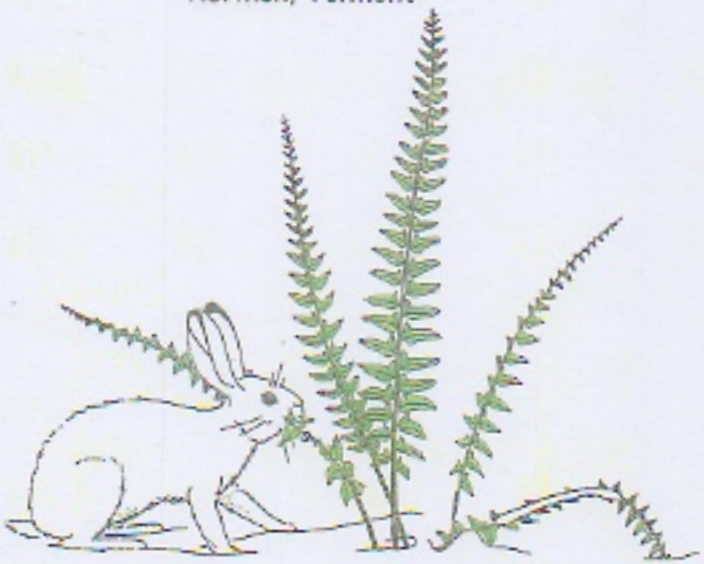
We affirm and promote respect for the interdependent web of life, of which we all are part

PATH GUIDE TO

# SPIRIT IN NATURE

Unitarian Universalist Congregation
of the Upper Valley
Norwich, Vermont



by Philip Kern, with additions for new plantings by Leah Goat

first edition March, 2003
second edition August, 2003
third edition December, 2017

# CONTENTS

## Preface to the third edition

Our Spirit-in -Nature Path was created in 2003 as an integral part of the suite of environmental actions that led to our becoming the first congregation to be recognized by the Unitarian Universalist Association as a Green Sanctuary. At that time the congregational commitment to environmental action fueled the energy of some half dozen or more members to lead the community effort to create the boardwalk and the path, to post thereon inspirational quotations from a variety of spiritual and philosophical traditions, to identify and label plants, and to prepare this guidebook, which includes a numbered sequence of natural history essays keyed to numbered posts on the path. During the ensuing years the path has served as a spiritual resource for us, both as individuals and in group activities, especially for our religious education program.

Alas, time takes its inexorable toll. The boardwalk has been repaired annually, rebuilt once, and needs rebuilding again. The benches and boards over wet places have decayed away. The path has been neglected and needs renewed attention. Strange time for a new edition, it might seem. Except that now the congregation as a whole, energized by our extraordinary building of a new Meetinghouse, by the loving and devoted leadership of Reverend Patience, and by the aesthetically inspired creation by Leah Goat of orchards and gardens, has achieved a renewed sense of energy and call to action.

Here, then, is this third edition of the Path Guide. It has been extensively revised, with some deletions where plants have been lost and a number of additions, especially for Leah's new plantings south and east of the Meetinghouse. The original plant list is updated, and a second list is added for the orchard and garden plantings, which are now shown on a new local map. Also the original map has been redrawn, and it shows the path now following quite a different route from the original one. This change was made partly to better incorporate the new plantings around the Meetinghouse. A second, and less innocuous, reason has emerged from the physical deterioration of the path across the boardwalk and through the woods. Because of the likely obstacle of the high cost of renewal, the locations of labeled and numbered plants in the woods have been confined to a much smaller area, and the rest of the woods path has been formally closed for the time being. It is likely that the boardwalk itself may have to be closed in the spring.

Still, the renewed path, at least on the near side of the boardwalk, will be open in the spring, with descriptive information on the new plantings and its new sequence of numbered posts keyed to accounts in the text. In the meantime this guide is housed in our library, and in the spring a second copy will be in the kiosk at the beginning of the path. Come walk. We hope to see you there


*What do we ever know that is higher than that power, which, from time to time, seizes our lives and reveals us startlingly to ourselves as creatures set down here bewildered? Why does death so catch us by surprise, and why love? We still and always want waking. We should amass half-dressed in long lines, like tribesmen, and shake gourds at each other, to wake up. Instead we watch television, and miss the show.*

Annie Dillard

## SPIRIT IN NATURE

*The spiritual life is, then, first of all a matter of keeping awake.*

Thomas Merton

Spirituality is, at least partly, a matter of waking up, of paying attention to our lives, and of acknowledging the profound mystery of existence. Acknowledging mystery means consciously confronting life's fundamental questions: why is there something instead of nothing? who are we? where are we? why are we here? In seeking paths by which to address these questions we must keep awake by avoiding the myriad distractions — ego, wealth, power, livelihood, politics, misguided archaic religious traditions, other fantasies, mindless chatter, drugs, and entertainment, including sports and the daily news — with which we humans

deliberately cloud our minds in order to avoid this very inquiry. Avoiding all distraction is necessary because these questions can be addressed only through seeking to know and understand the real world beyond our human screens, the "natural" world, specifically the origin, nature, and character of all life, and of the universe itself.

Those aspects of life's mystery that we can begin to resolve on nature's paths you may find to be instructive. Strangely enough, also, the more we comprehend of the natural world, the deeper the underlying mystery, reaffirming the mystical character of our quest. The spiritual lives that we crave, then, are to be sought not in the tangled strands of popular human culture, but by communion with the four-billion-year-old interdependent web of life and of all existence, of which we are a part. If you would find spirit, you will have to seek it, at least in large part, in "nature", in realms of thought that are addressed in natural history, physics, chemistry, cosmology, biology, neuroscience. One could begin by walking on this spirit-in-nature path, getting to know some of our non-human neighbors, and learning the ways of these wild neighborhoods.

## GENESIS

Events leading to the creation of this Spirit-in-Nature Path and this guide began in the spring of 2001 with a congregation workshop on social justice. The unexpected but virtually unanimous consensus of that workshop was that the single most urgent social problem was environmental degradation. Our determination to address this issue was reinforced in two ways. First there was a request for summer Sunday morning programs on natural history and the environment. Then we discovered that the Unitarian Universalist Association's study/action issue for that year was on the topic of Responsible Consumption as a Moral Imperative.

The ensuing eight-week series on that topic was one of the most well-attended and enthusiastically received summer programs in which we have engaged. By June, 2002, we were one of the first five Unitarian Universalist congregations to be recognized formally as a Green Sanctuary. One of our projects in that undertaking was to create this path, on the model of the Spirit-in-Nature Interfaith Path Sanctuary in East Middlebury, Vermont.

Reverend Paul Bortz, Unitarian Universalist Minister and President of the Board of Directors of East Middlebury Spirit in Nature, was most generous with advice and encouragement of our efforts. Funding was provided by our congregation's Sustainability Action Group, by a gift from former congregation member Louise Wickware, and through a grant from the New England Grassroots Environment Fund. Ms. Heather Trillium of the Upper Valley Trails Alliance gave assistance in path planning and construction, while some materials and all the design and labor were provided by members of the congregation. Design and original construction of the boardwalk and associated structures were directed by Colin High and Bob Eliason. Bob also made the numbered stakes, the original wooden plant labels, and inspirational signs.

Initial construction was carried out in the summer and fall of 2002 and was completed in 2003. The boardwalk was completely replaced in 2014, but now in 2017, because of limited resources, the boardwalk and the woodland parts of the Path have been deteriorating. The boardwalk remains open for the present, though its future is uncertain; our hope is that these parts of the path will soon be brought again into good condition.

This booklet, first prepared in February and March, 2003, and a second edition offered in August, 2003, is a guide to the path and to the natural history of this land. It may also serve as a faltering first step on a path seeking spirit in nature. On the path and around the Meetinghouse you will find tags identifying many of the plants and other natural features, and also numbered stakes keyed to the discussions in the following pages. You will also encounter signs with contemplative writings from a variety of spiritual traditions that may speak to Unitarian Universalists.

This third edition has been prepared in the summer and autumn of 2017, after landscaping and construction of the new Meetinghouse have been completed. We have totally updated and revised the content and sequence of the path site essays, as many plants and other features have been lost to the effects of environmental changes and construction effects. In addition, Leah Goat has designed and planted a perennial border, a screening hedge, an orchard, and other new plants behind the sitting rocks and at the Meetinghouse front entrance. She has written essays corresponding with new numbered posts for each of these new plantings as well and has also prepared Appendix C as an addendum to the original plant list and map.

All are welcome to the Unitarian Universalist Congregation's Spirit in Nature Path. We invite you to walk here in peace and love, to meet our fellow creatures on the land, to learn from nature's ways, and to meditate on human spirit and wisdom, and on the meaning of life. Here, as elsewhere, you are in community with the interdependent web of all existence, of which we are a part.

## LIST OF PLANTS

The original plant list, which is included in Appendix B, was initially compiled between May and December, 2002, was corrected and expanded from April through August, 2003, and then again in summer, 2017. More than 160 species and groups of species are included, showing both common and scientific names. Each plant's abundance is shown for five areas -- the lawns and grounds surrounding the Meetinghouse, the meadow, the wetland, the dry woodland (orange path markers), and the wet woodland (yellow markers). Also shown are the months when each plant species is in flower (or in spore) and whether it is a native or an alien (not native to this region). Appendix C includes lists of plants that are included in Leah Goat's newly created Perennial border, screening hedge, orchard, and sitting rocks plantings.

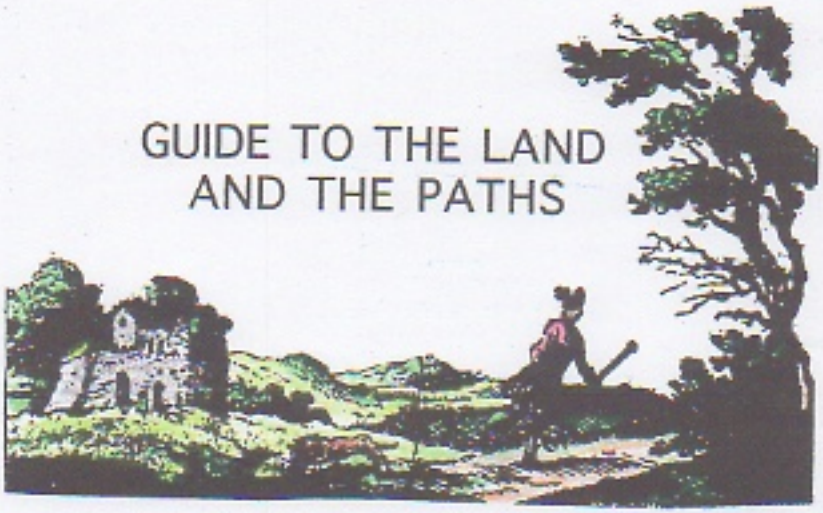
This guide is far from complete. We have not tried to identify the various species of mosses, violets, grasses, goldenrods, asters, and some others; many other species have certainly been missed (several dozen were added in the second season and again in 2017); and there must be misidentifications and other corrections to be made (many have been made already). Also, there are no lists of birds, mammals, insects, or other plant associates. We welcome any corrections or additions you are able to offer.

## MAP OF PROPERTY AND PATH

This map shows the revised course of the path and the locations of the numbered posts corresponding to the natural history essays in the following pages.


woodland
wet woodland
meadow
lawn
Palmer Court
Route 5 to Norwich
100 feet
path
wet woods path
boardwalk
wetland edge
meadow/lawn edge

# GUIDE TO THE LAND AND THE PATHS



These essays correspond to the numbered posts along the path. On the map you can see that post #1 is by the kiosk on the northern edge of the property behind the Meetinghouse, and that the succeeding numbered posts progress across the boardwalk and into the woods as far as site #16. Returning from there back across the boardwalk, the path turns right through the meadow, then to the right and counterclockwise around the Meetinghouse, finally to end back at the kiosk.

Many of these accounts are longer than is usual for such a guide. If, however, you would like to learn something more than a few curiosities about the lives of our fellow creatures on Earth, and about the nature of our living global community, you may find these elaborations to be of more than passing interest. Of course you are free to skip over what you will, but read on if you, too, seek understanding of the nature and meaning of the cosmos, of life, and of our lives. This is better than television, and more pertinent.

Because plants hold still for our attention and wave flowers in our faces, it has been rather simple to include a list of plants here. Consequently the emphasis of this guide may seem to be on plants alone, but you will find accounts of bacteria, fungi, animals, lichens, and other creatures as well, for our hope is to draw your attention to, and increase your understanding of and appreciation for, all of the interdependent web of life, of which we are a part. Thus, in addition to most of the major groups of our fellow creatures, you will find, where appropriate, commentary on evolution, ecology, environmental change and degradation, and the essential creative role in all of these of symbiosis and other cooperative interactions throughout the living world.

On this note, one might ask just why one should learn the names of plants, or of birds or butterflies? Simply knowing their names is not terribly important, after all. Still, learning to recognize a few flowers, and birds or mosses, is like knowing a few friends on your street. It is part of becoming familiar with one's neighborhood, of knowing a corner of your planet and your place in the cosmos. It is also a personal connection to the land, the waters, the skies, and the extraordinary novelty and beauty of the living world. I find too that identifying plants, or insects or lichens, is one of a handful of activities that keeps me awake, that makes me pay attention to my life, to all our communal lives.

