pellets of predators for teeth, bones and hair that might give clues to prey mammals that otherwise are hard to detect. Scats and pellets may also give you clues to prey insects and even prey birds that are present.

How to observe mammals. You have to be even more cautious and alert to see mammals than to see birds. You should be alone, and come in early morning or when no other persons are present. Some success may be had, however, if a group divides up into a line of "beaters" who drive game toward a line of "watchers". In any case, seldom will you see what you expect; but usually some form of life will give you a pleasant surprise. An excellent aid in reading animal sign of all kinds in Murie's Field Guide to Animal Tracks. But what you learn is what you see for yourself in the wild; what sharp eyes can see on a few trips would fill many books. Experience is the only way to sharpen the eye and ear.

III. AMPHIBIANS AND REPTILES

Toads are abundant in the school forest. You may also find a spring peeper - an inch-long frog with a faint "X" on its back. In late summer peepers give series of bird-like chirps from up in a tree. In spring, adult peepers and toads return to water to sing and breed. As there is no permanent water in our forest, this may be a long trip. (What do the frogs and toads find here that makes it worth while to come to the forest to live?)

No salamanders nor lizards have been found here to date; but they might occur under old logs. Snakes are very scarce in these woods; only one has been reported in the last four summers. Snakes are rarely seen even where they are abundant; for they will hear you coming and leave before you see them, unless you are a trained snake hunter. Rattlesnakes do still occur rarely to-day in the hilly Driftless Area extending from here to the Mississippi, but the chance of finding one here is very small. Anyone exercising ordinary caution in regard to where he puts his feet and hands need not worry about snakes.

IV. INVERTEBRATES

These "Animals without backbones" comprise most of the forest's fauna, in bulk as well as numbers and kinds. Molluscs are rare; the forest is not damp enough for most land snails, but you may find slugs, a kind of snail which builds no shell. Earthworms, too, are scarce, probably because the soils are generally very sandy. Sandy soil, being very porous, dries out rapidly and would not be able to keep the worms moist enough to survive; and the abundant aeration enables fungi and bacteria to eat up (decay) the leaf litter before the worms could have a chance to feed on it.

Most of the forest's invertebrates are arthropods ("jointed feet") with a hard exoskeleton. The worm-like arthropods with many legs are millipedes and centipedes. A large flat millipede inhabits this forest. Millipedes have two pairs of legs per body segment and eat plant matter, while centipedes have one pair per segment and generally eat insects and other small animals. Both frequent leaf mold and rotting logs, along with the little gray pill bugs or sow bugs, which are lobster-relatives (crustaceans) with a hard, turtle-like upper shell and ten pairs of legs. Most of the forest's arthropods are arachnids (four pairs of legs per individual) and insects (three pairs). Caterpillars often appear to have many legs, but on close inspection you will see three pairs of true legs near the head end; the other "legs" are not jointed and are just projections of the skin useful in grasping surfaces.

Arachnids include spiders, ticks and mites. Spiders usually catch and eat insects, though the harvestman or "daddy longlegs" eats plant matter. Spiders and their works are varied and often beautiful. Most spectacular are the circular webs strung across the trails in August and September by the

orb-weaving spiders. If you are lucky, you can watch one of these orbs being built. (How do you suppose this tiny spider gets that first strand fastened across between two bushes or trees which are three to ten feet apart? What kinds of insects would these suspended webs be likely to catch?)

Other types of spiders build different webs. The leaf-rollers make a house by rolling a green leaf and filling it with a web nest just as some caterpillars do. What other types of webs do you find? Still other spiders make no web but catch their prey on the run. Pencil-sized holes in the sandy woods are probably the work of trap-door spiders, big spiders that hide underground by day, camouflaging their entrance with a real hinged trapdoor made of soil held together on the inside with webs. Like the trapdoor spiders, two other kinds of spiders chase their prey. Jumping spiders hop about on tree bark and rock. Crab spiders - so named from the legs which project sideways from the body - are colored like the flowers they ambush insects from. Crab spiders are easily found on sunflowers, goldenrods and milkweeds. What other spiders do you find? Some rather large wood ticks occasionally get on one's clothes in spring. Some tiny bright red mites are found on the soil; others live as parasites on harvestmen!

Insects can be classified by habits and by structural characteristics. Here are the commonest insect groups for reference:

Name	Features	Mouth Parts	General Food Habits
Orthoptera (Grasshoppers, etc.)	Large; long hind legs for jumping; often make sounds.	Chewing	Plants and dead matter.
Lepidoptera (Moths, butterflies)	Large scaly wings	Chewing as larvae; sucking as adult	Plants
Coleoptera (Beetles)	Outer wings hard, opaque, meet in straight line.	Chewing	Plants, animals, and dead matter.
Hemiptera (Bugs)	Outer wings overlap, and are opaque only on forward half.	Sucking	Plants mostly.
Homoptera (Bugs)	Outer wings meet in straight line; or wingless. Cicadas make loud sound.	Sucking	Plants

Name	Features	Mouth Parts	General Food Habits
Diptera (Flies, etc.)	Only one pair of wings; some larvae aquatic.	Mostly sucking	Plants, animals, and dead matter.
Hymenoptera (Bees, wasps)	Two pairs of wings, joined in flight; or wingless	Chewing	Plants and animals.
Odonata (Dragonflies, etc.)	Two pairs of narrow wings; long slender abdomen; antennae very short; larvae aquatic	Chewing	Animals
Neuroptera (Lacewings)	Wings net-veined as in odonata but antennae long.	Chewing	Animals

Insects of the School Forest. Here are some insects to watch for, and see what they eat and who eats them:

ORTHOPTERA

Cockroaches: Under rocks and in rotting stumps. These wild ones are smaller than the pests of buildings.

Grasshoppers: Mostly in grassland, but some inhabit the forest. Some buzz in flight. The big "Carolina locust" in the parking lot has yellow-bordered black wings.

Katydids: The long-horned grasshoppers are big green or brown insects with long antennae. Different kinds sing in grass, shrubs, and treetops; many are nocturnal. Late summer.

Field crickets: Black or brown, hiding usually in grass outside the forest. One chirps irregularly all summer; another trills from August to frost.

Tree crickets: Delicate, green, nocturnal insects of shrubs. Their rhythmic chirps begin in July; later, in cool weather, they are heard by day as well as at night.

Camel crickets: Hump-backed and brown; found in damp rotting wood.

Walking sticks: Long, green or brown wingless creatures of the treetops, usually more a curiosity than a pest.

