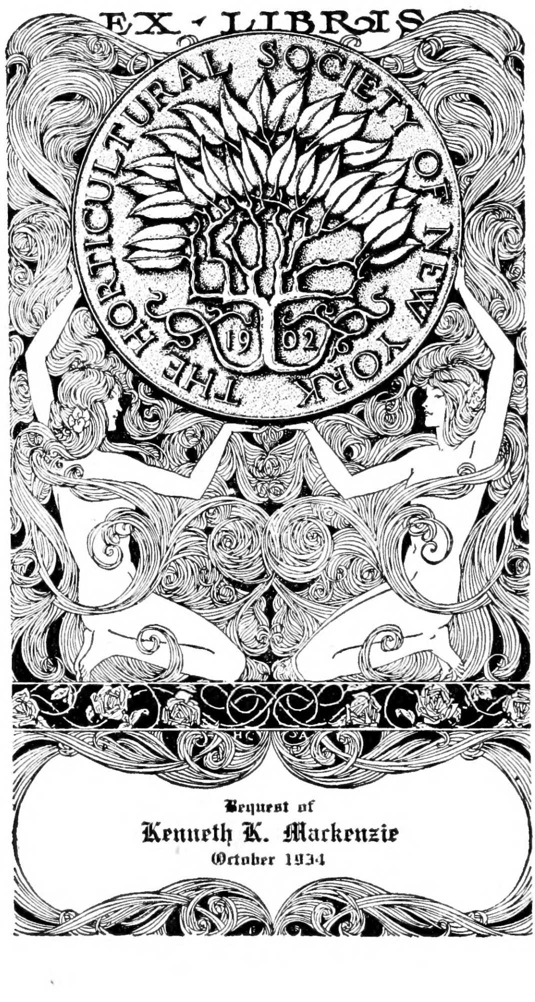
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XXII. A CONTRIBUTION TO THE KNOWLEDGE OF THE FLORA OF SOUTHEASTERN MINNESOTA.

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The work of the Minnesota Botanical Survey in southeastern Minnesota during the summer of 1899 was carried on with two main purposes in view: first, to collect and preserve plants in formalin for museum and class use, and second, to collect herbarium specimens of the higher seed plants. The work of collection was begun June 1st, and closed August 31st. The catalogue of species is, therefore, very incomplete in its enumeration of the early spring and autumn plants.

District of collection.—The territory in which the collections were made is in the extreme southeastern part of Minnesota, comprising the valleys of Winnebago and Crooked creeks, and the adjoining region near the Mississippi river. Nearly all of this territory is included in an area about twelve miles square, formed by the townships of Mayville and Crooked Creek, on the north, and Winnebago and Jefferson on the south.

Physiography.—The topography of this part of Houston county is not essentially different from that of most of the region south from Red Wing along the Mississippi river to the southern boundary of Minnesota and into Iowa. There is no part of it level or nearly so. It is almost entirely broken by the valleys of the two creeks and their smaller tributaries. The height above the sea level varies from 620 feet at the level of the Mississippi river in the southeastern corner of Jefferson, to 1200 feet in the northwestern corner of Mayville. Crooked creek, from the source of the north fork to its discharge into Bluff slough, is about eleven miles in length. It drains about 65 square miles of territory. The south fork, a branch about three miles long, lies entirely in Mayville. Winnebago creek from the Big spring near its source, to its discharge into Minnesota slough, is about twelve miles in length. There are three small branches, one of which has, within the last decade, become considerably smaller than it formerly was, on account of the drying up of several springs near its source. The amount of water discharged from each of the two main creeks during the summer months is probably not less than 1,500,000 cubic feet per day. Neither creek is very susceptible to changes of season, but either one will rise very rapidly after a sudden heavy rain-fall and return to its usual level in a few hours.

The bluffs are high and steep, and not adapted to cultivation. (Plates XXII. and XXVI.) However, many of the ridges are cultivated and form some of the best farms in this part of the state. The valleys being subject to overflow and the bluffs very steep, by no means the entire area is adapted to cultivation. This condition is very favorable for the collection of native plants.

The valleys are narrow, in no place exceeding a mile in width from the brow of one bluff to the brow of the one opposite.

In taking a view of the ecological groups of the plants inhabiting this region, the territory may, for convenience, be divided into river valley, creek valleys and bluffs.

The river valley is so distinct from the creek valleys that it is almost imperative that it be considered separately. The bluffs along the river vary somewhat from the other bluffs, but not sufficiently to warrant a division into river bluff and creek bluff.

River valley.—In the river valley I include the area from the foot of the bluffs on one side of the river, to the foot of the bluffs on the opposite side, not including any tributaries. Along this stretch of the river, from New Albin, Iowa, to Brownsville, Minnesota, the valley varies from three to five miles in width. The main channel of the river is from one-half a mile to a mile wide. The remainder of the area between the bluffs is formed of islands, sloughs and lakes during most of the year. (Plate XXV., B.) During the spring and early summer the whole area is generally flooded so that collection can be carried on only during the late summer and autumn. The river channel proper is not a fruitful field for the collection of higher plants. The sluggish sloughs, lakes and ponds, however, offer excellent conditions for such collection.

For consideration, the water plants of the river valley may be classified into four main groups: plankton, attached submerged aquatic, attached aquatic plants with natant leaves, and adaptive shore plants.

Plankton.

The plants forming this group are those which are not attached to any soil substratum, and so are rarely found in any of the swift-flowing currents, but rather on the surface of protected lakes and ponds and near the high banks of sloughs, where they are protected from rapid currents of wind and water. The plants comprising this group are:

Azolla caroliniana,
Ceratophyllum demersum,
Lemna minor,
Spirodela polyrhiza,
Utricularia vulgaris.

With them are often found plants of *Sagittaria* and *Potamogeton* which have been dislocated from their original position on the soil. They seem to grow nearly as well and bloom nearly as profusely as when attached. In this condition they form part of the plankton, but as they are originally attached and ordinarily remain so, I have not included them in the list of plankton types.

One of the most beautiful and interesting plants of this group is the small heterosporous fern, *Azolla caroliniana.* In the early part of the summer it is green or but slightly red in color and only scattered plants or very small patches can be found. In the later summer and autumn it covers large areas of water with a deep red pure growth or mixed with the duckweeds. In restricted areas it often grows so rapidly late in the summer that it is pushed up from the surface of the water and forms ridges and bunches above the water-level.

Attached submerged aquatic plants.

The floor of some of the very shallow ponds and sloughs is covered with a growth of bassweeds and pondweeds that are entirely immersed. This group contains but few species of the higher plants. The species collected are:

Naias flexilis,
Naias guadalupensis,
Potamogeton pusillus,
Potamogeton zosteraefolius.

Attached aquatic plants with natant leaves.

Castalia tuberosa, *Potamogeton lonchites*,
Nelumbo lutea, *Potamogeton natans*,
Nymphaea advena, *Sagittaria cuneata*.

Nearly every one who has ever visited any of the lakes or rivers of Minnesota is acquainted with at least one representative of this group, the white water-lily, *Castalia tuberosa*. This with the Indian lotus, *Nelumbo lutea*, and the yellow pond-lily, *Nymphæa advena*, all of which are members of the water-lily family, are the most conspicuous and beautiful of our river plants. They cover large areas of shallow water for sometimes a mile or more in extent. It may be of interest to call attention to the methods of adaptation of these plants to their aquatic habitat. The white water-lily and the yellow pond-lily carry their natant leaves on long flexible petioles which allow the leaves to remain upon the surface for variations of several feet in the height of the water. The Indian lotus, however, carries the leaf-blades upon stiff strong petioles some of which are carried up to the water surface and others are raised from one to three feet above the water. (Plate XXV., A.) In case the water rises the natant leaves are destroyed but those that are raised above the surface remain useful to the plant and may in this way be caused to float. The projecting leaves are not conspicuously modified in any way from those that were originally natant.

Both the Indian lotus and the white water-lily are abundant in the sloughs of the Mississippi river at Jefferson. The yellow pond-lily is not so abundant as either of the other two. The *Potamogetons* with floating leaves may be found growing with the water-lilies or in small patches scattered throughout the sloughs. They never cover very large areas to the exclusion of other plants.

Adaptive shore plants.

Alisma plantago-aquatica, *Sagittaria latifolia*,
Eleocharis acicularis, *Sagittaria rigida*,
Nelumbo lutea, *Scirpus lacustris*.
Polygonum emersum,

The plants living on the shores of the lakes and sloughs must adapt themselves to life under the varying conditions in which they may be placed by the rise and fall of the water. During low stages they may be left out of the water entirely and when the water is at its height most of them are nearly or quite submerged. The plants adapting themselves to these conditions might be considered as the *Sagittaria* group, for the two *Sagittarias—latifolia* and *rigida*—are the most abundant shore plants with the possible exception of *Eleocharis acicularis*. *Nelumbo lutea* may often be seen in times of very low water, growing on the muddy banks entirely emersed holding its leaves erect two or three feet above the mud, while the *Castalia* when placed under these conditions lodges its leaves on the mud where they soon die. *Polygonum emersum* covers many banks to the exclusion of other vegetation. It is adapted to living on the exposed mud or in the water but under the latter conditions it always projects its leaf-bearing stems out of the water and keeps the foliage leaves emersed.

Wet meadows of the river valley.

During a large part of the growing season the wet meadows of the river bottoms are submerged. When they are exposed for a sufficient length of time to become somewhat dry the grasses are generally cut for hay. The plants living under these conditions are mostly coarse grasses and sedges. No trees but willows seem to be able to live upon these meadows and they do not then attain tree size. Some of the plants forming the vegetation of the wet meadows are:

Asclepias incarnata,
Cyperus esculentus,
Eleocharis acicularis,
Elymus virginicus,
Eragrostis hypnoides,
Eupatorium purpureum,
Homalocenchrus virginicus,
Penthorum sedoides,
Scirpus atrovirens,
Scirpus cyperinus,
Sium cicutaefolium,
Sparganium eurycarpum,
Spartina cynosuroides,
Vernonia fasciculata,
Zizania aquatica.

Mud-flat vegetation.

The mud-flat comprises the highest land of the islands. It is flooded only during the early summer but on account of its growth of timber and shrubs the soil remains wet during the entire year. The largest trees growing anywhere in this region are found on the mud-flats of the Mississippi river.

The plants which form large trees on the islands are:

Acer saccharinum,
Betula nigra,
Fraxinus lanceolata,
Fraxinus nigra,
Gleditsia triacanthos,
Populus deltoides,
Quercus platanoides,
Salix amygdaloides,
Ulmus americana.

The following species do not attain large size, but are either scattered throughout as shrubs or small trees, or form a dense low growth on some of the lower grounds of the mud flat. (Plate XXV., A.)

Cephalanthus occidentalis,
Cornus amonum,
Salix fluviatilis,
Salix nigra.

Three species of woody vines are common throughout the islands. The Virginia creeper, *Parthenocissus quinquefolia*, and wild grape, *Vitis vulpina*, are abundant, covering and in many cases killing large trees. The climbing poison ivy, *Rhus radicans*, is common throughout the most densely wooded parts. It sometimes climbs to a height of twenty-five or thirty feet, and develops a stem from two to three inches in diameter.

During the late summer and autumn the mud-flat throughout is covered with a dense growth of coarse herbs most of which are perennials.

The following herbaceous plants grow on the mud-flat.

Acnida tamariscina,
Apocynum cannabinum,
Arisæma dracontium,
Bidens comosa,
Bidens frondosa,
Bidens lævis,
Cicuta bulbifera,
Helenium autumnale,
Ilysanthes gratioloides,
Lippia lanceolata,
Lobelia cardinalis,
Lycopus americanus,
Lycopus lucidus,
Lycopus rubellus,
Lycopus virginicus,
Lythrum alatum,
Mentha canadensis,
Mimulus ringens,
Onoclea sensibilis,
Polygonum hartwrightii,
Polygonum hydropiperoides,
Polygonum incarnatum,
Polygonum punctatum,
Polygonum virginianum,
Physalis philadelphica,
Physostegia virginiana,
Ranunculus pennsylvanicus,
Scutellaria lateriflora,
Stachys palustris,
Steironema ciliata,
Teucrium canadense,
Urtica gracilis,
Urticastrum divaricatum.

Creek valleys.—The valleys of the creeks present an entirely different aspect from the river valley. The creeks have their own well-defined channels to which they hold almost the year round. High waters never last for any great period of time. Those which are caused by the melting of the snows in the spring generally last from about noon to sun-down while those which are supplied by the heavy June showers generally rise and fall during the night or very early morning. The damage done to vegetation is almost restricted to the floods of the summer months. They come in the season of most rapid growth and destroy a large part of the season's growth with which they come in contact. The areas inundated by these floods are never very extensive compared to those along the river. At most points along the valleys the gradual rise of the land from the creeks to the bluffs is sufficient to prevent the formation of ponds and lakes by the rise of the water. The alluvial soils deposited on the flats do not dry up until late in the summer and so have very little growth besides coarse weeds. They are often cultivated but there is always the danger of the crops being destroyed by high water. Most of the best cultivated fields in the valleys are on the table lands adjacent to the foot of the bluffs. They are generally fertile, are protected from high water and hard winds and are not in a position to wash to any great extent. The steep banks on the north edges of the table lands are generally wooded and bear the richest and greatest variety of plants that can be found anywhere in this region. The table lands are often very sharply marked off from the creek bottoms and steep bluffs. Towards the heads of the creeks the table lands disappear and there is a gradual rise from the creeks to the bluffs.

The water vegetation of the creek valleys is almost entirely limited to the cold water plants of the springs and small streams. There are very few ponds or marshes to contain still water forms.

The vegetation of the land may be divided into that of the wet meadow, moist woods and mesophytic field. The wet meadow is about on a level with the banks of the creeks. It never becomes very dry and on the lower places shows some of the characters of a marsh. The vegetation of the moist woods is well shown on the wooded banks bordering the table lands. Moist woods often cover some of the protected table lands and extend for some distance up the narrow dark ravines. In places where timber covers the flooded areas the vegetation is similar to that of the mud flat on the islands near the river. The vegetation of the open table lands I have called mesophytic field.

Cold spring vegetation.

The valleys of Winnebago and Crooked creeks have a great many springs arising from the bases of the bluffs throughout their whole length but perhaps more numerous at the heads of the creeks than elsewhere. Some of the springs that outlet in low level land occasionally form small cold bogs in which the ordinary cold water plants find very favorable conditions for growth. A large spring near the head of Clear creek, a short branch of Crooked creek contains the greatest abundance of typical cold water plants of any spring visited. The large creeks do not contain much vegetation. The smaller creeks often contain plants similar to those of the cold springs.

The plants characteristic of cold running water are:

Batrachium divaricatum,
Batrachium trichophyllum,
Berula erecta,
Cardamine bulbosa,
Mimulus jamesii,
Philotria canadensis,
Roripa nasturtium,
Veronica americana.

Epilobiums—coloratum and *adenocaulon*—are often found growing in cold spring water but are not peculiar to this locality as they are also found growing in moist soil. None of the spring plants can be called common to large areas, for the conditions necessary for their growth are limited in extent.

Pond vegetation.

There are but very few natural ponds along the creeks. The ponds are generally artificial and as such present a variety of conditions and a corresponding variety of plants. A small natural pond in a bog near Crooked creek contains all it can hold of the yellow pond-lily. (Plate XXVII., B.) This is the only place in which any of the water-lily family were found outside of the sloughs and lakes of the Mississippi river.

Wet meadow vegetation of the creek valleys.

The wet meadows naturally cover a very large part of the creek valleys but under present conditions most of them are used for pasture, or where they can be easily drained for cultivation, though they are of course in constant danger of being flooded. Under these conditions there are but few wet meadows which have retained their original vegetation. Many of them under continual pasturing have grown up to coarse weeds and grasses. The greatest variety of plants is found where the wet meadow has been used as a hay meadow. This offers more nearly the natural conditions for such plants as *Lilium canadense* (Plate XXVII., A). *Habenaria leucophæa*, *Pedicularis lanceolata*, *Saxifraga pennsylvanica*, *Chelone glabra*, *Parnassia caroliniana*, *Onoclea sensibilis* and many others in the list.

The plants which grow in the wet meadows are:

Angelica atropurpurea,
Aster novæ-angliæ,
Aster prenanthoides,
Aster puniceus,
Aster sagittifolius,
Caltha palustris,
Cerastium longipedunculatum,
Chelone glabra,
Cicuta bulbifera,
Cicuta maculata,
Doellingeria umbellata,
Dryopteris thelypteris,
Gentiana crinita,
Gentiana flavida,
Habenaria leucophæa,
Habenaria psycodes,
Lilium canadense,
Lobelia syphilitica,
Lythrum alatum,
Macrocalyx nyctelea,
Mimulus ringens,
Onoclea sensibilis,
Parnassia caroliniana,
Pedicularis lanceolata,
Pimpinella integerrima,
Rudbeckia laciniata,
Rudbeckia triloba,
Rumex acetosella,
Rumex crispus,
Saxifraga pennsylvanica,
Silene alba,
Silphium laciniatum,
Silphium perfoliatum,
Viola obliqua,
Zizia aurea.

Moist woods vegetation.

As previously stated the most typical moist woods vegetation is to be found on the north banks of the table lands. The timber on the banks has much of it been left uncut and offers the very best conditions for the survival of moist woods vegetation. In the list of moist woods plants here given are included only those collected or noted from a single location in Winnebago valley. It is a bank about one-half a mile long bordering on the table land for the greater part of its length. Some of the plants listed do not seem to be typical moist woods plants and in such cases they have probably been driven to the margin of the thicket by the cultivation of the table land on one side and by the high water of the creek bottom on the other. The plants of the moist woods on this bank are:

Acer negundo,
Acer nigrum,
Actæa alba,
Actæa rubra,
Adiantum pedatum,
Adopogon virginicum,
Adoxa moschatellina,
Agastache scrophulariæfolia,
Agrimonia hirsuta,
Amelanchier canadensis,
Anemone quinquefolia,
Apios apios,
Apocynum androsæmifolium,
Aralia nudicaulis,
Aralia racemosa,
Arisæma triphyllum,
Asarum canadense,
Asclepias exaltata,
Asclepias incarnata,
Asclepias syriaca,
Asplenium acrostichoides,
Asplenium filix-fœmina,
Bicuculla cucullaria,
Bidens frondosa,
Bidens comosa,
Botrychium virginianum,
Campanula americana,
Carex rosea,
Carpinus caroliniana,
Caulophyllum thalictroides,
Cerastium longipedunculatum,
Circæa lutetiana,
Clematis virginiana,
Cornus candidissima,
Cornus rotundifolia,
Cornus stolonifera,
Corylus americana,
Cratægus punctata,
Cratægus tomentosa,
Cypripedium hirsutum,
Cystopteris bulbifera,
Deringa canadensis,
Diervilla diervilla,
Epilobium adenocaulon,
Epilobium coloratum,
Equisetum arvense,
Erigeron pulchellus,
Erythronium albidum,
Euonymus atropurpureus,
Eupatorium ageratoides,
Falcata comosa,
Fragaria americana,
Galium aparine,
Galium boreale,
Galium trifidum,
Galium triflorum,
Geranium maculatum,
Geum strictum,
Habenaria bracteata,
Hepatica acuta,
Heracleum lanatum,
Humulus lupulus,
Hydrophyllum virginicum,
Impatiens aurea,
Impatiens biflora,
Juglans cinerea,
Juglans nigra,
Lactuca floridana,
Lathyrus ochroleucus,
Lathyrus venosus,

Leptorchis liliifolia,
Lobelia syphilitica,
Lonicera dioica,
Lonicera sullivantii,
Malus ioensis,
Menispermum canadensis,
Mentha canadensis,
Micrampelis lobata,
Mitella diphylla,
Nabalus albus,
Nepeta cataria,
Onoclea struthiopteris,
Osmunda claytoniana,
Ostrya virginiana,
Oxalis stricta,
Parthenocissus quinquefolia,
Pedicularis canadensis,
Peramium pubescens,
Phlox divaricata,
Phryma leptostachya,
Podophyllum peltatum,
Polemonium reptans,
Polygonatum commutatum,
Polygonum incarnatum,
Polygonum hydropiperoides,
Populus grandidentata,
Populus tremuloides,
Potentilla canadensis,
Prunus americana,
Prunus nigra,
Prunus serotina,
Prunella vulgaris,
Prunus virginiana,
Pteris aquilina,
Pyrola elliptica,
Quercus coccinea,
Quercus macrocarpa,
Quercus rubra,
Quercus velutina,
Ranunculus abortivus,
Ranunculus septentrionalis,
Rhus glabra,
Ribes cynosbati,
Ribes floridum,
Ribes uva-crispa,
Rubus occidentalis,
Rubus villosus,
Rudbeckia laciniata,
Rudbeckia triloba,
Salix amygdaloides,
Salix fluviatilis,
Sambucus canadensis,
Sanicula gregaria,
Sanicula marylandica,
Silene alba,
Smilax herbacea,
Solidago canadensis,
Staphylea trifolia,
Syndesmon thalictroides,
Thalictrum dioicum,
Thalictrum purpurescens,
Tilia americana,
Trillium cernuum,
Trillium erectum,
Triosteum perfoliatum,
Ulmus americana,
Ulmus fulva,
Urtica gracilis,
Urticastrum divaricatum,
Uvularia grandiflora,
Vagnera racemosa,
Viburnum lentago,
Viola pubescens,
Viola obliqua,
Vitis vulpina,
Washingtonia claytoni,
Xanthoxylum americana.

Mesophytic field vegetation.

The mesophytic field vegetation as it exists in the creek valleys to-day is almost entirely a result of cultivation. The table lands which bear the plants of the mesophytic field were formerly almost entirely wooded. To-day they are cleared of timber and used for cultivation. They furnish the best fields for cultivation in the whole district. They are not subject to the overflow of the bottom lands, nor to the drought of the ridges, nor to the washouts of the side-hills. Being so extensively cultivated the plants growing upon them, which are not themselves cultivated, are almost confined to the edges of fields and thickets. Under such conditions a list of plants of this area would have no bearing upon the natural ecological groups.

Bluffs.—The bluffs bordering the river differ from those bordering creek valleys in being steeper and in having many more precipitous cliffs. The brow of the bluff along the river for almost the entire distance bordering the territory covered except where interrupted by branch valleys or ravines is one almost perpendicular limestone cliff, varying from a few feet to a hundred feet in height. Cliffs of this sort are not so common back from the river. The vegetation of the river bluffs differs to some extent from the creek bluffs in its character. Some of the common forest trees of the lowland of the creek valleys, instead of growing on the lowland of the river valley inhabit the foot of the river bluff. The proximity of the river bluff to larger areas of water seems to raise the moisture content of the soil of the river bluff above that of the creek bluff at the same height above water level. The growth then of such a tree as the black walnut at the foot of the river bluff does not show that it grows here under more arid conditions than in the creek valley, but that the same conditions of moisture in the soil are found at a higher level on the river bluff than on the creek bluff.

On all bluffs the vegetation shows the greatest variation with the direction of the slope. Those facing from south to west and receiving the direct rays of the sun from noon to 4 P. M. are generally bare of trees (Plate XXII., B) and shrubs while those facing from north to east are generally thickly wooded (Plate XXVI., B). Ravines with their greater amount of moisture in the soil and greater protection from winds are generally wooded to some extent whatever the direction of the slope (Plate XXII., A and B).

Near the heads of the creeks at the bases of the northern slopes are many moist limestone cliffs with their characteristic abundance of liverworts, mosses and ferns, sometimes almost to the exclusion of the higher seed plants. The moist cliffs bear more of the northern types of plants rare to this region than any one other special area.

The zones of forest vegetation on the bluffs are often very distinctly marked out by a few species. The oaks, *Q. rubra*, *Q. macrocarpa* and *Q. coccinea* extend from the valley to the ridge of the bluff in varying degrees of abundance and thus do not determine the zone. With these, however, are a few species which are limited either to the base or ridge. The aspen and a large-tooth poplar as primary and the ironwood, juneberry and wild crab as secondary species mark out the basal zone of forest and the white oak, white birch and shagbark hickory in varying proportions mark out the ridge forest. Between the zone containing white birch on the ridge and that containing the aspen at the base is a zone which is almost entirely covered with dark-barked trees. Thus the zones are clearly shown by the white bark of the white birch on the ridge and that of the aspen below with the dark-barked trees between.

The vegetation areas of the bluffs may be considered as moist cliffs, wooded slopes and ravines, ridge forests, bare slopes and open ridges, and dry rocks. The plants of the moist cliffs are hydrophytic; those of the wooded slopes and ravines which include a large part of the bluff area are mesophytic; the ridge forests are xerophytic and the bare slope, open ridge and dry rock plants which grow on the most exposed and dry areas in this region are distinctly xerophytic.

Moist cliff vegetation.

This group of plants is one of the most interesting of this region. One is always on the lookout for rare plants to this part of the state from the secluded and often almost inaccessible moist cliff. The short list of plants given here might be said to be almost peculiar to moist cliffs as they are rarely found elsewhere. Others might be named that grow upon moist cliffs, but which are more characteristic of moist woods.

Some of the plants characteristic of moist cliffs are:

Acer spicatum,
Adoxa moschatellina,
Betula lutea,
Circæa alpina,
Dirca palustris,
Pellæa stelleri,
Viburnum opulus.

Vegetation of wooded slopes and ravines.

This group of plants borders and perhaps encroaches upon the moist woods of the valley upon the one hand and the ridge forest upon the other. It covers a large area but does not represent the variety of species that are found in the moist woods of the valley.

Some of the plants of the wooded slopes and ravines are

Asplenium acrostichoides,
Asplenium filix-fœmina,
Castilleja coccinea,
Cypripedium hirsutum,
Cypripedium spectabilis,
Cystopteris fragilis,
Epilobium coloratum,
Erechtites hieracifolia,
Eupatorium ageratoides,
Falcata comosa,
Hieracium umbellatum,
Hieracium scabrum,
Hypericum maculata,
Hypericum majus,
Lilium umbellatum,
Lobelia cordifolia,
Lobelia inflata,
Onoclea struthiopteris,
Osmunda claytoniana,
Panax quinquefolia,
Pedicularis canadensis,
Polygonatum commutatum,
Pteris aquilina,
Rubus occidentalis,
Rubus villosus,
Silene stellata,
Smilax herbacea,
Smilax hispida.

Ridge forest vegetation.

Most of the woods upon the ridges are rather open and therefore present somewhat xerophytic conditions. The principal forest trees of the ridges are those which have been previously mentioned, *i. e.*, *Betula papyrifera*, *Hicoria ovata*, *Quercus alba* and *Quercus macrocarpa*. Scattered trees of other kinds are found on special areas. On the point of a bluff near the village of Freeburg, several trees of *Gymnocladus dioicus* were found in one of the most exposed locations that it could obtain. This is a very unusual location for this tree. *Prunus virginiana*, *Juniperus virginiana*, *Tilia americana* and *Celtis occidentalis* quite frequently grow near or on the rocky summits of the bluffs but do not cover large areas.

Bare slope and open ridge vegetation.

The soil of the southern slope and open ridge is generally largely formed of sand and broken limestone. It becomes very dry early in the summer, and then appears almost bare of vegetation except where it is broken by scattered junipers (Plate XXI., A) or patches of *Rhus glabra*.

Some of the plants characteristic of the bare slope and open ridge are:

Acerates viridiflora,
Asclepias verticillata,
Aster sericeus,
Bouteloua curtipendula,
Bouteloua hirsuta,
Coreopsis palmata,
Cyperus filiculmis,
Cyperus houghtoni,
Cyperus schweinitzii,
Draba caroliniana,
Elymus canadensis,
Helianthus occidentalis,
Euphorbia heterophylla,
Hieracium canadense,
Juniperus communis,
Juniperus sabina,
Kœleria cristata,
Kuhnistera candida,
Kuhnistera purpurea,
Lacinaria cylindracea,
Lacinaria scariosa,
Lappula lappula,
Linum sulcatum,
Lobelia spicata,
Oxalis violacea,
Polygala verticillata,
Polygonum tenue,
Pulsatilla hirsutissima,
Ratibida columnaris,
Rhus glabra,
Rhus radicans,
Silene antirrhina,
Valeriana edulis,
Viola pedata,
Viola pedatifida.

Dry rock vegetation (Plate XXI., B).

The rock plants and sand plants do not in many places form distinct groups. The sand of the bluffs nearly always contains considerable broken limestone and thus furnishes conditions favorable to the growth of limestone plants. *Pellæa atropurpurea* and *Camptosorus rhizophyllus* seem to be the only ones that are restricted to the bare limestone. The former prefers dryer and more exposed locations than the latter.

The characteristic plants of dry rocks are:

Betula papyrifera,
Campanula rotundifolia,
Camptosorus rhizophyllus,
Cystopteris bulbifera,
Juniperus communis,
Pellæa atropurpurea,
Valeriana edulis,
Zygadenus elegans.

Results of the survey.—The botanical survey of this part of the state was undertaken with a great deal of interest by the collectors. Never before has this region been explored for the purpose of botanical collection. Great opportunities were therefore offered in the search for species, which may have made this corner of the state the northern limit of their range and for those which may have strayed down the Mississippi river from their native home at its headwaters. With such possibilities in view the collectors were not disappointed with the results.

As a result of the survey 578 species of plants were collected, 26 of which are Pteridophyta, 5 Archispermæ, 87 Monocotyledons and 460 Dicotyledons.

In the catalogue of species are reported the following plants which either have not been previously reported from Minnesota or have been reported without any known authentic collection. The specimens have been placed in the Herbarium of the University.

Allionia linearis,†
Asplenium angustifolium,
Bidens comosa,*
Carex torta,
Cratægus macracantha,
Falcata pitcheri,*
Gleditsia triacanthos,
Helianthus atrorubens,
Hieracium umbellatum,†
Meibomia illinoensis,
Naias guadalupensis,
Prunus nigra,
Quercus prinoides,
Rudbeckia triloba,
Sanicula trifoliata,
Senecio plattensis.*

The following plants collected are of great interest as rare plants in the state or in this part of the state.

Arctostaphylos uva-ursi,
Asclepias obtusifolia,
Azolla caroliniana,
Betula lenta,
Carex lurida,
Cheilanthes gracilis,
Cratægus punctata,
Cyperus houghtoni,
Dasystoma grandiflora,
Dryopteris goldieana,
Gaura biennis,
Hamamelis virginiana,
Hydrocotyle americana,
Juniperus sabina,
Lactuca ludoviciana,
Lactuca sagittifolia,
Meibomia dillenii,
Polygonum tenue,
Polygonum virginianum,
Quercus platanoides,

* Previously collected but not reported from Minnesota.

† Previously reported from incorrect determinations or from general distribution ranges given in large manuals without authentic collection.

Sanicula gregaria,
Sagittaria cuneata,
Solidago erecta,
Thalesia uniflora,
Woodsia oregana.

CATALOG OF SPECIES COLLECTED.

The following catalog of plants contains only those collected by Mr. H. L. Lyon and the writer in the southeastern part of Houston county. With the exception of about ten species which were collected in Brownsville, they were all gathered in the townships of Mayville, Crooked Creek, Winnebago and Jefferson.

The determinations were almost entirely made by the collectors, each determining the plants of his own collection. The determinations of the species of *Physalis* were kindly made by Mr. P. A. Rydberg, of Columbia University, and those of *Quercus prinoides, velutina, coccinea* and *rubra*, and *Betula lenta* by Professor C. S. Sargent.

The nomenclature is that of Britton and Brown's Illustrated Flora of the Northern United States and Canada.

PTERIDOPHYTA.

OPHIOGLOSSACEÆ.

Botrychium virginianum (L.) Sw. Schrad. Journ. Bot. 2: 111. 1800.

Coll.: Lyon 38, Winnebago; 207, Mayville. June, July.
Infrequent, rich woods and shady banks.

OSMUNDACEÆ.

Osmunda claytoniana L. Sp. Pl. 1066. 1753.

Coll.: Lyon 43, Winnebago. June.
Common, shady hillsides and ravines.

POLYPODIACEÆ.

Onoclea sensibilis L. Sp. Pl. 1062. 1753.

Coll.: Lyon 326, Jefferson. Aug.
Common, wet meadows and river bottoms.

Onoclea struthiopteris (L.) Hoffm. Deutsch. Fl. 2: 11. 1795.

Coll.: Lyon 79, Winnebago; 208, Mayville. June, July.
Common, moist thickets and river bottoms.

Woodsia oregana D. C. EATON, Can. Nat. 2: 90. 1865.
Coll.: Lyon 306, Jefferson. Aug.
Rare and local, on brow of river bluff. The only previous collection reported from Minnesota is that from Stillwater by Miss Field. There are no previously collected specimens from Minnesota in the Herbarium of the University.

Cystopteris bulbifera (L.) BERNH. Schrad. Neues Journ. Bot. 1: Part 2, 26. 1806.
Coll.: Lyon 57, Winnebago. June.
Common on shaded rocks and limestone ledges.

Cystopteris fragilis (L.) BERNH. Schrad. Neues Journ. Bot. 1: Part 2, 27. 1806.
Coll.: Lyon 221, Mayville. July.
Frequent in deep woods.

Dryopteris thelypteris (L.) A. GRAY, Man. 630. 1848.
Coll.: Lyon 461, Brownsville. Aug.
Common in swamps and wet meadows along Wild Cat creek.

Dryopteris goldieana (HOOK.) A. GRAY, Man. 631. 1848.
Coll.: Lyon 203, 222, Mayville. July.
Rare and local, deep rich woods. The only previous authentic collection in Minnesota is that of Leiberg at Minneopa falls, Blue Earth County.

Dryopteris spinulosa (RETZ.) KUNTZE, Rev. Gen. Pl. 813. 1891.
Coll.: Lyon 253½, Mayville. July.
Rare and local, deep rich woods.

Camptosorus rhizophyllus (L.) LINK, Hort. Berol. 2: 69. 1833.
Coll.: Lyon 32, 65, Winnebago. June.
Infrequent or rare, limestone ledges and boulders.

Asplenium angustifolium MICHX. Fl. Bor. Am. 2: 265. 1803.
Coll.: Lyon 204, 224, Mayville. July.
Rare, deep rich woods. Not previously reported from Minnesota.

Asplenium acrostichoides SW. Schrad. Journ. Bot. 2: 54. 1800.
Coll.: Lyon 206, 223, Mayville; 318, Jefferson. July Aug.
Frequent, rich woods and moist thickets.

Asplenium filix-fœmina (L.) BERNH. Schrad. Neues Journ. Bot. 1: Part 2, 26. 1806.
Coll.: Lyon 205, 220, Mayville. July.
Common woods and thickets.

Adiantum pedatum L. Sp. Pl. 1095. 1753.
Coll.: Lyon 45, Winnebago. June.
Common, woods and shady banks.

Pteris aquilina L. Sp. Pl. 1075. 1753.
Coll.: Lyon 42, Winnebago. June.
Common, hillsides and cut-over timber lands.

Pellæa stelleri (S. G. GMEL.) WATT, Can. Fil. No. 2. 1869–70.
Coll.: Lyon 77, Winnebago. June.
Infrequent, moist limestone ledges.

Pellæa atropurpurea (L.) LINK, Fil. Hort. Berol. 59. 1841.
Coll.: Lyon 30, Winnebago. June.
Frequent, dry limestone cliffs and boulders.

Cheilanthes gracilis (FEÉ) METT. Abh. Senck. Nat. Gesell. 3: (reprint 36). 1859.
Coll.: Lyon 299, 305, Jefferson. Aug.
Rare and local, dry limestone cliff. There is no previous authentic collection of this from Minnesota in the University Herbarium. Sandberg's collection from Vermillion lake made in 1885 and reported as this species should be *Cheilanthes lanosa* (Michx.) Watt. which has not previously been reported from Minnesota.

Polypodium vulgare L. Sp. Pl. 1085. 1753.
Coll.: Lyon 76, Winnebago. June.
Local on limestone ledge.

SALVINIACEÆ.

Azolla caroliniana WILLD. Sp. Pl. 5: 541. 1810.
Coll.: Lyon 276, Allamakee Co., Iowa; 298, 444, Jefferson. Aug.
Abundant on sloughs and lakes of the Mississippi.

EQUISETACEÆ.

Equisetum arvense L. Sp. Pl. 1061. 1753.
Coll.: Lyon 102, Winnebago. June.
Frequent, meadows and pastures.

Equisetum pratense EHRH. Hanov. Mag. 138. 1784.
Coll.: Lyon 29, Winnebago. June.
Frequent in light shaded soil.

Equisetum hyemale L. Sp. Pl. 1062. 1753.
Coll.: Lyon 415, Winnebago. Aug.
Common.

Equisetum lævigatum A. BR.; Engelm. Amer. Journ. Sci. 46: 87. 1844.
Coll.: Lyon 18, Winnebago. June.
Local, moist meadows.

SELAGINELLACEÆ.

Selaginella rupestris (L.) SPRING. in Mart. Fl. Bras. 1: Part 2, 118. 1840.
Coll.: Lyon 78, Winnebago. June.
Infrequent, dry rocks.

SPERMATOPHYTA.

ARCHISPERMÆ.

PINACEÆ.

Pinus strobus L. Sp. Pl. 1001. 1753.
Coll.: Wheeler 166, 254, Winnebago. June.
Local on bluffs along Winnebago and Crooked Creeks.

Juniperus communis L. Sp. Pl. 1040. 1753.
Coll.: Wheeler 108, Winnebago; 213, Jefferson; 349, Crooked Creek. June, July.
Common on dry bluffs. (Plates XXI., A and B, XXIV., B.)

Juniperus virginiana L. Sp. Pl. 1039. 1753.
Coll. · Wheeler 158, 169, Winnebago. June.
Frequent on dry bluffs.

Juniperus sabina L. Sp. Pl. 1039. 1753.
Coll.: Wheeler 214, Jefferson. June.
Rare and local on dry bluffs. No previous collection reported from this part of the state. This is about the most southern point of collection for this species in the United States according to Britton and Brown.

TAXACEÆ.

Taxus minor (MICHX.) BRITTON, Mem. Torr. Club, **5**: 19. 1893.

Coll.: Wheeler 289, Crooked Creek; 317, Mayville; 433, Jefferson. July.

Infrequent, generally on dry limestone ridges, occasionally in woods. Not previously reported from the southern part of the state.

METASPERMÆ.

TYPHACEÆ.

Typha latifolia L. Sp. Pl. 971. 1753.

Coll.: Wheeler 266, Winnebago. June.

SPARGANIACEÆ.

Sparganium eurycarpum ENGELM. in A. Gray, Man. Ed. 2, 430. 1856.

Coll.: Wheeler 423, Jefferson. July.

NAIADACEÆ.

Potamogeton natans L. Sp. Pl. 126. 1753.

Coll.: Wheeler 460, Jefferson. Aug.

Potamogeton lonchites TUCKERM. Am. Journ. Sci (II.) **6**: 226. 1848.

Coll.: Wheeler 395, 488, Jefferson. Aug.

Potamogeton zosteræfolius SCHUM. Enum. Pl. Saell. 50. 1801.

Coll.: Wheeler 462, 490, 497, Jefferson. Aug.

Potamogeton pusillus L. Sp. Pl. 127. 1753.

Coll.: Wheeler 461, Jefferson. Aug.

Naias flexilis (WILLD.) ROST. & SCHMIDT, Fl. Sed. 384. 1824.

Coll.: Lyon 329, Jefferson. Aug.

Naias guadalupensis (SPRENG.) MORONG, Mem. Torr. Club, **3**: Part 2, 60. 1893.

Coll.: Lyon 443, Jefferson. Aug.

Not previously reported from Minnesota. Sloughs and lakes of the Mississippi river.

ALISMACEÆ.

Alisma plantago-aquatica L. Sp. Pl. 342. 1753.

Coll.: Lyon 384, Jefferson. Aug.

Sagittaria latifolia WILLD. Sp. Pl. **4**: 409. 1806.
Coll.: Wheeler 123, Winnebago; 304. Crooked Creek; 492, Jefferson. June–Aug.

Sagittaria cuneata SHELDON, Bull. Torr. Club, **20**: 283. *pl. 159.* 1893.
Coll.: Wheeler 491, 495, Jefferson. Aug.
Not previously reported from this part of the state or the Mississippi river. Frequent in sloughs.

Sagittaria rigida PURSH, Fl. Am. Sept. 397. 1814.
Coll.: Wheeler 486, Jefferson. Aug.

Sagittaria cristata ENGELM.; Arthur, Proc. Davenport Acad. **4**: 29. 1882.
Coll.: Lyon 481, Jefferson. Aug.

VALLISNERIACEÆ.

Philotria canadensis (MICHX.) BRITTON, Science (II.) **2**: 5. 1895.
Coll.: Lyon 174, Winnebago. July.

GRAMINEÆ.

Andropogon furcatus MUHL.; Willd. Sp. Pl. **4**: 919. 1806.
Coll.: Wheeler 404, Jefferson. July.

Chrysopogon avenaceus (MICHX.) BENTH. Journ. Linn. Soc. **19**: 73. 1881.
Coll.: Lyon 354, Jefferson. Aug.

Syntherisma sanguinalis (L.) NASH, Bull. Torr. Club, **22**: 420. 1895.
Coll.: Wheeler 424, Jefferson. July.

Panicum crus-galli L. Sp. Pl. 56. 1753.
Coll.: Wheeler 420, Lyon 478, Jefferson. July, Aug.

Panicum porterianum NASH, Bull. Torr. Club **22**: 420. 1895.
Coll.: Wheeler 388, Jefferson. July.

Panicum scribnerianum NASH, Bull. Torr. Club, **22**: 421. 1895.
Coll.: Wheeler 182, Winnebago. June.

Panicum virgatum L. Sp. Pl. 59. 1753.
Coll.: Wheeler 421, Jefferson. July.

Panicum capillare L. Sp. Pl. 58. 1753.
Coll.: Lyon 477, Jefferson. Aug.

Cenchrus tribuloides L. Sp. Pl. 1050. 1753.
Coll.: Lyon 287, Jefferson. July.

Zizania aquatica L. Sp. Pl. 991. 1753.
Coll.: Wheeler 523, Jefferson. Aug.

Homalocenchrus virginicus (WILLD.) BRITTON, Trans. N. Y. Acad. Sci. **9**: 14. 1889.
Coll.: Wheeler 564, Jefferson. Aug.

Spartina cynosuroides (L.) WILLD. Enum. 80. 1809.
Coll.: Wheeler 426, Jefferson. July.

Bouteloua hirsuta LAG. Var. Cienc. y Litter **2**: Part 4, 141. 1805.
Coll.: Wheeler 347, Crooked Creek; Lyon 291, Jefferson. July.

Bouteloua curtipendula (MICHX.) TORR. Emory's Rep. 153. 1848.
Coll.: Wheeler 362, Crooked Creek. July.

Eragrostis hypnoides (LAM.) B.S.P. Prel. Cat. N. Y. 69. 1888.
Coll.: Wheeler 524, Jefferson. Aug.

Kœleria cristata (L.) PERS. Syn. **1**: 97. 1805.
Coll.: Lyon 113, Winnebago. June.

Panicularia americana (TORR.) MACM. Met. Minn. 81. 1892.
Coll.: Lyon 59, Winnebago. June.

Bromus ciliatus L. Sp. Pl. 76. 1753.
Coll.: Lyon 414, Winnebago. Aug.

Bromus kalmii A. GRAY, Man. 600. 1848.
Coll.: Lyon 259, Jefferson. July.

Bromus secalinus L. Sp. Pl. 76. 1753.
Coll.: Lyon 184, Winnebago. July.

Elymus virginicus L. Sp. Pl. 84. 1753.
Coll.: Wheeler 418, Jefferson. July.

Elymus canadensis L. Sp. Pl. 83. 1753.
Coll.: Wheeler 292, Mayville. July.

CYPERACEÆ.

Cyperus schweinitzii TORR. Ann. Lyc. N. Y. **3**: 276. 1836.
Coll.: Lyon 375, Jefferson. Aug.

Cyperus esculentus L. Sp. Pl. 45. 1753.
Coll.: Wheeler 526, Jefferson. Aug.

Cyperus filiculmis Vahl, Enum. **2**: 328. 1806.
Coll.: Wheeler 348, Crooked Creek. July.

Cyperus houghtoni Torr. Ann. Lyc. N. Y. **3**: 277. 1836.
Coll.: Wheeler 346, Crooked Creek. July.

The only previous collection known from Minnesota is that of Holzinger, St. Croix River, Minn. Britton reports this collection in the Bull. Torr. Club, **18**: 368. 1891.

The collection from Crooked Creek was made from the summit of a very dry sandy hill. Both *C. houghtoni* and *C. schweinitzii* grow in sand but the former probably grows in the drier locality of the two.

Eleocharis acicularis (L.) R. & S. Syst. **2**: 154. 1817.
Coll.: Wheeler 527, Jefferson. Aug.

Scirpus lacustris L. Sp. Pl. 48. 1753.
Coll.: Wheeler 148, Winnebago. June.

Scirpus atrovirens Muhl. Gram. 43. 1817.
Coll.: Wheeler 267, Winnebago. June.

Scirpus cyperinus (L.) Kunth, Enum. **2**: 170. 1837.
Coll.: Lyon 168, Crooked Creek; Wheeler 425, Jefferson. June, July.

Carex lupulina Muhl.; Schk. Riedg. **2**: 54. *f. 123.* 1806.
Coll.: Lyon 280, Jefferson. July.

Carex lurida Wahl. Kongl. Acad. Handl. (II.) **24**: 153. 1803.
Coll.: Wheeler 142, Winnebago. June.

No Minnesota specimens in the Herbarium of the University. Previously collected at Lake Itasca, Sandberg No. 1180.

Carex hystricina Muhl.; Willd. Sp. Pl. **4**: 282. 1805.
Coll.: Wheeler 119, Winnebago. June.

Carex filiformis L. Sp. Pl. 976. 1753.
Coll.: Wheeler 121, Winnebago. June.

Carex torta Boott; Tuckerm. Enum. Meth. 11. 1843.
Coll.: Lyon 60, Winnebago. June.

Not previously reported from Minnesota. The nearest point of previous collection, as shown by the Herbarium of the University, is Winnebago county, Wisconsin.

Carex stipata Muhl.; Willd. Sp. Pl. **4**: 233. 1805.
Coll.: Wheeler 116, Winnebago. June.

Carex vulpinoidea Michx. Fl. Bor. Am. **2**: 169. 1803.
Coll.: Wheeler 144, Winnebago. June.

Carex rosea Schk. Riedgr. Nachtr. 15. *f. 179.* 1806.
Coll.: Wheeler 11, 143, Winnebago. June.

Carex tribuloides Wahl. Kongl. Vet. Acad. Handl. (II.) **24**: 145. 1803.
Coll.: Wheeler 118, Winnebago. June.

Carex cristatella Britton, Br. & Br. Ill. Fl. N. U. S. & Can. **1**: 357. *f. 865.* 1896.
Coll.: Wheeler 197, Winnebago. June.

ARACEÆ.

Arisæma triphyllum (L.) Torr. Fl. N. Y. **2**: 239. 1843.
Coll.: Lyon 31, Winnebago. June.

Arisæma dracontium (L.) Schott, Melet. **1**: 17. 1832.
Coll.: Lyon 239, Mayville; 248. Crooked Creek. July.
The only previous collections reported from Minnesota are Manning, Lake Pepin and Holzinger, Winona. Frequent in moist woods along the Mississippi River.

LEMNACEÆ.

Spirodela polyrhiza (L.) Schleid. Linnæa, **13**: 392. 1839.
Coll.: Wheeler 113, Winnebago. June.

Lemna minor L. Sp. Pl. 970. 1753.
Coll.: Wheeler 112, Winnebago. June.

COMMELINACEÆ.

Tradescantia virginiana L. Sp. Pl. 288. 1753.
Coll.: Lyon 45, Winnebago. June.

Tradescantia reflexa Raf. Atl. Journ. 150. 1832.
Coll.: Wheeler 410, Jefferson. July.
Not previously reported from Minnesota.

JUNCACEÆ.

Juncus effusus L. Sp. Pl. 326. 1753.
Coll.: Lyon 58, Winnebago. June.

Juncus tenuis Willd. Sp. Pl. **2**: 214. 1799.
Coll.: Lyon 73, Winnebago. June.

MELANTHACEÆ.

Zygadenus elegans Pursh, Fl. Am. Sept. 241. 1814.
Coll.: Lyon 49, Winnebago. June.

Uvularia grandiflora J. E. SMITH, Ex. Bot. **1**: 99. *pl. 51.* 1804–5.
Coll.: Lyon 91, Winnebago. June.

LILIACEÆ.

Lilium umbellatum PURSH, Fl. Am. Sept. 229. 1814.
Coll.: Lyon 146, Winnebago. June.
All previous collections of this species from Minnesota have been reported as *L. philadelphicum* L. The latter species so far as known has not been collected in Minnesota.

Lilium canadense L. Sp. Pl. 303. 1753.
Coll.: Lyon 199, Crooked Creek. July.
Common, moist meadows. (Plate XXVII., A.)

Erythronium albidum NUTT. Gen. **1**: 223. 1818.
Coll.: Herb. Wheeler 1, Winnebago. May.

CONVALLARIACEÆ.

Vagnera racemosa (L.) MORONG, Mem. Torr. Club, **5**: 114. 1894.
Coll.: Wheeler 67, Winnebago. June.

Vagnera stellata (L.) MORONG, Mem. Torr. Club, **5**: 114. 1894.
Coll.: Wheeler 97, Winnebago. June.

Unifolium canadense (DESF.) GREENE, Bull. Torr. Club, **15**: 287. 1888.
Coll.: Wheeler 98, Winnebago. June.

Polygonatum commutatum (R. & S.) DIETR.; Otto & Dietr. Gartenz. **3**: 222. 1835.
Coll.: Wheeler 78, 184, Winnebago; 570, Jefferson; Lyon 166, Crooked Creek. June, Aug.

Trillium erectum L. Sp. Pl. 340. 1753.
Coll.: Lyon 17, Winnebago. June.

Trillium cernuum L. Sp. Pl. 339. 1753.
Coll.: Herb. Wheeler 2, Winnebago. May.

SMILACEÆ.

Smilax herbacea L. Sp. Pl. 1030. 1753.
Coll.: Wheeler 376, Mayville; 467, Jefferson. July, Aug.

Smilax hispida MUHL.; Torr. Fl. N. Y. **2**: 302. 1843.
Coll.: Wheeler 372, Crooked Creek; Lyon 258, Jefferson. July.

AMARYLLIDACEÆ.

Hypoxis hirsuta (L.) COVILLE, Mem. Torr. Club, **5**: 118. 1894.
Coll.: Wheeler 91, Winnebago. June.

DIOSCOREACEÆ.

Dioscorea villosa L. Sp. Pl. 1033. 1753.
Coll.: Wheeler 322, Mayville; 364, Crooked Creek. July.

IRIDACEÆ.

Iris versicolor L. Sp. Pl. 39. 1753.
Coll.: Lyon 362, Jefferson. Aug.

Sisyrinchium angustifolium MILL. Gard. Dict. Ed. 7. 1759.
Coll.: Lyon 75, Winnebago. June.

ORCHIDACEÆ.

Cypripedium reginæ WALT. Fl. Car. 222. 1788.
Coll.: Wheeler 192, Winnebago. June.

Cypripedium candidum WILLD. Sp. Pl. **4**: 142. 1805.
Coll.: Wheeler 99, Winnebago. June.

Cypripedium hirsutum MILL. Gard. Dict. Ed. 8, No. 3. 1768.
Coll.: Wheeler 66, 82, Winnebago. June.

Orchis spectabilis L. Sp. Pl. 943. 1753.
Coll.: Herb. Wheeler 8, Winnebago. June.

Habenaria bracteata (WILLD.) R. Br. in Ait. Hort. Kew, Ed. 2, **5**: 192. 1813.
Coll.: Wheeler 106, Winnebago. June.

Habenaria leucophæa (NUTT.) A. GRAY, Man. Ed. 5, 502. 1867.
Coll.: Wheeler 299, Crooked Creek. July.

