

Botany on Black

A Photographic Survey

Lee W. Wilcox



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Cover image: Yellow avens (*Geum aleppicum*)

From the author/photographer

This eBook traces its origin to my photographing a number of botanical specimens for inclusion in our *Plant Biology* text as well as several other textbooks.

Seeing the intricate details, colors, and forms of the botanical specimens pop off the screen when photographed against a black background, I was led to capture images of additional subjects in this way.

Botany, as a scientific discipline, focuses on plants. As such, the majority of the subjects included here are plants, starting with relatively tiny bryophytes (mosses and their relatives), through lycophytes, ferns, gymnosperms (e.g., conifers), and angiosperms (the flowering plants). In addition to plants, botany departments and courses have traditionally included fungi and algae among the organisms studied.

Some technical details as well as a bit more information about each of the subjects that were photographed are included at the end of the book.

NOTE: When viewing the PDF, a more booklike experience can be had by using a "full screen" or "slideshow" mode. In Acrobat (Pro or Reader), select "View > Full Screen Mode." When viewing the file in Preview on the Mac, go to the View menu and select either "Slideshow" or "Enter Full Screen." Other PDF viewers typically have similar modes, though the particulars will vary. Depending on your software and electronic device, you may be able to mirror your display on a television—these images are best appreciated on a 4K screen.





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Sample

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Sample



Sample





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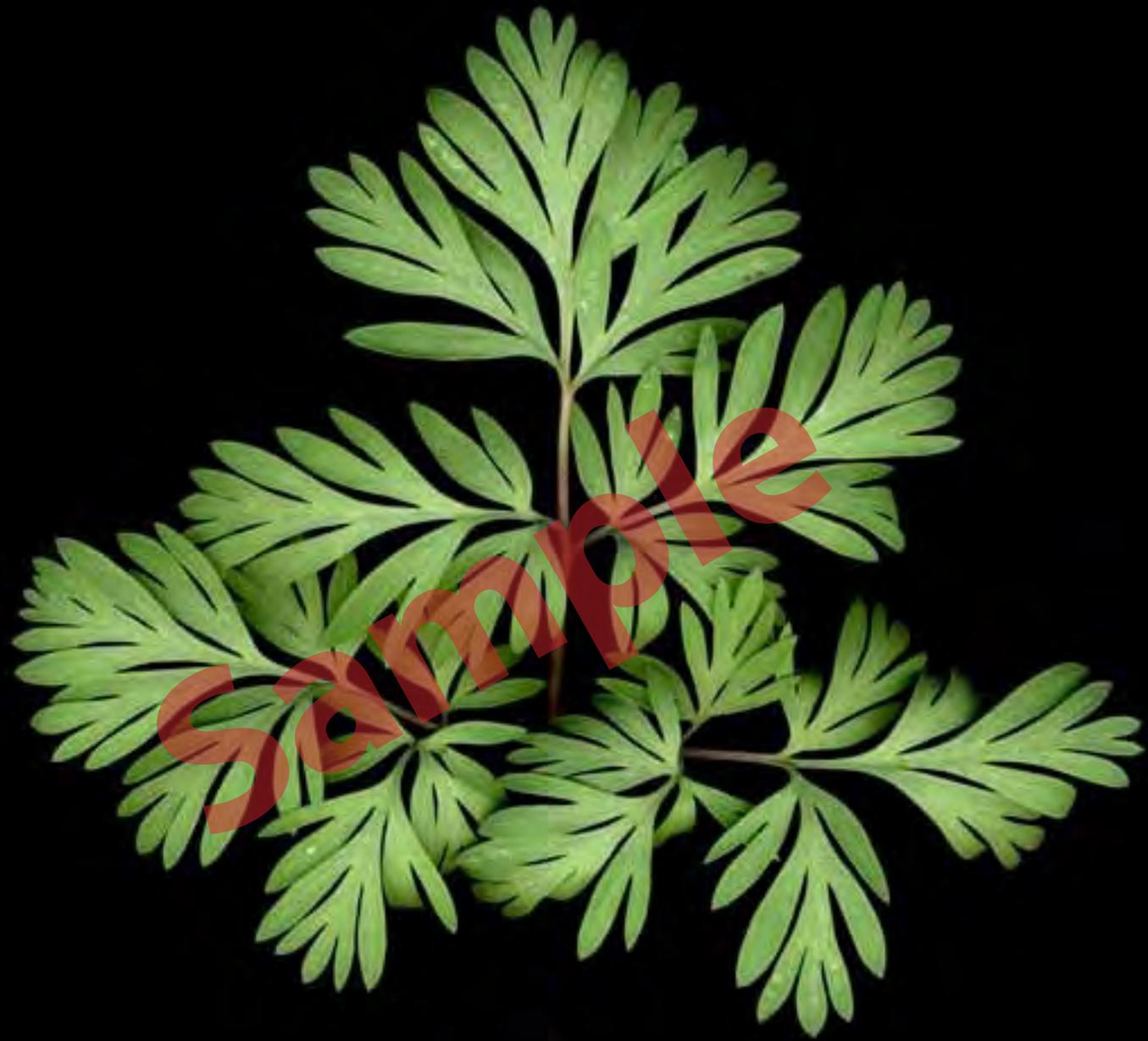
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Sample