LEPIDOPTERA

Butterflies: Club-tipped antennae, vertical resting wings, and diurnal habits distinguish them from moths. Adults like flowers and wet mud. Look for mourning cloak, sulfur, cabbage, monarch, viceroy, swallowtails, blues, red admiral, fritillaries, angle-wings, painted lady, skippers, and many others.

Moths: At night, their eyes will reflect lights. The pretty underwing moths can be lured to a mixture of beer and sugar spread on a tree trunk. The eight-spotted forester (white spots on black) flies by day. Hummingbird-like sphynx moths seek flowers in the evening. Most of the inch-worms (loopers), leaf-rollers, and fuzzy caterpillars are moths. One looper mimics a twig when at rest. Some let themselves down from the treetops on a thread. Rarely some will become abundant and defoliate the trees, causing them to leaf out twice in one season. The four giant silkworms are canopy eaters and rare. Small kinds of moths are innumerable. Some are trapped by milkweed flowers.

COLEOPTERA

Ground beetles: Shiny, black, nocturnal, predatory; rest in litter.

May or June Beetles: The June "Bugs" are big, brown evening fliers; fat curved white grubs eat roots in soil for 2 or 3 years.

Stag Beetles: Brown or Black "June Bugs" with large jaws.

Click Beetles: Narrow, brown, with a body joint that snaps if held in the hand or turned on its back. Larvae are wireworms in soil or rotting wood.

Rove beetles: Very slender; wings much shorter than body, but can fly; tail turns up as if to sting. Rotting wood.

Long-horned Beetles: Stout, with long antennae; adults feed on flowers outside the forest; larvae bore in dead wood.

Engraver Beetles: Branching tunnels cut by larvae just under bark of dead wood make interesting designs. The elm beetle carries the spores of Dutch elm disease about.

Primitive Weevils: Slender, dark. The female bores holes in dead wood with mandibles at end of long snout; the male has to help pull her out again!

Weevils: Snout beetles are plump, gray or green; they may play possum when caught, and squeak when held tightly. Some eat nuts.

Picnic beetles: Yellow spots on black; attracted to melon rinds and other food.

Dogbane beetles: Hemispherical; shiny metallic bronze-green.

Ladybird beetles: "Ladybugs" are small, hemispherical, short-legged, often orange with two or more black spots, with a faint characteristic odor. Many kinds. Larvae and adults are famous as eaters of aphids and scale insects.

Soldier beetles: Slim, trim; yellow and black; on flowers in fall.

Fireflies: Softer-shelled than most beetles, and head is covered by front of thorax. A small species gives single flashes at intervals; a larger kind gives series of 4-8 flashes. Larvae feed on insects in rotting wood and may glow.

Lycids: Related to fireflies but diurnal. One is broad, dull orange, with black transverse bands.

Fungus beetles; Small; mushrooms are their bread and butter.

Tiger beetles: Rather large, oblong, with broad head; quick on foot and wing. Larvae ambush insects from burrows in sand; adults run their prey down.

HEMIPTERA

Stink bugs: Large, round or shield-shaped, green or brown, fat. Wingless nymphs, conspicuous all summer, suck plant juices.

Ambush bugs: Small plump bugs, yellow or green and brown, camouflaged in flowers; they grasp their prey with stout hinged forelegs. Their odor is unpleasant.

Assassin bugs: Fast-flying dull black bugs; hunt other insects near flowers. They can bite.

Milkweed bugs: Red and black; quite large. The similar box elder bug has more veins in the wing's clear part.

Plant bugs: Small; best collected with a sweep net.

Lace bugs: Exquisite tiny forest bugs found on leaves.

HOMOPTERA

Cicadas: Big, clear-winged, broad-headed insects sometimes called locusts or harvest flies. With a special vibrating organ and big sounding board, their buzz-saw whines carry far through the treetops; their protests also tell you when a bird has caught one. Nymphs live four or more years in the ground.

Spit-bugs: The nymphs cover themselves with a mass of froth on stems and leaves of herbs and shrubs. Adults are aptly named frog-hoppers.

Tree-hoppers: Bizarre hard triangular insects, brown or green, some resembling thorns on a stem. May jump and hit you.

Leaf-hoppers: Numerous kinds, most very small, in various colors, on green stems, and even on dead leaves in cold weather. They are soft, taper from head back, and jump.

Aphids: The plant lice are tiny, numerous, prolific, wingless soft-bodied insects on leaves and green stems; various colors; some tended and defended by ants; treetop species cover ground plants with a rain of sticky honeydew; flying forms fill the air in fall.

Mealy bugs: Aphid-like but dull white or woolly; some jump.

Scale insects: Tiny; live under waxy scales they make on stems.

DIPTERA

Gnats: The blackflies get in your eyes in hot dry weather.

Mosquitoes: Scarce in this forest because standing water is scarce. Worst in the evening.

Midges: Small harmless mosquitoes; evening mating flight makes the forest hum.

Crane flies: Fragile, over-sized mosquitoes in damp places; some eat other insects.

Flesh flies: Greenbottle flies and others help you locate animal scats and carcasses; the maggots soon clean them up.

House flies: Since they prefer the wastes of man and domestic animals, house flies are rare here. Most of the forest's flies are not house flies though looking similar.

Deerflies: Beautiful eyes; fast silent wings; stinging bite; in hot, humid weather.

Bee flies: Resemble bees (but, like all flies, have larger eyes and only two wings). The flower flies are good pollinators. The hover flies make the forest hum in hot weather. Some larvae eat aphids. The rat-tailed maggot of the drone fly inhabits stagnant water (such as in a hollow stump), breathing through a long snorkel.

Robber flies: The assassin flies are long-bodied like dragonflies, and like them hunt insects; fly with a loud buzz.

Fruit flies: The little flies that advanced the science of heredity can be seen here living on mushrooms like the sulfur.

HYMENOPTERA

Ants: Various sizes, pale brown to black or two-toned. Important forest insects, often living in rotting wood. They help distribute forest seeds, and carry aphids to new plants. Watch how quickly the wingless workers will carry the larvae and pupae out of sight when a nest is disturbed. Ants, like bees, have developed a complex social structure.

Honey bees: Brought from Europe and escaped to the wild, the bees are right at home in several hollow trees here. The swarming when new queens leave the colony really makes the forest hum! Many wild bees resemble honeybees, but are solitary or have small colonies.

Bumblebees: Live in old mouse nests, etc.; you can safely stroke a bumblebee on a flower -- unless you are too near her nest!!

Sweat bees: Small bluegreen or gray bees that will light on your hand in hot weather; their harmless stings can be a nuisance.

Paper wasps: These, including hornets, are long, yellow or cream with black, and make various-sized paper houses. If you blunder onto a nest, back away steadily, making no fast motion to alarm the wasps.