Habenaria psycodes (L.) A. GRAY, Am. Journ. Sci. **38**: 310. 1840.
Coll.: Wheeler 386, Jefferson. July.

Peramium pubescens (WILLD.) MACM. Met. Minn. 172. 1892.
Coll.: Lyon 100, Winnebago. June.

Leptorchis liliifolia (L.) KUNTZE, Rev. Gen. Pl. 671. 1891.
Coll.: Wheeler 107, 168, 195, Winnebago; 350, Crooked Creek; 391, Jefferson. June, July.

JUGLANDACEÆ.

Juglans nigra L. Sp. Pl. 997. 1753.
Coll.: Lyon 243, Crooked Creek. July.

Juglans cinerea L. Sp. Pl. Ed. 2, 1415. 1763.
Coll.: Lyon 62, 108, Winnebago. June.

Hicoria minima (MARSH.) BRITTON, Bull. Torr. Club, **15**: 284. 1888.
Coll.: Lyon 149, Winnebago; 238, 239, Mayville; 475, Jefferson. June, Aug.

Hicoria ovata (MILL) BRITTON, Bull. Torr. Club, **15**: 283. 1888.
Coll.: Lyon 71, Winnebago; 474, Jefferson. June, Aug.

SALICACEÆ.

Populus alba L. Sp. Pl. 1034. 1753.
Coll.: Lyon 159, Winnebago. June.

Populus balsamifera candicans (AIT.) A. GRAY, Man. Ed. 2, 419. 1856.
Coll.: Lyon 156, Winnebago. June.

Populus grandidentata MICHX. Fl. Bor. Am. **2**: 243. 1803.
Coll.: Lyon 64, Winnebago. June.

Populus tremuloides MICHX. Fl. Bor. Am. **2**: 243. 1803.
Coll.: Lyon 88, Winnebago. June.

Populus deltoides MARSH, Arb. Am. 106. 1785.
Coll.: Lyon 125, Winnebago. June.

Salix nigra MARSH, Arb. Am. 139. 1785.
Coll.: Wheeler 265, Winnebago. June.

Salix amygdaloides ANDERS. Ofv. Handl. Vet. Akad. **1858**: 114. 1858.
Coll.: Wheeler 137, Winnebago. June.

Salix lucida MUHL. Neue Scrift. Ges. Nat. Fr. Berlin, **4**: 239. *pl. 6. f. 7.* 1803.
Coll.: Wheeler 138½, Winnebago; 232, Crooked Creek. June, July.

Salix fluviatilis NUTT. Sylva, 1: 73. 1842.
Coll.: Wheeler 136, Winnebago; 333, Crooked Creek. June, July.

Salix bebbiana SARG. Gard. & For. 8: 463. 1895.
Coll.: Wheeler 343, Crooked Creek. July.

Salix humilis MARSH, Arb. Am. 140. 1785.
Coll.: Wheeler 181, Winnebago. June.

Salix discolor MUHL. Neue Schrift. Ges. Nat. Fr. Berlin, **4**: 234. *pl. 6. f. 1.* 1803.
Coll.: Wheeler 138, Winnebago; 334, Crooked Creek. June, July.

BETULACEÆ.

Carpinus caroliniana WALT. Fl. Car. 236. 1788.
Coll.: Lyon 56, Winnebago. June.

Ostrya virginiana (MILL.) WILLD. Sp. Pl. **4**: 469. 1805.
Coll.: Wheeler 200, Winnebago. June.

Corylus americana WALT. Fl. Car. 236. 1788.
Coll.: Wheeler 22, Winnebago. June.

Corylus rostrata AIT. Hort. Kew. **3**: 364. 1789.
Coll.: Wheeler 223, Winnebago; 275, Crooked Creek. June.
Not previously collected from southern part of state. Local on bluffs.

Betula papyrifera MARSH. Art. Am. 19. 1785.
Coll.: Wheeler 215, Jefferson. June.
Common, dry ridges. (Plates XXIII., A and XXIV., B.)

Betula nigra L. Sp. Pl. 982. 1753.
Coll.: Wheeler 553, Jefferson. Aug.
Common in the lowlands of the Mississippi River.

Betula lenta L. Sp. Pl. 983. 1753.
Coll.: Wheeler 165, Winnebago. June.
Not previously collected in the southern part of the state. Rare.

Betula lutea MICHX. f. Arb. Am. 2: 152. *pl. 5.* 1812.
Coll.: Wheeler 199, Winnebago; 271, Crooked Creek; 325, Mayville. June, July.
Frequent in moist locations along Winnebago and Crooked creeks.

Betula pumila L. Mant. 124. 1767.
Coll.; Wheeler 272, Crooked Creek. June.
Local along Crooked creek, forming large thickets in wet meadows.

Alnus incana (L.) WILLD. Sp. Pl. 4: 335. 1805.
Coll.: Wheeler 617, Brownsville. Aug.
Local at mouth of Wild Cat creek.

FAGACEÆ.

Quercus rubra L. Sp. Pl. 996. 1753.
Coll.: Wheeler 640, 641, Jefferson. Aug.
Common throughout.

Quercus coccinea WANG. Amer. 44. *pl. 4. f. 9.* 1787.
Coll.: Wheeler 644, 645, Jefferson. Aug.
Common throughout.

Quercus velutina LAM. Encycl. 1: 721. 1783.
Coll.: Wheeler 642, 643, Jefferson. Aug.
Prof. Sargent writes about 643: "Collection 643, which I call *Q. velutina*, differs from that species as it usually occurs by the much smaller less tomentose buds; the acorns, however, are clearly from *Q. velutina*. I frequently have seen specimens of this same form from the region immediately west of the Great Lakes. It appears sometimes as if it might be a hybrid between *Q. velutina* and *Q. coccinea* but its occurrence is too frequent and its distribution too wide to admit of this supposition. With the present state of our knowledge I can but refer it to *Q. velutina*."

Q. velutina does not seem to be nearly so common in this region as *Q. coccinea*.

Quercus alba L. Sp. Pl. 996. 1753.
Coll.: Wheeler 638, Jefferson. Aug.
Common on ridges of bluffs throughout.

Quercus macrocarpa MICHX. Hist. Chen. Am. 2. *pl. 23.* 1801.
Coll.: Wheeler 639, Jefferson. Aug.
Common throughout.

Quercus platanoides (LAM.) SUDW. Rep. Secy. Agric. 1892: 327. 1893.
Coll.: Wheeler 366, Crooked Creek; 456, 538, 654, Jefferson. July, Aug.

No previous collection reported from Minnesota. Reported by Garrison as frequent at several points near the headwaters of the Mississippi. Frequent on the lowlands of the Mississippi in Jefferson and Crooked Creek townships and in Allamakee Co., Iowa.

Quercus prinoides WILLD. Neue Schrift. Ges. Nat. Fr. Berlin, 3: 397. 1801.

Coll.: Wheeler 360, Crooked Creek. July.

Not previously reported from Minnesota. Whether this is the species reported by Lapham as *Q. castanea* Willd. cannot be ascertained as there are no specimens from Lapham's collection in the Herbarium of the University.

The specimens were collected from two trees on the side of a bluff in section 19, township 102 N., range 4 W.

ULMACEÆ.

Ulmus americana L. Sp. Pl. 226. 1753.

Coll.: Wheeler 24, Winnebago. June.

Ulmus racemosa THOMAS, Am. Jour. Sci. **19**: 170. 1831.

Coll.: Wheeler 315, Mayville. July.

Infrequent on lowland near Crooked creek.

Ulmus fulva MICHX. Fl. Bor. Am. **1**: 172. 1803.

Coll.: Wheeler 23, Winnebago. June.

Celtis occidentalis L. Sp. Pl. 1044. 1753.

Coll.: Wheeler 240, Winnebago; 278, Crooked Creek; Lyon 374, Jefferson. June, Aug.

MORACEÆ.

Morus rubra L. Sp. Pl. 986. 1753.

Coll.: Lyon 368, Jefferson. Aug.

Infrequent along Mississippi river.

Humulus lupulus L. Sp. Pl. 1028. 1753.

Coll.: Lyon 312, Winnebago. Aug.

Cannabis sativa L. Sp. Pl. 1027. 1753.

Coll.: Lyon 282, Jefferson. Aug.

URTICACEÆ.

Urtica gracilis AIT. Hort. Kew. **3**: 341. 1789.

Coll.: Lyon 126, Winnebago. June.

Urticastrum divaricatum (L.) KUNTZE, Rev. Gen. Pl. 635. 1891.
Coll.: Lyon 117, Winnebago; 358, Jefferson. June, Aug.

Adicea pumila (L.) RAF.; Torr. Fl. N. Y. 2: 223. As synonym. 1843.
Coll.: Wheeler 327, Mayville; 653, Jefferson. July, Aug.

Parietaria pennsylvanica MUHL.; Willd. Sp. Pl. 4; 955. 1806.
Coll.: Lyon 191, Crooked Creek. July.

SANTALACEÆ.

Comandra umbellata (L.) NUTT. Gen. 1: 157. 1818.
Coll.: Lyon 90, Winnebago. June.

ARISTOLOCHIACEÆ.

Asarum canadense L. Sp. Pl. 442. 1753.
Coll.: Wheeler 57, Winnebago. June.

POLYGONACEÆ.

Rumex acetosella L. Sp. Pl. 338. 1753.
Coll.: Lyon 130, Winnebago. June.

Rumex crispus L. Sp. Pl. 335. 1753.
Coll.: Lyon 127, 158, Winnebago. June.

Polygonum hartwrightii A. GRAY, Proc. Am. Acad, 8: 294. 1870.
Coll.: Wheeler 606, Brownsville. Aug.

Polygonum emersum (MICHX.) BRITTON, Trans. N. Y. Acad. Sci. 8: 73. 1879.
Coll.: Wheeler 394, 458, Jefferson. July, Aug.

Polygonum incarnatum ELL. Bot. S. C. & Ga. 1: 456. 1817.
Coll.: Wheeler 419, Jefferson. July.

Polyonum hydropiper L. Sp. Pl. 361. 1753.
Coll.: Lyon 494, Jefferson. Aug.

Polygonum punctatum ELL. Bot. S. C. & Ga. 1: 455. 1817.
Coll.: Wheeler 537, 539, Jefferson. Aug.

Polygonum orientale L. Sp. Pl. 362. 1753.
Coll.: Wheeler 448, Jefferson. Aug.

Polygonum virginianum L. Sp. Pl. 360. 1753.
Coll.: Wheeler 580, Jefferson; 597.
Crooked Creek. Aug.
The only previous collections from Minnesota are Sheldon, Madison lake and Sheldon, Zumbrota. Infrequent in moist woods along Mississippi river.

Polygonum ramosissimum Michx. Fl. Bor. Am. **1**: 237. 1803.
Coll.: Wheeler 514, Winnebago; 531, Jefferson. Aug.

Polygonum tenue Michx. Fl. Bor. Am. **1**: 238. 1803.
Coll.: Wheeler, 351, Crooked Creek. July.
The only previous authentic collection from Minnesota is Moyer, Montevideo. Infrequent on dry sandy ridges.

Polygonum convolvulus L. Sp. Pl. 364. 1753.
Coll.: Wheeler 451, Jefferson. Aug.

Polygonum scandens L. Sp. Pl. 364. 1753.
Coll.: Wheeler 646, Jefferson. Aug.

Polygonum sagittatum L. Sp. Pl. 363. 1753.
Coll.: Wheeler 387, Jefferson. July.

CHENOPODIACEÆ.

Chenopodium botrys L. Sp. Pl. 219. 1753.
Coll.: Lyon 472, Jefferson. Aug.

Salsola tragus L. Sp. Pl. Ed. 2, 322. 1762.
Coll.: Lyon 396, Jefferson. Aug.

AMARANTHACEÆ.

Amaranthus retroflexus L. Sp. Pl. 991. 1753.
Coll.: Wheeler 598, Crooked Creek. Aug.

Amaranthus blitoides S. Wats. Proc. Am. Acad. **12**: 273. 1877.
Coll.: Wheeler 452, Jefferson. Aug.

Acnida tamariscina (Nutt.) Wood, Bot. & Fl. 289. 1873.
Coll.: Wheeler 522, 547, Jefferson. Aug.

Froelichia floridana (Nutt.) Moq. in DC. Prodr. **13**: Part 2, 420. 1849.
Coll.: Lyon 304, 325, Jefferson. Aug.

NYCTAGINACEÆ.

Allionia nyctaginea Michx. Fl. Bor. Am. **1**: 100. 1803.
Coll.: Wheeler 76, Lyon 40, Winnebago. June.

Allionia linearis PURSH, Fl. Am. Sept. 728. 1814.
Coll.: Wheeler 392, Jefferson. July.
Not previously collected in Minnesota. Collections Oestlund 155 and Herrick 256, Minneapolis, in the Herbarium of the University and reported in Metaspermæ of Minnesota Valley as *A. linearis* Pursh ? should be *A. hirsuta* Pursh.

AIZOACEÆ.

Mollugo verticillata L. Sp. Pl. 89. 1753.
Coll.: Lyon 279, 302, Jefferson. July, Aug.

CARYOPHYLLACEÆ.

Silene stellata (L.) AIT. f. Hort. Kew. **3**: 84. 1811.
Coll.: Lyon 254, Wheeler 508, Winnebago. July, Aug.

Silene alba MUHL. Cat. 45. 1813.
Coll.: Lyon 164, Winnebago. June.
The only previous collections from Minnesota are from Goodhue and Winona counties. Frequent along Winnebago and Crooked creeks.

Silene antirrhina L. Sp. Pl. 419. 1753.
Coll.: Wheeler 171, Winnebago. June.

Cerastium longipedunculatum MUHL. Cat. 46. 1813.
Coll.: Lyon 8, Winnebago. June.

NYMPHÆACEÆ.

Nymphæa advena SOLAND. in Ait. Hort. Kew. **2**: 226. 1789.
Coll.: Wheeler 307, Crooked Creek; 454, Jefferson. July, Aug. (Plate XXVII., B.)

Castalia tuberosa (PAINE) GREENE, Bull. Torr. Club, **15**: 84. 1888.
Coll.: Wheeler 293, 439, 496, Jefferson. July, Aug.

Nelumbo lutea (WILLD.) PERS. Syn. **1**: 92. 1805.
Coll.: Wheeler 409, 494, Jefferson. July, Aug.
Abundant in the sloughs of the Mississippi river at Jefferson. (Plate XXV., A.)

CERATOPHYLLACEÆ.

Ceratophyllum demersum L. Sp. Pl. 992. 1753.
Coll.: Lyon 367, 480, Jefferson. Aug.
Common in the sloughs of the Mississippi river at Jefferson and Crooked Creek.

RANUNCULACEÆ.

Caltha palustris L. Sp. Pl. 558. 1753.
Coll.: Lyon 244, Crooked Creek. July.

Actæa rubra (Ait.) Willd. Enum. 561. 1809.
Coll.: Lyon 450, Jefferson. Aug.

Actæa alba (L.) Mill. Gard. Dict. Ed. 8, No. 2. 1768.
Coll.: Lyon 16, Winnebago. June.

Aquilegia canadensis L. Sp. Pl. 533. 1753.
Coll.: Wheeler 84, Winnebago. June.

Anemone virginiana L. Sp. Pl. 540. 1753.
Coll.: Lyon 9, Winnebago; 245, Crooked Creek. June, July.

Anemone canadensis L. Syst. Ed. 12, **3**: App. 231. 1768.
Coll.: Lyon 286½, Jefferson. July.

Anemone quinquefolia L. Sp. Pl. 541. 1753.
Coll.: Herb. Wheeler 4, Winnebago. May.

Hepatica acuta (Pursh) Britton, Ann. N. Y. Acad. Sci. **6**: 234. 1891.
Coll.: Wheeler 134, Winnebago. June.

Syndesmon thalictroides (L.) Hoffmg. Flora, **15**: Part 2, Intell. Bl. 4, 34. 1832.
Coll.: Wheeler 36, Winnebago. June.

Pulsatilla hirsutissima (Pursh) Britton, Am. N. Y. Acad. Sci. **6**: 217. 1891.
Coll.: Wheeler 73, Winnebago. June.

Clematis virginiana L. Amoen. Acad. **4**: 275. 1759.
Coll.: Wheeler 194, Winnebago; 355, Crooked Creek. June, July.

Atragene americana Sims, Bot. Mag. *pl. 887*. 1806.
Coll.: Wheeler 259, Winnebago; 320, Mayville. June, July.

Ranunculus delphinifolius Torr.; Eaton, Man. Ed. 2, 395. 1818.
Coll.: Lyon 201, Crooked Creek. July.

Ranunculus abortivus L. Sp. Pl. 551. 1753.
Coll.: Wheeler 15, Winnebago. June.

Ranunculus pennsylvanicus L. f. Suppl. 272. 1781.
Coll.: Lyon 364, 378, Jefferson. Aug.

Ranunculus septentrionalis Poir. in Lam. Encycl. **6**: 125. 1804.
Coll.: Wheeler 6, Winnebago. June.

Batrachium trichophyllum (Chaix) Bossch, Prodr. Fl. Bot. 5. 1850.
Coll.: Lyon 67, Winnebago. June.

Batrachium divaricatum (Schrank) Wimm. Fl. Schles. 1841.
Coll.: Lyon 219, Mayville. July.

Thalictrum dioicum L. Sp. Pl. 545. 1753.
Coll.: Herb. Wheeler 13, Winnebago. June.

Thalictrum purpurascens L. Sp. Pl. 546. 1753.
Coll.: Lyon 99, Winnebago. June.

BERBERIDACEÆ.

Caulophyllum thalictroides (L.) Michx. Fl. Bor. Am. **1**: 205. 1803.
Coll.: Lyon 92, Winnebago. June.

Podophyllum peltatum L. Sp. Pl. 505. 1753.
Coll.: Lyon 1, Wheeler 157, Winnebago. June.

MENISPERMACEÆ.

Menispermum canadense L. Sp. Pl. 340. 1753.
Coll.: Wheeler 188, Winnebago. June.

PAPAVERACEÆ.

Sanguinaria canadensis L. Sp. Pl. 505. 1753.
Coll.: Lyon 169, Crooked Creek. June.

Bicuculla cucullaria (L.) Millsp. Bull. W. Va. Agric. Exp. Sta. **2**: 327. 1892.
Coll.: Wheeler 12, Winnebago. June.

CRUCIFERÆ.

Lepidium apetalum Willd. Sp. Pl. **3**: 439. 1801.
Coll.: Lyon 123, Winnebago. June.

Sisymbrium officinale (L.) Scop. Fl. Cam. Ed. 2, **2**: 26. 1772.
Coll.: Lyon 422, Winnebago. Aug.

Sisymbrium altissimum L. Sp. Pl. 659. 1753.
Coll.: Lyon 273, Wheeler 481, Jefferson. July, Aug.

Brassica nigra (L.) Koch, in Rœhl, Deutsche Fl. Ed. 3, **4**: 713. 1833.
Coll.: Lyon 233, Crooked Creek. July.

Brassica arvensis (L.) B.S.P. Prel. Cat. N. Y. 1888.
Coll.: Lyon 86, Winnebago. June.

Roripa palustris (L.) Bess. Enum. 27. 1821.
Coll.: Lyon 200, Crooked Creek. July.

Roripa nasturtium (L.) Rusby, Mem. Torr. Club, **3**: Part 3, 5. 1893.
Coll.: Lyon 89, Winnebago. June.

Cardamine bulbosa (Schreb.) B.S.P. Prel. Cat. N. Y. 4. 1888.
Coll.: Wheeler 167, Winnebago. June.

Bursa bursa-pastoris (L.) Britton, Mem. Torr. Club, **5**: 172. 1894.
Coll.: Lyon 120, Winnebago. June.

Camelina sativa (L.) Crantz, Stirp. Austr. **1**: 18. 1762.
Coll.: Lyon 213, Mayville. July.

Draba caroliniana Walt. Fl. Car. 174. 1788.
Coll.: Lyon 47, Winnebago. June.

Arabis lævigata (Muhl.) Poir. in Lam. Encycl. Suppl. **1**: 411. 1810.
Coll.: Wheeler 154, Winnebago. June.

Arabis canadensis L. Sp. Pl. 665. 1753.
Coll.: Lyon 111, Winnebago; 212, Crooked Creek. June, July.

Arabis glabra (L.) Bernh. Verz. Syst. Erf. 195. 1800.
Coll.: Lyon 122, Winnebago; 227, Mayville. June, July.

Erysimum cheiranthoides L. Sp. Pl. 661. 1753.
Coll.: Lyon 187, Crooked Creek; 226, Mayville. July.

CAPPARIDACEÆ.

Polanisia graveolens Raf. Am. Journ. Sci. **1**: 378. 1819.
Coll.: Lyon 277, Jefferson. July.

CRASSULACEÆ.

Penthorum sedoides L. Sp. Pl. 432. 1753.
Coll.: Wheeler 384, Jefferson. July.

SAXIFRAGACEÆ.

Saxifraga pennsylvanica L. Sp. Pl. 399. 1753.
Coll.: Wheeler 180, Winnebago. June.

Heuchera hispida Pursh, Fl. Am. Sept. 188. 1814.
Coll.: Wheeler 83, Winnebago. June.

Mitella diphylla L. Sp. Pl. 406. 1753.
Coll.: Wheeler 40, Winnebago. June.

Parnassia caroliniana MICHX. Fl. Bor. Am. **1**: 184. 1803.
Coll.: Wheeler 587, Crooked Creek; 629, Brownsville. Aug.

GROSSULARIACEÆ.

Ribes cynosbati L. Sp. Pl. 202. 1753.
Coll.: Wheeler 77, 110, Winnebago. June.

Ribes uva-crispa L. Sp. Pl. 201. 1753.
Coll.: Wheeler 30, 75, 248, Winnebago. June.
Frequently adventive in open woods throughout.

Ribes floridum L'HER. Stirp. Nov. **1**: 4. 1784.
Coll.: Lyon 82, Winnebago. June.

HAMAMELIDACEÆ.

Hamamelis virginiana L. Sp. Pl. 124. 1753.
Coll.: Wheeler 150, Winnebago. June.
Reported from southeastern Winona County. No Minnesota specimens in the Herbarium of the University. Local on north side of bluff in section 22 of Winnebago.

ROSACEÆ.

Opulaster opulifolius (L.) KUNTZE, Rev. Gen. Pl. 949. 1891.
Coll.: Lyon 33, 103, Winnebago. June.

Spiræa salicifolia L. Sp. Pl. 489. 1753.
Coll.: Lyon 438, 464, Jefferson. Aug.

Rubus occidentalis L. Sp. Pl. 493. 1753.
Coll.: Lyon 55, Winnebago; Wheeler 453, Jefferson. June, Aug.

Rubus villosus AIT. Hort. Kew. **2**: 210. 1789.
Coll.: Wheeler 105, Lyon 296, Winnebago. June, Aug.

Rubus canadensis L. Sp. Pl. 494. 1753.
Coll.: Wheeler 396, Jefferson. July.

Fragaria americana (PORTER) BRITTON, Bull. Torr. Club, **19**: 222. 1892.
Coll.: Wheeler 135, Winnebago. June.

Potentilla arguta PURSH, Fl. Am. Sept. 736. 1814.
Coll.: Lyon 247, Crooked Creek. July.

Potentilla monspeliensis L. Sp. Pl. 499. 1753.
Coll.: Lyon 439, Jefferson. Aug.

Potentilla canadensis L. Sp. Pl. 498. 1753.
Coll.: Wheeler 86, Winnebago. June.

Geum canadense JACQ. Hort. Vind. **2**: 82. *pl. 175.* 1772.
Coll.: Lyon 209, Crooked Creek. July.

Geum strictum AIT. Hort. Kew. **2**: 217. 1789.
Coll.: Wheeler 277, Lyon 195, Crooked Creek. June, July.

Agrimonia hirsuta (MUHL.) BICKNELL, Bull. Torr. Club, **23**: 509. 1896.
Coll.: Lyon 196, 228, Crooked Creek. July.

Rose blanda AIT. Hort. Kew. **2**: 202. 1789.
Coll.: Lyon 37, 431, Winnebago. June, Aug.

Rosa arkansana PORTER, Syn. Fl. Colo. 38. 1874.
Coll.: Wheeler 441, Lyon 343, Jefferson; Lyon 339, Winnebago. Aug.

POMACEÆ.

Malus ioensis (WOOD) BRITTON, in Britt. & Brown, Ill. Fl. **2**: 235. *f. 1980.* 1897.
Coll.: Wheeler 88, 160, Winnebago; 605, Crooked Creek. June, Aug.

Amelanchier canadensis (L.) MEDIC. Geschichte, 79. 1793.
Coll.: Wheeler 37, 500, Winnebago. June, Aug.

Amelanchier botryapium (L. f.) DC. Prodr. **2**: 632. 1825.
Coll.: Wheeler 253, Winnebago. June.

Amelanchier alnifolia NUTT.; T. & G. Fl. N. A. **1**: 473. As synonym. 1840.
Coll.: Wheeler 203, Winnebago. June.

Cratægus punctata JACQ. Hort. Vind. **1**: 10. *pl. 28.* 1770.
Coll.: Wheeler 141, 651, Winnebago. June, Aug.

Cratægus coccinea L. Sp. Pl. 476. 1753.
Coll.: Lyon 101, Winnebago, June.

Cratægus macracantha LODD.; Loudon, Arb. Brit. Ed. 2, **2**: 819. 1854.
Coll.: Wheeler 499, Winnebago. Aug.
Not previously reported from Minnesota.

Cratægus tomentosa L. Sp. Pl. 476. 1753.
Coll.: Lyon 3, Wheeler 140, Winnebago. June.

DRUPACEÆ.

Prunus americana Marsh. Arb. Am. 111. 1785.
Coll.: Wheeler 353, Crooked Creek. July.

Prunus nigra Ait. Hort. Kew. 2: 165. 1789.
Coll.: Wheeler 321, 354, Mayville; 501, Winnebago. July, Aug.

Not previously reported from Minnesota. This species has been recognized by horticulturists in several parts of the state but no previous authentic collections are known to have been made. It is common on the lowlands of the North and South forks of Crooked creek. Also collected on the banks of Winnebago creek and in East Burns valley, Winona county.

Prunus virginiana L. Sp. Pl. 473. 1753.
Coll.: Wheeler 345, Crooked Creek. July.

Prunus serotina Ehrh. Beitr. 3: 20. 1788.
Coll.: Wheeler 178, Winnebago. June.

CÆSALPINACEÆ.

Cassia chamæcrista L. Sp. Pl. 379. 1753.
Coll.: Lyon 256, Jefferson. July.

Gleditsia triacanthos L. Sp. Pl. 1056. 1753.
Coll.: Lyon and Wheeler; 413, W. Jefferson. July.

Not previously reported from Minnesota. This tree has been frequently cultivated for ornament throughout the southern part of the state but no native trees have previously been reported. It is frequent on the islands of the Mississippi river in northeastern Iowa and extends north along the river into Houston county, Minnesota, where it probably reaches its northern limit. The tree from which the collection was made is 59 feet high and has a trunk-circumference of 6 feet, 3 feet from the ground.

Gymnocladus dioica Koch, Dendrol. 1: 5. 1869.
Coll.: Lyon 193, 230, Crooked Creek; 271, Jefferson. July. (Plate XXIV., A.)

PAPILIONACEÆ.

Baptisia bracteata Ell. Bot. S. C. & Ga. 1: 469. 1817.
Coll.: Wheeler 94, Lyon 34, Winnebago; Lyon 202, Crooked Creek. June, July.

Baptisia leucantha T. & G. Fl. N. A. **1**: 385. 1840.
Coll.: Lyon 194, Crooked Creek. July.

Trifolium hybridum L. Sp. Pl. 766. 1753.
Coll.: Lyon 421, Winnebago. Aug.

Trifolium repens L. Sp. Pl. 767. 1753.
Coll.: Lyon 118, Winnebago. June.

Amorpha fruticosa L. Sp. Pl. 713. 1753.
Coll.: Lyon 473, Jefferson. Aug.

Amorpha canescens PURSH, Fl. Am. Sept. 467. 1814.
Coll.: Wheeler 291, Mayville. July.

Kuhnistera candida (WILLD.) KUNTZE, Rev. Gen. Pl. 192. 1891.
Coll.: Wheeler 397, Jefferson. July.

Kuhnistera purpurea (VENT.) MACM. Met. Minn. 329. 1892.
Coll.: Lyon 262, Jefferson. July.

Astragalus carolinianus L. Sp. Pl. 757. 1753.
Coll.: Lyon 257, 395, Jefferson. July, Aug.

Meibomia grandiflora (WALT.) KUNTZE, Rev. Gen. Pl. 196. 1891.
Coll.: Lyon 198, 246, Crooked Creek. July.

Meibomia dillenii (DARL.) KUNTZE, Rev. Gen. Pl. 195. 1891.
Coll.: Wheeler 482, Jefferson. Aug.
No previously collected Minnesota specimens in the Herbarium of the University.

Meibomia illinoensis (A. GRAY) KUNTZE, Rev. Gen. Pl. 198. 1891.
Coll.: Wheeler 390, 446, Jefferson; 609, Brownsville. July, Aug.
Not previously reported from Minnesota. Frequent and in some places common in dry fields and hillsides.

Meibomia canadensis (L.) KUNTZE, Rev. Gen. Pl. 195. 1891.
Coll.: Wheeler 331, Crooked Creek. July.

Lespedeza capitata MICHX. Fl. Bor. Am. **2**: 71. 1803.
Coll.: Wheeler 525, Jefferson. Aug.

Lathyrus venosus MUHL.; Willd. Sp. Pl. **3**: 1092. 1803.
Coll.: Lyon 48, Winnebago. June.

Lathyrus ochroleucus HOOK. Fl. Bor. Am. **1**: 159. 1833.
Coll.: Lyon 87, Winnebago. June.

Falcata comosa (L.) KUNTZE, Rev. Gen. Pl. 182. 1891.
Coll.: Wheeler 507, Lyon 332, Winnebago; Lyon 469, Jefferson. Aug.

Falcata pitcheri (T. & G.) KUNTZE, Rev. Gen. Pl. 182. 1891.
Coll.: Wheeler 573, Jefferson. Aug.

Not previously reported from Minnesota. Several specimens of this species, previously reported as *F. comosa*, have been collected in southern Minnesota. Probably common throughout the southern part of the state.

Apios apios (L.) MACM. Bull. Torr. Club, **19**: 15. 1892.
Coll.: Wheeler, 337, Crooked Creek; Wheeler 399, Lyon 388, Jefferson. July, Aug.

Strophostyles helvola (L.) BRITTON in Britt. & Brown, Ill. Fl. 2: 338. *f. 2235*. 1897.
Coll.: Lyon 387, Jefferson. Aug.

GERANIACEÆ.

Geranium maculatum L. Sp. Pl. 681. 1753.
Coll.: Lyon 4, Winnebago. June.

OXALIDACEÆ.

Oxalis violacea L. Sp. Pl. 434. 1753.
Coll.: Lyon 50, Winnebago. June.

Oxalis stricta L. Sp. Pl. 435. 1753.
Coll.: Lyon 81, Winnebago. June.

LINACEÆ.

Linum sulcatum RIDDEL, Suppl. Cat. Ohio Pl. 10. 1836.
Coll.: Wheeler 290, Mayville; 431, Jefferson. July.

RUTACEÆ.

Xanthoxylum americanum MILL. Gard. Dict. Ed. 8, No. 2. 1768.
Coll.: Wheeler 132, 413, Winnebago. June, Aug.

POLYGALACEÆ.

Polygala verticillata L. Sp. Pl. 706. 1753.
Coll.: Wheeler 342, Crooked Creek; 428, Jefferson. July.

Polygala viridescens L. Sp. Pl. 705. 1753.
Coll.: Lyon 483, Jefferson. Aug.

Polygala senega L. Sp. Pl. 704. 1753.
Coll.: Lyon 21, Winnebago. June.

EUPHORBIACEÆ.

Acalypha virginica L. Sp. Pl. 1003. 1753.
Coll.: Lyon 349, 397, 463, Jefferson. Aug.

Euphorbia glyptosperma Engelm. Bot. Mex. Bound. Surv. 187. 1859.
Coll.: Wheeler 434, Jefferson. July.

Euphorbia maculata L. Sp. Pl. 455. 1753.
Coll.: Wheeler 430, Jefferson. July.

Euphorbia nutans Lag. Gen. & St. 17. 1816.
Coll.: Wheeler 336, Crooked Creek. July.

Euphorbia corollata L. Sp. Pl. 459. 1753.
Coll.: Lyon 189, Wheeler 375, Crooked Creek. July.

Euphorbia heterophylla L. Sp. Pl. 453. 1753.
Coll.: Wheeler 466, Jefferson. Aug.

Euphorbia cyparissias L. Sp. Pl. 461. 1753.
Coll.: Lyon 437, Jefferson. Aug.

ANACARDIACEÆ.

Rhus hirta (L.) Sudw. Bull. Torr. Club, **19**: 82. 1892.
Coll.: Lyon 319, Jefferson. Aug.

Rhus glabra L. Sp. Pl. 265. 1753.
Coll.: Lyon 272, Jefferson. July.

Rhus radicans L. Sp. Pl. 266. 1753.
Coll.: Lyon 327, 350, Jefferson. Aug.

CELASTRACEÆ.

Euonymus atropurpureus Jacq. Hort. Vind. **2**: 5. *pl. 120.* 1772.
Coll.: Lyon 140, Winnebago; 263, Jefferson. June, July.

Celastrus scandens L. Sp. Pl. 196. 1753.
Coll.: Wheeler 104, Winnebago; Lyon 380, Jefferson. June, Aug.

STAPHYLEACEÆ.

Staphylea trifolia L. Sp. Pl. 270. 1753.
Coll.: Wheeler 202, Winnebago. June.

ACERACEÆ.

Acer saccharinum L. Sp. Pl. 1055. 1753.
Coll.: Lyon 149, Winnebago; 274, Jefferson. June, July.

Acer nigrum Michx. f. Hist. Arb. Am. **2**: 238. *pl. 16.* 1810.
Coll.: Wheeler 149, Winnebago. June.

Acer spicatum Lam. Encycl. **2**: 381. 1786.
Coll.: Wheeler 163, 198, Winnebago; 319, Mayville; 625, Brownsville. June, Aug.
Frequent on moist shaded cliffs throughout.

Acer negundo L. Sp. Pl. 1056. 1753.
Coll.: Lyon 119, Winnebago. June.

BALSAMINACEÆ.

Impatiens aurea Muhl. Cat. 26. 1813.
Coll.: Wheeler 328, Mayville. July.

RHAMNACEÆ.

Ceanothus americanus L. Sp. Pl. 195. 1753.
Coll.: Lyon 66, Winnebago; Wheeler 356, Crooked Creek. June, July.

Ceanothus ovatus Desf. Hist. Arb. **2**: 381. 1809.
Coll.: Wheeler 92, Lyon 66½, Winnebago. June.

VITACEÆ.

Vitis vulpina L. Sp. Pl. 203. 1753.
Coll.: Wheeler 139, Winnebago; 344, Crooked Creek. June, July.

Parthenocissus quinquefolia (L.) Planch. in DC. Mon. Phan. **5**: Part 2, 448. 1887.
Coll.: Wheeler 235, Winnebago; Lyon 379, Jefferson. June, Aug.

TILIACEÆ.

Tilia americana L. Sp. Pl. 514. 1753.
Coll.: Lyon 211, Mayville. July.

MALVACEÆ.

Malva rotundifolia L. Sp. Pl. 688. 1753.
Coll.: Lyon 491, Jefferson. Aug.

Napæa dioica L. Sp. Pl. 686. 1753.
Coll.: Lyon 266, Jefferson. July.
Previously collected at Vasa and Lanesboro. Rare on lowland near Winnebago creek.

Abutilon abutilon (L.) RUSBY, Mem. Torr. Club, **5**: 222. 1894.
Coll.: Lyon 283, Jefferson. July.

HYPERICACEÆ.

Hypericum ascyron L. Sp. Pl. 783. 1753.
Coll.: Lyon 235, Crooked Creek; 436, Winnebago. June, Aug.

Hypericum maculatum WALT. Fl. Car. 189. 1788.
Coll.: Wheeler 442, 483, Jefferson; 615, Brownsville; Lyon 452, Jefferson. Aug.

Hypericum majus (A. GRAY) BRITTON, Mem. Torr. Club, **5**: 225. 1894.
Coll.: Wheeler 427, Jefferson; 601, Crooked Creek. July, Aug.

CISTACEÆ.

Helianthemum majus (L.) B.S.P. Prel. Cat. N. Y. 6. 1888.
Coll.: Lyon 167, Crooked Creek; Wheeler 477, Jefferson; 633, Brownsville. Aug.

Helianthemum canadense (L.) MICHX. Fl. Bor. Am. **1**: 308. 1803.
Coll.: Wheeler 631, Brownsville. Aug.

Lechea stricta LEGGETT; BRITTON, Bull. Torr. Club, **21**: 251. 1894.
Coll.: Wheeler 359, Crooked Creek; Lyon 331, Winnebago. July, Aug.

VIOLACEÆ.

Viola pedatifida DON, Gard. Dict. **1**: 320. 1831.
Coll.: Wheeler 429, Jefferson. July.

Viola obliqua HILL, Hort. Kew. 316. *pl. 12.* 1769.
Coll.: Wheeler 114, Winnebago. June.

Viola pedata L. Sp. Pl. 933. 1753.
Coll.: Wheeler 216, Jefferson. June.

Viola pubescens AIT. Hort. Kew. 3: 290. 1789.
Coll.: Wheeler 205, Winnebago. June.

THYMELEACEÆ.

Dirca palustris L. Sp. Pl. 358. 1753.
Coll.: Wheeler 520, Winnebago. Aug.
Rare in moist thickets near Winnebago creek.

LYTHRACEÆ.

Lythrum alatum PURSH, Fl. Am. Sept. 334. 1814.
Coll.: Lyon 281, Wheeler 416, Jefferson. July.

ONAGRACEÆ.

Epilobium coloratum MUHL.; Willd. Enum. **1**: 411. 1809.
Coll.: Wheeler 479, Jefferson; 608, Brownsville. Aug.

Epilobium adenocaulon HAUSSK. Oest. Bot. Zeit. **29**: 119. 1879.
Coll.: Wheeler 323, Mayville; 595, Crooked Creek; Lyon 457, Jefferson. July, Aug.

Onagra biennis (L.) SCOP. Fl. Carn. Ed. 2, **1**: 269. 1772.
Coll.: Lyon 166½, Winnebago; 286, Jefferson. June, July.

Œnothera rhombipetala NUTT.; T. & G. Fl. N. A. **1**: 493. 1840.
Coll.: Lyon 323, Jefferson. Aug.

Gaura biennis L. Sp. Pl. 347. 1753.
Coll.: Wheeler 574, Jefferson. Aug.
No previous authentic collection from Minnesota. There are no Minnesota specimens in the Herbarium of the University. Miss Manning's collection of 1883 from Pepin, Wis., is probably the one upon which is based the report of this species by Upham and others.

Circæa lutetiana L. Sp. Pl. 9. 1753.
Coll.: Wheeler 270, Crooked Creek. June.

Circæa alpina L. Sp. Pl. 9. 1753.
Coll.: Lyon 152, Winnebago. June.

ARALIACEÆ.

Aralia racemosa L. Sp. Pl. 273. 1753.
Coll.: Lyon 345, Jefferson. Aug.

Aralia nudicaulis L. Sp. Pl. 274. 1753.
Coll.: Lyon 15, Winnebago. June.

Panax quinquefolium L. Sp. Pl. 1058. 1753.
Coll.: Lyon 210, Mayville; Wheeler 469, Jefferson. July, Aug.

UMBELLIFERÆ.

Angelica atropurpurea L. Sp. Pl. 251. 1753.
Coll.: Wheeler 311, Crooked Creek. July.

Heracleum lanatum Michx. Fl. Bor. Am. **1**: 166. 1803.
Coll.: Lyon 93, Winnebago. June.

Sanicula marylandica L. Sp. Pl. 235. 1753.
Coll.: Wheeler 175, Winnebago. June.

Sanicula gregaria Bicknell, Bull. Torr. Club, **22**: 354. 1895.
Coll.: Wheeler 177, Winnebago. June.

The only precious collection from Minnesota is that of Sheldon, Milaca, 1892.

Sanicula canadensis L. Sp. Pl. 235. 1753.
Coll.: Lyon 260, Jefferson. July.

Sanicula trifoliata Bicknell, Bull. Torr. Club, **22**: 359. 1895.
Coll.: Lyon 214, Mayville. July.

Not previously reported from Minnesota.

Pimpinella integerrima (L.) A. Gray, Proc. Am. Acad. **7**: 345. 1868.
Coll.: Wheeler 179, Winnebago. June.

Washingtonia claytoni (Michx.) Britton in Brit. & Brown, Ill. Fl. **2**: 530. *f. 2680.* 1897.
Coll.: Lyon 7, Winnebago. June.

Sium cicutæfolium Gmel. Syst. **2**: 482. 1791.
Coll.: Wheeler 545, Lyon 449, Jefferson. Aug.

Zizia aurea (L.) Koch, Nov. Act. Caes. Leop. **12**: 129. 1825.
Coll.: Wheeler 174, Winnebago; Lyon 261, Jefferson. June, July.

Zizia cordata DC. Prodr. **4**: 100. 1830.
Coll.: Lyon 292, 352, Jefferson. July.

Cicuta maculata L. Sp. Pl. 256. 1753.
Coll.: Wheeler 338, Crooked Creek. July.

Cicuta bulbifera L. Sp. Pl. 255. 1753.
Coll.: Wheeler 607, Brownsville. Aug.

Deringa canadensis (L.) KUNTZE, Rev. Gen. Pl. 266. 1891.
Coll.: Wheeler 193, Winnebago. June.

Berula erecta (HUDS.) COVILLE, Contr. Nat. Herb. **4**: 115. 1893.
Coll.: Wheeler 588, Crooked Creek. Aug.
In cold springs at the head of Clear creek.

Hydrocotyle americana L. Sp. Pl. 234. 1753.
Coll.: Wheeler 314, Mayville. July.
The only previously reported locality of collection is St. Croix Falls. Rare in moist woods near Crooked creek.

CORNACEÆ.

Cornus circinata L'HER. Cornus, 7. *pl. 3*. 1788.
Coll.: Wheeler 81, Winnebago. June.

Cornus amonum MILL. Gard. Dict. Ed. 8, No. 5. 1768.
Coll.: Lyon 351, Jefferson. Aug.

Cornus stolonifera MICHX. Fl. Bor. Am. **1**: 92. 1803.
Coll.: Wheeler 69, 173, Winnebago. June.

Cornus candidissima MARSH, Arb. Am. 35. 1785.
Coll.: Wheeler 172, Winnebago. June.

PYROLACEÆ.

Pyrola elliptica NUTT. Gen. **1**: 273. 1818.
Coll.: Wheeler 191, Winnebago; 276, Crooked Creek. June, July.

ERICACEÆ.

Arctostaphylos uva-ursi (L.) SPRENG. Syst. **2**: 287. 1825.
Coll.: Lyon 116, Jefferson. June.
On a sandy point of a bluff in section 19 of Jefferson.

PRIMULACEÆ.

Lysimachia terrestris (L.) B.S.P. Prel. Cat. N. Y. 34. 1888.
Coll.: Lyon 249, Crooked Creek. July.

Steironema ciliatum (L.) RAF. Ann. Gen. Phys. **7**: 192. 1820.
Coll.: Lyon 251, Crooked Creek. July.

Dodecatheon meadia L. Sp. Pl. 144. 1753.
Coll.: Wheeler 340, Crooked Creek. July.

Previously collected only in Winona and Wabasha counties. Rare in moist woods.

OLEACEÆ.

Fraxinus lanceolata Borck. Handb. Forst. Bot. 1 : 826. 1800.
Coll.: Lyon 300, Jefferson. Aug.

Fraxinus nigra Marsh. Arb. Am. 51. 1785.
Coll.: Lyon 173, Crooked Creek. June. (Plate XXIII., B.)

GENTIANACEÆ.

Gentiana crinita Froel. Gen. 112. 1796.
Coll.: Lyon 454, 488, Jefferson. Aug.

Gentiana quinquefolia L. Sp. Pl. 230. 1753.
Coll.: Lyon 455, 487, Jefferson. Aug.

Gentiana flavida A. Gray, Journ. Sci. (II.) 1 : 180. 1846.
Coll.: Wheeler 516, Winnebago; 596, Crooked Creek. Aug.

APOCYNACEÆ.

Apocynum androsæmifolium L. Sp. Pl. 213. 1753.
Coll.: Lyon 188, Crooked Creek. July.

Apocynum cannabinum L. Sp. Pl. 213. 1753.
Coll.: Lyon 471, Jefferson. Aug.

Apocynum cannabinum glaberrimum DC. Prodr. 8 : 439. 1844.
Coll.: Lyon 357, Jefferson. Aug.

ASCLEPIADACEÆ.

Asclepias tuberosa L. Sp. Pl. 217. 1753.
Coll.: Wheeler 287, 369, Crooked Creek; Lyon 356, Jefferson. July, Aug.

Asclepias incarnata L. Sp. Pl. 215. 1753.
Coll.: Lyon 177, Winnebago; 365, Jefferson. June, Aug.

Asclepias obtusifolia Michx. Fl. Bor. Am. 1 : 115. 1803.
Coll.: Wheeler 569, Jefferson. Aug.

Previously reported only by Lapham. Infrequent on dry hillsides.

Asclepias exaltata (L.) Muhl. Cat. 28. 1813.
Coll.: Lyon 178, Winnebago. July.

Asclepias syriaca L. Sp. Pl. 214. 1753.
Coll.: Lyon 176, Winnebago. July.

Asclepias verticillata L. Sp. Pl. 217. 1753.
Coll.: Wheeler 286, Crooked Creek; 378, Jefferson. July.

Acerates viridiflora (RAF.) EATON, Man. Ed. 5, 90. 1829.
Coll.: Lyon 179, Winnebago; 309½, Jefferson. July, Aug.

CONVOLVULACEÆ.

Convolvulus sepium L. Sp. Pl. 153. 1753.
Coll.: Wheeler 306, Crooked Creek. July.

Convolvulus spithamæus L. Sp. Pl. 158. 1753.
Coll.: Wheeler 207, Winnebago; 358, 371, Crooked Creek; 385, Jefferson. June, July.

CUSCUTACEÆ.

Cuscuta indecora CHOISY, Mem. Soc. Gen. **9**: 278. *pl. 3. f. 5.* 1841.
Coll.: Wheeler 436, 557, 647, Jefferson. July, Aug.

Cuscuta coryli ENGELM. Am. Journ. Sci. **43**: 337. *f. 7–11.* 1842.
Coll.: Wheeler 503, Winnebago. Aug.

Cuscuta gronovii WILLD.; R. & S. Syst. 6: 205. 1820.
Coll.: Wheeler 308, 592, Crooked Creek; 438, 440, Jefferson. July, Aug.

Cuscuta paradoxa RAF. Ann. Nat. 13. 1820.
Coll.: Wheeler 437, 648, Jefferson. July, Aug.

POLEMONIACEÆ.

Phlox pilosa L. Sp. Pl. 152. 1753.
Coll.: Herb. Wheeler 14, Winnebago. June.

Phlox divaricata L. Sp. Pl. 152. 1753.
Coll.: Lyon 5, Winnebago. June.

Polemonium reptans L. Syst. Ed. 10, No. 1. 1759.
Coll.: Wheeler 33, Winnebago. June.

HYDROPHYLLACEÆ.

Hydrophyllum virginicum L. Sp. Pl. 146. 1753.
Coll.: Lyon 11, Winnebago. June.

Hydrophyllum appendiculatum MICHX. Fl. Bor. Am. **1**: 134. 1803.
Coll.: Wheeler 324, Mayville. July.

Macrocalyx nyctelea (L.) KUNTZE, Rev. Gen. Pl. 434. 1891.
Coll.: Lyon 19, Winnebago. June.

BORAGINACEÆ.

Lappula lappula (L.) KARST. Deutsch. Fl. 979. 1880–83.
Coll.: Lyon 186, Crooked Creek. July.

Lappula virginianum (L.) GREENE, Pittonia, **2**: 182. 1891.
Coll.: Lyon 237, Mayville. July.

Lithospermum gmelini (MICHX.) A. S. HITCHCOCK, Spring Fl. Manh. 30. 1894.
Coll.: Lyon 281½, Jefferson. July.

Lithospermum canescens (MICHX.) LEHM. Asperif. 305. 1818.
Coll.: Lyon 27, Winnebago. June.

Lithospermum angustifolium MICHX. Fl. Bor. Am. **1**: 130. 1803.
Coll.: Wheeler 450, Jefferson. Aug.

Onosmodium caroliniana (LAM.) DC. Prodr. **10**: 70. 1846.
Coll.: Wheeler 352, Crooked Creek. July.

Lycopsis arvensis L. Sp. Pl. 139. 1753.
Coll.: Lyon 110, Winnebago. June.
Not previously reported from Minnesota.

VERBENACEÆ.

Verbena urticifolia L. Sp. Pl. 20. 1753.
Coll.: Wheeler 406, 548, Jefferson. July, Aug.

Verbena hastata L. Sp. Pl. 20. 1753.
Coll.: Wheeler 403, Jefferson. July.

Verbena stricta VENT. Desc. Pl. Jard. Cels. *pl. 53*. 1800.
Coll.: Wheeler 401, Jefferson. July.

Verbena bracteosa MICHX. Fl. Bor. Am. **2**: 13. 1803.
Coll.: Wheeler 635, Brownsville. Aug.

Lippia lanceolata MICHX. Fl. Bor. Am. **2**: 15. 1803.
Coll.: Lyon 279, Jefferson; Wheeler 622, Brownsville. July, Aug.
Common on the very low lands of the Mississippi river.

LABIATÆ.

Teucrium canadense L. Sp. Pl. 564. 1753.
Coll.: Wheeler 414, Jefferson. July.

Scutellaria lateriflora L. Sp. Pl. 598. 1753.
Coll.: Wheeler 455, Jefferson; 517, Winnebago. Aug.

Scutellaria cordifolia MUHL. Cat. 56. 1813.
Coll.: Wheeler 468, Jefferson. Aug.

Scutellaria parvula MICHX. Fl. Bor. Am. 2: 11. 1803.
Coll.: Lyon 39, Winnebago. June.

Agastache scrophulariæfolia (WILLD.) KUNTZE, Rev. Gen. Pl. 511. 1891.
Coll.: Wheeler, 465, Jefferson; Lyon 315, Winnebago. Aug.

Nepeta cataria L. Sp. Pl. 570. 1753.
Coll.: Lyon 288, 492, Jefferson. July.

Glecoma hederacea L. Sp. Pl. 578. 1753.
Coll.: Lyon 229, Crooked Creek. July.

Prunella vulgaris L. Sp. Pl. 600. 1753.
Coll.: Wheeler 407, Jefferson. July.

Physostegia virginiana (L.) BENTH. Lab. Gen. and Sp. 504. 1834.
Coll.: Lyon 295, Jefferson. July.

Leonurus cardiaca L. Sp. Pl. 584. 1753.
Coll.: Wheeler 256, Lyon 418, Winnebago; Wheeler 295, Mayville. June, July, Aug.

Stachys palustris L. Sp. Pl. 580. 1753.
Coll.: Wheeler 300, Crooked Creek. July.

Monarda fistulosa L. Sp. Pl. 22. 1753.
Coll.: Lyon 185, Crooked Creek. July.

Blephila hirsuta (PURSH) TORR. Fl. U. S. 27. 1824.
Coll.: Lyon 225, Mayville; Wheeler 498, Winnebago. July, Aug.

Hedeoma pulegioides (L.) PERS. Syn. 2: 131. 1807.
Coll.: Wheeler 610, Brownsville. Aug.

Previously reported from the Mississippi river by Garrison and Miss Manning, but there are no Minnesota specimens in the Herbarium of the University.