Technical Information

A number of digital cameras (Canon Powershot S20, Nikon Coolpix 4500, and Nikon dSLRs—D70, D200, D300s) were used to photograph the subjects pictured in this book. A Nikkor 60 mm f2.8D macro lens was generally used with the dSLRs. Some images were scanned on an Epson Expression 1600 flatbed scanner. A few images were taken using microscopes—a stereo (dissecting) microscope and a compound microscope, both of which were equipped with darkfield optics (meaning the subject is illuminated against a black background).

Subjects were mostly shot against a black background in a studio setting, though several large, rooted plant specimens were photographed in greenhouses against a black fabric background.

In a few instances, at least some light passed through the subjects and two images were made using polarized light, which causes crystalline structures to glow against a black background.

To insure a seamless appearance, the backgrounds were converted to pure black during post-processing.



8 Peatmoss
(*Sphagnum* sp.)

Peatmosses have a distinct head-like tuft of branches and the different species vary from green to brown to red. They are wide-spread wetland plants that play a major role in Earth's global carbon cycle. Mosses and liverworts resemble the ancient plants that first occupied the land.



9 The liverwort,
Preissia quadrata

Liverworts are simple plants, many of which are flattened and hug the substrate on which they grow. Look closely and you will see little cups on this plant, which contain "gemmae"—small pieces of tissue that can grow into new plants (a form of asexual reproduction).



10 The lycophyte,
Lycopodiella inundata

This lycophyte (plants with food- and water-conducting tissue; simple, generally small leaves; and sexual reproduction by spores) lives in bogs, typically growing on a lawn of peatmosses. Spore-producing cones will develop on the two upright branches.



11 Running clubmoss
(*Lycopodium clavatum*)

Another lycophyte, the running clubmoss, has a horizontal stem that "runs" along the surface of the ground. Another common name is the ground pine (though it's not closely related to pines). It also produces spores in cones (not seen here).



12 Water horsetail
(*Equisetum fluviatile*)

Horsetails, or scouring rushes, are now grouped within the ferns, even though they have a growth form quite distinct from what we think of as more typical ferns. The black, pointed structures seen here on the stem represent the tips of tiny leaves that fuse to form a sheath around the stem.



13 Water horsetail
(*Equisetum fluviatile*)

Some horsetails have no branches but water horsetail does, and, like other branched species, the branches push their way through the fused leaves. This rather curious process is just underway here, with only the tiny branch tips showing.



