The Winter-Green Herbaceous Flowering Plants of Ohio

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THE WINTER-GREEN HERBACEOUS FLOWERING PLANTS OF OHIO

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Nearly everyone is familiar in some way with plants which are green in winter in the Deciduous Forest region. The evergreen conifers, especially the pines, spruces, firs and cedars, planted extensively for landscape purposes, are probably the most widely recognized. In fact, the terms evergreen and conifer are commonly used by the layman as synonyms. Winter wheat, and the bluegrass and dandelions of lawns are likewise familiar species which add greenness to landscapes in a season when the leaves of most plants have withered and died. Overwintering leaves of candytuft, foxglove, sweet william, chrysanthemum, and others are well-known to gardeners and nurserymen. Botanists have long been aware of the winter-green leaves of such shrubs as Rhododendron, Kalmia, and others of the Heath Family, as well as the frequency of winter-greenness among ferns, and the conspicuous greenness of mosses, as a group, in the winter aspect of almost any forest.

During the months of November through February, however, when snow cover is absent, there is a large population of green herbaceous plants in field and forest which appear little or none the worse for the presumed rigors of the season. Far from being devoid of herbaceous plants in the winter, the ground is dotted with green nearly everywhere. This population consists of many different kinds of plants, and the species, genera, or families to which they belong often cannot be ascertained by the usual vegetative characters customarily used in their identification. These are the plants with which this paper is concerned.

Earl (1907) noted that a number of species in Ohio are winter-green in addition to conifers and woody dicots. In her compilation 16 genera and 27 species of herbaceous angiosperms are cited. She classed Glechoma hederacea and some species of Lamium among the most hardy of herbaceous perennials, the genera Senecio, Taraxacum, and Achillea among the more hardy of the winter-green rosette plants, and such species as Poa pratensis and Nepeta cataria among those which partly withstand freezing. Of this list, one species (Sempervivum tectorum) is strictly cultivated, three are not known to occur in Ohio from The Ohio State University herbarium records (Moneses uniflora, Pyrola asarifolia and its variety purpurea), and one is considered to be very doubtfully winter-green (Malva rotundifolia).

Griggs (1914) classified the evergreen plants in the Sugar Grove region of Ohio in three groups: (1) "Typical shade-loving evergreens with leaves appearing late in the season", consisting of Goodyera pubescens, Pyrola elliptica, and Epigaea repens; (2) "shade-loving herbs with hibernating leaves replaced in spring by new ones", represented by Hepatica acutiloba, H. americana, Carex plantaginea, Tiarella cordifolia, and Maianthemum canadense; and (3) "evergreen herbs with leaves or shoots ascending sufficiently from the ground partially to surmount a blanket of fallen leaves", in which Mitchella repens and Gaultheria procumbens are the flowering species cited.

There apparently has been no attempt made, in North America at least, to list comprehensively the winter-green species of any geographical area, to describe these species in the winter condition, or to devise keys by which they may be
identified in winter. Lidforss (1907) enumerated more than 130 winter-green central and northern European vascular species growing in the Botanical Gardens at Lund, Sweden, which were used in his chiefly physiological studies of winter-green plants. More recently Nilsson (1949) has observed degrees of winter hardiness exhibited by over 4,200 ornamental herbaceous species growing in Sweden.

The standard manuals of Fernald (1950) and Gleason (1952) make only occasional reference to species as being winter-green. A rather large number of introduced weed species are described as "winter annuals" in the weed manuals of Muenscher (1935) and Georgia (1923), covering the ranges of Gray's Manual and Britton and Brown's Illustrated Flora, and in various publications encompassing the weed floras of more limited areas. Mention of perennial species which are winter-green, in treatises of any kind dealing with the taxonomy, ecology, or physiology of flowering plants, is rare, and descriptions of winter annuals or winter-green perennials in the winter condition are essentially non-existent.

SOURCES OF DATA

During the winters of 1945–48, more than 1,000 herbaceous winter-green plants were selectively collected in the field and transplanted in clay pots. Thereafter some were placed in cold frames in The Ohio State University Botanical Garden, duplicate specimens were placed in the greenhouse, and triplicate specimens, when collected, were retained for the herbarium. As these plants flowered and fruited, they were identified and the determinations checked with specimens in The Ohio State University herbarium. Although a number of problems were encountered in maintaining this extremely diverse population in such a manner that anthesis might occur in all, determinations were ultimately made of all but a half-dozen or so plants. After the first year, collections were made between mid-December and the last of February since it became evident the first winter that for many of our native species there is a cold period requirement, necessary for the breaking of winter dormancy, which is not fulfilled in this region until sometime in December.

Collections were made by habitat, and such habitats as seemed most likely to contain chiefly native flora were the principal collecting areas. The most extensive collections were made in the Hocking Hills of Fairfield and Hocking Counties, Ohio, because of the region's great diversity of habitats and richness of flora. The winter herbaceous flora of the Oak and Mixed Mesophytic communities of this region is considered to be representative of these communities throughout most of the Allegheny Plateau of eastern and southern Ohio. Collections were also made in Beech-Sugar Maple forests in central Ohio, and in swamp forests, prairies, bogs, old field communities, and on pioneer sites in both central and southern Ohio. A number of stands of all of the principal forest types of central and southern Ohio were visited over the three-year period, and it is believed that most, if not all, of the winter-greens which are at all common in forest communities of this part of the State were collected. The flora of the upland forests was relatively more thoroughly studied than the more diverse flora of some of the swamp forest types. Likewise forest species were more intensively collected than species of pioneer communities or other sites on which various stages of succession were occurring.

THE WINTER-GREEN FLORA

In the list which follows are included all flowering plant species (excepting shrubs) which are known from the present field study to be green throughout the winter in central and southern Ohio. Such species as Saponaria officinalis, in which many of the leaves often remain green until midwinter but have obviously been so severely injured that recovery will not ensue, have not been included.
Species referred to as “winter annuals” by Muenscher (1935), Georgia (1923), or Runnels and Schaffner (1931), which were not collected during this investigation but which are known to occur in Ohio from records of The Ohio State University herbarium, have also been included; these are marked with an asterisk—almost all are Eurasian weed species, many of which are rare or have restricted distributions in the State at the present time. Except for three species, the Panicums have been included on the authority of Hitchcock and Chase (1950), who characterize the group to which these Ohio species belong as having “basal leaves usually distinctly different from those of the culm, forming a winter rosette.” A few other species are included on the authority of other authors, and are so designated by citation of their publications. Synonymy and phylogenetic order are essentially those of Fernald (1950).

It is not presumed that the list includes all of the herbaceous angiosperms which regularly have green, living leaves throughout the winter in Ohio. Grasses, sedges, and rushes were collected only occasionally, and these families without question, on the basis of field observations, are only partially represented. Several members of the Labiatae remain unidentified because of failure of anthesis under greenhouse or cold frame conditions, and it seems probable that a number of additional species in this family will be demonstrated to be winter-green. Representatives of the Cruciferae in the present list are largely the “winter annuals” of the weed manuals, and the native biennial and perennial winter-green mustards are doubtless not well represented in this compilation. The present list, consisting of 287 species, represents about 16 percent of Ohio’s herbaceous flowering species. It is anticipated that the percentage will be no less than 20 when the list is more nearly complete.

**Gramineae**

*Bromus kalmii* Gray  
*B. secalinus* L.*  
*B. japonicus* Thunb.*  
*B. mollis* L.*  
*B. sterilis* L.*  
*B. tectorum* L.*  
*Poa pratensis* L.  
*Hordeum jubatum* L.*  
*Elymus virginicus* L.  
*Hystrix patula* Moench  
*Deschampsia caespitosa* (L.) Beauv.  
*Danthonia spicata* (L.) Beauv.  
*Agrostis perennans* (Walt.) Tuckerm.  
*Cinna arundinacea* L.  
*Panicum linearifolium* Scribn.  
*P. bicknellii* Nash  
*P. microcarpon* Muhl.  
*P. boreale* Nash  
*P. dichotomum* L.  
*P. yodkinense* Ashe  
*P. meridionale* Ashe  
*P. lanuginosum* Ell.  
*P. villosissimum* Nash  
*P. columbium* Scribn.  
*P. sphaeroacarp* Ell.  
*P. polyanthes* Schultes  
*P. malacophyllum* Nash  
*P. oligosanthes* Schultes  
*P. leibergii* (Vasey) Scribn.  
*P. sanguineum* Gray  
*P. commutatum* Schultes  
*P. clandestinum* L.  
*P. latifolium* L.  
*P. boscii* Poir.  
*Andropogon virginicus* L.

**Cyperaceae**

*Carex plantaginea* Lam.  
*C. platyphylla* Carey  
*C. gracilescens* Steud.

**Juncaceae**

*Juncus effusus* L.  
*Luzula acuminata* Raf.  
*L. campestris* (L.) DC.

**Liliaceae**

*Chamaelirium luteum* (L.) Gray  
*Allium vineale* L.

**Iridaceae**

*Iris virginica* L.

**Orchidaceae**

*Goodyera pubescens* (Willd.) R. Br.  
*Aplectrum hyemale* (Muhl.) Torr.

**Polygonaceae**

*Rumex crispus* L.  
*R. obtusifolius* L.  
*R. acerosella* L.