Yellowjackets: These bee-like wasps are small, but hazardous if you step in a hole where they nest. Again, the rule is: get away but without making fast motions; NEVER swat at a wasp or bee, even if he lights on you!

Picnic bees: In late summer and fall these bees with many yellow stripes can be a nuisance, insisting on sharing your meal. They won't attack you, though, and they don't eat much!

Hunting wasps: Various kinds (some blue-black) hunt, anesthetize and carry off spiders or caterpillars to provision their nest for the larvae, which they then abandon, usually in a hole in the ground.

Ichneumon wasps: They have long ovipositors for laying eggs deep in wood or inside a caterpillar; these are not "stingers". They are important in controlling the insects they parasitize. Various sizes, often blue-black, some with red bodies. Some hunt on flowers.

ODONATA

Dragonflies: Wings held at right angles to body. Although these large predaceous insects develop in water, they are strong fliers and some are seen here. All colors.

Damselflies: More delicate than dragonflies, and hold wings parallel to body when resting. Blue, gray, green.

NEUROPTERA

Lacewings: Small, slow-flying soft insects with rounded gauzy wings. Summer ones are green and have unpleasant sharp odor; fall ones are smaller, pale brown. Larvae eat plant lice and are called aphis lions.

Ant-lions: Adults look like damselflies but have prominent antennae. Larvae, called doodle bugs, build pits in sand to trap ants.

MISCELLANEOUS INSECT GROUPS

Springtails: Tiny jumpers on damp rotting wood and moist soil, or may walk on water or snow.

Lice: Look for them in birds' nests.

Fleas: They will look for you, especially if you are near a fresh carcass or a squirrel's nest!

Galls: In almost any plant, various swellings and curious growths occur. These contain the eggs or larvae of small insects - gall midges and flies, gall wasps, or gall aphids - which cause the plant to build a house around them of characteristic shape and color. Oaks alone are host for 100 kin of gall insects, each producing a different kind of gall! Some Plant Galls of Illinois by Winterringer (Ill. State Museum, Springfield) is a good illustrated introduction to galls.

Leaf miners: Winding white streaks in a leaf are caused by tiny caterpillars or maggots which eat the center of the leaf while staying between the top and bottom skins.

How insects grow. Since their skeleton is on the outside, insects must molt or shed their skin in order to grow. You may find a limp insect waiting for his new skin to harden so that his joints will again act as levers and permit him to move.

All insects except the cicadas and June beetles live for a single season, and must develop anew from eggs each year. Many insects, such as most orthoptera, overwinter as eggs; these are found as adults chiefly in late summer. But many other insects overwinter as adults, or as pupae, so that adult insects of some kind can be found at any season. Some, like certain butterflies and flies, develop so fast that several generations occur each season.

There are two types of development. One group (Lepidoptera, Coleoptera, Diptera, Hymenoptera, Odonata, and Neuroptera) have three distinct stages. The young insect is very different from the adult in form, structure and habits and is called a larva (plural, larvae). A larva about to transform itself into an adult builds a hard shell and remains immobile for a time; this is the pupa. Moths and butterflies spin a cocoon or chrysalis about themselves in which to pass the pupal stage. To sum up: The stages are egg, larva, pupa, adult.

The other group (Hemiptera, Homoptera, and Orthoptera) have no abrupt transitions; the young, called nymphs, are similar to the adults except that the wings do not develop until the nymph is nearly adult size. Thus the series is: egg, nymph, adult.

How to study insects: Flowers are the richest collecting ground, but don't forget the soil, dead wood, leaves, stems, bark, grass, and rocks. A sweep net will reveal many small insects you would overlook, and even a few big ones that were camouflaged. Many of the most important forest insects are out of reach, but sooner or later one will fall to the ground where you can catch him. It is necessary to search every week all through the season. The best way to learn insects is to make a mounted collection. A good, simple introduction to insects is the Golden Nature Guide to Insects by Zim and Cottam. The serious amateur student can go far with Jaques' How to Know the Insects. With this can be used Lutz' Field Book of Insects. A relatively safe insect killer is ethyl acetate (fingernail polish remover).

Insects and forestry. Insects do most of the eating of trees; yet many are friends of the forest. These include insects that digest or chew up dead wood and fallen leaves, returning minerals to the soil and helping trees prune themselves of dead or weak branches. A few trees, like basswood, depend on insects for pollination. Last but not least are the predatory insects which eat the tree-eating insects and potentially harmful fungi. When tree-eaters become too numerous, their predators also begin to increase and put a brake on their numbers. In this the secondary eaters protect the primary eaters as well as the trees from destruction; for death of the trees means death to all for all that live on them too! It may be said, too, that the insects that live directly on live tree parts help the trees, since they tend to prefer sick, weakened or over-aged trees, thus removing them as competitors of the healthier and younger trees. In short, any insect really harmful to the forest would have destroyed the forest, and itself, long ago!

Why, then, do we speak of forest pests and spend money trying to control them? The reasons relate to man's activities and needs. (1) Without killing the trees, herbivorous insects may lower their productivity below its maximum potential, thus keeping the growth rate down. Here the insects simply compete with man for part of the forest's product. The worst pests in this regard are those like the gypsy moth which man brought accidentally from other lands and which therefore are not as well controlled by local predators as are the native insects which have evolved here. Fortunately, the school forest does not suffer from introduced insects. The native inch-worms rarely seriously defoliate the trees here.

(2) Because insects are very fussy about their food, they tend to attack only one kind of tree and only at a certain stage of its growth. Hence the climax forst, having trees of many kinds and ages growing together, is the least likely to experience harm to a large number of trees at one time; only the overmature and injured trees are likely to suffer damage. A diversity of predatory insects also helps keep the climax forest on an even keel. But in the pioneer and subclimax stands, like aspen, pine and oak, there may be less diversity of plants and animals, and the trees tend to be more even-aged, as they certainly are in our forest. The destruction of such stands is all right in nature, for it helps get them out of the way to make room for the invading climax stage. But when these non-climax stands happen to be of value to man, they must be guarded against the possibility of a single pest getting out of hand when weather and predatory hazards fail to keep such pests in check; for they could destroy many trees before the time for harvest with maximum return.