Hedeoma hispida PURSH, Fl. Am. Sept. 414. 1814.
Coll.: Lyon 51, Winnebago. June.

Clinopodium vulgare L. Sp. Pl. 587. 1753.
Coll.: Lyon 411, Winnebago. Aug.

Kœllia virginiana (L.) MacM. Met. Minn. 452. 1892.
Coll.: Wheeler 363, Crooked Creek; 405, Jefferson. July.

Lycopus virginicus L. Sp. Pl. 21. 1753.
Coll.: Wheeler 537, Jefferson. Aug.

Lycopus rubellus Moench, Meth. Suppl. 146. 1802.
Coll.: Lyon 314, 417, Winnebago. Aug.

Lycopus americanus Muhl.; Bart. Fl. Phil. Prodr. 15. 1815.
Coll.: Lyon 335, 348, Jefferson. Aug.

Lycopus lucidus Turcz.; Benth. in DC. Prodr. **12**: 178. 1848.
Coll.: Lyon 459, Jefferson. Aug.

Mentha canadensis L. Sp. Pl. 577. 1753.
Coll.: Lyon 199, Crooked Creek. July.

SOLANACEÆ.

Physalis philadelphica Lam. Encycl. **2**: 101. 1786.
Coll.: Lyon 359, Jefferson. Aug.

Mr. Rydberg says: "This is a very peculiar form that I have never seen before. It may be a new species but in order to make a good description fruit is required. At present it should be referred to *P. philadelphica* with which it agrees except in the very large and broad leaves. In that respect it resembles *P. macrophysa* Rydb. but the latter is a perennial not an annual as this plant."

Physalis virginiana Mill. Gard. Dict. Ed. 8, No. 4. 1768.
Coll.: Lyon 63, Winnebago. June.

Physalis heterophylla Nees, Linnæa, **6**: 463. 1831.
Coll.: Lyon 150, Winnebago. June.

Solanum nigrum L. Sp. Pl. 186. 1753.
Coll.: Lyon 192, Crooked Creek. July.

Datura tatula L. Sp. Pl. Ed. 2, 256. 1762.
Coll.: Wheeler 379, Jefferson. July.

SCROPHULARIACEÆ.

Verbascum thapsus L. Sp. Pl. 177. 1753.
Coll.: Wheeler 474, Jefferson. Aug.

Scrophularia marylandica L. Sp. Pl. 619. 1753.
Coll.: Lyon 190, Winnebago; 353, Jefferson. June, Aug.

Chelone glabra L. Sp. Pl. 611. 1753.
Coll.: Wheeler 586, Crooked Creek. Aug.

Mimulus ringens L. Sp. Pl. 634. 1753.
Coll.: Wheeler 383, 546, Jefferson. July, Aug.

Mimulus jamesii T. & G.; BENTH. in DC. Prodr. **10**: 371. 1846.
Coll.: Lyon 68, Winnebago; Wheeler 589, Crooked Creek. June, Aug.

Ilysanthes gratioloides (L.) BENTH. in DC. Prodr. **10**: 419. 1846.
Coll.: Lyon 361, 382, Jefferson; Wheeler 578½, Crooked Creek. Aug.

Veronica americana SCHWEIN.; BENTH. in DC. Prodr. **10**: 468. 1846.
Coll.: Wheeler 147, Winnebago. June.

Veronica peregrina L. Sp. Pl. 14. 1753.
Coll.: Lyon 83, Winnebago; Wheeler 415, Jefferson. June, July.

Leptandra virginica (L.) NUTT. Gen. **1**: 7. 1818.
Coll.: Lyon 234, 250, Crooked Creek. July.

Dasystoma grandiflora (BENTH.) WOOD. Bot. & Flor. 231. 1873.
Coll.: Wheeler 512, Winnebago. Aug.
This is the first authentic specimen of this seen from Minnesota.

Gerardia aspera DOUGL.: BENTH. in DC. Prodr. **10**: 517. 1846.
Coll.: Lyon 407, Jefferson. Aug.

Gerardia tenuifolia VAHL, Symb. Bot. **3**: 79. 1794.
Coll.: Lyon 406, 456, Wheeler 575, Jefferson; Wheeler 602, Crooked Creek. Aug.

Castilleja coccinea (L.) SPRENG. Syst. **2**: 775. 1825.
Coll.: Wheeler 85, Winnebago. June.

Castilleja sessiliflora PURSH, Fl. Am. Sept. 738. 1814.
Coll.: Lyon 69, Winnebago. June.

Pedicularis lanceolata MICHX. Fl. Bor. Am. **2**: 18. 1803.
Coll.: Wheeler 515, Winnebago; 600, Crooked Creek. Aug.

Pedicularis canadensis L. Mant. 86. 1767.
Coll.: Lyon 35, Winnebago. June.

LENTIBULARIACEÆ.

Utricularia vulgaris L. Sp. Pl. 18. 1753.
Coll.; Lyon 267, Wheeler 459, Jefferson. July, Aug.

OROBANCHACEÆ.

Thalesia uniflora (L.) BRITTON, Mem. Torr. Club, 5: 298. 1894.

Coll.: Lyon 70, Winnebago. June.

PHRYMACEÆ.

Phryma leptostachya L. Sp. Pl. 601. 1753.

Coll.: Wheeler 298, Crooked Creek. July.

PLANTAGINACEÆ.

Plantago major L. Sp. Pl. 112. 1753.

Coll.: Lyon 124, Winnebago. June.

RUBIACEÆ.

Cephalanthus occidentalis L. Sp. Pl. 95. 1753.

Coll.: Wheeler 365, Crooked Creek; 435, Jefferson; 624, Brownsville. July, Aug.

Common on the lowlands of the Mississippi river.

Galium aparine L. Sp. Pl. 108. 1753.

Coll.: Wheeler 9, Winnebago. June.

Galium boreale L. Sp. Pl. 108. 1753.

Coll.: Lyon 53, Winnebago; 199½, Crooked Creek. June, July.

Galium triflorum MICHX. Fl. Bor. Am. 1: 80. 1803.

Coll.: Wheeler 41, Winnebago. June.

Galium trifidum L. Sp. Pl. 105. 1753.

Coll.: Wheeler 42, Winnebago. June.

Galium asprellum MICHX. Fl. Bor. Am. 1: 78. 1803.

Coll.: Wheeler 593, Crooked Creek. Aug.

CAPRIFOLIACEÆ.

Sambucus canadensis L. Sp. Pl. 269. 1753.

Coll.: Wheeler 412, 649, Jefferson. July, Aug.

Sambucus pubens MICHX. Fl. Bor. Am. 1: 181. 1803.

Coll.: Wheeler 133, Winnebago. June.

Viburnum opulus L. Sp. Pl. 268. 1753.

Coll.: Lyon 129, Winnebago; Wheeler 591, Crooked Creek. June, Aug.

Viburnum dentatum L. Sp. Pl. 268. 1753.

Coll.: Wheeler 201, Winnebago. June.

Viburnum lentago L. Sp. Pl. 268. 1753.
Coll.: Wheeler 39, Winnebago. June.

Triosteum perfoliatum L. Sp. Pl. 176. 1753.
Coll.: Wheeler 2, Winnebago. June.

Lonicera dioica L. Syst. Ed. 12, 165. 1767.
Coll.: Wheeler 190, Winnebago. June.

Lonicera sullivantii A. Gray, Proc. Amer. Acad. **19**: 76. 1883.
Coll.: Wheeler 122, Winnebago. June.

Diervilla diervilla (L.) MacM., Bull. Torr. Club, **19**: 15. 1892.
Coll.: Lyon 46, Winnebago. June.

ADOXACEÆ.

Adoxa moschatellina L. Sp. Pl. 367. 1753.
Coll.: Wheeler 196, Winnebago. June.
Frequent in moist woods.

VALERIANACEÆ.

Valeriana edulis Nutt. in T. & G. Fl. N. A. **2**: 48. 1841.
Coll.: Wheeler 159, Winnebago. June.

CAMPANULACEÆ.

Campanula rotundifolia L. Sp. Pl. 163. 1753.
Coll.: Lyon 36, Winnebago. June.

Campanula aparinoides Pursh, Fl. Am. Sept. 159. 1814.
Coll.: Lyon 194½, Crooked Creek. July.

Campanula americana L. Sp. Pl. 164. 1753.
Coll.: Wheeler 339, Crooked Creek. July.

Legouzia perfoliata (L.) Britton, Mem. Torr. Club, **5**: 309. 1894.
Coll.: Lyon 148, Winnebago. June.

Lobelia cardinalis L. Sp. Pl. 930. 1753.
Coll.: Wheeler 464, Jefferson; 578, Crooked Creek. Aug.

Lobelia syphilitica L. Sp. Pl. 931. 1753.
Coll.: Lyon 310, 340, Jefferson. Aug.

Lobelia spicata Lam. Encycl. **3**: 587. 1789.
Coll.: Lyon 115, Jefferson. June.

Lobelia inflata L. Sp. Pl. 931. 1753.
Coll.: Wheeler 480, 554, Jefferson; 612, Brownsville. Aug.

CICHORIACEÆ.

Cichorium intybus L. Sp. Pl. 813. 1753.
Coll.: Wheeler 594, Lyon 468, Crooked Creek. Aug.

Adopogon virginicum (L.) KUNTZE, Rev. Gen. Pl. 304. 1891.
Coll.: Lyon 20, 337, Wheeler 506, Winnebago. June, Aug.

Taraxacum taraxacum (L.) KARST. Deutsch. Fl. 1138. 1880–83.
Coll.: Lyon 121, Winnebago. June.

Sonchus asper (L.) ALL. Fl. Ped. **1**: 222. 1785.
Coll.: Lyon 264, Jefferson. July.

Lactuca scariola L. Sp. Pl. Ed. 2, 1119. 1763.
Coll.: Lyon 374, Jefferson. Aug.

Lactuca ludoviciana (NUTT.) DC. Prodr. **7**: 141. 1838.
Coll.: Lyon 285, 445, 447, Jefferson. July.
Previously reported only by Sheldon from Sleepy Eye.

Lactuca sagittifolia ELL. Bot. S. C. & Ga. **2**: 253. 1821–24.
Coll.: Lyon 363, Jefferson. Aug.
Previously reported only by Sheldon from Lake Benton.

Lactuca floridana (L.) GAERTN. Fruct. & Sem. **2**: 362. 1791.
Coll.: Lyon 334, 410, 423, Winnebago. Aug.

Hieracium umbellatum L. Sp. Pl. 804. 1753.
Coll.: Wheeler 627, Brownsville. Aug.
No authentic specimens previously reported from Minnesota.

Hieracium canadense MICHX. Fl. Bor. Am. **2**: 86. 1803.
Coll.: Wheeler 443, Jefferson; Lyon 311, 341, Wheeler 510, Winnebago. Aug.

Hieracium scabrum MICHX. Fl. Bor. Am. **2**: 86. 1803.
Coll.: Wheeler 485, Lyon 336, 405, 462, Jefferson; Wheeler 513, Winnebago; Wheeler 636, Brownsville.

Nabalus albus (L.) HOOK. Fl. Bor. Am. **1**: 294. 1833.
Coll.: Wheeler 521, Winnebago. Aug.

AMBROSIACEÆ.

Ambrosia trifida L. Sp. Pl. 987. 1753.
Coll.: Wheeler 417, Jefferson. July.

Ambrosia artemisiæfolia L. Sp. Pl. 987. 1753.
Coll.: Lyon 495, Jefferson. Aug.

Xanthium canadense MILL. Gard. Dict. Ed. 8, No. 2. 1768.
Coll.: Lyon 424, Winnebago. Aug.

COMPOSITÆ.

Vernonia fasciculata Michx. Fl. Bor. Am. 2: 94. 1803.
Coll.: Wheeler, 408, Jefferson. July.

Eupatorium purpureum L. Sp. Pl. 838. 1753.
Coll.: Lyon 347, Wheeler 563, Jefferson; Wheeler 519, Winnebago. Aug.

Eupatorium altissimum L. Sp. Pl. 837. 1753.
Coll.: Wheeler 533, 568, Jefferson; Lyon 412, Winnebago. Aug.

Eupatorium perfoliatum L. Sp. Pl. 838. 1753.
Coll.: Wheeler 493, Jefferson. Aug.

Eupatorium ageratoides L. f. Suppl. 355. 1781.
Coll.: Lyon 293, Jefferson. July.

Kuhnia eupatorioides L. Sp. Pl. Ed. 2, 1662. 1763.
Coll.: Wheeler 532, 555, 571, Lyon 370, 381, 489, Jefferson. Aug.

Lacinaria cylindracea (Michx.) Kuntze, Rev. Gen. Pl. 349. 1891.
Coll.: Lyon 181, Crooked Creek; 290, Jefferson. July.

Lacinaria pycnostachya (Michx.) Kuntze, Rev. Gen. Pl. 349 1891.
Coll.: Lyon 265, Jefferson. July.

Lacinaria scariosa (L.) Hill, Veg. Syst. 4: 49. 1762.
Coll.: Lyon 313, Winnebago. Aug.

Solidago flexicaulis L. Sp. Pl. 879. 1753.
Coll.: Lyon 371½, 484, Jefferson; Wheeler 590, Crooked Creek. Aug.

Solidago hispida Muhl.; Willd. Sp. Pl. 3: 2063. 1804.
Coll.: Lyon 294, Jefferson. July.

Solidago erecta Pursh, Fl. Am. Sept. 542. 1814.
Coll.: Lyon 371, Jefferson. Aug.
Reported from Stearns County but no Minnesota specimens previously seen.

Solidago speciosa Nutt. Gen. 2: 160. 1818.
Coll.: Lyon 467, Jefferson. Aug.

Solidago ulmifolia Muhl.; Willd. Sp. Pl. 3: 2060. 1804.
Coll.: Lyon 433, Winnebago. Aug.

Solidago serotina Ait. Hort. Kew. 3: 211. 1789.
Coll.: Lyon 360, Jefferson. Aug.

Solidago missouriensis NUTT. Journ. Acad. Phila. **7**: 32. 1834.
Coll.: Lyon 289, 373, Jefferson. July.

Solidago canadensis L. Sp. Pl. 878. 1753.
Coll.: Lyon 330, Winnebago. Aug.

Solidago nemoralis AIT. Hort. Kew. **3**: 213. 1789.
Coll.: Wheeler 611, Brownsville. Aug.

Solidago rigida L. Sp. Pl. 880. 1753.
Coll.: Lyon 372, 403, Jefferson. Aug.

Euthamia graminifolia (L.) NUTT. Gen. **2**: 162. 1818.
Coll.: Wheeler 565, Jefferson. Aug.

Boltonia asteroides (L.) L'HER. Sert. Angl. 27. 1788.
Coll.: Lyon 385, Wheeler 561, Jefferson. Aug.

Aster drummondii LINDL. in Hook. Comp. Bot. Mag. **1**: 97. 1835.
Coll.: Wheeler 551, Jefferson; Lyon 426, Winnebago. Aug.

Aster sagittifolius WILLD. Sp. Pl. **3**: 2035. 1804.
Coll.: Lyon 402, 451, Jefferson; Wheeler 583, 599, Crooked Creek. Aug.

Aster patens AIT. Hort. Kew. **3**: 201. 1789.
Coll.: Wheeler 584, Crooked Creek. Aug.

Aster novæ-angliæ L. Sp. Pl. 875. 1753.
Coll.: Lyon 425, Winnebago; 482, Jefferson. Aug.

Aster puniceus L. Sp. Pl. 875. 1753.
Coll.: Wheeler 585, Crooked Creek. Aug.

Aster prenanthoides MUHL.; Willd. Sp. Pl. **3**: 2046. 1804.
Coll.: Wheeler 518, Lyon 409, Winnebago; Wheeler 582. Crooked Creek. Aug.

Aster lævis L. Sp. Pl. 876. 1753.
Coll.: Wheeler 509, Lyon 435, Winnebago; Wheeler 616, 626, Brownsville. Aug.

Aster sericeus VENT. Hort. Cels. *pl. 33*. 1800.
Coll.: Wheeler 218, Jefferson. June.

Aster ptarmicoides (NEES) T. & G. Fl. N. A. **2**: 160. 1841.
Coll.: Lyon 441, Jefferson. Aug.

Aster salicifolius LAM. Encycl. **1**: 306. 1783.
Coll.: Wheeler 552, Lyon 400, Jefferson; Lyon 427, Winnebago. Aug.

Aster paniculatus Lam. Encycl. 1: 306. 1783.
Coll.: Wheeler 540, Jefferson; 623, Brownsville. Aug.

Erigeron pulchellus Michx. Fl. Bor. Am. 2: 124. 1803.
Coll.: Lyon 28, Winnebago. June.

Erigeron annuus (L.) Pers. Syn. 2: 431. 1807.
Coll.: Lyon 84, 420, 432, Winnebago; Wheeler 562, Jefferson. Aug.

Erigeron ramosus (Walt.) B.S.P. Prel. Cat. N. Y. 27. 1888.
Coll.: Wheeler 530, 572, Jefferson. Aug.

Leptilon canadense (L.) Britton, in Brit. & Brown, Ill. Fl. 3: 391. *f. 3827*. 1898.
Coll.: Lyon 303, Jefferson. Aug.

Doellingeria umbellata pubens (A. Gray) Britton, in Brit. & Brown, Ill. Fl. 3: 392. 1898.
Coll.: Lyon 399, Jefferson; Wheeler 581, Crooked Creek. Aug.

Antennaria plantaginifolia (L.) Richards. App. Frank. Journ. Ed. 2, 30. 1823.
Coll.: Lyon 23, Winnebago. June.

Gnaphalium obtusifolium L. Sp. Pl. 851. 1753.
Coll.: Lyon 338, 440, 465, Jefferson. Aug.

Polymnia canadensis L. Sp. Pl. 926. 1753.
Coll.: Wheeler 316, Mayville; Lyon 344, Jefferson. July, Aug.

Silphium perfoliatum L. Sp. Pl. Ed. 2, 1301. 1763.
Coll.: Lyon 215, 240, Crooked Creek. July.

Silphium laciniatum L. Sp. Pl. 919. 1753.
Coll.: Wheeler 297, Crooked Creek. July.

Heliopsis helianthoides (L.) B.S.P. Prel. Cat. N. Y. 28. 1888.
Coll.: Wheeler 614, Brownsville. Aug.

Heliopsis scabra Dunal, Mem. Mus. Paris, 5: 56. *pl. 4*. 1819.
Coll.: Wheeler 330, Crooked Creek. July.

Rudbeckia triloba L. Sp. Pl. 907. 1753.
Coll.: Wheeler 502, Winnebago; 535, Jefferson. Aug.
Not previously reported from Minnesota. Infrequent, edges of thickets.

Rudbeckia hirta L. Sp. Pl. 907. 1753.
Coll.: Wheeler 301, 329, Crooked Creek; 613, Brownsville. July, Aug.

Rudbeckia laciniata L. Sp. Pl. 906. 1753.
Coll.: Lyon 232, Crooked Creek; Wheeler 542, Jefferson. July, Aug.

Ratibida pinnata (Vent.) Barnhart, Bull. Torr. Club, **24**: 410. 1897.
Coll.: Wheeler 374, Crooked Creek. July.

Ratibida columnaris (Sims) D. Don; Sweet, Brit. Fl. Gard. **2**: 361. 1838.
Coll.: Wheeler 536, Jefferson. Aug.
Not previously reported from eastern Minnesota. Rare, dry banks.

Helianthus atrorubens L. Sp. Pl. 906. 1753.
Coll.: Wheeler 634, Brownsville. Aug.
Not previously reported from Minnesota. The only previous collection known is that of Sandberg, Hennepin Co., Aug., 1889.

Helianthus scaberrimus Ell. Bot. S. C. & Ga. **2**: 423. 1824.
Coll.: Wheeler 445, 528, Jefferson; 579, Crooked Creek. Aug.

Helianthus occidentalis Riddell, Suppl. Cat. Ohio Pl. 13. 1836.
Coll.: Wheeler 444, Lyon 322, Jefferson; Wheeler 511, Winnebago. Aug.

Helianthus grosse-serratus Martens, Sel. Sem. Hort. Loven. 1839.
Coll.: Wheeler 549, Jefferson. Aug.

Helianthus divaricatus L. Sp. Pl. 906. 1753.
Coll.: Wheeler 566, 576, Jefferson; 630 Winnebago. Aug.

Helianthus tracheliifolius Mill. Gard. Dict. Ed. 8, No. 7. 1768.
Coll.: Wheeler 603, Crooked Creek. Aug.

Helianthus strumosus L. Sp. Pl. 905. 1753.
Coll.: Wheeler 632, Brownsville. Aug.

Helianthus tuberosus L. Sp. Pl. 905. 1753.
Coll.: Wheeler 567, Jefferson. Aug.

Coreopsis palmata Nutt. Gen. **2**: 180. 1818.
Coll.: Lyon 160, Winnebago; 182, Crooked Creek. June, July.

Bidens lævis (L.) B.S.P. Prel. Cat. N. Y. 29. 1888.
Coll.: Wheeler 560, Jefferson. Aug.

Bidens comosa (A. GRAY) WIEGAND, Bull. Torr. Club, **24**: 436. 1897.
Coll.: Wheeler 544, 559, Jefferson; 628, Brownsville. Aug.

Not previously reported from Minnesota. The only previously collected authentic specimen seen from Minnesota is that of Aiton, Minneapolis, Sept., 1890.

Common on the low wet ground throughout.

Bidens frondosa L. Sp. Pl. 832. 1753.
Coll.: Wheeler 541, Jefferson. Aug.

Helenium autumnale L. Sp. Pl. 886. 1753.
Coll.: Wheeler 487, Jefferson. Aug.

Achillea millefolium L. Sp. Pl. 899. 1753.
Coll.: Wheeler 398, Jefferson. July.

Anthemis cotula L. Sp. Pl. 894. 1753.
Coll.: Lyon 269, 284, Jefferson. July.

Chrysanthemum leucanthemum L. Sp. Pl. 888. 1753.
Coll.: Lyon 231, Crooked Creek. July.

Tanacetum vulgare L. Sp. Pl. 844. 1753.
Coll.: Lyon 416, Winnebago. Aug.

Artemisia dracunculoides PURSH, Fl. Am. Sept. 742. 1814.
Coll.: Wheeler 370, Crooked Creek; Lyon 369, 390, Jefferson. Aug.

Artemisia serrata NUTT. Gen. **2**: 142. 1818.
Coll.: Lyon 383, Jefferson. Aug.

Artemisia gnaphalodes NUTT. Gen. **2**: 143. 1818.
Coll.: Wheeler 550, Jefferson; Lyon 419, Winnebago. Aug.

Erechtites hieracifolia (L.) RAF. DC. Prodr. **6**: 294. 1837.
Coll.: Lyon 342, 446, Jefferson; Wheeler 621, Brownsville. Aug.

Mesadenia reniformis (MUHL.) RAF. New Fl. **4**: 79. 1836.
Coll.: Wheeler 273, Crooked Creek. June.

Senecio plattensis NUTT. Trans. Am. Phil. Soc. (II.) **7**: 413. 1841.
Coll.: Wheeler 100, Winnebago. June.

Not previously reported from Minnesota. The only previous known collection in this state is that of Prof. Conway MacMillan from Hennepin county.

Senecio aureus L. Sp. Pl. 870. 1753.
Coll.: Lyon 54, Winnebago. June.

Arctium minus Schk. Bot. Handb. **3**: 49. 1803.
Coll.: Wheeler 432, Jefferson. July.

Carduus lanceolatus L. Sp. Pl. 821. 1753.
Coll.: Lyon 242, Crooked Creek. July.

Carduus discolor (Muhl.) Nutt. Gen. **2**: 130. 1818.
Coll.: Lyon 377, Jefferson. Aug.

Carduus odoratus (Muhl.) Porter. Mem. Torr. Club, **5**: 345. 1894.
Coll.: Herb. Wheeler 25, Winnebago. July.

Description of Plate XXI.

A. Juniper point, Crooked creek valley. Southwest side of bluff dotted with junipers and white birch.

B. Base of bluff, upper Winnebago valley. White pine, juniper and white birch along the upper edge of cliff.

Plate XXII.

A. Western slope of bluff. The woods follow the areas of greatest moisture *i. e.*, the ravines and foot of bluff and the water course in the valley. The shrubs in the valley mark the course of a small creek and are principally willows and dogwoods.

B. Southern slope of bluff showing the steep bare slopes and the thickly wooded ravine. The extreme base of the bluff to the left has been cleared of timber for cultivation.

Plate XXIII.

A. Grove of white birch.

B. Swamp vegetation. *Spathyema* growing in the shade of black ash and yellow birch.

Plate XXIV.

A. Group of coffee trees (*Gymnocladus*).

B. White birch and juniper on side of bluff.

Plate XXV.

A. Slough and island vegetation. *Sagittarias* and *Nelumbo* are the most prominent water plants, and willows and cottonwood on the island in the background.

B. General view of river valley from bluffs on Minnesota side of river. The river channel is on the farther side at the base of the Wisconsin bluffs.

Plate XXVI.

A. General view of Winnebago valley showing general distribution of forest vegetation. The valley is almost entirely cleared for cultivation.

B. South branch of Winnebago valley. The northern slope of bluff is densely wooded.

Plate XXVII.

A. *Lilium canadense* growing in moist meadow of creek valley.

B. Pond vegetation. Yellow pond-lily with water grasses and sedges.

PLATE XXI

THE HELIOTYPE PRINTING CO., BOSTON

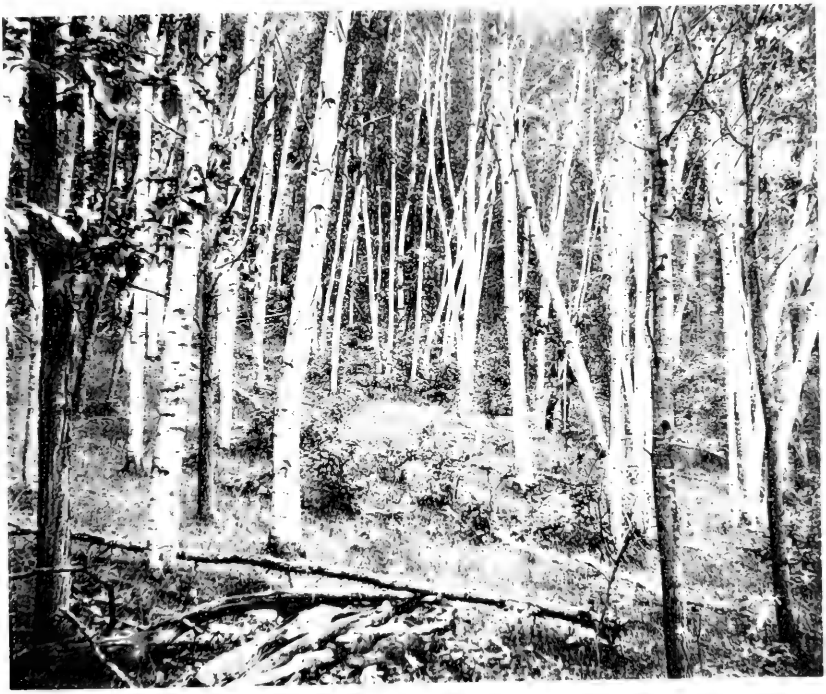

PLATE [illegible].

THE HELIOTYPE PRINTING CO. BOSTON

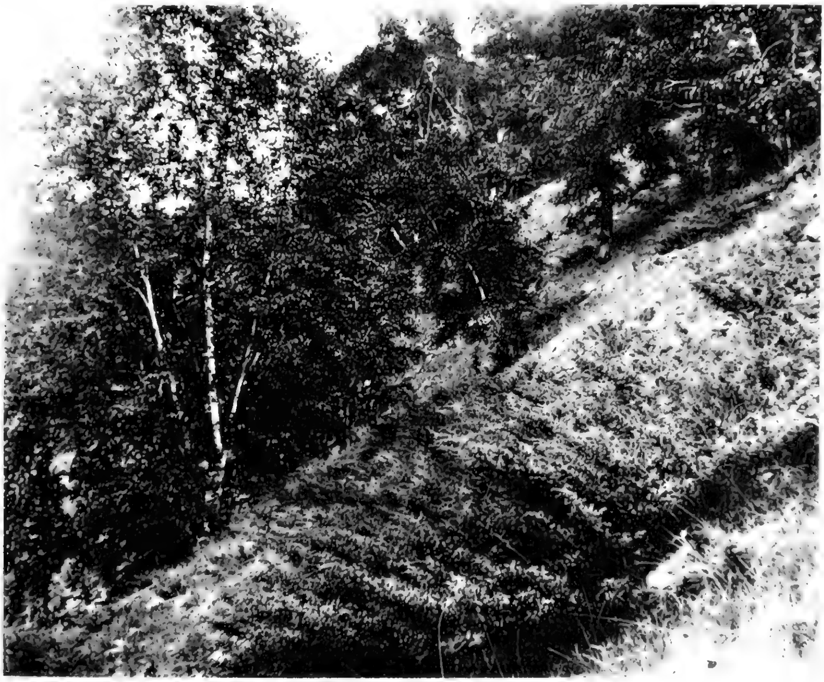

PLATE XXIV.

PLATE XXV

THE HELIOTYPE PRINTING CO., BOSTON

PLATE XXVI

THE HELIOTYPE PRINTING CO., BOSTON

XXIII. THE SEED AND SEEDLING OF THE WESTERN LARKSPUR (*Delphinium occidentale* Wats.).

Francis Ramaley.

The seeds of *Delphinium occidentale* vary in color from a yellowish brown to a brownish black. The testa is somewhat irregularly roughened but not pitted or rugose as in many species of the genus, *e. g.*, the official species, *D. staphisagria*. The seeds are three angled with rounded sides and bluntly pointed at the ends. The edges are either merely sharp angled or else the angles project, forming conspicuous wings. (See Fig. 4 and 5.) The seeds are anatropous as in other Ranunculaceæ. The vascular bundle extending from the hilum is small, about 80 microns in diameter. It is situated in the parenchyma of one of the angles. The cells of the bundle are about 2 or 3 microns in diameter, in cross section.

Endosperm.—The body of the seed within the seed-coat consists chiefly of endosperm, the embryo being very small. (See Fig. 5 and 6.) In the endosperm, two distinct portions may be recognized. The inner portion, an ellipsoidal mass, is rich in oily matter. The outer portion contains some oil, but the cubical or prismatic cells of which it is composed are chiefly filled with proteid grains. There is no starch present in any part of the seed.

Embryo.—The embryo, which exhibits slight differentiation, is placed at the micropylar end of the seed. It is embedded in the inner endosperm. The embryo is small, about 0.4 mm. long or one-fifth the length of the entire seed. (See Fig. 5).

Seed-coat.—The testa consists of a large-celled epidermis with a thick cuticle and of four or five layers of large-celled parenchyma. (See Fig. 14.) These cells have yellow or brownish walls and contain only air. They are usually very much flattened in the dry, ripe seed but swell out in seeds which have been soaked in water. The tegmen consists of a single layer of small rectangular cells with thick periclinal and thin anticlinal walls. The cell walls are of a dull brownish color and the cavities are without contents.

Germination takes place in from four to six weeks when seeds are placed under favorable conditions. The cotyledons generally escape from the seed-coat before appearing above ground. This is easily done because by this time the endosperm has been completely used and the seed-coat is likely to be somewhat rotted during the long period of germination.

Morphology of the Seedling.—In the young seedling the cotyledons are small, the blades being generally about 4 mm. in length when they first emerge above the surface of the soil. They increase considerably in size, becoming 8 mm. long and 6 mm. wide. They are ovate, bluntly pointed, with three principal veins from which spring conspicuous secondary veins. The petioles are connate from their bases to a point only a few millimeters from the blades. The structure formed of the united petioles emerges above the surface of the soil in the form of an arch, thus simulating a hypocotyl. (See Fig. 1.) The connate bases of the cotyledons form a dome-shaped structure covering the growing point of the shoot. This structure may be termed the cotyledonary sheath. The development of the foliage leaves causes a rupture of the cotyledonary sheath. Through the opening formed the first and succeeding leaves emerge. (See Figs. 2 and 3.) The cotyledons wither and finally disappear about the sixth week after germination. The first internodes of the stem do not elongate and the sub-aërial portion of the plant consists only of a rosette of long-petioled leaves, until the somewhat scape-like flowering stem is produced. The early foliage leaves show considerable variation in the blade. The first is palmately tri-lobed with narrow sinuses. In some specimens the lobes are pointed, in others rounded. The separate lobes are sometimes rather deeply one- to two-toothed. Later leaves may be similar or may be five-lobed, the lobes generally mucronate, or acute, not rounded. The young seedling of the plant studied resembles that of *Delphinium nudicaule*, first observed by Asa Gray,* and accurately described by Darwin.† Lub-

*Gray. Botanical Text Book, Ed. VI, 1: 22. 1879.

† Darwin. The Power of Movement in Plants, p. 80 (American Edition).

bock,* mentions that in *Delphinium trollifolium* and in *Delphinium consolida* the petioles of the cotyledons are united in the same way.

Anatomy of the Seedling.—As this has apparently not been described for any species of *Delphinium* a somewhat extended account will be given. It may be well to state at the outset that the present writer has studied only the seedling and not the flowering stem. The young root has a thick cortex and small central stele. The endodermis, though thin-walled, is conspicuous in properly stained sections because of the thickened cuticularized spots on the radial walls. The xylem is arranged in two small groups. (See Fig. 7.) In an older portion of the root (Fig. 8) the xylem forms an elongated mass in the center of the stele. Higher up the vascular tissue extending to the cotyledons passes out abruptly on either side at right angles to the longer diameter of the xylem mass. (Fig. 9.) Passing upward the xylem strand divides into six or more bundles as the transition occurs from root to stem. At the same time the cortex becomes thinner. In a cross section at this point (Fig. 10) the cotyledonary sheath is seen surrounding the stem. In a section somewhat higher up (Fig. 11) the bases of the early foliage-leaves may be seen placed alternately. Here the stem abruptly narrows and a rupture of the cotyledonary sheath permits the emergence of the first foliage-leaf. (Figs. 2 and 3). The cotyledonary sheath now becomes smaller, narrowing to form the structure previously spoken of as resembling a hypocotyl. Sections of this structure show that its component petioles are not completely fused at any point (Fig. 12.) A slit-like passage, lined with epidermis, extends upward to the point where the petioles separate completely.

Anatomy of the cotyledonary Sheath.—No difference is to be noted between the outer epidermis and that lining the cavity. It is, in both cases, composed of elongated cells which are square in cross section. There are two vascular bundles, one for each component petiole. These are small but show no peculiarities in structure. The fundamental tissue is a large-celled parenchyma.

Anatomy of the Laminæ of the Cotyledons.—Each lamina has three principal veins which send off numerous branches. The epidermis is composed of thin-walled cells, somewhat

* Lubbock. On Seedlings, 2: 96. 1892.

larger on the upper surface than on the lower. These cells have a very sinuous outline when seen in surface view. Stomata are confined to the lower leaf surface. A loose palisade layer lies next to the upper epidermis. The spongy parenchyma below this has large air cavities. A few short, clavate, unicellular trichomes sometimes occur on the under surface of the leaf.

Anatomy of the foliage leaves.—The leaves have sheathing bases and channeled petioles. In the center of the petiole there is an air cavity. Five or more vascular bundles form a circle outside this cavity. (See Fig. 13.) Each bundle consists of a large mass of xylem, a very small amount of phloëm and, external to this, a small mass of stereom with lignified cell walls. The fundamental tissue is loose parenchyma. No special hypoderma is developed. The epidermis is thin-walled. The leaf laminæ are thin and composed of very loose tissue. The epidermal cells are large and have sinuous outlines. An interesting peculiarity is to be noted in the palisade. The cells of this tissue are frequently branched at the upper end. (See Fig. 15.) This peculiarity was noted, according to Solereder,* by Haberlandt in certain species of allied genera, but that investigator failed to find branched palisade cells in any of the species of *Delphinium* which he studied. The stomata of the foliage leaves are confined to the lower surface of the leaf. A row of short, simple, pointed trichomes is placed along the margin of the leaf and a very few similar trichomes are scattered on the upper surface.

Explanation of Figures, Plate XXVIII.

Figures 1, 2, 3. Seedlings of *Delphinium occidentale* in various stages of development (natural size). In Figures 1 and 2 the united petioles of the cotyledons have the appearance of a hypocotyl. In Figure 2 the first leaf appears as a small projection at the base of the petioles of the cotyledons.

Figure 4. Seed. × 18.

Figure 5. Longitudinal section of seed showing the minute embryo. The dotted ellipse indicates the line of division between the inner, oily portion of the endosperm and the outer part containing aleuron grains. × 18.

* Solereder. Syst. Anat. der Dicotyledonen, 18, 1899.

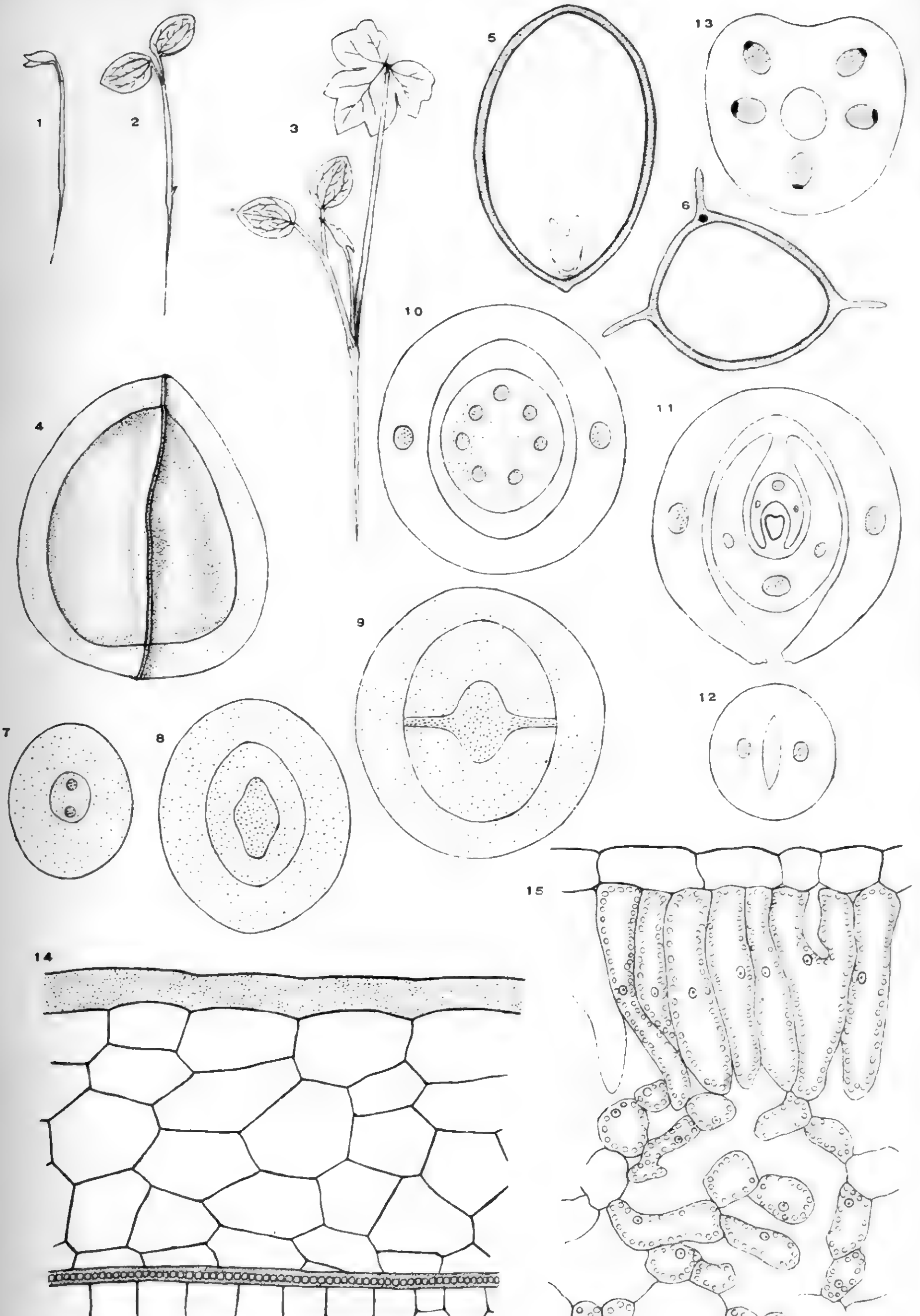

PLATE XXVIII.

Figure 6. Transverse section of seed through the equator. The vascular bundle is in the upper corner. × 18.

Figures 7, 8, 9, 10, 11, 12. All × 18. Diagrams of cross sections of the seedling cut at various levels. Figure 7. The root, thick cortex and small stele with two xylem masses. Figure 8. The root, higher up, a single mass of xylem. "From this the cotyledonary leaf traces extend out horizontally" (Figure 9). Figure 10. The cotyledonary sheath with two vascular bundles encloses the stem. Figure 11. The cotyledonary sheath is ruptured. The sheathing bases of the foliage leaves, arranged alternately, enclose the small triangular apex of the stem. Figure 12. The united petioles of the cotyledons with the slit-like air passage.

Figure 13. Diagram of a cross section of the petiole of the first leaf. The central air cavity is shown, also the circle of vascular bundles (dotted), each with a small amount of stereom (black). × 24.

Figure 14. Section of a seed soaked in water. The epidermis has a very thick cuticle; the parenchyma is large-celled. The layer of small cells with thick walls is the tegmen. The endosperm cells are prismatic (contents not shown). × 270.

Figure 15. Vertical section of the blade of first foliage leaf. Two stomata are shown in the lower epidermis. One of the cells of the palisade layer is branched at the top. Chlorophyll bodies and nuclei are shown in the cells. × 270.

A PRELIMINARY LIST OF MINNESOTA ERYSIPHEÆ.

E. M. Freeman.

The collection of fungi in Minnesota has been carried on by the Geological and Natural History Survey of the state at various times for the past fourteen years.* In 1886 Professor J. C. Arthur assisted by Prof. L. H. Bailey and E. W. D. Holway, Esq., made a collection of fungi in St. Louis county especially in the region about Vermillion lake. A list of the plants collected was published in Bulletin No. 3 of the Geological and Natural History Survey of Minnesota. Since that time numerous collections have been made by Dr. A. P. Anderson, Messrs. E. P. Sheldon, C. A. Ballard and others, but lists of the collected plants have not yet been published. The list given below comprises records of all the Erysipheæ which have been collected in Minnesota up to the present time and deposited at the herbarium of the University of Minnesota.

A number of specimens had been identified by Mr. Sheldon and these together with the above mentioned collection of Professor Arthur and his party have in every case been reëxamined so that the writer assumes the sole responsibility of the determinations. The specimens have been compared with such well known exsiccati as Ellis' North American Fungi, de Thümen's Mycotheca Universalis and others. For the sake of completeness the collection made by Professor Arthur and party is incorporated in this list and where the nomenclature has been changed the name published by Professor Arthur is placed in parentheses after the collection citation. In 1884† A. B. Seymour made a few collections along the Northern Pacific Railroad. Speci-

* A list of Minnesota fungi published by Dr. A. E. Johnson in the Bulletins of the Minnesota Academy of Natural Sciences during the years 1876–1879 cannot be considered authentic, since no collection is available for comparison.

† Seymour, A. B. List of Fungi, collected in 1884 along the Northern Pacific Railroad. Proc. Bost. Soc. Nat. Hist. **24**: 182–191. 1889.

mens of these were not left at the University herbarium. No species however are reported by him, that have not been collected by the staff of the survey. Mention of Seymour's collections is appended to each species reported by him.

The nomenclature of Burrill * has been made use of in the list and for full synonymy the reader is referred to the works cited below. Britton and Brown's Illustrated Flora of the United States and Canada has been closely followed in the naming of all host plants.

Of the Erysipheæ, nineteen species in all have been collected, distributed among the genera as follows: *Sphærotheca*, 3; *Erysiphe*, 5; *Uncinula*, 3; *Phyllactinia*, 1; *Podosphæra*, 1; *Microsphæra*, 6. In field work carried on during such a long period of time and by as many as ten collectors acting independently, it is to be expected that the number of collections of common forms will be increased at the expense of the number of species. A glance at the list given below will show that such has been the case in Minnesota. There are undoubtedly at least a dozen more species of blights in the state, and it is hoped that this list will aid future observations. In citing the district of collection, only the county name is given.

1. **Sphærotheca humuli** (DC.) BURRELL, Bull. Ill. St. Lab. Nat. Hist. **2**: 400. 1887.

On leaves of:

Rubus hispidus L.: St. Louis, July, 1886, Holway 46. (*S. castagnei* Lev.)

Viola sp. indet.: Brown, July, 1891, Sheldon 851.

Humulus lupulus L.: ———,† Sheldon 7020.

2. **Sphærotheca castagnei** LEV. Ann. Sci. Nat. III. **25**: 139. 1851.

On leaves of:

Taraxacum taraxacum (L.) KARST.; St. Louis (?); July, 1886, Holway 276. (Not published in Arthur's report.)

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* Burrill, T. J., and Earle, F. S. Parasitic Fungi of Illinois. Bull. Ill. St. Lab. Nat. Hist. **2**. 1887.

Ellis, J. B., and Everhart, B. M. North American Pyrenomycetes, 2–30. 1892.

† Mr. Sheldon's last field note book has not, up to the present time, been found. Consequently the dates of collection, the district and the name of the host plant often cannot be determined. The missing data are indicated as above.

Pedicularis lanceolata MICHX.; Lincoln, August, 1891, Sheldon 1522.

Bidens frondosa L.; Lincoln, August, 1891, Sheldon 1516, —— September, 1893, Sheldon 6092, Hennepin, Oct., 1898, Freeman 50.

Seymour reports this species on *Erechtites hieracifolia* and *Nabalus* sp. at Lake Minnetonka.

3. **Sphærotheca mors-uvæ** (SCHW.) B. & C. Grev. **4**: 158. 1876.

On leaves of:

Ribes floridum L'HER.: St. Louis, July, 188, Holway 84 (*Sphærotheca pannosa* LEV.); Kandiyohi, July, 1892, Frost 249.

4. **Erysiphe cichoracearum** DC. Flore Franc. **2**: 274. 1815.

On leaves of:

Ambrosia artemisiæfolia L.: Hennepin, 1890, MacMillan; ——, Sheldon 7322; ——, Sheldon 6162; ——, Sheldon 6131; Ramsey, Sept., 1898, Freeman 61.

Ambrosia psilostachya DC. Traverse, Sept., 1893, Sheldon 7081.

Ambrosia trifida L.: Pope, Aug., 1891, Taylor 1126; Brown, Sept., 1891; Sheldon 1243; Traverse, Sept., 1893, Sheldon 7086; Goodhue, Aug., 1893, Anderson 727; Ramsey, Sept., 1898, Freeman 62; Hennepin, Sept., 1898, MacMillan.

Heliopsis scabra DUNAL.: Kandiyohi, Aug., 1892, Frost 449.

Cnicus sp. indet.: Hennepin, 1890, MacMillan; Traverse, Sept., 1893, Sheldon 7072.

Carduus sp. indet.: ——, Sheldon 7357; Hennepin, 1890, MacMillan.

Aster puniceus L. var. *lucidulus* A. GRAY: Lincoln, Aug., 1891, Sheldon 1507.

Aster sp. indet.: Winona, Sept., 1888, Holzinger; Hennepin, Oct., 1898, Freeman 63; Hennepin, Oct., 1892, Sheldon 4123.

Solidago canadensis L.: ——, Sheldon 6082.

Solidago sp. indet.: Hennepin, 1890, MacMillan; Waseca, June, 1891, Taylor 188; Hennepin, Oct., 1891, Sheldon; Goodhue, Aug., 1893, Anderson 814.

Helianthus divaricatus L.: ——, Sept., 1893, Sheldon 6089.

Helianthus decapetalus L.: Brown, July, 1891, Sheldon, 1244.

Helianthus grosse-serratus MARTINS: Traverse, Sept., 1893, Sheldon 7106.

Helianthus scaberrimus ELL.: ——, Sept., 1893, Sheldon 6143; Ramsey, Sept., 1898, Freeman 64.

Helianthus tuberosus L.: Goodhue, Aug., 1893, Anderson 705; Ramsey, Sept., 1898, Freeman 65.

Heilanthus sp. indet.: Traverse, Sept., 1893, Sheldon 7085; Hennepin, 1890, MacMillan; Blue Earth, June, 1891, Sheldon 483; Winona, Sept., 1888, Holzinger; Lincoln, Aug., 1891, Sheldon 1418.

Verbena stricta VENT.: Ramsey, Sept., 1898, Freeman 66.

Verbena urticifolia L.: Chisago, Aug., 1892, Taylor 1639; Hennepin, Aug., 1890, MacMillan; Hennepin, Sept., 1898, Freeman 67.

Verbena hastata L.: Hennepin, Oct., 1892, Sheldon 4128; Pope, Aug., 1891, Taylor 1188; Goodhue, Aug., 1893, Anderson 827; Ramsey, Sept., 1898, Freeman 68.

Verbena sp. indet.: Traverse, Sept., 1893, Sheldon 7030; Carver, July, 1891, Ballard 650; Traverse, Sept., 1893, Sheldon 7071.

Rudbeckia laciniata L.: Hennepin, Sept., 1898, MacMillan.

Senecio aureus L.: Brown, July, 1891, Sheldon 1153.

Hydrophyllum virginicum L.: Blue Earth, June, 1891, Sheldon 203.

Grindelia squarrosa (PURSH) DUNAL: Pipestone, Aug., 1891, Sheldon 1434.

Lappula virginiana (L.) GREENE: Blue Earth, June, 1891, Sheldon 483; St. Louis, July, 1886, Holway 78.

Lappula sp. indet.: Brown, Aug., 1891, Sheldon 1232.

Coreopsis palmata NUTT.: Winona, Sept., 1888, Holzinger.

5. **Erysiphe communis** (WALLR.) FR. Summa. Veg. Scand. 406. 1849.

On leaves of:

Eupatorium ageratoides L.: Hennepin, Oct., 1893, Sheldon 4083.

Lathyrus venosus MUHL.: Winona, Sept., 1888, Holzinger 326; Pope, July, 1891, Taylor 1181; Mille Lacs, July, 1892, Sheldon 2755; Otter Tail, Aug., 1892, Sheldon 3661.

Lathyrus sp. indet. ——, Sheldon 6127.

Œnothera sp. indet.: Hennepin, 1890, MacMillan.

Clematis virginiana L.: Hennepin, 1890, MacMillan.

Anogra albicaulis (PURSH) BRITTON.: Brown, July, 1891, Sheldon 1195.

Strophostyles helvola (L.) BRITTON: Pope, July, 1891, Taylor 1136.

Falcata comosa (L.) KUNTZE: Pope, July, 1891, Taylor 1136.

Oxygraphis cymbalaria (PURSH) PRANTL: Lincoln, Aug., 1891, Sheldon 1357.

Astragalus canadensis L.: Lincoln, Aug., 1891, Sheldon 1423; Hennepin, Sept., 1898, MacMillan.

Aragallus involutus A. Nels.: Lincoln, Aug., 1891, Sheldon 1390.

An undetermined plant of pea family: Traverse, Sept., 1893, Sheldon 7257.

Thalictrum purpurascens L.: Chisago, Sept., 1893, Sheldon 6188.

Thalictrum sp. indet.: Cass. Aug., 1893, Anderson 706.

Onagra biennis (L.) SCOP. ——, Sept., 1893, Sheldon 6146.

Anemone virginana L.: Traverse, Sept., 1893, Sheldon 7089.

Lotus americanus (NUTT.) BISH.: Big Stone, Sept., 1893, Sheldon, Traverse, Sept., 1893, Sheldon 7201.

Polygonum aviculare L.: Ramsey, Sept., 1898, Freeman 51.

Seymour reports *E. communis* on *Lathyrus?* at Lake Minnetonka.