**Portulacaceae**

*Claytonia virginica* L.
Caryophyllaceae
Scleranthus annuus L.*
Spergula arvensis L.*
Arenaria serpyllifolia L.
Stellaria media (L.) Cyrillo
S. longifolia Muhl.
Cerastium vulgatum L.
C. arvense L.*
C. nutans Raf.
C. viscosum L.
Agrostemma githago L.
C. vulgatum L.
C. arvense L.*
C. nutans Raf.
C. viscosum L.
Coronopus didymus (L.) Sm.
Capsella bursa-pastoris (L.) Medic.
Camelina sativa (L.) Crantz*
C. microcarpa Andrz.*
Neslia paniculata (L.) Desv.*
Raphanus raphanistrum L.*
Brassica juncea (L.) Coss.*
B. nigra (L.) Koch*
B. rapa L.*
Conringia orientalis (L.) Dumort.*
Alliaria officinalis Andrz.*
Sisymbrium officinale (L.) Scop.*
S. altissimum L.*
Aralidopsis italiana (L.) Heynh.
Descurainia pinnata (Walt.) Britt.*
Erysimum cheiranthoides L.*
E. repandum L.*
Rorippa islandica (Oeder) Borbas
Nasturtium officinale R. Br.
Barbarea vulgaris R. Br.
B. verna (Mill.) Aschers.
Cardamine bulbosa (Schreb.) BSP.
C. douglassii (Torr.) Britt.
C. pensylvanica Muhl.
Arabis pows Sulliv.
A. laevigata (Muhl.) Poir.
Crassulaceae
Sedum acre L.
S. ternatum Michx.
S. telephium L. (Eari, 1907)
S. telephoides Michx. (Eari, 1907)
Saxifragaceae
Saxifraga virginica L.
S. pensylvanica L.
Tiarella cordifolia L.
Heuchera americana L.
Mitella diphylla L.
Chrysosplenium americanum Schwein.
Rosaceae
Fragaria virginiana Duchesne
Potentilla recta L.
P. norvegica L.
P. intermedia L.
P. simplex Michx.
Geum canadense Jacq.
G. virginianum L.
G. vernum (Raf.) T. & G.
Agrimonia gryposepala Wallr.
A. parviflora Ait.
Leguminosae
Trifolium pratense L.
T. repens L.
T. hybridum L.
Medicago lupulina L.
Vicia sativa L.*
V. angustifolia Reichard*
V. caroliniana Walt.
V. villosa Roth
Callitrichaceae
Callitriche heterophylla Pursh
Guttiferae
Hypericum punctatum Lam.
H. muticum L.
<table>
<thead>
<tr>
<th>Family</th>
<th>Species</th>
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<tr>
<td>Cistaceae</td>
<td><em>Lechea racemulosa</em> Lam.</td>
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<td><em>Viola papilionacea</em> Pursh</td>
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<td></td>
<td><em>V. sagittata</em> Ait.</td>
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<td></td>
<td><em>V. triloba</em> Schwein.</td>
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<td><em>V. striata</em> Ait.</td>
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<td></td>
<td><em>V. conspersa</em> Reichenb.</td>
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<td></td>
<td><em>V. rostrata</em> Pursh</td>
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<td>Cactaceae</td>
<td><em>Opuntia humifusa</em> Raf. (Earl, 1907)</td>
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<td>Onagraceae</td>
<td><em>Epilobium coloratum</em> Biehler</td>
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<td><em>E. glandulosum</em> Lehmann</td>
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<td><em>Oenothera biennis</em> L.</td>
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<td><em>Gaura biennis</em> L.</td>
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<td>Umbelliferae</td>
<td><em>Sanicula gregaria</em> Bickn.</td>
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<td><em>Chaerophyllum procumbens</em> (L.) Crantz</td>
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<td><em>Osmorhiza claytoni</em> (Michx.) C. B. Clarke</td>
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<td><em>O. longistylis</em> (Torr.) DC.</td>
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<td><em>Toriks japonica</em> (Houtt.) DC.</td>
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<td><em>Zizia aurea</em> (L.) W. D. J. Koch</td>
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<td><em>Cryptotaenia canadensis</em> (L.) DC.</td>
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<td><em>Heracleum maximum</em> Bartr.</td>
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<td><em>Daucus carota</em> L.</td>
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<td><em>Chimaphila umbellata</em> (L.) Nutt.</td>
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<td><em>C. maculata</em> (L.) Pursh</td>
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<td><em>Pyroa secunda</em> L. (Fernald, 1950)</td>
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<td><em>P. elliptica</em> Nutt.</td>
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<td><em>P. rotundifolia</em> L.</td>
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<td><em>Gaultheria procumbens</em> L.</td>
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<td><em>Samolus parviflorus</em> Raf.</td>
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<td><em>Sabatia angularis</em> (L.) Pursh</td>
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<td><em>Obolaria virginica</em> L.</td>
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<td><em>Polemonium reptans</em> L.</td>
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<td><em>Phlox divaricata</em> L.</td>
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<td><em>P. stolonifera</em> Sims</td>
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<td><em>Hydrophyllum canadense</em> L.</td>
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<td><em>Phacelia purshii</em> Buckl.</td>
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<td><em>Myosotis scorpioides</em> L.</td>
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<td><em>Lappula echinata</em> Gilib.*</td>
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<td>Labiatae</td>
<td><em>Glechoma hederacea</em> L.</td>
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<td><em>Prunella vulgaris</em> L.</td>
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<td><em>Leonurus cardiaca</em> L.</td>
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<td><em>Lamium amplexicaule</em> L.</td>
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<td><em>L. purpureum</em> L.</td>
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<td><em>L. maculatum</em> L. (Earl, 1907)</td>
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<td><em>L. album</em> L. (Earl, 1907)</td>
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<td><em>Blephilia ciliata</em> (L.) Benth.</td>
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<td><em>Veronica serpyllifolia</em> L.</td>
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<td><em>V. persica</em> Poir.*</td>
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<td><em>Castilleja coccinea</em> (L.) Spreng.</td>
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<td><em>P. lanceolata</em> L.</td>
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<td><em>G. pilosum</em> Ait.</td>
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<td></td>
<td><em>Mitchella repens</em> L.</td>
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<td><em>Houstonia caerulea</em> L.</td>
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<td><em>H. longifolia</em> Gaertn.</td>
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<td><em>Linnaea borealis</em> L. (Fernald, 1950)</td>
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<td>Valerianaceae</td>
<td><em>Valerianella oitioria</em> (L.) Poll.*</td>
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<td><em>V. intermedia</em> Dyal</td>
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<td>Dipsacaceae</td>
<td><em>Dipsacus sylvestris</em> Huds.</td>
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<td>Campanulaceae</td>
<td><em>Campanula americana</em> L.</td>
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<td><em>Lobelia cardinalis</em> L.</td>
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<td></td>
<td><em>L. siphiatia</em> L.</td>
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<td></td>
<td><em>L. speciosa</em> Lam.</td>
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<td></td>
<td><em>L. inflata</em> L.</td>
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Vegetative form. Differences in degree of elongation of the internodes of the overwintering above-ground stems are responsible for the most pronounced differences in vegetative form. In most cases, the internodes are quite distinctly either elongated or not elongated.

Where internodes are clearly elongated, leaves are distinctly opposite, alternate, or whorled along the length of the stem. Stems may be branched or simple, and erect, ascending, decumbent, or prostrate. The terminal bud is rarely more than eight and usually less than five centimeters above ground. To this group belong the species of the following: Cerastium, Sedum, Leguminosae, Epigaea, Gaultheria, Lysimachia (nummularia), Obolaria, Phlox, Labiatae (except Prunella and Salvia), Veronica, Rubiaceae, Chrysosplenium, Hypericum, Lechea, and Polymnia. In a few cases, e.g., Chimaphila spp., stems are elongate but the leaves are crowded near the tip, and in Claytonia there are but two leaves borne at the end of a fragile usually non-green stem which is several centimeters long. In Houstonia caerulea, stems are frequently highly branched forming a polster. For the most part, the vegetative form and vegetative characters of plants belonging to this group are essentially like those at other seasons of the year.

Where the internodes are not appreciably elongated, the leaves are crowded on short simple usually erect stems and may be ascending or prostrate. The terminal bud is rarely more than eight and usually less than five centimeters above ground. To this group belong the species of the following: Cerastium, Sedum, Leguminosae, Epigaea, Gaultheria, Lysimachia (nummularia), Obolaria, Phlox, Labiatae (except Prunella and Salvia), Veronica, Rubiaceae, Chrysosplenium, Hypericum, Lechea, and Polymnia. In a few cases, e.g., Chimaphila spp., stems are elongate but the leaves are crowded near the tip, and in Claytonia there are but two leaves borne at the end of a fragile usually non-green stem which is several centimeters long. In Houstonia caerulea, stems are frequently highly branched forming a polster. For the most part, the vegetative form and vegetative characters of plants belonging to this group are essentially like those at other seasons of the year.

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Where the internodes are not elongated, the leaves are crowded on short simple usually erect stems and may be ascending or prostrate. The terminal bud is rarely more than eight and usually less than five centimeters above ground. To this group belong the species of the following: Cerastium, Sedum, Leguminosae, Epigaea, Gaultheria, Lysimachia (nummularia), Obolaria, Phlox, Labiatae (except Prunella and Salvia), Veronica, Rubiaceae, Chrysosplenium, Hypericum, Lechea, and Polymnia. In a few cases, e.g., Chimaphila spp., stems are elongate but the leaves are crowded near the tip, and in Claytonia there are but two leaves borne at the end of a fragile usually non-green stem which is several centimeters long. In Houstonia caerulea, stems are frequently highly branched forming a polster. For the most part, the vegetative form and vegetative characters of plants belonging to this group are essentially like those at other seasons of the year.
Species with well-developed flat rosettes are those of the following genera and families: Goodyera, Cruciferae (most), Arabis (laevigata), Saxifraga (virginiensis), Agrimonia, Epilobium, Sabatia, Verbascum, Castilleja, Plantaginaceae, Dipsacus, Lobelia, Antennaria, Gnaphalium, Cirsium, and Lactuca.

Tufted forms include: Gramineae, Cyperaceae, Juncaceae, Liliaceae, Rumex, Dianthus, Corydalis, Ranunculaceae, Cardamine, Tiarella, Heuchera, Fragaria, Potentilla, Viola, Umbelliferae, Pyrola, Lysimachia (cilia), Polemonium, Hydrophyllum, Valerianella, Campanula, Aster, Solidago, Rudbeckia, Chrysanthemum, and Senecio (aureus).

Species which are often difficult to classify as having either distinct rosettes or tufts are those of Silene, Saxifraga (pensylvanica), Geum, Oenothera, Gaura, Salvia, Erigeron (annuus), and Hieracium. In some, e.g., Phacelia, Leonurus cardiaca, and Houstonia (caerulea, longifolia, and canadensis), the degree of internode elongation is variable. Watercress (Nasturtium officinale) is singular in that during much of the winter season individuals have elongated internodes, but by mid-February this population at least sometimes has been replaced by one consisting of distinct rosettes.

Approximately 47 percent of the species cited here as being winter-green occur as tufts; 23 percent have a rosette form; 20 percent have elongated internodes; six percent occur as either tufts or rosettes; and four percent may have elongated internodes or not, depending apparently upon environmental conditions during the autumn and winter seasons.

Time of appearance of the winter leaves. The winter-green species are biennials and perennials: 73 percent are perennials, 35 percent biennials, and two percent biennials and under certain conditions perennials. Examples of the last group are Rudbeckia triloba, Lychnis alba, Ranunculus abortivus, and Oenothera biennis, specimens of all of which were perennial for four years or longer in the Botanical Garden. Species described in weed manuals and other publications as “winter annuals” have life cycles spanning two growing seasons, and hence are biennials in the sense that a biennial is one in which germination of the embryo takes place during one growing season and flowering and death occur in the subsequent growing season.

The overwintering leaves of biennials (and first-year perennials) apparently are those formed during summer or autumn growth following germination of the embryo. The winter leaves may persist at the time of flowering, although usually by this time they have disappeared or are present only as remnants.

Perennials exhibit a wide range of variation in time of appearance of the overwintering leaves. In some of the spring-flowering species, e.g., Hepatica spp. and Saxifraga virginiensis, the leaves which will overwinter appear during flowering or shortly thereafter, and persist until the following spring. In others, e.g., Cardamine bulbosa and Isopyrum bibernum, the old winter leaves die by early summer along with the spring growth, and new winter leaves appear during the autumn. This growth regime, characterized by the presence of leaves in the autumn, winter and spring months is found, with variations in the time of appearance and death of the leaves, in a number of other species, e.g., Claytonia virginica. In this species the winter leaves begin growth in early winter and continue until time of flowering in April, after which death of the above-ground parts occurs.

In a number of spring-flowering species, the summer and winter leaves have essentially the same appearance, and the latter are apparently merely those which are present when the winter season commences. Examples of this group are Sedum ternatum, Fragaria virginiana, and Houstonia caerulea. Winter leaves of such summer-flowering species as Potentilla spp. and Lysimachia nummularia also do not appear to be the result of growth occurring during a period specifically related to the time of flowering or to the changing autumn environment.

In still others among the spring-flowering species, e.g., Viola spp., the winter leaves appear at a definite time in late summer or autumn, accompanied by death of the summer leaves.

Among summer- and autumn-flowering perennial species, the winter leaves first appear by far most frequently during flowering or soon thereafter, continue growth as long as favorable environmental conditions prevail, and persist until the following spring or in some cases into summer. All such tufts or rosettes are in reality branches arising from buds usually near the below-ground base of the old stem—“basal offshoots” of some authors—and the time of formation
of these vegetative buds (or those of spring-flowering species as well) is unknown in most cases. Examples of this group are *Aster* and *Solidago* spp., *Rudbeckia* spp., *Lobelia* spp., and *Anemone virginiana*.