Monarch Butterfly

More important than the names, in any case, is knowing something about how our neighbors live, individually and in community, for although we as a global human family are rapidly forgetting, we are members of that community. The single most important cause of all our environmental woes is the fact that increasing numbers of us, of all our fellow humans, live not on planet Earth but in a cloud of electronic distractions, mostly in sealed buildings lining paved streets connected by limos and airliners. When we don't know where or how our food originates, or

our water, air, or other resources, or where the wastes go, or what other folks are doing with hazardous chemicals, or how important to us our non-human neighbors are, and why, then the planetary community of life, including us, is in deep distress. Gary Snyder had it right when he wrote that "we should stay together, go light, and learn the flowers." Just a few flower names might be enough.

So come walk on the path and meet some of your closest and friendliest neighbors. The willows and perhaps red maples may be in flower by the end of March, certainly by the first week of April, and witch hazel likely will still be blooming in December. It is a long and glorious season of flowers and life here. Don't miss them. As Annie Dillard wrote, "we are here to bear witness, so the creation doesn't play to an empty house".

## 1. Bacteria, the highest form of life

By the current consensus on biological classification and naming, life on Earth is divided into three parts, and these are the Domain Archaea, the Domain Bacteria, and the Domain Eucarya. Most of what are discussed below are creatures in the plant kingdom, which is in the Domain Eucarya; this domain also includes animals, fungi, algae, and all other life forms consisting of cells that have nuclei in which the genetic material is confined. But before we consider the plants, let's begin with the bacteria, which are so different from plants and animals that biologists now classify them in their own unique Domain, containing only single-celled creatures which have no cell nucleus and typically contain only a single circular chromosome.

billion-year-old fossilized bacterial colonies

Bacteria (with their close relatives in the Domain Archaea) are the most abundant, most diverse, and arguably most important, creatures on the planet, being the founders of all life on Earth as well as essential facilitators and overseers of virtually all global ecosystems. Their earliest fossils are in rocks some three billion years old; the Bacteria have ruled the planet for a very long time.


This compost heap is home to astronomical numbers of bacteria (and presumably archaeans, and lots of microscopic eucaryotes as well), as are all septic tanks and other sewage systems. Probably their most widely recognized environmental role is as decomposers, recycling dead creatures and wastes back into reusable molecules, while keeping the planet from being buried irrevocably under organic debris.

Also, however, bacteria play a primary role in maintaining global cycles of carbon, nitrogen, and other elements essential to all life, and of oxygen and carbon dioxide, thus also for climate control. Their extraordinary array of symbiotic associations with virtually all other living creatures (perhaps excepting viruses) is such that many species, including humans, could not survive without them. Nor could the biosphere as a whole, for, in addition to their role at the center of virtually all global ecosystems, bacteria are the only global supplier of usable nitrogen (see #23, Clovers, . . .).


Yet another astoundingly exceptional, biosphere-dominating, and defining trait of bacteria is their ability, through several processes, to share genes readily and frequently with one another, even among different species, so that they are also the most adaptable and rapidly evolving creatures on Earth. We have learned this to our dismay by the ease and speed with which bacterial pathogens become resistant to antibiotics (helped along by our extraordinarily foolhardy, indiscriminate, decades-long overuse of those fundamental health essentials). As

they are not genetically independent of one another, in a sense all bacteria can be thought of as belonging to a single species; they might even be regarded as a single disseminated global creature.

Walking here, or anywhere, you cannot ignore the bacteria. You smell their chemical wastes in compost, dead animals, decaying plants, and toilets. They live on and in plants, birds, nematodes, and fungi. The soil beneath our feet may contain 10 billion in a spoonful. Another billion occupy every square centimeter on the surface of your gums, and they throng your digestive system, your lungs, nose, and ears, your skin, and, in the form of mitochondria, every cell in your body (see #9, Chloroplasts, . . .). We, and all of life, cannot survive without them. In a real sense, all the rest of us are merely vehicles for bacterial reproduction and evolution.

## 2. Sensitive fern, *Onoclea sensibilis*

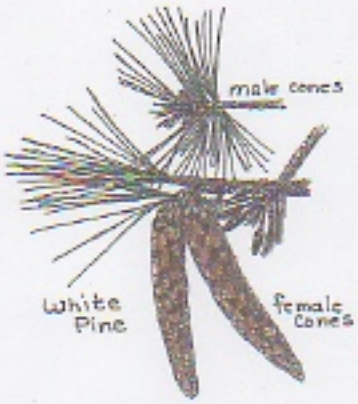

In Appendix B you will find a discussion of the life histories of plants, describing the four groups into which plants have been classified. These groups fall into an evolutionary sequence, with the mosses and liverworts having evolved first, presumably from alga-like ancestors. They in turn gave rise to ferns, horsetails, and club mosses, which later evolved into the conifers, cycads, and their allies, and these finally yielded the flowering plants, with their 200,000 species dominating present-day global vegetation.

The sensitive fern (see also the Christmas fern, #16; the ostrich fern, #21; and the swamp horsetail, #7) represents the second group in that evolutionary succession, with a fossil record going back some 400 million years. This is a very common and gregarious woodland species in the Upper Valley, occupying damp or wet meadows and edges of woods. It is up early in the spring and departs early in the fall, as it is highly "sensitive" to temperature and is one of the first ferns to succumb to autumn chilling. Notice that, unlike most other ferns that carry spores under

their leaves, the spore cases of sensitive ferns are borne on separate stems, which remain conspicuously dry and erect through the winter.

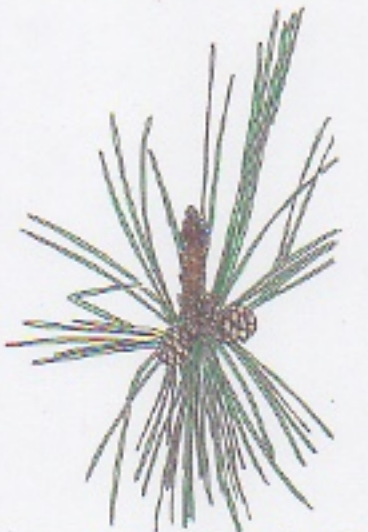
### 3. White pine, *Pinus strobus*

Pines and their coniferous kin, together with cycads, ginkgoes, and podocarps, are the third in evolutionary sequence of the four plant groups (See Appendix B). They are the evolutionary link between the earlier ferns and their allies and the later flowering plants, and they have a fossil record beginning about 300 million years ago.




Pine, to most New Englanders, means white pine, perhaps the most easily recognized tree in our landscape. Unfortunately the most majestic specimens went long ago for masts to his majesty's navy and, since then, to hurricanes, lumber, and pulpwood. The white pine is another reminder of the irrevocable devastation of North America's, and Earth's, primeval (pre-human) natural bounty — five-foot-thick pines, baskets of six-foot cod, skies filled with passenger pigeons, plains covered with bison.

The white pine provides seeds for squirrels, chipmunks, mice, and many birds; needles as food for deer and birds; bark and twigs for beaver, porcupine, and rabbits; shelter for deer and birds; famine food (the inner bark) for people; wood and paper; and shining green in the winter landscape. The male cones are catkin-like and clustered at branch ends. In late June the pollen lies thick on the leaves of understory plants, and on us.




One of several less familiar native species around the Upper Valley is red pine, *Pinus resinosa*, which grows in extensive stands on sandy, rocky peaks like Blueberry Mountain and Black Mountain. It is also found now in orderly plantations, especially along highways and as ornamental plantings. This red-barked tree has a more open crown than the white

pine, and its needles are in pairs instead of fives. Its groves are park-like, light, and inviting.

CAUTION
THE BOARDWALK MAY HAVE LOOSE OR UNSOUND BOARDS. PLEASE WALK CAREFULLY AND REPORT ANY UNSAFE PLACES AT THE MEETINGHOUSE OR WITH A NOTE AT THE KIOSK.

### 4. Swamp saxifrage, *Saxifraga pensylvanica*

At this and the next two sites we find the first of the many species of flowering plants growing here, all members of the fourth and final stage of plant evolution (See Appendix B). Their earliest fossils are only about 100 million years old.

The swamp saxifrage is a shy plant that hides away in normally rather inaccessible places. Our boardwalk, though, takes us right through its wetland habitat, and perhaps a dozen or more of them have been shooting up to flower here each May into June, before long-stemmed grasses, sedges, and other taller plants cut off the light, and the deer nip off their apparently tasty flower stalks. Emerging from a cluster of erect lance-shaped leaves, that thin but stout stalk, a couple of feet tall, bears clusters of inconspicuous tiny red flowers.

Swamp Saxifrage

Over the years these saxifrages have been expanding from an original two or three specimens restricted to this small clump to the dozen or more all along the boardwalk, revealing how natural communities are constantly changing on such small scales.

### 5. Water avens (purple avens), *Geum rivale*

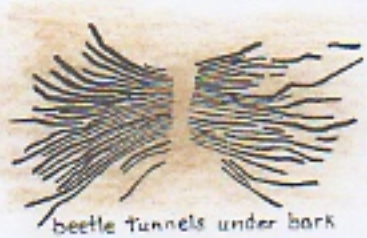
Perhaps the most exotic-looking of the avenses, and the one with the wettest feet, is the water

avens, which inhabits swamps and wet meadows. Its clustered, delicately nodding flowers have deep cups of purple sepals largely enclosing the pale yellowish petals. Much-divided and sharply toothed pale green leaves add to the elegant form and strange palette of the thickets of these avens that rise above the sphagnum and dark pools of water. Like its neighbors, swamp saxifrage and dwarf raspberry, these lovely flowers emerge in May, before taller swamp plants grow up to block the sunlight, but they wave their spidery purple seed pods into July.

American Elm

### 6. American elm, *Ulmus americana*

Many small but mostly dead or dying elm trees are growing along the boardwalk. Until it died a few years ago we had one mature and healthy specimen growing at the entrance to the original Meetinghouse. As you probably know, American elms have largely succumbed to Dutch elm disease, which is caused by a fungus that invaded from Europe in 1930, then spread to infect the entire continent. This is a particularly dramatic example of unintentional human introduction of a lethal alien species, though this invasion has been not nearly so devastating as the virtually total extermination of the American chestnut, eastern North America's once-overwhelmingly dominant forest tree, by chestnut blight, which was introduced by another alien fungus.



beetle tunnels under bark

Young elms usually thrive for a few years, commonly reaching heights of a few tens of feet before being killed by the fungus. If you look carefully among these dying trees along the boardwalk, you may see traces of the characteristic tunnel systems which are excavated below the tree's bark by larvae of the elm bark beetle, which transmits the fungus from tree to tree.

elm bark beetle

This is one of relatively few animal signs here on the path, where one can be all but totally unaware of the animal presence. In early summer, though, we hear the whistle of the neighborhood cardinal, the

rollicking "witchity witchity" song of the yellowthroat, and the more musical offering of the song sparrow from farther back in the undergrowth. The animals that most of us are aware of, though, are black flies and mosquitoes in May and June. Less obvious are the sapsuckers, who have left their distinctive arrays of sap wells on some trees (see Apple: #11). Here on the boardwalk we may also find droppings left in the night, and hidden back in the sheltered wetland glades are well-trodden deer paths. We see their tracks in snow on the winter boardwalk also, along with those of squirrels, ravens, other birds, and smaller rodents. It is clear that more animals live here than meet the casual human eye.


Where do animals (Domain Eucarya of course) fit in life's ecological web? Collectively we occupy the herbivore, carnivore, and omnivore levels of food webs. We take organic molecules built by plants from water and carbon dioxide, and we shuttle those molecules on to the decomposers, who finally tear them apart, releasing the last of the energy captured in photosynthesis by plant chloroplasts, and renewing environmental water and carbon dioxide supplies. The oxygen we all use to break down those molecules of course was created as a byproduct of that original synthesis by the plants.

Even those black flies and mosquitoes that we encounter here are part of this intricate system by which the global community, in simply living its individual lives, sustains stable conditions of climate and of ocean, soil, and atmospheric chemistry. The biosphere has been sustaining itself in this way forever, since even before plants and animals evolved, having taken control of environmental regulation four billion years before humans came on the scene to "manage and improve" its work. The living community keeps the planet clean and livable for itself and for us. It would continue to do so if we had the sense simply to let it do its work, that is, simply to let it all live.

## 7. Swamp horsetail, *Equisetum litorale*

The horsetails share the life cycle of the ferns and clubmosses, and the familiar adult plants produce spores (from cone-like tips of the stems) rather than flowers, pollen, and seeds (see Appendix B). The plant body is distinctively hollow, grooved, and jointed, somewhat like bamboo. Horsetail roots take up minerals dissolved in water. Grains of silica (quartz) that are then deposited in the stems produce the grittiness that made these plants useful for scouring pots and pans in primitive societies. When gold is present, they absorb that too, and they have sometimes been assayed by prospectors seeking gold deposits. Together with ancient club mosses and ferns, horsetail ancestors 300 million years ago grew up to 100 feet tall and 3 feet in diameter, forming waterside forests that are now preserved in Appalachian coal seams and as abundant fossils in associated rocks.


Here along the shaded parts of the boardwalk you see conspicuous groups of swamp horsetails, with tall and straight, but fragile, hollow, thin-walled green stems bearing whorls of quite thin, straight branchlets. With some searching around the edges of the meadow and yard areas you might also find some of the small, irregular, scrubby field horsetails that are scattered there. Also present on the property, though not easily accessible in the deeper parts of the wettest woods, are small patches of the tiny, curly, matted, dwarf horsetail, the smallest living species. Look for the stem-tip spore cases of horsetails when they mature during the summer.