6. **Erysiphe aggregata** (PECK) FARLOW, Bull. Bussey, Inst. **2**: 227. 1878.

On leaves of:

Alnus incana (L.) WILLD.: St Louis, July, 1886, Holway 51.

7. **Erysiphe galeopsidis** DC. Flore Franc. **6**: 108. 1815.

On leaves of:

Stachys palustris L.: Lincoln, Aug., 1891, Sheldon 1572; Lincoln, Aug., 1891. Sheldon 1261.

Seymour reports this species on *Stachys palustris* at Detroit, Minnesota.

8. **Erysiphe graminis** DC. Flore Franc. **6**: 106. 1815.

On leaves of:

Poa pratensis L.: Waseca, June, 1891, Taylor 228. No perithecia found. Conidial stage (*Oidium monthoides* Link) only is present.

9. **Uncinula salicis** (DC.) WINT. Die Pilze **1**^{2}: 40. 1887.

On leaves of:

Salix sp. indet.: Winona, Sept., 1888, Holzinger; Chisago, Sept., 1891, Sheldon 4263; Traverse, Sept., 1892, Sheldon 7172; Traverse, Sept., 1892, Sheldon 7013; Chisago, Aug., 1892, Taylor 1634; Otter Tail, July, 1892, Sheldon 3936; Hennepin, Oct., 1893, Sheldon 4093; McLeod, Aug., 1. J. McElligott; Traverse, Sept., 1893, Sheldon 7069; Ramsey, Sept., 1898, Freeman 60.

Salix bebbiana SARG.: Chisago, Sept., 1891, Sheldon 4246.

Salix myrtilloides L.: Otter Tail, July, 1892, Sheldon 3573½.

Salix discolor MUHL.: Hennepin, Oct., 1893, Sheldon 4089.

Populus deltoides MARSH.: Hennepin, July, 1889, Sheldon; Hennepin, Oct., 1889, MacMillan; Wabasha, Sept., 1893, Edna Porter.

Populus grandidentata MICHX.: Hennepin, 1890, MacMillan.

Populus tremuloides MICHX.: Goodhue, Aug., 1893, Anderson 707.

Populus sp. indet. Hennepin, Oct., 1889, MacMillan.

Seymour reports *U. salicis* on *Salix* sp. at Lake Minnetonka.

10. **Uncinula clintonii** PECK, Rep. N. Y. St. Mus. **25**: 96. 1873. Trans. Alb. Inst. **7**: 216.

On leaves of:

Tilia americana L.: Winona, Sept., 1888, Holzinger.

11. **Uncinula necator** (SCHW.) BURRILL. N. A. Pyren. 15. 1892.
   On leaves of:
      Parthenocissus quinquefolia (L.) PLANCH.: Ramsey, Sept., 1898, Freeman 59; Hennepin, Sept., 1898, F. K. Butters.
12. **Phyllactinia suffulta** (REB.) SACC. Mich. **2** : 50. 1880.
   On leaves of :
      Tilia sp. indet.: Le Sueur, June, 1891, Sheldon 64. Seymour reports this species on *Betula* ? at Lake Minnetonka.
13. **Podosphæra oxyacanthæ** (DC.) D. BY. Beitr. Morph. und Phys. der Pilze, Part 3, 48. 1870.
   On leaves of:
      Prunus sp. indet.: Hennepin, 1890, MacMillan.
      Cratægus (?) sp. indet.: Le Sueur, June, 1891, Sheldon 62. ——; Wabasha, Sept., 1893, Edna Porter.
14. **Microsphæra russellii** CLINTON, Rep. N. Y. St. Mus. **26**: 80. 1874.
   On leaves of:
      Oxalis stricta L.: Winona, Aug., 1888, Holzinger.
15. **Microsphæra ravenelii** BERK. Grev. **4**: 160. 1876.
   On leaves of:
      Lathyrus sp. indet.: Goodhue, Aug., 1892, Ballard 1152; Goodhue, Aug., 1893, Anderson 708.
      Seymour reports *M. ravenelii* Berk. on *Lathyrus* ? at Detroit, Minn.
16. **Microsphæra quercina** (SCHW.) BURRILL, Bull. Ill. St. Lab. Nat. Hist. **2**: 424. 1887.
   On leaves of:
      Quercus macrocarpa MICHX.: Hennepin, 1890, MacMillan; Ramsey, Sept., 1898, Freeman 52.
17. **Microsphæra symphoricarpi** HOWE, Bull. Torr. Club, **5**: 3. 1874.
   On leaves of:
      Symphoricarpos sp. indet.: Hennepin, 1890, MacMillan; Waseca, June, 1891, Taylor 615; Goodhue, Aug., 1893, Anderson 815; ——, Sheldon 7262; ——, Sheldon 7392.
      Symphoricarpos racemosa MICHX.: Traverse, Sept., 1893, Sheldon 7084.
      Symphoricarpos symphoricarpos (L.) MACM. Traverse, Sept., 1893, Sheldon 7083.

Symphoricarpos occidentalis HOOK.: Ramsey, Sept., 1898, Freeman 53.

18. **Microsphæra diffusa** C. & P. Journ. of Bot. **11**: 1872. Rep. N. Y. St. Mus. **25**: 95. 1873.

On leaves of:

Lespedeza violacea (L.) PERS.: Winona, Sept., 1889, Holzinger.

Lathyrus sp. indet.: Hennepin, 1890, MacMillan.

Meibomia canadensis (L.) KUNTZE.: Lincoln, Aug., 1891, Sheldon 1521; ——, Sept., 1893, Sheldon 6105.

Seymour reports *M. diffusa* on *Lespedeza capitata* at Brainerd.

19. **Microsphæra alni** (DC.) WINT. Die Pilze 1^2: 38. 1887.

On leaves of:

Lonicera sp. indet.: St. Louis, July, 1886, Holway 242, (*M. dubyi* Lev.); Ramsey, Sept., 1898, Freeman 56.

Lonicera hirsuta Eaton: St. Louis, July, 1886, Holway 150, (*M. dubyi* Lev.).

Syringa vulgaris L.: Hennepin, July, 1889, Sheldon; Hennepin, Oct., 1891; ——, Sheldon 5806; Goodhue, Aug., 1893, Anderson 714.

Alnus sp. indet.: Hennepin, 1890, MacMillan.

Viburnum lentago L.: Waseca, June, 1891, Sheldon, 506½; Case, Aug., 1893, Anderson 668; Ramsey, Sept., 1898, Freeman 54.

Viburnum sp. indet.: Ramsey, Sept., 1898, Freeman 55.

Lonicera dioica L.: Goodhue, Aug., 1893, Anderson 753.

Corylus americana WALT.: Ramsey, Sept., 1898, Freeman 57.

Tilia americana L.!: Hennepin, Oct., 1898, Freeman 58.

Seymour reports this species on *Ceanothus americanus* at Brainerd and on *Syringa vulgaris* and *Betula* at Lake Minnetonka.

NATIVE AND GARDEN DELPHINIUMS OF NORTH AMERICA.

K. C. Davis.

The name *Delphinium* (Linn. Sp. Pl. 530, 1753) is from the Greek *delphin*, a dolphin, from the resemblance of the flower, The common name is Lark Spur.

It is a genus of beautiful, hardy plants, annual or perennial, erect, branching herbs. Leaves palmately lobed or divided; large, irregular, showy flowers in a raceme or panicle; sepals petal-like, five, the posterior one prolonged into a spur; petals two or four, small, the two posterior ones usually spurred, the lateral or lower ones small if present; the few carpels always sessile, forming many-seeded follicles.

There are probably more than 200 species. In fact Huth's last complete monograph recognized 198 species besides a number of doubtful ones. The following treatment includes the native and cultivated *Delphiniums* of North America, 52 species and many varieties and garden forms. Thirty species are native of America north of Mexico, thirteen of which are used in gardens. Thirteen Old World species have been introduced into the American trade. Nine Mexican species are distinct, and none of them are in use. The mark (†) after a description indicates which plants are not used in the trade. Four species are of much greater popularity than the others: the annual *D. Ajacis*, and the perennials *D. grandiflorum*, *D. hybridum*, and *D. formosum*. The last three have been especially prolific in giving us new garden forms.

In presenting this paper I wish to extend thanks to those who have materially helped me, especially to those who have freely given me the privilege of examining numerous specimens: Dr. J. N. Rose, Professor E. L. Greene, Dr. N. L. Britton and Dr. B. L. Robinson.

The recent extended articles on the genus are: A. Gray, "An attempt to Distinguish Between the American Delphiniums," Bot. Gaz. **12**: 49–54, 1887; and Syn. Fl. **1**: 45–52, 1895. E. Huth, "Monog. Gattung Delphinium," in Engl. Bot. Jahrb. **20**: 322–499, 1895. K. C. Davis, in Bailey's Cyclopedia of American Horticulture.

Synopsis of Species of Delphinium.

A. Roots annual; petals only 2, united; follicles 1.
  B. Follicles pubescent, ½ to 1½ inches long..............1. *Ajacis*.
  BB. Follicles glabrous, ¼ to ½ inch long..................2. *consolida*.
AA. Roots perennial; petals 4; follicles 3 to 5.
  B. Sepals red.
    C. Plant glabrous; seeds smooth........................3. *nudicaule*.
    CC. Plant partly pubescent; seeds thin winged.....4. *cardinale*.
  BB. Sepals greenish yellow, yellow, or sometimes marked with blue.
    C. Inflorescence and leaves densely hairy.
      D. Flowers not tinged with blue...................5. *viridescens*.
      DD. Flowers sordid white tinged with blue...6. *Californicum*.
    CC. Inflorescence and leaves glabrescent or soon becoming so.
      D. Mature follicles densely hairy..................7. *Przewalskii*.
      DD. Mature follicles smooth or sulcate.
        E. Seeds with plates or scales in transverse rows...8. *Zalil*.
        EE. Seeds winged and somewhat wrinkled.........9. *viride*.
  BBB. Sepals blue, or varying to white, or white.
    C. Species native north of Mexico, or introduced from Old World.
      D. Height 1½ feet or less.
        E. Natives of America north of Mexico.
          F. Petioles dilating and somewhat sheathing at the base.
            G. Stem lax; follicles glabrous or becoming so.
              H. Roots fascicled and thickened but not tuberiform. 10. *bicolor*.
              HH. Roots fasciculately tuberous, or grumose. 11. *decorum*.
            GG. Stem rather stout, erect: follicles pubescent.
              H. Length of sepals about equalling the petals.
                I. Seeds winged at the angles........12. *hesperium*.
                II. Seeds scaly and bur-like............13. *Hanseni*.
              HH. Length of sepals much greater than petals. 14. *variegatum*.
          FF. Petioles hardly dilating at the base.

G. Coats of seeds smooth; roots fasciculately tuberous.
15. *tricorne.*

GG. Coats of seeds winged or wrinkled, roots not tuberous, but in some grumose.

H. Roots not grumose.

I. Sepals shorter than the spur.

J. Leaves thickish; racemes long.
16. *Andersonii.*

JJ. Leaves not thick; racemes shorter; flowers smaller.........................17. *Parishii.*

II. Sepals as long as spur, much surpassing petals.
18. *Parryi.*

HH. Roots coarsely granular or grumose; carpels always 3, seeds wing-margined.

I. Pedicels longer than the flowers; follicles spreading when mature..................19. *Menziesii.*

II. Pedicels shorter than flowers; follicles spreading only at tips.................20. *pauciflorum.*

EE. Natives of Asia but introduced to American gardens.

F. Sepals somewhat persistent; bractlets opposite, lanceolate, entire, near the flower.........21. *Brunonianum.*

FF. Sepals deciduous; bractlets alternate, linear, or linear-lobed, distant from flower.........22. *Cashmirianum.*

DD. Height more than 1½ feet (except in a few cases).

E. Seeds wrinkled or scaly, hardly winged (except in 28 and 29); all native of the United States except 23.

F. Follicles always 3.

G. Upper petals violet.....................23. *altissimum.*

GG. Upper petals yellowish, or yellow with blue tips.

H. Inflorescence a crowded, erect, pyramidal raceme.
24. *exaltatum.*

HH. Inflorescence open and somewhat branching; pedicels long and slender...............25. *Treleasi.*

FF. Follicles commonly varying from 3 to 5 on each plant.

G. Stems more or less leafy.

H. Sepals and spurs blue.

I. Stem leafy; radical leaves few.
26. *Carolinianum.*

II. Stem leaves mostly near the base; radical leaves many.

J. Root a flattish tuber...........27. *Oreganum.*

JJ. Root woody-fibrous......... .....28. *Geyeri.*

HH. Sepals and spurs chiefly white..29. *camporum.*

GG. Stem leafless.

H. Petioles of root leaves much longer than blades.
30. *scaposum.*
HH. Petioles of root leaves nearly equalling blades.
31. *uliginosum.*
EE. Seeds decidedly winged.
F. Upper petals white, never yellow.....32. *trolliifolium.*
FF. Upper petals often yellow or yellowish.
G. Species from Old World introduced into gardens; follicles always 3.
H. Lower petals deep blue, 2-lobed, yellow-bearded.
33. *elatum.*
HH. Lower petals bright blue, entire, undulate or slightly 2-lobed.
I. Flowers very large; spurs 9 to 10 lines long.
34. *grandiflorum.*
II. Flowers smaller; spurs 5 to 8 lines long.
35. *cheilanthum.*
GG. Species from west of the Rockies; follicles always 3.
H. Plant glabrous, at least in lower part.
I. Roots fascicled, not tuberous nor grumose.
J. Follicles pubescent............36. *scopulorum.*
JJ. Follicles glabrous...............37. *glaucum.*
II. Root tuberous or grumose.
J. Lower pedicels rather spreading, longer than the spurs.
K. Sepals equal to spur in length.
38. *glaucescens.*
KK. Sepals shorter than the spur.
39. *Nuttallii.*
JJ. Lower pedicels and others appressed, shorter than spurs.........................40. *distichum.*
HH. Plant pubescent throughout.........41. *simplex.*
EEE. Seeds scaly; lower petal 2-lobed; Old World type.
F. Petioles hardly dilating at base, not sheathing; lower petals yellow bearded ....42. *formosum.*
FF. Petioles sheathing at base; beard on lower petals not yellow.
G. Flowers in loose panicles..........43. *Maackianum.*
GG. Flowers in dense racemes...........44. *hybridum.*
CC. Natives of Mexico, not introduced to American gardens.
D. Carpels puberulent to hairy at first.
E. Plant glandular-hispid above.................45. *Madrense.*
EE. Plant not glandular-hispid in upper parts.

F. Lower petals provided with a scale-like appendage at base.
G. Stamens puberulent....................46. *bicornutum.*
GG. Stamens glabrous.
H. Upper petals tipped with yellow..47. *Ehrenbergi.*
HH. Upper petals not tipped with yellow.
48. *pedatisectum.*
FF. Lower petals with appendages wanting or obscure.
G. Leaves pubescent or villose.
H. Upper petals blue...................49. *latisepalum.*
HH. Upper petals yellow with blue tips.
50. *tenuisectum.*
GG. Leaves glabrous. .....:.............51. *leptophyllum.*
DD. Carpels glabrous.................................52. *Wislizeni.*

1. **D. Ajacis** LINN. Sp. Pl. 531. 1753.
D. consolida SIBTH. & SM. Fl. Græca, Prod. **1**: 370. 1806. Not L.
D. ornatum BOUCHÉ, in Bot. Zeit. **1**: 26. 1843.
D. pubescens GRISEB. Spicil. Fl. Rumel. **1**: 319. 1843. Not DC.
Ceratosanthus ajacis SCHUR. Enum. Pl. Transs. 30. 1866.
? *D. addendum* MCNAB. in Trans. Bot. S. Edinb. **9**: 335. 1868.

An erect annual about 18 inches high with a few spreading branches: leaves of stem sessile, deeply cut into fine linear segments; root-leaves similar but short-petioled: flowers showy, blue or violet, varying to white, more numerous than in *D. consolida*, in a spicate raceme; petals 2, united; calyx-spur about equalling the rest of the flower: but one follicle, pubescent; seeds with wrinkled, broken ridges. May to Aug. Europe. Fl. Græca, *t. 540.* Rev. Hort. 1893, p. 228.

2. **D. consolida** LINN. Sp. Pl. 530. 1753.
D. segetum LAM. Fl. Fr. **3**: 325. 1778.
D. monophyllum GILIB. Fl. Lithuan. **2**: 287. 1781.
D. versicolor SALISB. Prod. 375. 1796.
Ceratosanthus consolida SCHUR. Verh. Sieb. Ver. Naturf. 46. 1853.

An erect, hairy annual, 1 to 1½ feet high: leaves similar to *D. Ajacis:* flowers few, loosely panicled, pedicels shorter than the bracts, blue or violet or white; petals 2, united: follicle 1, glabrous; seeds with broken, transverse ridges. June to Aug. Europe. Baxter Brit. Bot. 4. *t. 297*. Rev. Hort. 1893, p. 228 (var. *ornatum candelabrum*).

3. **D. nudicaule** TORR. & GRAY, Fl. **1**: 33. 1838.
D. sarcophyllum HOOK. & ARN. Bot. Beech. 317. 1841.
D. decorum var. *nudicaule* HUTH, Delph. N. Am. 9. 1892.
D. peltatum HOOK. ex. Huth, Bot. Jahrb. **20**: 449. 1895.

Stem 1 to 1½ feet high, glabrous, branched, few-leaved: leaves rather succulent, 1 to 3 inches across, lobed to the middle or farther 3 to 7 times, the secondary lobes rounded and often mucronate; petioles 3 to 5 inches long, dilated at the base: flowers panicled; sepals bright orange-red, obtuse, scarcely spreading, shorter than the stout spur; petals yellow, nearly as long as sepals; spurs long and funnel-form: follicles 3, spreading and recurved, soon becoming glabrous; seeds thin-winged. April to July. Along mountain streams, Northern California. Bot. Mag. 5819. Flor. des Serr. **19**: 1949. Revue Hort. 1893, p. 259. Marsh, Hot Springs near Santa Rosa, Calif., a pubescent form with thicker leaves. Collected by Coville, May, 1884.

4. **D. cardinale** HOOK. Bot. Mag. *t. 4887*. 1855.
D. coccineum TORR. Pac. Ry. Rep. **4**: 62. 1857.
D. flammeum KELLOGG, in Proc. Calif. Acad. **2**: 22. 1863.

Stem erect, 2 to 3½ feet high, partly pubescent: leaves smooth, fleshy, deeply 5-parted, the parts cut into long, linear lobes: elongated, many-flowered raceme, flowers bright red with petal limbs yellow: follicles glabrous, usually 3; seeds smooth. July to Aug. California. Gartenflora, 208. Flor. des Serr. 11, p. 63. *t. 1105*. Garden **19**: 273.

5. **D. viridescens** LEIBERG, Proc. Biol. Soc. Wash. **11**: 39. 1897.

Roots fascicled not tuberous: plant 5 feet high, pubescent, especially above: lower stem-leaves often 3-parted and again 3–5-lobed and toothed; upper leaves dissected into narrow lobes; leaves all thin; pedicels slender, short, appressed; a narrow bractlet near the base or half way up, and a pair very near the flower: inflorescence and follicles very hairy: flowers cream to greenish-yellow, small; spurs nearly horizontal, longer than the sepals, and as long as the upper pedicels. May to July. Type near Peshaston and Wenatchee, Okanogan Co., Wash., 1500 feet (†).

6. **D. Californicum** Torr. & Gray, Fl. **1**: 31. 1838.
D. exaltatum Hook. & Arn. Bot. Beech. 317. 1841. Not Ait.
D. exaltatum var. *Californicum* Huth, Delph. N. Am. 11. 1892.
D. Californicum var. *scapigerum* Huth, Bot. Jahrb. **20**: 451. 1895.
? *D. virescens* Rydb. Bull. Torr. Club, **26**: 385. 1899. (Fragment only.)

Stem stout, 2 to 8 feet high; lower leaves very large, deeply cleft, divisions broad wedge shaped; upper with narrower divisions and lanceolate lobes: racemes dense: flowers sordid whitish with tinges of blue; sepals and spur each about ⅓ inch long: follicles much like those of *D. exaltatum*. Dry places. Monterey to Mendocino Co., Calif. (†).

Var. **laxiusculum** Huth, Bot. Jahrb. **20**: 451. 1895.

Inflorescence very loose and open. San Francisco region and northern Mexico.

7. **D. Przewalskii** Huth, Bot. Jahrb. **20**: 407. 1895.
D. Przewalskianum Hort.

Nearly glabrous, often branched at base, erect, varying much in height: leaves 3 to 5 times deeply parted; parts divided into narrow obtuse lobes: flowers clear yellow, or sometimes tipped with blue, spur equalling the sepals: follicles 3, densely hairy. July to Aug. Asia.

8. **D. Zalil** Ait. & Hems. Trans. Linn. Soc. II, **3**: 30. 1888.
D. hybridum var. *sulphureum* Hort.

Stem nearly simple, erect, 1 to 2 feet high, rather glabrous or becoming so: leaves of several narrow, linear lobes, dark green, petioles not dilating at the base: flowers large, light yellow, in long racemes: follicles 3, longitudinally ribbed and furrowed; seeds with transverse, fibrous plates. June to July. Persia. Bot. Mag. 7049. Garden **50**: 1094; **54**: 347. Gard. Chron. III, 20, 247.

9. **D. viride** WATS. Proc. Am. Acad. **23**: 268. 1888.

Root rather thick, branching: plant glaucous, about 2 feet high; stems glabrous: leaves pubescent, with segments acutely lobed, upper ones more deeply divided and segments narrower: racemes open, few-flowered; pedicels 1 to 2 inches long, glabrous or somewhat pubescent; sepals yellowish green, much shorter than the stout spur; petals purple, shorter than the sepals, lower ones entire or cleft, villous: follicles 3, not spreading, very finely pubescent; seeds large, coats dark, wrinkled and somewhat winged at the ends. Gravelly bluffs, east base of Sierra Madre, Chihuahua, Mex. (†).

10. **D. bicolor** NUTT. Journ. Acad. Phila. **7**: 10. 1834.

D. Menziesii GRAY, Proc. Acad. Phila. **1863**: 57. Not DC.

D. Menziesii var. *Utahense* WATS. Bot. King Exp. 12. 1871.

Erect, rather stout, ½ to 1 foot high, from fascicled roots: leaves small, thick, deeply parted, and divisions cleft except perhaps in the upper leaves, segments linear: obtuse raceme rather few-flowered; the lower pedicels ascending 1 to 2 inches: spur and sepals nearly equal, ½ inch long or more, blue; upper petals pale yellow or white, blue veined; lower petals blue: follicles glabrous or becoming so. May to Aug. Dry woods. Colorado, west and north to Alaska.

Var. **Montanense** RYDB. Mem. N. Y. Bot. Gard. **1**: 157. 1900.

Plant glandular-pilose; leaves thicker than in the type. Region of Helena and southward into Yellowstone Park (†).

Var. **Nelsonii** n. var. *D. Nelsoni* GREENE, Pitt. **3**: 92. 1896.

Roots sometimes slightly fascicled-tuberiform: lowest leaves long-petioled: seeds winged as in the type. Southern Wyoming to middle Colorado (†).

Var. **cognatum** n. var.

D. cognatum GREENE, Pitt. **3**: 14. 1896.

Much like the type but the root leaves with very broad segments, plant glabrescent, or hairy on the flowers: sepals narrower than the type, spurs often markedly incurved: follicles 3, glabrous. It is also much like *D. Andersonii*, but has some stem leaves, and the flowers are different. Western Humboldt Mts., Nevada (†).

Var. **glareosum** n. var.

D. glareosum GREENE, Pitt. **3**: 257. 1898.

Rootstock thick, either simple or branched: plant 3 to 8 inches high, with 1 to 3 stem leaves: follicles 3 to 5, glabrous or nearly so. Summit of Mt. Steele, Wash. (†).

11. **D. decorum** FISCH. & MEY. Ind. Sem. Hort. Petrop. **3**: 33. 1837.

D. hesperium HUTH, Bot. Jahrb. **20**: 446. 1895.

Stem slender and weak, ½ to 1½ feet high, smooth or nearly so: leaves few, bright green, upper ones small, 3–5-parted into narrow lobes, lower and radical ones somewhat reniform in outline and deeply 3–5-parted, lobes often differing widely: flowers in a loose raceme, or somewhat panicled; sepals blue, ½ inch long, equalling the spurs; upper petals at least tinged with yellow: follicles 3, thickish, glabrous; seeds rugose, not winged. Spring. Calif. Bot. Reg. **26**: 64.

Var. **gracilentum** n. var.

D. gracilentum GREENE, Pitt. **3**: 15. 1896.

Differs from the type chiefly in the radical leaves, which are larger, deeply about 5-parted or lobed, the lobes mostly oval or oblong, obtuse and entire, apiculate: pedicels often filiform. Foothills of Sierra Nevada in California (†).

Var. **patens** GRAY, Bot. Gaz. **12**: 54. 1887.

D. patens BENTH. Pl. Hartw. 296. 1848.

D. tricorne var. *patens* HUTH, Delph. N. Am. 13. 1892.

Stem erect: racemes compact: flowers small, sepals a third to a half inch long, upper petals often deeply lined with blue; seeds somewhat winged. Siskiyou Co. to southern California (†).

12. **D. hesperium** GRAY, Bot. Gaz. **12**: 54. 1887.

D. Menziesii var. *ochroleucum* TORR. & GRAY, Fl. **1**: 31. 1838.

D. azureum TORR. & GRAY, Fl. **1**: 660. 1840. In part.

D. azureum & *D. simplex* HOOK. & ARN. Bot. Beech. 317. 1841.

D. simplex WATS. Bot. Calif. **1**: 10. 1876.

Roots fascicled, short, some of them fusiform, 2 feet high; stem and leaves puberulent, or hairy below: leaves rather small, much dissected into narrow parts: racemes long, many flowered;

flowers violet-purple varying to whitish, sometimes reddish purple; sepals less than ½ inch long, about equalled by the petals and by the spur; upper petals lined and bordered with blue; pedicels erect in fruit, lowest ones about 1 inch long, others much shorter: follicles 3 to 5, short-oblong, puberulent, ½ inch or less long; seeds black with broad light wings at the angles. West Oregon south to Monterey, Calif. (†).

Var. **recurvatum** n. var.

D. recurvatum GREENE, Pitt. 1: 285. 1889.

Upper petals yellow, not bordered nor lined with blue. Calif. (†).

13. **D. Hanseni** GREENE, Pitt. 3: 94. 1896.

D. hesperium var. *Hanseni* GREENE, Fl. Fr. 304. 1892.

D. Hanseni var. *arcuatum* GREENE, Pitt. 3: 94. 1896.

Closely allied to *D. hesperium*, but very slender: racemes dense but lax: flowers smaller than that type and of a much lighter blue; seeds densely scaly, giving a white, bur-like appearance. Amador Co., Calif. (†).

14. **D. variegatum** Torr. & Gray, Fl. 1: 32. 1838.

D. grandiflorum var. *variegatum* HOOK. & ARN. BOT. Beech. 317. 1841.

D. decorum BENTH. Pl. Hartw. 295. 1848. Not Fisch. & Mey.

Root, stem and leaves like *D. hesperium:* flowers larger, only few in a raceme; sepals much surpassing the petals: follicles like that species or longer. Monterey, Calif., to the upper Sacramento valley. Common along streams, etc. Well worth introduction to gardens (†). *D. Macounii* GREENE, in Herb. (Macoun no. 18,078, Geo. Surv. Canada) is a low weak form or variety with deeper, less fascicled roots. Rockies. Lat. 39° 40′.

Var. **apiculatum** GREENE, Fl. Fr. 304. 1892.

D. apiculatum GREENE, Pitt. 1: 285. 1889.

Leaf segments broader: flowers more numerous (†).

Var. **Blochmanæ** n. var.

D. ornatum GREENE, Fl. Fr. 304. 1892. Not Bouché.

D. Blochmanæ GREENE, Erythea, 1: 247. 1893.

Leaf segments long and linear: sepals narrower than the type, light blue or white; petals with crisp margins. Nipowa, Calif. Specimens at Berkeley (†).

Var. **Emiliæ** n. var.

D. Emiliæ GREENE, Erythea, **2**: 120. 1894.

Plants often 3 feet high: racemes elongated: flowers usually more numerous than in the type. Open places near the head of Knight's Valley, Sonoma Co., Calif. (†).

15. **D. tricorne** MICHX. Fl. **1**: 314. 1803.

D. flexuosum RAF. Ann. Nat. **1**: 12. 1820.

D. aconitifolium MUHLENB. ex Huth, Bot. Jahrb. **20**: 445. 1895.

Stem succulent, about 1 foot high: leaves 3–5-parted with 3–5-cleft linear lobes; petioles smooth, hardly dilating at the base: flowers large, blue, rarely whitish; upper petals sometimes yellow, with blue veins; lower ones white-bearded; sepals nearly equalling the spur: follicles 3 or 4, very long, becoming glabrous, strongly diverging; seeds smooth. May. Northern States. Lodd. Bot. Cab. **4**: 306. Very beautiful and much used.

16. **D Andersonii** GRAY, Bot. Gaz. **12**: 53. 1887.

D. decorum var. *Nevadense* WATS. Bot. Calif. **1**: 11. 1876. In part.

D. Menziesii WATS. Bot. King Exp. 1871. Not DC.

D. tricorne var. *Andersonii* HUTH, Delph. N. Am. 13. 1892.

Stem erect, robust, nearly glabrous, 1½ feet high: leaves rather small, thickish, cuneate divisions, lobes obtuse, short: racemes long, dense: flowers blue; sepals ½ inch long, shorter than the spur: follicles 3 to 5, about ½ inch long, not recurving; seeds winged. Western Nevada to mountains of California (†). *D. Sonnei* GREENE, Pitt. **3**: 264, 1897, is a slender, weak form, from California (†).

17. **D. Parishii** GRAY, Bot. Gaz. **12**: 53. 1887.

Several stemmed, much like the following, but with racemes and flowers smaller: sepals oblong, ¼ to ⅓ inch long, hardly surpassing the petals, shorter than the spur; upper petals yellowish: seed-coats transversely wrinkled; margin broad, winglike. Southeastern California, southward into Lower California (†).

18. **D. Parryi** GRAY, Bot. Gaz. **12**: 53. 1887.

Much like the last: leaves not thick, divisions or lobes few and linear: sepals oval, over ½ inch long, much surpassing the petals, fully as long as the spur: follicles as in the last; seeds with loose coats, folded at the angles forming wing-like processes. Southern California (†).

19. **D. Menziesii** DC. Syst. **1**: 355. 1818.

D. pauperculum GREENE, Pitt. **1**: 284. 1889.

Plant sparingly pubescent: stem simple, slender, ½ to 1½ feet high, few-leaved: leaves small, 3–5-parted, the divisions mainly cleft into linear or lanceolate lobes; petioles hardly dilating at the base: flowers in simple conical racemes; sepals blue, somewhat pubescent outside, nearly equalling the spurs in length; upper petals yellowish: follicles 3, pubescent or sometimes glabrous; seeds black-winged on the outer angles. April to June. On hills, California and northward to Alaska. Bot. Reg. **14**: 1192.

20. **D. pauciflorum** NUTT. ex Torr. & Gray, Fl. **1**: 33. 1838.

D. Nuttallianum PRITZ. in Walpers Rep. **2**: 744. 1843.

D. Menziesii var. *pauciflorum* HUTH, Bot. Jahrb. **20**: 445. 1895.

Stem slender, nearly glabrous, ½ to 1 foot high; oblong or fusiform fasciculate-tuberous roots: leaves small, parted into narrow linear lobes; petioles not dilating at base: flowers and fruit similar to those of *D. Menziesii*, but on shorter pedicels. May to June. Colorado to Washington and California.

Var. **Nevadense** GRAY, Syn. Fl. **1**: 50. 1895.

D. decorum var. *Nevadense* WATS. Bot. Calif. **1**: 11. 1876. In part.

Leaves much dissected: racemes with spreading pedicels: flowers often pinkish purple; sepals longer than in the type but shorter than the spur: follicles much like the type. Sierra Nevadas, above Cisco, and in Plumas Co., Calif., into Nevada (†).

Var. **depauperatum** GRAY, Bot. Gaz. **12**: 54. 1887.

D. tricorne var. *depauperatum* HUTH, Delph. N. Am. 13. 1892.

Stem leaves few, lobes ovate to lanceolate: racemes fewer flowered than in the type and in the preceding variety. Northwestern Nevada into Oregon (†).

21. **D. Brunonianum** Royle, Ill. Bot. Himal. 56. 1839.
D. moschatum Munro ex Hook. f. & Thoms. Fl. Ind. 53. 1858.

Stems erect, ½ to 1½ feet high: plant somewhat pubescent: upper leaves 3-parted, lower ones reniform, 5-parted, segments deeply cut, musk scented: flowers large, light blue with purple margins, center black; spur very short; sepals 1 inch long, membranous and often clinging until the fruit is mature: follicles 3 or 4, villose. June to July. China. Revue Belg. **1863**: 34. Bot. Mag. 5461.

22. **D. Cashmirianum** Royle, Ill. Himal. 55. 1839.

Plant pubescent, not very leafy: stem simple, erect, slender, 10 to 18 inches high: root leaves orbicular, 2–3 inches in diameter, 5–7-lobed, coarsely acutely toothed and cut: petioles 5–8 inches long; stem leaves short-petioled, 3–5-lobed, cut like the radical ones, all rather thick and bright green: inflorescence corymbose, the branches rather spreading: flowers 2 inches long, deep azure blue; spur broad, obtuse, inflated, decurved, little over half as long as sepal; upper petals almost black, 2-lobed, lateral ones greenish: follicles 3 to 5, hairy, July to September. Himalayas. Bot. Mag. 6189. Gartenflora, 1105. Garden **18**: 261. Rev. Hort. 1893, p. 259.

Var. **Walkeri** Hook. Bot. Mag. *t. 6830.* 1885.

Stem very short, leafy, many-flowered: upper leaves less lobed or almost entire, small, long-petioled: flowers very large, light blue with yellow petals. Suited to rockwork.

23. **D. altissimum** Wallich. Pl. Asiat. Rar. **2**: 25. *t. 128.* 1831.

Stem tall and slender, branched; plant shaggy-hairy above: leaves palmately 5-parted, the divisions 3-lobed and toothed; bracts long-lanceolate: flowers blue or purple in long branching racemes; spur straight or slightly incurved, equalling the sepals; petals 2-lobed: 3 erect follicles; seeds not winged nor scaly. August to September. Himalayas.

24. **D. exaltatum** Aiton, Hort. Kew. 1 ed. **2**: 244. 1789.
D. trydactylum Michx. Fl. **1**: 314. 1803.
D. lilacinum Willd. ex Huth. Bot. Jahrb. **20**: 455. 1885.

Stem stout, 2 to 4 feet high, smoothish: leaves flat, nearly glabrous, deeply cleft into 3 to 7 wedge-shaped lobes, which are often trifid, petioles usually not dilated at the base: flowers medium in size, blue with upper petals yellow, sepals nearly equalling the spur in length; flowers on long, crowded, erect, pyramidal racemes: follicles 3, pubescent or smooth; seed coats irregularly wrinkled. June to August. Borders of woods. Alabama and Carolina to Minnesota.

25. **D. Treleasei** B. F. BUSH, n. sp.

Roots fascicled, rather fleshy: stem green, slender but erect, usually 2 to 4 feet high, simple or branched, glabrous throughout, somewhat glaucous: only 1 or 2 true stem leaves, basal leaves 2 to 5, 2 to 5 inches across, about 5-parted, and lobed into narrow segments with calloused tips; petiole of lowest stem leaf dilating: inflorescence open and somewhat branching; pedicels long and very slender, ascending or spreading, pubescent on upper part; spurs and sepals about equal, blue, puberulent without; petals much shorter than sepals and very narrow; upper petals blue at the ends, lower ones blue with dense yellow beard; spur straight, sometimes 2-lobed; sepals narrowly ovate; bractlets very small and slender, usually not very close to the pubescent receptacle: follicles 3, not divergent, sparsely hairy; styles divergent, ⅓ the length of follicles; stigmas 2-lobed; seed coats dark brown, loose and much wrinkled. Collected by B. F. Bush (No. 73), May 28, 1898, Eagle Rock, Mo.; (No. 81) June 10, 1899, Forsyth, Mo. Common in barrens (†).

This is perhaps most nearly related to *D. Carolinianum*. Besides the difference in floral characters the plant is glabrous, somewhat glaucous: roots fleshy, fascicled: racemes open: stem leaves about 2: follicles always 3.

26. **D. Carolinianum** WALT. Fl. Carol. 155. 1788.
D. azureum MICHX. Fl. **1**: 314. 1803.
D. virescens NUTT. Gen. **2**: 14. 1818.
D. azureum var. *laxiflorum* HUTH, Bot. Jahrb. **20**: 450. 1895.

Stem 1½ to 2½ feet high, not much branched, plant somewhat pubescent: leaves 3–5-parted, the divisions 3–5-cleft into usually linear lobes: spicate racemes slender, usually many-flowered: flowers small, azure-blue; spurs slender: 3 to 5 follicles, oblong, erect; seeds transversely wrinkled and roughened. Florida to South Carolina, west to Missouri, Arkansas, and Mississippi. Paxt. Mag. **16**: 258.

Var. **album** HORT.

A garden variety, somewhat taller: leaves larger and with broader divisions: flowers creamy-white. There is a double form of this not much used in the trade.

Var. **vimineum** GRAY, Bot. Gaz. **12**: 52. 1887.

D. vimineum D. DON, in Sweet's Brit. Fl. Gard. II, **4**: *t. 374.* 1838.

D. virescens GRAY, Pl. Lindh. **2**: 142. 1850.

Very slender and tall, more branched, and with looser inflorescence than the type: seeds larger, transversely winged or deeply and thinly wrinkled. Gulf region of Louisiana and Texas. Bot. Mag. 3593. Bot. Reg. **13**: 1999 (as *D. azureum*) (†).

27. **D. Oreganum** HOWELL, Fl. N. W. Am. **1**: 22. 1897.

Tuber flattish, somewhat branched: plant finely pubescent, stem often slender, 1 to 2 feet high, sparingly leafy: leaves dissected into acute linear lobes: racemes rather open: flowers large, blue; sepals broadly lanceolate, shorter than the slender spur, and longer than the petals; upper petals yellow or white at tip, lower ones blue, truncate, bearded: follicles 3 to 4 lines long, 1 line broad, densely tomentose, not spreading; seed triangular with rounded and rugose back, and truncate summit. Open places. Willamette valley, Oregon. It differs from *D. Carolinianum* chiefly in its open paniculate inflorescence, its very small follicles, few stem leaves, and its seed characters (†).

28. **D. Geyeri** GREENE, Erythea, **2**: 189. Dec., 1894.

This differs from *D. camporum* in the color of the flowers, which are almost wholly blue, and in having the upper branchlets much larger than in that species: seeds somewhat winged and roughened. High plains, western Nebraska and Kansas, west to the mountains (†).

Var. **Wootoni** n. var.

D. Wootoni RYDB. Bull. Torr. Club, **26**: 587. 1899.

This southern variety is intermediate between *D. camporum* and *D. Geyeri* in the size of its upper branchlets: sepals blue or bluish, petals white or nearly so. Arizona and New Mexico (†).

Var. **geraniifolium** n. var.

D. geraniifolium RYDB. Bull. Torr. Club, **26**: 583. 1899.

Differs from the type only in having broader leaf segments, bractlets variable in size, and pedicels slightly more spreading. Charles valley, Arizona (†).

29. **D. camporum** GREENE, Erythea, **2**: 183. Nov., 1894.

D. albescens RYDB. Bull. Torr. Club, **26**: 583. 1899.

Roots fascicled, fleshy-fibrous: stem stout, erect, 1 to 3 feet high, pubescent throughout, especially above: a dense cluster of finely dissected root-leaves, and very few stem-leaves: raceme long and simple, often dense; pedicels short, erect or appressed: flowers white with blue spots on sepals, and sometimes tinged with blue or flesh color; spurs straight or curved, longer than the sepals; upper petals often tinged with yellow, lower ones 2-lobed, bearded: follicles pubescent, seeds scaly and often winged at the angles. Widely distributed. Manitoba to Arkansas and San Antonio, Texas, west to the Rockies (†).

Var. **Penardi** n. var.

D. Penardi HUTH, in Helios **10**: 27. 1893.

Flowers and leaves much like the type: upper petals toothed: seeds large, black, slightly scaly. Flagstaff Hill and Boulder, Colo., *fide* Huth. No type of this is known in America, but seeds of it have been sent to Columbia University by M. E. Autran, of the Boissier Herbarium. A specimen from Esmeralda Co., Neb. (W. H. Shockley, 1881), in Gray Herbarium agrees in characters of seeds and leaves, but not in color of flowers. It is an intermediate form between this variety and *D. Geyeri* (†).

Var. **macroseratilis** n. var.

D. macroseratilis RYDB. Bull. Torr. Club, **26**: 585. 1899.

Slender, leaf-segments fewer than in the type: flowers much the same. Represents the southern variation of the *camporum* group. Tom Greene Co., Tex. (†).

30. **D. scaposum** GREENE, Bot. Gaz. **6**: 156. 1881.

Root a cluster of thickened, fleshy fibres: stem leafless as in *D. nudicaule;* radical leaves rather fleshy, pubescent, 3-parted, the divisions wedge-shaped, 3–5-cleft or toothed, the teeth ending in a calloused point: racemes many-flowered, pedicels as long as the deep azure blue flowers; spur incurved: follicles 3 to 5; seed coat somewhat loose and wrinkled. Southern Utah and Arizona (†).

31. **D. uliginosum** Curran, Bull. Calif. Acad. **1**: 151. 1885.

Stem leafless, often branching: radical leaves 3-cleft, lobes entire or 1–3-toothed: racemes rather few-flowered: blue sepals ½ inch long, equalling the straight spur: follicles 3 to 5, erect, nearly ½ inch long; seed coats minutely wrinkled and muriculate. Lake Co., Calif., in swampy ground (†).

32. **D. trolliifolium** Gray, Proc. Am. Acad. 8: 375. 1872.
D exaltatum var. *trolliifolium* Huth, Delph. N. Am. 11. 1892.

Stem 2 to 5 feet, leafy, often reclining: leaves thinnish, large, often reniform at base, 3–7-parted, lobes wedge-shape, incised: racemes in large plants 1 to 2 feet long and very loose: flowers blue with upper petals white; spur and sepals each ¾ inch long: follicles glabrous; seeds with thin wing or crown at the end. April. Moist grounds, Columbia river.

33. **D. elatum** Linn. Sp. Pl. 531. 1753.
D. intermedium Willd. ex Ait. Hort. Kew. 1 ed. **2**: 243. 1789.
D. Clusianum Host. Fl. Aust. **2**: 67. 1797.
D. alpinum Waldst. & Kit. Pl. Rar. Hung. **3**: 273. 1812.
D. palmatifidum DC. Syst. **1**: 358. 1818 in part.
D. ranunculifolium Wall. Cat. n. 4716. 1828.
D. pyramidale Royle, Ill. Bot. Himal. 56. 1839.
D. discolor Fisch. ex Huth, Bot. Jahrb. **20**: 399. 1895.

Glabrous, 2 to 3½ feet high: leaves somewhat pubescent, 5–7-parted, parts rather narrow, cut-lobed; upper leaves 3–5-parted; petioles not dilated at the base: raceme much like *D. exaltatum*, or more spike-like: flowers blue with dark violet petals; sepals ovate, glabrous, nearly equalling the spurs: follicles 3, seeds transversely wrinkled, not scaly. June to August. Bot. Reg. **23**: 1963. Gartenflora, 736 *b* & *c* (vars.), Flor. des Serr. **12**: 1287 (var. *flore-pleno*). Revue Hort. 1859, p. 529; 1893, p. 258.—A polymorphous and complex species of Europe. It is probable that all or nearly all the plants sold here under this name should be called *D. exaltatum*, which is a closely allied species.

34. **D. grandiflorum** Linn. Sp. Pl. 531. 1753.
D. sinense Fisch. ex Link, Enum. Hort. Berol. **2**: 80. 1822.
D. virgatum Jacq. f. ex Spreng. Syst. **2**: 617. 1825. Not Poir.

Stem rather slender, 2 to 3 feet high: leaves rather small, many times parted into nearly distinct, narrow, linear lobes: flowers large, blue, varying to white, the spur and lower petals often violet, upper petals often yellow; spurs long and taper-pointed: follicles 3, pubescent; seeds triangular, coats wrinkled, not scaly. July to August. Siberia. Bot. Mag. 1686. Garden **46**: *t. 991* & p. 484.

There are several garden varieties: var. *album*, Hort. Flowers pure white. Var. *album-pleno* Hort. Flowers double and pure white. Var. *flore-pleno* Hort. Flowers double, blue, very pretty.

Var. **Chinensis** Fischer ex DC. Prod. **1**: 53. 1824.

Stems very slender, not much branched: leaves and flowers like the type, but flowers more numerous. China. Lodd. Bot. Cab. **1**: 71. A favorite garden plant.

35. **D. cheilanthum** Fisch. ex DC. Syst. **1**: 352. 1818.
D. magnificum Paxt. Mag. Bot. **16**: 258. 1849.
D. formosum Hort. Not Boiss. & Huet.

Stem erect, simple or branched, 2 to 3 feet high: leaves glabrous or slightly pubescent, 5-parted, the lobes pointed, sub-trifid and somewhat toothed: flowers dark blue, the upper petals sometimes pale yellow, the lower ones inflexed, ovate, entire; spur rather long, straight or somewhat curved: 3 follicles, either glabrous or pubescent; seeds three-cornered, three-winged, not scaly. June and July. Siberia. Bot. Reg. **6**: 473. Gartenflora, **13**: 253.

36. **D. scopulorum** Gray, Pl. Wright. **2**: 9. 1853.
D. exaltatum Hook. Fl. **1**: 25. 1829.
D. exaltatum var. *scopulorum* Huth, Delph. N. Am. 12. 1892.

Stem 2 to 5 feet high, glabrous below: leaves 5–7-parted, the basal ones with very broad segments, which are round and apiculate at apex; other leaves more narrowly cleft; petioles dilating at the base: flowers blue or purple, rarely white, upper petals often yellow; spur one-half inch long, equalling the sepals; racemes simple, densely many-flowered: follicles 3, pubescent; seeds black with loose coats, not scaly, but slightly winged. Aug. to Sept. Moist ground, west of Rockies.

Var. **subalpinum** GRAY, Bot. Gaz. **12**: 52. 1887.

D. occidentale WATS. Bot. Calif. **2**: 428. 1880.

D. elatum var. *occidentale* WATS. Bot. King Exp. 11. 1871.

D. exaltatum var. *Barbeyi* HUTH, Delph. N. Am. 11. 1892.

D. Barbeyi HUTH, Bull. Herb. Boiss. **1**: 335. *t. 17.* 1893.

A smaller plant, pubescent above: broader divisions of leaves: shorter racemes: larger and deeper colored flowers: follicles glabrous; seeds much like the type. Wasatch Mountains.

Var. **stachydeum** GRAY, Bot. Gaz. **12**: 52. 1887.

Stem erect, 3 to 6 feet high: leaves with narrow divisions: plant cinereous-pubescent throughout; seeds black like the type. Oregon to New Mexico and Arizona (†).

Var. **attenuatum** JONES, Proc. Cal. Acad. II, **5**: 617. 1895.

Stems in tufts, 3 to 4 feet high: leaves like the type; pubescence like var. *subalpinum:* flowers large, deep blue, with an odor of musk; sepals long and narrow, 3 times as long as the petals, and longer than the spur; upper petals white, lower ones bearded. Utah. Allied to *D. elatum* (†).

Var. **diversifolium** n. var.

D. diversifolium GREENE, Pitt. **3**: 93. 1896.

Stems often tufted, rather tall and slender: lowest leaves nearly reniform in outline, not more than 3-parted, the parts with lobes rounded at the ends, the sinuses very narrow; other leaves like the type: plant somewhat pubescent in upper parts and on the follicles. Moist meadows, head waters of the Humboldt river, eastern Nevada (†).

37. **D. glaucum** WATS. Bot. Calif. **2**: 427. 1880.

D. scopulorum WATS. Bot. Calif. **1**: 11. 1876.

D. scopulorum var. *glaucum* GRAY, Bot. Gaz. **12**: 52. 1887.

D. exaltatum var. *glaucum* HUTH, Delph. N. Am. 11. 1892.

Much like *D. scopulorum:* plants with a broader type of leaves, often glaucous, glabrous, or the pedicels slightly glandular-pubescent: lower petals deeply lobed: pistils and fruits glabrous; seeds black with light wings. Sierra Nevada, California and San Bernardino mountains, altitude 6,000 to 10,000 feet, north to Alaska (†).

38. **D. glaucescens** RYDB. Mem. N. Y. Bot. Gard. **1**: 155. 1900.

Rootstock thickened: stem somewhat angled, plant finely pubescent especially above, or in age glabrate, somewhat glaucous, 1 to 2 feet high: leaves divided to near the base into 5 to 8 cuneate divisions, these generally deeply 3-cleft: raceme simple, rather short, lower bracts linear, longer than the flowers, the upper ones subulate; pedicels and flowers densely pilose, pedicels spreading: flowers dark blue or variegated with white, somewhat nodding; spur straight, equalling the sepals; upper petals yellowish white, tipped and tinged with blue: ovaries densely hairy; fruit not seen. Rocky places, Cedar mountains, Montana, and Yellowstone Park. Differs from *D. glaucum* in its shorter and more pilose inflorescence, lower and more tufted habit, and in hairy ovaries (†).

Var. **multicaule** RYDB. Mem. N. Y. Bot. Gard. **1**: 156. 1900.

More bushy than the type and less pubescent: leaf segments longer and narrower: flowers smaller; spur curved. Rock slides, Cedar Mt., Montana (†).

39. **D. Nuttallii** GRAY, Bot. Gaz. **12**: 54. 1887.

D. exaltatum var. *Nuttallii* HUTH, Delph. N. Am. 9. 1892.

D. Columbianum GREENE, Erythea, **2**: 193. 1894.

D. simplex NUTT. ex Huth, Bot. Jahrb. **20**: 472. 1895.

Stem erect, simple, nearly glabrous, leafy, 1½ to 2½ feet high: leaves thinnish, 3–5-parted, parts divided into many linear-oblong lobes: racemes long, many-flowered; sepals deep blue, ovate, sparingly pubescent, shorter than the spur; petals blue or upper ones yellow, lower ones white-bearded: follicles 3, pubescent, rather erect; seeds thin, dark with yellow wings. Summer. Low open woods, Columbia River.

Var. **leucophæum** n. var.

D. leucophæum GREENE, Erythea, **3**: 118. 1895.

A slender whitish plant, with sepals and lower petals white, upper petals blue. Oregon (†).

40. **D. distichum** GEYER, in Hook. London Journ. Bot. 6: 68. 1847.

D. simplex var. *distichiflorum* HOOK. l. c. 67.

D. azureum TORR. Bot. Wilkes Exped. 217. 1854.

Not so tall as *D. simplex*, glabrous or inflorescence puberulent: leaves rather thicker: flowers and fruit much like those of *D. simplex;* upper petals whitish. Low prairies of eastern Oregon and Washington, eastward in Montana (†).

Without seeing the follicle and seeds of *D. Burkei* GREENE, Erythea, **2**: 183, 1894, it is best not to consider it as distinct from *D. distichum.* The type specimen is at Kew. Thus far no preserved specimens showing follicles and seeds were found. The type is supposed to have come from the "Snake Country, probably in Idaho," but collectors in that region have been unable to rediscover the plant.

41. **D. simplex** DOUGL. ex Hook. Fl. **1**: 25. 1829.

D. azureum var. *simplex* HUTH, Delph. N. Am. 9. 1892.

Stem nearly simple, 2 to 3 feet high, soft-pubescent throughout: leaves many-parted into linear divisions and lobes: racemes dense, little branched: flowers pale blue with upper petals yellow, lower petals white-bearded; sepals equalling the spur: follicles 3, pubescent; seeds dark with margins white-winged. June. Mountains of Idaho and Oregon.