(3) Finally, several tree diseases are carried from tree to tree by insects which otherwise are harmless. The chief disease of our forest is oak wilt, a fungus which attacks all oaks but is most likely to be lethal to black and red oaks. When infected, the tree turns brown in summer, and the bark soon peels off. While some of the openings in our forest were caused by the cutting of red oaks in 1951, others probably resulted from the spread of oak wilt via rootgrafts from one infected tree to another, until all the black and red oaks the fungus could reach were killed. The only way this fungus can then reach new trees is by being carried by the sap-feeding beetles which gather at injured places where the sap oozes forth. In an infected tree, the fungus grows exposed at such places, and the beetles may carry some of the fungus with them when they fly away and feed later at exposed places on healthy trees. Fortunately, for unknown reasons, this long-range dispersal of oak wilt does not happen very often; many black and red oak stands in Southern Wisconsin have not been ravaged by oak wilt even though oak wilt has probably been present for thousands of years. Also, fortunately, the School Forest is composed mostly of white oaks, on which the fungus usually causes only the occasional loss of a branch.

The other tree disease that may affect our forest is Dutch elm disease, an introduced fungus that attacks and kills non-sapling elms. It is carried from tree to tree by engraver beetles that harmlessly feed on live elm twigs as adults and

harmlessly breed only under the bark of newly-dead elm wood. As succession proceeds in this forest, the number of elms will increase. Sooner or later, dutch elm disease may be expected to be brought here by means of the fungus hitch-hiking on elm beetles which in turn hitch-hike on motor vehicles. The disease may be expected to keep the abundance of large elms in the forest to a minimum.

Insect control. Control measures are themselves difficult to apply and regulate so that they will not do more damage than good. For example, most insecticides are non-specific; DDT will kill not only most of the engraver and sap-feeding beetles and the inch-worms, but also will kill most of the ichneumon wasps that parasitize caterpillars, and most of the ladybugs that control aphids, and may kill or render sterile some of the forest's insect-eating birds. Because of their rapid reproductive rate, the herbivorous insects we try to keep down with insecticides may recover faster from these kills than will their predators, and may run wild for a while after being temporarily controlled by the insecticide. Or perhaps a different insect, which had been under natural control, will now become a pest until the predators recover. Methods to reduce the danger of these side-effects include careful timing of application of the insecticide.

Insecticidal chemicals pose other problems, too, such as favoring the most resistant individuals over many generations, resulting in a population that no longer can be controlled by the chemical. While poisons are still needed for emergency action against sudden outbreaks of pests, better control methods are under study which are more specific for a given pest and which are preventatives rather than cures. These are often called biological control methods. One such method is to introduce or encourage predators or diseases which specifically attack only the insect whose control is desired; the difficulty here is that the predator or disease must find a way to continue to live whenever its prey or host has been controlled and reduced to minimum numbers. Other types of biological control include trapping the pest insect by the use of chemicals which copy or simulate the scent by which the female attracts the male; removal of the males leads to infertile eggs or lopsided sex ratios and prevents future populations from being abundant. Another method is to release insects made sterile by radiation; when they mate with the wild insects of the same (pest) species, the next generation is interfered with. In general, few insects have received enough study to permit application of these very promising methods of control.

FOREST TERMS

Trees can be divided into two groups according to any of the following four pairs of terms.

Flowering as compared to Coniferous (cone-bearing)

Broadleaf as compared to Needleleaf

Deciduous (losing leaves in fall) as compared to Evergreen

Hardwood as compared to Softwood (lumbering terms)

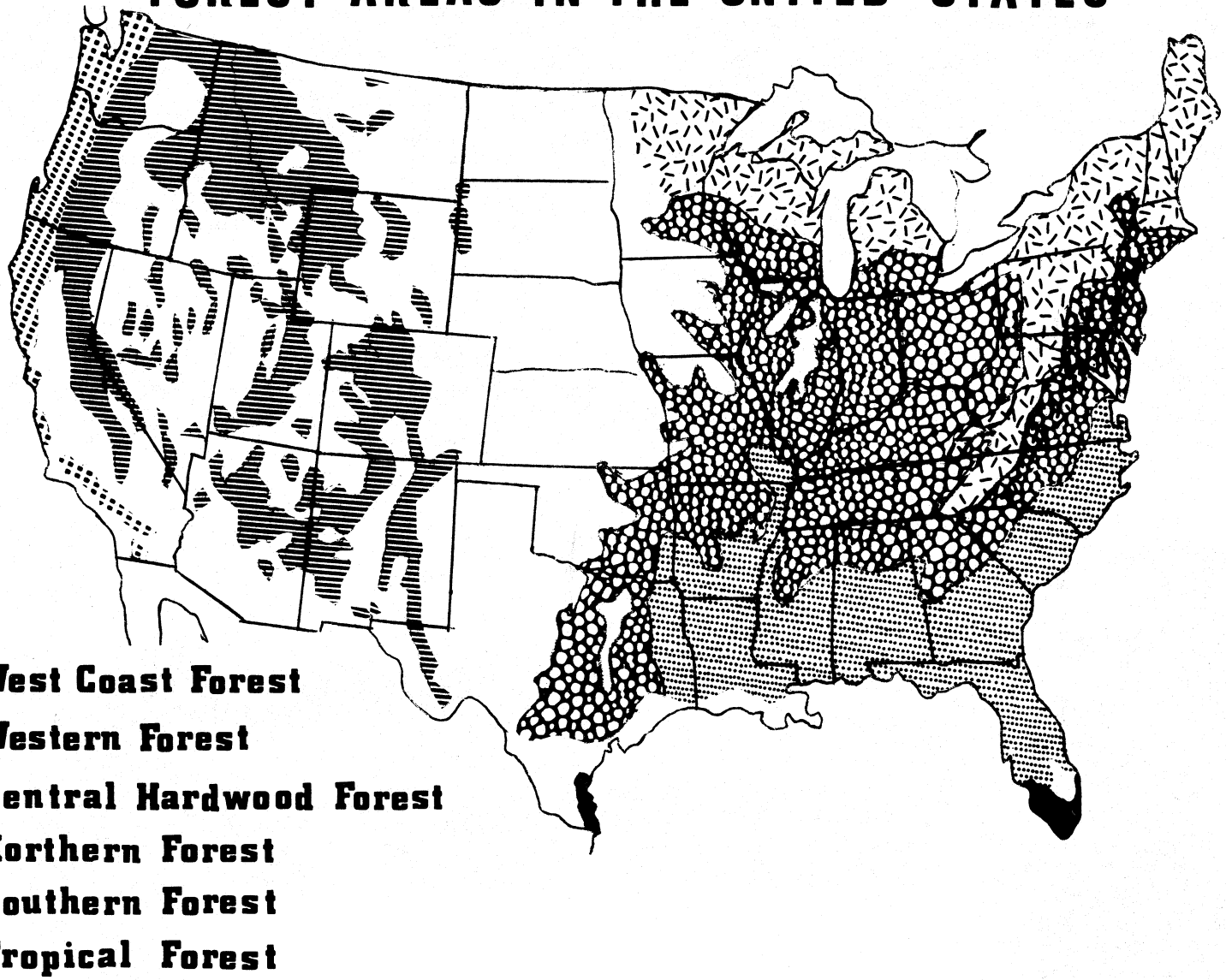
In Wisconsin most flowering trees are also broadleaf, deciduous, and hardwood. Most conifers, such as pines, are needle bearing, evergreen, and softwood. There are exceptions, however. For example, tamarack is a needle bearing tree which is deciduous. Basswood, a broadleaf tree, has relatively soft wood.