The overwintering leaves of both biennials and perennials are frequently distinctly different in appearance from the leaves present at other seasons. In other cases they are similar but at variance in some respects, and in still others the overwintering leaves are indistinguishable from those of other seasons. These seasonal differences have been described only in isolated instances, even monographers usually failing to mention them. A notable exception is the treatment of the genus *Heuchera* by Rosendahl *et al.* (1936), who state that "Often the leaves produced in the late summer, which usually persist throughout the winter, are of quite different size and shape from those produced during active growth in the spring." Failure to describe these seasonal variations in leaves is apparently due to the practice of limiting observation largely or entirely to plants in the flowering condition. As a result, the growth regimes of winter-green and most other herbaceous species, as well, are imperfectly known.

**ECOLOGY OF THE WINTER FLORA**

Daily, seasonal, and annual regimes of the major weather elements, as measured by official agencies and as referred to in most ecological reports, bear slight resemblance to actual environmental conditions surrounding plants in the lowest layer of air (Wolfe, 1944). Especially is this true of above-ground parts of plants during winter. An intensive study of environmental conditions was not within the scope of this investigation, but attention is here called to some general conditions and certain problems associated with the ecology of the winter-greens.

Solar radiation is a major weather control, and in local situations is especially important in relation to air and soil temperatures, and consequently to the rates of processes in plants. On the forest floor insolation during the winter months is never less than five times greater than that in mid-July (Wolfe, *et al.*, 1949). A conspicuous increase in light intensity during October and November, and rapid decrease during April and May, result respectively from disappearance of the canopy and its closure. Light intensities during the winter months are probably more than adequate for photosynthesis.

Because of this insolation, temperatures of plants themselves may be higher during the daytime than air temperatures a few feet above them. Likewise, minimum temperatures of plants are ordinarily lower than those of this air during the night or other times when radiation exceeds insolation. Since official Weather Bureau air temperatures are not usually those of the air surrounding plants (Wolfe, *et al.*, 1949), the range of temperature to which the above-ground parts of plants are subjected in winter, as a result of fluctuating air temperatures and insolation and radiation, can only be guessed until actual measurements of the temperatures of the plants themselves are made.

Temperatures to which winter leaves of plants are exposed range from well below freezing to considerably above freezing. This range is greater in fully exposed habitats, such as cliff faces and denuded roadside banks, than in forest communities where plants are commonly surrounded by leaf litter. Even in forest conditions the leaves may be frozen solid at times during daylight hours. Those of *Dianthus armeria* and *Epilobium coloratum*, both pioneer species, have been found a number of times frozen so solidly that a slight touch was sufficient to break off a leaf. That temperatures are often low enough to freeze above-ground parts, in nearly any natural habitat in Ohio, and yet not result in death of these organs, has been observed many times in the field.

Lowest minimum temperatures to which these plants are exposed, and highest maximums, occur where insolation in daytime and radiation at night are greatest. In forest habitats, leaf litter conditions modify minimum temperatures upwards. In fully exposed situations, minimums may conceivably be less than 0°F on certain
winter nights. Exposure to the most extreme minimums rarely occurs in any habitat of an area, since these extremes almost always follow snowfall (Dole, 1927, and Beatley, 1953). Under snow, temperatures remain essentially uniform day and night. In the absence of snow, however, temperatures of exposed parts of plants may sometimes rise well above freezing in the daytime even if air temperature is below 32°F. What maximum temperatures plant tissues may attain is not known, but during daylight hours they must often be considerably above 32°F, as evidenced by widespread thawing of adjacent substrates and melt-water on cliff faces.

Underground parts of forest plants are rarely, if ever, exposed to sub-freezing temperatures since the soil beneath even a moderately deep leaf litter rarely freezes (Wolfe, 1949). Where leaf litter is scanty or absent, soils may be frozen solid during certain periods. Since the temperatures of roots and other underground organs are essentially the same as the surrounding soil, the below-ground tissues are either never frozen or frozen only during certain periods. While upper soil temperatures are lower in winter than in other seasons, and while water absorption may be reduced under these conditions, it probably does not cease as long as the soil is unfrozen. That availability of water may be a factor in the distribution of winter-greens is indicated by the nature of vegetation along stream banks and in other wet or moist habitats. Here plants are most abundant in the winter, best developed, and the brightest green. Water relations in winter-green herbs, especially absorption and transpiration, seem worthy of study out-of-doors, or at least under simulated field conditions.

A discussion of the physiology of winter-greens is beyond the scope of this paper, but two processes which appear to have possible ecological significance should be mentioned, viz., photosynthesis and growth. Although winter photosynthesis is not known to have been measured in native herbaceous plants, there is no reason to assume that it does not occur since light intensities are not limiting, daytime temperatures some of the time (perhaps much of the time) are not unfavorable, and water absorption can occur in forest plants the winter through and in others at least during certain periods. If photosynthesis occurs in winter, even intermittently, a new field of problems becomes apparent, including the importance of this process in winter to the survival of plants in which it occurs, and its significance in certain problems of plant distribution.

It is certain from both field inspection and observations of plants transplanted to the Botanical Garden, that growth of leaves occurs in the Ohio region during winter both under snow cover and exposed. The so-called growing season appears from these observations to be in reality a period of accelerated growth, while the winter season, at least for some species, is one of merely decelerated growth. Actual measurements of rates of winter growth, its periodicity, conditions under which it occurs, its physiological significance, and its relation to plant distribution are problems which have been investigated as yet in only isolated instances.

That a period of low temperatures is often requisite to the breaking of dormancy of many native perennials, and certain biennials as well, has been clearly indicated by attempts to force flowering in greenhouse conditions during this study. Similar observations of native perennial species were made by Rosendahl (1914) a number of years ago. Examples of species for which a cold period, or its equivalent, was found necessary in the present study are Lobelia cardinalis, Dianthus armeria, Hieracium spp., and most species of Aster and Solidago. Measurements of degree and duration of low temperatures requisite to the breaking of dormancy in native herbaceous plants have not been made. Also, alternating

2The dormant condition, as used in this paper, refers to the winter vegetative condition. Breaking of dormancy refers to elongation of the stems of tufts and rosettes, and to initiation of flower primordia in plants with elongated internodes in the winter condition.
periods of low and relatively higher temperatures, which may be factors in break-
ing of dormancy, are open to further investigation. The minimum duration and
degree of low temperatures, and alternating "cold" and "warm" periods necessary
for each species can be expected to differ widely. Whatever these requisites are,
they apparently are satisfactorily met within the diverse microclimates in which
native species of the Ohio region pass the winter.

The full extent to which effects of low temperatures on the processes related
to dormancy are controlling factors in plant macrodistribution can only be sur-
mised. Local distribution may also be related to the particular winter conditions
necessary to fulfill very specific requirements of some species during the dormant
period. These winter conditions may prevail only in certain microhabitats.
The local distribution of some species, regardless of their possible ecological
amplitude at other seasons, may conceivably be limited by the environmental
complexes which characterize winter microclimates. The study of these condi-
tions, using winter-green species, may prove a fruitful approach to local distribu-
tion problems.

The extent to which all of the species enumerated here are winter-green in all
habitats in which they may grow is unknown. Most, especially the native forest
species, are believed to have winter leaves in most, if not all, of the habitats in
which the species occur. A single exception is known: Viola papilionacea is
winter-green in certain valleys of Fairfield and Hocking Counties, but does not
appear to be so in swamp forests of the Columbus area. Whether such variation
in behavior is due to genotypic or environmental differences, or both, is not known;
it can only be said, on the basis of present information, that within each of the
species there must be at least some biotypes in which the potentiality of winter-
greenness is expressed in at least some environments. It is suggested that, in
general, species of relatively broad ecological amplitudes are those most likely
to be demonstrated not to be winter-green in all habitats in which they occur.

Ecological classification of the winter-green species. The herbaceous winter-
greens may be classified in a general way on the basis of their association with
the major vegetation types. The numbers of species and abundance of individuals
which make up the winter ground cover societies vary conspicuously among the
vegetation types. In the Oak-Chestnut association, species are numerous but
individuals usually occur as scattered specimens and are nowhere abundant.
This is generally true also of Beech-Sugar Maple forests, where number of species
and individuals is somewhat correlated with degree of disturbance. Of the forest
communities, number of species is greatest and individuals are most abundant in
swamp forests. Greatest paucity of species occurs in Hemlock and Hemlock-
Beech communities, where but one species, Michella repens, together with Christ-
mas Fern (Polystichum acrostichoides), constitutes the ground layer society the
year around. In general, it is in the pioneer habitats such as old fields and their
developmental stages, and unforested flood plains and stream banks, in which the
greatest diversity of the winter flora occurs; here also individuals are most abun-
dant. In these pioneer sites, the ground may be locally nearly carpeted with
green throughout the winter season.

In the ecological classification which follows, those which are referred to as
"common" generally occur in most communities with which they are associated,
though they may not necessarily be abundant. Species considered as "frequent
to infrequent" are those which may occasionally occur in these vegetation types,
or may be almost common under certain conditions. Species introduced into
Ohio are indicated by (I).
Swamp Forest communities, including such developmental societies as are found in marshes, swales, wet old fields and sandbars, as well as the strictly arboreal communities of Sycamore-Cottonwood-Willow, Elm-Ash-Soft Maple, Mixed Swamp Forest, and their related types.

Common to abundant:

- *Elymus virginicus*
- *Stellaria media* (I)
- *Claytonia virginica*
- *Ranunculus abortivus*
- *Barbara vulgaris* (I)
- *Geum canadense*
- *Agrimonia parviflora*
- *Viola striata*
- *Chaerophyllum procumbens*
- *Osmorhiza claytoni*
- *O. longistylis*

Common to abundant:

- *Lysimachia nummularia* (I)
- *L. ciliata*
- *Glechoma hederacea*
- *Galium aparine*
- *G. triflorum*
- *Valerianella intermedia*
- *Aster cordifolius*
- *A. prenanthoides*
- *Senecio obovatus*
- *S. aureus*

Frequent to infrequent:

- *Cinna arundinacea*
- *Hystrix patula*
- *Panicum spp.*
- *Carex plantaginea*
- *C. gracilesens*
- *Juncus effusus*
- *Allium vineale* (I)
- *Stellaria longifolia*
- *Cerastium vulgatum* (I)
- *C. nutans*
- *C. viscosum* (I)
- *Ranunculus seleratus*
- *R. recurvatus*
- *R. septentrionalis*
- *Isopyrum biternatum*
- *Rorippa islandica*
- *Cardamine bulbosa*
- *C. douglasii*
- *C. pensylvanica*
- *Geum virginianum*
- *G. vernum*
- *Agrimonia gryposepala*
- *Hypericum punctatum*
- *H. mutilum*
- *Viola papilionacea*
- *Epilobium coloratum*

Rare:

- *Sanicula gregaria*
- *Zizia aurea*
- *Cryptotaenia canadensis*
- *Thaspium trifoliatum*
- *T. barbinode*
- *Heracleum maximum*
- *Polemonium reptans*
- *Vicia caroliniana*
- *Hydrophyllum canadense*
- *Phacelia purshii*
- *Prunella vulgaris* (I)
- *Leonurus cardiaca* (I)
- *Lamium purpureum* (I)
- *L. amplexicaule* (I)
- *Blephilia kirsuta*
- *Lobelia cardinalis*
- *L. siphilitica*
- *Solidago flexicaulis*
- *S. patula*
- *S. rugosa*
- *Aster puniceus*
- *A. tradescantsi*
- *Erigeron pulchellus*
- *E. philadelphicus*
- *Polymnia canadensis*
- *Rudbeckia laciniata*
- *Lactuca canadensis*

Beech-Sugar Maple association and its borders.