42. **D. formosum** BOISS. & HUET, Diagn. Sec. II, **5**: 13. 1856.

D. speciosum BOISS. & HUET ex Huth, Bot. Jahrb. **20**: 410. 1885. Not. M. Bieb.

Stem strong, 2 to 3 feet high, hairy below, rather glabrous above: lower leaves 5–7-parted, long-petioled, upper ones 3–5-parted, short-petioled or sessile, all alternate: racemes many-flowered: flowers blue with indigo margins; spur long, violet colored, bifid at the tips: follicles 3, pubescent; seeds scaly. June to July. Asia Minor, perhaps; but its origin is disputed. Flor. des Serr. **12**: 1185.

43. **D. Maackianum** REGEL, in Mem. Acad. Petersb. VII, **4**: 9. 1861.

Erect, 3 feet high, pubescent or glabrous, branched above: leaves pubescent on both sides, base often truncate or reniform, 3–5-parted, the parts serrate; the bases of petioles dilated:

flowers in loose panicles; peduncles yellow-hairy, with the bracts often inserted above the base; sepals blue, ½ as long as the spurs; petals dark violet: follicles often glabrous, ¾ inch long; seeds small, distinctly scaly. July. Siberia. Gartenflora, 344.

44. **D. hybridum** STEPH. ex Willd. Sp. Pl. **2**: 1229. 1799.
D. davuricum GEORGI, Beschr. Russ. Reich. III, **4**: 1052. 1800.
D. fissum WALDST. & KIT. Pl. Rar. Hung. **1**: 83. *t. 81*. 1802.
D. hirsutum PERS. Syn. **2**: 82. 1807.
D. tauricum PALLAS ex Bieb. Fl. Taur. Cauc. **2**: 13. 1808.

Stem 3 to 4 feet high, pubescent above: root somewhat bulbous: leaves 5- to many-parted, lobes linear, petioles dilated and sheathing at the base: racemes dense: flowers blue, lower limbs white-bearded; straight spur, longer than the sepals: follicles 3, hairy; ovate seeds with transverse scales. June to August. Mountains of Asia. Revue Hort. 1893, p. 258.—There are many double and semi-double varieties of this type. Var. *flore-pleno* HORT., has large double flowers colored as in the type. Var. *Barlowi* PAXT., has very large semi-double flowers, deep blue with brownish center; a supposed hybrid with *D. grandiflorum*. Bot. Reg. 1944.

45. **D. Madrense** WATS. Proc. Am. Acad. **25**: 141. 1890.

Resembles *D. pauciflorum;* slender, 2 feet high or less, from a thickened rootstock, pubescent with reflexed hairs below, glandular-hispid above: leaves 3-parted, the lobes 5–7-cleft into linear-oblong segments, lowest ones less cleft: flowers few, small, pale blue, in a slender raceme; spur narrow, straight; lateral petals long-villous: carpels short, glandular-hispid. May. In mountains near Monterey, Mexico. Collected by Pringle (n. 3014) (†).

46. **D. bicornutum** HEMSL. Diagn. Pl. Nov. **2**: 17. 1879.

Stem nearly simple, stout, 2 to 4 feet high, glabrous or puberulent on inflorescence and under the leaves: leaves long-petioled, 5-parted, 3–5-lobed; bracts linear; pedicels bibracteolate; bractlets cuneate: flowers blue, spurs nearly straight, sepals oblong; upper petals narrow, obtuse or retuse; lower petals bifid: carpels 3, puberulent at first. Oaxaca (†).

Var. **Hemsleyi** HUTH, Bot. Jahrb. **20**: 453. 1895.

Spurs distinctly 2-lobed at the end (†).

47. **D. Ehrenbergi** HUTH, in Bull. Herb. Boiss. **1**: 336. *t. 17, f. 2.* 1893.

Stem simple, succulent, very leafy, 1 to 2 feet high; petioles long with dilating bases: leaves 3–5-parted, cut into many oblong or linear lobes: racemes few-flowered, pedicels erect, lower ones 1 to 2 inches long: flowers blue; spurs straight, equalling the sepals, which are oval, pubescent; upper petals yellow with blue tips, lower ones 2-lobed, sparsely bearded, appendiculate at base: follicles 3, erect, pubescent. Near El Cerro, Mex. (†).

48. **D. pedatisectum** HEMSL. Diagn. Pl. Nov. **2**: 18. 1879.

Stem branching, branches smooth: leaves 3–7-parted, parts scarcely lobed, puberulent: flowers blue, on long, slender, puberulent pedicels; bracts and bractlets linear-subulate; sepals oblique-oblong; upper petals deeply 2-lobed, much shorter than the spur, lower petals 2-lobed, bearded, appendiculate at base; stigmas glabrous: follicles 3, tomentose when young; styles long. Mexico. Specimen at Kew (†).

49. **D. latisepalum** HEMSL. Diagn. Pl. Nov. **2**: 17. 1879.

Plant pubescent or villose: stem nearly simple: leaves 5-parted; the parts of the basal leaves again 3–5-lobed, parts of stem leaves nearly linear: flowers few on slender pedicels; spurs slightly curved, nearly equalling the sepals; sepals villose; upper petals narrow, slightly 2-lobed at the points; lower petals not appendiculate, deeply 2-lobed, much bearded on both sides; stamens glabrous: follicles 3, clothed with white pubescence when young. 9,000 feet. Mt. Tanga, Oaxaca, Mex. Specimen at Kew (†).

50. **D. tenuisectum** GREENE, Erythea, **2**: 184. 1894.

Root thick, woody, deep: stem 2 to 3 feet high, simple or little branched, not very stout, sulcate above: plant finely pubescent throughout, leafy: leaves very finely dissected into linear segments, the lower stem leaves on rather long petioles dilated at base: racemes about 8 inches long, loosely flowered, pedicels very slender, nearly erect, upper ones not longer than the spurs; bractlets of lower pedicels lobed; bractlets of upper pedicels slender and near the flowers; sepals about equal to spur in length, blue within, tinged with yellow outside; upper petals yellow with blue tips; lower ones either blue or yellowish, 2-lobed with a few long, white hairs on inside of lobes: follicles 3, large, slightly spreading; seeds nearly black, coats roughened, forming slight wings at the angles. Cool banks of ravines in plains at base of the Sierra Madre, Chihuahua, Mex. Collected first by C. G. Pringle (n. 1184), Sept. 27, 1887. Differs essentially from *D. scopulorum* in its finely dissected leaves (†).

51. **D. leptophyllum** Hemsl. Diagn. Pl. Nov. **2**: 18. 1879.

Stem 3 to 4 feet high, glabrous, somewhat branched: leaves glabrous, deeply 5-parted, and cut into oblong to linear lobes; bracts entire, linear: inflorescence open, few-flowered; pedicels 1 to 2 inches long; bractlets remote from flower: flowers large, blue; spur large; sepals puberulent, ovate, obtuse, ⅔ inch long; petals dull yellow; upper ones slightly 2-lobed, nearly glabrous; lower ones deeply 2-lobed, slightly bearded: follicles 3, densely villose when young, half inch long when mature, not spreading: seed slightly winged, and transversely wrinkled. October. San Luis Potosi and Montes San Miguelito, Guanajuata, southern Mexico (†).

52. **D. Wislizeni** Engelm. in Wisliz. Tour N. Mex. 106. 1848.

Stem simple, 2 to 2½ feet high, slender, glabrous, glaucous; petioles elongated, lower ones dilated at base: leaves cut into linear segments; pedicels long: flowers few, spur 2½ inches long, blue, slightly pubescent outside; the outer sepal acute, others obtuse: follicles glabrous even when young. Wislizeni region, Mexico. Later found near Cosihuiriachi, 8,000 feet. In flower in Sept. (†).

Excluded.

D. urceolatum Jacq. Coll. **1**: 153, 1786, is figured in Bot. Mag. n. 1791, but no nativity is given. From character it may be allied to *D. exaltatum*, but it is probably not American.

INDEX TO SPECIFIC AND VARIETAL NAMES OF DELPHINIUM.

XXVI. NATIVE AND CULTIVATED RANUNCULI OF NORTH AMERICA AND SEGREGATED GENERA.

K. C. Davis.

Few groups of plants are perhaps less understood than this one. The range of variation in characters is rather limited and yet the number of species is very great. Six genera have taken from *Ranunculus* about thirty-six species and yet that genus retains more species than any other of the order Ranunculaceae. About 350 names have already been given to American plants of this group.

Key to Genera.

A. Akenes transversely wrinkled; roots fibrous; aquatic or ditch herbs; flowers white..**Batrachium.**

AA. Akenes not transversely wrinkled.

B. Developed carpels not longitudinally ribbed or striated.

C. Roots not a cluster of thickened tubers, or several times longer than thick.

D. Flowers mostly yellow or white; akenes compressed, never lanceolate, smooth, papillose or spiny.............**Ranunculus.**

DD. Flowers white; akenes lanceolate, utricular; style hooked. **Kumlienia.**

CC. Roots a cluster of thickened tubers; leaves crenate, cordate; cotyledon only 1..**Ficaria.**

BB. Developed carpels longitudinally ribbed or striated.

C. Leaves pinnately compound or lobed; akenes terete, style persistent, slender, recurved...........................**Cyrtorhyncha.**

CC. Leaves not as above; akenes compressed.

D. Akenes with beaks somewhat reflexed; leaves rounded and lobed..**Arcteranthis.**

DD. Akenes minutely sharp-pointed; leaves crenate-dentate, oval-cordate to reniform................................**Oxygraphis.**

BATRACHIUM S. F. Gray, Nat. Arr. Brit. Pl. **2**: 720. 1821.

(Name from the Greek, in allusion to the aquatic habitat of the plants.)

Aquatic, or semi-aquatic perennial herbs; leaves dissected or lobed, submerged ones usually with filiform segments; petioles with stipular-dilated membranous bases: flowers solitary, opposite the leaves, rather small, white; sepals usually 5; petals usually 5, base often yellowish; claw with a naked nectar pit; stamens several or many: ovules oblique, compressed, not margined, nearly beakless, transversely rugose. About 20 species, mostly of north temperate regions of the world. The following are all that are found in North America. Section Batrachium DC. Syst. **1**: 233, under *Ranunculus*.

Key to Species.

A. Aquatic leaves with filiform segments present; receptacle hairy.
  B. Leaves all sessile or nearly so......................1. *divaricatum*.
  BB. Leaves, except the upper ones long-petioled.
    C. Emersed leaves always present, with segments broader than linear..2. *aquatile*.
    CC. Emersed leaves if present only fleshy or nearly linear. 3. *trichophyllum*.
AA. Aquatic leaves none, or few, and with few divisions; receptacle glabrous.
  B. Styles minute, shorter than the ovaries............4. *hederaceum*.
  BB. Styles long and filiform....................................5. *Lobbii*.

1. **B. divaricatum** Wimm. Fl. Schles. 10. 1841.
   Ranunculus aquatilis β. Linn. Sp. Pl. 556. 1753.
   R. divaricatus Schrank, Baier. Fl. **2**: 104. 1789.
   R. circinatus Sibth. Fl. Oxon. 175. 1794.
   R. aquatilus var. *stagnatalis* DC. Prod. **1**: 27. 1824.
   Batrachium circinatum Spach. Hist. Veg. **7**: 201. 1839.
   R. stagnatalis Wallr. Sched. Crit. 285. 1848.
   R. aquatilis var. *divaricatus* Gray, Man. 2 ed. 7. 1856.
   R. longirostris Godron, Ess. 32. *f. 9*. 1862.
   R. aquatilis var. *longirostris* Lawson, Rev. Canad. Ranunc. 43. 1870.

Leaves sessile to the dilated stipule-like base, dissected into rigid lobes spreading at right angles to the stem, not collapsing when taken from the water; no floating nor emersed leaves:

petals several-nerved, deciduous: styles subulate, as long as the ovaries, stigma surface along the inner side: receptacle hairy. July. Chihuahua, Mex., Texas to British Columbia, eastward and northward to Hudson Bay. Also in Europe.

2. **B. aquatile** WIMM. Fl. Schles. 8. 1841.
Ranunculus aquatilis LINN. Sp. Pl. 556. 1753.
R. aquatilis var. *heterophyllus* DC. Prod. **1**: 26. 1824.
R. aquatilis var. *hispidulus* DREW, Bull. Torr. Club, **16**: 150. 1889.
R. Grayanus FREYN, Deutsche Bot. Monats. **8**: 179. 1891.

Floating leaves round-reniform, 3–5-lobed or parted, and the divisions 2–3-cleft; submersed ones with filiform segments, widely spreading, rather firm, but collapsing when taken from water; all the leaves often slightly hispid below: styles subulate, shorter than the ovaries, introrsely stigmatose: receptacle hairy among the carpels. Ponds and quiet shallow streams. California to Alaska, Europe and Asia.

3. **B. trichophyllum** BOSSCH. Prod. Fl. Bot. 5. 1850.
Ranunculus trichophyllus CHAIX. in Vill. Hist. Pl. Dauph. **1**: 335. 1786.
R. flaccidus PERS. in Usteri. Ann. Bot. **5**: pt. 14: 39. 1795.
R. pantothrix BROT. ex DC. Syst. **1**: 235. 1818.
R. aquatilis var. *cæspitosus* DC. Prod. **1**: 26. 1824.
R. aquatilis var. *brachypus* HOOK. & ARN. Bot. Beech. 316. 1841.
R. confervoides FRIES, Sum. Veg. Scand. **1**: 139. 1846.
R. aquatilis var. *submersus* GORDON, in Gren. & Godr. Fl. Fr. **1**: 23. 1848.
R. aquatilis var. *trichophyllus* GRAY, Man. 5 ed. 40. 1867.
R. Porteri BRITTON, Bull. Torr. Club, **17**: 310. 1890.
R. aquatilis var. *confervoides* GRAY, Syn. Fl. **1**: 21. 1895.
R. aquatilis var. *flaccidus* GRAY, l. c. 21.

This species is polymorphous, including those with filiform segments to all the leaves or with some of the leaves rather fleshy, or some narrowly linear, and the submersed leaves are mostly flaccid, but may be rigid when taken from the water. The plants have adapted themselves to either aquatic or to muddy habitats. Widely distributed; America, Europe, Asia.

4. **B. hederaceum** S. F. Gray, Nat. Arr. Brit. Pl. **2**: 721. 1821.

Ranunculus hederaceus LINN. Sp. Pl. 556. 1753.

Semi-aquatic, rooting freely from the nodes, in the mud: leaves seldom submersed, but floating or resting on the mud; all reniform or nearly so, angulate-lobed, never finely dissected; peduncles as short as the petioles: petals deciduous: styles shorter than ovaries, introrsely stigmatose; receptacle glabrous. Naturalized from Europe at Norfolk, Va., and on Newfoundland.

5. **B. Lobbii** HOWELL, Fl. N. W. Am. **1**: 13. 1897.

Ranunculus hederaceus var. TORR. Pac. Ry. Rep. **4**: 62. 1853.

R. hederaceus var. *Lobbii* LAWSON, Rev. Canad. Ranunc. 44. 1870.

R. hydrocharis subsp. *Lobbii* HIERN. Seem. Journ. Bot. **9**: 66. *t. 114.* 1871.

R. aquatilis var. *Lobbii* WATS. Bibl. Index 17. 1878.

R. Lobbii GRAY, Proc. Am. Acad. **21**: 364. 1886.

Leaves commonly all floating, small, truncate or cordate at base, divergently 3-parted: petals persistent; stamens 5 to 10; styles long and filiform; stigma terminal. In mud or water of pools, etc. California and Oregon.

RANUNCULUS LINN. Sp. Pl. 548. 1753.

The name is the Latin diminutive for frog, given because many of the species grow in wet places.

The genus is by far the largest in the Ranunculaceæ, comprising upwards of 200 species. 90 of these are natives or naturalized in North America; of those in the trade in this country five are native here; one in the Canaries; five in Europe, and two of these also in Asia. Those cultivated are so indicated in the following treatment. Members of the genus are found in mountainous regions, and in cold and temperate parts of the globe.

Perennial (rarely annual) herbs: leaves alternate, simple, entire, lobed, dissected or divided: flowers yellow, white or rose; sepals usually 5, deciduous or marcescent-persistent; petals 5 or more, conspicuous or minute, nectar pit and scale at base; carpels many, 1-ovuled: akenes generally flattened, smooth, papillose or spiny, borne in a head or spike; styles minute or elongated.

In 1886 A. Gray wrote a revision of the North American *Ranunculi* found north of northern Mexico. This was published in Proc. Am. Acad. **21**: 363–378. In Syn. Flora **1**: 20–39, the revision is brought down to 1895. Since that date the list of species has rapidly increased and since Gray's first revision two new North American genera have been segregated from this one. In 1892 N. L. Britton discussed six species "R. repens and its Eastern North American allies," Trans. N. Y. Acad. Sci. **12**: 2–6. Britton and Brown's Ill. Flora gives 31 species in eastern United States and Canada. In 1880 J. Freyn gave a long treatment of about ten species in Flora, **63**: 179.

The present treatment includes 96 species, eighteen of which are found only in Mexico and south of there.

Tentative Key to Species and Groups of Species.

A. Sepals and petals deciduous (except in 77); petals yellow or white, with nectary on the claw covered by scale; sepals 5, (rarely only 3 or 4); petals 5 or more; carpels not utricular when mature, usually somewhat compressed.—Sec. Euranunculus, Gray.

- B. Leaves, at least some of them, lobed or divided.
  - C. Flowers yellow (except some cultivated forms of 31).
    - D. Plants terrestrial.
      - E. Plants not spreading by rooting branches or stolons, except in 12, 26 and 27.
        - F. Sepals glabrous or pubescent but not densely clothed with black or brown wool.
          - G. Akenes armed or clothed with prickles, spines or prominent papillæ.........1. *arvensis;* 2. *muricatus;* 3. *parviflorus;* 4. *hebecarpus;* 5. *Galeottii.*
          - GG. Akenes nearly smooth or pubescent.
            - H. Leaves, at least some of the radical ones, divided, the leaflets either sessile or stalked.
              - I. Radical leaves with some of the leaflets stalked.
                - J. Petals short, about the length of the sepals, or shorter.
                  - K. Head of fruit globose...............6. *alceus.*
                  - KK. Head of fruit oblong to cylindric. 7. *Pennsylvanicus.*
                - JJ. Petals longer than the sepals.

K. Beaks of akenes not hooked.

L. Petals about 5 (or 6), except perhaps in 13.

M. Head of fruit longer than thick.

N. Sepals reflexed.

8. *Macounii*; 9. *Sardous*.

NN. Sepals spreading 10. *micranthus*; 11. *fascicularis*; 12. *septentrionalis*.

MM. Head of fruit globose.

N. Stem leaves present; roots fibrous.

13. *Hookeri*; 14. *pilosus*; 15. *Bloomeri*; 16. *hispidus*.

NN. Stem leaves present, roots from a thickened bulb......17. *bulbosus*.

NNN. Stem leaves wanting.

18. *Icelandicus*.

LL. Petals 7 to 16 (double in 21).

19. *orthorhynchus*; 20. *dichotomus*; 21. *Llavænus*; 22. *macranthus*: 23. *subalpinus*.

KK. Beaks of akenes recurved or hooked.

24. *canus*; 25. *amarillo*; 26. *repens*.

II. Radical leaves with the leaflets all sessile.

27. *palmatus*; 28. *Aschenbornianus*; 29. *acriformis*; 30. *Californicus*; 31. *Asiaticus*.

HH. Leaves, at least the radical ones, usually not parted to the base, and in some species only lobed or cleft.

I. Types found native or naturalized north of Mexico.

J. Sepals exceeding the petals, or sometimes a trifle shorter, recurved.

K. Beaks of akenes minute, curved, or nearly wanting....32. *abortivus*; 33. *sceleratus*; 34. *eremogenes*.

KK. Beaks of akenes nearly half the length of the body, recurved...35. *Allegheniensis*; 36. *recurvatus*; 37. *Bongardi*.

JJ. Sepals decidedly shorter than the petals.

K. Akenes compressed, or flat, with firm or indurated margin.

L. Sepals reflexed...........38. *occidentalis*; 39. *Turneri*.

LL. Sepals spreading.
40. *acris;* 41. *McCallai.*
KK. Akenes turgid or lenticular, marginless.
L. Head of fruit oblong or cylindraceous.
42. *pedatifidus;* 43. *vicinalis;* 44. *Eschscholtzii;* 45 *eximius;* 46. *saxicola.*
LL. Head of fruit globose or oval.
47. *Suksdorfii;* 48. *ovalis;* 49. *Arizonicus.*
II. Types from Old World, cultivated here, not naturalized..........................50. *montanus;* 51. *corthusæfolius.*
III. Types found only in Mexico and southward (see also var. of 32).
J. Plants with several slender scapose stems bearing only bracts and terminal flowers.
52. *longipedunculatus.*
JJ. Plants usually with true stems, 1 to 8 inches high.................. ....53. *Donianus;* 54. *multicaulis;* 55. *Mexicanus.*
JJJ. Plants with true stems one foot high or more.............56. *uncinatus;* 57. *petiolaris.*
HHH. Leaves all 2 to 4 times ternately parted or divided, divisions 1 line or less in width; flowers few, large; plants alpine or subalpine, low, decumbent or spreading...........58. *adoneus;* 59. *triternatus.*
HHHH. Leaves all palmately or pedately lobed or divided; sepals nearly equal to the petals; plants low, tufted, arctic or alpine.
60. *Grayi;* 61. *pygmæus.*
HHHHH. Leaves, some of them, quite entire (except in 62); others with a few entire lobes; plants low and glabrous......62. *oxynotus;* 63. *digitatus;* 64. *glaberrimus.*
FF. Sepals densely clothed beneath with black or dark brown wool...................65. *Macauleyi;* 66. *nivalis.*
EE. Plants spreading by slender creeping stolons or rootstocks.......67. *natans;* 68. *hyperboreus;* 69. *Lapponicus.*
DD. Plants aquatic or amphibious.
70. *delphinifolius;* 71. *Purshii;* 72. *Missouriensis.*
CC. Flowers white (except in a double garden form of 73).
73. *aconitifolius;* 74. *Pallasii.*
BB. Leaves entire or only denticulate or crenulate, not lobed, from linear to oblong-lanceolate (or ovate in 75); plants varying from

erect to creeping and rooting at the nodes; aquatic or in low wet ground, or terrestrial.........................Sec. FLAMMULA.

C. Blades of stem leaves amplexicaul, leaves entire; flowers white.................................... ....75. *amplexicaulis.*

CC. Blades of stem leaves not amplexicaul; flowers yellow.

D. Stamens numerous.

E. Plant low or erect, not spreading by slender creeping stems.

F. Habitat aquatic..........................76. *Lambertianus.*

FF. Habitat terrestrial.

G. Sepals and petals persistent...........77. *arnoglossus.*

GG. Sepals and petals deciduous.

H. Claw of petal 1 line long........78. *unguiculatus.*

HH. Claw of petal not nearly so long.

I. Akenes beaked.

J. Stems 2 to 3 feet high, often rooting at lower nodes.......... ....79. *ambigens.*

JJ. Stems much lower, not rooting at nodes.

K. Mature fruit glabrous.

L. Beak as long as the akene body. 80. *Madrensis.*

LL. Beak much shorter than akene body.

M. Petals 4 to 6 lines long; plants solitary, not much tufted..81. *alismæfolius.*

MM. Petals about 3 lines long; plants often tufted or covering the ground. 82. *alismellus.*

KK. Mature fruit villous-pubescent. 83. *Lemmoni.*

II. Akenes beakless; styles deciduous. 84. *oblongifolius.*

EE. Plant spreading by slender, or fistulous creeping stems.

F. Lower leaves sometimes cordate; flower stems ascending.

G. Margins of some of the leaves slightly denticulate. 85. *hydrocharoides.*

GG. Margins of leaves entire............86. *samolifolius.*

FF. Lower leaves never cordate.

G. Petals no longer than the sepals.......87. *stolonifer.*

GG. Petals nearly twice the length of the sepals.

H. Number of petals 8 to 10; plant glabrous. 88. *vagans.*

HH. Number of petals 4 to 8; plants never entirely glabrous.

I. Stems filiform or nearly so, and usually rooting at each node; peduncles usually less than 2 inches; radical leaves few..............89. *reptans.*

II. Stems larger, at least at the base, peduncles longer.

J. Radical leaves not tufted; stems seldom ascending..........................90. *Unalaschensis.*

JJ. Radical leaves tufted; stem somewhat ascending...........................91. *microlonchus.*

DD. Stamens only 1 to ten.

E. Head of fruit oblong; stem leaves distinctly petioled. 92. *trachyspermus.*

EE. Head of fruit small, globose; stem leaves sessile or nearly so...93. *pusillus.*

AA. Sepals and petals marcescent-persistent; petals white or rose, with ample nectary and imperfect scale; carpels wholly or partly utricular, but compressed and broad.......Sec. CRYMODES, Gray.

B. Plant and sepals somewhat pubescent.................94. *glacialis.*

BB. Plant and sepals glabrous.

C. Akenes about 3 lines long, wholly utricular; plant about 6 inches high, stoutish.................................95. *Andersoni.*

CC. Akenes hardly half as large, not inflated; plant taller and more slender...96. *juniperinus.*

1. **R. arvensis** LINN. Sp. Pl. 555. 1753.

Glabrous or sparsely pubescent, erect, 1 to 2 feet high, branched above: lower leaves petioled, others sessile or nearly so, nearly all divided; leaflets either stalked or sessile, cleft or parted into linear-oblong segments: petals yellow, 2 to 3 lines long; sepals of same length, spreading: akenes few, flattened, armed with long spines; beak half their length or more, stout; head depressed-globose. Europe. Naturalized in New Jersey, and near northern seaports.

2. **R. muricatus** LINN. Sp. Pl. 555. 1753.

Sparsely pubescent or glabrous, often erect, succulent, branched near the base, 6 to 20 inches high: lower leaves on long broad petioles, reniform to round cordate, 3–5-cleft and coarsely crenate-dentate: petals deep yellow, 3 lines long; sepals shorter, spreading: akenes compressed, large, conspicuously muricate-spiny; beak stout, slightly curved: head loose, globose. Asia and Europe. Naturalized near towns in Virginia to Louisiana, also in California and southern Oregon.

3. **R. parviflorus** LINN. Sp. Pl. 2 ed. 780. 1763.
R. trachyspermus ELL. Sketch 2: 65. 1824.

Hairy, 4 to 10 inches high, very slender, spreading, branching: leaves petioled, reniform to cordate-orbicular, ½ to 1 inch broad, 3-cleft or parted or divided, segments cuneate, oval, obtuse, cut and toothed; the upper leaves sometimes 5-parted, short-petioled: peduncles short, slender; petals pale yellow, hardly 1 line long; sepals about the same length: akenes oblique, very flat, margined, papillose; beak short, sharp. Europe. Naturalized in waste places, Maryland, North Carolina, Florida, west to Arkansas and Texas.

4. **R. hebecarpus** HOOK. & ARN. Bot. Beech. 316. 1841.
R. parviflorus var. TORR. & GRAY, Fl. 1: 25, 659. 1838.
R. hebecarpus var. *pusillus* WATS. Bot. Calif. 1: 8. 1876.

Plant shaggy-hairy, slender, ½ to 1 foot high, branched: leaves reniform to roundish, small, 3–5-parted or divided, segments sessile or subsessile, often laciniately cleft: peduncles short; petals hardly a line long, pale yellow; sepals about equalling the petals: akenes few, semi-oval, compressed, clothed with recurved bristles; beak short, subulate, recurved: head small. Washington through western California to lower California.

5. **R. Caleottii** TURCZ. in Bull. Soc. Nat. Mosc. 27: 2: 276. 1854.

Roots not seen: plants otherwise annual: stem somewhat branched, radical and lower stem-leaves 3-parted, the divisions stalked, 3-lobed or parted, the lobes toothed or cut, acute or obtuse, appressed pilose; petioles openly pilose with appressed hairs; upper stem-leaves 3-parted, the highest one sometimes not lobed: sepals reflexed, openly pilose; petals longer than sepals, obovate-oblong, obtuse: akenes compressed, margined, tubercles on the sides, style deciduous. Oaxaca, Mex. Alt. 7,000 to 9,000 feet.

6. **R. alceus** GREENE, Erythea, 3: 69. 1895.

One foot high or less, slender, branching, soft-hirsute and villous: leaves about 1 inch long, and much like those of *R. canus:* petals roundly obovate, about 1 line long, yellow: akenes many, obliquely obovoid, glabrous; beak stout, recurved: head globose. Elk mountains, Mendocino County, Calif.

7. **R. Pennsylvanicus** LINN. F. Suppl. 272. 1781.
   R. Canadensis JACQ. Misc. **2**: 343. 1781.
   R. trifolius MOENCH. Meth. Suppl. 70. 1802.
   R. hispidus PURSH, Fl. **2**: 395. 1814. Not Michx.
   R. fascicularis WATS. Bot. King Exp. 9. 1871.

Plant hirsute or hispid, stout, erect, 8 to 20 inches high, very leafy, but the radical leaves often dying down: leaves petioled, ternately compound; leaflets well stalked, 3-parted and cleft, much incised and toothed, segments acute: flowers small, yellow, on short peduncles; petals oblong to obovate, 1 to 2 lines long; sepals about the same length, reflexed: receptacle hairy: akenes 1 line long, oblique or semi-oval, compressed, roughened; beak subulate, stout, short, nearly straight: head of fruit oblong to cylindric. Wet ground, Nova Scotia to Georgia west to Arizona and British Columbia Jacq. Ic. Rar. *t. 105*.

8. **R. Macounii** BRITTON, Trans. N. Y. Acad. Sci. **12**: 3. 1892.
   R. hispidus HOOK. Fl. **1**: 19. 1829. Not Michx.
   R. repens var. *hispidus* TORR. & GRAY, Fl. **1**: 658. 1838. In part.

Erect or declined, hairy, branching, 1 to 2 feet long, stems rather few leaved: leaves ternately compound, leaflets usually on slender stalks, crenate, variously cleft and lobed, segments acute: petals yellow, obovate, about 3 lines long; sepals shorter, often reflexed, falling early: akenes smooth; beak subulate, flat, short and sharp: head oblong or oval. Moist places. western Ontario to British Columbia south to Iowa, and in mountains to Arizona.

Var. **Oreganus** n. var.
   R. hispidus var. *Oreganus* GRAY, Proc. Am. Acad. **21**: 376. 1886.
   R. Oreganus HOWELL, Fl. N. W. Am. **1**: 19. 1897.

Plant often taller, smoothish or with scattered hairs: flowers often larger. Shaded wet grounds, Willamette valley, Ore., to Frazer valley, east to Kootenai lake, Brit. Col.

9. **R. Sardous** CRANTZ, Stirp. Austr. **2**: 84. 1763.
   R. parvulus LINN. Mant. **1**: 79. 1767.
   R. Philonotis EHRH. Beitr. **2**: 145. 1788.
   R. hirsutus CURT. Fl. Lond. **2**: *t. 40*. 1821.

Plant hirsute especially below, 3 to 15 inches high: lower leaves 3-parted or 3-foliate, middle leaflets stalked, others often sessile, all obovate-cuneate to roundish, cleft and toothed as in *R. repens:* petals yellow, 4 to 6 lines long; sepals much shorter, reflexed: akenes flat, orbicular, thin-margined; beak short-subulate: head oblong. Asia Minor, northern Africa, Europe. Naturalized at Savannah, Norfolk, Philadelphia, New York and St. John, N. B.

10. **R. micranthus** NUTT. ex Torr. & Gray, Fl. **1**: 18. 1838.
R. abortivus var. *micranthus* GRAY, Man. 5 ed. 42. 1867.

Allied to *R. abortivus*, but more slender, villous; roots of slender tubers: most of the lower leaves 3-parted, or divided with the leaflets stalked: receptacle glabrous or nearly so. April to May. Massachusetts, New York to Colorado, and Saskatchewan.

11. **R. fascicularis** MUHL. Cat. 54. 1813.

Roots a fascicle of thickened fibres or tubers: plant finely pubescent throughout, 3 to 10 inches high, tufted: leaves mostly radical, long-petioled, 3- (rarely 5-) divided; middle leaflet stalked, others usually sessile, deeply lobed and cleft into oblong segments: petals 5 to 6, bright yellow, obovate-oblong, rounded at apex, 4 to 6 lines long; sepals much shorter, spreading: akenes flattened, slightly margined, glabrous; beak nearly their length; head ovate or oblong. April to May. Ontario, New England to Texas, and Manitoba. Meehan's Mo. 2. *t. 1.* *R. apricus* GREENE, Pitt. **4**: 145, 1900, is a form from Indian Territory with the leaflets rather narrow and sometimes entire.

Var. **Deforesti** n. var.

Differs from the type in having all leaves but the first radical ones cleft into linear to spatulate lobes: roots less thickened: plant 3 to 4 inches high: petals 5 to 10, linear to oblong, 2 to 4 lines long. Collected by Harry P. DeForest (G. 42) near Rossville, Ill., April, 1885.

12. **R. septentrionalis** POIR. in Lam. Encycl. **6**: 125. 1804.
? *R. lucidus* POIR. l. c. 113.
R. tomentosus POIR. l. c. 127.
? *R. Philonotis* PURSH, Fl. **2**: 393. 1814.
R. Belvisii DC. Syst. **1**: 291. 1818.

R. fascicularis SCHLECHT. Animad. Ranunc. **2**: 30. *t. 2.* 1820. Not Muhl.

R. Schlechtendalii HOOK. Fl. **1**: 21. 1829. (As to type.)

Plant glabrous or sometimes pubescent, 1 to 3 feet high, branching, lower branches often rooting at their nodes, and running some distance: lower petioles very long: leaves composed of 3-stalked leaflets, which are mostly cuneate and cleft into broad lobes: petals yellow, obovate, 6 lines long; sepals half as long, spreading: akenes much compressed, widely margined; beak nearly as long, subulate, flat: head of fruit rather small, ovoid. Often in low, wet places. New Brunswick to Georgia, northwestward to Winnipeg.

13. **R. Hookeri** SCHLECHT. in Linnæa, **9**: 610. 1835.

Stem erect, branched, 1 to 2 feet high: lower leaves and petioles pilose with spreading yellowish hairs, upper leaves with peduncles sulcate, pubescence appressed: leaves subpinnate, nearly as narrow as in *R. repens:* sepals reflexed; petals narrow; receptacle pilose: akenes oblique, roundly obovate, laterally margined, marked with minute impressions and often a few scattered tubercles on sides, acuminate; base of style persistent: head of fruit globose. Allied to *R. acris* in habit and roots; to *R. repens* in foliage. Its narrow often numerous petals and reflexed calyx remove it from all. Vera Cruz, Oaxaca, in San Miquelito Mts., and other places in Mexico. Common in grass lands.

14. **R. pilosus** H.B.K. Nov. Gen. & Sp. **5**: 36. 1821.

Roots thick-fibrous, many: stem ascending, somewhat dichotomously branched above, hirsute: radical leaves petiolate, ternate, appressed-pilose, 10 to 15 lines wide, 1 to 1½ inches long; leaflets cut-toothed, lateral ones sessile, ovate-rhomboid, sometimes 2–3-lobed; terminal leaflets large, on stalks 2 to 6 lines long, subrotund, 3-lobed or 3-parted; lower stem leaf like the radical leaves but much dissected, short-petioled; upper stem leaves gradually less dissected, those near the flowers sessile: flowers as large as in *R. bulbosus*, peduncles silky; sepals 5, ovate, acutish, pubescent outside, reflexed, much shorter than the petals, deciduous; petals 5 (rarely 6), oblong, with rounded tips, 5 lines long, glabrous, supplied with a scale on the claw: akenes glabrous, oblong to obovate, compressed, tapering into the persistent style; fruit in globose head. High altitudes, Guatemala. Also near Bogota, U. S. of Colombia.

15. **R. Bloomeri** WATS. Bot. Calif. 2: 426. 1880.
R. Chilensis HOOK. & ARN. Bot. Beech. 134. 1841.

Stem ascending, 1 to 2 feet long, sparsely hairy or becoming glabrous: radical leaves bright green, long-petioled, some broadly cordate or ovate, coarsely dentate or incised, others 3-parted, some divided into 3 leaflets which are short-stalked and the middle one often 3-lobed; stem leaves short petioled: petals yellow, 6 lines long, emarginate; sepals shorter: akenes glabrous, 2 lines long, turgid; beak slender, subulate, persistent. San Francisco bay.

16. **R. hispidus** MICHX. Fl. 1: 321. 1803.
R. Marilandicus POIR. in Lam. Encycl. 6: 126. 1804.
R. repens var. *Marilandicus* TORR. & GRAY, Fl. 1: 21. 1838.
R. fascicularis BRITTON, Pl. N. J. 3. 1881.

Appressed-pubescent, when young densely villous: stems slender, ascending or spreading, ½ to 2 feet long: leaves palmately 3-parted, or pedately or pinnately 3–5-divided; the divisions ovate, or variable, middle one often stalked, others usually sessile; all often cuneate at base, sharply cleft or lobed: petals 5 or more, light yellow, 3 to 6 lines long; sepals half as long, spreading: akenes broadly oval, lenticular, margined, abruptly tipped; beak half their length, subulate, slightly curved; head ovoid to globose. Earliest spring. Canada through Eastern and Middle States to Florida and Arkansas.

17. **R. bulbosus** LINN. Sp. Pl. 554. 1753.
R. speciosus HORT. ex VILM. Fl. Pl. Terre 1 ed. 722. 1865.

Plant from a true bulb, erect, about 1 foot high, hairy: leaves petioled, 3–5-parted, the divisions sometimes stalked, segments lobed: flowers terminating the branches, bright yellow, large; petals large, obovate, shining above; sepals much smaller, often reflexed: akenes compressed, with short beak, borne in a globose head. Spring and summer. Persia, Europe, northern Africa. The double form is perhaps best suited for culture.

18. **R. Icelandicus** n. sp.

Caudex short, roots fibrous: plant pubescent throughout: no true stem, scape about 3 inches high, nearly erect, slender: leaves about 1 inch long on petioles the same length, blade 3-divided or parted, the leaflets sessile or the middle one stalked; segments with about 3 entire or toothed cuneate lobes: petals 5, yellow, large, obovate-cuneate, obcordate or retuse; sepals shorter, spreading, pubescent: carpels much like those of *R. acris.* Collected June, 1895, by Elizabeth Taylor at Seydisfjordr, Iceland.

19. **R. orthorhynchus** Hook. ex Gray, Proc. Am. Acad. **21**: 377. 1887.

R. ornithorhynchus Walp. Rep. **1**: 43. 1842 (by error).

Root thick fibrous: plant 10 to 18 inches high, erect, branched, hirsute to nearly glabrous: leaves oblong in outline, pinnately compound; 5 to 7 leaflets cleft and incised, quite variable; upper leaflets often confluent and sessile or nearly so, lower ones well stalked: petals 7 to 16, yellow, rarely purple beneath, obovate, 4 to 6 lines long; sepals much shorter, pubescent beneath, reflexed, deciduous: akenes glabrous, obliquely ovoid, compressed, 1 to 2 lines long, margined; style of same length, straight, rigid, persistent: head globose. May to July. Wet places. British Columbia to western Oregon and Montana. Cultivated.

Var. **platyphyllus** Gray, Proc. Am. Acad. **21**: 377. 1886.

R. macranthus Wats. Bot. King Exp. 9. 1871. Not Scheele.

R. maximus Greene, Bull. Torr. Club, **14**: 118. 1887.

Often 3 feet or more high: leaves larger, 2 to 4 inches across, the leaflets often 3 inches long, and laciniately cut: petals often larger than the type. Wasatch Mountains, northern Utah, Pyramid lake, northern Nevada, northern California, Washington, Idaho. Cultivated.

20. **R. dichotomus** Moc. & Sesse. ex DC. Syst. **1**: 288. 1818.

Stem erect, often dichotomously branched: radical leaves very long-petioled, bipinnate: flowers yellow; sepals reflexed: akenes with acuminate erect beaks. Mexico.

21. **R. Llavænus** Schlecht. in Linnæa, **10**: 233. 1836.

Stem prostrate, the flowers on erect or ascending branches, terminal: leaves 3-divided and again 3-lobed, segments narrowly and sharply cut-toothed; middle leaflet stalked, lateral ones sessile, all cuneate at base; the long petioles hirsute, widely sheathing and smooth at the base: peduncles sulcate; receptacle pilose: flowers yellow; calyx reflexed: akenes obliquely round-obovate, slightly margined laterally, terminated by the long erect style, smooth: head of fruit globose. June to July. Meadows, Jalapa, Vera Cruz. Allied to *R. dichotomus*, leaves nearly as finely dissected, yet much allied to *R. Hookeri.*

22. **R. macranthus** SCHEELE, in Linnæa, **21**: 585. 1848.
R. repens var. *macranthus* GRAY, Pl. Lindh. **2**: 141. 1850.

Plant hairy; erect or spreading, ½ to 3 feet high: leaves 3–5-divided, the middle leaflet longer stalked than the others, lobed and cleft into narrower segments than in *R. septentrionalis:* petals 7 to 16, yellow, 5 to 7 lines or longer, oblong to obovate; sepals shorter, spreading: receptacle hairy: akenes flat, ovate to orbicular, widely margined; style subulate, long, often only partly persistent: head large, slightly lengthened. Texas, southwestern Arizona into Sonora, Mex.

23. **R. subalpinus** n. n.
R. delphinifolius H.B.K. Nov. Gen. & Sp. **5**: 38. 1821. Not Torr.

Roots fibrous: stem erect, branched above, few-flowered, silky-hairy: radical leaves long-petioled, pilose on both sides, ternate, lateral leaflets subsessile, 2-parted, terminal one well stalked, 3-parted, segments 2–3-lobed, incised and toothed; lobes lanceolate; stem leaves similar but smaller, short-petioled: flowers on long peduncles, erect, as large as in *R. bulbosus;* sepals 5, silky outside, reflexed, ovate, acutish, yellowish, much shorter than the corolla; petals about 15 (*fide* Bonpl.), yellow, glabrous, 5 lines long, spatulate-oblong, apex rounded, claw furnished with a scale: young ovaries many, small, sessile, ovate to subrotund, compressed, glabrous; style long and slender. May. Moist places. Altitude 8,000 to 9,000 feet. San Miguelito Mountains and at Guanajuato, Mex.

24. **R. canus** BENTH. Pl. Hartw. 294. 1848.
R. Californicus var. *canus* WATS. Bot. Calif. **1**: 8. 1876.

Plant canescent when young but often becoming green and sparingly villous; erect or ascending, rather large, 1 to 2 feet high: leaves with mostly 3 or more divisions; the middle one stalked; leaflets cuneate, 2–3-cleft and again incised: petals yellow, 5 to 6 lines long, obovate; sepals half as long, reflexed, soft-hairy: akenes about 2½ lines long; beak less than half as long, broad, hooked. Sacramento valley, Calif.

Var. **Blankinshipii** ROBINSON, Syn. Fl. **1**: 1: 35. 1895.

The silky coat persistent but less dense than in the typical plants: akenes plainly hispid and papillose. Capay, Yolo County, Calif.

Var. **hesperoxys** n. var.

R. hesperoxys GREENE, Erythea, **2**: 189. 1894.

Plants much greener than the type; doubtless due to the early falling of the canescence. California.

25. **R. amarillo** BERTOL. Fl. Guat. 24. 1840.

Hirsute, stem branched, ascending: lower leaves petioled; leaves compound; leaflets stalked, subcordate-ovate, acute, 3-lobed, cut-toothed; the upper leaves often short-petioled, ternate, divisions lanceolate, dentate: petals about 8, yellow, oblong-cuneate; sepals shorter, hairy, reflexed; flowers as large as *R. acris:* akenes compressed, glabrous; style long, erect but recurved at tip: head of fruit globose. Guatemala.

26. **R. repens** LINN. Sp. Pl. 554. 1753.

R. prostratus POIR. in Lam. Encycl. **6**: 113. 1804.

R. Clintonii BECK. Bot. 9. 1833.

Roots fibrous: plant more or less hairy; spreading by runners; flower stems often ascending 6 to 12 inches: leaves petioled, 3-divided; middle leaflet or all of them stalked, often again 3-lobed or cleft, and somewhat coarse toothed, bases cuneate or truncate: petals obovate, 5 to 6 lines long; sepals much shorter, spreading, hairy below: akenes compressed, margined; beak short, stout, slightly bent: head globose. May to July. Common. Nova Scotia and Newfoundland to Virginia, westward. Also Europe and Asia. Cultivated.

27. **R. palmatus** ELL. Sketch, **2**: 61. 1824.

Included by Gray, '86, with *R. septentrionalis* which it is much like; plant smaller, more decumbent; runners often long: leaves 1 inch across, thin, somewhat 3-parted or divided, divisions ovate, coarsely few-toothed; lowest leaves often subentire: flowers 6 lines broad. Pine lands and swampy places, Tennessee, South Carolina, Florida.

28. **R. Aschenbornianus** SCHAU. in Linnæa, **20**: 719. 1847.

Stem erect, many-flowered: leaves hairy to subhirsute; radical leaves long-petioled, ternate to bipinnate, the pinnules 3-parted to many lobed, the lobes nearly linear; peduncles silky: sepals reflexed: receptacle subpilose: akenes compressed, slightly margined, smooth, with fine impressions or punctures, style straight: fruit in a globose head. Mountains of Mexico near "Tutam."

29. **R. acriformis** GRAY, Proc. Am. Acad. **21**: 374. 1886.

R. acris HOOK. Fl. **1**: 18. 1829 (partly).

Plant with short rather appressed pubescence, slender, erect, 1 foot or more in height: leaves all 3–7-parted or divided; divisions 2–3-cleft or lobed, into lanceolate or linear segments which are often entire: petals yellow, roundly obovate, about 3 lines long; sepals about half as long, spreading or becoming reflexed: akene 1 to 2 lines long: beak half as long, curved. Eastern Rockies in Alberta; Montana, Wyoming; wet places. Southern Colorado at 10,000 feet.

R. Montanensis Rydb. Mem. N. Y. Bot. Gard. **1**: 166, 1900, is a form with beak more slender and more curved.

30. **R. Californicus** BENTH. Pl. Hartw. 295. 1848.

R. acris var. *Deppii* NUTT. ex Torr. & Gray, Fl. **1**: 21. 1838.

R. delphinifolius TORR. & GRAY, Fl. **1**: 659. 1838. Not Torr.

R. dissectus HOOK. &. ARN. Bot. Beech. 316. 1841. Not Bieb.

R. regulosus GREENE, Pitt. **2**: 58. 1890.

Roots fibrous: plant rather weak, ½ to 2 feet high, usually pubescent or hirsute; branching and without leaves in upper part: leaves ternately divided or parted, or palmately 5-divided into linear or narrow often 2–3-parted divisions: petals 6 to 15, glossy yellow, oblong or narrowly obovate, 4 to 6 lines long: akenes flat, slightly margined, nearly 2 lines long: beak very short. Rather dry places. Western California and adjacent Oregon, common. Cultivated.

Var. **Ludovicianus** (GREENE).

R. Ludovicianus GREENE, Bull. Cal. Acad. Sci. **2**: 58. Mch. 6 1886.

R. Californicus var. *latilobus* GRAY, Proc. Am. Acad. **21**: 375. 1886.

Basal leaves 3-parted, divisions broadly or narrowly cuneate, incisely cleft or laciniate: stem leaves not so much dissected. Southern California.

Var. **crassifolius** GREENE, Erythea, **1**: 125. 1893.

Stout and low, sparingly villous throughout: lower leaves not so deeply parted as the type, coarsely toothed; stem leaves mostly deeply parted into 3 oval or oblong quite entire segments: flowers and akenes larger than in the type. Ft. Bragg, Mendocino Co., Calif.

31. **R. Asiaticus** Linn. Sp. Pl. 552. 1753.

Roots fleshy: plant erect, either simple or branched, ½ to 1 foot high: leaves petiolate, becoming sessile toward the top, ternate or biternate; segments toothed or deeply 3-lobed; flowers terminating in the stems and branches, variable in color: calyx spreading, becoming reflexed; petals large, obovate, blunt: fruits in spike. May to June. Asia Minor. Flor. des Serr. **16**: 1679 (fl–pl). Revue Hort. Belg. **1890**: 133 (var. *superbissimus*). Sibth. Fl. Gr. 518. The cultivated forms of this species are constantly increasing in number. They are of two main types: (1) The florist's section called Persian Ranunculi or true *R. Asiaticus*. (2) The gardener's section, called Pivoine and Turban Ranunculi, or var. *Africanus*. There are many named forms of each in the American trade.

32. **R. abortivus** LINN. Sp. Pl. 551. 1753.
R. nitidus WALT. Car. 159. 1788.

Sparingly pubescent or quite glabrous, one-half to 2 feet high, branched: stem leaves sessile or short-petioled, once or twice 3-parted or lobed, segments oblong or linear, somewhat cuneate; lower leaves long-petioled, lucid green, crenate or lobed, broadly cordate, roundish, or ovate: petals pale yellow, hardly over a line long; sepals longer and larger, reflexed; receptacle short, pubescent: akenes compressed, glabrous, tipped with the minute, curved beak: head small, globose. Spring. Moist grounds and woods. Labrador to Florida, north and west to Colorado and British Columbia. Var. *encyclus* FERNALD, Rhodora, **1**: 52, 1899, a slender, flexuose form with thinner, glossy, orbicular, radical leaves.

Var. **Harveyi** GRAY, Proc. Am. Acad. **21**: 372. 1886.

R. abortivus var. *grandiflorus* ENGELM. ex Branner & Coville, Ark. Geol. Surv. **6**: 162. 1891.

R. Harveyi BRITTON, Mem. Torr. Club, **5**: 159. 1894.

Stem and foliage more slender and roots often thicker than in the type: plant somewhat pubescent: petals of the extreme forms 3 lines long and much longer than the sepals: akenes sometimes few, large and in a globose head, but varying to those of the type. Damp rocks, Arkansas to St. Louis, Mo.

Var. **australis** BRAND. Zoe **4**: 399. 1894.

Lower leaves large, reniform: petals 2 to 3 lines long; flowering in August. Abundant in wet places, high summits of Sierra de la Laguna and San Fransisquito, Lower California.

33. **R. sceleratus** LINN. Sp. Pl. 551. 1753.

Stems stout, hollow: plant glabrous or nearly so, one-half to 2 feet high, branching: radical and lower stem leaves thick, long-petioled, 3–5-lobed, reniform or cordate; lobes cuneate, crenately incised or cleft; upper stem leaves sessile or petioled, deeply lobed or parted; the lobes cuneate-oblong or linear, toothed or entire: petals 1 to 2 lines long, yellow; sepals often a little shorter: akenes numerous, very small, compressed, glabrous, barely apiculate: head oblong. April to Aug. Wet ditches and shallow water. New Brunswick to Florida and somewhat westward. Europe and Asia.

34. **R. eremogenes** GREENE, Erythea, **4**: 121. 1896.

R. sceleratus var. *multifidus* NUTT. ex Torr. & Gray, Fl. **1**: 19. 1838.

Leaves more dissected than *R. sceleratus:* stem nearly leafless: head of akenes nearly globose or ovate, large. Habitat of that species, eastern base of Rockies in Colorado to the Sierra Nevadas, to northwest British America and south to Arizona.

Var. **degener** GREENE, Pitt. **4**: 144. 1900.

Stems several, short, ascending: roots coarser than in the type: akenes with no marginal development: head more rounded. Southern Colorado.

35. **R. Allegheniensis** BRITTON, Bull. Torr. Club, **22**: 224. 1895.

R. abortivus HOOK. Fl. **1**: 15. 1829. In part.

This is also closely allied to *R. abortivus* in habit and foliage. Plant glabrous, not lucid: akenes slightly compressed and margined, tipped with subulate hooked or recurved styles hardly half their length. April, May, North Carolina, Virginia, Massachusetts.