DISCUSSION IDEAS

Ideas which might be brought out in a class discussion comparing a cornfield to an oak forest:

Corn Field	Oak Forest
One species of plant	Many species of plants
One plant height	Three layers of plants
Annual plants	Mostly perennial plants, a few annuals
Yield removed from area each year; fertilizer necessary	Yield is returned to soil, recycled
Need for weed control	Few weeds present
Needs continual care	Self maintaining
Type of vegetation determined by man	Type of vegetation determined by climate, soil and length of time left undisturbed
Food production to benefit man	Food production benefits varied animal population
Large production of food per acre capable of supporting man	Cannot support large human population
Continued growth of corn depletes soil	Soil improves as forest continues to grow
Soil vulnerable to wind and rain erosion each fall, winter and spring	Soil protected by continual vegetation cover

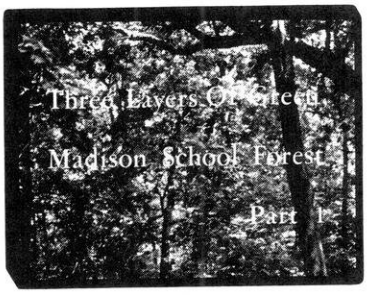
FOREST AREAS IN THE UNITED STATES



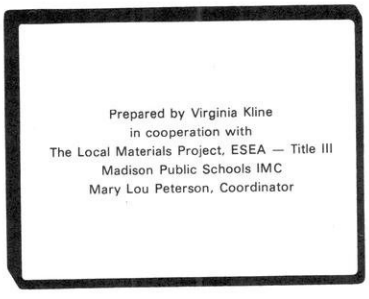
1
Colophon
(Bird calls)

SPECIAL NOTE:

Please do not judge the quality of the beautiful full-color pictures in the Filmstrip by the appearance of the black-and-white photos in this Guide! Obviously, there is no comparison between full-color and black and white pictures.



2
Title Frame
Part I: Introduction and canopy layer.
(Bird calls)

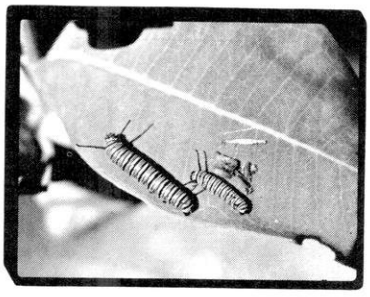


3
Credit Frame
(Bird calls)

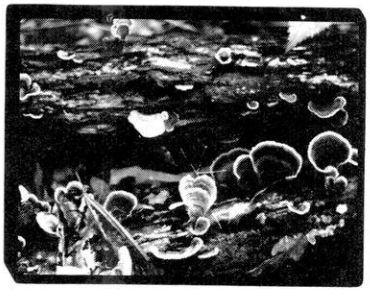
4
In contrast to the cultivated land around it, the Madison School Forest is a natural community — a community made up of countless plants and animals living together untended, each one playing its own interlocking role in the total scheme.

5
Each plant and animal is affected in some way by other plants and animals of the forest — all competing, sharing, living, dying in relationships so complex that only a small fraction of the mysteries of a natural community are understood by man today.

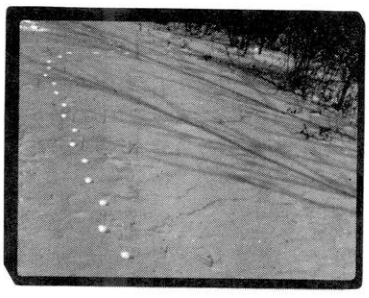
6
Vital to this and any other living community are the green plants, for these are the food manufacturers on which all other life depends. Only in a green leaf is the sun's energy captured and changed to food energy, to be stored and converted many times over as it is used by a series of living things.



7
Caterpillars eating a green leaf, . . .



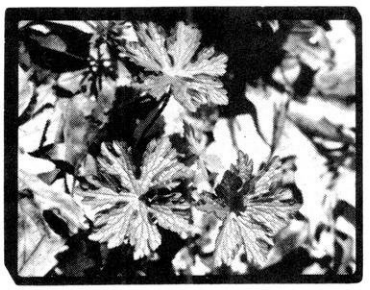
8
. . . fungi living on a fallen log . . .



9
. . . a fox hunting for mice on a cold winter day — all are using energy first captured by a green leaf.

Human beings also live on energy first captured by green leaves. Tracing foods that boys and girls eat back to a green leaf is a good classroom activity. Ex: cheese — from milk — from cows — which eat grass.

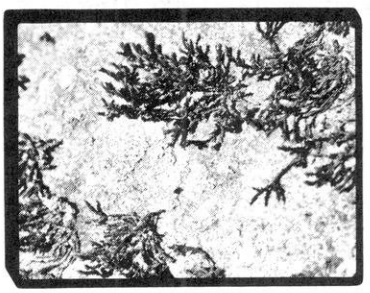
10
In the School Forest the food makers are found over our heads, at our feet, and at a level in between. Three layers of green, each layer manufacturing food that will be used by the living things of the forest; each layer made up of many kinds of green plants.



11
Each kind of green plant has its own shape . . .

12
. . . and size, . . .

13
. . . its own habit of growth . . .



14
. . . and its own requirements for sunlight, water, and soil. Such great diversity is an important characteristic of a natural community.

15
As the plants grow and die each performs other roles in addition to the vital one of food production, such as making shade, . . .

16

. . . or providing the right site for a forest animal to have a home or raise a family.

17

Interesting relationships can be seen in every square foot of the forest. Here living green leaves have been chewed by some forest insect. A plant that once had green leaves now lies as a rotting log on the forest floor. A light colored fungus is growing from the side of it, using the log for food. In the process it is changing the log into soil enriching humus which helps to keep the soil moist for the roots of the green plant which fed the insect. The fungus has softened the log enough so that ants can now make tunnels through the wood and make their home there. This tunneling will hasten the breakdown of the wood into humus. A small green plant finds the top of the log exactly the location it needs to grow into a soft green carpet.

18

Looking for such interrelationships is an exciting part of exploring the three layers of green on which all the life of the forest depends.