## 8. *Sphagnum* and other mosses

Here we see a representative of the oldest and first among the four evolutionary groups of land plants (see Appendix B). Nearly all of the mosses and liverworts have remained small because they lack the vessels that are necessary for transporting water and

nutrients through the bodies of larger plants. The genus *Sphagnum* contains nearly 400 species (ours have not yet been identified), and it is one of the dominant plants of this wetland, as it is of swamps and especially bogs in general. These are much larger than most mosses because, living in water, they need no internal transport vessels. Its spore-bearing appendages are not conspicuous, but those of other mosses can be seen as thin hair-like crowned stalks growing from the tips of the familiar leafy plants by early summer. Watch for the many species of mosses, unfortunately none of them identified here, that grow on soil, rocks, and trees.

### 9. European and glossy buckthorn, *Rhamnus cathartica* and *R. frangula* (aliens), and other invasive alien species

Both of these buckthorn species, native to Europe, have been planted extensively on this continent, in part to provide berries for wild birds. Because they immigrated unaccompanied by natural enemies, they have spread aggressively here, overwhelming habitats, displacing native species, and thereby reducing diversity. As you have read above, other alien intruders have caused even more devastating environmental catastrophes like chestnut blight, Dutch elm disease, west Nile and other deadly viruses, and the decimation of native creatures on tropical islands like Hawaii, where most of the flowers, other plants, and birds that tourists flock there to see are aliens.

Of some 150 plant species identified on our land, at least 46 are not native to this region. The buckthorns are especially intrusive, as they totally dominate the woodlands and the wetland, many of them with trunk diameters up to 4-6 inches. Other aggressive aliens here include Morrow's honeysuckle and Canada thistle (see #19). Even seemingly wild and natural New England has a largely altered,

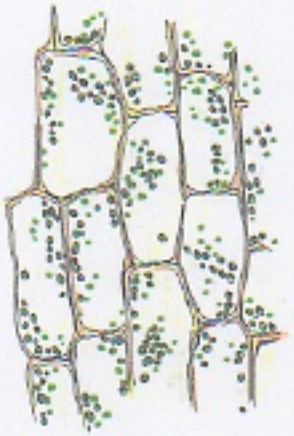
European Buckthorn

Glossy Buckthorn

alien landscape with displaced species, disrupted ecosystems, and threats from new diseases.

### 10. Chloroplasts, symbiosis, and evolution

Have a seat at the Octagon and enjoy the cool greenness. Green is the color of chlorophyll molecules, which capture energy from light, that energy then cascading from plants through animals, fungi, microbes, viruses, and sustaining nearly, but not quite entirely, all life forms on the planet. Most of that captured light comes from photons in the red and blue parts of the solar spectrum, so that the unabsorbed photons from the green center of the spectrum are reflected to our watching eyes. (It is the death of chlorophyll molecules in the autumn that leaves plants colored briefly by red, orange, and yellow pigments.)



Chloroplasts in leaf cells

Chlorophyll molecules reside in chloroplasts, which are tiny bodies, or organelles, within the cells of leaves and other green plant tissues. The many chloroplasts that occupy each plant cell embody one of the great wonders of evolution. Each chloroplast not only contains chlorophyll, but it also carries its own genes in a single circular chromosome, while the paired linear chromosomes carrying the plant's own genes are in the nuclei of all its cells. Moreover, the chloroplast's single chromosome carries other features which make it totally unlike those of plant chromosomes, but identical with those of bacteria. In fact, the genes they carry are bacterial genes, and these are, or once were, bacterial chromosomes.

In recent decades biologists have learned that all chloroplasts of plants, algae, and other non-bacterial photosynthetic creatures originated some billion years ago, when photosynthetic bacteria (carrying naked chlorophyll) came to live within the cells of other, non-photosynthesizing bacterial species. Perhaps they had been consumed. Perhaps they were initially parasites. Whatever their original relationship,

some of them eventually became permanent residents, living within the host cell in symbiotic association and sharing their own products of photosynthesis in exchange for the benefits of that home.

One or more of these symbiotic pairs evolved to form the first algae, which in time gave rise to mosses, ferns, and finally the higher plants. By then the original nature of the newly evolved chloroplasts was lost, except for their possession of bacterial chromosomes and genes. Most of the original genes also have now been lost, leaving only the few that are necessary to photosynthetic processes. Around you here are just a few of Earth's quarter million living plant species. All exist as a result of those symbiotic associations among different species of bacteria a billion years ago.

The same is also true of animals, fungi, and all other eucaryotes as well, for their source of energy, from the oxidation of organic molecules, is in mitochondria, which are similar tiny organelles that contain bacterial chromosomes and have a similar evolutionary origin through ancient symbioses. If these two symbiotic associations had not emerged, the biosphere would have no chloroplasts or mitochondria today, and Earth would have no plants, no fungi, no animals, no humans, no mindfulness, no minds. This is one of the most powerful demonstrations that the truly creative force in life and in evolution is not competition, but cooperation through symbiosis. It's not a dog-eat-dog world; its a dog-help-dog biosphere.

Symbiosis, literally "living together", is a universal feature of life, as virtually no creature on the planet lives without one or more symbiotic partners. Probably you have seen cowbirds feeding on and around cows, and have heard about clown fish and anemones aphids and ants, and other well-known symbiotic teams, species that live together and share or exchange resources. This symbiotic evolutionary origin of both chloroplasts and mitochondria is one of

DNA in mitochondria

the most powerful demonstrations of the fundamental role played by symbiosis in the origin, evolutionary creativity, and sustainability of life on Earth, and you will find more remarkable illustrations of this as you read on. It's not a dog-eat-dog world at all; it's dog-help-dog!

### 11. Apple, *Pyrus malus* (alien)

While several crabapple species and the closely related common pear are native to North America, the wild, or common, apple, from which thousands of varieties have been developed both in cultivation and by accident, is native to Europe and Asia. Apples and pears have been cultivated by humans in that region for at least 2000 years. Enormous numbers of gamebirds, songbirds, mammals, insects, and other animals now feed on countless apple varieties, many of them growing wild in old orchards or scattered through fields or woods throughout the Upper Valley, as do many of us human gleaners. In addition to the several large trees on the back lawn, hiding here in the woods are a few scattered trees, which have become greatly elongated by striving toward the light that has become increasingly distant as taller forest trees have grown up around what apparently once was a small orchard.

The horizontal rows of small holes in the trunk and branches of this tree have been drilled by sapsuckers, a woodpecker species that returns repeatedly to feed on insects attracted to the sap and to drink the sap itself. On hot days of late summer, the birds flock to these sap springs, perhaps made more attractive by fermentation in the heat. Unfortunately, though attractive to some birds and other animals, many trees are killed by girdling, when the ranks of holes have been gradually extended and enlarged until they coalesce, cutting off the upward flow of water from the roots and downward flow of chlorophyll-created food.

### 12. Enchanter's nightshade and dwarf enchanter's nightshade, *Circaea quadrisulcata* and *Circaea alpina*

Notice that the name of the genus is *Circaea*, for Circe, the enchantress. It is said that Circe used this plant in the potion she brewed to turn Odysseus's companions to swine. Though called a nightshade, it is in the evening primrose family and unrelated to the true nightshades, and, though inedible, it is not poisonous. The dwarf is smaller, 3 to 10 inches tall rather than 12 to 24, and has 1- to 2-inch leaves more coarsely toothed than the 2- to 4-inch leaves of the larger species. Though these alien species are uncommon in North America, both have grown together at this spot and also separately throughout the woods, their clusters of tiny pairs of two-lobed white flowers appearing in July and August.

Enchanter's Nightshades

### 13. Helleborine, *Epipactis helleborine* (alien), and mycorrhizal fungi

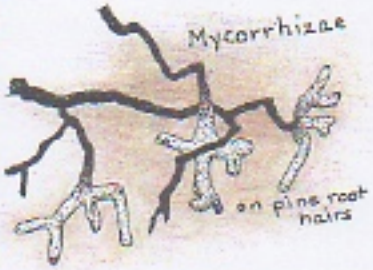
The alien helleborine, the only woodland orchid on this property, blossoms in these white pine woods in July and August. It is not abundant here, and its presence at specific sites is not reliable from year to year, but two specimens have grown and bloomed at this spot in 2017. If it is missing here when you read this, you might still find others among the nearby trees. Its presence reveals that the soil is extensively populated by mycorrhizal fungi, without which no orchid can survive, and their seeds will not germinate.

Shelf Fungi

The fungi (mushrooms, molds, mildews, and others) are not plants, but constitute a separate eucaryote kingdom of their own, and, to our surprise, they are more closely related to animals than to plants. No fungus has chlorophyll, and they all live either as parasites or as "saprophytes", feeding entirely on dead organic remains. Mushrooms and the like are the reproductive structures of fungi, the bodies of which are in the form of sometimes vast webs of white, thread-like hyphae that penetrate

through soil or through living tissues or dead or dying bodies of plants, animals, and other creatures, or any other organic materials.

The mycorrhizae are a large and varied group of soil fungi that live only in symbiotic association with almost all plants. Like most fungi, the elaborate networks of threadlike hyphae that constitute their bodies extend widely through the soil. Hyphal tips penetrate plant roots in a permanent association, through which the fungus obtains sugars and other nutrients from the plant in exchange for enormously increasing the plant's uptake of water and dissolved minerals. These fungi rely entirely on their plant hosts for all their nutriment, and most plants depend on the fungi for anything other than a marginal existence. As some 90 per cent or more of all plants on Earth are engaged in these mycorrhizal symbioses, it is clear that the planet's vegetation would be enormously less luxuriant without it. It is highly likely, in fact, that the very first plants evolved, hundreds of millions of years ago, from some similar alga-fungus symbiosis. Among the many living species of mycorrhizal fungi are included those that produce such familiar mushrooms as some of the boletes, chanterelles, amanitas, and many others.




Even more extraordinary than just these mutual benefits, the mycorrhizal hyphae serve as conduits through which any of their host plants that are living in shade or poor soil or otherwise inhospitable sites can obtain nutrients from more favorably situated plants. Nearly all plants, then, are not independent creatures at all, but all are connected together in the soil, feeding the fungi that sustain their own water and nutrient supplies and that provide them with the means to share resources among themselves.

Anywhere one walks, in forest, meadow, or grassland, and especially in nutrient-poor habitats like bogs and deserts, nearly all the plants one sees are connected together in the soil, feeding the fungi that sustain their own water and nutrient supplies and that

provide them with the means to share resources among themselves.

Further, all orchids, and a number of other plants as well, cannot exist at all without their mycorrhizal associates. Orchid growers know that their seeds will not even germinate if a suitable fungus is not present in the soil, and the plants, once germinated, will die if the fungus is eliminated. When you see the helleborine in our pine woods, remember that they are here only because of the presence and health of the vast network of mycorrhizal fungi that penetrates the soil beneath your feet, otherwise revealing its presence only when spore-producing mushrooms rise in season above the ground. This symbiosis, like those of the nitrogen-fixing bacteria and the lichens, is another of major global significance, playing profound roles both in ecosystem functioning and in evolution. It truly is a dog-help-dog world!

mushrooms of mycorrhizal fungi

CAUTION

AT THE PATH JUNCTION JUST BEYOND POST #13 THE ORANGE-MARKED PATH PROCEEDS STRAIGHT AHEAD, AND THE YELLOW-MARKED PATH TURNS SHARP RIGHT. BOTH ROUTES CAN BE HAZARDOUS, ESPECIALLY DURING AND AFTER WET WEATHER. PLEASE BE CAREFUL, AND TURN BACK IF THE PATH IS BLOCKED OR OVERLY SLIPPERY. THIS SPIRIT-IN-NATURE GUIDE CONTINUES TO THE RIGHT ON THE YELLOW PATH THROUGH SITES 14 THROUGH 16, THEN REVERSES DIRECTION AND RETURNS BACK ACROSS THE BOARDWALK.

poison ivy in wet woods

### 14. Christmas fern, *Polystichum acrostichoides*

Several of our many New England fern species are evergreen, but this is the one that is conspicuously hardy and robust all winter, when it splashes dark green bouquets of spreading fronds across colorless landscapes. Spores are produced in ranks of red-brown capsules under special leaves among the thick, shiny, spiny-tipped, almost holly-like foliage. The leaves provide emergency food for snowshoe hares and other animals in hard winters. The Christmas fern is common here in both our dry and wet woodlands.


### 15. Witch hazel, *Hamamelis virginiana*

Witch hazel is also present in the screening hedge (see #26). A liniment made by distilling its bark and leaves in alcohol is a healing astringent used for bruises and skin irritations. The Iroquois People used the leaves to make tea, which they sweetened with maple syrup. Witch hazel also bestows the last wild flowers to bloom in the New England year. These extraordinary, delicate blossoms may appear in October, even after the leaves have fallen, and often they are still blooming into December, a last bit of summer color in the early winter landscape. By spring the seeds will have been flung explosively into the surrounding woods by an ejection mechanism in the drying seed pods.


### 16. American hornbeam, *Carpinus caroliniana*

Hornbeam nuts, buds, and catkins are eaten by birds, squirrels, and other animals, and deer sometimes feed on leaves and young twigs. This small tree's name comes from "horn", suggesting toughness, and "beam",

from the German "baum", meaning tree. Also known as ironwood, its name describes the close-grained, very hard, and heavy wood, which has been used for bowls and dishes, levers, and hammer handles. The tree even looks tough, as its short, crooked trunk is irregularly fluted, resembling the muscles of a flexed human arm. The small nuts are enclosed in three-lobed, leaf-like, green bracts, and the long, hanging clusters of these are quite distinctive and unusual.