14 Field horsetail
(*Equisetum arvense*)

As with lycophytes, horsetails and other ferns reproduce sexually by spores. In horsetails, they are produced in a distinctive cone, which in the field horsetail, occurs on short-lived colorless shoots. The field horsetail also has branched, green photosynthetic shoots.



15 Field horsetail
(*Equisetum arvense*)

In a closer view, popcorn-shaped spore-containing sacs (sporangia) appear green because of the many green spores that are produced inside. Spores have been released from sporangia higher up on the cone.



16 Maidenhair fern
(*Adiantum pedatum*)

Like other ferns (but not horsetails), the maidenhair's leaves (fronds) begin as "fiddleheads" that unroll during development.



17 Maidenhair fern
(*Adiantum pedatum*)

Farther along in development, individual leaflets are also seen to unfurl and enlarge as does the leaf as a whole.



18 Interrupted fern
(*Osmunda claytoniana*)

Fiddleheads of the common interrupted fern can be quite fuzzy. This fern's name comes from the fact that a few specialized leaflets on a frond produce sporangia and spores. Sporangia occur in a wide variety of patterns on the fronds of different fern species.



19 Marsh fern
(*Thelypteris palustris*)

This wetland fern has sporangia that nearly cover the undersurface of the leaflets (the top side of a leaf photographed in the fall is shown here, however). It grows in sunnier places than most ferns prefer.



20 The aquatic fern,
Salvinia

A floating fern found primarily in warm climates, large populations of *Salvinia* can clog waterways.



21 The aquatic fern,
Salvinia

The small, egg-beater-like hairs on the surface act as tiny tent poles, forcing a "tent" of water to bead up on top of the hairs. This creates an air space between the water and the leaf surface, helping the leaf to float and to conduct photosynthesis even if submerged.



22 Mosquito fern
Azolla sp.

A related aquatic fern, mosquito fern is considerably smaller than *Salvinia*. It has chambers on the underside of its leaves that harbor photosynthetic cyanobacteria (blue-green algae), which can convert atmospheric nitrogen into a form usable by the fern (nitrogen is a critical nutrient).



23 Ebony spleenwort,
(*Asplenium platyneuron*)

This relatively small, attractive fern has fronds with dark midribs, to which the leaflets are attached.



24 Eastern hemlock
(*Tsuga canadensis*)

This is the first example in this book of a seed plant, in this case a gymnosperm (more specifically, a conifer). The seeds are "naked" ("gymnosperm" means naked seed), which is to say they are not surrounded by a fruit, as are the seeds of flowering plants.



25 Tamarack
(*Larix laricina*)

The immature, purple cones of this gymnosperm contain female reproductive structures, and will give rise to seeds. The pollen-producing cones (not seen here) are smaller.



26 Shagbark hickory
(*Carya ovata*)

The red, bowl-like structures are bud scales, which protect the enclosed bud during the wintertime. This and the remainder of the plants shown in this book are flowering plants (angiosperms).



27 Ohio buckeye
(*Aesculus glabra*)

Leaves are emerging from somewhat less flamboyant bud scales of the buckeye. This and the hickory bud contains leaves, whereas other buds may contain flowers or leaves plus flowers.



28 Leatherleaf
(*Chamaedaphne calyculata*)

This bog plant, related to cranberries and blueberries, has tough, leathery evergreen leaves that persist over winter but often turn red-brown. Developing green buds are seen here on a branch tip collected in early spring.



29 black walnut
(*Juglans nigra*)

Young leaves and twigs of black walnut can be quite fuzzy. Below the young green leaves, a bud is evident, just above a whitish leaf scar (the place on the stem where a leaf had been attached during the previous growing season before it fell off in the fall).



30 Bur oak
(*Quercus macrocarpa*)

Lobes of bur oak leaves are rounded—more so than suggested here by the relatively tiny, young leaves. The bur oak is a large, valuable tree that tends to grow in open areas.