19

The top layer, made up of the trees, is called the canopy. Most of the food for the forest is made here. A forest is named according to its most important canopy trees; the School Forest is an oak forest.

The type of canopy tree determines to a large extent the composition of the lower layers.

20
The oak forests of southern Wisconsin are part of a band of forest stretching from New York to Texas which is called the Central Hardwood Forest. Notice that Wisconsin is about as far northwest as this type of forest grows.

This forest belt is also referred to as Southern Hardwood Forest.

21
Other terms that might be used to describe our forest are broadleaf and deciduous. Because the trees are deciduous, fall marks the end of the season of food making for the trees of the forest.

Terms defined — sheet in Source Material.

22
In winter the tree lives on food which has been stored in branches, trunks, and roots. Even in winter we can get acquainted with the canopy trees and see some of the relationships the trees have with other living things of the forest.

23
The most common large tree in the forest is white oak. No matter where you are in the forest several large white oaks will be visible. These trees are easy to identify by the light gray rather smooth bark. The leaves have rounded lobes as you see here.

24
It is interesting that the light gray rather smooth texture of the white oak bark is due to the action of a small plant which grows on the bark. If you look closely you will find that plant — a small white fungus which uses the bark of white oak for food. This small plant causes the tree to shed the outer layers of bark before the bark becomes old and deeply ridged. Thus a very small fungus makes it easy to tell the white oaks from the other trees.

25

Can you tell which are white oak branches in this picture? . . . The dark colored branches are those of black oak, another very important tree in the School Forest.

26

Notice that the leaves of black oak have bristle tipped lobes. Black oaks have deeply grooved bark; the outer ridges are very old bark. Growing on the old bark ridges are some gray-green plants called lichens. Unlike the small white fungus which feeds on the white oak, the lichens used the black oak only for support — another kind of relationship in the forest.

> A lichen is actually two plants, an alga and a fungus, growing together in close association. The fungus provides support and collects water and minerals. The alga, a green plant, makes food for both. Each is dependent upon the other in this relationship.

27

Red oak bark often has lichens on it too and looks very much like the black oak. Even the leaves are similar, with bristle tipped lobes. Since they are alike in many ways, some scientists feel that red and black oaks are really variations of the same kind of tree.

28

In summer look for the very shiny leaves which will help identify black oaks. Once you can recognize white, black, and red oaks you will be able to identify nearly all the large trees in the forest.

29

Four less common trees which are part of the canopy are also easy to know by their distinctive bark. Bur oak is closely related to the white oak, and like the white oak has leaves with rounded lobes. The bark of bur oak is thick, with deep corky ridges. Since this bark is very fire-resistant the bur oak has a good chance of surviving a fire.

30

Big toothed aspen bark is smooth and light-colored when young but with age develops dark crevices. Aspen grows along the edges of the forest, or in places where a fire once made an opening in the forest.

31

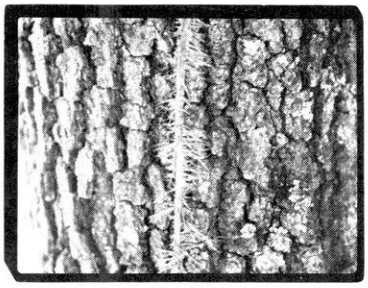
Shagbark hickory bark peels off in long strips which curve outward at top and bottom. This spring picture shows a branch of the tree with large pink buds which enclose the new leaves.

32

Black cherry bark peels off in oval shaped pieces. Crevices, rough bark, deep ridges, curling edges — the bark of the canopy trees provides hundreds of hiding places for certain kinds of insects which spend all or part of their lives on the trunks of trees. Some use the tree for food; others only for shelter and protection.

33

A small bird called a nuthatch goes up and down the trunks of the forest trees all year round, checking each ridge and crack for such hidden insects, which provide it with the particular kind of food it needs. The nuthatch has feet designed for rapid movement on vertical surfaces. It is the only bird in the forest which can go down a tree trunk head first! Can you tell what kind of tree the nuthatch is checking in this picture?



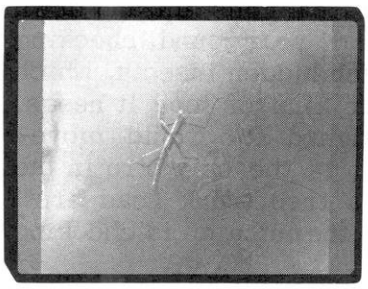
34
The trunks of the canopy trees are also important to woody vines of the forest. Like the lichens which we saw on the black and red oaks, the vines use the trees only for support. They do not take food from the tree. Woodbine can be seen fastened tightly to the bark by means of hundreds of small roots. Other vines use different methods of support.

35
The bark of one vine, wild grape, peels in strips which are used by birds for nest building — another interesting relationship between living things in the forest.

36
In a sunny position the three woody vines of the forest — bittersweet (shown here), grape and woodbine — all produce fruit which is relished by birds of the forest. Perhaps such fruit is especially important to the birds in winter when snow covers food on the ground. The birds in turn help the vines by carrying the berry seeds to new locations.

37
The trees begin their job of food production in May, when green leaves appear on the branches of the oak trees towering over our heads. Notice that the leaves have already provided food for insects.

The blossoms appear at this time also — male or staminate flowers in long clusters, (shown here) produce wind borne pollen. Inconspicuous female or pistillate flowers after receiving pollen produce acorns.



38
The growing tree leaves attract many kinds of sucking and chewing insects. One of the tree leaf eating insects is the walking stick, which here has fallen onto a red jacket.

39
The insects eating the canopy leaves in turn become food for keen sighted birds which feed high in the tree tops such as Baltimore oriole, rose-breasted grosbeak, and blue jay (shown here). During spring migration, many kinds of warblers feed on insects in the canopy.

40
By June the tree leaves are large and hide the nests of scarlet tanagers, orioles, wood pewees and other canopy nesting birds. The leaves intercept much of the sunlight, making the forest cooler than the farmland nearby. Large quantities of water are given off by the millions of tree leaves. The air in the forest becomes moist as well as cool. The air within the forest is often still even when the branches high overhead sway in the wind.

41
Because of these effects the lower layers of the forest are growing under different living conditions than the canopy trees high in the wind and sunshine or the farm crops in the open fields nearby.

42
Late summer finds the canopy branches providing the cicadas with high perches for their short-lived singing after years in the ground below.

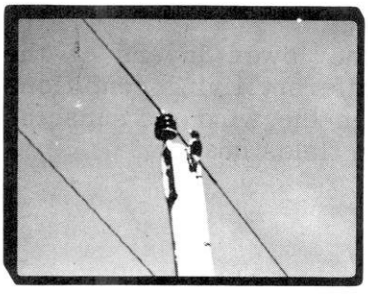
43
In the fall the big crop of the forest begins to ripen and fall to the ground. Acorns are a neatly packaged concentrated food . . .