Common:

- *Silene virginica*
- *Claytonia virginica*
- *Hepatica acutiglora*
- *H. americana*
- *Heuchera americana*

- *Mitella diphylla*
- *Osmorhiza claytoni*
- *O. longistylis*
- *Phlox divaricata*
- *Galium aparine*
Frequent to infrequent, or common locally:

- Carex spp.
- Ranunculus abortivus
- R. recurvatus
- Anemone virginiana
- Isopyrum bilernatum
- Stellaria longifolia
- Cardamine douglasii
- Tiarella cordifolia
- Geum canadense
- G. virginianum
- Viola papilionacea
- V. rostrata
- Cryptotaenia canadensis
- Obolaria virginica
- Polemonium reptans
- Hydrophyllum canadense
- H. appendiculatum
- Blephilia hirsuta
- Solidago flexicaulis
- Aster macrophyllus
- Erigeron pulchellus
- Senecio obvatus

Mixed Mesophytic or Hemlock-Hardwood associations or both.

Common:

- Mitchella repens
- Aster divaricatus
- A. cordifolius

Frequent to rare, or common locally:

- Goodyera pubescens
- Aplectrum hyemale
- Tiarella cordifolia
- Heuchera americana
- Chrysosplenium americanum
- Viola blanda
- Coptis groenlandica
- Pyrola rotundifolia
- P. eliptica
- P. secunda
- Gaultheria procumbens
- Solidago caesia
- Aster cordifolius
- Antennaria plantaginifolia

Oak associations, including Oak-Chestnut, Oak-Hickory, and Oak-Pine, and their borders.

Common:

- Panicum lanuginosum
- Saxifraga virgininsensis
- Heuchera americana
- Pragaria virginiana
- Potentilla simplex
- Epigaea repens
- Gaultheria procumbens
- Mitchella repens
- Solidago caesia
- Aster cordifolius
- Antennaria plantaginifolia

Frequent to infrequent:

- Hystrix patula
- Panicum spp.
- Carex spp.
- Luzula campestris
- L. acuminata
- Chamaelirium luteum
- Goodyera pubescens
- Silene virginica
- S. pensylvanica
- Hepatica acutiloba
- H. americana
- Anemone virginiana
- Sedum ternatum
- Vicia caroliniana
- Viola triloba
- Chimaphila umbellata
- C. maculata
- Sabatia angularis
- Obolaria virginica
- Phlox divaricata
- Arabis laevigata
- Salea lyrata
- Blephilia ciliata
- Veronica officinalis
- Galium pilosum
- Houstonia longifolia
- Lobelia inflata
- L. spicata
- Solidago nemoralis
- S. erecta
- Aster macrophyllus
- Gnaphalium spp.
- Senecio obvatus
- Hieracium venosum
- H. paniculatum
- H. gronovii
Crevice, Ledge, Cliff Face, or Cliff Top communities.

<table>
<thead>
<tr>
<th>Plant Name</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Silene rotundifolia</td>
<td>A. laevigata</td>
</tr>
<tr>
<td>Hepatica americana</td>
<td>Sedum ternatum</td>
</tr>
<tr>
<td>H. acutiloba</td>
<td>Saxifraga virginiensis</td>
</tr>
<tr>
<td>Aquilegia canadensis</td>
<td>Lechea racemulosa</td>
</tr>
<tr>
<td>Corydalis flavula</td>
<td>Epigaea repens</td>
</tr>
<tr>
<td>Arabis patens</td>
<td>Houstonia longifolia</td>
</tr>
<tr>
<td>A. laevigata</td>
<td>Aster laevis</td>
</tr>
</tbody>
</table>

Old Fields and developmental phases, including lawns, pastures, roadides and cultivated grounds.

Common to abundant:

<table>
<thead>
<tr>
<th>Plant Name</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bromus spp. (I)</td>
<td>Verbascum thapsus (I)</td>
</tr>
<tr>
<td>Danthonia spicata</td>
<td>V. blatteria (I)</td>
</tr>
<tr>
<td>Andropogon virginicus</td>
<td>Veronica officinalis</td>
</tr>
<tr>
<td>Allium vineale (I)</td>
<td>V. serpyllifolia</td>
</tr>
<tr>
<td>Rumex spp. (I)</td>
<td>V. arvensis (I)</td>
</tr>
<tr>
<td>Stellaria media (I)</td>
<td>Plantago major (I)</td>
</tr>
<tr>
<td>Cerastium vulgatum (I)</td>
<td>P. rugelii</td>
</tr>
<tr>
<td>Dianthus armeria (I)</td>
<td>P. lanceolata (I)</td>
</tr>
<tr>
<td>Ranunculus abortivus</td>
<td>Dipsacus sylvestris (I)</td>
</tr>
<tr>
<td>Lepidium virginicum</td>
<td>Solidago nemoralis</td>
</tr>
<tr>
<td>Capsella bursa-pastoris (I)</td>
<td>S. juncea</td>
</tr>
<tr>
<td>Barbarea vulgaris (I)</td>
<td>Aster pilosus</td>
</tr>
<tr>
<td>Fragaria virginiana</td>
<td>Erigeron annuus</td>
</tr>
<tr>
<td>Potentilla norvegica</td>
<td>E. strigosus</td>
</tr>
<tr>
<td>P. simplex</td>
<td>Antennaria plantaginifolia</td>
</tr>
<tr>
<td>Trifolium spp. (I)</td>
<td>Gnaphalium obtusifolium</td>
</tr>
<tr>
<td>Medicago lupulina (I)</td>
<td>Achillea millefolium</td>
</tr>
<tr>
<td>Oenothera biennis</td>
<td>Chrysanthemum leucanthemum (I)</td>
</tr>
<tr>
<td>Daucus carota (I)</td>
<td>Cirsium vulgar</td>
</tr>
<tr>
<td>Prunella vulgaris (I)</td>
<td>Taraxacum officinale (I)</td>
</tr>
<tr>
<td>Leonurus cardiaca (I)</td>
<td>Lactuca spp.</td>
</tr>
</tbody>
</table>

Frequent to infrequent, or common only locally:

<table>
<thead>
<tr>
<th>Plant Name</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arenaria serpyllifolia (I)</td>
<td>Plantago aristata</td>
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<tr>
<td>Cerastium nutans</td>
<td>P. virginica</td>
</tr>
<tr>
<td>Agrostemma githago (I)</td>
<td>Houstonia caerulea</td>
</tr>
<tr>
<td>Lychnis alba (I)</td>
<td>H. longifolia</td>
</tr>
<tr>
<td>Silene antirrhina</td>
<td>H. canadensis</td>
</tr>
<tr>
<td>Draba verna (I)</td>
<td>Lobelia spicata</td>
</tr>
<tr>
<td>Brassica spp. (I)</td>
<td>L. inflata</td>
</tr>
<tr>
<td>Sisymbrium spp. (I)</td>
<td>Solidago rugosa</td>
</tr>
<tr>
<td>Arabidopsis thaliana (I)</td>
<td>S. rigida</td>
</tr>
<tr>
<td>Potentilla recta (I)</td>
<td>Aster laevis</td>
</tr>
<tr>
<td>Vicia spp. (except V. caroliniana) (I)</td>
<td>Erigeron philadelphicus</td>
</tr>
<tr>
<td>Viola sagittata</td>
<td>Gnaphalium purpureum</td>
</tr>
<tr>
<td>Gaura biennis</td>
<td>Rudbeckia hirta</td>
</tr>
<tr>
<td>Sabatia angularis</td>
<td>R. triloba</td>
</tr>
<tr>
<td>Lithospermum arvense (I)</td>
<td>R. lactiniata</td>
</tr>
<tr>
<td>Blephilia ciliata</td>
<td>Hieracium gronovii</td>
</tr>
</tbody>
</table>
KEY TO THE WINTER-GREEN HERBACEOUS FLOWERING PLANTS
OF CENTRAL AND SOUTHERN OHIO

1. Leaves longitudinally veined ................................................................. 2
1. Leaves not longitudinally veined ............................................................... 12
2. Leaves with split or closed sheaths, blades grass-like, many times longer than
   broad (except in Panicum spp.), many-veined ......................................... 3
2. Leaves without sheaths, blades usually not grass-like ................................ 5
3. Blades ending in a gland-like tip, leaf sheaths closed; more or less webbed-hairy. Luzula spp.
3. Blades not ending in a gland-like tip, or if so, leaf sheaths split or open ........ 4
   4. Leaves with sheaths split on the side opposite the blade, 2-ranked ............... Gramineae
   4. Leaves with closed sheaths, 3-ranked .................................................... Cyperaceae
5. Leaves hollow, circular in cross-section, sometimes grooved on upper side, with a strong
   onion odor, up to 40 cm. long .............................................................. Allium vineale
5. Leaves flat, not hollow ................................................................. 6
6. Blades grass-like, 2–6 mm. broad, 3-veined, narrowed to short, slender, margined
   petioles ................................................. Planaria Aristata
6. Blades not grass-like ................................................................. 7
7. Leaves solitary, plaited, erect ................................................................. Aplectrum Hymalae
7. Leaves not solitary, several to many in a more or less flat rosette ..................... 8
   8. Leaves dark green with 5–7 white main veins and many fine white reticulating
      veins ................................................................. Goodyera pubescens
   8. Leaves not white-veined ................................................................. 9
9. Leaves villous-pubescent; obovate, oblong or linear; prairies ......................... Castilleja Cocccinea
9. Leaves not villous, but glabrous or pubescent ........................................... 10
10. Blades narrowly oblong to lanceolate, less than 2.5 cm. broad, with tufts of long
    matted brownish or whitish hairs at the bases of the petioles ....................... Plantago Lanceolata
10. Leaves spatulate, mostly more than 2.5 cm. broad ................................... 11
11. Blades bright or pale green, tapering into margined petioles shorter than the blades, entire,
    smooth and glabrous, more than 7-veined (usually many-veined); forest species, rare
    except locally ............................................................... Chamaelirium Luteum
11. Blades dark green, abruptly narrowed into stout, unmarginated, channelled petioles about
    the same length as or shorter than the blades, entire, undulate, or shallowly dentate,
    glabrous or sparingly pubescent, 5–7-veined; common weed of lawns, roadsides and
    waste grounds ................................................................. Plantago Major
   P. rugelii
12. Leaves very finely 2–3-pinnately dissected, the ultimate segments (or lobes)
    linear or narrowly linear-lanceolate, rarely more than 1 mm. broad, the leaves
    with a feathery appearance; plants with a strong odor; weeds of roadsides, fields,
    and waste grounds ............................................................... 13
12. Leaves not finely 2–3-pinnately dissected as above ................................... 15
13. Blades with 12–30 pairs of primary divisions; ultimate segments linear-oblong, less than
    1 mm. broad, blades 2–5 cm. broad; horizontal rhizome ............................ Achillea Millefolium

*Based upon winter field characters.
13. Blades with fewer than 10 pairs of primary divisions ............................................. 14

14. Plants with a long, stout, fleshy taproot, ultimate leaf segments or lobes about 1 mm. broad, leaves more than 5 cm. long, petioles long and slender, leaves tufted ........................................... Daucus carota

14. Plants not with a long, fleshy taproot, ultimate leaf segments linear or filiform, usually less than 0.5 mm. broad, leaves sessile or nearly so, 2–5 cm. long, alternate on short, simple or branched stems ........................................... Anthemis cotula

15. Leaves compound, or so deeply divided as to appear compound, the segments distinct or nearly so .......................................................... 16

15. Leaves simple .......................................................... 54

16. Most of the leaves ternately compound, ternately decompound, or simple but 3-divided (i.e., with 3 distinct segments) ........................................... 17

16. Leaves not ternately compound, ternately decompound, or 3-divided ........................................... 33

17. Blades binate .......................................................... 18

17. Blades once-ternate ................................................... 23

18. Ultimate leaflets pinnatifid with oblong, obtuse lobes 1–7 mm. long, 1–3 mm. broad, sheath with a scarious, villous margin ................................ Chaerophyllum procumbens

18. Ultimate leaflets not pinnatifid ........................................... 19

19. Plants, especially the roots, with an anise or licorice odor; leaflets coarsely serrate, dentate or incised, sparingly or densely pubescent throughout ........................................... Osmorhiza spp.