CAUTION

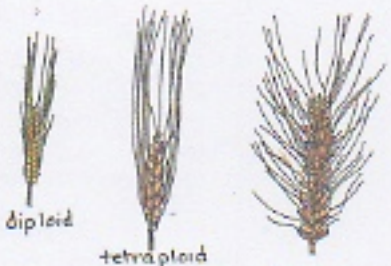
FROM THIS POINT ON THE YELLOW PATH BECOMES ROUGHER AND SEASONALLY QUITE WET AND TREACHEROUS. TO CONTINUE FOLLOWING THE NUMBERED SPIRIT-IN-NATURE SEQUENCE RETURN THE WAY YOU HAVE COME, GO BACK ACROSS THE BOARDWALK, AND TAKE THE FIRST RIGHT TURN INTO THE MEADOW.

**17. Willows, hybrids, genome duplications, and the global organism**

At least three species are growing here: pussy willow (*Salix discolor*), bebb willow (*S. bebbiana*), and black willow (*S. nigra*). It is difficult to know if there are others, for willows are highly variable in form, and they commonly interbreed to produce a bewildering array of hybrids, mingling the characteristics of the combined species.


Plants, in fact, are much more flexible with their chromosomes than are most animals. Many species have duplicated all or parts of

their genomes one or more times during their evolutionary history, providing opportunities for more rapid evolutionary change, as extra copies of genes are subject to mutation, which may give rise to novel biological features. "Polyploid" wheat and other grains have become more robust and heavily seed-producing as their original diploid condition, with chromosomes in pairs, has multiplied to "tetraploid" (four of each chromosome), and even "hexaploid" (six of each chromosome), or higher. Much less commonly a few animals also have duplicated chromosomes. Several such events are now thought to have occurred during human evolution.



wheats

Chromosome duplications are but one aspect of the stunning power and capability of DNA. In a sense, every DNA molecule on the planet has lived an unbroken chain of existence for four billion years, at every cell division its two strands separating and each one building a new mate. Earth's entire, incomprehensibly vast population of DNA molecules therefore can be thought of as a single, immortal, global organism. One might even consider all individual living creatures, including ourselves, as merely vehicles created by DNA to carry itself from one generation to the next.


human chromosomes during mitosis

The genetic differences between species, and between individuals within species, provide their DNA with variation from which natural selection chooses characteristics to improve not only the fitness of individuals and species but even the fitness of the entire ecosystem. Especially favored are characteristics that extend and improve the effectiveness of symbiosis and other cooperative interactions, because these are all-powerful forces both in ecosystem fitness and in evolutionary change. In short, the global population of DNA has for four billion years or so been constantly varying its myriad individual molecules in order to

improve its communal adaptation to environments everywhere and the effectiveness of the associations of its many-specied parts. In the process it has produced mind, consciousness, intelligence, and awareness of its own existence.

### 18. Virginia rose, *Rosa virginiana*

In 2004 the UUCUV held a sort of Native Plant Revival. As one of our activities in qualifying for Unitarian Universalist Association Green Sanctuary status we obtained a small forest's worth of native shrubs and trees, especially species that provided flowers and food for wildlife, from the New Hampshire state nursery. First we took orders from members of the congregation for native plants to be grown on their own properties. After those orders were all filled, we planted the leftovers on the Meetinghouse grounds, from the lawn area to the meadow and the wetland. Most of these plants failed to survive in the long term, but the few long-term survivors include gray dogwood and American mountain ash (see #30), and the star of that show has been the Virginia rose, which you can see here spreading through the meadow. This is a widespread native species, growing in moist to dry thickets and meadows.

### 19. Canada thistle (alien), *Cirsium arvense*

This species is easily distinguished from the many other thistles by its numerous small purple flowers and intricately twisted leaves. Like most thistles it is biennial, a ground-hugging rosette of leaves growing the first year and wintering under the snow, then sprouting the characteristic prickly flower stalk the second spring. This alien species is a

particularly intrusive pasture and meadow weed, difficult to eliminate because of its spreading underground stems. Native to Eurasia, it is now established from Labrador to Alaska and south to the Gulf of Mexico.

It was decided in June, 2003, that we might try to eradicate this thistle from our land. Over several years a small group of UU thistlephobes uprooted many thousands of plants, and after a decade the invaders were reduced to fewer than some dozens each summer. They staged a minor resurgence during the distraction of the new building construction in 2015-16, but now in 2017 they seem to be coming under control again.

For this new 2017 edition of the path guide we have chosen to retain this posted station for its educational and historical value, but we no longer retain a living plant here. If you see any thistles growing here, feel free to uproot them (but wear gloves, or, better yet, just tell us about them).

Canada Thistle eradication

## 20. Goldenrod, *Solidago* sp., and plant galls

During the couple of decades that we have been paying attention, this meadow has provided a dramatic demonstration of the constantly changing nature of many biological communities. The small grove of trees you have just walked through has sprung up anew out of low grasses, thistles, and other meadow plants, which until a few years ago were accompanied by a thicket of ostrich ferns crowded along the Meetinghouse end of the path, with a band of goldenrod around it, mostly to the south. Now we have removed the thistles, the ferns have retreated, and the goldenrod has taken over the meadow to the near exclusion of grasses, sedges, and other

21. Ostrich Fern, ***Matteuccia struthiopteris***

This is the fern of epicurean fiddlehead fame. In late summer the ostrich fern produces spores in small beads, which are clustered by the hundreds on separate feather-like fronds, green in the spring, then turning brown and usually remaining upright through the next winter. You will see them here. When the spores are mature, they will come off like colored dust on your hand.

Ostrich fern

22. Orchard and children's garden

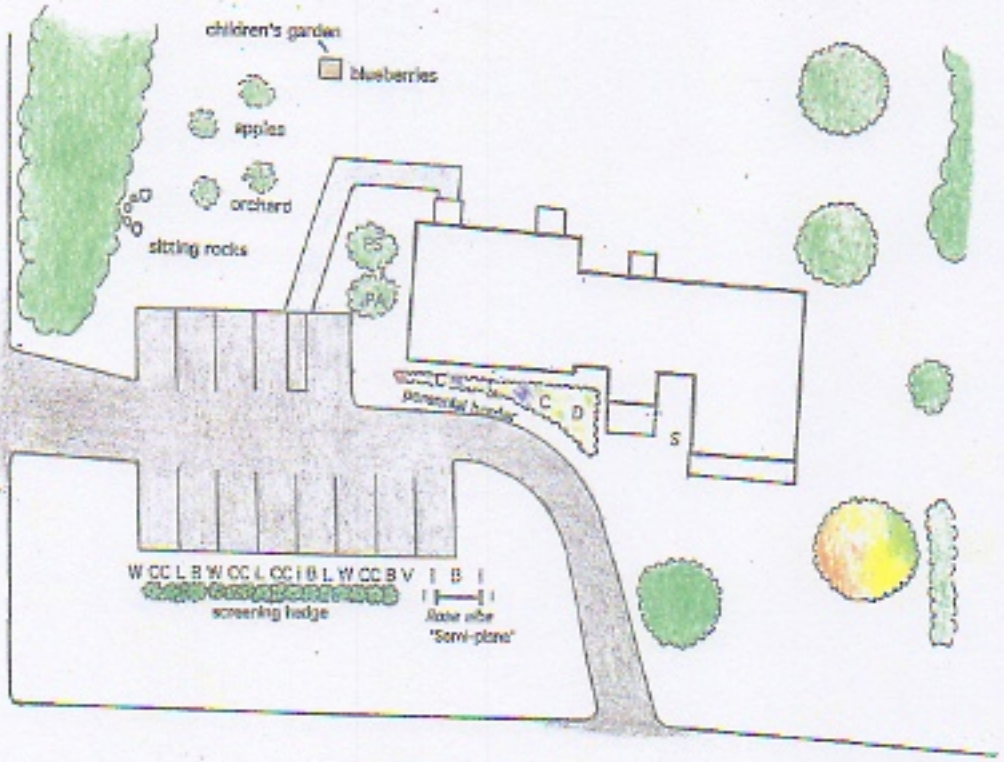
To the south of the Meetinghouse are the orchard and children's garden. Four rootstock apple trees will be grafted with scions from our two ancient and tasty apple trees (see #31, Lichens) to preserve their good genetics. The plum trees are *Prunus 'Alderman'* (red plums) and *'Superior'* (yellow/pink plums). The fenced children's garden contains a variety of hardy blueberries, *Vaccinum* sp. (See Appendix 3.)

23. Clovers, legumes, and nitrogen

Around the orchard and in the June and July meadow and lawn look for cow vetch as well as red, white, yellow, and Alsatian clovers (all aliens, incidentally). If you ever have occasion to dig one up, look for the tiny nodules on the roots. They are packed with nitrogen-gleaning microbes.

Red Clover

In fact, all the plants in the huge, worldwide legume family engage with certain microbes in yet another extraordinary symbiotic association. In this case several species of bacteria and protozoa are the only creatures on the planet that are able to "fix" nitrogen, to convert this essential element to ammonia and




Shrubs and Trees 2016

W witch hazel
CC chokeberry
L lilac 'Charlie X'
B bayberry

I inkberry
PS plum 'Superior'
PA plum 'Alderman'

D doublefile viburnum
S downy serviceberry
C *Clethra* (summersweet)
V *Viburnum carlesii*

nitrates, the forms in which virtually all other living beings can use it. Most nitrogen fixers occupy nodules on the roots of legumes -- peas, beans, alfalfa, clover, and their many prolific relatives, though a few other kinds of plants engage in these associations as well. In exchange for a home and food, they fix nitrogen -- for themselves, for their plant hosts, and, by prolifically stocking the soil around them, for all plants, animals, fungi, microbes, and other creatures, including you and me. Thus this symbiosis benefits not only the two associated species, but the entire planetary biosphere as well. Without it neither plants nor animals, nor all the rest of life on Earth, would exist with the abundance and diversity that we know them. Its dog-help-dog, over and over again.

legume root nodules

### 24. Sitting rocks: native shrubs

Behind this crescent of rocks are the native woodland-edge shrubs pagoda dogwood, *Cornus alnifolia*, and American fly honeysuckle, *Lonicera canadensis*, which has drooping pairs of yellow bells in spring followed by twinned pink berries in summer. (Also see Appendix 3.)

### 25. Quaking aspen (popple), *Populus tremuloides*, and clones

Cloning is much more common among plants than among animals, and the quaking aspen is one of the most striking examples in North America. Both quaking and bigtooth aspens grow here and both are prolific producers of early spring catkin flowers and seeds. The quaking aspen also spreads rapidly, though, by sending up clones from underground runners.

The aspens in this narrow grove on Palmer Court may all be clones, though it is difficult to know, as there are no obvious distinguishing features. If, however, you have been in western mountains in the fall, you have probably seen how large aspen groves commonly are a uniform autumn gold throughout, while different groves are somewhat different shades from one another. Each grove, often thousands of genetically identical trees, is a forest of clones, each grove with a slightly different clock for color change.

## 26. Screening hedge

This hedge running between the parking lot and Route 5 contains native shrubs, with the exception of a dark purple lilac, *Syringa vulgaris 'Chales X'* (circa 1830), and the scented Korean spice viburnum, *Viburnum carlesii (19th c.)*. The two evergreen shrubs are our native holly, the inkberry, *Ilex glabra*, and northern bayberry, *Myrica pensylvanica* (crush a leaf for the scent); the waxy berries are used to make candles. Chokeberry, *Aronia melanocarpa*, was named for its mouth-puckering berries, which flavor many foods, including gummi bears. Autumn-flowering witch hazel, *Hamamelis Virginiana*, is discussed above (also see #16); watch for its fragrant yellow ribbons in the fall. In front of the meter structure is *Rosa Alba 'Semi-plena'*, which is thought to be the 'White Rose of York' from the 15th c. British Wars of the Roses and has been long cultivated for rose oil (attar of roses). (Also see Appendix 3.)

witch hazel

## 27. Meetinghouse entrance

To the right of the entrance is a native running serviceberry, *Amelanchier stolonifera*,

also called juneberry and shadbush or shadblow because it blooms early in the spring when the shad are running, as up Mink Brook in Hanover. In the fall it has red berries that birds love and humans eat in pies.

To the left of the entry is a doublefile viburnum, with white flowers in tiers in spring and clusters of berries in the fall. *Viburnum plicata f. tomentosum* was imported from Japan in 1814 and was selected here for its resistance to the Eurasian viburnum leaf beetle, which has been defoliating native viburnums since the 1990s.

The perennial border contains plants that are either native to our area or were imported by the mid-19th century, so could have been grown in the gardens of our Greek Revival style farmhouse. Shrubs include native summersweet, *Clethra alnifolia 'Paniculata'*, and 'Mme. Hardy' rose (1832). (See Appendix 3.)

28. Linden (American basswood), *Tilia americana*


In the Great Lakes region the basswood (the forester's name) is an important tree for cabinet making and musical instruments. Quail, squirrels, and other animals eat the seeds, while deer and rabbits browse leaves and twigs. Its fragrant flowers produce a honey that some say is unsurpassed in flavor and delicacy, and the leaves are used to make tea. Other species of this family in India provide jute, which is used in burlap, cord, and gunny sacks.

The linden (the horticulturist's name) in the front yard is our Celebration Tree -- planted as part of the celebration service in June of 1997, just after we had purchased this property. After the service, Religious

common meadow plants (see #33, grasses, .). In August, 2017, from inside the Meetinghouse one looks out the doors at a world framed in a shining wave of gold. If we leave it alone, of course, it will all go eventually to trees.