31 Oak leaves
(*Quercus* sp.)

Small, developing leaves and a few pollen-producing flowers (catkins) of another oak species are shown here. Note the pointed leaf lobes here.



32 Purple pitcher plant
(*Sarracenia purpurea*)

This is a carnivorous bog plant with leaves modified to capture small animal prey. Bogs are low in nitrogen, which plants need to survive. Pitcher plants and several other bog plants have evolved a carnivorous lifestyle to acquire this valuable nutrient through capturing prey.



33 Purple pitcher plant
(*Sarracenia purpurea*)

Look closely and you will see downward-pointing hairs on the green and purple top portion of the leaf (the hood). These hairs make it difficult for prey to climb out of the hollow leaf. Some prey (usually insects) slip into rainwater contained in the leaves and are digested.



34 White pitcher plant
(*Sarracenia leucophylla*)

Another pitcher plant, this species grows along the Gulf Coast in the Southern United States.



35 Arrowleaved tearthumb
(*Polygonum sagittatum*)

This spindly plant supports itself by grabbing onto sturdier nearby plants by use of sharp projections on its stems and leaves. When older and dry, these brittle barbs easily penetrate the skin and make encounters with this plant rather unpleasant.



36 Dutchman's breeches
(*Dicentra cucullaria*)

The feathery leaves of this spring ephemeral complement the breeches-shaped flowers. Though attractive, all the parts may be toxic if ingested.



37 Virginia waterleaf
(*Hydrophyllum virginianum*)

Some populations of Virginia waterleaf have variegated leaves (having patches of different color). There is some evidence that this feature may reduce damage done to the plants by herbivores (plant-eating animals).



38 Cinquefoil
(*Potentilla* sp.)

Members of this rose-family genus typically have palmately compound leaves (that is, leaves are divided into leaflets that come off the leaf stalk or "petiole" like fingers from the palm of one's hand).



39 Smooth sumac
(*Rhus glabra*)

Leaves of this poison-ivy relative can be quite large and are pinnately compound (leaflets ["pinnae"] are attached laterally to the leaf stalk, often in pairs).



40 Yellow avena
(*Geum aleppicum*)

This rose-relative was photographed using polarized light, which make crystalline structures stand out, such as the fine hairs that grow on this and many other plants.



41 Black-eyed Susan
(*Rudbeckia hirta*)

This sunflower family species is another rather hairy plant. On older parts of the stem, each hair emerges from a red-pigmented spot.



42 Tussock sedge
(*Carex stricta*)

Sedges are grasslike plants, many of which (like this species) are found in wetlands. A young inflorescence (a cluster of flowers) is seen here before the individual flowers have opened.



43 Pussy willow
(*Salix discolor*)

The familiar pussy willow has fuzzy hairs interspersed with the tiny clustered flowers. In this case, these inflorescences are made up of male flowers that will produce pollen. Male and female flowers of this species are produced on separate plants.



44 Korean spice-bush
(*Viburnum carlesii*)

Colorful modified leaves (bud scales) protect developing flowers inside that will have white to pale-pink petals in this pleasantly scented ornamental shrub.



45 Lilac
(*Syringa vulgaris*)

Lilac has rather fuzzy buds that will develop into the familiar flowers.



46 Miterwort
(*Mitella diphylla*)

This spring ephemeral has tiny, snowflake-like flowers that have to be seen close-up to be fully appreciated. The species name (which means "two leaves") comes from the plant having two leaves that are attached about halfway up the stem.



47 Dotted horsemint
(*Monarda punctata*)

The pink structures here are bracts, modified leaves that emerge from the stem beneath the cluster of flowers (which are small and dotted).



48 Cow's Horn
(*Euphorbia grandicornis*)

The small, yellow-green structures on the margin of the plant are relatively tiny flowers. Old World desert euphorbs (members of the family Euphorbiaceae) have evolved growth forms similar to those of New World cacti.