19. Plants not with an anise or licorice odor ........................................... 20

20. Ultimate leaflets ovate, acute at the apex, sharply serrate, and if lobed, the lobes acute .......................................................... 21

20. Ultimate leaflets wedge-shaped, obtuse at the apex and obtusely lobed, not serrate .......................................................... 22

21. Leaflets sharply and closely serrate ........................................... Zizia aurea

21. Leaflets coarsely serrate or incised ........................................... Thaspium barbinode

22. Leaflets mostly longer than 1.5 cm., the lobes not mucronate, veins usually inconspicuous above, glabrous to softly pubescent ................................ Aquilegia canadensis

22. Leaflets mostly less than 1.5 cm. long, lobes minutely mucronate, veins prominent above, smooth and entirely glabrous ................................ Isopyrum biternatum

23. Leaves alternate on stems with elongated internodes, leaflets denticulate or serrulate ........................................... 30

23. Leaves tufted, leaflets serrate, dentate, crenate, or incised, always conspicuously toothed ........................................... 24

24. Petioles without definite stipules, although usually dilated into membranous-margined bases and sheathing ........................................... 25

24. Petioles with definite stipules ........................................... 29

25. Blades mostly broader than long, leaflets variously cleft into sharply toothed lobes, short-stalked or sessile; chiefly in Beech-Sugar Maple or Oak-Chestnut woods ........................................... Anemone virginiana

25. Blades mostly broader than long ........................................... 26

26. Petioles densely long-pubescent, hollow, strongly dilated at the base; terminal leaflet broadly ovate or orbicular in outline, commonly 3-lobed, 6–12 cm. broad, laterals smaller, broadly ovate, 2–3-lobed, all bluntly or acutely toothed, stalked; swamp forests and other moist grounds ................................... Heracleum maximum

26. Petioles not densely long-pubescent, hollow, or strongly dilated at the base, or if so, not otherwise as above ........................................... 27

27. Leaflets closely, sharply, and doubly serrate, the terminal one abruptly narrowed into a margined, toothed stalk or less commonly cuneate at the base, leaflets thin, glabrous ........................................... Cryptotaenia canadensis

27. Leaflets not as above ........................................... 28

28. Leaflets finely, regularly and closely crenate-dentate, ovate or ovate-lanceolate, cordate at the base and the lateral usually strongly oblique, sessile or short-stalked, the terminal long-stalked, smooth and glabrous, thickish ........................................... Thaspium trifoliatum
28. Leaflets coarsely serrate, cleft into 2-3 broad lobes which in turn are usually lobed or incised, sparingly pubescent or glabrate, thin... *Ranunculus septentrionalis*

29. Stipules membranous, white, ovate-oblong, about 0.5 cm. broad and 1 cm. long, entire, sparingly hirsute or glabrate; leaflets coarsely serrate. ... *Potentilla norvegica*

29. Stipules greenish, lanceolate-oblong, 1 mm. or less broad, less than 1 cm. long, dentate, hirsute; blades coarsely incised-serrate... *Fragaria virginiana*

30. 6-12 veins on either side of the midvein of each leaflet, stipules ovate or lanceolate, dentate or entire, blades pinnately 3-foliolate. ... *Medicago lupulina*

30. 20-30 veins on either side of the midvein of each leaflet, stipules not dentate, leaflets all from the same point... 31

31. Leaflets finely denticulate; stipules ovate, leaves more or less pubescent and usually with a pale spot on the upper side... *Trifolium pratense*

31. Leaflets serrulate with sharp-pointed, spine-like teeth; stipules ovate-lanceolate, blades glabrous, usually not with a pale spot on the upper side... 32

32. Stems creeping and rooting at the nodes, stipules mostly less than 1 cm. long... *Trifolium repens*

32. Stems ascending or decumbent, stipules mostly 1-2 cm. long... *Trifolium hybridum*

33. Blades digitately 5-7-foliolate... 34

33. Blades not digitately 5-7-foliolate... 36

34. Stipules adnate to bases of the petioles, tips free; blades 5-7-foliolate, more or less villous-pubescent, especially below... 35

34. Petioles expanded at the base and sheathing, but not with stipules; blades 5-foliolate, the leaflets thin, distinct or commonly the lateral slightly united at the base, all about the same size, wedge-shaped or obovate, 2-6 cm. long, sharply and mostly doubly serrate with bristle-tipped teeth, glabrous... *Sanicula gregaria*

35. Leaflets (exclusive of stalks) mostly 1-3 cm. long, obovate or oval, coarsely serrate, commonly glossy, dark green above, firm and thickish, usually ascending... *Potentilla simplex*

35. Leaflets (exclusive of stalks) mostly 3-6 cm. long, oblanceolate or oblong-lanceolate, not glossy, bright green, thin and flaccid, incised-dentate with divergent teeth, spreading on the ground... *Potentilla recta*

36. Blades pinnately decompound... 37

36. Blades once-pinnately compound or divided... 41

37. Petioles dilated into membranous-margined bases... 38

37. Petioles not dilated as above; blades rather finely dissected into linear, oblong or wedge-shaped segments, acutely or obtusely toothed or lobed, pale green, glabrous, slender-petioled... *Corydalis flavula*

38. Plants, especially the roots, with an anise or licorice odor; leaflets coarsely serrate, dentate or incised, sparingly or densely pubescent throughout... *Osmorhiza* spp.

38. Plants not with an anise or licorice odor... 39

39. Ultimate leaflets pinnatifid with oblong, obtuse lobes 1-3 mm. broad, sheath with a scarious, villous margin... *Chaerophyllum procumbens*

39. Ultimate leaflets broad, not pinnatifid... 40

40. Leaflets sharply and closely serrate... *Zizia aurea*

40. Leaflets coarsely serrate or incised... *Thaspium barbinode*

41. Leaves even-pinnate, alternate on trailing, branched, weak stems, rachises terminating in slender tendrils, leaflets small... 42

41. Leaves odd-pinnate, i.e., with a terminal leaflet... 44

42. Tendrils forked; fields, roadsides and waste places... 43

42. Tendrils mostly unforked (simple); woodland borders... *Vicia caroliniana*

43. Leaves and stem villous-pubescent... *Vicia sativa*

43. Leaves glabrous or glabrate... *V. angustifolia*
44. Plants strictly aquatic, usually in small streams or at outlets of springs, many
plants occurring together and covering the water surface; leaves not in rosettes
(except in late winter), 3–9 leaflets, terminal one larger than the lateral and
nearly orbicular.  

*Nasturtium officinale*

44. Plants terrestrial, or if growing in water, then in distinct, usually symmetrical
rosettes.  

45. Petioles with distinct stipules adnate to the base, the tips free; principal leaflets not
varying greatly in size, deeply serrate, with small, interposed leaf segments.  

46. Principal leaflets 11–17, close together and crowded.  

*Agrimonia parviflora*

46. Principal leaflets mostly 5 or 7, not crowded or close together.  

*Agrimonia gryposepala*

47. Terminal leaflet sharply 3- or 5-lobed.  

48. Leaves large, 10–20 cm. long, 6–14 cm. broad, 3–7-divided, the lowest lateral
leaflets the longest, 3–7 cm. long, all sharply and coarsely toothed, acutely lobed
or incised.  

*Rudbeckia laciniata*

48. Leaves 2–5 cm. long, 1–2 cm. broad, 5–11-divided, the lowest lateral leaflets the
smallest, less than 0.5 cm. long, all entire or sparingly toothed, obtuse or acute
at the apex.  

*Phacelia purshii*

49. Roots, petioles and veins with bright orange or yellow sap; leaflets mostly 7, obovate
or ovate, 2–3.5 cm. long, 1–2.5 cm. broad, crenate-lobed, the lobes or teeth all very
obtuse, petioles dilated at the base and clasping.  

*Chelidonium majus*

49. Plants not with bright orange or yellow sap, or if so, not otherwise as above.  

50. Terminal leaflet about the same size as the laterals; leaflets 3–7 pairs and the
terminal one, elliptic or ovate, 0.5–2 cm. long, entire, glabrous, sessile.  

*Polemonium reptans*

50. Terminal leaflet conspicuously larger than the lateral.  

51. Leaves more or less softly pubescent all over; 3–7 principal leaflets, with or without
small interposed segments, ovate or obovate, more or less shallow round-lobed or incised,
dentate or crenate.  

*Geum* spp.

51. Leaves glabrous.  

52. Terminal leaflet orbicular, 2–5 cm. broad, cordate or rounded at the base, rosettes
glossy dark green.  

53. Terminal leaflets obovate, less than 2 cm. broad, narrowed at the base, rosettes
bright green and not shining; 2–8 pairs of lateral leaflets.  

*Cardamine pensylvanica*

53. 1–4 pairs of lateral leaflets  

*Barbarea vulgaris*

53. 4–8 pairs of lateral leaflets  

*Barbarea verna*

54. Leaves opposite, alternate, or whorled on a simple or branched stem with distinct
internodes (in *Houstonia* spp. internodes short but usually leaves borne on
minutely branched stems).  

55. Leaves in a flat rosette or tufted, stems always simple and with greatly reduced
internodes.  

95

55. All or some of the leaves verticillate.  

56. Leaves opposite or alternate.  

56. Leaves verticillate in 3's, thick and succulent; light green, 0.5–2 cm. long, usually
crowded at the end of the stem.  

*Sedum ternatum*

56. Leaves not verticillate in 3's, or if so, not thick and succulent.  

57. Leaves all verticillate on weak, 4-angled stems in 4's, 6's, or 8's, more than one whorl
on each stem.  

58. Leaves not 4-angled, leaves not all verticillate, or if so, stems not as above.  

59. Leaves glabrous or glabrate except for the margins or midveins, in whorls of 6 or
8, or the older ones commonly in 4's.  