About 70 species of goldenrod grow in the northeast, making this the most diverse wildflower genus, but we have not yet identified any of the species growing here. By middle summer many goldenrod stems will be occupied by roundish swellings about an inch in diameter. These swellings are galls, and they are initiated by certain species of insects that inject their eggs, together with plant-growth-hormone-mimicking chemicals, into the growing stem. The plant responds by growing the solid fleshy gall around the eggs, and the worm-like larvae then consume the inner parts of the gall tissue. (If you cut into a goldenrod gall while it is developing, you will probably find a larva inside.) Later they metamorphose, eat a hole to get out, and fly away, leaving the conspicuous hollow gall on the dry stem through the winter.


More than 2000 species of insects (also fungi, bacteria, viruses, worms, and even some plants) are known to produce distinctive galls on many kinds of plants. Other insects, called inquilines, deposit eggs in already existing galls, so their larvae can share in the vegan meal. Nature has also provided parasitic species, whose larvae consume the offspring of both gall insects and inquilines.

In these symbioses all the benefit seems to go to the insects, though the plants usually do not appear to be harmed. Oaks are the most heavily galled plants, but many other species have galls on leaves, stems, or flowers. Can you find any others here, where they are often common on willow, grape, or dogwood leaves?

Education Director Sparrow Alden conducted the first community walk across the wetland and into the woods. Then a blessing bag was buried in the lawn south of the furthest apple tree. The final event that day was the planting of this linden tree, then just five feet tall with two spindly branches. Since then our now-robust Celebration Tree has been watered each year by pourings from the September water ceremony, and it is the site of various other celebratory gatherings. May this tree thrive in remembrance of our coming to this land and as a living symbol of our Green Sanctuary.

### 29. American mountain ash, *Sorbus americana*

This is another of the native plants we obtained during our Native Plant Revival in the summer of 2004. In the wild it grows most commonly on high mountain slopes. Because of its elegant dark green, sharply-toothed, pinnate leaves, showy bunches of white flowers, and striking clusters of bright red berries, it is also widely grown as an ornamental, along with the European species *Sorbus aucuparia*.

### 30. The lawn

This grassy lawn, like lawns everywhere, is the quintessential symbol of human dominance over nature -- our insatiable need to tame and control the wild world, to reduce it to a clipped, contained, unthreatening domestic subservience. In our human strongholds we not only exclude everything but grass; we even exclude undesirable varieties of the grasses themselves, and all are trimmed and shaped to human pleasure and decree.

Selfheal

But have you looked closely at this lawn? Is it really so? No. Of course not. Not at all. By the end of July, mingling down among these grasses, happily trampled and regularly mowed, you will find, if you look closely, mosses, liverworts, horsetails, a host of tiny treelets, probably fernlets, and at least the following wildflowers: lesser stichwort, mouse-ear chickweed, white and yellow clover, black medick, a variety of violets, moneywort, gill-over-the-ground, selfheal, thyme-leaved speedwell, common and English plantain, and common dandelion. In addition, around the edge of the plantation and in the shelter of the building grows another group of taller plants that prefer not to be mowed, including lady's thumb, doorweed, clearweed, yellow wood sorrel, three-sided mercury, downy and northern willow-herb, Indian tobacco, common ragweed, and certainly others. Wild nature is robust, resilient, invasive, persistent, and ever hopeful, and, thank the gods, like all of life, it refuses to be left out.


## 31. Lichens (on apple tree) and symbiosis

On the bark of the backyard apple trees you will find at least two species of lichens. Look for radiating finger-like lobes in small, thin, pale gray mats, and then for brighter yellow-green, more circular mats with shaggy surfaces. Most trees carry similar encrusting forms or more loosely attached scaly species. On the ground you may find the plant-like reindeer "moss" or the familiar red-topped English soldiers.


Lichens are not plants but consist of a fungus which contains cells of either algae or photosynthetic bacteria. These latter provide their fungal hosts with sugars and other organic molecules in exchange for home,

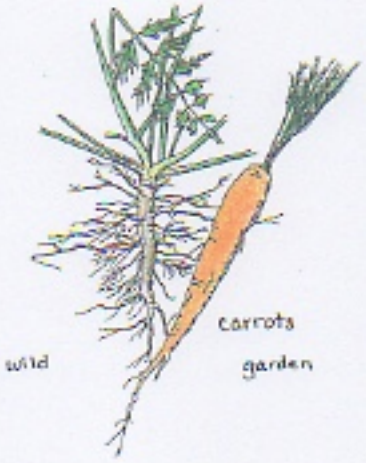
water, and mineral nutrients. These fungal species are entirely dependent on this association and exist only as lichens.

Here is yet another symbiosis, and this one too is of global significance, as some 25,000 species attach to rocks, soil, plant stems and leaves, buildings, and other surfaces in virtually all non-aquatic habitats.


It has been suggested even that lichens may be in the throes of the evolutionary birth, through symbiotic association, of a new kingdom of life. Staying together, and cooperating, has long been a path to ecosystem health and to biological success and survival. For the last time, and admitting that competition plays a fundamental role in life at all ecological levels, it is clear that most of the dominant, world-changing innovations in the history of life on Earth have been facilitated and driven by the cooperative interactions of symbiosis, of living together for mutual benefit.

### 32. Queen Anne's lace (birds' nest, wild carrot), Daucus carota (alien)

Another alien and now one of our most familiar meadow flowers from summer into fall, Queen Anne's lace is the same species as the garden carrot. This is a biennial and if you leave carrots in your garden through the winter, they will grow in the second summer into something like the wild Queen Anne's lace, several specimens of which usually are visible in the meadow here in August. One can also dig up the wild plant and find a carrot at its root, though this unrefined wild form is small, white, tough, and scarcely edible. Here is a fine illustration of what selective breeding can do; show it to your evolution-denying creationist friends. Until the past few years



Queen Anne's lace was quite abundant here, but since the goldenrod has taken over, only a few plants remain, mostly in this small remaining patch of grasses and sedges. When its in bloom from July through September, look for the single tiny purple blossom that is usually present in the center of each of the compound flowers.

### 33. Unidentified grasses and sedges; questions, and existential mystery

Among the grasses and sedges we find a high proportion of aliens, which make up as much as 90 per cent of meadow species. This is a consequence of centuries of importation for cattle pasturing. Native grasses, especially those of the once vast tallgrass prairie, have been virtually eliminated from the continent because of their evolutionary adaptation to tip-browsing by roaming bison and elk, while invading Eurasian grassland plant species are adapted to sedentary, close-cropping cattle.


In the absence of someone called to identify our many grasses and sedges, this unnamed lush growth will serve as a reminder of all those species that we have not yet pigeon-holed, also including violets, goldenrods, and mosses; of the species we haven't yet found; and of all that we humans have yet to learn about the living community of which we are a part. We are left then, as always, with cascades of questions. What are these plants? More important, how do they live, and why? Why is there something instead of nothing? How should we be living, we creatures set down here bewildered?

In addition to this basic conundrum of the meaning of life, science in the past century, even as it has yielded explanations of once-puzzling phenomena, has increasingly revealed

to us the seemingly incomprehensible nature of the universe. The more we understand, the deeper is our mystification at the nature of reality.

Unlike sound waves, for example, light is found, regardless of the motion of the observer, to travel always at constant speed, one of the few true constants in nature. If one could travel away from Earth at speeds near that of light, one would measure shorter time intervals between events and one would age less than would non-traveling contemporaries. Traveling at the speed of light, if that were possible, one would not age at all. Light also, like all matter and energy, exists as both particles and waves, with the apparently weird consequence that single particles (photons) can travel two paths simultaneously. Even more bizarre, the paths followed by particles are influenced by the actions of human observers, even when observations are made after the fact. (If you have little knowledge of these basic features of the world around us, there are many excellent books that can give non-physicists like most of us something of a sense of the nature of reality.)

Thus our senses betray us at extremes of size and motion; nothing is as it seems, and the world we occupy is bizarre beyond imagining. Even scientists now speak of the mystical nature of the cosmos.

Here in the familiar daily world, meanwhile, if you know some grasses or sedges, or want to learn about them, add your contributions to this guide. If you think you know some paths to addressing some of these other questions, tell us about those too. As Annie Dillard reminded us, "we still and always want waking."

New England Aster

Here at the northwest corner of the yard you will find the memorial stone placed when the Spirit-In-Nature Path was dedicated in October, 2003. Walk back down to the kiosk and you will have completed the circuit and come back to the beginning. You might like to have a seat here now and to contemplate some of what you have seen and learned from your walk.

### 34. The interdependent web of life: a global organism and spirit in nature

What, then, is the nature of life on Earth, and what does that nature suggest about life's origin and its meaning, and about how each of us humans might choose to live our "one wild and precious life".? Consider a train of thought that may bear on this path of inquiry. At least ninety per cent of Earth's plants are connected together in the soil by mycorrhizal fungi in a symbiotic association that literally constitutes a living web that encircles the planet. Less rigidly bound in physical continuity are ecosystem food webs, in which plants grow from sunlight, water, and carbon dioxide; herbivores eat plants; carnivores eat herbivores or other carnivores; and decomposers recycle wastes from all levels to resupply the plants. Global cycles of carbon, nitrogen, sulfur, oxygen, and carbon dioxide and other molecular combinations of these elements link the entire biosphere to the soils, waters, and atmosphere. Through these cycles the biosphere regulates climate. All these networks and cycles combine in weaving into the physical/chemical world the interdependent global web of life.

Turkey
with grape fern

Other symbioses add yet more strands to this boundless web, revealing the powerful role of cooperative interactions in its structure. Essential nitrogen is made available to all

creatures by symbiotic bacteria and protozoa. Nothing lives without one or another kind of symbiotic bacteria or other creatures, and many animals and plants, including ourselves, could not exist without them. All bacteria exchange genes with one another, even among different species. In the seas no coral can survive for long without its algal symbionts. Mitochondria that provide energy for nearly all creatures other than bacteria originated from symbioses among the ancestors of those bacteria, as did the plant chloroplasts that now capture photosynthetic energy from the sun, and begin the distribution of that essential energy to nearly all living beings on the planet. These organelles reveal that even major advances in evolution have been driven by symbiotic associations, further emphasizing the powerful role of cooperative interactions in sustaining life.


Not a vast collection of independent beings, then, we see in nature that all of life is literally an interdependent web, in a sense a single planet-encircling organism, some elements of which may drift together and apart, but which all depend on the integrity of the whole. Life is a global being, of which we ourselves constitute only a few, but the conscious, thinking, waking, questioning, potentially spiritual few, of its uncountable interdependent parts.

But how, and why, does this planet of life exist? So far this suggested train of thought has addressed only the nature of life, but consider now the question of whether nature might also offer a direction of inquiry into life's meaning. Perhaps there are clues in the fundamental properties of the cosmos -- in the structure and behavior of atoms and in a relentless universal process of material aggregation. At its origin the universe consisted solely of hydrogen in the form of

dissociated protons and electrons. Some of the protons immediately fused to form helium nuclei, and in the first few billion years fusion in new-formed stars produced the first of the other elements, including carbon, oxygen, and nitrogen. Thus these essential elements in life, especially in DNA and in their partner proteins, were among those in the vanguard of the on-going evolutionary creation of the 100-odd chemical elements in the cosmos.

The atoms of these elements also embody the universal tendency for matter to aggregate hierarchically to form structures of ever greater size and complexity. We all know how quarks clump to form protons and neutrons; the latter combine in atomic nuclei, and electrons join them to form atoms; atoms then combine in molecules; molecules grow ever larger, ultimately, in life, to behemoths of millions of atoms. Life carries this trend further, molecules building cells, cells forming tissues, tissues constructing organs, and so on to the enormous complexity of black flies, violets, mycorrhizae, the mammalian brain, and the hierarchical structure of ecosystems in the planetary biosphere. The symbiotic and other cooperative interactions described above are further expressions of this aggregational tendency, and they have long been a powerful force in evolution and in ecosystem structure and function. Keeping awake and knowing something of nature thus tells us that the universe seems to have originated in order to create life and that the most effective processes in sustaining ecological communities and in driving the principal evolutionary advances of life on Earth have been these cooperative relationships.

Each of these aggregational steps proceeds only under suitable physical and chemical conditions, of course, and though the sites where such conditions exist are sparse, the

*Through telescopes we see the majestic galaxies stretching away like celestial cities to unlimited distances. Galaxies are the cradles of life. Who can doubt for a moment the existence of life out there in the galaxies ?*

Harrison: Masks of the Universe

cosmos is incomprehensibly large. In places like this planet, places that spangle the universe in infinite numbers, the entire aggregation process can play out, and life, mind, conscious self-awareness, and perhaps spirituality are inevitable, here and elsewhere.

Why is there something instead of nothing? Who are we, and why are we here? Why is there beauty beyond comprehension? We cannot answer these questions, but whatever is responsible for the existence of this universe, integral to the original design are life and mind, the concepts of meaning, beauty, love, and hope, and of freedom, peace, and justice for all living creatures.


## MARCH

*Heaven walks among us ordinarily muffled in such triple or tenfold disguises that the wisest are deceived and no one suspects the days to be gods.*

Emerson

By the end of March, gods willing, ducks and geese will be quacking and honking northward, and the first wildflowers of the new season should also be aloft. "If the snow is off the ground", you say. But snow doesn't matter, for the season's first flowers are on trees. Seize these days. Walk on the paths, where heaven walks. Look overhead for the flowers, and learn to know the plants with whom we share this land.

Alders and pussy willows may be blooming in the Upper Valley by now. Here we have, in addition to pussy willow, at least two other species, so let's watch them for the first spring flowers. On the ground, meanwhile, grasses, clover, and other plants will be sprouting from last year's still-green leaves.