44

. . . which is the main diet of the squirrels of the forest. Squirrels bury acorns in the ground to insure a winter food supply, and in the process become planters of oak trees.

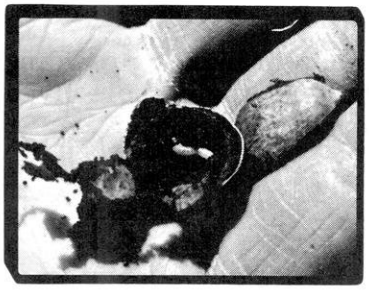
45

They also gather oak leaves to build round nests high in the canopy safe from land bound predators.



46

The red-headed woodpecker, a forest dweller which is often seen on the telephone poles nearby, eats acorns and stores them by tucking them under loose strips of bark on the forest trees.



47

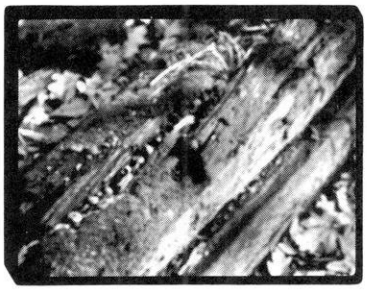
Acorns are eaten from within also, by a small insect larva, getting its share of the energy first captured from the sun's rays by the oak leaves. Sometimes fishermen collect acorns in order to use such larvae as bait.

48

When a branch or a tree dies, its production of food ceases, yet it continues to play important roles in the forest. A dead limb is a favorite singing post for many forest birds.

49

As the wood rots, ants make their tunnels within; woodpeckers in turn peck holes in search of ants. Hollow trunks may become homes for birds such as nuthatch and woodpecker and later for mammals including squirrel and raccoon.



50

Hollow trunks of trees blown down by the wind provide safe tunnels for mice and chipmunks. A salamander may spend its days in the cool darkness beneath the log. Can you see signs that this log served as a "picnic table" for a forest animal?

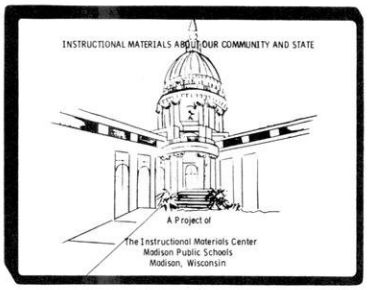
51

A few logs, such as this one, have a special use as sound amplifiers. This log has been used by a male ruffed grouse whose courting dance has scraped off the moss on the log. During the dance the wings make rapid vibrations which are amplified by the hollow log to make a loud drumming noise.

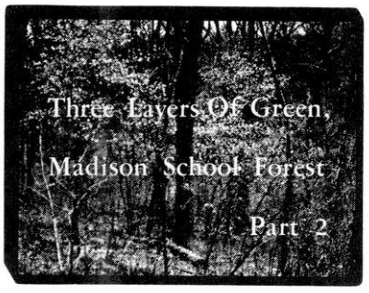
For many years the tree lies on the forest floor, changing through the action of fungi, bacteria, and insects into soft spongy humus which will help the soil to hold water. Minerals released from the wood will help fertilize a new tree or perhaps a delicate wildflower. Use and re-use of life's building materials is very important in a natural community.

52

End of Part I.
(Bird calls)



1
Colophon
(Bird calls)



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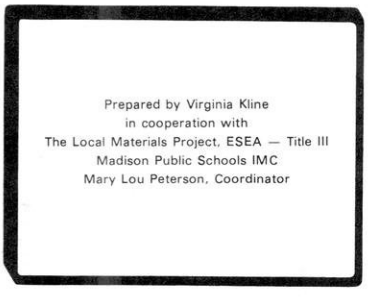
(Bird calls)

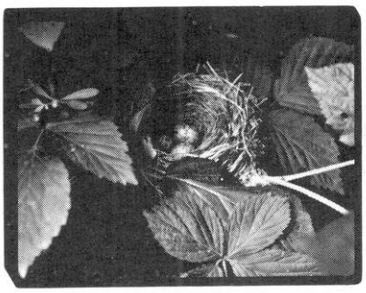


3
Credit Frame
(Bird calls)

4
The middle layer of the forest includes some young trees and a thick growth of shrubs. The presence of many shrubs or "brush" is a special characteristic of an oak forest. Most of these shrubs will grow best in full sun and do not thrive in deep shade. They survive in an oak forest because oak trees do not cast extremely dense shade and because there are many openings in the canopy where trees have been blown down or have died of disease. In such openings the shrub growth often makes an impenetrable barrier.

The young trees in the middle layer are discussed in the set titled "Madison School Forest", Part II "Signs of the Future".

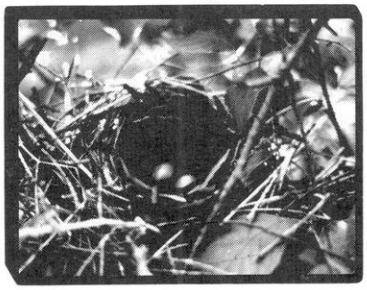
5
The shrubs are especially important to animal life. A tangle of blackberries can conceal a rabbit or a woodchuck, or provide overhead protection from owls for a deer mouse foraging at night.



6

Here the thorns of blackberry provide sharp protection for the nest of an indigo bunting.

> Another interesting relationship is revealed in this picture. The eggs in the nest are cowbird eggs. Cowbirds build no nests of their own but lay eggs in other birds' nests. The young cowbirds then are cared for by the birds which build the nest.



7

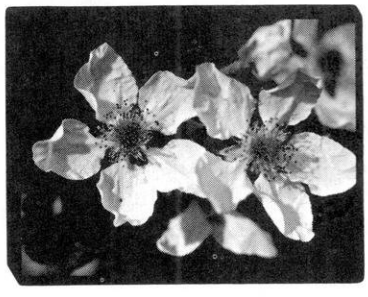
The thick shrub layer attracts many other birds which like this kind of nest building site — cardinal, blue jay, rose-breasted grosbeak, wood thrush, and catbirds are common in our forest because of the shrubs. A catbird built this nest about five feet above the ground in a shrub. The day the picture was taken there were two eggs; the next day three; the next day four. On the fifth day an adult catbird was sitting on five eggs in the nest — egg laying was completed and incubation had begun.

8

In winter the same nest with a roof of snow provided a snug home for deer mice. After the snow melted evidence of the mouse diet remained.