*Galium pilosum*
59. Biennial, plants very fragile, cotyledons persistent; leaves 0.5–3 cm. long, usually at least some of them in 6's or 8's, mucronate, stems sometimes hairy at the nodes. .................. \textit{Galium aparine}

59. Perennial, usually many branches arising from the base, stems slender but not extremely fragile; leaves 0.5–1.5 cm. long, usually most of them in 6's, strongly mucronate. .................. \textit{Galium triflorum}

60. Leaves mostly opposite with some verticillate on the same stem, less than 1 cm. long, not coriaceous, entire. \textit{Lechea racemulosa}

60. Leaves verticillate or scattered on the suberect stem, 1–8 cm. long, coriaceous, serrate. .................. \textit{Lechea maculata}

61. Leaves mottled with white along the veins, 2.5–8 cm. long, ovate or ovate-lanceolate. .................. \textit{Chimaphila maculata}

61. Leaves not mottled, dark green and shining, 1–5 cm. long, spatulate or cuneate-oblanceolate. .................. \textit{Chimaphila umbellata}

62. Leaves alternate. .................. \textit{Solidago gigantea}

62. Leaves opposite. .................. \textit{Myosotis scorpioides}

63. Blades sharply and rather shallowly serrate; lanceolate, prominently 3-veined, smooth and glabrous except for the rough margins and ciliate petioles, acute or subacuminate at the apex, gradually tapering into short, marginated petalsioles, internodes only slightly elongated; swamp forests or moist pioneer sites. .... \textit{Solidago gigantea}

63. Blades entire. .................. \textit{Myosotis scorpioides}

64. Leaves thin; bright green, oblong to oblong-lanceolate, 1–6 cm. long; marshy places. \textit{Myosotis scorpioides}

64. Leaves thick and more or less coriaceous; stem somewhat woody. .................. \textit{Myosotis scorpioides}

65. Leaves clustered (mostly in 3's) at the ends of creeping branches, dark green, shining above, pale beneath, blades oval, oblong, or obovate. \textit{Gaultheria procumbens}

65. Leaves not appearing clustered, bright or dark green above, not pale beneath or shining above, dull, blades oval or nearly orbicular, often forming large patches. .................. \textit{Epigaea repens}

66. Stems strongly and distinctly 4-angled, not twisted. .................. \textit{Hypericum punctatum}

66. Stems not 4-angled, or (in \textit{Lysimachia}) obscurely so and slightly twisted. .................. \textit{Blephilia hirsuta}

67. Blades 3–5 palmately lobed, 2–8 cm. long and nearly as broad; blades very veiny, lobes acute or acuminate, incised or dentate. .................. \textit{Blephilia ciliata}

67. Blades not lobed, mostly 1–3.5 cm. long. .................. \textit{Blephilia ciliata}

68. Blades pinnately veined, serrate; plants rather densely villous throughout, branches creeping, decumbent, or ascending \textit{Blephilia hirsuta} in swamp forests or other moist sites. \textit{B. ciliata} in dry pioneer sites or Oak forests

68. Blades palmately veined or nearly so (3–5 main veins originating at or near the base of blade), usually deeply crenate. .................. \textit{Blephilia hirsuta}

69. Plants with a pungent odor, stems creeping with many small ascending branches; blades orbicular or reniform. \textit{Glechoma hederacea}

69. Plants not with a pungent odor, stems merely decumbent (although sometimes rooting at the lower nodes) and branched mostly at the base. \textit{Glechoma hederacea}

70. Lower leaf blades orbicular or broadly ovate, upper ones ovate, all petioled. \textit{Lamium purpureum}

70. All leaf blades orbicular or nearly so, the lower petioled, the upper sessile and more or less clasping. \textit{Lamium amplexicaule}

71. Leaves copiously black-dotted, especially at the margins; 4-ranked, glabrous, oblong or ovate-lanceolate, obtuse, sessile or short-petioled, mostly 1–2 cm. long. \textit{Hypericum punctatum}

71. Leaves not black-dotted. .................. \textit{Hypericum punctatum}

72. Leaves small, mostly 0.5–2 cm. long, crowded, thickish, entire, internodes very short, stem minutely more or less highly branched, stout and rigid. .................. \textit{Hypericum punctatum}

72. Plants not as above. .................. \textit{Hypericum punctatum}
73. Leaves all less than 1 cm. long, 1-3 mm. broad, spatulate, oblanceolate or obovate, sparingly short-pubescent above and sometimes appearing ciliolate but the hairs not in definite rows, petioles usually as long as or longer than the blades; highly branched forms forming polsters. ........................................... *Houstonia caerulea*

73. Most of the leaves more than 1 cm. long, sparingly short-pubescent above or glabrous, ciliate or not, petioles usually not as long as the blades. ........................................... 74

74. Leaves ciliate, *i.e.*, the hairs in definite rows, blades elliptic to suborbicular, petioles usually shorter than the blades but sometimes as long or longer. ........................................... 74

74. Leaves not ciliate, *i.e.*, with the hairs in definite rows, although frequently appearing so, commonly glabrous throughout, petioles rarely as long as the blades and usually much shorter. ........................................... *Houstonia longifolia*

75. Plants minute, leaves less than 5 mm. long, thin, close together but not crowded, slightly downy-pubescent, stems swollen at the nodes, simple or branched. ........................................... *Arenaria serpyllifolia*

75. Leaves longer than 5 mm. ........................................... 76

76. Plants semi-aquatic, in well-lighted seepage areas; blades bright green, broadly ovate, orbicular or almost reniform, crenate. ........................................... *Chrysosplenium americanum*

76. Plants terrestrial ........................................... 77

77. Blades deeply pinnatifid, the lobes acute or acuminate at the apex, dentate or incised-dentate, leaves 3-25 cm. long, petioles commonly purple with a pair of dilated, foliaceous appendages at the base. ........................................... *Polymnia canadensis*

77. Leaves not pinnatifid. ........................................... 78

78. Leaves entire or undulate. ........................................... 79

78. Leaves serrate, crenate, dentate, or obscurely toothed ........................................... 91

79. Blades broadly obovate to wedge-shaped, sessile, clasping, and crowded on the simple, erect stem, the stem 6-10 cm. high, leaves entire, dark green, thickish or coriaceous, 0.8-2.5 cm. long. ........................................... *Obolaria virginica*

79. Leaves not as above. ........................................... 80

80. Blades orbicular or broadly ovate, mostly less than 2 cm. long, with short, unmarginated petioles, glabrous throughout. ........................................... 81

80. Blades not orbicular or broadly ovate, or if so, not otherwise as above. ........................................... 82

81. Leaves dark green, some or all of them with a whitish midvein; plants characteristic of Hemlock, Hemlock-Beech, and Oak-Chestnut forests. ........................................... *Mitchella repens*

81. Leaves bright green, not with a whitish midvein, minutely glandular-punctate, stem angled; common in swamp forests. ........................................... *Lysimachia nummularia*

82. Blades linear or linear-lanceolate, glabrous throughout. ........................................... 83

82. Blades not linear or linear-lanceolate, or if so, pubescent. ........................................... 84

83. Leaves 2, 5-15 cm. long. ........................................... *Claytonia virginica*

83. Leaves more than 2, 0.5-2.5 cm. long. ........................................... *Stellaria longifolia*

84. Blades ovate or elliptic, mostly more than 2 cm. long, firm and somewhat coriaceous, usually dark green. ........................................... 85

84. Blades obovate, oblanceolate, or if ovate, then less than 2 cm. long, not at all coriaceous, usually bright green. ........................................... 87

85. Stems prostrate and trailing, plants forming a dense carpet over the ground, stems usually much longer than 15 cm.; leaves glabrous, short-petioled, glossy. ........................................... *Vinca minor*

85. Stems erect or ascending, or rarely decumbent, not trailing, usually less than 15 cm. long, plants occurring singly; margins of blades rough with short, stiff hairs. ........................................... 86

86. Leaves sessile, 1-veined. ........................................... *Phlox divaricata*

86. Blades narrowed into short, margined petioles, lateral veins conspicuous and uniting near the margin. ........................................... *Phlox paniculata*

87. Plants glabrous except for a line of hairs along the petioles and stem; blades ovate, frequently cordate at the base. ........................................... *Stellaria media*

87. Plants more or less pubescent throughout. ........................................... 88
88. Leaves obovate, varying from 2-8 cm. long on the same branch, 1-3 cm. broad, softly pubescent above, smooth and satin-like beneath; Jackson, Hocking, Fairfield, and Athens Counties. Phlox stolonifera

89. Leaves mostly 2-4 cm. long, oblanceolate or spatulate, sparingly hirsute above, glabrous or nearly so beneath, thin; petioles margined, rather slender, usually as long as or longer than the blades. Cerastium nutans

90. Leaves mostly 1–2 cm. long, obovate or spatulate, or the blades oblong, hirsute above and below, thick. Cerastium vulgatum

91. Blades finely and regularly serrate, 1-3 cm. long, softly pubescent throughout. Veronica officinalis

92. Blades denticulate; oblong, thick and fleshy, 0.5-2 cm. long, glabrous. Veronica serpyllifolia

93. Blades crenulate or rarely entire, mostly 0.5–1 cm. long, glabrous or puberulent. Veronica persica

94. Teeth minutely but conspicuously white callose-tipped, the margins more or less strongly crisped; leaves less than 8 cm. long, in flat rosettes. Lobelia cardinalis

95. Teeth not both crisped and with callose-tipped teeth. Lobelia siphilitica

96. Plants of swamp forests, stream banks and open, marshy places. Lobelia inflata

97. Plants of dry woods or fields, or waste grounds. Lobelia spicata

98. Leaves acute at the apex, smooth and glabrous throughout or sparingly short-pubescent; along stream banks or sometimes in open, marshy places. Lobelia siphilitica

99. Leaves loosely hirsute above, and especially on the veins beneath, thin; dry woods, fields and waste grounds; biennial. Lobelia inflata

100. Leaves pubescent on both sides with short, stiff hairs, especially near the base and margins, thickish and firm; dry, mostly sandy soil; perennial. Lobelia siphilitica

101. Leaves glabrous, or nearly so, more or less purple-veined. Hieracium venosum

102. Leaves prickly on the margins and veins beneath. Lactuca scariola

103. Leaves not prickly as above.
103. Petioles and leaf rachises not hollow. \textit{Lactuca} spp.

103. Petioles and leaf rachises hollow. \textit{Taraxacum officinale}

104. Leaves prickly, large. 105

104. Leaves not prickly. 106

105. Leaves glabrous; blades very rugose, with whitish, stout, blunt spines on the veins, especially the midvein beneath, and scattered on the upper surface, crenate, dark green. \textit{Dipsacus sylvestris}

105. Leaves more or less strigose-pubescent or hispid above and below; margins and sometimes the veins beneath with sharp spines, usually more or less triangular- Lanceolate lobed or pinnatifid, or sometimes merely serrate, dark or bright green. \textit{Cirsium} spp.

106. Most of the leaves with pinnatifid, lobed, or incised blades. 107

106. Most of the leaves not with pinnatifid, lobed or incised blades. 133

107. Most of the blades pinnately lobed, incised, or pinnatifid (excluding all that are only 2- or 3-lobed). 108

107. Most of the blades palmately lobed (including all that are 2- or 3-lobed) or incised. 125

108. Blades suborbicular or broadly ovate in outline, broadest across the lowest pair of segments or lobes, the segments or lobes shallow or deep, coarsely toothed or incised, petioles expanded at the base and clasping, the blades with or without large irregular patches of pale green or white on the upper surface, 3-7 lobed or divided. 109

108. Blades not suborbicular or broadly ovate in outline, not broadest at base, not splotched with pale green or white. 111

109. Blades 3-7-divided, the terminal segment 3-lobed, glabrous or nearly so throughout, not splotched with pale green or white. \textit{Rudbeckia laciniata}

109. Blades 3-7-lobed, the lobes shallow or deep, more or less rough-pubescent throughout, usually splotched with pale green or white. 110

110. Perennial, with large scaly rhizomes usually at or near the surface of the ground. \textit{Hydrophyllum canadense}

110. Biennial, without scaly rhizomes. \textit{Hydrophyllum appendiculatum}

111. Plants not with bright orange or yellow sap, or if so, not otherwise as above. \textit{Chelidonium majus}

112. Leaves with stellate-pubescence; more or less lobed or pinnatifid, 3-15 cm. long, the lobes acute and toothed. \textit{Capsella bursa-pastoris}

112. Leaves not with stellate pubescence. 113

113. Leaves granular-viscid on the lower side; spatulate-oblong in outline, pinnatifid or lyrate lobed, 4-10 cm. long, about 1 cm. broad, hoary-pubescent with white scale-like hairs, often in pairs. \textit{Lepidium campestre}

113. Leaves not granular-viscid on the lower side, or not otherwise as above. 114

114. Blades runcinate-pinnatifid. 115

114. Blades not runcinate-pinnatifid. 116

115. Leaves pubescent with rather long, scattered, stiff hairs; lobes 3-6 pairs and the terminal, dentate, crenate, lobed or entire. \textit{Sisymbrium officinale}

115. Leaves glabrous, or if pubescent, with soft, downy hairs; lobes wavy-toothed or entire, often auriculate at the base, usually 6 or more pairs and the terminal one. \textit{Sisymbrium altissimum}

116. Blades deeply pinnatifid, \textit{i.e.}, divided to, or almost to the midvein, the midvein unmargined or slightly margined, the lateral segments distinct or almost distinct and rather uniform in size. 117

116. Blades not deeply pinnatifid as above. 123

117. Plants strictly aquatic, usually in small streams or at outlets of springs, many plants occurring together and covering the water surface; leaves not in rosettes (except in late winter), 3-9 segments, terminal one larger than the lateral and nearly orbicular, about 1 cm. broad. \textit{Nasturtium officinale}
Plants terrestrial, or if in aquatic habitat, the leaves in distinct, usually symmetrical rosettes.