36. **R. recurvatus** Poir. in Lam. Encycl. **6**: 125. 1804.
R. lanuginosus Walt. Car. 159. 1788. Not Linn.
R. saniculæformis Muhl. Cat. 54. 1813.
R. tomentosus Spreng. Neue Entd. **1**: 287. 1820.

Plant hirsute or only slightly hairy, erect, ½ to 2 feet high, branching: all the leaves petioled and never divided to the base, 1½ to 3 inches wide, deeply 3-cleft, the lobes broadly cuneate, acute, toothed or lobed: petals light yellow, about 2 lines long; sepals of same length or little longer: akenes compressed, margined: beak one-half their length, recurved. Damp woods, Nova Scotia to Lake of the Woods, south to Missouri and Florida.

37. **R. Bongardi** Greene, Erythea, **3**: 54. 1895.
R. occidentalis var. *parviflorus* Torr. Bot. Wilkes Exp. 214. 1854.
R. occidentalis var. *Lyalli* Gray, Proc. Am. Acad. **21**: 373. 1886. Not *R. Lyalli* Hook. f.
R. tenellus var. *Lyalli* Robinson, Syn. Fl. **1**: **1**: 33. 1895.
R. Greenei Howell, Fl. N. W. Am. **1**: 18. 1897.
R. Earlei Greene, Pitt. **4**: 15. 1899.
R. Lyalli Rydb. Mem. N. Y. Bot. Gard. **1**: 166. 1900.

Much like the following variety which is better known and was formerly considered the type. Plant more hirsute: leaf segments much broader: petals rather of the larger size, somewhat persistent: akenes somewhat hispid; styles rather long. Northern California to Colorada and Montana and to Fort Wrangel, Alaska.

Var. **Douglasii** (Howell).
R. recurvatus Bong. Veg. Sitch. 123. 1831. Mainly, not Poir.
R. tenellus Nutt. ex Torr. & Gray Fl. **1**: 23. 1838. Not Viviani.
R. Nelsoni var. *tenellus* Gray, Proc. Am. Acad. **8**: 374. 1872.

R. occidentalis var. *tenellus* GRAY, Proc. Am. Acad. **21**: 373. 1886.
R. occidentalis var. *Eiseni* GRAY, l. c. (in small part).
R. Nelsoni var. *glabriusculus* HOLZINGER, Cont. Nat. Herb. **3**: 210. 1895. Not *R. glabriusculus* Rupr.
R. Bongardi var. *tenellus* GREENE, Erythea, **3**: 54. 1895.
R. Douglasii HOWELL, Fl. N. W. Am. **1**: 18. Mch. 15. 1897.
R. arcuatus HELLER, Bull. Torr. Club, **24**: 310. June 29. 1897.

Slender, erect, usually over one foot high, slightly pubescent or glabrous, hirsute on petioles and peduncles: leaves deeply 3–5-cleft; segments broadly cuneate to oblanceolate, coarsely toothed: petals 1 to 2 lines long; receptacle glabrous: akenes compressed, glabrous, semi-oval; styles persistent, circinate-revolute; head small, globose. Southern California, Idaho, to Alaska.

38. **R. occidentalis** NUTT. ex Torr. & Gray, Fl. **1**: 22. 1838.
R. recurvatus var. *Nelsoni* DC. Syst. **1**: 190. 1818.
R. recurvatus (2 forms) SCHLECHT. Animad. Ranunc. **2**: 28. 1820.
R. Schlechtendalii HOOK. Fl. **1**: 21. 1829. (As to plant.)
R. Nelsoni GRAY, Proc. Am. Acad. **8**: 374. 1872.
R. Eiseni KELLOGG, Proc. Calif. Acad. Sci. **7**: 115. 1877.
R. occidentalis var. *Eiseni* GRAY, Proc. Am. Acad. **21**: 373. 1886 (mainly).
R. occidentalis var. *brevistylus* GREENE, Pitt. **3**: 14. 1896.

Plant villous with spreading hairs, 5 to 18 inches high: lower leaves petioled, round cordate, 3–5-cleft or parted; segments cuneate-obovate, often 2–3-cleft and cut; some leaves 3-divided with the leaflets stalked; upper stem leaves smaller with lanceolate segments: petals yellow, large, spreading; sepals half as long, reflexed: akenes glabrous or sparsely bristled: style flattened, subulate, hooked, half as long as akenes; receptacle glabrous: head of fruit ovoid. Low open places. Alaska to Montana and California.

Var. **Howellii** GREENE, Pitt. **3**: 14. 1896.
R. Howellii GREENE, ex Howell, Fl. N. W. Am. **1**: 17. 1897.

Rather leafy; upper leaves more deeply and repeatedly cleft: styles longer, slender, subulate, nearly straight. Dry hills, Ashland, Oregon, southward toward Klamath river, Calif.

Var. **ultramontanus** GREENE, Pitt. 3: 13. 1896.

Plant tufted; divisions of lower leaves not cuneiform, deeply cleft into lanceolate segments; upper ones lanceolate, entire: several flowers ½ inch across: styles hooked. Moist places, Truckee river, east of Sierras, Calif.

Var. **Rattani** GRAY, Proc. Am. Acad. **21**: 373. 1886.

R. Rattani HOWELL, Fl. N. W. Am. **1**: 17. 1897.

R. ciliosus HOWELL, l. c.

Differs from the type in having the akenes covered with short, stiff hairs and also roughened with papillæ. Josephine county, Ore., to central California.

Var. **robustus** GRAY, Proc. Am. Acad. **21**: 373. 1886.

R. occidentalis GRAY, Proc. Am. Acad. 8: 374. 1872.

Stem stout, often a foot high: flowers large, 9 to 15 lines long, long-peduncled: petals broadly obovate: akenes numerous, very large. Unalaska and islands westward.

39. **R. Turneri** GREENE, Pitt. **2**: 296. 1892, except syn.

Plant appearing much like a tall specimen of *R. occidentalis*: petals longer, 4 to 7 lines long: flowers long-peduncled: more akenes in a head; styles circinately-revolute, strongly so. Porcupine river, Alaska.

40. **R. acris** LINN. Sp. Pl. 554. 1753.

Plant hairy up to the sepals, erect, ½ to 3 feet high, often branched: radical leaves on long slender petioles; others with shorter petioles sheathing the stem, or nearly sessile: leaves 3-parted nearly to the base, the divisions ovoid-cuneate, 2–3-lobed and coarsely toothed or cut; bracts linear, lobed or entire: flowers yellow, 9 to 12 lines across, several, on rather short peduncles; sepals hairy beneath, ovate, shorter than the petals; petals 5, glabrous, obovoid, obtuse, bearing a prominent scale at base: akenes compressed, coriaceous on margins; style very short: head globose. May to September. Newfoundland, Canada, Eastern States. Said to be naturalized from Europe. Var. *flore-pleno* HORT. is more used in the trade. Bot. Mag. 215.

41. **R. McCallai** n. sp.

Stem erect, slender, 12 to 20 inches high, branched toward the top, somewhat pubescent: radical leaves hairy, on slender hairy peduncles 2 to 4 inches long; blade 3–5-parted nearly or quite to the base, segments less than 1 inch long, cuneate, divergent, cleft into 2 to 3 linear lobes; stem leaves none or bract-like, subtending the branches, or a small one near the middle: flowers 2 to 6, large, yellow; petals 5, obovate, entire or obcordate; sepals shorter, spreading, hairy: carpels ovate in a globose head; styles subulate, hooked: receptacle glabrous. Collected by W. A. McCalla (2113) near Banff, Alberta, Canada, July, 1899, in wet meadows. Differs from *R. acris* in its leaves, usually naked stem, etc.

42. **R. pedatifidus** J. E. SMITH in Rees' Cycl. No. 72. 1813–16.

R. arcticus RICHARDS. in Frankl. 1st Journ. 1 ed. App. 741. 1823.

R. affinis R. BR. Parry 1st Voy. App. 265. 1824.

R. amœnus LEDEB. Fl. Alt. **2**: 320. 1830.

R. auricomus HOOK. f. Arc. Pl. 283, 312. 1862.

Plant sparsely hairy, 3 to 15 inches high, slender, sometimes branched: radical and lower stem leaves petioled, broadly ovate, crenate, toothed, lobed, or cleft nearly to the base into segments which are often narrow; upper stem leaves deeply cleft, nearly sessile, lobes narrow: petals yellow, 3 to 4 lines long; sepals shorter, pubescent beneath: akenes often hairy, with short beak: head oblong to cylindric. Quebec to Arctic regions, west to Alaska; Rockies to Colorado and Arizona. Ledeb. Ic. *t. 113*.

Var. **cardiophyllus** BRITTON, Bull. Torr. Club, **18**: 265. 1891.

R. cardiophyllus HOOK. Fl. **1**: 14, and vars. *t. 6*. 1829.

R. affinis var. *lasiocarpus* TORR. Bot. Wilkes Exp. 213. 1854.

R. affinis var. *leiocarpus* TRAUT. ex Midden. Reise in Sibir. 62. 1856.

R. affinis var. *cardiophyllus* GRAY, Proc. Am. Acad. Phil. **1863**: 56.

R. affinis var. *validus* GRAY, Proc. Am. Acad. **21**: 371. 1886.

R. affinis var. *micropetalus* GREENE, Pitt. **2**: 110. 1890.

R. Arizonicus var. *subaffinis* GREENE, l. c. 60. Not Gray.

R. inamœnus GREENE, Pitt. **3**: 91. 1896.

Differs from the type in its stouter habit, radical leaves often cordate at base, usually not much lobed, but variable: flowers larger: akenes either hairy or glabrous. New Mexico and Arizona to Montana, east to Labrador.

Var. **pinetorum** (GREENE).

R. cardiophyllus var. *pinetorum* GREENE, Pitt. **4**: 144. 1900.

Stem short, canescently villous: roots strongly and copiously developed: leaves oval, often subcordate, or truncate at base, margins crenate: flower 1 inch across: head of akenes not so long as in the type, ovoid or globose. Pine woods, Graham's Park, southern Colorado. 7,800 feet.

43. **R. vicinalis** GREENE, Pitt. **4**: 145. 1900.

This is an Alaskan plant from the region of Fort Selkirk, which differs from *R. pedatifidus* in its larger flowers, and in having the radical leaves cleft or parted into about 7 lobes, and these again 3-cleft. But we find this leaf character in some Colorado forms of that type.

44. **R. Eschscholtzii** SCHLECHT. Animad. Ranunc. **2**: 16. *t. 1.* 1819.

R. nivalis var. *Eschscholtzii* WATS. Bot. King Exp. 8. 1871.

R. ocreatus GREENE, Pitt. **4**: 15. 1899.

Caudex short, oblique, roots fibrous: plant slightly hairy, 3–8 inches high: leaves roundish or broader in outline; stem leaves 3–5-lobed or parted, lobes lanceolate to oblong or linear spatulate; basal leaves with broader lobes, or lobed like the others: flowers 1 to 3; petals yellow, broadly obovate, sometimes slightly crenulate or obcordate, 3 to 6 lines long; sepals pubescent beneath: akenes lenticular, margined, glabrous; beak sharp, straight or sometimes recurved: head of fruit oblong or nearly globose. North Alaska in mountains to southern California, east to Colorado.

45. **R. eximius** GREENE, Erythea, **3**: 19. 1895.

R. alpeophilus A. NELSON, Bull. Torr. Club, **26**: 350. 1899.

Much like *R. Eschscholtzii*, but often larger, nearly glabrous:

radical leaves broader, less divided; upper leaves with lobes 1–2 inches long: sepals nearly glabrous: akenes broadly oval or obovate. Mountains of Wyoming, Idaho, Colorado.

46. **R. saxicola** RYDB., Mem. N. Y. Bot. Gard. **1**: 164. 1900.
Allied to *R. Suksdorfii;* differs slightly in the form of the lower leaves, which are often more reniform-flabellate: akenes pubescent: head of fruit oblong. Cedar mountain and Mill Creek, Montana, Yellowstone Park.

47. **R. Suksdorfii** GRAY, Proc. Am. Acad. **21**: 371. 1886.
Roots fibrous: stems slender, 3 to 6 inches high, glabrous: radical and lowest stem leaves small, about 6 to 8 lines long, subreniform to broadly flabelliform with truncate base, deeply 3–5-cleft or parted; divisons cuneate, again 3–5-cleft or incised; upper stem leaves with linear divisions: flowers 1 to 3, deep yellow; petals round obovate, retuse, 4 to 6 lines long: akenes turgid-lenticular, sharp-edged, glabrous; style persistent for a time, slender, ¾ line long, equalling the akene body: head of fruit globular. July to Aug. Damp places, 6,000 to 8,000 feet alt. Olympic mountains, Mt. Rainier, Mt. Adams east to the Blue mountains, Oregon and into Montana. Cultivated.

48. **R. ovalis** RAF. Proc. Dec. 36. 1814.
R. rhomboideus GOLDIE, Edin. Phil. Journ. **6**: 329. *t. 11. f. 1.* 1822.
R. brevicaulis HOOK. Fl. **1**: 13. *t. 7.* 1829.
R. auricomus var. *Cassubicus* E. MEYER Pl. Labr. 96. 1830.

Pubescent, 3 to 15 inches high: radical and lower leaves roundish to ovate-oblong, crenate, or slightly lobed, base truncate or cuneate, petioled, 3–7-divided, lobes linear or oblong: petals yellow, narrow, 3 to 6 lines long; sepals much shorter: akenes oval, minutely beaked: head of fruit globose. Wisconsin and northern Illinois, north to Labrador and the Northwest Territory.

49. **R. Arizonicus** LEMMON ex Gray, Proc. Am. Acad. **21**: 370. 1886.
R. affinis TORR. Bot. Mex. Bound. 29. 1858. (In part.)
Roots fascicled, somewhat thickened: plant glabrous or with soft-villous hairs below, 6 to 12 inches high: radical leaves

oval to oblong, cordate, crenate-dentate; the later ones often 5-cleft and again 3–5-lobed; stem leaves 1–3-ternate with narrow linear divisions: petals yellow, often 6 to 7, ovate to oblong, 3 to 5 lines long: akenes compressed, thin-margined, pubescent: head small, globose. Willow Spring, and mountains of southern Arizona.

Var. **subaffinis** GRAY, Proc. Am. Acad. **21**: 370. 1886.

R. Arizonicus GREENE, Pitt. **2**: 60. 1890.

R. subsagittatus var. *subaffinis* GREENE, Pitt. **2**: 110. 1890.

R. subaffinis RYDB. Bull. Torr. Club, **24**: 246. 1897.

Plant lower than the type, usually 1-flowered: akenes densely pubescent, with subulate style nearly their own length: head of fruit oval. High altitudes. Mt. Agassiz, in San Francisco, mountains of Arizona. Also Chihuahua.

Var. **subsagittatus** GRAY, Proc. Am. Acad. **21**: 370. 1886. Stouter than the above; villous at least at first: stem simple, few-flowered: radical leaves thick, oblong, bases subcordate to sagittate: petals broader than in the type: head of akenes larger, oval. Wet ground. Northern Arizona to San Francisco mountains.

50. **R. montanus** WILLD. Sp. Pl. **2**: 1321. 1799.

Rootstock creeping, 1–3 inches long, ⅓ inch thick: plant 6 inches high, pubescent with soft appressed or spreading hairs, especially toward the top: radical leaves few, petiolate, smooth, orbicular in outline, 3-parted, and lobed into blunt, toothed segments; stem leaves sessile or nearly so, clasping the stem, 3–5-parted into narrow somewhat toothed or entire lobes: flowers solitary, terminating the simple or once-branched stem, 1 inch or larger; sepals concave, acute, yellowish-green, slightly hairy; petals 5, large, broadly obovoid, bright yellow, with small scale and pore at base: akenes turgid, glabrous; beak strongly hooked, puberulent. May to July. Europe. Cultivated. Bot. Mag. 3022. Bot. Cab. 1610.

Var. **dentatus** BAUMG. Enum. Stirp. Magn. Trans. **2**: 124. About 1823.

R. carpaticus Herbich. Sel. Pl. Rar. Galic 15. 1836.

Leaves much more toothed than in the type: plant much taller: flowers larger. Cultivated. Bot. Mag. 7266. Garden **52**: 1138.

51. 1809. **R. corthusæfolius** WILLD. Enum. Hort. Berol. 588.

Root of thick, fleshy, fasciculated fibers: plant velvety hairy, 1 to 3 feet high: lower leaves long-petioled, roundish to reniform, incised, and with cut and toothed lobes; stem leaves divided into 3 to 5 narrow lobes; upper ones sessile: flowers several or many, terminal and axillary, rather paniculate; sepals 5, ovate to lanceolate, green with pale margins; petals 5, large, broadly obovate, glossy yellow: akenes compressed, hairy on sides, tapering into recurved styles nearly their own length: head of fruit short oval. May, Island of Teneriffe, Canary group. Garden, **45**: 944. Bot. Mag. 4625. Not very hardy, and needs protection in winter and early spring. It is well suited for pot culture. It is increased by division of the roots in autumn.

52. **R. longipedunculatus** SCHEIDW. in Hortic. Belge. **5**: 163. *t. 9.* 1838.

Roots fibrous: stem slender, weak, scapose, often once branched near the base: plant pilose with yellowish hairs: radical leaves 3-lobed, middle lobe trifid, otherwise mostly entire; true stem leaves wanting or very low; petioles 1 to 1½ inches long: peduncles 4 to 5 inches long, slender, erect or ascending, bibracteate: flowers 1 or 2, terminal; petals 12 to 15, oblong-lanceolate, acutish, yellow; sepals reflexed. Wet places, Real del Monte, north of Mexico City.

53. **R. Donianus** PRITZ. ex Walp. Rep. **2**: 740. 1843.
R. humilis D. DON, ex G. Don, Gen. Syst. **1**: 34. 1831. Not Pers. 1807.

Short, 1 to 3 inches high, pilose: radical leaves stalked, cordate, obtuse, slightly 3-lobed and crenate: peduncles long, radical, axillary and terminal: flowers small, yellow: carpels rather inflated, beaked. Mexico.

54. **R. multicaulis** D. DON, ex G. Don, Gen. Syst. **1**: 34. 1831.

Plant about 3 to 4 inches high, pilose: stems numerous, prostrate or ascending: radical leaves petioled, cordate-roundish, 3-lobed; lobes crenate: stem leaves sessile, entire, opposite or apparently so: flowers yellow, medium size; petals emarginate, much longer than the sepals which are reflexed: carpels rather inflated, pointed: head of fruit ovate. Mexico.

55. **R. Mexicanus** n. n.

R. geoides H.B.K. Nov. Gen. and Sp. **5**: 37. *t. 429.* 1821. Not Siev. 1794.

Roots fibrous: stem 5 to 8 inches high, simple or branched low; plant silky pubescent up to and including under side of sepals: radical leaves 3-parted nearly to midrib: divisions toothed or incised, ovate-cuneate; petiole 1 to 2 inches long; stem leaf with 3 to 5 narrow segments, sessile or on petiole sheathing the stem; bracts linear: flowers (rarely 2 to 3), large, terminating long, erect peduncles; sepals 5, ovate, much shorter than petals, reflexed; petals 10, spatulate oblong, rather obtuse, 5–7 lines long, spreading, claw provided with nectar pit and scale: akenes compressed, smooth; style as long as akene body, persistent for a time, erect. May. Real del Monte, north of Mexico City; Guajuco, Nuevo Leon, northern Mexico.

56. **R. uncinatus** D. Don ex G. Don, Gen. Syst. **1**: 35. 1831.

Roots fibrous: stem erect, 1 foot high: plant glabrous: radical leaves not seen; stem leaves long-petioled, 3-parted, segments 3-lobed; lobes toothed or again lobed, acute; leaves near the flower ternate, leaflets linear-lanceolate, acute, quite entire: flowers small, yellow, terminal and lateral, on slender peduncles: akenes few, ending in hooked beaks: head globose. Mexico.

57. **R. petiolaris** H.B.K. Nov. Gen. and Sp. **5**: 36. *t. 428.* 1821.

Roots fibrous: stem erect, striate, puberulent, somewhat branched above, about 6-flowered: radical leaves on petioles 6 to 7 inches long, 3-parted nearly to the midrib; the divisions often 2–3-lobed and incised; the lobes often somewhat oblong-cuneate, deep green and appressed-pubescent above, pale and appressed-pilose beneath; stem leaves short-petioled, smaller and with much more slender lobes; bracts linear-lanceolate, lobed or entire; base of petioles membranaceous, somewhat sheathing: flowers medium size, on erect peduncles which are pilose; sepals 5, ovate-oblong, acute, pilose beneath, shorter than the petals, reflexed, deciduous; petals 5, obovate, rounded at the end, a claw and scale at base, yellow, glabrous, about 4 lines long, much exceeding the stamens: akenes oblique, compressed, glabrous, rather abruptly joined to the short, persistent style: head of fruit subglobose. September. Near "Los Joares"; and Santa Rosa, state of Mexico. Altitude, 8,400 feet.

58. **R. adoneus** GRAY, Proc. Acad. Phila. **1863**: 56.
R. amœnus GRAY, Am. Journ. Sci. Ser. 2, **33**: 241. 1862. Not Ledeb.
R. orthorynchus var. *alpinus* WATS. Bot. King Exp. 9. 1871.

Root slender-fibrous: plant shaggy-hairy, 4 to 12 inches high, sometimes becoming decumbent: leaves usually 2–3-times 3-parted and lobed, lobes all narrow-linear, acute; primary divisions of leaves sessile or nearly so; petioles of basal leaves membranous in lower part; stem leaves sessile or on a sheathing base, usually borne opposite resembling an involucre: petals 5 (or 6 to 8), large, yellow, rounded outwardly, cuneate at base, 6 lines long, much exceeding the lanceolate sepals which are hairy beneath: akenes somewhat compressed, acutish: style long, straight, subulate; head globular to oblong. Summer. Rockies of Colorado. Altitude 10,000 feet. Cultivated. Introduced 1881.

59. **R. triternatus** GRAY, Proc. Am. Acad. **21**: 370. 1886.

Roots fascicled, fleshy-fibrous: plant low: leaves often 3-times 3-divided and parted; leaflets long-petioled, their lobes narrow-linear to linear-spatulate and obtuse: petals yellow, 4 to 5 lines long, obovate: akenes turgid, not margined; beaks slender: receptacles thick: head of fruit globose. Near Goldendale, S. Wash.

60. **R. Grayi** BRITTON, Bull. Torr. Club, **18**: 265. 1891.
R. pedatifidus HOOK. Fl. **1**: 18. *t. 18.* 1829. Not Smith.
R. Hookeri REGEL, Bull. Soc. Nat. Mosc. **34**: 2: 47. 1861. Not Schlecht.
R. Drummondi GREENE, Erythea, **2**: 192. 1894.

Rather stout, 1–2-flowered: basal leaves either biternately or pedately divided and parted into linear oblong or spatulate lobes, main divisions often stalked: stem leaves similar, only 1 or 2: petals 3 lines long; sepals shorter, sparsely and finely villous: akenes each about 1 line long, borne in a globular head. Lat. 52° to 55°, on eastern Rockies, Gray's Peak, Colo., and near Ironton, 12,000 to 13,000 feet.

61. **R. pygmæus** Wahl. Fl. Lapp. 157. *t. 8. f. 1.* 1812.
R. Lapponicus Oed. Fl. Dan. *t. 144.* 1762. Not Linn.

Very minute, 1 or 2 inches high, puberulent or glabrous: leaves 3–5-lobed or divided, 2 to 5 lines wide, lower ones on slender petioles, others subsessile: flowers 2 to 3 lines across; petals yellow, little longer than the sepals: akenes lenticular; beak slender: head of fruit somewhat oblong, 2 lines long. High Rockies of Montana to Colorado, polar regions across America, Greenland, Europe and Asia.

Var. **Sabinii** n. var.
R. Sabinii R. Br. Parry 1st Voy. App. 264. 1824.
Flowers larger than the type: sepals hairy. Montana.

62. **R. oxynotus** Gray, Proc. Am. Acad. **10**: 68. 1874.

Caudex short, roots fibrous: plant glabrous, 4 to 10 inches high: radical leaves in a numerous tuft, 6 to 10 lines across, mostly round-reniform, with several roundish lobes or deep crenations: stem leaves 1 or 2, flabelliform to cuneate, 3–5-cleft or parted; lobes lanceolate-linear to oblong: petals yellow, broadly obovate, 4 to 5 lines long, exceeding the sepals: akenes compressed, semiovate, glabrous, about 1 line long; beak strong, subulate: head of fruit 6 lines long: receptacle thick and fleshy. Mineral King Mt., Mariposa Co., and central Sierras, all in California.

63. **R. digitatus** Hook. Kew Journ. **3**: 124. *t. 4.* 1851.

Very low, glabrous: roots a cluster of slender tubers: stem leaves few, subsessile, 2–4-parted; lobes oblong-lanceolate to nearly linear; radical leaves similar or entire and lanceolate, petiolate: petals 5 to 11, yellow, spatulate-oblong, 3 to 5 lines long: akenes slightly compressed and margined; styles slender: head very small, often elongated. Yellowstone Park to northern Nevada.

64. **R. glaberrimus** Hook. Fl. **1**: 12. *t. 5.* 1829.
R. brevicaulis Hook. Lond. Journ. Bot. **6**: 66. 1847.
R. Austinæ Greene, Erythea, **3**: 44. 1895.

Root a cluster of thickened fibers: plant rather succulent, 4 to 10 inches high, glabrous: radical leaves roundish to oblanceolate or spatulate; base tapering or obtuse, often 2–5-lobed above, or crenate or entire; stem leaves usually deeply 3-lobed or parted, lobes entire: petals yellow, broadly obovate, 3 to 6 lines long; sepals nearly as long, often purple beneath: akenes puberulent or glabrous, lenticulate, slightly margined, with small, short beak: fruit in a globose to oblong head. Early spring. British Columbia to California and Colorado.

Var. **ellipticus** GREENE, Fl. Francis, 298. 1892.

R. ellipticus GREENE, Pitt. **2**: 110. 1890. **3**: 92. 1896.

Basal leaves elliptic-lanceolate to oblong, entire or only once lobed on one side: petals often much narrower than in the type: head of akenes drooping to the ground. Distributed with the type in its lower altitudes and southern range.

65. **R. Macauleyi** GRAY, Proc. Am. Acad. **15**: 45. 1880.

R. nivalis REP. Chief Eng. U. S. A. **1878**: 1833. Not Linn.

Some of the roots thick and fleshy: plant 3 to 7 inches high; stem villous-hairy to glabrous, young leaves very villous on margins: leaves thick, lanceolate to ovate-spatulate, entire except toward the apex, there often coarsely or finely 2 to 10 toothed; lower leaves petiolate, others sessile or on short, sheathing petioles: petals obovate to flabelliform, crenulate, 5 to 7 lines long, yellow; sepals shorter, densely coated beneath with dark brown hairs; peduncles hairy: akenes smooth, somewhat compressed, slightly margined; styles linear-subulate, persistent, nearly straight: head of fruit ovate to oblong or cylindric. Near snow line, 11,500 feet altitude in La Plata mountains and San Juan Co., Colo.

66. **R. nivalis** LINN. Sp. Pl. 553. 1753.

R. sulphureus SOLAND. in Phipp's Voy. 202. 1774.

A short caudex with slender roots: plant pubescent or becoming glabrous below, 3 to 7 inches high: lower leaves cuneate-flabelliform to reniform, about 3-lobed or deeply cleft; lobes sometimes notched; upper leaves subsessile, about 5-lobed or parted, divisions linear-oblong, entire: petals yellow, obovate to roundish, sometimes emarginate, 3 to 4 lines long; sepals shorter, densely wooly: akenes rather turgid; beak subulate. Greenland, Hudson Bay region, Alaska, Hall island, Behring Sea, south in Rockies to Lat. 55°, Northern Asia and Europe.

67. **R. natans** C. A. MEYER ex Ledeb. Ic. *t. 114.* 1830.

R. radicans C. A. MEYER ex Ledeb. Ic. *t. 116.* 1830.

R. Purshii TORR. Ann. Lyc. N. Y. **2**: 162. 1828. Not Richards.

R. hyperboreus var. *natans* REGEL, Bull. Soc. Nat. Mosc. **34**: pt. 2: 43. 1861.

Much like *R. hyperboreus*, but differing in having leaves larger, reniform or truncate at base, lobes 3 to 5, often more rounded: petals much larger; receptacle thickened and fleshy: head of fruit larger. Creeping and rooting in mud or sometimes floating in shallow water. Rockies of Colorado. Also northern Asia.

68. **R. hyperboreus** ROTTB. Skrift. Kjoeb. Selsk. **10**: 458. *t. 4. f. 16.* 1770.

Low creeping plant with slender and glabrous stems and petioles: one or two leaves from each (rooting) node, broadly ovate with rounded or truncate bases, 3-lobed or slightly cleft, margins of lobes nearly entire; petioles sheathing at the base: flowers minute, few, yellow; petals about equalling the reflexed sepals; peduncles 1 inch or less in length: akenes hardly compressed; beak almost wanting: head of fruit globose, hardly 2 lines broad. Wet soil. Greenland, Labrador, Arctic Alaska; also Europe and Asia.

69. **R. Lapponicus** LINN. Sp. Pl. 553. 1753.
Anemone nudicaulis GRAY, in Bot. Gaz. **11**: 17. 1886.

Scapose from filiform rootstocks, 3 to 6 inches high: radical leaves long-petioled, 3-parted, the divisions obovate-cuneate, obtuse, crenate or lobed: scape slender, taller than the leaves, often with a lobed, bract-like leaf: flower solitary, yellow; petals 5 to 6; sepals of about the same length, reflexed: akenes a line or more long, ovate, tapering into the persistent, hooked beak. North shore of Lake Superior, west to the Rockies, north to Arctic America; also Europe and Siberia.

70. **R. delphinifolius** TORR. ex Eaton, Man. 2 ed. 395. 1818.
R. multifidus PURSH, Fl. **2**: 736. 1814. Not Forsk.
R. flaviatilis BIGEL. Fl. Bost. 1 ed. **1**: 39. 1814. Not Willd.
R. lacustris BECK & TRACY, N. Y. Med. & Phys. Journ. **2**: 112. 1823.
R. Beckii G. DON, Gen. Syst. **1**: 39. 1831.
R. Purshii var. *aquatilis* LEDEB. Fl. Ross. **1**: 35. 1841.
R. multifidus var. *terrestris* GRAY, Man. 5 ed. 41. 1867.

Aquatic or partly emersed, with long fistulous stems: submersed leaves ternately decompound into narrow filiform or capillary divisions, flaccid, petioles very short and sheathing; emersed leaves smaller, and much less dissected, often only 3–7-parted into cuneate lobes, petioles often longer than blades; young leaves from nodes taking root on muddy banks, still less lobed and divided, their petioles and under sides hairy: petals deep yellow, 5 to 8, broadly obovate, 4 to 6 lines long, exceeding the sepals: akenes rather turgid, obliquely ovate, hardly 1 line long, becoming callous-margined on base and ventral edge; beak half their length, straight, compressed: head of fruit globose or oblong. Quiet water, and muddy ditches and banks. North Carolina to northern Canada, west to British Columbia and California. Also Siberia.

71. **R. Purshii** RICHARDS, Frankl. 1st Journ. 741. 1823.

R. pusillus LEDEB. Mem. Acad. Petrop. **5**: 546. 1812.

R. Gmelini DC. Syst. **1**: 303. 1818.

R. Langsdorfii DC. Prod. **1**: 34. 1824.

R. limosus NUTT. ex Torr. & Gray, Fl. **1**: 20. 1838.

R. radicans REGEL, Bull. Soc. Nat. Mosc. **34**: pt. 2: 44–5. 1861. Not Mey.

R. multifidus var. *limosus* LAWSON, Rev. Canad. Ranunc. 47. 1870.

R. multifidus var. *repens* WATS. Bot. King Exp. 8. 1871.

Stems slender, rooting at lower nodes and creeping, in muddy places, pubescent on younger parts: leaves slender-petioled, 3 to 12 lines broad, palmately divided into obtuse lobes and segments: petals yellow or whitish, 1 to 3 lines long, ovate; sepals smaller, falling early: akenes smooth, ½ line long, no caloused margin; style persistent, slender, shorter than the body: head of fruit smaller than in *R. delphinifolius*. Bogs, ditches, etc. Arctic America to Northern Michigan, west to British Columbia and Washington, south to New Mexico.

72. **R. Missouriensis** GREENE, Erythea, **3**: 20. 1895.

Much like *R. Purshii* in habit and leaves: differs in being sparingly pubescent: leaves wider than long, 1 to 3 inches wide: head of fruit more oblong: akenes prominently callous-margined up one edge, sides wrinkled; style subulate, ½ as long as body. Missouri to New Mexico.

73. **R. aconitifolius** LINN. Sp. Pl. 551. 1753.

Plant pubescent, ½ to 3 feet high, branched: leaves palmately 3–5-parted, parts cut-toothed, upper ones sessile and with oblong to linear-lanceolate lobes: flowers white, several on a stem; sepals flat, pubescent; petals oblong, cuneate to orbicular. May to June. Mountains of middle Europe. Var. *flore-pleno* HORT., called White Bachelor's Button, and Fair Maids of France, has very ornamental, double, white, globose flowers. Garden 45, p. 29 and 48, p. 506. Var. *luteus-pleno* HORT., flowers much doubled but of a golden yellow color. The type and varieties are used in borders and half wild places.

74. **R. Pallasii** SCHLECHT. Animad. Ranunc. **1**: 15. *t. 2.* 1819.

Plant creeping, glabrous: stems and petioles large, hollow; ascending part of stem naked or 1-leaved: leaf-blades short, linear to oblong, rather obtuse, entire or sometimes 2–3-lobed: petals 8 to 11, oblong to obovate, white, 4 to 6 lines long; sepals 3 to 4, shorter, greenish, broad: akenes thin-crustaceous, 2 lines long; beak short. In shallow water. Arctic Alaska, St. Lawrence islands, etc., across to northern Asia, and Lapland.

75. **R. amplexicaulis** LINN. Sp. Pl. 549. 1753.

Stems erect, 5 to 10 inches high, with two or three flowering branches, glabrous: leaves entire, ovate to lanceolate, amplexicaul, acuminate, glabrous or at first with hairy edges soon becoming glabrous, glaucous: flowers 3 to 6, either terminal or axillary, pure white with yellow stamens; sepals pointed; petals much larger, obtuse. Mountains of southeastern Europe. The plant is well suited to garden use and does not intrude upon other plants. It does not do well in the dryest places. The cut flowers preserve their freshness well. Bot. Mag. 266 (poor). Bot. Cab. 1593. Journ. Hort. III, 35, p. 345. Gard. Chron. 1883, **19**: 788.

76. **R. Lambertianus** D. DIETR. Syn. Pl. **3**: 316. 1843.

Plant swimming: leaves lanceolate, entire or subdenticulate, their long petioles sheathing the stem at their base: flowers small, yellow, axillary or terminal; petals obtuse, longer than the stamens and sepals. Wet places. Mexico. *R. natans* NEES, ex G. Don, Gen. Syst. **1**: 31, 1831 (not C. A. Meyer), is probably a form of this with leaves sometimes bifid. Mexico.

77. **R. arnoglossus** GREENE, Pitt. **4**: 143. 1900.

Plant tufted, about 6 inches high: leaves feather-veined, elliptic and elliptic-lanceolate, entire; petioles of all shorter than the blade, sheathing at base: flowers many, large; petals 5, obovate, obtuse, commonly persistent with the sepals: akenes many: head dense, globose. Subalpine in the Ruby mountains of eastern Nevada.

78. **R. unguiculatus** GREENE, Pitt. **4**: 142. 1900.

Stem 1 foot or more high, solitary: radical leaves 1 or 2 only, erect, elliptical, or obovate-elliptic, acute, entire or obscurely denticulate, 2 to 3 inches long; petioles as long; stem leaves narrower, short-petioled: flowers 2 to 4, or more in the large plants; peduncles long, puberulent, naked; petals about 10, persistent, narrow, claw ½ line long; sepals narrow, spreading, deciduous: akenes glabrous, obliquely obovoid, slightly compressed; beak stout, slightly recurved: head depressed globose. 11,500 feet. Southern Colorado. C. F. Baker, August 28, 1899.

79. **R. ambigens** WATS. Bibl. Index, **1**: 16. 1878.

R. Flammula PURSH, Fl. **2**: 391. 1814. Not Linn.

R. Lingua PURSH, l. c. Not Linn.

R. alismæfolius BENTH. Pl. Hartw. 295. 1848. In part. Not Geyer.

R. obtusiusculus BRITTON, Ill. Fl. **2**: 76. 1895. Not Raf.

Plant 2 to 3 feet high, stout, glabrous or nearly so, erect, but sometimes rooting at the lower nodes, hollow: leaves usually on short petioles with broad, membranous, sheathing bases; blades lanceolate with tapering bases, serrate, denticulate or entire, 2 to 4 inches long: petals 5 to 7, yellow, 2 to 3 lines long; sepals shorter: akenes small, obliquely oval, compressed, thickened along one margin; beaks subulate, narrow, erect or little curved, nearly as long as akene body: head of fruit globose. Wet grass lands. Mountains of Georgia and Tennessee to Missouri, north and east to Canada and New England.

Var. **obtusiusculus** n. var.

R. obtusiusculus RAF. in Desv. Journ. Bot. **1**: 225. 1808.

Differs from the type in its slender, straight, erect stem: its single root, like an annual, and its linear-lanceolate sepals.

80. **R. Madrensis** Rose, Cont. Nat. Herb. **5**: 199. 1899.

Plant erect, rather slender, 6 to 12 inches high, glabrous on lower parts; 1–4-flowered; radical leaves 1 to 2 inches long, petioled, linear to linear-oblong, with coarse distant teeth, obtuse; base cuneate; stem leaves reduced to bracts, simple or 3-lobed: flowers yellow, on long slender peduncles which are hairy near the flower; receptacle hairy; petals about 10, obovate to oblong, 3 to 4 lines long: akenes hardly 1 line long, compressed, glabrous; beak as long, slender. Sierra Madre mountains, between Santa Gertrudis and Santa Teresa, Tepic Ty., and in Zacatecas. Altitude 7,400 to 10,000 feet.

81. **R. alismæfolius** Geyer, in Benth. Pl. Hartw. 295. 1848.

R. Flammula Hook. Lond. Journ. Bot. **6**: 66. 1847.

R. Bolanderi Greene, Bull. Calif. Acad. Sci. **2**: 58. 1886.

R. Hartwegi Greene, Erythea, **3**: 45. 1895.

Roots fibrous, fascicled: plant erect, usually robust, 6 to 15 inches high, branching or nearly simple, slightly pubescent on peduncles: leaves oblong to lanceolate, tapering at base, entire or denticulate, 1 to 3 inches long; petioles short and broad, sheathing at base; upper stem leaves sessile: petals yellow, 6 to 10, obovate, 4 to 6 lines long; sepals much shorter, reflexed: akenes compressed, smooth; beak short, often hooked: head of fruit nearly globose. Wet grounds. British Columbia and Colorado to California.

Var. **Calthæflorus** n. var.

R. Calthæflorus Greene, Erythea, **3**: 45. 1895.

Leaves repand-denticulate, and much broader than the type: flowers and petals not different. Colorado, in boggy ground, 8,000 feet.

82. **R. alismellus** Greene, Fl. Francis, **2**: 97. 1892.

R. alismæfolius var. *alismellus* Gray, Proc. Am. Acad. **7**: 327. 1868.

R. alismæfolius var. *montanus* Wats. Bot. King Exp. 7. 1871.

Much like *R. alismæfolius*, but usually very slender, dwarf, often nearly scapiform: leaves lanceolate-elliptical to ovate: petals smaller, 3 lines long. Plants often form a thick covering over the wet ground. High altitudes, Sierra and Trinity Mts., California to Colorado and northward.

Var. **Populago** n. var.

R. Populago GREENE, Erythea, **3**: 19. January, 1895.

R. Cusickii JONES, Proc. Calif. Acad. Sci., Ser. 2, **5**: 615. October; 1895.

Like the type, but with radical leaves ovate, cordate; margins slightly wavy. Southwestern Oregon, Idaho.

83. **R. Lemmoni** GRAY, Proc. Am. Acad. **10**: 68. 1874.

Stems scapose, tufted, 5 to 10 inches high: plant villous-pubescent on lower parts: leaves rather thick, lanceolate, entire: flowers 1 or 2 on a stem; petals about three lines long, obovate to oblong: akenes turgid, villous-pubescent, borne in an oval head. Rare. Truckee and east part of Sierras, California.

84. **R. oblongifolius** ELL. Sketch **2**: 58. 1824.

R. Flammula MICHX. Fl. **1**: 221. 1803. Not Linn.

R. Flammula var. *laxicaulis* TORR. & GRAY, Fl. **1**: 16. 1838.

R. pusillus var. *oblongifolius* TORR. & GRAY, l. c. 17.

R. laxicaulis DARBY, Bot. S. St. 204. 1855.

Annual; about 1 to 2 feet high, erect or ascending, rarely rooting at the lower nodes, branched above, many-flowered: leaves shaped nearly as in *R. pusillus*, or sometimes broader: petals 5, yellow, longer than the sepals; stamens many: akenes few, often globular or slightly flattened, smooth or minutely punctate; style deciduous: head of fruit globose. April to September. Wet grounds. Florida to southern Virginia, west to southern Missouri and Texas.

85. **R. hydrocharoides** GRAY, Mem. Am. Acad. **5**: 306. 1855.

Stems ascending, 5 to 10 inches high, rooting at the lower nodes, with creeping, fistulous branches at the base: leaves mostly long-petioled, entirely or nearly so, usually less than 1 inch long, rather succulent; basal leaves round-cordate to oval, blending into the form of the upper ones which are obovate to spatulate: petals 5 or more, 2 to 3 lines long; sepals much shorter: akenes small; beak narrow, short: head of fruit small, globose. In standing water and wet soil. Southwestern Arizona into adjacent California, and in Lower California, at La Chuparosa and Sierra de la Laguna. Flowers appearing very late at high altitudes.

86. **R. samolifolius** GREENE, Pitt. **3**: 13. 1896.

Much like *R. hydrocharoides*. Leaves entire, obtuse, oblanceolate, petioled; upper ones oval or obovoid: petals obovate; sepals round-ovoid, spreading: akenes like that species. High altitude, Mt. Shasta, southward.

87. **R. stolonifer** HEMSL. Diag. Pl. Nov. 17. 1879.

Plant small, entirely glabrous, spreading by stolons: stem erect, 2 to 6 inches or less: leaves subentire or sometimes crenate, the radical ones long-petioled, reniform or roundish elliptical to lanceolate-oblong; blade 3 to 12 lines long, petiole 1 to 2, with base membranous and dilated; stem leaves sessile, narrow: flowers small, yellow, long-peduncled; receptacle conical, glabrous; sepals oblong, 1 to 1½ lines long; petals 5 or 6, oblong-elliptical, about 1¼ lines long, the long claw with a conspicuous nectary; stamens longer than petals, filaments dilated: akenes much compressed, slightly margined, glabrous: head of fruit globose. Near Morales in San Luis Potosi, Mex., 6,000 to 8,000 feet altitude.

88. **R. vagans** WATS. Proc. Am. Acad. **26**: 131. 1891.

Plant low, glabrous, spreading by elongated stolons: leaves narrowly lanceolate, or the lowest ovate-lanceolate, entire or with a few often slender teeth toward the apex: petals 8 to 10, oblong-obovate, about 2½ lines long, a prominent nectar pore above the narrow claw; sepals little over half as long: akenes smooth, in a dense globose head 2½ lines in diameter. Flor de Maria, State of Mexico. Aug., 1890. Pringle no. 3177.

89. **R. reptans** LINN. Sp. Pl. 549. 1753.

R. filiformis MICHX. Fl. **1**: 320. 1803.
R. reptans var. *filiformis* DC. Syst. **1**: 248. 1818.
R. Flammula var. *filiformis* HOOK. Fl. **1**: 11. 1829.
R. Flammula var. *reptans* E. MEYER, Pl. Labr. 96. 1830.

Stem prostrate, rooting at the nodes, pubescent or nearly glabrous: leaves linear-lanceolate to spatulate, usually entire, 1 to 2 inches long, narrowed into the petiole: peduncles ascending, 1 to 3 inches, each terminated by a single flower; petals

4 to 7, bright yellow, 2 to 3 lines long, exceeding the sepals; stamens many: akenes flattened somewhat; beak minute, sharp. Coast of Arctic America, Newfoundland; near ponds and lakes, New Jersey to California: Greenland, Europe, Asia.

Var. **Gormani** n. var.

R. Gormani GREENE, Pitt. 3: 91. 1896.

Like the type, but with leaves broadly ovate or deltoid-ovate, acute, few-toothed, 6 to 8 lines long. Near Crater lake, southern Oregon.

90. **R. Unalaschensis** BESS. ex Ledeb. Fl. Ross. 1: 32. 1841.

R. Flammula var. *intermedius* HOOK. Fl. 1: 11. 1829.

R. reptans var. *intermedius* TORR. & GRAY, Fl. 1: 16. 1838.

R. Flammula var. *Unalaschensis* LEDEB. ex Regel, Bull. Soc. Nat. Mosc. 34: pt. 2: 41. 1861.

R. reptans var. *strigulosus* FREYN, Deutsch. Bot. Monats. 8: 181. 1891.

R. intermedius HELLER, Bull. Torr. Club, 25: 280. 1898. Not Poir. nor Eaton.

This differs from *R. reptans* in its more robust habit, longer peduncles, leaves larger, sometimes being 3 to 5 inches long and 2 to 6 lines wide. Newfoundland past the Great Lakes to Oregon and California, northward. Europe. Asia.

91. **R. microlonchus** GREENE, Erythea, 4: 122. 1896.

Allied to *R. reptans*, often more hairy; stem slender, somewhat ascending, 1–few-flowered: radical leaves in a tuft, shaped as in that species or a little broader; stem leaves few, short petioled to subsessile: flowers 4 lines broad; petals 5 to 8, obtuse; sepals spreading: akenes as in that species but with a short, stout, blunt beak: head of fruit depressed-globose. Northern Idaho.

92. **R. trachyspermus** ENGELM. ex Gray Pl. Lindh. 1: 3. 1850.

R. trachyspermus var. *angustifolius* ENGELM. l. c.

Annual: plant glabrous, ½ to 2 feet high, sometimes rooting at the lower nodes: leaves slender-petioled, oblong to linear lanceolate, entire or denticulate, bases often tapering; petioles of stem leaves expanded near the bases: peduncles rather short;

petals 1 to 3 or 5, pale yellow, about 1 line long; stamens only 5 to 10: akenes oblong, hardly compressed, slightly margined; beak very short: head of fruit oblong. Low, wet places, Dallas, Tex., south and southeast.

93. **R. pusillus** POIR. in Lam. Encycl. 6: 99. 1804.
R. Flammula WALT. Car. 159. 1788. Not Linn.
R. Bonariensis POIR. in Lam. Encycl. 6: 102. 1804.
R. humilis PERS. Syn. 2: 102. 1807.

Annual: plant ½ to 2 feet high, slender, weak, branching, glabrous: basal and lower stem-leaves mostly ovate, petiolate; others nearly sessile, linear or lanceolate; all entire or minutely toothed: petals yellow, few, barely exceeding the sepals; stamens 1 to 10: akenes obovate, tipped with the base of the style: head of fruit globose. Marshy ground, New York, New Jersey, to Florida, through Gulf region to Texas and Missouri.

Var. **Lindheimeri** GRAY, Proc. Am. Acad. 21: 367. 1886.
R. trachyspermus var. *Lindheimeri* ENGELM. ex Gray Pl. Lindh. 1: 3. 1850.
R. Biolettii GREENE, Pitt. 2: 225. 1892.

Low, rarely a foot high: akenes more papillose-roughened than in the type. Middle coast of California to Galveston, Tex., and New Orleans.

94. **R. Andersoni** GRAY, Proc. Am. Acad. 7: 327. 1868.
Oxygraphis Andersoni FREYN, Flora, 70: 140. 1887.

About 6 to 8 inches high, stem one-leaved or a naked scape: basal leaves rather thick, 2 to 3 times ternately or pedately divided or parted, lobes linear to lanceolate: flowers 1 or 2; sepals glabrous; petals ½ inch long, pink or rose, orbicular, obovate or flabellate, claws narrow: akenes compressed, but wholly utricular with membranous walls, oblique obovate to orbicular, ¼ inch long, a very narrow membranous margin; apex abruptly sharpened with a very short style. Boise City, Idaho, Salt lake, Utah, to eastern Sierras of California and Nevada.

95. **R. juniperinus** JONES, Proc. Cal. Acad. Sci., Ser. 2, 5: 616. 1895.
R. Andersoni var. *tenellus* WATS. Bot. King Exp. 7. *t. 1, f. 8–10.* 1871.

Plant taller and more slender than *R. Andersoni;* usually branched once, 1-leaved and 2-flowered: radical leaves more finely dissected than in that species: petals white or rose-purple without: akenes flat, not inflated, very small, only 1 to 1½ lines long. Rocky places in woods of Utah.

96. **R. glacialis** LINN. Sp. Pl. 553. 1753.

Roots fibrous: plant low: lower leaves petioled, others sessile and involucrate, all 3-parted or trifid and again lobed; upper ones often villous: flowers 1 to 3, white or reddish; petals obovate to cuneate, blunt; sepals shorter, very densely hairy. Summer. Mountains of Europe, Arctic regions, Greenland. Garden 45, p. 28; 48 p. 501.

KUMLIENIA GREENE, Bull. Calif. Acad. **1**: 337. 1886.

(Named for the late botanist, Prof. Kumlien of Wisconsin.)

Low perennials; stem nearly leafless, 1–2-flowered: leaves mostly radical, rounded and lobed: sepals 5 to 7, white, conspicuous; petals 5, small, oval, fleshy, with nectariferous pit and slender claw; stamens and pistils many: akenes lanceolate, acuminate, compressed, membranaceous, and utricular, obscurely 1-nerved on the sides; style hooked, persistent; seed much shorter than the cell. A monotypic genus of narrow distribution. Of it Greene remarks that it has the general aspect of *Ranunculus;* flowers of *Caltha*, with nectary-like petals of *Helleborus*, the utricular fruit peculiar. This is section PSEUDAPHANTOSTEMMA of Gray, under *Ranunculus*.

K. histricula GREENE, l. c.

Ranunculus hystriculus GRAY, Proc. Am. Acad. **7**: 328. 1868.

Stems 4 to 10 inches high, bearing 1 or 2 3-lobed leaves: radical leaves round-reniform, with 5 broad rounded lobes; petioles long: flowers 1 or 2: akenes 3 lines long including the style. April to June. Portland, Ore., east to the Sierra Nevadas. Rare.

FICARIA HUDS. Fl. Angl. 213. 1762.

(Latin for fig, referring to the thickened roots.)

Perennial herbs with tuberous roots; plants all glabrous; stems branched or simple: leaves petioled, entire or toothed, cordate: flowers large, solitary, either axillary or terminal; sepals 3 to 5, deciduous; petals about 8 (7 to 12), yellow, or red at the base; carpels numerous, blunt, not wrinkled nor ribbed, cotyledon only 1: akenes borne in a head. A genus of only about three species natives of Europe and Asia. The following one is naturalized here:

F. ranunculoides MOENCH, Meth. 215. 1794.

Ranunculus Ficaria LINN. Sp. Pl. 550. 1753.
F. verna HUDS. Fl. Angl. 1 ed, 214. 1762.
F. polypetala GILID. Fl. Lituan. **2**: 259. 1781.
F. Ficaria KARST. Deutsch. Fl. 565. 1880–83. (Not binomial.)
F. communis DUM.-COURS. Bot. Cult. 2 ed. **4**: 445. 1811.
F. calthæfolia REICHB. Fl. Germ. Excurs. 718. 1830–32.
F. grandiflora ROBERT, Cat. Toulon, **57**: 112. 1838.
F. Roberti F. SCHULTZ, Arch. Fl. 346. 1848.
F. ambigua BOR. Fl. Cent. Fr. 3 ed. **2**: 20. 1857.
F. nudicaulis KERN. in Oestr. Bot. Zeitschr. **13**: 188. 1863.
F. intermedia SCHUR. Enum. Pl. Transs. 14. 1866.
F. transsilvanica SCHUR. l. c. 14.
F. aperata SCHUR. in Verh. Naturf. Ver. Bruenn. **15**: 231. 1877.
F. Holubyi SCHUR. l. c. 32.
F. rotundifolia SCHUR. l. c. 32.