Witch hazel will still be in flower on the yellow path in November, and perhaps in December. It will be a long and glorious season of days, of gods, of flowers, 200 or more species over 9 or 10 months, accompanied by their plant, animal, fungus, and microbe neighbors. Don't miss them.

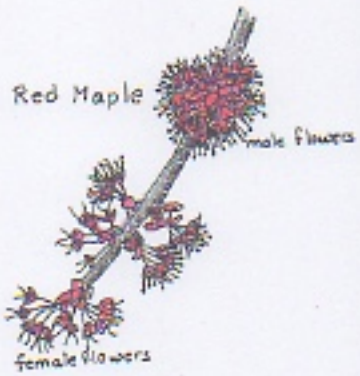
## APRIL

*In the next century or the one beyond that, they say, are valleys, pastures; We can meet there in peace if we make it. To climb these coming crests, one word to you, to you and your children: Stay together, learn the flowers, go light.*

Gary Snyder

April is the month when the eastern forests' most abundant and majestic tree, the American chestnut, once blossomed. Now it is the month of Earth Day, in remembrance, and in hope.

Before all is obscured by erupting flowers and leaves, this might be a good time to search out the lichens. See #6 for an account of these creatures, and look on the trunks and branches of the apple trees and pines, in the ground in the meadow and the lawn, and on the fence by the driveway.




By April's first week red maples should be casting a rosy tint across Upper Valley hillsides, while aspen (popple) and willow catkins will be evident. In mid-April violets will be flowering here, joined elsewhere in the Upper Valley by coltsfoot, bloodroot, trout lillies, hepatica, trailing arbutus, and others. By Earth Day we'll be seeing trillium and dandelions along our paths.

April is a month to celebrate and sustain our mother Earth and her stunning gift of life. Let's offer thanks, and support.

# MAY

*This is our life, these are our lighted seasons, and then we die. In the meantime, in between time, we can see. The scales are fallen from our eyes, the cataracts are cut away, and we can work at making sense of the color-patches we see in an effort to discover where we so incontrovertibly are. It's common sense: when you move in, you try to learn the neighborhood. I am as passionately interested in where I am as is a lone sailor sans sextant in a ketch on the open ocean. What else is he supposed to be thinking about?*

Annie Dillard

Cold winter is now a dim memory, as May's trees sing with north-bound warblers, rhodora and lady's slippers tint bogs and woods, and cowslips and dandelions roll yellow carpets across Upper Valley swamps and fields. Every week now will bring new flowers to the neighborhood, each in its season, to replace the preceding week's fading blossoms. Don't miss the show.


One of our most familiar neighborhood flowers is the low, creeping lawn interloper that spreads a purple blush over yards and fields from May through July. Look for gill-over-the-ground in the Meeting House lawn and scattered through the wet woodland as well.

Yellow is the early color in the meadow. Look for common winter cress, common cinquefoil, golden alexanders, and the ubiquitous dandelion. Yellow wood sorrel, one of the longest-flowering plants, will bloom in the woods from now through September. It will be accompanied in May by ethereal clouds of white foamflower and various colors of violets, while the first blossoms of wild strawberry will speckle woodland edges and the meadow.

May's most exotic floral display of all, though, is in the wetland. Before the canopy of long-legged grasses, sedges, and sweetflag intercepts the light, several swamp denizens will blanket the still-open spaces. Right on the edge of the boardwalk we will find low thickets of dwarf raspberries, crowds of purple water avenses, and, if we are lucky, even a few tiny-flowered swamp saxifrages. This is the best show in May.

And what of the animals? By now we will certainly be hearing the "wichity wichity" song of the yellowthroat. Its nest will be hidden on or near the ground under the grasses and sedges that are beginning to cover the swamp. What other birds can you hear or see?


Wallace Stegner wrote, "I may not know who I am, but I know where I've been." But where, so incontrovertibly, are we? Why is there something instead of nothing? Why is it all so heartbreakingly beautiful? If we try to learn the neighborhood, we can at least know SOME THING about where, so incontrovertibly, we have been.

JUNE

*The driving force in nature, on this kind of planet with this kind of biosphere, is cooperation. . . . Natural selection tends, in the long run,to pick as real winners the individuals, and then the species, whose genes provide the most inventive and effective ways of getting along. The most inventive and novel of all schemes in nature, and perhaps the most significant in determining the great landmark events in evolution, is symbiosis, which is simply cooperation being carried to its extreme. But something vaguely resembling symbiosis, less committed and more ephemeral, a sort of wish to join up, pervades the biosphere.*

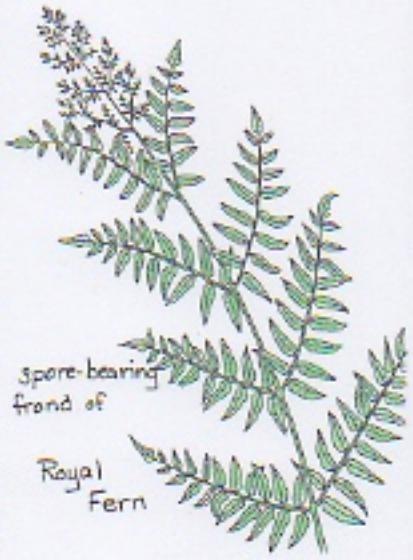
Lewis Thomas

In June plant diversity erupts, as ever more species emerge and ecosystems become increasingly complex and interconnected. Lady's slippers and mountain azaleas are pilgrimage destinations around the Upper Valley (don't miss the showy lady's slippers at Woodstock's Eshqua Bog around the 20th), and after the solstice we will be tasting the first wild strawberries. May typically brings only some ten to twenty new flowers, while june offers more than thirty.

In the wild ground around the parking area look for mullein, bladder campion, and curled dock. In the lawn we may find a few forget-me-nots as well as thyme-leaved and other speedwells, some chickweeds, and selfheal. The latter is another purple flower that grows in the grass like gill-over-the-ground, but it also will keep blooming into September in woods and fields. With it in the woods watch for Jack-in-the-pulpit, tall buttercup, one-flowered pyrola, and starflower.

The two buckthorn species that begin flowering in June raise the issure of alien species, which is discussed in #17. Another alien is the Dutch elm disease fungus, which is transmitted by the elm bark beetle, the larvae of which bore distinctive galleries under the bark of elms. These galleries can be seen on the debarked surfaces of dead elms by the boardwalk entrance kiosk and around the Octagon seating area. This fungus apparently has not yet infected the Elm by the Meeting House door or several others isolated in the woodlands.

In the woods the interrupted fern, cinnamon fern, and royal fern will be shedding spores by the end of June. So will the pines, and by mid-month understory leaves may be spattered with pollen in the pine woods.




The real June spectacle, though, is in our meadow, where 20 or more new flowers emerge in May, including 5 legumes (clover and vetch), which raises another interesting topic. All the plants in this huge, worldwide family engage in an extraordinary symbiotic relationship with certain microbes (see #

12). This is a classic symbiotic association, part of Thomas's "joining up" that pervades the biosphere. As he said, nice guys don't finish last; nice guys last longest.

As is usually the case, then, there is bad news and good news. All lands are overrun with alien plants that disrupt local ecosystems, but essential symbiotic and other community interconnections remain largely intact. Its all part of today's fabric of life, our own planetary community of competing and cooperating neighbors. We, too, should be thinking about ways to join up.

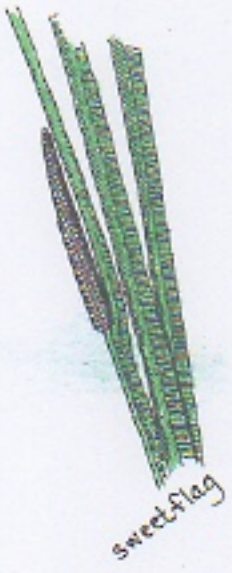
## JULY

*In a holy place with a god I walk;*
*On a chief of mountains with a god I walk;*
*In old age wandering, with a god I walk;*
*On a path of beauty with a god I walk.*

Navajo

For half a season we have been learning the neighborhood, learning the flowers, and walking paths of beauty. In high summer, when the majestic cardinal flower graces shores in the Upper Valley, and we are all out picking wild blueberries and raspberries on chiefs of mountains, its so easy to know the days to be gods.

In July diversity remains high, introducing even a few more new flowers than in June. The lone newcomers in the darkening woods are helleborine, our only orchid, and the two enchanter's nightshades. The wetland's early low plants meanwhile are being overwhelmed by midsummer's taller cattail, sweetflag, day lilly, touch-me-not, Joe Pye weed, and bittersweet nightshade. Only in the open ground of the meadow and the Meeting House yard do new species continue to proliferate.



## AUGUST

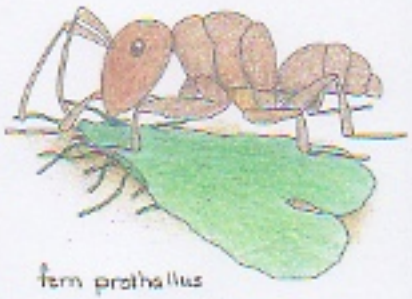
*If we had a keen vision and feeling of all ordinary human life, it would be like hearing the grass grow and the squirrel's heart beat, and we should die of that roar which lies on the other side of silence.*

George Eliot

It is high summer, but Arctic-nesting shorebirds are beginning to swarm southward toward their southern hemisphere winter homes, while here in the Upper Valley you can hear the blackberries and wild plums ripening. July and August together share peak-of-summer honors, as the greatest numbers of plants are in bloom during this season. Some 40 flowers can be seen in the yard area now, and 30-odd in the meadow, as these sun-swept open habitats take advantage of midsummer light and warmth.

Clovers especially continue in abundance, their resident microbes packing the larders with transformed nitrogen. Other meadow highlights in August include the season's first goldenrods and enormous New England asters, harbingers of imminent autumn, and a few brilliant spikes of blue vervain. An apparent bit of good fortune has so far kept the infamous purple loosestrife from invading the wet places. By August the wetland itself remains dominated by tall, light-gathering vegetation, as statuesque boneset joins its near relative Joe Pye weed, as do turtleheads, several other aster species, and the vine-like arrow-leaved tearthumb.

In the dark woodlands, especially under the pines, ghostly helleborine continues in elegant flower, revealing the presence of extensive soil populations of symbiotic mycorrhizal fungi (see #21). Listen for the growing grass, and for the beating of the hearts of squirrels. We can survive ONLY IF we have that keen vision and feeling of all ordinary life.



fern prothallus

## September

*Flower in the crannied wall,*
*I pluck you out of the crannies,*
*I hold you here, root and all, in my hand,*
*Little flower -- but if I could understand*
*What you are, root and all, and all in all,*
*I should know what God and man is.*

Tennyson

In September broad-winged hawks, redtails, and other raptors are beginning to circle southward. We watch them overhead while harvesting wild grapes. The season is turning through the equinox, yet the year's wildflower pageant continues only slightly abated, and October's fewer flowers will vie with flaming foliage in painting the autumn landscape. Still, except for the usual aster and goldenrod species, usually only half a dozen other flowers are still with us in October, while there may still be three dozen in September.

Except for those asters and goldenrods, then, only a scant handful of flowers will survive September's end. Among the many plants that will be ending their season now are several that have been with us for most of the summer. The champion is the yellow wood sorrel, which has been renewing its bright yellow blossoms in yard, meadow, and woodlands since May, nearly half a year in flower. Several others first bloomed in June, including selfheal, yarrow, wild madder, and several fleabanes.

Now that the flowers are beginning to fade for the season, we are reminded to wonder at them, for truly, if we could understand what they are, root and all, and all in all, perhaps we would know better what god and man is. What we think we know is summarized in Appendix B. Then to see the last summer flowers, walk out on the paths, for soon we will have the cold nights of flowerless winter for wondering. What can we understand, we creatures set down here bewildered, about what we are and why, and what is the meaning of the beauty of a flower?

# APPENDIX A

## Spirit-in-Nature Plant List
## UUCUV Meetinghouse Property
## November, 2017

symbols:

NAT: n: native; a: alien

FLR: months of flower or spore production -- March, April, etc.: Mr, Ap, My, Jn, Jl, Au, S, O, N, D.