Terminal lobe orbicular or suborbicular, 2-5 cm. broad, the lateral segments distinct, or nearly so, all entire or undulate.

Terminal lobe not orbicular, or if so, not otherwise as above.

1-4 pairs of lateral segments. **Barbarea vulgaris**

4-8 pairs of lateral segments. **Barbarea verna**

Terminal lobe greatly exceeding the lateral ones in size.

Terminal lobe not greatly exceeding the lateral ones in size although it may be distinctly larger, narrowed at the base, 2-8 pairs of lateral segments; sometimes submerged. **Cardamine pensylvanica**

Leaves pubescent with scattered stiff hairs; 2-4 lateral segments. **Brassica nigra**

Leaves glabrous or puberulent. **Salvia lyrata**

Petioles usually as long as or longer than the blades; blades spatulate or oblanceolate in outline, rarely over 2 cm. broad, more or less deeply lobed or pinnatifid, the lobes with sinuate-crenate to dentate margins, conspicuously rugose above. **Chrysanthemum leucanthemum**

Blades sessile or very short-petioled; oblong to lanceolate in outline, usually more than 2 cm. broad, more or less deeply lobed or pinnatifid, the lobes with sinuate-crenate to dentate margins. **Verbascum blattaria**

Petioles in the form of ochreae; blade hastate, the basal lobes spreading; blades 2-7 cm. long, glabrous and entire, or the basal lobes 1-2-toothed. **Rumex acetosella**

Stipules, if present, not in the form of ochreae. **Mitella diphylla**

Petioles retrorsely hirsute, blades 3-5-lobed, the lobes acute or acuminate at the apex. **Tiarella cordifolia**

Petioles retrorsely hirsute, blades 3-5-lobed, the lobes obtuse or rounded at the apex. **Mitella diphylla**

Petioles retrorsely hirsute, blades 3-5-lobed, the lobes obtuse or rounded at the apex. **Mitella diphylla**

Petioles retrorsely hirsute, blades 3-5-lobed, the lobes obtuse or rounded at the apex. **Ranunculus recurvatus**

Petioles retrorsely hirsute, blades 3-5-lobed, the lobes obtuse or rounded at the apex. **Ranunculus recurvatus**

Petioles retrorsely hirsute, blades 3-5-lobed, the lobes obtuse or rounded at the apex. **Ranunculus recurvatus**
132. Blades palmately 3–5-lobed, orbicular or broadly ovate in outline, the lobes acute or acuminate at the apex, coarsely and sharply dentate and incised, very veiny, more or less finely rough-pubescent; roadsides, fields, and waste grounds. 

Leonurus cardiaca

133. At least some of the blades distinctly cordate at the base. 

134. Leaves with membraneous, sheathing, united stipules (ochreae). 

135. Margins crisped, blades dark green, more or less papillose. 

Rumex crispus

136. Blades with entire, undulate or angled margins. 

137. Plants aquatic; blades yellow-green, deeply cordate, with a conspicuous crimson spot at the base of the midvein. 

Nuphar advena

138. Plants terrestrial. 

139. Blades deltoid-ovate or oblong in outline with flaring teeth at the base, sparingly and shallowly serrate above, 3–5 cm. long, obtuse or acute at the apex. 

Viola sagittata

140. Blades as above. 

141. Teeth conspicuously yellowish callose-tipped; sparingly pubescent with short, flat, ribbon-like hairs. 

Campanula americana

142. Sinuses at the base of the blade wide and shallow; crenate, sometimes 2–3-lobed. 

Ranunculus abortivus

143. Blades sharply serrate, some of them sometimes ternately decompound. 

Zizia aurea

144. Blades mostly less than 2.5 cm. long, broadly ovate to orbicular, and often rather finely crenate-serrate. 

145. Blades mostly 3–7 cm. long, broadly ovate to almost lanceolate, coarsely and frequently irregularly serrate or dentate. 

146. Leaf tufts arising directly from the rhizome. 

Viola papilionacea. 

V. triloba 

V. blanda

147. Leaves densely velvety-pubescent above and below; blades ovate to broadly ovate, irregularly shallowly dentate-crenate or crenulate. 

Aster undulatus

148. Leaves not densely pubescent as above. 

V. striata 

V. rostrata 

V. conspersa
148. Blades large, 10-15 cm. long, 5-13 cm. broad, with broad, sharp-pointed teeth, sinuses deep and irregular, rough-pubescent above with scattered hairs; frequently in colonies. *Aster macrophyllus*

148. Blades 3-8 cm. long. ........................................... 149

149. Blades sharply dentate, the teeth with conspicuous incurved, bristle-like tips 0.5-1 mm. long; chiefly in the Plateau. *Aster divaricatus*

149. Blades serrate, or sometimes the teeth blunt, sometimes with bristle-like tips but always minute (tips less than 0.5 mm. long), usually purple beneath, petioles ciliate at least toward the base; common in woods throughout the State. *Aster cordifolius*

150. Leaves densely woolly with long, branched hairs above and below, or white-tomentose, especially below; not 3-veined. ........................................... 151

150. Leaves not densely woolly or white-tomentose as above, or if white-tomentose below, then 3-veined. ........................................... 152

151. Leaves woolly with long, coarse, branched and interlacing hairs, mostly 5-15 cm. long. ........................................... *Verbascum thapsus*

151. Leaves softly white-tomentose, especially densely so below, 2-5 cm. long. ........................................... *Gnaphalium* spp.

152. Pubescence when present of simple hairs. ........................................... 153

152. Pubescence of stellate and 2-branched hairs, not appressed, blades narrowed into slender petioles about the same length as the blades, entire or sparingly shallow-toothed; old sandy fields and pastures. *Arabidopsis thaliana*

153. Pubescence of 2-branched and simple, appressed hairs, blades narrowed into short petioles, coarsely toothed or repand-denticulate; cultivated and waste grounds. *Erysimum repandum*

154. Leaves linear, grass-like, 3-15 cm. long, 2-6 mm. broad, acuminate at the apex, entire or coarsely serrate or dentate near the apex, more or less pubescent on the upper surface with simple, 2-branched and stellate hairs; chiefly in the southern counties. *Antennaria plantaginifolia*

154. Pubescence of stellate and 2-branched hairs, not appressed, blades narrowed into slender petioles about the same length as the blades, entire or sparingly shallow-toothed; old sandy fields and pastures. *Arabidopsis thaliana*

155. Blades prominently 3- or 5-veined. ........................................... 156

155. Blades not prominently 3- or 5-veined. ........................................... 156

156. Leaves linear, grass-like, 3-15 cm. long, 2-6 mm. broad, acuminate at the apex, 3-veined. *Plantago aristata*

156. Leaves not linear, or if so, not many times longer than broad. ........................................... 157

157. Leaves dull dark green and arachnoid above, densely white-tomentose beneath, 3-veined, obovate, spatulate or broadly oval, often forming broad patches. ........................................... *Antennaria plantaginifolia*

157. Leaves not white-tomentose beneath. ........................................... 158

158. Blades entire or sometimes repand-denticulate. ........................................... 159

158. Blades sharply serrate or dentate, the teeth usually shallow. ........................................... 162

159. Leaves villous-pubescent. ........................................... 160

159. Leaves glabrous or short-pubescent. ........................................... 161

160. Leaves densely villous-pubescent, oblong, obovate or sometimes linear, acute or obtusish at the apex, entire; prairie species rare except locally. *Castilleja coccinea*

160. Leaves villous-pubescent, but not densely so, grayish-green, obovate or spatulate, obtuse or acutish at the apex, entire or repand-denticulate; moist pioneer sites and open swamp forests of the southern and southeastern Plateau. *Plantago virginica*

161. Leaves glabrous, not over 2.5 cm. long, broadly ovate to orbicular, sessile or nearly so, pale green, in a 4-8-leaved rosette, the leaves paired with regard to size. *Sabatia angularis*
161. Leaves short-pubescent with a tuft of brownish or whitish hairs at the base of the margined petioles, 4–15 cm. long, narrowly oblong-lanceolate or linear-elliptic, dark green. ........................................... Plantago lanceolata

162. Blades sharply serrate, the teeth rather shallow and not remote, tapering gradually into short, margined petioles, smooth and glabrous except for the rough-ciliate margins and the ciliate petioles, internodes slightly elongated. ........................................... Solidago gigantea

162. Blades serrate or dentate, but sparingly so, more or less abruptly narrowed into margined petioles, mostly bristly-hispid, leaves distinctly tufted and usually spreading on the ground. ........................................... Rudbeckia hirta

163. Leaves thin, bright green, rather softly pubescent above and below, usually some of them 3-lobed or 3-divided. ........................................... Rudbeckia triloba

163. Leaves thick, more or less hirsute or hispid, never 3-lobed or 3-divided. ........................................... Rudbeckia speciosa

164. Leaves dark green, blades of at least some of them abruptly narrowed into distinctly margined petioles, the margins 0.8–3 mm. broad; confined to the prairies. ........................................... Rudbeckia speciosa

164. Leaves bright green, blades narrowed into very slightly margined petioles; prairie species, but also in fields, along roadsides, and in waste grounds. ........................................... Rudbeckia hirta

165. Blades entire, undulate, denticulate, crenulate or serrulate (i.e., entire or obscurely toothed). ........................................... Lepidium campestre

165. Blades distinctly serrate, dentate, or crenate. ........................................... Prunella vulgaris

166. Petioles with stipules in the form of ochreae; leaves large, glabrous. ........................................... Rumex obtusifolius

166. Stipules, if present, not in the form of ochreae. ........................................... Rumex crispus

167. Margins crisped, blades dark green; more or less papillose. ........................................... Rumex crispus

167. Margins not crisped, merely undulate; petioles and veins usually red or reddish, blades bright green. ........................................... Rumex obtusifolius

168. Blades granular-viscid on the lower side, hoary-pubescent with scale-like hairs, often in pairs, entire, obtuse at the apex, blades tapering to petioles. ........................................... Lepidium campestre

168. Blades not granular-viscid on the lower side. ........................................... Prunella vulgaris

169. Blades conspicuously glandular-dotted; ovate, 1–5 cm. long, crenate with shallow teeth, undulate or entire, obtuse or acutish at the apex, abruptly narrowed at the base and usually subcordate, sparingly pubescent throughout; common in waste grounds and disturbed forests. ........................................... Pyrola rotundifolia

169. Blades not glandular-dotted. ........................................... Pyrola elliptica

170. Blades entire. ........................................... Pyrola elliptica

170. Blades undulate, denticulate, serrulate or crenulate, sometimes minutely so. ........................................... Pyrola rotundifolia

171. Blades crenulate or plicate-crenulate; oval, elliptic or orbicular, reticulately veined, smooth and glabrous, petioles unmargined; Hemlock-Hardwood forests. ........................................... Epilobium coloratum

171. Blades not crenulate or plicate-crenulate, petioles margined when present. ........................................... Epilobium coloratum

172. Blades crenulate, broadly oval or elliptic, thin, membranous, dull dark green, usually mucronulate at the apex, longer than the petioles. ........................................... Epilobium coloratum

172. Blades crenulate, orbicular or oval, coriaceous, bright green and shining above, usually as short as the petioles. ........................................... Epilobium coloratum

173. Leaves smooth and glabrous, margins closely, irregularly, and sharply serrulate and curled under, blades usually strongly but loosely rugose, oblong, 2–7 cm. long, 0.5–2 cm. broad, bright green; wet pioneer habitats. ........................................... Solidago rigida

173. Leaves not glabrous, or if so, not otherwise as above. ........................................... Solidago rigida

174. Petioles mostly much shorter than the blades. ........................................... Solidago rigida

174. Petioles mostly as long as or longer than the blades, slender and slightly margined, leaves 8-30 cm. long, 2–4.5 cm. broad, blades ovate-lanceolate or oblong, serrulate or rarely entire, more or less scabrous above with short hairs; uncommon except locally in prairie areas. ........................................... Solidago rigida
Blades irregularly undulate-denticulate, the narrowed portion at the base frequently dentate, acute or acuminate at the apex, pinnately-veined, the midvein broad and the lateral prominent, lanceolate or oblanceolate, thick and leathery; uncommon except locally in wet or moist grounds.