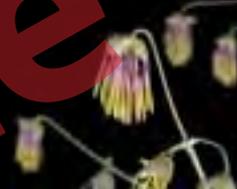
49 Poinsettia
(*Poinsettia pulcherrima*)

Also a "euphorb," the red- (or otherwise-) colored parts of the familiar poinsettia are actually bracts (modified leaves). The flowers are the small greenish structures in the center.



50 Early meadow rue
(*Thalictrum dioicum*)

The female (shown here) and male flowers of early meadow rue are produced on separate plants. Both are relatively tiny and are best appreciated up close.



51 Early meadow rue
(*Thalictrum dioicum*)

Male flowers have pollen-producing stamens whose anthers hang down, which makes it easier for wind to dislodge and transport the pollen to female flowers on nearby plants.



52 White oak
(*Quercus alba*)

As with those of early meadow rue, other oaks, and a variety of other plants, the male flowers hang down and are easily blown about by the wind, which helps disperse pollen.



53 Red oak
(*Quercus rubra*)

Again, male flowers are seen here. Red oak leaves have pointed lobes, as opposed to the rounded lobes of white and bur oaks.



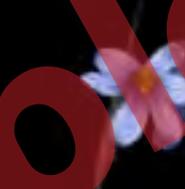
54 Columbine
(*Aquilegia canadensis*)

The attractive columbine flower has "spurs" at the top, the swollen tips of which contain nectar that can be accessed by pollinators such as hummingbirds, butterflies, and hawkmoths.



55 Columbine
(*Aquilegia canadensis*)

A fully open flower is seen here. The bright yellow stamens have emerged.



56 Blue-eyed grass
(*Sisyrinchium* sp.)

Though called a "grass" and having leaves resembling those of grasses, these plants are technically not grasses. They are actually more closely related to irises.



57 Marsh marigold
(*Caltha palustris*)

This wetland plant is a member of the buttercup family, which is one of the more ancient flowering plant families. Most members have tender (non-woody) stems and flowers with numerous stamens and carpels (the female flower part that contains ovules, which develop into seeds if fertilized).



58 Wild geranium
(*Geranium maculatum*)

A common plant that dots the woods and roadsides in Eastern North America. Here, a flower has just opened. Some of the anthers have not yet split open and released their pollen.



59 Wild geranium
(*Geranium maculatum*)

These flowers are at a slightly later stage of development and all the anthers are releasing pollen. Note the greenish female flower parts in the center. The swollen base is the "ovary," which develops into the fruit, with seeds inside.



60 Paw-paw
(*Asimina triloba*)

Flowers of the paw-paw, a large shrub or small tree, develop into rather large, edible fruits having numerous seeds and a custardy texture.



61 Paw-paw
(*Asimina triloba*)

Flowers are seen from the side here.



62 Cattleya orchid
(*Cattleya* sp.)

The flower of this familiar orchid consists of 3 sepals (the lowermost parts of flowers, often green in other plants) and 3 petals. One petal of orchids, the lip, usually differs in appearance from the two others. It lies toward the bottom here serves as a landing platform for pollinators.



63 Clamshell orchid
(*Prosthechea cochleata*)

The "clamshell" portion of the flower shown here is the lip, which (unlike in *Cattleya*) is located at the top. This is a less-common condition among the orchids.



64 Grass-pink orchid
(*Calopogon tuberosus*)

An orchid of boggy areas, grass-pink orchid is another case where the lip is located at the top of the flower (which is actually where the lip of all orchid flowers begins development—in most orchids, the flower twists as it develops such that the lip ends up on the bottom).



65 *Paphiopedilum* sp.

The lip is in the more normal position in this orchid—a "paph." This genus is native to Southeast Asia and nearby island nations and contains a wide variety of beautiful species.



66 Virginia waterleaf
(*Hydrophyllum virginianum*)

Unlike the specimen shown earlier having variegated leaves, this Virginia waterleaf individual has solid-green leaves.