YD: yard -- lawn, trees
MD: meadow
WT: wetland
WD: woodland (yellow)
WWD: wet woodland (orange)

A: abundant
C: common
U: uncommon
R: rare

04: native plants planted in spring, 2004

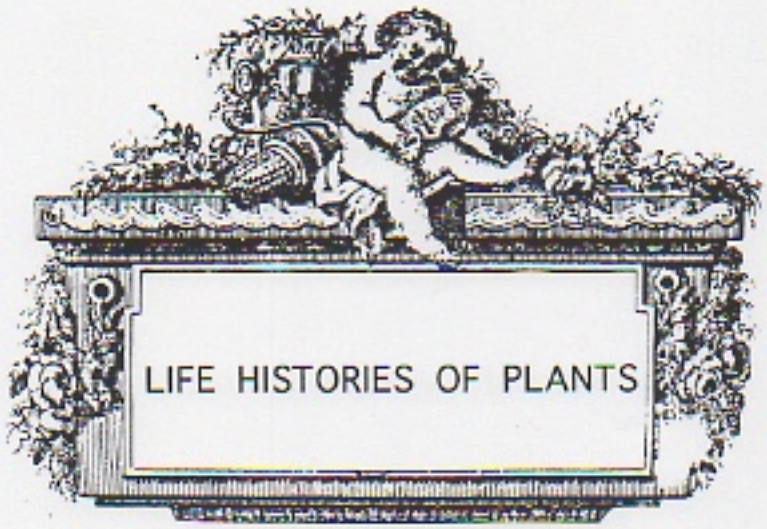
| SPECIES | NAT | FLR | YD | MD | WT | WD | WWD |
|---|---|---|---|---|---|---|---|
| Sphagnum moss *Sphagnum* sp. | n | Jy | U | U | A | U | C |
| other mosses (several unidentified species) | | | | | | | |
| ostrich fern *Matteuccia struthiopteris* | n | 2ndAp | U | A | | | |
| sensitive fern *Onoclea sensibilis* | n | 2ndMy | U | A | A | A | C |
| Christmas fern *Polystichum acrostichoides* | n | ?Jy-O | | | | U | U |
| cinnamon fern *Osmunda cinnamomea* | n | Jn | | | | U | U |
| interrupted fern *Osmunda claytoniana* | n | My-Jn | | | | C | C |
| royal fern *Osmunda regalis* | n | Jn | | | | U | U |
| other ferns (several unidentified species) | | | | | | | |
| dwarf horsetail *Equisetum scirpoides* | n | Jy | | | | | U |
| field horsetail *E. arvense* | n | My | C | A | | | |
| swamp horsetail *E. fluviatile* | n | Jn-Jy | | | A | | |
| white pine *Pinus strobus* | n | Jn | C | | C | A | C |
| eastern hemlock *Tsuga canadensis* | n | My | | | | U | U |
| red spruce *Picea rubens* | n | My | R | | | | |
| common cattail *Typha latifolia* | n | Jy-Au | | U | | | |
| timothy *Phleum pratese* | n | Jy | | A | | | |
| other grasses (many species) | | My- | A | A | A | C | A |
| sedges (several species) | | Ap- | | C | C | | |
| sweetflag *Acorus calamus* | n | Jy | | | A | | |
| common blue-eyed grass *Sisyrinchium montanum* | n | Jn | | C | | | |
| Jack-in-the-pulpit *Arisaema atrorubens* | n | My-Jn | | | | U | U |
| red trillium *Trillium erectum* | n | Mr-Jn | | | | | U |
| Canada lily *Lilium canadense* | n | Jy | | | R | | |
| day lily *Hemerocallis fulva* | a | Jy | | | A | | |
| trout Lily *Erythronium americanum* | n | Mr | | | | R | R |
| sessile-leaved bellwort *Uvularia sessilifolia* | n | My | | | | R | |
| star-of-Bethlehem *Ornithogalum umbellatum* | a | Jn | R | | | | |
| helleborine *Epipactis helleborine* | a | Jy-A | | | | C | C |
| ragged fringed orchis *Habenaria lacera* | n | Jy | | R | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| American hazelnut *Corylus americana* | n | Ap | | | | | |
| American hornbeam *Carpinus caroliniana* | n | My | | | | | U |
| gray birch *Betula populifolia* | n | My | R | | | | |
| paper birch *Betula papyrifera* | n | My | U | | | U | U |
| northern bayberry Myrica pensylvanica | n | | X | | | | |
| American elm *Ulmus americana* | n | Ap-My | U | | C | U | C |
| bigtooth aspen *Populus grandidentata* | n | Ap | | | | U | C |
| quaking aspen *Populus tremuloides* | n | Ap | U | U | U? | U | C |
| balsam poplar *Populus balsamifera* | n | Ap | U | | | | |
| bebb willow *Salix bebbiana* | n | Ap-My | U | C | C | | |
| | | | | | | | |
| black willow *Salix nigra* | n | Mr-My | | U | | | |
| pussy willow *Salix discolor* | n | Ap-My | | U | | | |
| bitter dock *Rumex obtusifolius* | a | Jy-A | U | | | | |
| curled dock *Rumex crispus* | a | Jn | U | U | | | |
| arrow-leaved tearthumb *Polygonum sagittatum* | n | Au-S | | U | U | | |
| doorweed *Polygonum aviculare* | a | Au-S | U | | | | |
| lady's thumb *Polygonum persicaria* | a | Jy-A | U | | | | |
| lesser stichwort *Stellaria graminea* | a | Jn-S | C | C | | U | |
| long-leaved stichwort *Stellaria longifolia* | a | Jn | C | | | | |
| mouse-ear chickweed *Cerastium vulgata* | a | Jy | U | | | | |
| | | | | | | | |
| clearweed *Pilea pusila* | n | Jy-S | C | | | | |
| soapwort *Saponaria officinalis* | a | Au | | U | | | |
| bladder campion *Silene cucubalus* | a | Jn-O | U | | | | |
| tall buttercup *Ranunculus acris* | a | My-Au | | C | | C | C |
| Japanese barberry *Berberis thunbergii* | a | Jn | | | | | U |
| creeping yellow cress *Rorippa sylvestris* | a | Jn-S | U | | | | |
| common winter cress *Barbarea vulgaris* | a | My-Jn | | U | | | |
| toothwort *Dentaria diphylla* | n | My | | | | | R |
| live-forever *Sedum purpureum* | a | Au-O | U | | | | U |
| foamflower *Tiarella cordifolia* | n | My-Jn | | | | U | U |
| | | | | | | | |
| swamp saxifrage *Saxifraga pensylvanica* | n | My | | | U | | |
| witch hazel *Hamamelis virginiana* | n | S-D | | | | | U |
| 04 Virginia rose *Rosa virginiana* | n | | | C | | | |
| wild strawberry *Fragaria virginiana* | n | My-Jn | | C | | U | |
| common cinquefoil *Potentilla simplex* | n | My-Au | U | C | | U | U |
| rough cinquefoil *Potentilla norvegica* | n | Jn-Jy | U | | | | |
| rough-fruited cinquefoil *Potentilla recta* | a | Jy | U | U | | | |
| black raspberry *Rubus occidentalis* | n | Jn | U | U | | | |
| dwarf raspberry *Rubus pubescens* | n | M | | | A | U | A |
| purple-flowering raspberry *Rubus odoratus* | n | Jy-Au | U | | | | |
| | | | | | | | |
| red raspberry *Rubus Ideaus* | n | Jn | U | C | | | U |
| water avens *Geum rivale* | n | My-Jn | | U | A | | C |
| white avens *Geum canadense* | n | Jy | U | | | | |
| summersweet *Clethra alnifolia* | n | | X | | | | |
| meadowsweet *Spiraea latifolia* | n | Jy-A | | U | U | | U |
| chokeberry *Aronia melanocarpa* | n | | X | | | | |
| chokecherry *Prunus virginiana* | n | My-Jn | U | | | C | U |
| apple *Pyrus malus* | a | My | C | | | U | |
| 04 mountain ash Sorbus americana | n | Jn | U | | | | |
| running serviceberry *Amelanchier stolonifera* | n | My | | R | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| white sweet clover *Melilotus alba* | a | Jy-Au | U | | | | |
| Alsatian clover *Trifolium hybridum* | a | Jn-Au | U | U | | | |
| red clover *Trifolium pratense* | a | Jn-O | | C | | U | |
| white clover *Trifolium repens* | a | Jn-O | A | | | U | |
| yellow clover *Trifolium agrarium* | a | Jn-Jy | U | U | | | |
| cow vetch *Vicia cracca* | a | Jn-Au | | U | | | |
| hog peanut *Amphicarpa bracteata* | n | Au-S | | | | | U |
| black medick *Medicago lupulina* | a | Jy-Au | C | | | | |
| yellow wood-sorrel *Oxalis europaea* | n | My-S | U | C | | C | U |
| three-seeded mercury *Acalypha rhomboidea* | n | S | U | | | | |
| | | | | | | | |
| poison ivy *Rhus radicans* | n | My- | | | | | A |
| staghorn sumac *Rhus typhina* | n | Jy | C | | | | |
| 04 winterberry holly *Ilex verticillata* | n | | | | R | | |
| inkberry *Ilex glabra* | n | | X | | | | |
| Amur maple *Acer ginnala* | a | Jn | R | | | | R |
| boxelder *Acer negundo* | n | Ap-My | C | | | | |
| red maple *Acer rubrum* | n | Ap | | | | U | |
| sugar maple *Acer saccharinum* | n | My | U | | | | |
| Virginia creeper *Parthenocissus quinquefolia* | n | Jn | U | U | | | U |
| European buckthorn *Rhamnus frangula* | a | Jn-Au | | | A | A | |
| | | | | | | | |
| glossy buckthorn *Rhamnus cathartica* | a | My-Jn | C | | A | A | A |
| riverbank grape *Vitis riparia* | n | Jn | C | U | | C | |
| linden *Tilia americana* | n | Jy | R | | | | |
| spotted touch-me-not *Impatiens capensis* | n | Jy-S | C | U | A | | |
| common St. Johnswort *Hypericum perforatum* | a | Jy-Au | | U | | | |
| common evening primrose *Oenothera biennis* | n | Jy-O | C | U | | | |
| small sundrops *Oenothera perennis* | n | Jn | R | | | | |
| downy willow herb *Epilobium strictum* | n | A | U? | | | | |
| northern willow herb *Epilobium glandulosum* | n | A | U | | | | |
| purple-leaved willow herb *E. coloratum* | n | A-S | | U | U | | |
| | | | | | | | |
| violets (several unidentified species) | n | M-Jn | U | U | | | |
| dwarf enchanter's Nightshade *Circaea alpina* | n | Jy | | | | U | |
| enchanter's nightshade *Circaea quadrisulcata* | n | Jy-A | | | | U | |
| golden Alexanders *Zizia aurea* | n | My-Jn | U | U | | | |
| Queen Anne's lace *Daucus carota* | a | Jy-O | U | C | | | |
| 04 gray dogwood *Cornus racemosa* | n | | | R | | | |
| red-osier dogwood *Cornus stolonifera* | n | Jy-A | U | U | C | | |
| pagoda dogwoo *Cornus alnifolia* | n | | X | | | | |
| one-flowered pyrola *Moneses uniflora* | n | Jn-Jy | | | | U | |
| round-leaved pyrola *Pyrola rotundifolia* | n | Jy | | | | R | |
| | | | | | | | |
| starflower *Trientalis borealis* | n | Jn | | | | U | U |
| moneywort *Lysimachia nummularia* | a | Jy | U | | | | |
| common milkweed *Asclepias syriaca* | n | Jy | U | C | | | |
| hedge bindweed *Convolvulus sepium* | n | Jy-Au | | U | | | |
| forget-me-not *Myosotis scorpioides* | a | Jn-Jy | | | | R | R |
| gill-over-the-ground *Glechoma hederacea* | a | My-Jy | A | | | | U |
| selfheal *Prunella vulgaris* | n | Jn-O | C | C | | | U |
| hemp nettle *Galeopsis tetrahit* | n | S | U | C | | | |
| catnip *Nepeta cataria* | a | Jy-A | U | | | | |
| white ash *Fraxinus americana* | n | My | | | | A | C |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| forsythia *Syringa suspense* | a | Ap-My | U | | | | | |
| lilac *Syringa vulgaris* | a | My-Jn | U | | | | | |
| bird's-eye speedwell *Veronica chamaedrys* | n | Jn | | | | | | U |
| common speedwell *Veronica officinalis* | n | Jn-Jy | | | | | C | U |
| corn speedwell *Veronica arvensis* | n | My | | U | | | | |
| thyme-leaved speedwell *Veronica serpyllifolia* | n | My-Jn | A | U | | | | |
| blue vervain *Verbena hastata* | n | Jy-Au | | U | | | | |
| bittersweet nightshade *Solanum dulcamara* | n | Jn-Au | U | | A | | | U |
| common mullein *Verbascum thapsus* | a | Jn-Au | U | | | | | |
| turtlehead *Chelone glabra* | n | Au-S | | | U | | | |
| | | | | | | | | |
| small bedstraw *Galium trifidum* | n | Jn-Jy | | A | C | U | | |
| wild madder *Galium mollugo* | a | Jn-S | | C | | U | | U |
| common plantain *Plantago major* | a | Jy-Au | A | | | | | |
| English plantain *Plantago lanceolata* | a | Jy-S | U | | | | | |
| American fly honeysuckle *Lonicera Canadensis* | n | | X | | | | | |
| morrow's honeysuckle *Lonicera morrowi* | a | My-Jn | U | C | C | | | |
| arrowwood *Viburnum recognitum* | n | Jn | | R | R | | | |
| high-bush cranberry *Viburnum trilobum* | n | Jn | | U | | | | |
| Indian tobacco *Lobelia inflata* | n | Jy-S | U | U | | | | |
| common fleabane *Erigeron philadelphicus* | n | Jn-Jy | C | C | | | | |
| | | | | | | | | |
| daisy fleabane *Erigeron annuus* | n | Jn-S | C | C | | | | |
| lesser daisy fleabane *Erigeron strigosus* | n | Jn-A | U | | | | | |
| horseweed *Erigeron canadensis* | n | Au-S | C | | | | | |
| flat-topped aster *Aster umbellatus* | n | Au-O | | | C | | | |
| New England aster *Aster novae-angliae* | n | Au-O | | U | U | | | |
| small white aster *Aster vimineus* | n | Au-S | | | U | | | C |
| other asters (several unidentified species) | n | Au | C | A | C | C | | C |
| goldenrod *Solidago sp.* (several unidentified sp.) | n | Au-O | C | A | C | | | C |
| black-eyed Susan *Rudbeckia serotina* | n | Jy-Au | | U | | | | U |
| yarrow *Achillea millefolium* | a | Jn-S | U | A | | | | |
| | | | | | | | | |
| field hawkweed *Hieracium pratense* | a | Jn-Jy | C | C | | | | |
| orange hawkweed *Hieracium aurianticum* | a | Jn-Jy | | U | | U | | U |
| nipplewort *Lapsana communis* | a | Jy | | | | | | R |
| ?wall lettuce *Mycelis muralis* | a | Jy | | | | R | | |
| oxeye daisy *Chrysanthemum leucanthemum* | a | Jn-Au | | A | | | | |
| bull thistle *Cirsium vulgare* | a | Au | | U | R | | | |
| Canada thistle *Cirsium arvense* [extirminated?] | a | Jy-S | R? | R? | | | | R? |
| spiny-leaved sow thistle *Sonchus asper* | a | Jy-O | R | | | | | |
| common dandelion *Taraxacum officinale* | a | My-Jn | A | A | | U | | U |
| Fall Dandelion *Leontodon autumnalis* | a | Au-O | ? | | | | | |
| | | | | | | | | |
| yellow goatsbeard *Tragopogon pratensis* | a | Au-S | U | | | | | |
| boneset *Eupatorium perfoliatum* | n | Au-S | | C | U | | | |
| spotted Joe-pye weed *Eupatorium maculatum* | n | Jy-S | | C | A | | | |
| common burdock *Arctium minus* | a | Jy-Au | U | | | | | |
| common ragweed *Ambrosia artemisiifolia* | n | Au-S | U | | | | | |
| tansy ragwort *Senecio jacobea* | a | Jn | | U | U | | | |
| pineapple weed *Matricaria matricarioides* | a | Jy | C | | | | | |

# APPENDIX B




## Alternation of Generations

In addition to the clearly evident differences between plants and animals, these two kingdoms of life also differ profoundly in their life cycles. Knowledge of the basic features of plant life histories is essential to understanding flowers, spores, pollen, and other plant features. After reading this account, you will have a better understanding of and appreciation for the lives of the plants that you encounter here.