Stem scape-like, or 1–2-leaved, about 5 inches high: leaves ovate cordate, obtuse, crenate, 1 to 2 inches long; petioles broad: flowers yellow; petals 8 or 9; sepals 3: head of fruit globose: akenes beakless, truncate. Run wild on Long island; Staten island; Hingham, Mass.; Richmond Co., N. Y., and near Philadelphia. Regne Vegetale **9**: 6.

CYRTORHYNCHA NUTT. ex Torr. & Gray, Fl. **1**: 26. 1838.

(From the Greek, meaning curved-beak.)

Slender, erect, perennial herbs, with fibrous roots: leaves lobed: flowers small, yellow; sepals 5, spreading deciduous; petals 5, narrowly spatulate or oblong, pit at base, small; stamens many: akenes terete, longitudinally ribbed; style incurved. A monotypic genus. Section CYRTORHYNCHA Gray, under *Ranunculus*.

C. ranunculina NUTT. l. c.

Ranunculus Nuttallii GRAY, Proc. Acad. Phil. 56. 1863.

R. ranunculinus RYDBERG, Bot. Surv. Neb. 3: 23. 1894.

Glabrous, 6 to 10 inches high: leaves usually narrowly lobed; basal ones long-petioled; stem leaves few, beneath the branches: flowers several, somewhat corymbose: akenes tipped with the persistent, slender, recurved style. Spring and Summer. Nebraska to Wyoming. *C. neglecta*, in Greene's herbarium, is a form with roots more succulent; stems and leaves like the above; petals perhaps a little larger.

ARCTERANTHIS GREENE, Pittonia, 3: 190. 1897.

(Combination of *Arctic* and *Eranthis:* in allusion to its habitat and resemblance to *Eranthis*, or *Cammarum*).

A monotypic genus of perennial herbs: roots rather fascicled or clustered on a short caudex: leaves mostly radical, rounded and lobed: flowers solitary; sepals 5; petals 10; stamens many: akenes in a head, longitudinally ribbed, beaks reflexed. Part of Section CYRTORHYNCHA Gray, Syn. Fl. 1: 23, under RANUNCULUS.

A. Cooleyæ GREENE, l. c. 190. *pl. 3.*

Ranunculus Cooleyæ VASEY & ROSE, Contr. Natl. Herb. 1: 289, pl. 22. 1893.

Kumlienia Cooleyæ GREENE, Erythea, 2: 193. 1894.

Plant glabrous, 3 to 8 inches high: scape 1–2-flowered, sometimes bearing a small leaf near the middle, extending above the leaves when in fruit; basal leaves many, orbicular, one inch or more across, deeply 3-parted, and again lobed and toothed, glandular tips to the teeth; petioles broadened or sheathing at the base: flowers yellow; sepals oblong, obtuse, deciduous; petals oblong, obtuse, tapering into a slender claw at base: carpels compressed laterally, 1–3-nerved on each side; reflexed style short; ovule erect. August. Mountain tops near Juneau, and St. Elias Alps, Alaska.

OXYGRAPHIS BUNGE Verz. Suppl. Fl. Alt. 46. 1836.

(From Greek, meaning sharp-style.)

Trailing and running perennial herbs, with fibrous roots: leaves crenate-dentate or lobed, long-petioled, glabrous: flowers small, yellow, one to several on scape-like stems; sepals often 5, deciduous; petals 5–12, pit at base small; stamens many: akenes compressed, somewhat swollen, thin-walled, striate with simple or branched nerves: head of fruit oblong or oval. Several species, but the following only is found in America.—Section HALODES, Gray, Proc. Am. Acad. **21**: 366, under *Ranunculus*.

O. Cymbalaria PRANTL, in Engl. & Prantl, Nat. Pfl. Fam. 3: Abt. 2, 63. 1891.
?*Ranunculus saluginosus* PALL. Reise. **3**: 263. 1776.
R. Cymbalaria PURSH, Fl. **2**: 392. 1814.
R. halophilus SCHLECHT. Animad. Ranunc. **1**: 23. *t. 4. f. 1.* 1819.
R. tridentatus H.B.K. Nov. Gen. & Sp. Pl. **5**: 42. 1821.
R. Cymbalaria var. *alpinus* HOOK. Fl. **1**: 11. 1833.
Cyrtorhyncha Cymbalaria BRITTON, Mem. Torr. Club, **5**: 161. 1894.

Leaves orbicular to ovate, cordate or truncate at base, one inch long or even much less: scapes short; receptacle elongating in fruit: akenes minutely sharp-pointed. Summer. Shady shores and moist saline or salt grounds. Arctic sea coasts to New Jersey, west to Minnesota, thence south and west. Also Mexico, South America, Greenland, Asia.

INDEX TO NAMES OF RANUNCULUS.

(References to other genera are indicated by their initials.)

XXVII. A SYNONYMIC CONSPECTUS OF THE NATIVE AND GARDEN THALICTRUMS OF NORTH AMERICA.

K. C. Davis.

The name *Thalictrum* (Linn. Sp. Pl. 545. 1753) is probably from *Thallo*, to grow green, and has reference to the young shoots which are of such a bright green color.

This group includes several forms which are well suited for the mixed border and rock garden, and the robust forms are well placed in the wild garden. Many are very hardy, and only the more southern forms of those given below are at all tender. *Thalictrums* are valued for their healthy heads of flowers, contrasted with their handsome stems and leaves which are often of a purple cast. They may be propagated by seed or by division of roots in early spring just as growth begins. Any good loamy soil will suit them if well drained.

The latest monograph of the genus was in 1885, by LeCoyer, in Bull. Soc. Roy. de Bot. de Belge, where he describes 69 species. In 1886 Wm. Trelease published a fine treatment of "North American species of *Thalictrum*" in Proc. Bost. Soc. Nat. Hist. **23**: 293–304, in which he recognized eleven species and four varieties north of Mexico. His treatment is rather closely followed by Robinson in Gray's Synop. Fl. 1895. Since that time at least ten new species have been described—chiefly from Mexico—several of which are by J. N. Rose in Contr. U. S. Natl. Herb. **5**: 185, October 31, 1899. Only five have been introduced to our gardens from other countries.

Erect perennial herbs: leaves ternately compound and decompound; stem leaves alternate: flowers diœcious, polygamous, or perfect in some species, rather small, generally greenish-white or sometimes purple or yellow, borne in a panicle or loose raceme; sepals 4 or 5, deciduous; petals wanting; stamens many, showy; carpels usually few, 1-seeded.

Key to Species of Thalictrum.

A. Natives of United States or introduced.
  B. Flowers perfect.
    C. Filaments widened above; anthers ovate, obtuse.
      D. Akenes sessile, in a head, ovate oblong.........*petaloideum.*
      DD. Akenes stalked, widely spreading, straight along dorsal margin.
        E. Styles very short; stigma almost sessile.........*clavatum.*
        EE. Styles as long as width of akene............*sparciflorum.*
    CC. Filaments filiform; anthers linear, acute, or mucronate.
      D. Stigma hastate or spurred; flower-stem abruptly recurved near the fruit...*alpinum.*
      DD. Stigma not spurred nor hastate.
        E. Fruits sulcate; stigma dilated on one side of the short style......... ....*minus.*
        EE. Fruits longitudinally veined; stigma terminal, minute, not dilated, style short.................................*glaucum.*
  BB. Flowers polygamo-diœcious.
    C. Anthers linear, mucronate; filaments thread-like. *purpurascens.*
    CC. Anthers ovate, obtuse; filaments broadened above. *polygamum.*
  BBB. Flowers diœcious, with rare exceptions.
    C. Filaments widened above; anthers ovate, rather obtuse. *aquilegifolium.*
    CC. Filaments thread-like; anthers linear, acute or mucronate.
      D. Mature fruits rather firm or thick-walled, not greatly flattened, filled by the seed; leaves glabrous.
        E. Blades of leaflets very thin.
          F. Roots tuberous; stem reclining.......................*debile.*
          FF. Roots coarsely fibrous; stem erect.............*dioicum.*
        EE. Blades of leaflets firm, veiny below.
          F. Styles clubbed............................. *Caulophylloides.*
          FF. Styles not clubbed.
            G. Akenes well stalked...........................*coriaceum.*
            GG. Akenes nearly sessile.......................*venulosum.*
      DD. Mature fruits less firm, thin-walled, 2-edged, either flattened or turgid.
        E. Leaflets very thin..................................*occidentale.*
        EE. Leaflets firm.
          F. Pistils 5–11 (rarely 13) ....*Fendleri.*
          FF. Pistils 7–20.................. ....*polycarpum.*
AA. Natives of Mexico, not introduced into United States.
  B. Leaflets peltate or subpeltate.

C. Akenes at least twice as long as broad.
D. Plant glaucous throughout; akenes narrowly elliptical, tapering at base or stalked.
E. Divisions of leaves large, crenations broad and shallow. *peltatum.*
EE. Divisions of leaves small, with small ovate teeth. *Jaliscanum.*
DD. Plant not at all glaucous; akenes subsessile, one side straight .... *Cuernavacanum.*
CC. Akenes a little longer than broad.
D. Leaves once or twice ternate; leaflets large, orbicular. *Pringlei.*
DD. Leaves 4 or 5 times ternate; leaflets small, ovate. *Guatemalense.*
BB. Leaflets subpeltate on only part of the plant........*pubigerum.*
BBB. Leaflets not peltate nor subpeltate.
C. Flowers perfect.
D. Plant pubescent ....*longistylum.*
DD. Plant glabrous........................ ....*Pachucense.*
CC. Flowers monœcious or polygamous (*T. papillosum* doubtful).
D. Plant glabrous or only glandular, very little or no pubescence.
E. Akenes ribbed, not gibbous.
F. Leaves 4–5 times ternate; leaflets 1 to 2 inches across. *grandiflorum.*
FF. Leaves 2–3 times pinnate; leaflets small and thin. *Galeottii.*
EE. Akenes with convex protuberances on the ribs.
F. Anthers mucronate..........................*Hernandezii.*
FF. Anthers linear, but rather blunt..............*gibbosum.*
DD. Plant pubescent, hispid or hairy.
E. Fruits not woolly.
F. Leaflets glabrous above, glandular-hispid beneath. *lanatum.*
FF. Leaflets papillose above; hairy veins prominent beneath ....*papillosum.*
EE. Fruits woolly.....................................*tomentellum.*
CCC. Flowers diœcious.
D. Leaves pinnately compound..........................*pinnatum.*
DD. Leaves ternately compound.
E. Styles wanting.......................................*Madrense.*
EE. Styles filiform, 3–4 lines long............*grandifolium.*

T. petaloideum LINN. Sp. Pl. 2 ed. 771. 1762.

Stem round, nearly 1 ft. high, almost naked: leaves 3–5-parted; leaflets smooth, ovate, entire, or 3-lobed: flowers corymbose, perfect; sepals white, rotund; filaments pink, anthers yellow: fruits ovate-oblong, striated, sessile. June–July. Northern Asia. Bot. Cab. **9**: 891. Not yet in trade lists but well worthy of use in gardens (†). Lec. 3. *f. 15*.

T. clavatum DC. Syst. **1**: 171. 1818.

T. filipes TORR. & GRAY, Fl. **1**: 38. 1838.

T. nudicaule SCHWEINITZ ex T. & G. Fl. **1**: 39. 1838.

Plant glabrous, 1 to 2 feet high, branching above: leaves 2 to 3 times ternate: leaflets oval to obovate, rather large, thin, about 3-lobed but variable, base variable: flowers perfect, in a cymose panicle; filaments spatulate and petal-like, with short, blunt anthers: akenes widely spreading on weak stalks of nearly their own length, obliquely ovoid, flattened; styles short; stigma minute. May, June. Wet mountain places, western Virginia to Alabama (†). Lec. 3. *f. 10*.

T. sparciflorum TURCZ. F. & M. Ind. Sem. Petrop. **1**: 40. 1835.

T. clavatum HOOK. Fl. **1**: 2. 1833, not DC.

T. Richardsonii GRAY, Am. Journ. Sci. **42**: 17. 1842.

Stem erect, sulcate, 2 to 4 feet high, branching, usually glabrous: leaves triternate, upper ones sessile; leaflets short-stalked, round or ovate, variable in size and shape of base, round-lobed or toothed: flowers in leafy panicles on slender pedicels, perfect; sepals obovate, whitish, soon reflexed; filaments somewhat widened; anthers very short: akenes short-stalked, obliquely obovate, flattened, dorsal margin straight; 8–10-nerved; styles persistent. Northern Asia, through Alaska to Hudson Bay, in mountains in Colorado and southern California. Introduced to gardens in 1881. Lec. 3. *f. 8*.

T. alpinum LINN. Sp. Pl. 545. 1753.

Stems smooth, naked or 1-leaved, only 4 to 8 inches high, from a scaly rootstock: leaves tufted at the base, twice 3–5-parted; leaflets coriaceous, orbicular or cuneate at the base, lobed, revolute: flowers in a raceme, perfect; sepals greenish, equalling the yellow stamens: stigma linear; akenes small, obliquely obovoid. Newfoundland to Arctic Alaska, in Rockies to southern Colorado, Europe, northern Asia, Greenland and Iceland. Bot. Mag. 2237. Lec. 4. *f. 13* (†).

T. minus LINN. Sp. Pl. 546. 1753.
T. saxatile VILL. Prosp. 50. 1779.
T. purpureum SCHANG. in Pall. N. Nord. Beitr. **6**: 42. 1794.
T. saxatilis HORT.

Stems round, sulcate, 1 to 2 feet high: leaflets variable, acute or obtusely lobed, often glaucous: flowers drooping in loose panicles, perfect; sepals yellow or greenish: fruit ovate-oblong, sessile, striated. Summer. Europe, Asia, northern Africa. A polymorphous species in the variation of the leaflets. Lec. 5. *f. 2, 3, 4.*

Var. **adiantifolium** HORT.
T. adriantoides HORT.
T. adiantifolium BESS. ex Eichw. Skizze 182. 1830.
Leaflets resembling those of *Adiantum;* a form much used and admired.

Var. **Kemense** TRELEASE, l. c. 300. 1886.
T. Kemense FRIES, Fl. Holland, 94. 1817–18.
T. minus var. *elatum* LEC. l. c. 283. 1885. In part.
Leaves thrice-ternate; otherwise much like the type.

T. glaucum DESF. Thal. 1 ed. 123. 1804.
T. speciosum HORT. ex POIR. Encycl. **5**: 315. 1804.

Stems erect, round, striated, glaucous, 2 to 5 feet high: leaflets ovate-orbicular, 3-lobed, lobes deeply toothed: flowers in an erect panicle, perfect; sepals and stamens yellow: fruits 4 to 6, ovate, striated, sessile. June, July. Southern Europe. Lec. 5, *f. 8.*

T. purpurascens LINN. Sp. Pl. 546. 1753.
T. rugosum PURSH. Fl. **2**: 389. 1814.
T. revolutum DC. Syst. **1**: 173. 1818.
T. Cornuti var. *a* HOOK. Fl. **1**: 3. *t. 2.* 1833.
T. dasycarpum FISCH. & LALL. Ind. Sem. Hort. Petrop. 72. 1841.
T. purpureum HORT.

A polymorphous species, allied to *T. polygamum:* stem 3 to 6 feet high, branching above, leafy, pubescent or glabrous, sometimes glandular; leaflets larger than in that type: flowers in a long, loose, leafy panicle, polygamo-diœcious; filaments narrow, anthers rather long, taper pointed: akenes slightly stalked, ovoid, glabrous or pubescent with 6 to 8 longitudinal wings; style slender, persistent; stigma long and narrow, Canada to Florida, west to the Rockies. June, Aug. Introduced 1883.

Var. **ceriferum** AUSTIN, Gray Man. 5 ed. 39. 1867.

T. revolutum LEC. l. c. 146. *t. 3, f. 1.*

This is a variety with waxy glands.

T. polygamum MUHL. Cat. 54. 1813.

T. corynellum DC. Syst. **1**: 172. 1818.

T. Cornuti var β HOOK. l. c. 3.

T. Cornuti TORR. & GRAY, Fl. **1**: 38. 1838.

T. leucostemon KOCH. & BAUCHÉ, Ind. Sem. Hort. Berol. App. 13. 1854.

Erect, 3 to 8 or more ft. high, branching and leafy, smooth or pubescent, not glandular: leaves 3–4 times ternate or terminally pinnate; leaflets oblong to orbicular, bases variable, 3–5 apical lobes: flowers in a long, leafy panicle, polygamo-dioecious; sepals white; filaments broadened when young; anthers short: akenes ovoid, stipitate, 6–8-winged or ribbed; with stigmas as long, which become curled. July–August. Low or wet grounds, Canada to Florida, west to Ohio. Introduced 1881. Lec. 2. *f. 12.* *T. pubescens* Pursh, Fl. **2**: 388, 1814, is probably a very pubescent form of this and might be called var. *pubescens.*

Var. **macrostylum** ROBINSON, Syn. Fl. **1**: 17. 1895.

T. Cornuti var. *macrostylum* SHUTTLE. in Dist. Pl. Rugel, 1845–6.

T. Cornuti var. *monostyla* BOT. ZEIT. **3**: 218, 219. 1845.

T. macrostylum SMALL & HELLER, Mem. Torr. Club, 3: 8. 1892.

Slender; leaflets small, nearly entire: fertile flowers less numerous and in a more spreading panicle: akenes in a small, dense, spherical head. Mountains of western North Carolina to Georgia.

T. aquilegifolium LINN. Sp. Pl. 547. 1753.

Stem large, hollow, 1 to 3 feet high, glaucous: leaves once or twice 3–5-parted; leaflets stalked or the lateral ones nearly sessile, slightly lobed or obtusely toothed, smooth, suborbicular:

flowers in a corymbose panicle, diœcious; sepals white; stamens purple or white: fruit 3-angled, winged at the angles. May–July. Europe, northern Asia. Bot. Mag. 1818; 2025 (as var. *formosum*). Garden 47, p. 357; 50, p. 117. Lec. 3. *f. 5.*

The old name, *T. Cornuti* L. Sp. Pl. 545, may be a synonym of this, and, if so, it is the older name being published on a preceding page; but *T. Cornuti* was described as an American plant which *T. aquilegifolium* is not. As the description and old figures of *T. Cornuti* L. do not agree with any American plant the name may well be dropped, as Robinson and DeCandolle have suggested. Those plants advertised as *T. Cornuti* are probably *T. aquilegifolium.*

T. debile BUCKLEY, Am. Journ. Sci. **45**: 175. 1843.

Root a cluster of fusiform tubers: stem decumbent, ½ to 1 foot long, glabrous, simple or branched, few-leaved: leaves 2 to 3 times ternate; petioles long and slender; leaflets nearly ½ inch across, thin, rotund, the 3 rounded lobes entire or again lobed, bases variable: flowers remote, in long, simple panicles, diœcious; stamens often 10, filaments little longer than the anthers: akenes 2–5, nearly sessile, spreading, oblong, not flattened, 8–10-ribbed; style minute. Moist or shady places. Georgia to Texas. Lec. 2. *f. 1* (†).

Var. **Texanum** GRAY, Cat. Coll. Hall, Pl. Tex. 3. 1873. Name only.

Stems more rigid and erect; leaflets smaller, thicker and nearly sessile. A Texas form of the above (†). Described in Syn. Fl. **1**: 18. 1895.

T. dioicum LINN. Sp. Pl. 545. 1753.

T. lævigatum MICHX. Fl. **1**: 322. 1803.

T. Carolinianum Bosc. in DC. Syst. **1**: 174. 1818.

Rather slender, 1 to 2 feet high, glabrous: leaves 3 to 4 times 3-parted; leaflets thin, orbicular, several-lobed or revolute, bases variable: flowers in a loose, leafy panicle with slender pedicels, diœcious; stamens much longer than the greenish sepals: anthers linear, obtuse, exceeding their filaments in length: akenes ovoid, nearly or quite sessile, longer than their styles, with about 10 longitudinal grooves. Early spring. Woods. Labrador to Alabama, west to the foot of the Rockies. Introduced sometime before 1891. Lec. 3. *f. 2, 3.*

T. Caulophylloides SMALL, Bull. Torr. Club, **25**: 136. 1898.

Plant glabrous, 2 to 4 feet high, from a horizontal rootstock; leaves on long petioles; leaflets deep green, firm, oval or broader than long, 1 to 2 inches long, glaucous beneath and with prominent nerves, bases variable, apically 3–5-sharp-lobed; flowers diœcious: akenes elliptic, 3 lines long, sharply ribbed, contracted at the base and stalked, style persistent, clubbed, ½ the length of akenes. Spring and summer. Mountains of Tennessee.—Allied to *T. coriaceum*, but differing in the leaflets and the shorter club-shaped style (†).

T. Coriaceum SMALL, Mem. Torr. Club, **4**: 98. 1893.
T. dioicum var. *coriaceum* BRITTON, Bull. Torr. Club, **18**: 363. 1891.

Stem sulcate, somewhat branched, raising 3 to 4 feet from the yellow rootstocks: leaves 3 to 4 times ternate, rather short-petioled, lower petioles with stipule-like bases; leaflets coriaceous, broadly obovate, acutely toothed or lobed; bases variable; veins prominent on the whitish under surface: flowers in a loose panicle, diœcious; sepals and stamens whitish; anthers linear, longer than the slender filaments: pistillate flowers purple; akenes stalked, oblong-ovoid, 8–10-ribbed; styles of less length, persistent. May–June. Mountains of eastern Kentucky into Virginia and north Carolina (†).

T. venulosum TRELEASE, *l. c.*, 302. 1886.
T. campestre GREENE, Erythea, **4**: 123. 1893.
(?) *T. Fendleri* J. M. MACOUN, Bot. Gaz. **16**: 285. 1893.

Allied to *T. dioicum*: stem simple, erect, 10–20 inches high, glabrous, glaucous; bearing 2 to 3 long-petioled leaves above the base; leaves 3 to 4 times 3-parted; leaflets short-stalked, rather firm, rounded and lobed at the apex, veiny beneath: flowers in a simple panicle, diœcious, small; sepals ovate; stamens 10–20 on slender filaments; anthers oblong, slender pointed: akenes nearly sessile, 2 lines long, ovoid, tapering to a straight beak, thick-walled and 2-edged. South Dakota, westward and southward in the mountains. Introduced 1889.

T. occidentale GRAY, Proc. Am. Acad. 8: 372. 1872.
T. dioicum var. *oxycarpum* TORR. Bot. Wilkes Exped. 212. 1854.

Allied to *T. dioicum* which it closely resembles; but it is more robust, taller: leaves glandular-puberulent: akenes long, slender, thin-walled, 2-edged, ribbed, not furrowed. Introduced 1881.

T. Fendleri ENGLEM. ex Gray in Mem. Am. Acad. **4**: 5. 1849.

A variable species: plants 1 to 3 feet high, rather stout and leafy: leaves 4 to 5 times pinnatifid, upper stem leaves sessile; leaflets rather firm, ovate to orbicular, usually with many shallow rounded or acuminate lobes, bases variable: flowers diœcious, in rather compact panicles; stamens many, anthers long: akenes nearly sessile, obliquely ovate, flattened, 3 to 4 ribs on each face. July–Aug. Western Texas to Montana. Introduced 1881. Lec. 2. *f. 9.*

Var. **Wrightii** TRELEASE, l. c. 304. 1886.

T. Wrightii GRAY Pl. Wright **2**: 7. 1852.

The upper leaves petioled; leaflets smaller, puberulent below: akenes plump, sigmoid, reticulated. Aug.–Sept. Dry regions. New Mexico, southern Arizona into Chihuahua. Lec. 2. *f. 8.*

Var. **platycarpum** TRELEASE, l. c. 304. 1886.

T. platycarpum GREENE, Pitt. **1**: 166. 1888.

T. hesperium GREENE, Pitt. **2**: 24. 1889.

Inflorescence sparsely glandular-puberulent: leaflets like the type: akenes flat, erect, dilated, the veins mostly longitudinal. Central and southern California.

T. polycarpum WATSON, Proc. Am. Acad. **14**: 288. 1879.

T. Fendleri var. *polycarpum* TORR. Pac. R. Rep. 4: 61. 1853.

T. Fendleri BREW. & WATS. Bot. Calif. **1**: 4. 1876. In part.

T. cæsium GREENE, Fl. Francis, 309. 1892.

Allied to *T. Fendleri:* glabrous throughout: leaflets long-petioled: flowers diœcious in rather close panicles: akenes larger in a dense globose head, stalked, obovoid, turgid tapering into reflexed styles. Summer. Sandy streams, California to Columbia river. Introduced 1881. Lec. 3. *f. 4.*

T. peltatum DC. Prod. **1**: 11. 1824.

Plant tall, glabrous or glaucous: upper stem leaves twice ternate: leaflets pale, 3 inches across, orbicular, mostly peltate, apically lobed or crenate: flowers polygamous in an open panicle: akenes flattened, obliquely oblong, being nearly straight on edge, base tapering but sessile, both faces 2–3-veined; styles ⅓ inch long, rather persistent. August. Morelos, south of Mexico City. Rose, l. c. 186, redescribes and figures this, plate 21. He concludes that DeCandolle's type may have been found in the same region. Type in U. S. Nat. Herb. 7448, distributed as *T. Pringlei* (†).

T. Jaliscanum Rose, l. c. 187. 1899.

Stems tall, glabrous and glaucous; upper leaves ternate, the leaflets peltate, orbicular, 6 to 10 toothed, glabrous: inflorescence a large open panicle: carpels narrowly elliptical, somewhat cuneate at base, strongly nerved. Quoted from Rose by whom it was first collected on tableland in northeastern Jalisco. Differs from *T. peltatum* in its small leaflets with small rounded teeth (†).

T. Cuernavacanum Rose, l. c. 187. 1899.

About 2 feet high, branching above, somewhat pubescent, never glaucous: leaves twice ternate; leaflets roundish, 1 inch across, palmate, broadly crenate: inflorescence an open panicle; flowers perfect; anthers linear; akenes 2 lines long, narrowed at both ends, subsessile, one side straight, 3–4-ribbed; styles long. Morelos, south of Mexico City (†).

T. Pringlei Wats. Proc. Am. Acad. **25**: 141. 1890.
T. pubigerum Pringle, ex Rose, l. c. 187. 1899.

About 2 feet high, glabrous: leaves 1 to 2 times ternate; leaflets usually peltate, suborbicular, ½ to 2 inches across, coarsely 5–9-toothed, not glandular: inflorescence an open panicle, with slender nodding pedicels; flower polygamo-diœcious: anthers linear, long apiculate: akenes compressed, semi-ovate, straight on one side, 6–8-ribbed, 2 lines long; styles long, somewhat persistent. June–August. Near the capital of Jalisco, and the coast slope of the same state (†).

Var **reticulatum** Rose, l. c. 188. 1899.

A lower, somewhat pubescent form: leaflets peltate, entire or 3–5-angled, dark green above, strongly net-veined: flowers in a narrow panicle; peduncles nodding in fruit. Western foothills of Tepic Territory (†). The type 3372 in U. S. Natl. Herb. is a form of the same variety with the leaflets shallow-round-lobed, and some of them only subpeltate.

T. Guatemalense Rose & C. DC., Contr. Natl. Herb. **5**: 188. 1899.

Stems about 2 feet high; slender, branched, somewhat hairy: leaves 4 to 5 times ternate; leaflets small, ovate, peltate, somewhat roughened, strongly veined below: akenes turgid, hardly 2 lines long. Guatemala (†).

T. pubigerum Benth. Pl. Hartw. 285. 1839–57.

Plant rather tall, nearly simple, glabrous or pubescent, finely striated; leaves 2 to 4 times pinnate; leaflets distant, their stalks stipuled, often ovate, sometimes subpeltate, cordate or roundish at base; summit 3-toothed, often with other smaller teeth: flowers monœcious or polygamous, reddish; anthers linear, mucronate: akenes stipitate, glabrous, flattened, obliquely ovate, reticulately veined, protuberiferous, reflexed; style withering. Summer. West central Vera Cruz (†).

T. longistylum DC. Syst. **1**: 171. 1818.

Plant tall, sparsely pubescent even to the fruits: leaflets roundly lobed and toothed outwardly, pubescent beneath: flowers perfect, anthers slender, pointed: fruits flattened a little, reticulately ribbed, straight along one side; styles slender, longer than the body before becoming broken. August. Moist banks, Sierra de las Cruces, Mexico, 10,000 feet. Also South America (†).

T. Pachucense Rose, l. c. 188. 1899.

Delicate glabrous plant, 8 to 12 inches high; roots fibrous: leaves only 3 to 4 inches long, mostly basal, 3 times ternate; leaflets 2 to 4 lines long, broad or narrow, bases variable: flowers perfect, on erect pedicels which become bent in fruit; sepals purplish; anthers narrow, apiculate: ovaries oblong; style long and slender. Open woods. High altitudes. Southern Hidalgo (†).

T. grandiflorum Rose, l. c. 188. 1899.

T. grandifolium Rose, l. c. 143. 1897. Not Wats.

Stems 5 to 8 feet high, glabrous: leaves 1 to 2 feet long, 4 to 5 times ternate; main petiole short with long dilating stipules; leaflets stalked, large, nearly orbicular, 1 to 2 inches across, often cordate at the base, 3 to 7 roundish lobes, sometimes a little hairy on under veins: flowers in a large, nearly naked panicle, polygamous; filaments slender; anthers linear: akenes flattened, strongly nerved, style persistent. Morelos, south of Mexico City (†).

T. Galeottii Lec. l. c. **24**: 131. *t. 2. f. 6.* 1885.

Rather tall and simple, glabrous, 2–3-pinnate; stipules ample; leaflets small, thin, ovate to obovate, toothed or lobed above, glabrous: panicles rather leafy; flowers small, whitish, monœcious or polygamous; sepals slightly dentate; anthers linear, somewhat obtuse: pistils 5 to 11: akenes nearly sessile, compressed, glabrous, semi-ovate, veined, widely spreading; styles long, slender, withering. September–October. Mountains of central Vera Cruz (†).

T. Hernandezii Tausch. in Presl. Reg. Haenk. **2**: 69. 1835.

Stem 3–5 feet high; glandulous, leafy, branching; leaves 2 to 3 times 5-parted; leaflets large, often subsessile, variable in outline, usually oval, 3-lobed or sharp toothed above; under side glandular: flowers in a conical panicle, monœcious or polygamous; sepals 4, greenish; anthers linear, mucronate: akenes 5–7, sessile or stipitate, obliquely ovate, compressed, spreading, irregularly ribbed and protuberiferous; styles long, slender, somewhat persistent. June–August. Southeastern Mexico, Oaxaca, etc. Lec. *2. f. 2* (†).

T. gibbosum Lec. l. c. **24**: 132. *t. 2. f. 7.* 1885.

Tall, erect, simple, or branched, glabrous: leaves 2 to 3 times pinnate, petiole stipuled; leaflets small, thin, oval, stalked, 3 sharp teeth above, often other small ones: panicles slightly leafy: flowers monœcious or polygamous, small, greenish; sepals feebly dentate; anthers linear, usually blunt; pistils 4–5: akenes stalked, flattened, tapering above and below, glabrous, strongly ribbed, reticulated and provided with protuberances, widely spreading; style long and slender, withering. Sept.–Oct. Mountains of western Oaxaca (†).

T. lanatum Lec. in Bull. Soc. Roy. Bot. Belg. **16**: 226. 1877.

Rather tall and leafy, hispid: leaves 2 to 3 times pinnate, very short petioled or sessile; leaflets variable in size and form, often orbicular or obovate, cordate or rounded at base, firm, glandular-hispid beneath, short-stalked, tridentate at summit, often with other smaller teeth: panicles many-flowered, monœcious or polygamous; sepals whitish; anthers linear, mucronate: akenes 5 to 7, sessile or nearly so, spreading, reticulately ribbed, glandulous; styles long and filiform, rather persistent. June–Aug. Oaxaca, southeastern Mexico (†). Closely allied to *T. Hernandezii*, but differing in being glandular hispid, and having no convex protuberances on the akenes.

T. papillosum Rose, l. c. 189. 1899.

Low, hairy: leaves small, 3 times ternate; leaflets roundish, often cordate at base, somewhat 3-lobed, papillose above, hairy, veins prominent beneath: panicles short; pedicels becoming reflexed in fruit: akenes 1 line long, few-ribbed. Northern Jalisco and western Zacatecas (†). Fruit much shorter than in *T. lanatum*.

T. tomentellum Robinson & Seat. Proc. Am. Acad. **28**: 103. 1893.

Stem striate, glandular, finely and densely pubescent throughout: leaves 3 times pinnate on petioles 1 to 2 inches long; leaflets suborbicular, subcordate, shallowly 3-lobed; the lobes rounded, often with 2 to 3 rounded teeth: flowers in a pyramidal subnaked panicle, polygamo-diœcious; pedicels becoming reflexed in fruit: sepals 2 lines long; anthers setiform at tip: carpels about 10, scarcely stipulate, woolly, roughly reticulated, acuminate; style very long, filiform, often deciduous. July. About Lake Patzcuaro, Michoacan (†).

T. pinnatum Wats. Proc. Am. Acad. **23**: 267. 1888.

Hardly 2 feet high, glabrous and glaucous, slender: root fascicled, tubero-fibrous: leaves lanceolate in outline, 2 ½ inches long or less, very shortly petioled, pinnate with about 7 (or fewer) pairs of divisions, the lower divisions ternate, with small lobed leaflets, the upper reduced to a single 3-lobed leaflet: flowers diœcious: sepals of the fertile flowers very small; stigmas short and rather thick: akenes ovate, about one line long, undulately ribbed, the oval seed filling the cavity. September. Pine plains, east base Sierra Madre, Chihuahua. Description from the original (†).

T. Madrense Rose, l. c. 188. 1899.

Glabrous, slender, 1 foot or less high, from a cluster of thickened roots: leaves small, sessile, once or twice ternate: leaflets mostly 3-toothed or lobed: flowers diœcious (?); fertile flowers often axillary and single; styles wanting; stigma short and thickened: akenes with strong, undulate ribs. Quoted from Dr. Rose, who first collected it in southern Durango and northern Tepic (†).

T. grandifolium WATS. Proc. Am. Acad. **23**: 267. 1888.

Tall, usually glabrous: leaves 3 to 4 ternate, petiolate, with dilated stipules; leaflets 1 to 2½ inches long, obliquely rounded, often cordate, or upper ones cuneate at base, obtusely lobed, veins prominent beneath with a few scattered, short, stout, curved hairs: panicles spreading and somewhat leafy-bracteate; flowers nodding, diœcious: akenes semicircular, beaked by the short, stout base of the long filiform style (3 to 4 lines), compressed, faintly and irregularly nerved: seed flattened-subovate, filling the cavity. October. Under cliffs of Sierra Madre, Chihuahua (†).

T. Wrightii GRAY, occurs in both Mexico and New Mexico. It is placed in this arrangement as a variety of *T. Fendleri*, which see.

THALICTRUM INDEX.

gibbosum Lec.
glaucum Desf.
grandiflorium Rose.
grandifolium Rose = above.
grandifolium Wats.
Gautemalense Rose & C.DC.
Hernandezii Tausch.
hesperium Greene = *Fendleri* var.
Jaliscanum Rose.
Kemense Fries. = *minus* var.
lævigatum Michx. = *dioicum*.
lanatum Lec.
leucastemon Koch. & Bauche. = *polygamum*.
longistylum DC.
macrostylum Rob. var. of *polygamum*.
macrostylum Small & Heller = *polygamum* var.
Madrense Rose.
minus L.
minus var. *Kemense* Trelease.
minus var. *elatum* Lec. = *minus* var.
nudicaule Schw. = *clavatum*.
occidentale Gray.
Pachucense Rose.
papillosum Rose.
peltatum DC.
petaloideum L.
pinnatum Wats.
platycarpum Greene = *Fendleri* var.
Pringlei Wats.
Pringlei var. *reticulatum* Rose.
polycarpum Wats.
polygamum Muhl.
pubescens Pursh = *polygamum* var.
pubigerum Benth.
purpurascens L.
purpureum Hort. = *purpurascens*.
purpureum Schang. = *minus*.
revolutum DC. = *purpurascens*.
revolutum Lec. = *purpurascens* var.
Richardsonii Gray = *sparciflorum*.
rugosum Pursh = *purpurascens*.
saxatile Vill. = *minus*.
saxatilis Hort. = *minus*.
sparciflorum Turcz.
speciosum Poir. = *glaucum*.
tomentellum Rob. & Seat.
venulosum Trelease.
Wrightii Gray = *Fendleri* var.

NOTE.—The mark (†) indicates that the species or variety has not yet been introduced to the American trade. Citations after descriptions are mostly to pictures. "Lec." refers to LeCoyer's monograph.

XXVIII. SOME PRELIMINARY OBSERVATIONS ON DICTYOPHORA RAVENELII BURT.

C. S. Scofield.

The name *Dictyophora* was first applied by Desvaux in 1809 to a plant bearing a netted veil or indusium, and the genus so named was later included under the general family Phalloideæ, established by Fries in 1823. The family was given thorough systematic arrangement by Dr. Ed. Fischer * in 1888, and in 1896 Dr. E. A. Burt † published a systematic account of the ten known North American species under six genera.

The development of the sporophore has been especially studied in plants of this family, and this process has been described for many of the species. In the present paper less attention has been given to this particular feature of the life history, not that it is less interesting, but because in some of the stages it is not dissimilar to other species that have already been well described and figured.

Collection of material.—The material for the study of *Dictyophora ravenelii* was collected about September 25, 1899. It was found on low moist ground in rather dense woods near the west shore of Lake Calhoun, Minneapolis, Minnesota. The mycelium of the plant was more or less abundant over an area of five or six square yards, and the sporophores seemed to occur over most or all of this extent. The period of fruiting is evidently long, for photographs of the mature plants were made at least a month before the material was collected, and at the time of collection sporophores in nearly all stages of development were abundant.

Two collections of material were made: that of the first collection was put directly into thirty per cent. alcohol and afterward passed gradually into ninety per cent.; while that of the

* Saccardo, Syl. Fung. **7**: 1888.

† Bot. Gaz. **22**: 1896.

second collection was placed in a one per cent. solution of chromic acid, from which after twenty-four hours it was transferred to water and after thorough washing was carried by easy stages into seventy per cent. alcohol.

Methods.—The material for study was, with a few exceptions, dehydrated, imbedded in paraffin, and cut with a Minot microtome, carried down to fifty per cent. alcohol, stained in a fifty per cent. alcohol saturated solution of Bismarck brown, transferred into pure xylol and permanently mounted in Canada balsam. Some of the small portions of the mycelium and younger stages in the development of the sporophore were first stained *in toto*, and either mounted directly in formalin water and sealed or transferred to paraffin and cut and stained again if necessary. The pre-staining method proved very effectual and was of great help in guarding against the loss of very small bodies, and aided in the imbedding process. Numerous other staining methods were tried, but none gave as good result for structural study as the one outlined.

The vegetative tract consists of a complex weft of mycelial strands, which vary in size from something less than one-tenth of a millimeter in diameter up to two millimeters or more. The complexity of the weft is greatly augmented by the copious branching of the strands and not uncommonly crossing strands become more or less fused together. Some of the larger strands have a length of one meter or more, and often continue with unvarying diameter for forty or fifty centimeters.

The larger proportion of the mycelium is found near the surface of the soil where it is covered with leaf mould and may be found to some extent in the leaf mould itself. Some of it, however, runs to a considerable depth in the soil, but without diminishing in size or ending there as would a root of a higher plant. Invariably, strands found at the greatest depth of twenty to thirty centimeters could be traced to the surface in both directions. Branching seems to be less frequent on the strands found deep in the soil, and it was not possible to locate in any case what seemed to be the definite center of growth.

Each mycelial strand is composed of two general areas: the central and the peripheral. In the very small threads the central area (Fig. 9, *B*) consists of a few large hyphæ, very long in proportion to their diameters, aud without very definitely marked cross-septa. Their general direction is, of course, along the strand, but they are more or less twisted about each other, very much as are the threads which make up a strand of yarn.

The peripheral area (Fig. 9, *c*) is composed of loosely intertwining hyphæ, much smaller and more profusely branched than the central hyphæ, and extending out somewhat into the surrounding soil (Fig. 8). They seem to resemble very much the root hairs on the roots of higher plants. It seems quite probable that the hyphæ of the peripheral areas of the smaller strands function as the absorptive area of the plant, while the larger central hyphæ act as conduction paths.

In the larger strands the peripheral hyphæ occupy a relatively smaller part of the strand and seem to abandon their absorptive, to assume more of a cortical function, being reduced in the very large strands to a smooth disorganized coating. The central hyphæ by their habit of twisting about each other make it difficult to determine their method of growth and branching, for they do not continue long enough in the plane of the section to be studied with ease, and in no case were definite cross-septa noted although they doubtless exist.

Upon the mycelium are borne two distinct kinds of bodies: (1) the reproductive body, and (2) what it has seemed best to call a storage body or "tuber." The latter will be considered first.

The tuber makes its appearance as a slight enlargement of a mycelial strand, and in the early stages of its development seems to be merely the result of rapid growth of the peripheral hyphæ. There seems to be little regularity in the size or shape of the tubers and even less in regard to their place of occurrence upon the mycelium. In Fig. 10 one of the larger tubers is shown, natural size, and upon a connecting strand is shown at "*a*" the base of an old sporophore. The strand bearing this tuber seems to have been more or less branched and the tuber is lobed to some extent to follow the branching. The tuber is made up of very closely woven hyphæ which are much distorted, evidently by being packed full of somewhat granular material. In general structure it appears homogeneous except the region of the strand upon which it is borne, where the hyphæ seemed to leave the strand to some extent and mingle with those of the tuber, but not so much so that the direction of the strand cannot be clearly followed throughout. A section of a young tuber is diagrammatically shown in Fig. 11. The cell contents of the hyphæ of the tuber respond very neatly to a test for glycogen given by Dr. L. Errera,* and it seems very probable that this substance is a very large, if not the chief constituent of the cells. Errera's test is made with a reagent composed of 450 parts of water, three parts of KI and one part of iodine, and he designates it as "solution Iodée au $\frac{1}{450}$." According to him, material possessing glycogen when stained in this solution or when mounted in a drop of it takes on a reddish brown color, which disappears in a temperature of 50–60° C., but returns upon recooling. Some of the tests made on *Dictyophora* tubers were with material taken from 70 per cent. alcohol sectioned, transferred to water and mounted directly in a drop of the reagent.

In other instances sections that had been machine cut, stained in Bismarck brown, and mounted in Canada balsam were soaked in xylol to remove the cover glass and balsam, carried through alcohol to water, stained for a moment in Errera's mixture, and then mounted in water. In every case the reaction was sharp in all particulars.

Assuming that Errera's test is a correct one, and there appears no good reason for doubting it, it is evident that a large portion at least of the cell contents of the tuber is glycogen. Zopf, Burt † and others have associated the presence of glycogen in fungi with the immediate need of the plant for rapid growth, but there is at least a possibility that this reserve food supply in the tuber is in some way connected with the economy of the plant in reproducing itself vegetatively the following season. Or it may be that there exists a direct connection between the tuber and the rapidly developing sporophore, though there is no evidence that any of the supply of glycogen has been exhausted from any of the tubers collected or found upon the vegetative tract. If it is found upon further investigation that these tubers are connected with vegetative reproduction and that by means of them it is possible to artificially propagate the plant, it will be of great advantage in the study of the younger stages of development of the reproductive area. Hitherto the rare occurrence of the plant and its allies has made the study extremely difficult.

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* Leo Errera, Sur le Glycogène ches les Basidiomycetes, 1885.

† Bot. Gaz. **24**: 1897.

The reproductive area usually occurs on a branch strand of the mycelium. The length of this branch varies with the distance of the main strand below the surface of the soil. In some instances this branch is so short that the sporophore seems sessile upon the main strand. Often the sporophore-bearing branch and the strand from which it comes are very small (Fig. 8), and the main strand here seems to diminish but little in size after giving off the branch. Both the branch and the strand, however, increase in size as the sporophore develops. In all cases the development of the sporophore takes place very close to the surface of the soil so that upon nearing maturity it pushes partially above the surface before the rupturing of the volva and the elongation of the stipe takes place. A number of these nearly mature sporophores are shown in an accompanying plate. Before taking up the development of the sporophore a brief description of the mature organ will be given to explain the parts and to define the terms used.

The mature sporophore (Fig. 7) is 8–10 cm. high and consists of a base B, volva V^1, V^2, V^3, stipe S, indusium I, pileus P and gleba G. The base may be considered for the present as a part of the volva, although structurally and developmentally it doubtless belongs to the same area as the stipe. The volva is slightly pinkish and consists of more or less definitely organized outer and inner layers with a disorganized milky-gelatinous layer between. The stipe is hollow, 2–3 cm. in diameter, dirty white, tapering at each end, with walls composed of several layers of chambers and passing with the pileus into a thick, white, recurved collar at the distal end. The border of the collar is entire, not convoluted as in some species.

The indusium or veil is membraneous and not of definite structure. It is attached at the point of union of the stipe and pileus and also to the volva near the base (Fig. 7, *i*). It ruptures irregularly upon the elongation of the stipe and may break from near either the point of attachment, or partially from both, and hang about the stipe as is shown in the first cut. Most commonly, however, it seems to break from near its attachment to the volva and hang between the pileus and stipe.

The pileus is conic-campanulate, 2.5–3.5 cm. long and 2–3 mm. thick, dirty white and with an entire, slightly recurved margin. It is composed of closely folded layers of pseudo-parenchymatous tissue, which give to its surface a finely wrinkled or granulate appearance.

The gleba is thin, slightly shorter than the pileus, very dark olive green and much firmer in texture and more persistent than is common with the other members of the genus; deliquescing slowly in dry weather and without so much of the fœtid odor common to the plants of this class.

The description of the development of sporophore must begin with the youngest stage found, although manifestly a complete description should start rather with the activity, nuclear or cytologic, that takes place before the spore-bearing branch is formed.

In the youngest stage found (Fig. 1), the sporophore was about .4 mm. in diameter and borne upon a branch about .1 mm. in diameter. The young sporophore consisted of but two distinguishable areas; the central (Fig. 1, *r*) and the peripheral (Fig. 1, *v*), the chief difference being that the hyphæ of the central area were somewhat larger and took a much deeper stain than those of the other. The two areas of the strand seemed to be continued into the sporophore with a slight increase in the proportional space occupied by the outer one. The line between them is not as clearly marked as in the strand, the hyphæ being closely anastomosed. A detail of the structure of this stage is shown in Fig. 12. Much time and ingenuity was spent in attempting to determine the condition in the strand just previous to the formation of the sporophore. It seems evident that one must look for the starting point in the main strand or at least in the very young branch.

There seems to be good reason for believing that some cell fusion may take place in the strand previous to the giving off of the sporophore branch. In Fig. 8 is shown a small mycelial strand with a branch "*a*" leading to a very small sporophore. Near the middle of this strand is shown one hypha much more prominent than the rest, so much so that it may readily be seen through the surrounding tissue, and by careful focusing its course may be traced for some distance either side of the place of branching. It is difficult to see through the tissue, and still more difficult to get sections to show whether or not an actual fusion has taken place, which has given rise to a new body. Evidently a fusion of some kind may have occurred, and, in the reaction following, one of the hyphæ may have come to be of a slightly different nature, for the single hypha is not particularly prominent except near the branching point. The uniform presence of this prominent hypha would suggest the idea that it is intimately concerned with the formation of the sporophore while also perhaps evidence that a fusion has taken place at this point may be seen in the knotted condition of the hypha. This gives rise to the thought that a cell fusion at this point may have initiated all the resulting activities. In Fig. 9 is shown a section of a small strand at the branching point and the supposed evidence of fusion is here very clear. That the peculiar deep-staining ability of this prominent hypha is consequent to such a fusion is indicated by the fact that the hypha cannot be traced along the strand any great distance from this point.

It is unfortunate that the technique of the material is not sufficiently developed to make possible a study of the nuclear phenomena at this point, for clearly the complete solution of this problem must lie in the study of the nuclear processes.

Whatever action takes place here is a matter of considerable importance in the life history of the plant, for the subsequent differentiation of the hyphal tissue is very complex.

The first marked step in the differentiation of the sporophore is shown in Fig. 2. The gelatinization of the area between the outer and inner layers of the volva is shown at V^2. There is a somewhat indefinite integument formed about the whole body by the breaking down of the hyphæ at the surface. The hyphæ lying in the area of the stipe *S* also begin to be prominent and tissue of much the same nature extends out like an umbrella from the top of the stipe area. This is evidently brought about by the apical growth of the large hyphæ shown in Fig. 1. Being limited by the denser hyphæ of the periphery, they take a downward direction. This tissue "*P*" gives rise later to the pileus and gleba and there remains between this and the stipe a tissue of the same structure as that of the volva. The tissue of the base "*B*" is similar in structure to that of the stipe, but closer in texture. The next important stage is shown in Fig. 3. Here the different areas are fairly well marked. The area between pileus and stipe is distinct, but is composed of very loosely woven hyphæ. It is in direct connection with the tissue of the volva, but is nearly separated from it by the base "*B*," which has extended considerably.

There becomes evident at this point an area of less tension near the middle of this base and just below the stipe. This is connected by a small pore, through the base, with the partially disorganized tissue in the center of the stipe. The stipe already shows very slightly its chambered structure and the areas of the pileus and gleba are distinguishable.

In Fig. 4 the relative size of the various parts is shown to be considerably modified. Gelatinization of the middle area of the volva is nearly complete. The indusium is almost entirely cut off from the volva and occupies a much smaller space than in the previous stage. The gleba is greatly enlarged, and the hymenial layer is beginning to show and the pressure of the whole receptaculum is beginning to be exerted upon the inner layer of the volva. The next stage as shown in Fig. 5 shows general enlargement of the parts and rapid development. Just how this enlargement takes place is not easy to understand. Certainly it is not altogether due to enlargement of existing hyphæ for excepting in the stipe and pileus actual measurement of the cells in the various stages show slight differences in the sizes of individual cells, so that enlargement must be very largely due to apical growth and branching.

The development as shown from Figs. 2 to 5 must go on very rapidly, for comparatively few sporophores in these stages were found. In Fig. 6 is shown the sporophore practically mature. The tissue in the middle of the stipe *X* is almost completely disorganized, showing the wall of the other side of the stipe in one or two places. The walls of the stipe are fully developed, but the cells of the walls of the chambers are closely compressed, especially at the angles. The indusium is reduced to a thin layer adhering closely to the sides. The inner layer of the volva is drawn very tightly over the gleba and is pressed against the outer layer at the tip. The gleba is completely developed and the spores are nearly or quite formed.

Fig. 7 shows the mature plant as previously described. The parts of it may now be described in detail. The base *B* is made up of small but entire hyphæ closely interwoven and shown in detailed structure in Fig. 19. The base forms a cup which loosely contains the base of the stipe to which it is attached only slightly, just about the pore which connects the hollow of the base with the hollow of the stipe. The tissue of the central area of the strand is in direct connection with the tissue of the base and the peripheral area of the strand at this time greatly reduced leads directly into the coating of the base and the outer layer of the volva.

The volva having been so tightly compressed before rupturing, has its two layers so close together that they might readily be mistaken for one, and the detailed structure is hard to recognize. The outer layer is hardened and the interstices between the hyphæ are filled with gummy material. The inner layer has its hyphæ lying for the most part in the direction of the recent strain and connects by a thin layer with the indusium.