67 Joe-pye weed
(*Eupatorium maculatum*)

A common North American member of the sunflower family, this joe-pye weed plant has buds about to break and reveal the purple flowers.



68 Spiderwort
(*Tradescantia ohioensis*)

This blue-flowered plant is a close relative of the common houseplant, *Tradescantia zebrina*, which has distinctive striped leaves.



69 Northern catalpa
(*Catalpa speciosa*)

The northern catalpa is an attractive tree whose showy flowers give rise to long, thin podlike fruits. Leaves are large and heart-shaped.



70 Wild rose
(*Rosa* sp.)

This is an opening flower of one of the several pink-colored wild rose species.



71 Multiflora rose
(*Rosa multiflora*)

A sometimes weedy and invasive plant, multiflora rose nevertheless has attractive white flowers.



72 Crabapple
(*Malus* sp.)

Crabapple flowers are familiar to most. Here they are shown in the bud stage...



73 Crabapple
(*Malus* sp.)

...while here they have opened to reveal a typical rose-family flower structure.



74 Sunflower head
(*Helianthus* sp.)

A developing head of a sunflower species (not the large common sunflower) is shown here. The sunflower head (a type of inflorescence with densely packed flowers) mimics the appearance of certain solitary flowers found in other plant families.



75 Yellow coneflower
(*Ratibida pinnata*)

This prairie plant has a well defined "cone" that consists of small "disk" flowers (or "florets") that have both male and female parts. The flowers on the periphery are female and have their petals fused into a long strap-like "petal."



76 Queen Anne's-lace
(*Daucus carota*)

This plant, also known as wild carrot (it's the same species as the plant whose root we eat), has a type of inflorescence specific to its family (the celery or carrot family). It is shown here while still developing.



77 Queen Anne's-lace
(*Daucus carota*)

This underside view better shows the arrangement of the individual flowers on their stalks. Terminal umbrella-like groups are themselves grouped into a larger flat-topped inflorescence known as a compound umbel.



78 Beebalm
(*Monarda fistulosa*)

Beebalm, or wild bergamot, is a member of the mint family, with flowers packed into head-like inflorescences. Flowers have not fully opened here.



79 Beebalm
(*Monarda fistulosa*)

A more-developed inflorescence is seen here in side view. Male and female flower parts are extending from the tubular flowers. The receptive tip of a female flower is known as the "stigma" and if pollen finds its way there, it may germinate and produce a tube through which sperm move to the ovule and egg cell.



80 Boxelder
(*Acer negundo*)

Like other numerous other wind-pollinated trees, the male flowers of boxelder hang down and pollen can be dislodged and blown about by the wind.



81 Boxelder
(*Acer negundo*)

The female flowers likewise droop down on flower stalks. The female and male flowers of boxelder are produced on separate trees.



82 Sugar maple
(*Acer saccharum*)

Unlike the boxelder, a particular sugar maple tree produces both male and female flowers. The pollen-producing anthers are most obvious here but some stigmas (the part of female flower that pollen sticks to) are visible toward the upper right.



83 Nodding thistle
(*Carduus nutans*)

Thistles belong to the sunflower family. Shown here is a shoot tip that will eventually develop into a flower head.



84 Staghorn sumac
(*Rhus hirta*)

A common shrub, the flowers of staghorn sumac turn a bright red (see page 105).



85 Tartarian honeysuckle
(*Lonicera tatarica*)

This is an invasive plant that nevertheless has attractive flowers that vary in color from white to pink to red. Orange or red berries are produced.



86 Dutchman's pipe
(*Aristolochia* sp.)

Flowers of this widespread genus can be quite showy. Compounds in *Aristolochia* can be toxic to the liver as well as lead to cancer.



87 Crown vetch
(*Coronilla varia*)

This legume plant is viny and can be invasive in some areas. Individual flowers in the cluster closely resemble those of other pea family members.