Unlike most animals, all plants have two different adult forms, one reproducing sexually and the other asexually, in a regular alternation of generations, as follows: An adult plant that has pairs of chromosomes in all its cells (as do most animals) undergoes sexual cell division (meiosis) to

produce spores, each of which has only one chromosome from each original pair. These spores grow into a second adult form, in which all cells have only half the original chromosomes. This adult form, by asexual cell division (mitosis), produces sperm and/or eggs, still with half numbers of chromosomes (as in animal sperm and eggs). When a sperm fertilizes (fuses with) an egg, the resulting single cell (the zygote) again has full pairs of chromosomes. This zygote then grows into an adult plant like the original one, completing the life cycle and the alternation of sexual and asexual generations.


This basic pattern is followed in all plants, but the nature and relative prominence of the two adult forms, of the spores, and of other elements in the life cycle differ profoundly in the four groups into which the plant kingdom divides itself. These differences also reflect clearly the evolutionary relationships and history among these four groups.

Mosses and liverworts were the first plants, and the fossil record suggests an origin some 500 to 600 million years ago. Mosses apparently evolved into the first ferns, horsetails, and club mosses around 400 million years ago. These plants formed the first forests, but they were restricted to water margins by the sperm's need for water in the soil through which to swim to eggs. From the ferns, possibly through a now-extinct group called seed-ferns, arose the conifers and their relatives some 300 million years ago. Earth grew green as plants then spread across the drier uplands. Finally, some of the conifer group gave rise to the flowering plants approximately 100 million years ago, giving rise gradually to a modern-looking landscape.

## Mosses and Liverworts

These are the most primitive of plants, the first of the four plant groups to have evolved from the algae (and possibly fungi) that preceded them. They are invariably small plants because they lack the water- and nutrient-transporting vascular tissues of the higher plants. All the cells of the familiar adult liverwort or moss, including the sphagnum and other

mosses growing here (but unlike animals and the other three plant groups), have only one chromosome of each original pair. This adult plant produces sperm and eggs asexually (by mitosis) in the crown of leaves at the top of the plant. Raindrops splash sperm onto nearby plants, where they fertilize eggs to form zygotes, each with full pairs of chromosomes.

The zygotes then grow into the second adult form, which is a simple thin stalk that grows up right from the top of the original leafy plant. All the cells in that stalk have full pairs of chromosomes, and, in the umbrella- or pod-like capsule that grows at its tip, sexual cell division (meiosis) then produces spores, again with half pairs of chromosomes. When the spores are mature, they drift off and germinate in the soil to grow into another familiar leafy moss. During the summer the second adult form, the spore-producing stalk, can often be seen growing from the tips of the familiar leafy mosses, and also from the broad, lobed, often liver-shaped leaves of liverworts that grow on soil, rocks, trees, and other damp or sheltered surfaces.

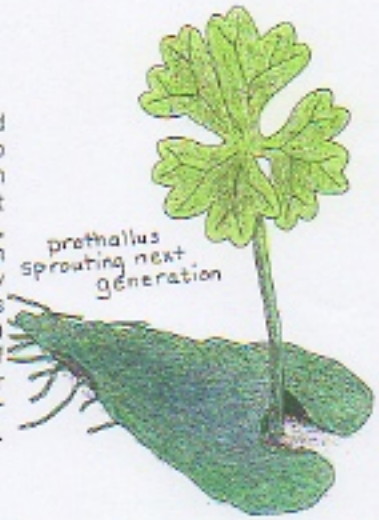
Moss
both adult forms

## Ferns, Horsetails, and Club Mosses

Unlike those of the mosses and liverworts, the cells of the familiar adult ferns, horsetails, and club mosses all have full pairs of chromosomes (they are equivalent to the spore-producing stalk atop the leafy moss plant). These adults produce spores by sexual cell division (meiosis), the spores thus having only one chromosome from each original pair. The spores are shed when mature, and any that germinate in the soil grow into adult plants of very different form, all of them tiny, up to half an inch or so long, growing directly on or even within the soil, and having cells with only one chromosome from each original pair (equivalent to the leafy moss). Sometimes one can find, in the soil around familiar ferns, this less conspicuous adult form -- the prothallus -- a heart-shaped film, one cell in thickness, usually no more than a quarter inch long.

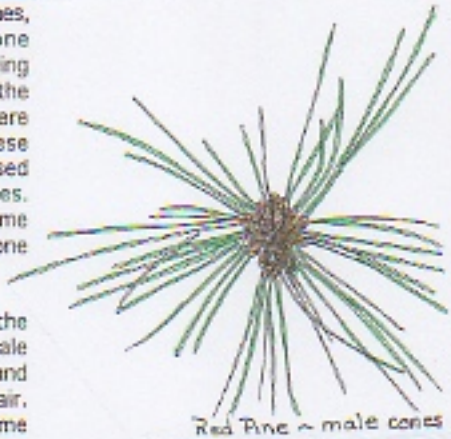
fern
spores

These tiny plants then produce sperm and eggs, by asexual cell division (mitosis). In order to find an egg, the sperm must swim through water in the pore spaces in the soil. This is the reason that ferns and their relatives tend to live in wet climates, though some have adapted to quite dry places, even deserts, where they must wait for a brief rainy season to reproduce. When a swimming sperm finds and fertilizes an egg, the resulting cell (the zygote) again has both members of all pairs of chromosomes, and it then grows into the familiar adult fern, horsetail, or club moss. Thus, usually over the course of two years, is the life cycle completed.




## Conifers and Their Relatives

Pines and other conifers, together with cycads, ginkgoes, podocarps, and some other plants, constitute the third major plant group. Adult pines, like ferns, produce spores, each with one chromosome from each pair. Instead of scattering spores to the wind, though, they keep them in the tissues where they form. The spores develop there and grow into either female or male cones. These cones are the second adult stage, entirely composed of cells with only one of each pair of chromosomes. Clusters of tiny male cones crowd the tips of some pine branches, while tips of other branches host one or a few female cones.

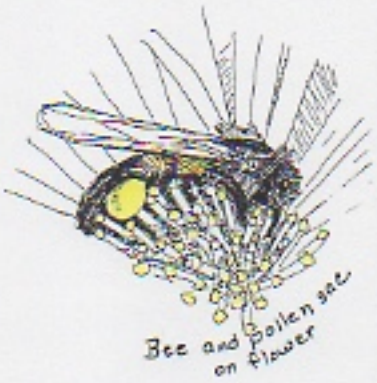



By asexual cell division (mitosis), sperm, in the form of pollen grains, are produced in the male cones, and eggs in the female cones. The sperm and eggs have one chromosome from each original pair. Any windblown pollen grain that happens to come upon a female cone can fertilize an egg to form a cell with full pairs of chromosomes (a zygote). That cell then grows to form a seed, another evolutionary innovation, which provides these plants with a dormant stage that can wait until conditions are suitable for its germination to grow into a new adult tree.

## Flowering Plants

Flowering plant life history is in general like that of the conifers. Flowering plant spores, though, grow not into cones but into flowers, which are the second generation adult plants, and all the cells of which have just one of each original pair of chromosomes. Asexual cell division (mitosis) within the flowers then produces sperm (pollen) and eggs, also with half of each chromosome pair.

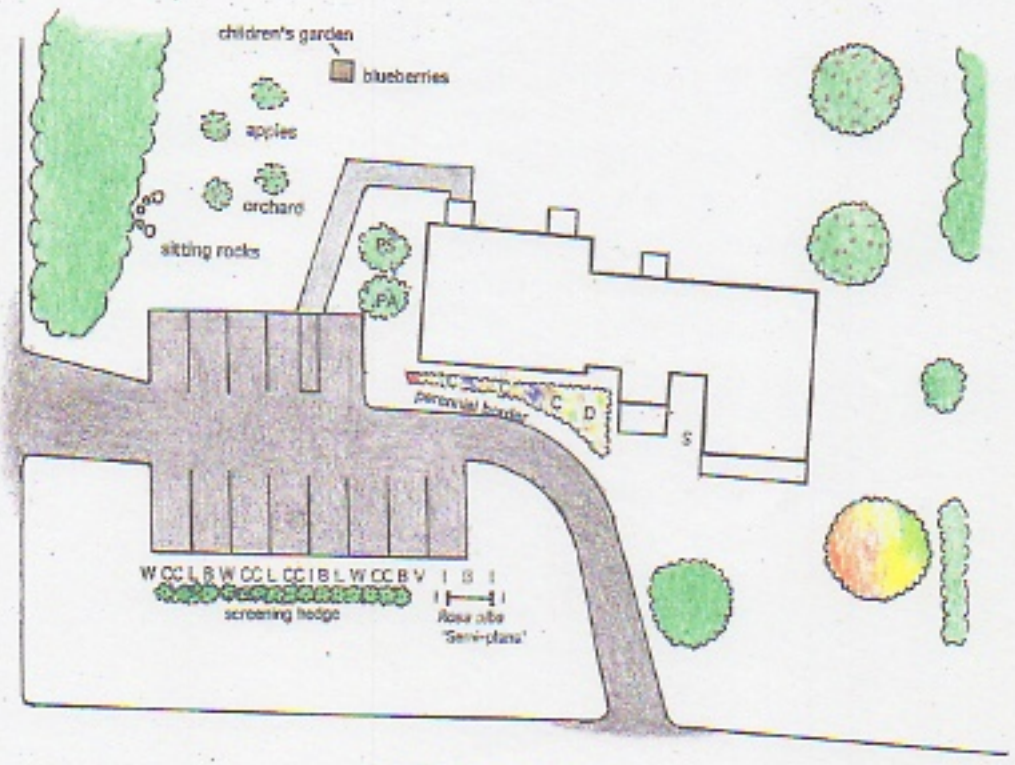
Most flowering plant pollen grains are larger than those of conifers and must therefore be carried by insects to fertilize the eggs, usually in other flowers, commonly on other plants. Evolution produced flowers, with their bright colors, fragrant scents, and sweet nutritious nectar, simply as a means of enticing insects for pollination. Insects and flowering plants thus diversified together in a process of coevolution, which has resulted in many specific pairs of plant species with their exclusive pollinators, such as milkweed and monarch butterflies. As in the conifer group, the fertilized egg (a zygote, now with full pairs of chromosomes), grows into a seed. Evolution has further improved these dormant structures over those in conifers by the development of wings, hooks, down, sweet fleshy fruits, or projectile devices, all designed to facilitate seed dispersal, and all to be seen here on the paths.




When the conifers and their kin evolved 250 million years ago, plants were able to spread away from wet places and wet climates, and Earth's lands turned green. When the flowering plants evolved 150 million years later, all the flower colors spread across the globe.

# APPENDIX C

## LIST AND MAP
## NEW PLANTS IN 2016
by Leah Goat




Shrubs and Trees 2016

| | | | | | |
|---|---|---|---|---|---|
| W | witch hazel | I | inkberry | D | doublefile viburnum |
| CC | chokeberry | PS | plum 'Superior' | S | downy serviceberry |
| L | lilac 'Charlie X' | PA | plum 'Alderman' | C | *Clethra* (summersweet) |
| B | bayberry | | | V | *Viburnum carlesii* |

# SUGGESTED READING

## Field Guides


Brockman, C. Frank, 1968, Trees of North America, Golden Press.
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Harrison, Edward, 1984, 2003 (second edition), Masks of the universe (1987 winner of UUA Melcher Award).
Heinrich, Bernd, 1997, The trees in my forest.
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-----, 1983, Late night thoughts on hearing Mahler's ninth symphony.
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Warner, W. H., 1976, Beautiful swimmers: watermen, crabs and the Chesapeake Bay. (1977 Pulitzer prize in non-fiction).
Wessels, Tom, 1997, Reading the forested landscape: a natural history of New England.
Williamson, Henry, 1927, Tarka the Otter.
-----, 1936, Salar the salmon.