**Oenothera biennis**

**Gaura biennis**

Blades regularly and minutely denticulate, obtuse or acutish at the apex, 1-veined, oval, ovate, obovate, or oblanceolate, thick and leathery; uncommon except locally in wet or moist grounds.

**Saxifraga pensylvanica**

Largest leaves mostly less than 1 cm. broad; linear, oblong, oblanceolate, or if less than 5 cm. long, sometimes spatulate.

**Agrostemma githago**

Largest leaves mostly more than 1 cm. broad; oblanceolate, obovate or spatulate.

**Lappula echinata**

177. Leaves densely silky-pubescent with long spreading hairs, narrowly oblanceolate;

**Silene antirrhina**

177. Leaves not densely silky-pubescent as above.

178. Leaves hoary-pubescent; roots reddish.

178. Leaves not hoary-pubescent.

179. Leaves obscurely veined, bright green.

179. Leaves distinctly 1-veined, pale green.

**Lappula echinata**

180. Leaves linear or narrowly linear-oblanceolate, 2-8 cm. long, 3-6 mm. broad, dark green, rather thick and succulent, rigid, margins ciliate, otherwise glabrous or glabrate; chiefly in the Plateau, especially in upland Andropogon communities and in clearings.

180. Leaves spatulate, oblanceolate or oblong, usually less than 5 cm. long.

181. Plants stoloniferous, leaves tufted and ascending, oblong or oblanceolate, 2-5 cm. long, blades narrowed into broadly margined petioles, appressed short-pubescent; shallow pools, sluggish streams or other wet grounds.

181. Plants not stoloniferous, leaves in a flat rosette, oblanceolate or spatulate, 1-2 cm. long, blades narrowed into slender margined petioles, puberulent or glabrate, mucronate, margins more or less ciliate; old fields and open woods, especially in sandy soils.

182. Plants of rocky ledges, crevices, and cliff bases, Hocking, Jackson, Pike, and Ross Counties; leaves obovate or broadly spatulate, mostly 2-4 cm. long, obtuse at the apex but pointed, margins more or less crisped.

**Valerianella intermedia**

182. Plants not as above.

183. Leaves tufted, ascending, thin and tender, smooth and glabrous except for occasional hairs on the margins, upper surface and the midvein beneath, spatulate to oblanceolate, obtuse and rounded at the apex, mucronate, 5-10 cm. long, 1-2 cm. broad, petioles margined, much longer than the blades; common in moist pioneer habitats.

**Silene antirrhina**

183. Leaves spreading on the ground, or if ascending, not otherwise as above.

184. Petioles as long as or longer than the blades, margined, slender, leaves glabrate, thick and firm, dark green; 2-25 cm. long, spatulate or oblanceolate, 1-veined; Oak Chestnut woods or forest borders.

**Silene virginica**

184. Petioles much shorter than the blades, broadly margined, bright green, not thick and firm, softly pubescent throughout; pioneer habitats.

185. Blades pinnately veined, the veins prominent and commonly lighter green or yellowish.

**Lychnis alba**

185. Blades 1-veined, the lateral veins not prominent.

**Silene noctiflora**

186. Blades deltoid-ovate or oblong in outline with flaring teeth or incised-dentate at the base, sparingly and shallowly serrate above, petioles unmargined, slender.

**Viola sagittata**

186. Blades not as above.

187. Margins strongly and closely crisped, rest of blade flat or nearly so; obovate to oblanceolate.
187. Margins not strongly and closely crisped, or if so, rest of blades more or less rugose, or not otherwise as in 188.

188. Blades thick, firm and somewhat succulent, light green and obscurely veined above, reddish beneath and 1-veined, short-pubescent or glabrate, mostly dentate, the abruptly narrowed basal portion entire, petioles broad, margined; dry or rock banks along forest borders, in the Plateau... *Saxifraga virginensis*

188. Blades thickish, dark green, 1-veined above, sparingly long-pubescent above, smooth and glabrous beneath, sharply serrate-dentate or almost laciniate; wooded slopes of ravines or stream banks... *Arabis laevigata*

189. Leaves more or less hispid-pubescent, the hairs not minute, mostly easily seen with the unaided eye.

189. Leaves glabrous, or with minute hairs on the upper surface, or the margins sometimes ciliate.

190. Blades mostly abruptly narrowed into slender, slightly marginated petioles usually longer than the blades.

190. Blades mostly cuneate at the base or gradually narrowed into relatively broad, marginated petioles shorter than the blades.

191. Blades coarsely and usually deeply dentate, sometimes incised-dentate toward the base, pubescence spreading, 2.5-7 cm. broad... *Erigeron annuus*

191. Blades sparingly shallow-serrate or almost entire, pubescence somewhat appressed, 0.5-1.5 cm. broad... *Arabis laevigata*

192. Petioles long-ciliate; leaves 2-10 cm. long, 1-2 cm. broad, sparingly coarsely dentate or incised-dentate, biennial; weed of fields, roadsides and waste ground... *Thlaspi arvense*

192. Petioles not long-ciliate, perennials; mostly forest or woodland border species... *Arabis laevigata*

193. Blades thin, rather sparingly pubescent above and below, the hairs not long, coarsely or shallowly dentate; swamp forests or moist pioneer habitats... *Erigeron philadelphicus*

193. Blades thickish and firm, long-pubescent above and below, the hairs stiff or stiffish, especially dense along the margins, sparingly and remotely shallow-toothed; woodland borders, rarely in pioneer habitats... *Erigeron pulchellus*

194. Leaves with a garlicky odor when crushed; oblanceolate, coarsely dentate, long-petioled, in a flat rosette, biennial; waste grounds... *Thlaspi arvense*

194. Leaves not with a garlicky odor when crushed, perennials... *Erigeron annuus*

195. Most of the blades sharply serrate all around, or the narrowed basal portion entire, the teeth not shallow, appressed or remote, blades very thin and flat, or curled as though not fully expanded, bright green, abruptly narrowed into slightly marginated petioles, glabrate above, glabrous below, not scabrous; forest species, especially in Beech-Sugar Maple and Oak-Chestnut types... *Solidago caesia*

195. Blades not mostly sharply serrate all around, thin, or abruptly narrowed into slightly marginated petioles as above... *Solidago flexicaulis*

196. Leaves 1.5-5 cm. long, 1-2 cm. broad, usually curled as though not fully expanded, blades ovate to lanceolate... *Solidago caesia*

196. Leaves 5-15 cm. long, 2-5 cm. broad, flat, blades ovate to broadly elliptic, often doubly serrate... *Solidago flexicaulis*

197. At least the upper surface of the blades more or less scabrous (when rubbed toward the base) with minute, stiffish hairs, or minutely pubescent with more than occasional hairs and not scabrous... *Solidago caesia*

197. Leaves entirely glabrous, or glabrous except for the ciliate or ciliolate (sometimes very minutely so) margins...

198. Leaves large, mostly 8-20 cm. long... *Solidago patula*

198. Leaves all usually much less than 8 cm. long... *Solidago flexicaulis*

199. Blades oval or elliptic, thickish and somewhat rugose, very rough above when rubbed toward the base, obtuse or acute at the apex; swamps, bogs, and seepage slopes... *Solidago patula*
199. Blades lanceolate or elliptic-lanceolate, rather thin and not rugose, acute or sub-acuminate at the apex, pubescent above with minute hairs but not scabrous; dry pioneer habitats ................................................................. Solidago juncea

200. Blades rugose above and below, petioles usually shorter than the blades; minutely pubescent or scabrous above, ciliolate, blades oval, ovate or lanceolate, thickish, sharply serrate ................................................................. Solidago rugosa

200. Blades not rugose, petioles usually longer than the blades ........................................... 201

201. Plants of dry pioneer habitats, especially in sandy or clayey soil; densely minutely pubescent or scabrous, blades mostly spatulate ................................................................. Solidago nemoralis

201. Plants of swamp forests, stream banks and roadside ditches; pubescent, scabrous or glabrate, blades ovate or ovate-lanceolate ................................................................. Aster prenanthoides

202. Leaves thick and succulent, very smooth and flat, glaucous or light green, glabrous except for the ciliolate margins (sometimes minutely so), shallowly crenate or serrate ................................................................. 203

202. Leaves bright or dark green, usually thickish and sometimes slightly succulent, but usually not extremely smooth, with or without marginal hairs ................................................................. 204

203. Leaves not glaucous, light green; Oak-Chestnut woods of the Plateau; margins conspicuously ciliolate, mostly crenate, blades obtuse to very obtuse and rounded at the apex, petioles shorter than the blades, broad and flat ................................................................. Solidago erecta

203. Leaves usually conspicuously glaucous as well as light green; cliffs and wooded bluffs, or dry roadside banks, general distribution; margins with minute, rigid, forward-pointing hairs, irregularly serrate-crenate, petioles slightly to broadly margined, shorter or longer than the blades, blades acute or obtuse and rounded at the apex ................................................................. Aster laevis

204. Blades obovate with a cuneate base, suborbicular or broadly spatulate, more or less rugose, dark green, very obtuse and rounded at the apex, regularly crenate-dentate, often purple below, entirely glabrous or the very young ones silvery webbed-hairy, in a flat rosette ................................................................. Senecio obovatus

204. Blades not as above ................................................................. 205

205. Blades ovate, abruptly narrowed into slightly margined petioles usually longer than the blades; swamp forests ................................................................. Aster lateriflorus

A. prenanthoides

205. Blades not both ovate and abruptly narrowed into slightly margined petioles ........... 206

206. Blades sharply serrate with flaring, acuminate teeth, chiefly from the middle to the apex, acute or acuminate at the apex, long-tapering at the base, minutely ciliolate; swamp forests ................................................................. Aster tradescanti

206. Blades not sharply serrate as above, shallow-serrate, denticulate or almost entire ........................................................................................................................................... 207

207. Leaves ciliate; spatulate or oblanceolate, 2-10 cm. long, 0.5-1.5 cm. broad, sparingly shallow-serrate above the middle or almost entire; dry or moist pioneer sites ................................................................. Aster pilosus

207. Leaves not ciliate; blades lanceolate or obl-long-lanceolate, irregularly denticulate, 4-10 cm. long, 1-1.5 cm. broad; wet pioneer sites ................................................................. Aster puniceus
LITERATURE CITED