9

The food production of this middle layer of green benefits many creatures throughout the year. Shrub blossoms such as those of shadbush in early spring . . .



10

. . . and of blackberry in June attract insects in search of nectar and pollen. These insects in turn pollinate the flowers, thus insuring a good crop of fruits which will benefit other animals of the forest.

11
The green leaves of the shrubs provide food for insects throughout the summer. These are the green leaves of hazelnut, a shrub which in fall produces nuts eaten by squirrels and chipmunks.

12
In late summer and fall the berries of gray dogwood, blackberry, shadbush, and other shrubs are eaten by many birds and animals from robins to skunk and red fox.

13
Like the trees of the forest, the shrubs are deciduous, and live through the winter on food stored in branches and roots. Hazelnut shows brilliant fall color before losing its leaves.

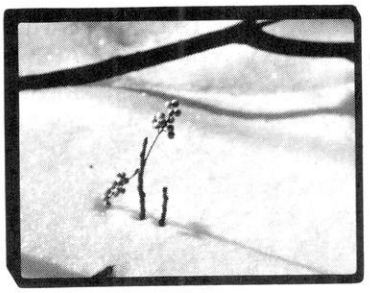
14
Fall is the time when deer have a special use for shrubs and young trees of the forest. When the new antlers of the buck are mature, the velvet-like covering which has nourished the growing antler peels off. Here a buck has rubbed its antlers against the trunk of a shrub to hasten the peeling process.

15
In winter the middle layer becomes survival insurance for rabbit and deer. Snow covers the ground layer of plants. The canopy is out of reach for non-climbing animals. Stored in the stems and buds of the middle layer plants, within reach, is the life-giving energy captured by the green leaves of the shrubs during the summer.

16

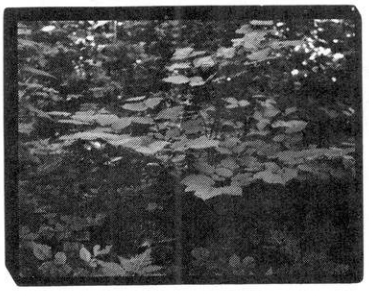
Here is a tale of a wintertime meal. Perhaps you can identify the diner. The clues are the round pellet-like droppings on the snow and the sharply cut off stem in the upper left-hand portion of the picture.

Cottontail rabbit.



17

One shrub which is very common in the forest appears to be especially attractive food for rabbits in winter. On a winter walk in the School Forest you will see many sharply cut off stalks of poison ivy. The berries of poison ivy stay on the stalks through the winter and provide food for winter birds.



18

The sunlight which reaches the forest floor is even less than that which reached the shrub layer. The plants in the lowest layer of green must get along on what is left. Food production is less in this layer and growth tends to be slow. The plants do not have woody stems and are referred to as herbs. In order to obtain enough sunlight to survive, the plants of the forest floor have developed many interesting adaptations along the long road of evolution.

Evolution is an ongoing process in natural areas such as this one. We, in this century, observe but one paragraph in the long continuous story of evolution.

19

For example, plants adapted to living in shade often have broad leaves held horizontally. May apple leaves look like green umbrellas.

20

Many forest plants come up early in spring. Bellwort blooms in late April or early May.

21

Some shade adapted plants grow new leaves in the fall which stay green beneath the snow. You can see the leaves of sweet cicely coming up among the fall leaves here.

22

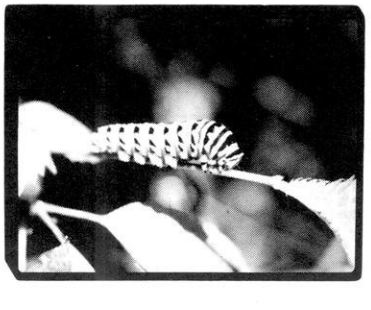
Some plants form large patches by underground runners. This is part of a very large patch of Canada Mayflower.

23

A few forest plants grow very tall. This is the tallest herb in the forest, spikenard.

Can you think of reasons why all these habits of growth (frames 19 to 23) are helpful in a shady place?

See "Survival in the Shade" Techniques 1-4, pages 8 and 9 , Chapter 4, Madison School Forest, reprinted in this guide.



24

Though the amount of food produced in the herb layer is much less than that produced in the canopy, still to many forest creatures it is a very important small amount. This swallowtail caterpillar will eat only leaves of particular herbs — those which are members of the parsley family. The wooly bear caterpillar eats plantain, while the larva of the red admiral butterfly requires nettle leaves.

25

A particular leaf miner spends its larval stage within the layers of white snakeroot leaves, leaving a white trail. The wide variety of plants in the forest community insures a wide variety of insect life.

26

Like the other layers of green, the herb layer not only makes food but affects the forest community in other ways. One important group of plants plays a special role in soil enrichment. Growing on the roots of these plants are small nodules in which live certain kinds of bacteria. These bacteria have a unique ability. They are able to take nitrogen from the air and change it into a form which can be used by growing plants. Tick trefoil (shown here) and . . .

27

. . . hog peanut are two examples of plants with such nodules which help enrich the soil with nitrogen.

More in Madison School Forest, Chapter 4, "Soil Fertility and Tick-Trefoil" and "Three Forms of Nitrogen Insurance" Page 7.

28

The herb layer is vital too in soil erosion control. The leaves falling from the canopy are held on the soil surface by the herb layer, thus preventing loss of soil by wind and rain. Where a trail is made the herb layer is destroyed. Wind and rain carry the leaf litter away. Erosion on the exposed trail is rapid, especially when it is on a hill. The lowest layer of green benefits even the giant trees overhead by preventing such erosion.

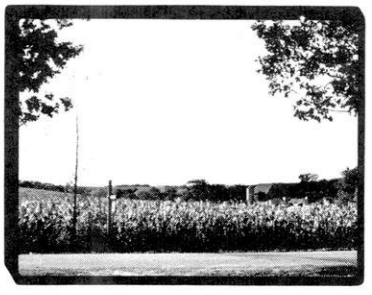
29

Where the leaf litter is held on the soil many small creatures live beneath the moist decaying leaves.

The millipede lives on decaying matter in the soil, hastening the break-down process.

30
Some birds such as the towhee scratch at the leaves with their feet looking for beetles or grubs to eat.

31
These pictures have shown only a glimpse of all the action and reaction of a natural community by focusing on the role of the producers of that community. This great variety of plant and animal life with the endless interrelationships can be observed only in natural areas such as the School Forest which have been set aside as places where man's role is limited to that of preserver and observer.



32
Elsewhere man in his many activities has substituted uniformity for variety, and constant care and control . . .

33
. . . for intricate natural balances.

34
The End.
(Bird calls)

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