88 Highbush cranberry
(*Viburnum opulus*)

This is a shrub that is cultivated for its attractive flowers and bright-red fruits. The larger flowers on the periphery of the inflorescence are sterile, while those in the center have both male and female parts and are fertile.



89 Highbush cranberry
(*Viburnum opulus*)

The underside of an inflorescence is seen here.



90 Variegated dogwood
(*Cornus alba*)

White flowers and buds are shown here on a tender green twig, which eventually turn woody and are bright red in fall and winter.



91 Red powderpuff
(*Calliandra haematocephala*)

Long, slender stamens give this pea-family member its powderpuff appearance.



92 Waterweed
(*Myriophyllum* sp.)

The flowers of this feathery aquatic plant can be overlooked as they are quite tiny and emerge only a short distance from the water's surface. Fuzzy pink female flowers are seen here.



93 Waterweed
(*Myriophyllum* sp.)

The anthers of male flowers are seen here.



94 Swamp milkweed
(*Asclepias incarnata*)

Varying in color, flowers of milkweed species have a very distinctive structure. Rather than individual pollen grains being carried from flower to flower by pollinators, special structures carrying whole batches of pollen are transported.



95 Whorled milkweed
(*Asclepias verticillata*)

This narrow-leaved species has pale-green to white flowers and is toxic to some grazing animals.



96 Marsh cinquefoil
(*Comarum palustre*)

A member of the rose family, this mostly wetland plant can be bred with strawberries to form hybrids.



97 Leatherleaf
(*Chamaedaphne calyculata*)

Leatherleaf is a bog shrub that is related to cranberries and blueberries. In addition to these three plants, a number of other representatives of the same family occur in bogs. Flowers in the group tend to be bell-shaped and similar in appearance to those shown here.



98 Flower of an hour
(*Hibiscus trionum*)

Although a weedy plant, this *Hibiscus* species has attractive flowers and leaves. *Hibiscus* flowers typically have five stigmas on short branches. They can be seen when zooming way in.



99 Flower of an hour
(*Hibiscus trionum*)

Viewed from beneath, the patterning on the petals is seen to differ from that on their upper surface.



100 Prairie farnes flower
(*Phemeranthus rugospermus*)

A plant native to the Central U.S., this plant is threatened in some regions. Its flowers open for just one day, and only in the afternoon.



101 Canada mayflower
(*Maianthemum canadense*)

This primarily northern species is closely related to asparagus.



102 Purple pitcher plant
(*Sarracenia purpurea*)

The hollow, pitcher-shaped leaves of this plant were shown earlier. The sturdy flower typically faces downward and has an elaborate structure that forces pollinators (usually bees) through tight openings to increase chances for pollination. The purple petals do not remain on the flower very long.



103 Black locust
(*Robinia pseudoacacia*)

A late-Spring-flowering tree, the black locust has fragrant flowers that resemble those of other pea family members. Its wood is hard and rot-resistant.



104 Mock strawberry
(*Duchesnea indica*)

Though brightly colored, fruits of the mock strawberry have very little flavor compared to their strawberry cousins. Botanically speaking, the little "seeds" on the surface are actually the fruits (with seeds inside). The red, fleshy portion derives from tissue at the base of the flower, from which all the flower parts originate.



105 Queen Anne's-lace
(*Daucus carota*)

The inflorescence of Queen Anne's-lace has been shown earlier. Spiny fruits have developed here and actually the whole inflorescence may detach and become a miniature tumbleweed.



106 Beebalm
(*Monarda fistulosa*)

Even after the flowers have fallen off, the head-like inflorescences of beebalm remain attractive at the fruiting stage.



107 Siberian elm
(*Ulmus pumila*)

These fuzzy fruits have flattened tissue around the periphery (wings) that aid in their dispersal.



108 Boxelder
(*Acer negundo*)

Both male and female flowers of boxelder were shown earlier. Here, the female flowers have developed into fruits ("samaras") with wings that help them helicopter down from the trees, which helps them travel a greater distance from the parent tree.



109 Staghorn sumac
(*Rhus hirta*)

The fuzzy fruits have developed from flowers (shown earlier).



110 Milkweed
(*Asclepias* sp.)

Familiar to many, the seeds of milkweeds are formed in podlike fruits. Seeds have a tuft of white filaments, which make them easily dispersed by wind.



111 Cottongrass
(*Eriophorum angustifolium*)

Actually a sedge (though still related to grasses), cottongrass is typified by having tufts of cottony, white hairs when the fruits have developed.



112 Bur oak
(*Quercus macrocarpa*)

The sizable acorns of the bur oak have caps that are fringed.



113 Acorn
(*Quercus* sp.)

As is typically the case when seeds germinate, the root was the first thing to emerge from this acorn. The two yellow-green seed leaves (cotyledons) provide food to give the young oak a head start. The outmost part of the acorn was removed.



114 Avens
(*Geum* sp.)

Fruits of avens species are tiny and are tipped by persistent styles (a style is the often elongated part of the female flower that lies between the ovary and stigma(s)).



115 Avens
(*Geum* sp.)

Here, the styles are reddish and differently shaped.



116 Goat's beard
(*Tragopogon dubius*)

The dandelion-like tufts on the fruits of goat's beard were photographed here under polarized light, which highlights their crystalline nature.



117 Cranberry
(*Vaccinium macrocarpon*)

Cranberry fruits seem somewhat out of scale compared to the tiny leaves of these small, viny bog plants. To harvest, fruits are mechanically separated from the vines in flooded (usually artificial) bogs and the berries, which float, can then be corralled and processed.



118 Tangerine (*Citrus tangerina*)

The familiar fruit is lit from beneath in this shot.



119 Gala apple
(*Malus domestica*)

A thick slice was photographed using light passing through it.



120 Pineapple
(*Ananus comosus*)

The pineapple is an example of a "multiple" fruit, which means that fruits from all the flowers and ovaries in an inflorescence fuse together to create the larger fruit we know. The fig is another example of a multiple fruit.



121 Corn
(*Zea mays*)

Corn "silk" (actually stigmas plus styles) emerges from a corn ear and provides a surface for wind-blown pollen grains to land and germinate. Here, an undeveloped ear was stripped of its husks and individual styles/stigmas can be seen attached to each kernel.



122 Orange bracket fungus
(*Pycnoporus cinnabarinus*)

Moving away from plants, the same bracket fungus is shown here in both top and bottom views. On the underside, small pores are visible, from which spores are released.



123 Red crust fungus
(*Peniophora rufa*)

This is a fungus in the same major group as the bracket fungi and most mushrooms. It grows as little cushions on dead aspen trees while the bark is still present.



124 Leaf rust
(*Arthuriomyces peckianus*)

Rust fungi are also members of the fungal group that includes familiar mushrooms and bracket fungi. They typically have complicated life cycles with multiple stages that occur on different plant hosts and can cause considerable damage to plants.



125 A lichen

A lichen is actually not an individual life form. Rather, it represents a symbiotic relationship between a fungus (or more than one) plus green algae and/or cyanobacteria bacteria. The algae and cyanobacteria contribute food (via photosynthesis) and the primary fungal partner supplies protection and nutrients to the photosynthesizers.



126 *Micrasterias* sp.

This alga and the next are members of the group of green algae that are most closely related to land plants. They are single-celled organisms known as desmids and often have intricate cell wall shapes and ornamentation. The gray area in the center is the cell's (DNA-containing) nucleus.



127 *Euastrum* sp.

Here, as in *Micrasterias*, the single cell is divided into two halves or "semi-cells." When a cell divides, the semi-cells split apart and a new semi-cell forms on each of the original ones. A new semi-cell starts out as a small bulge and gradually develops the shape and ornamentation seen in older cells.