The stipe is made up of several rows of irregular chambers as shown in Fig. 13 in cross section. Some of these chambers open to the outside, but none of them to the middle of the stipe. The chamber walls, one of which is shown in detail in Fig. 17, are made up of much distended hyphæ which look in section like the parenchymatous cells of higher plants. The chambers contain filmy remnants of disorganized tissue. The remnant of the tissue in the hollow of the stipe *X*, hangs usually from the apex of the stipe or some of it may remain attached at the base. The chambers of the stipe walls become smaller toward either end and at the apex the wall passes into the recurved collar where the contents of the chambers, though somewhat disorganized, are not absorbed.

The indusium which has been the cause of the trouble in classification is hardly to be considered the true indusium common to the genuine members of the genus *Dictyophora*. It is not a definitely organized structure, but rather the remnant of a portion of the tissues of the periphery of the young sporophore caught between the pileus and the base. Penzig* in describing *Ithyphallus tenuis*, speaks as follows: "Eine andere bemerkenswerthe Erscheinung bei *Ithypallus tenuis* ist das Auftreten einer Art von Indusium zwischen dem Hute und dem oberen Theile des Stieles. Auch Ed. Fischer (l. c., p. 22) kurz die Andesenheit einer Haut, welche er als 'Rest der stiel und Hute trennenden Primordialgewedes' auffast. Dieses Gedielde ist nicht in allen Individuen gleich ausgedildet: einmal nur als ausserest, feines, durchsichtiges Häutchen, andere Male aber als zienlich derbe, compacte membran, welche den Stiel kragenartig oder fast glockenförmig umgiebt. Ihere structur ist nicht pseudoparenchymatisch; vielmehr ist sie aus eng verflochtenen, cylindrischen Hyphen zusammengesetz."

Burt† in describing this plant writes: "This species has been

*Ann. Jard. Bot. de Buitenzorg, 2d Ser. Vol. I., part 2.

† Bot. Gaz. 22. 1896.

placed in the genus *Dictyophora* on account of its having a persistent membrane hanging about the angle between the pileus and the stipe. This membrane is composed of the same tissue, the intermediate tissue *A* of my figures; which gives rise to the veil in *D. duplicata*. Differentiation of this tissue does not advance in *D. ravenelii* to the final stage of making this membrane pseudoparenchyma, or is this final stage reached in the case of hyphæ composing the pileus in *I. impudicus* and in *D. duplicata*, yet no one would hesitate on that ground to use the term *pileus* in connection with those species. It seems best to apply the term *veil* to this membrane in *D. ravenelii* which looks like a veil, has the position of a veil, is composed of a tissue forming the veil in other species and is likely to be regarded as a veil without question by every botanist meeting this fungus for the first time and attempting its determination."

Burt's interpretation of this structure seems hardly the best one. The membrane as shown in detail in Fig. 15 bears no resemblance whatever to the tissue of the stipe and pileus shown in detail with the same enlargement in Figs. 14 and 16. The attachment of this membrane at the base of the volva and the fact that it ruptures irregularly, are both strong reasons for not considering it as a true veil or indusium. It would seem better to regard it rather as tissue which in other species of both *Ithyphallus* and *Dictyophora*, is completely disorganized—with the exception possibly of *I. tenuis*, mentioned by Penzig, where also a similar structure occurs. The presence of this tissue, although noted by the earlier writers, was not considered of importance enough to exclude the plant from the genus in which its other characteristics certainly placed it.

The pileus is composed of tissue very similar in structure to that of the stipe, except that the walls are closely folded and the tissue of the chambers is not so completely disorganized. The structure of one of the folds is shown in Fig. 14 while a longitudinal section showing the relative position of the walls is shown in Fig. 18. From a surface view the pileus has a finely wrinkled or granulated appearance. It is firmly attached to the apex of the stipe just below the collar. The line of demarkation between the pileus and the stipe at the point of attachment is not easy to make out. In fact at the point of union the tissue of the three areas, stipe, pileus and collar is homogeneous. It is close within the axis of the stipe and pileus that the so-called indusium is attached and often it clings so closely to the inner surface of the pileus as to be mistaken for a portion of that structure.

The gleba is much more persistent than in most forms of the family, maintaining itself for some hours after the elongation of the stipe. Its structure at this stage is very indefinite. Slight traces of the hymenium may be found, but for the most part it consists of a disorganized tissue containing masses of spores scattered about, held by the surrounding substance. The spores are very small, 1.5–2.5 mikrons in diameter, somewhat oblong and greenish black. In order to show the structure of the gleba the drawings for Figs. 16 and 17 were made from a young stage of the sporophore such as is shown in Fig. 6.

In conclusion the results of the study so far made upon this plant seem to suggest the following points:

1. The mycelium of the plant is of considerable structural importance and deserves further attention.

2. There are borne upon the mycelium certain organs which seem to function as storage places for reserve material.

3. There is in the young mycelial threads very good evidence of the occurrence of cell fusion previous to, or in intimate connection with the formation of the sporophore.

4. The indusium of this plant cannot be considered homologous with the indusium of true members of the genus *Dictyophora;* but is rather the persisting remnant of tissue which is completely broken down in most other plants of this order.

Explanation of Plates.

Plate XXIX.—Field view of undeveloped sporophores, from photograph by C. J. Hibbard.

Plate XXX.—Field view showing mature sporophore, from photograph by C. J. Hibbard.

Plate XXXI.—Structure and development of *I. ravenelii.*

1. A very young sporophore; *V*, volva; *R*, receptaculum. × 50.

2–7. Development of the sporophore; *B*, base; *V*, the outer layer of the volva; V^2, the middle layer of the volva; V^3, the inner layer of the volva; *I*, indusium; *S*, stipe; *P*, pileus; *G*, gleba; *C*, collar, and *X*, tissue remnant within the stipe.

8. Small mycelial strand with branch "a" leading to young sporophore. × 50.

9. Section of small strand at point of branching, showing large hypha at "a"; central area *B*; peripheral area *C*. × 100.

10. Tuber with connecting mycelium and base of an old sporophore at *A*. Natural size.

11. Section through a small tuber showing continuous mycelial strand. × 5.

12. Detail of portion of young sporophore shown in Fig. 1. × 500.

13. Diagrammatic view of section of stipe. × 5.

14. Detail of a fold of pileus tissue. × 500.

15. Detail of portion of indusium showing large drops of gelatine at hyphal ends. × 500.

16. Portions of hymenial layer in immature sporophore. × 500

17. Portion of wall of chamber of stipe. × 500.

18. Diagrammatic view of pileus and gleba immature. × 15.

19. Detail of portion of tissue of the base of the sporophore. × 500.

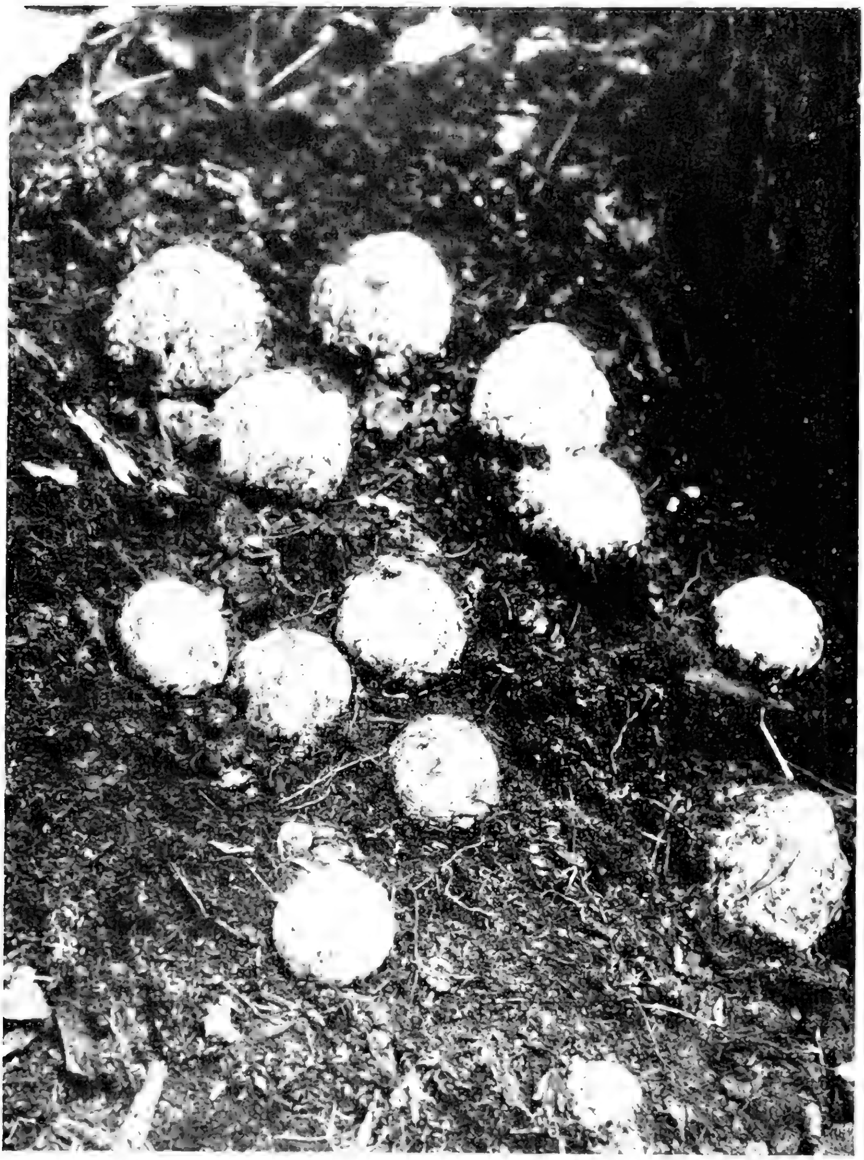
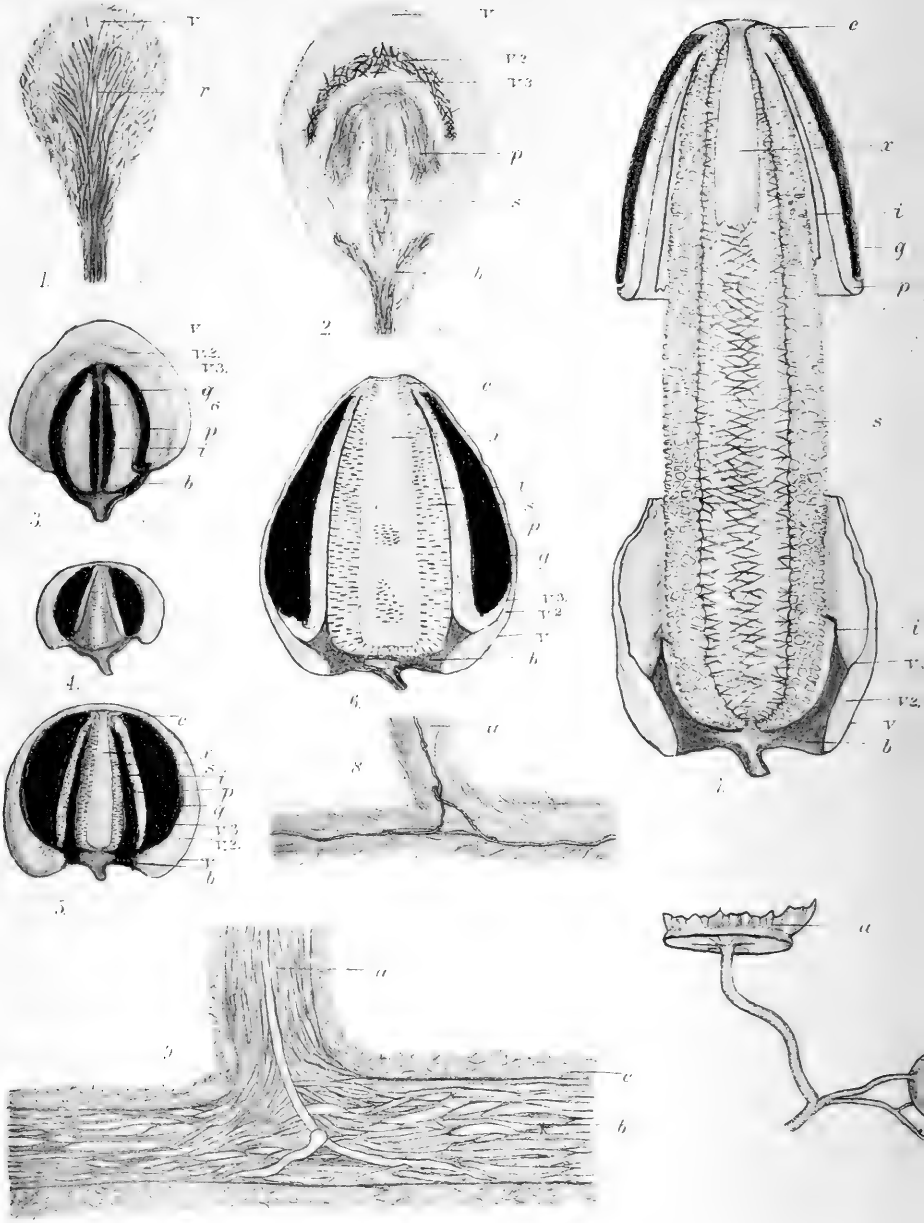
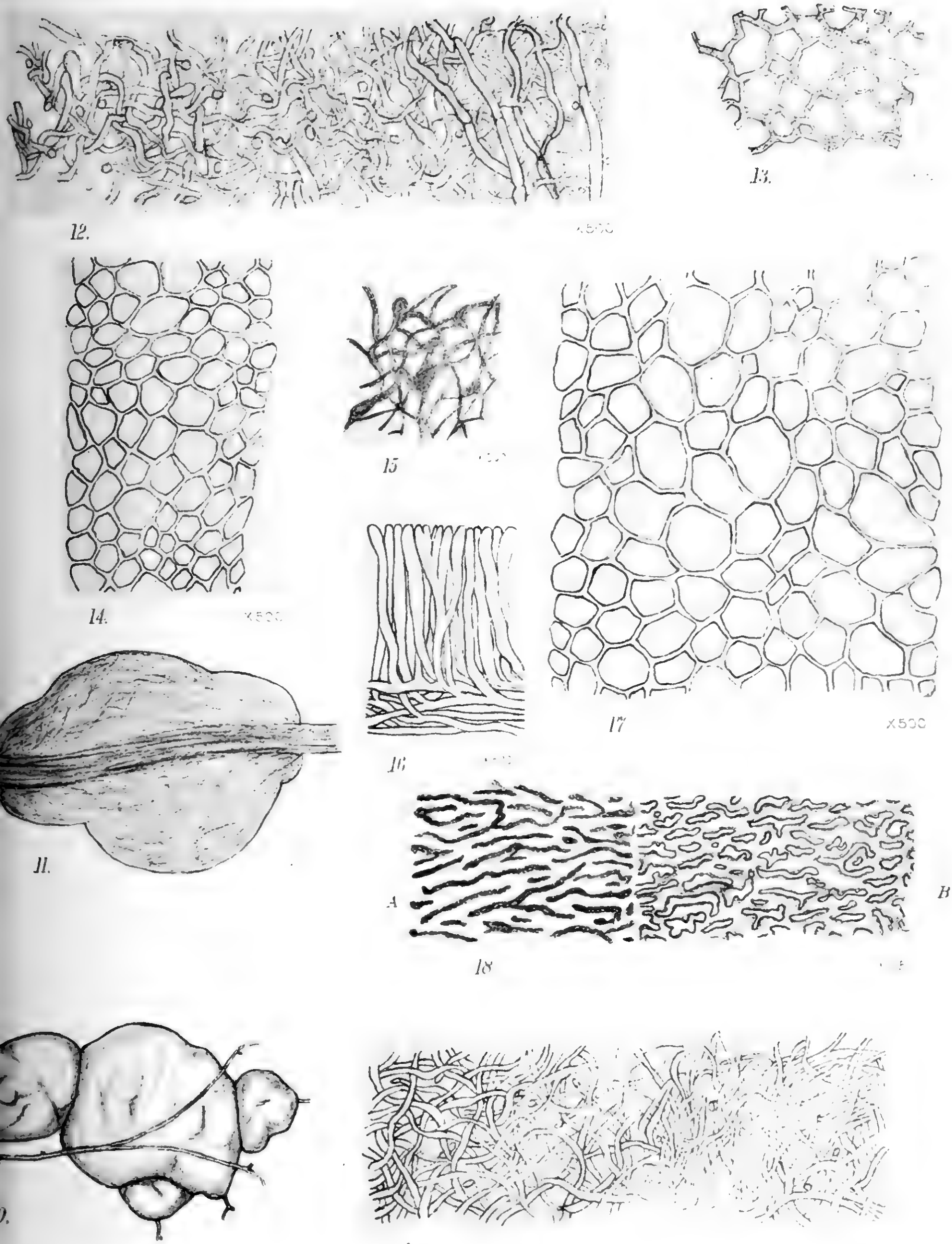


PLATE XXIX

Plate XXX.




12.
x500
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15
16
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x500
11.
A
B
18
19.

XXIX. A PRELIMINARY LIST OF MINNESOTA UREDINEÆ.

E. M. Freeman.

The following list comprises the Uredineæ collected in Minnesota up to the present time, by the Botanical Survey Staff. The materials are taken from the collections cited in my preliminary list of Minnesota Erysipheæ.* In addition to these Dr. L. H. Pammel has made numerous collections at Hokah and other points in southeastern Minnesota. These have not been included in the present report but may be found in Trelease's Parasitic Fungi of Wisconsin.† *Puccinia anemones-virginianæ* is the only species collected by Dr. Pammel in Minnesota which has not been collected elsewhere in the State.

No representatives of the Endophyllaceæ or of the Schizosporaceæ have yet been found in Minnesota. Of the Melampsoraceæ five genera with seven species are reported, viz: *Chrysomyxa* 1 species, *Cronartium* 1, *Coleosporium* 1, *Melampsora* 3, *Calyptospora* 1; of the Pucciniaceæ seven genera with 62 species: *Uromyces* 14, *Puccinia* 39, *Gymnoconia* 1, *Uropyxis* 1, *Gymnosporangium* 4, *Phragmidium* 4, *Triphragmium* 1; of isolated *Æcidia* (including *Peridermia*) 30; of isolated *Uredo* 2.

On May 11, 1900, there was collected in Mille Lacs county a very large witches' broom on a white pine. The broom measures fully 9 feet across. The distortion of the branches is very pronounced and the leaves of the broom are considerably smaller than the normal. The cause of the formation cannot at present be positively ascertained. There are no indications that the branches contain an abundant mycelium and the material was collected early in the spring before æcidia had time to form. So far as I am aware no authentic record of a witches' broom upon pines caused by a fungus parasite exists.

* Minn. Bot. Stud. 2^4: 417. 1900.

† Trans. Wisc. Acad. Sci. A. and L. 6: 1884.

In Sargent's Sylva* is a statement that pines are sometimes subject to the distortions known as witches' brooms. Dr. Farlow writes, however, that this statement was based on a reported witches' broom on *Pinus ponderosa* from Montana and that further study of the material demonstrated that the distortions were not typical witches' brooms, nor were they caused by a fungus parasite. No definite statement as to the cause of the broom of white pine collected in Minnesota can be made until older material is obtained and a more detailed description is therefore deferred.

DESCRIPTION OF PLATE XXXII.

Witches' broom on *Pinus strobus*, Mille Lacs county, Minn. After photograph by R. S. Mackintosh, May, 1900.

I. MELAMPSORACEÆ.

Chrysomyxa UNGER.

One species of this genus has been found. Common on *Pyrolas* throughout the State.

1. **C. pirolatum** (KOERN.) WINT. Die Pilze 1^1: 250. 1884.
   On leaves of:
   Pyrola rotundifolia L.: Goodhue, (II) Je. 1893, Ballard; Freeborn, (II) My. 1891, Sheldon 5964 and 5963.
   Pyrola elliptica NUTT.: Aitken, (II) Je. 1892, Sheldon 2101; Houston, (II) Je. 1899, Lyon 98; Mille Lacs, (II) My. 1900, H. B. Carey and Freeman 560.
   Pyrola secunda L.: St. Louis, (II) Jy. 1886, Holway 27. [*Uredo pyrolæ* (Gm.) Wint.]

Cronartium FRIES.

Not yet collected by the survey staff, but one species has been reported by Seymour.

1. **C. asclepiadeum** (WILLD.) FR. Obs. Myc. 1: 220. 1815.
   Var. **quercuum** B. & C.
   Crow Wing, (III) Ag. 1884, Seymour. (Economic Fungi. A. B. Seymour and F. S. Earle, No. 215.)

Coleosporium LÉVEILLÉ.

One species found. Very abundant throughout the State. Uredospore form most abundant and conspicuous. Only one collection of the teleutospores has been made.

* Sylva of N. A. 11: 12.

1. **C. sonchi-arvensis** (P.) WINT. Die Pilze 1[1]: 247. 1884.
On leaves of:
Solidago serotina AIT.: Lincoln, (II) Ag. 1891, Sheldon 1506; Houston, (II) Ag. 1899, Lyon 360.
Solidago canadensis L.: Traverse, (II) S. 1893, Sheldon 7080.
Solidago flexicaulis L.: Case, (II) Ag. 1893, Anderson 702.
Solidago sp. indet.: Chicago, (II) S. 1891, Sheldon 4261; Lincoln, (II) Ag. 1891, Sheldon 1420; Hennepin, (II) O. 1898, Freeman; Traverse, (II) S. 1893, Sheldon 7308; Houston, (II) Ag. 1899, Lyon 430.
Laciniaria sp. indet.: Traverse, (II) S. 1893, Sheldon 7381.
Aster divaricatus L.: St. Louis, (II) Jy. 1886, Holway 102.
Aster macrophyllus L.: Cass, (III) Ag. 1893, Ballard 1747.
Aster sp. indet.: St. Louis, (II) Jy. 1886, Holway 165 and 251; Winona, (II) Jy. 1888, Holzinger 139; Houston, (II) Ag. 1899, Lyon 401 and 398; Hennepin, (II) S. 1889, MacMillan; Hennepin, (II) Ag. 1892, Sheldon 4122.
Doellingeria umbellata (DILL.) NEES: St. Louis, Jy. 1886, Holway 83.

Melampsora CASTAGNE.

Three species. The uredo forms of those species growing on *Populus* and *Salix* are especially abundant. All three species are Hemi-melampsoras.

1. **M. epilobii** (P.) FCKL. Sym. Myc. 44. 1869.
On leaves of:
Epilobium coloratum MUHL.: ——, (II) S. 1893, Sheldon 6147; St. Louis, (II) Jy. 1886, Holway 35 and 89.
Epilobium lineare MUHL.: St. Louis, (II) Jy. 1886, Holway 49.
Epilobium sp. indet.: Waseca, (II) Je. 1891, Sheldon 357.

2. **M. populina** (JACQ.) LEV. Ann. Sci. Nat. III. 8: 375. 1847.
On leaves of:
Populus tremuloides MICHX.: Otter Tail, (II) Ag. 1892, Sheldon 3890; St. Louis, (II) Jy. 1886, Holway 198

Populus deltoides MARSH.: Lincoln, (II) Ag. 1891, Sheldon 1573; Hennepin, (II) S. 1899, Lyon; Winona, (II). S. 1888, Holzinger; Hennepin, (II) S. 1889, MacMillan.

3. **M. salicis-capreæ** (P.) WINT. Die Pilze 1[2]: 239. 1884.
On leaves of:
Salix discolor MUHL.: St. Louis, (II) Jy. 1886, Holway 101.
Salix myrtilloides L.: St. Louis, (II) Jy. 1886, Holway 166.
Salix sp. indet.: Hennepin, (II) S. 1890, MacMillan; Brown, (II) Jy. 1891, Sheldon 1087 and 995; Blue Earth, (II) Jy. 1891, Sheldon 478; Mille Lacs, (II) Jy. 1892, Sheldon 2978; Hennepin, (II) O. 1892, Sheldon 4126.

Calyptospora J. KÜHN.

The well-known species on the mountain cranberry has been collected only in one locality.

1. **C. goeppertiana** KÜHN. Hedw. 8: 81. 1869.
On *Vaccinium vitis-idæa* L.: Cooke, (III) Jy. 1899, MacMillan; Cooke, (III) Jy. 1900, Mrs. C. J. Hibbard.

II. PUCCINIACEÆ.

Uromyces LINK.

Fourteen species of *Uromyces* have been found in the State. Seven of these are found upon plants of the Pulse family. Very common also are those species found upon *Euphorbia*, *Arisæma* and *Polygonum*. Four species belong to the *Hemiuromyces*, seven to the *Euuromyces* and of the remaining three, the life histories are incomplete. The *Euuromycetes* are all autœcious.

A. AUT-EUUROMYCES.

1. **U. fabæ** (P.) DE BARY, Ann. Sci. Nat. IV. **20**: 76. 1863.
Uromyces polymorphus Pk. * differs from this species only in greater variability of the teleutospore form. The pedicel is no criterion. I have therefore included forms on *Lathyrus* and *Vicia* under *U. fabæ* although exhibiting considerable variation in spore form.

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*Ellis. N. A. Fungi no. 1442.

On *Vicia linearis* (NUTT.) GREENE: Traverse, (II) S. 1893, Sheldon 7374.

Vicia americana MUHL.: Mille Lacs, (II and III) Jy. 1892, Sheldon 2926.

Vicia sp. indet.: Traverse, S. 1893, Sheldon, (II) 7320 and (III) 7256; ——, (III) —— 1892, Sheldon 3816 (?).

Lathyrus venosus MUHL.: Mille Lacs, (II) Jy. 1892, Sheldon 2940.

Lathyrus sp. indet.: ——, (III) —— 1893, Sheldon 6127 and 6129.

2. **U. appendiculatus** (P.) LINK. Berl. Ges. Nat. Freunde Mag. **7**: 28. 1816.

On *Strophostyles helvola* (L.) BRITTON: Houston, (I) Je. 1899, Lyon 24; Houston, (II, III) Ag. 1899, Lyon 389.

3. **U. albus** DIET. & HOLW. Hedw. **36**: 297. 1897.

According to Dietel this is *Æcidium album* Clint. (*Æcidium porosum* Pk.). No experiments indicating this are cited. The specimen reported below differs from Dietel's description in that the teleutospore sori are found on the leaves (not on the stem), and the color of the sori is not black but dark brown.

This material (Holway 25) was reported by Arthur * as *Uromyces orobi* (P.) Wint. (II), and (Holway 14) as *Æcidium porosum*.

On *Vicia americana* MUHL.: St. Louis, (II, III) Jy. 1886, Holway 25; St. Louis, Jy. 1886, Holway 14; Mille Lacs, (I) Jy. 1892, Sheldon 2720; Aitkin, (I) Jy. 1892, Sheldon 2658.

4. **U. trifolii** (ALB. & SCHW.) Wint. Die Pilze $\mathbf{1}^{1}$: 159. 1884.

On *Trifolium repens* L.: St. Louis, (I, II) Jy. 1886, Holway 34; Hennepin, (II, III) Jy. 1890, MacMillan; ——, (II) —— 1893, Sheldon 6098.

5. **U. euphorbiæ** COOKE & PECK, Rep. N. Y. St. Mus. Nat. Hist. **25**: 90. 1873.

Arthur's recent experiment † although too incomplete to be conclusive indicates strongly that *Uromyces euphorbiæ* is an autœcious Euuromyces.

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* l. c.

† Cultures of Uredineæ in 1899. J. C. Arthur.

On *Euphorbia maculata* L.: Mille Lacs, (I) Jy. 1892, Sheldon 3136.

Euphorbia serpyllifolia Pers.: Pine, (II, III) Je. 1899, Freeman 528; Hennepin, (II, III) Jy. 1890, MacMillan.

Euphorbia heterophylla L.: Houston, (II, III) Ag. 1899, Lyon 317.

Euphorbia marginata PURSH: Renville, (II, III) Jy. 1891, Sheldon 957.

Euphorbia glyptosperma ENGELM.: Chisago, (II, III) Ag. 1892, Taylor 1568½; Brown, (II, III) Jy. 1891, Sheldon 969 and 1170.

Euphorbia sp. indet.: Renville, (II, III) 1890, MacMillan.

6. **U. polygoni** (P.) FCKL. Symb. Myc. 64. 1869.

Of this very common species uredospores and teleutospores only can at present be reported. Some æcidium material on what appeared to be a *Polygonum* was found in 1900 in Wright county (Freeman 698), but the amount of material was insufficient for accurate and positive determination.

On *Polygonum aviculare* L.: Winona, (III) on leaves and stem, N. and O. 1893, Edna Porter; St. Louis, (II) Jy. 1886, Holway 5, 113 and 116.

Polygonum ramosissimum MICHX.: Brown, (II, III) on leaves and stem, Jy. 1891, Sheldon 1048; Lincoln, (III) Ag. 1891, Sheldon 1545.

Polygonum sp. indet.: Traverse, (III) on leaves and stem, S. 1893, Sheldon 7253; Winona, (II, III) S. 1888, Holzinger.

7. **U. caladii** (SCHW.) FARLOW, Ellis N. A. Fungi, No. 232. 1879. Abundant wherever *Arisæma* is found.

On the leaves and spathe of:

Arisæma triphyllum (L.) TORR.: Blue Earth, (I) Je. 1891, Sheldon 114; Chisago, (III) S. 1893, Sheldon 6309; Hennepin, (I) My. 1899, Freeman 308; Ramsey, (I) My. 1899, Freeman 317; Houston, (I) Je. 1899, Lyon 97; Hennepin, (I) My. 1899, MacMillan; Hennepin, (I) F. 1899, E. A. Cuzner (in university plant house); Wright, (I) My. 1900, Freeman 581; Pope, (III) Jy. 1892, Taylor 916; Winona, My. 1889, Holzinger.

B. Hemiuromyces.

8. **U. lespedezæ** (Schw.) Pk. Ellis, N. A. Fungi, No. 245. 1879.
   On *Lespedeza capitata* Michx.: Winona, (III) S. 1888, Holzinger; Chisago, (III) S. 1893, Ballard 1819.

9. **U. hedysari-paniculata** (Schw.) Farlow, Ellis, N. A. Fungi, No. 246. 1879.
   On *Meibomia* sp. indet.: ——, (III) 1893, Sheldon 7078.

10. **U. terebinthi** (DC.) Wint. Die Pilze 1[1]: 147. 1884.
   On *Rhus radicans* L.: Kandiyohi, (III) Jy. 1892, Frost 302.

11. **U. caryophyllinus** (Schrank.) Schroet. Brand and Rost-Pilz. Schles. 10. 1872.
   On *Dianthus caryophyllus* L.: Ramsey, (III) on leaves and stem, Ap. 1900, Freeman.

C. Life Histories Incompletely Known.

12. **U. argophyllæ** Seym. Proc. Bost. Soc. Nat. Hist. 185. 1889.
   On *Psoralea argophylla* Pursh: Traverse, (III) S. 1893, Sheldon 7353; Lincoln, (III) Ag. 1891, Sheldon 1546.

13. **U. pyriformis** Cooke, Rep. N. Y. St. Mus. Nat. Hist. **29**: 69. 1878.
   On *Acorus calamus* L.: Carver, (III) Je. 1891, Ballard 13; Wright, (III) My. 1900, Freeman 636.

14. **U. rudbeckiæ** Arth. & Holw. Bull. Ill. St. Lab. Nat. Hist. **2**: 163. 1885.
   On *Rudbeckia laciniata* L.: ——, (III) S. 1893, Sheldon.

Puccinia Persoon.

Thirty-nine species have been collected: 10 *Aut-eupuccinia*, 6 *Heter-eupuccinia*, 2 *Brachypuccinia*, 2 *Pucciniopsis*, 7 *Hemipuccinia*, 1 *Micropuccinia*, 3 *Leptopuccinia*, and 8 with imperfectly known life histories. Very abundant are those species found on Mints, *Helianthus* and allied genera, on grasses, sedges and *Polygonum*. Those forms formerly included under *P. hieracii* (Schum.) Mart. have been separated as far as possible according to the recent researches of Jacky.* The high degree of specialization in the habit of these forms which has

* Die Compositen-bewohnenden Puccineen vom Typus Puccinia hieracii und deren Specialisierung. Bern. 1899.

been demonstrated in these experiments emphasizes the need of special research in cultures upon American species. It is possible to utilize Jacky's results only upon species common to both Europe and America. *Puccinia amorphæ* Curt. upon species of *Amorpha* have been retained under Schroeter's genus *Uropyxis*.

A. Aut-eupuccinia.

1. **P. adoxæ** Hedw. Fl. Fr. 2: 220. 1815.
   On *Adoxa moschatellina* L.: Winona, (I) My. 1889, Holzinger.
2. **P. calthæ** Lk. in Linné, Sp. Pl. 6²: 79. 1825.
   On *Caltha palustris* L.: St. Louis, (II) Jy. 1886, Holway 96.
3. **P. convolvuli** (P.) Cast. Obs. 1: 16. 1842.
   On *Convolvulus sepium* L.: Winona, (II, III) Ag. 1888, Holzinger; Brown, (I) Jy. 1893, Sheldon 899; Blue Earth, (I) Je. 1891; Sheldon 374.
   Convolvulus spithamæus L.: Winona, (III) Ag. 1888, Holzinger 6.
4. **P. galii** (P.) Schwein. Syn. Fung. Car. Sup. 73. 1822.
   On *Galium asprellum* Michx.: St. Louis, Jy. 1886, Holway 94.
   Galium concinnum Torr. & Gray: Winona, Ag. 1888, Holzinger 198.
5. **P. gentianæ** (Strauss) Lk. in Linné Sp. Pl. 6²: 73. 1825.
   On *Gentiana andrewsii* Griseb.: Brown, (II, III) Jy. 1891, Sheldon.
   Gentiana puberula Michx.: Glenwood, (II, III) Ag. 1891, Taylor 1179.
6. **P. pimpinellæ** (Strauss) Link in Linné Sp. Pl. 6²: 77. 1825.
   On *Washingtonia claytoni* (Michx.) Britton: Houston, (II, III) Je. 1899, Lyon 41.
7. **P. violæ** (Schum.) DC. Fl. Fr. 6: 92. 1815.
   On *Viola canadensis* L.: Lake, (I) Je. 1893, Sheldon 4758.
   Viola blanda Willd.: St. Louis, (II, III) Jy. 1886, Holway 131; Lake, (I) Je. 1893, Sheldon 4735; Wright, (I) My. 1900, Freeman 662.

Viola blanda palustriformis A. GRAY: Hennepin, (I) My. 1891, Sheldon 5961.

Viola blanda amœna (LE CONTE) B.S.P.: Crow Wing. (I) Je. 1892, Sheldon 2150; Mille Lacs, (I) Jy. 1892, Sheldon 2705½.

Viola scabriuscula (T. & G.) SCHWEIN.: Wright, (I) My. 1900, Freeman 592.

Viola sp. indet.: Hennepin, (II, III) S. 1889, MacMillan; Brown, (III) Jy. 1891, Sheldon 845 and 850; Hennepin, (III) O. 1892, Sheldon 4090; ——, (III) S. 1893, Sheldon 7242.

8. **P. menthæ americana** BURRILL, Bull. Ill. St. Lab. Nat. Hist. **2**: 189–191. 1885.

The echination, which distinguishes this form from the European form, is in almost all specimens most marked at the apex of the teleutospores. Many teleutospores are almost smooth at the base. European teleutospore specimens are sometimes slightly echinate at the apex.

On *Monarda fistulosa* L.: Chisago, Ag. 1883, Arthur; Winona, (III) Ag. 1888, Holzinger 42; Winona, (II, III) Ag. 1888, Holzinger; Hennepin, (III) 1890, MacMillan; Hennepin, (III) O. 1893, Sheldon 4096; Traverse, (III) S. 1893, Sheldon 7175; Winona, (III) S. 1893, Edna Porter; Hennepin, (III) S. 1898, MacMillan; Houston, (III) Ag. 1899, Lyon 321.

Koellia virginiana (L.) MACM.: Winona, (II, III) Ag. 1888, Holzinger 164.

Mentha canadensis L: Hennepin, (II, III) Ag. 1883, Arthur; St. Louis, (II, III) Jy. 1886, Holway 236; Lincoln, (II, III) Ag. 1891, Sheldon 1419; Ramsey, (II) Je. 1899, Freeman 458; Ramsey, (II, III) S. 1898, Freeman.

Mentha sp. indet.: ——, (II, III) 1893, Sheldon 6070 and 7019; Traverse, (II, III) S. 1893, Sheldon 7382.

9. **P. tanaceti** DC. Fl. Fr. **2**: 222. 1815.

The *Puccinia* on *Helianthus* differs from that on *Tanacetum* only in having a slightly broader teleutospore. This is especially true of the distal cell. Culture experiments are necessary to separate these forms.

On *Artemisia dracunculoides* PURSH: Houston, (II, III) Ag. 1899, Lyon 391; Traverse, (III) S. 1893, Sheldon 7311.

Heliopsis helianthoides (L.) B.S.P.: Winona, (II, III) Jy. 1888, Holzinger 204.

Helianthus grosse-serratus MARTENS: Lincoln, (III) Ag. 1891, Sheldon 1544.

Helianthus tuberosus L.: Goodhue, (II, III) Ag. 1893, Anderson 726.

Helianthus giganteus L.: St. Louis, (II) Jy. 1886, Holway 133.

Helianthus annuus L.: Winona, (III) Ag. 1889, Holzinger; Hennepin, (II, III) O. 1889, MacMillan; McLeod, (II) Jy. 1890, T. J. McElligott; Hennepin, (III) —— 1890, E. A. Cuzner; Traverse, (III) S. 1893, Sheldon 7366; Ramsey, (III) S. 1898, Freeman; ——, (III) 1893, Sheldon, 5823, 6175 and (II, III) 7195; Hennepin, (II, III) O. 1889, MacMillan.

Helianthus sp. indet.: Traverse, (III) S. 1893, Sheldon 7378; ——, (III) 1893, Sheldon 7136 and 6067.

10. **P. Chondrillæ** CORDA, Icon. Fung. **4**: 15. 1840.

The Minnesota specimens of the *Puccinia* on *Lactuca* exhibit morphological characters which according to Jacky (l. c.) distinguish this form from those on *Prenanthes*. The teleutospore has no well-developed papilla and no constriction and is elliptical in form. The germ pores are irregular in position, often occurring at the summit.

On *Lactuca pulchella* (PURSH) DC.: ——, (III) S. 1893, Sheldon.

Lactuca sp. indet.: Traverse, (III) S. 1893, Sheldon 7241 and 7125.

B. HETER-EUPUCCINIA.

11. **P. angustata** PECK, Rep. N. Y. St. Mus. Nat. Hist. **25**: 123. 1873.

On *Scirpus atrovirens* MUHL.: Ramsey, (II, III) O. 1898, Freeman.

Lycopus virginicus L.: St. Louis, (I) Jy. 1886, Holway 216; Blue Earth, (I) Je. 1891, Sheldon 484.

This species is connected with *Æcidium lycopi* Ger. according to Arthur (l. c.).

12. **P. caricis** (SCHUM.) REBENT. Prod. Fl. Neom. 356. 1804.

The connection of *Æcidium urticæ* Schwein. on *Urtica* with *P. caricis* has been confirmed for American specimens. (Arthur, l. c.) The æcidia are found on both lamina and petiole.

On *Carex castanea* WAHL.: Lake, (III) Je. 1893, Sheldon 4822.

Carex utriculata BOOTT: Houston, (III) My. 1900, Lyon 537.

Carex sp. indet.: ——, (III) 1893, Sheldon 7135, 7368 and 7122; Hennepin, (III) O. 1898, Freeman; Hennepin, (III) S. 1900, Freeman 786½.

Urtica gracilis AIT.: Ramsey, (I) My. 1899, Freeman 322; Waseca, (I) Je. 1891, Sheldon 206 and Taylor 302.

Urtica sp. indet.: Hennepin, (I) 1893, Sheldon 5968 and 5967.

13. **P. phragmitis** (SCHUM.) KÖRN. Hedw. **15**: 179. 1876.

In Europe it has been demonstrated by several investigators that the æcidium on various species of *Rumex* belongs to *P. phragmitis*. According to the recent culture experiments of Arthur (l. c.) æcidia were easily obtained upon *Rumex crispus* and *Rumex obtusifolius*. According to the same author no authentic and undoubted record of the collection of *Æcidium rubellum* GMEL. has been reported upon American species of *Rumex*. A Minnesota specimen of *Rumex britannica* L. was collected in 1899 (Freeman 471) upon which several groups of æcidia were found. Upon comparison with *Æcidium rubellum* on *R. hydrolapathum* * the two specimens were found to agree perfectly in all morphological characters.

The spots are circular and usually of a reddish color, not swollen. Pseudoperidia on lower surface of the leaf somewhat crowded, leaving usually a free central area, flat, cup-shaped with revolute lacerate margin. Spores 17–23 $\mu \times$ 11–17 μ. It seems very probable therefore that this æcidium on *Rumex britannica* belongs to *P. phragmitis*. Arthur's explanation that the æcidium on *Rumex* has up to this time been overlooked is therefore probably correct.

On *Rumex britannica* L.: Ramsey, (I) Je. 1899, Freeman 471.

Phragmites phragmites (L.) KARST: ——,(III) 1893, Sheldon 7119.

14. **P. rhamni** (P.) WETTST. Verh. Zool.-Bot. Ges. Wien. **35**: 545. 1885. (*P. coronata* CDA.)

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* Krieger Fung. Sax. no. 853.

On *Avena sativa* L.: Brown, (II) Jy. 1891, Sheldon 1045.
Rhamnus alnifolia L'HER.: Houston, (I) Ag. 1900, Lyon 546; Ramsey, (I) My. 1899, Freeman 316; ——, (I) 1893, Sheldon 5963; Hennepin, (I) My. 1891, Sheldon 5969.

15. **P. poculiformis** (JACQ.) WETT. Verh. Zool.-Bot. Ges. Wien. **35**: 544. 1885. (*P. graminis* PERS.)

There is no good reason for not accepting Wettstein's name. The species is exceedingly abundant although but few collections have been made.

On *Avena sativa* L.: Brown, (III) Jy. 1891, Sheldon 1104; Goodhue, (II) Ag. 1893, Anderson 710.
Undetermined grasses: ——, (II, III) 1893, Sheldon 7120; ——, (II), 1893, Sheldon 7126.

16. **P. rubigo-vera** (DC.) WINT. Die Pilze $\mathbf{1}^1$: 217. 1884.

On *Triticum vulgare* L.: Kandiyohi, (II) Jy. 1892, Frost 285 and (II, III) 283½; Goodhue, (II, III) Ag. 1893, Anderson 711; Traverse, (III) S. 1893, Sheldon 7387.
Hordeum vulgare L.: Waseca, (II, III) Je. 1891, Sheldon 529.

C. BRACHYPUCCINIA.

17. **P. hieracii** (SCHUM.) MART. Flora Mosq. 226. 1817.

Jacky's results (l. c.) can be utilized only in separating out the form on *Taraxacum*. Those on *Hieracium* and *Carduus* require further cultural investigation on American specimens.

On *Hieracium canadense* MICHX.: Hennepin, (III) O. 1889, MacMillan.
Carduus sp. indet.: Winona, (II) Ag. 1888, Holzinger 41; ——, (II, III) 1893, Sheldon 6097 and 6059; Traverse, (II, III) S. 1893, Sheldon 7398; Ramsey, (II, III) S. 1898, Freeman.

18. **P. taraxaci** PLOWRIGHT, Brit. Ured. and Ustil.: 186 and 187. 1889.

This species seems to be founded on negative results of Plowright and recently of Jacky. Inoculations with Pucciniæ from other composites gave in all cases negative results.

On *Taraxacum taraxacum* (L.) KARST.: Traverse, (II) S. 1893, Sheldon 7324; Hennepin, (II) Ag. 1883, Arthur; Ramsey, (II) My. 1899, Freeman 360; Hennepin, (II, III) S. 1898, Freeman.

D. PUCCINIOPSIS.

19. **P. grossulariæ** (GM.) WINT. Die Pilze 1^1: 198. 1884.
On *Ribes rubrum* L.: St. Louis, (III) Jy. 1886, Holway 213.

20. **P. podophylli** SCHWEIN. Syn. Fung. Car. Sup.: 72 No. 489. 1822.
On *Podophyllum peltatum* L.: Winona, (I) My. 1889, Holzinger; Winona, (III) Je. 1889, Holzinger; Houston, Je. 1899, Lyon (I) 2 and (III) 80.

E. HEMIPUCCINIA.

21. **P. polygoni-amphibii** P. Syn. Meth. Fungi 227. 1801. Very widely distributed and abundant.
On *Polygonum amphibium* L.: Hennepin, (II, III) S. 1889, MacMillan; ——, (II, III) 1893, Sheldon 6076.
Polygonum hartwrightii A. GRAY: Hennepin, (II, III) Ag. 1883, Arthur; Hennepin, (II, III) S. 1889, MacMillan; Otter Tail, (II, III) Ag. 1892, Sheldon 3897; Traverse, (II, III) S. 1893, Sheldon 7377.
Polygonum emersum (MICHX.) BRITTON: Hennepin, (II, III) Ag. 1883, Arthur; St. Louis, (II) Jy. 1886, Holway 50 and (II, III) Holway 48; Winona, (II, III) S. 1888, Holzinger 252.
Polygonum sp. indet.: Lincoln, (II, III) Ag. 1891, Sheldon 1549 and 1570; ——, (III) 1893, Sheldon 7137.

22. **P. argentata** (SCHULTZ) WINT. Die Pilze 1^2: 194. 1884.
On *Impatiens biflora* WALD.: Ramsey, (III) S. 1898, Freeman.

23. **P. pruni-spinosæ** PERS. Syn. Meth. Fung. 226. 1801.
On *Prunus pumila* L.: Crow Wing, (II, III) Ag. 1890, MacMillan and Sheldon 92.

24. **P. kuhniæ** SCHWEIN. Syn. Fung. Am. Bor. 296. 1834.
On *Kuhnia eupatorioides* L.: Ramsey, (III) S. 1898, Freeman.

25. **P. tomipara** TREL. Trans. Wisc. Acad. Sci. A. and L. **6**: 23. 1884.
On *Bromus ciliatus* L.: St. Louis, (II) Jy. 1886, Holway 12. Also reported at Detroit (Becker Co.) in Ell. and Ever. N. A. Fungi No. 1842. 1884.

26. **P. sorghi** SCHWEIN. Syn. Fung. Am. Bor. 295. No. 2910. 1831.

On *Zea mays* L.: St. Louis, (II) Jy. 1886, Holway 136; ——, (II) 1893, Sheldon 6148; Brown, (II) Jy. 1891, Sheldon 1065.

Sorghum sp. indet.: Hennepin, (III) O., 1890, Sheldon 5742.

27. **P. emaculata** SCHWEIN. Syn. Fung. Am. Bor. 295. No. 2912. 1834.

On *Panicum capillare* L.: Lincoln, (III) Ag. 1891, Sheldon 1530; Traverse, (III) S. 1893, Sheldon 7375 7376.

F. MICROPUCCINIA.

28. **P. thalictri** CHEV. Fl. Paris. **1**: 417. 1826.

On *Thalictrum* sp. indet.: Cass, (III) Jy. 1893, Anderson 573.

G. LEPTOPUCCINIA.

29. **P. asteris** DUBY, Botan. Gallic. **2**: 888. 1828.

On *Aster macrophyllus* L.: St. Louis, Jy. 1886, Holway 37; Cass, Jy. 1893, Ballard 1652.

Aster sagittifolius WILLD.: Houston, Ag. 1899, Lyon 451.

Aster sp. indet.: Lake, Jy. 1886, Holway, 273.

There is a great similarity in the spots, sori and spores of *P. asteris* on *A. macrophyllus* to those of *P. xanthii* Schwein.

30. **P. circææ** PERS. Tent. Disp. Meth. 39. 1797.

On *Circæa alpina* L.: St. Louis, Jy. 1886, Holway 214.

Circæa lutetiana L.: Winona, Jy., 1888, Holzinger 206 and 132; Pope, Jy. 1891, Taylor 887.

Circæa sp. indet.: Cass, Jy. 1893, Ballard 1655.

31. **P. ornata** ARTH. & HOLW. Rep. Bot. Wk. in Minn. for year 1886, **3**: 30. 1887.

On *Rumex britannica* L.: St. Louis, (III) Jy. 1886, Holway 223.

Rumex sp. indet.: Crow Wing, (III) Ag. 1890, MacMillan and Sheldon.

H. LIFE HISTORIES IMPERFECTLY KNOWN.

32. **P. variolans** HARK. Bull. Calif. Acad. Sci. **1**: 35. 1884.

On *Eriocarpum spinulosum* (NUTT.) GREENE: Traverse, (III) S. 1893, Sheldon 7101.

33. **P. nardosmiæ** E. & E. Journ. Myc. 1: 85. 1885.
On *Petasites palmata* (AIT.) A. GRAY: St. Louis, (III) Jy. 1886, Holway 232.

34. **P. porphyrogenita** CURT. Thüm. Myc. Univ. No. 545. 1876.
On *Cornus canadensis* L.: St. Louis, (III) Jy. 1886, Holway 108; St. Louis, (III) Je. 1893, Sheldon 4622.

35. **P. hydrophylli** PECK & CLINT. Rep. N. Y. St. Mus. Nat. Hist. 30: 54. 1879.
On *Hydrophyllum virginicum* L.: Hennepin, (III) My. 1891, Sheldon 1968 and 1981; Meeker, (III) Je. 1892, Frost 37; Ramsey, (III) My. 1892, Sheldon 1969; Aitken, (III) Je. 1892, Sheldon 2072; ——, (III) 1893, Sheldon 5803; Hennepin, (III) My. 1899, Freeman 310.

36. **P. tiarellæ** B. & C. N. A. Fungi, No. 549. 1881.
On *Mitella nuda* L.: St. Louis, (III) Jy. 1886, Holway 62.

37. **P. haleniæ** ARTH. & HOLWAY, Rep. Bot. Wk. in Minn. 3: 30. 1886.
On *Tetragonanthus deflexus* (J. E. SMITH) KUNTZE: St. Louis, (III) Jy. 1886, Holway 100.

38. **P. mesomegala** B. & C. Grev. 3: 53. 1874.
On *Clintonia borealis* (AIT.) RAF.: St. Louis, (III) Jy. 1886, Holway 18.

39. **P. xanthii** SCHWEIN. Syn. Fung. Car. Sup. 500. 1822.
Berkeley and Ravenel have described a variety *ambrosiæ*. The spores on *Ambrosia* do not, however, differ morphologically from those on *Xanthium*.

On *Xanthium canadense* MILL.: Hennepin, (III) O. 1889, MacMillan; Brown, (III) Jy. 1891, Sheldon 861 and 1008; Carver, (III) Jy. 1891, Ballard 756; Lincoln, (III) Ag. 1891, Sheldon 1262; Otter Tail, (III) Ag. 1892, Sheldon 3898; Traverse, (III) S. 1893, Sheldon 7259; Hennepin, (III) S. 1898, Butters; Ramsey, (III) Jy. 1899, Freeman 531; Houston, (III) Ag. 1899, Lyon 458.

Ambrosia trifida L.: Lincoln, (III) Ag. 1891, Sheldon 1266; Brown, (III) Ag. 1891, Sheldon 1227.

Gymnoconia LAGERH.

Separated from *Puccinia* on account of the æcidia, which are destitute of a pseudoperidial wall and are at first covered only by the epidermis of the host.

1. **Gymnoconia interstitialis** (SCHLECT.) LAGERH. Ured. Herb. El. Fr. Tromsö. Mus. Arshefter **17**: 84. 1894. (*Cæoma nitens* SCHWEIN. and *Puccinia peckiana* HOWE.)

The æcidial stage (*Cæoma nitens* Schwein.), the common raspberry rust, is abundant throughout the State. The teleutospores have not yet been found in Minnesota.

On *Rubus strigosus* MICHX.: Mille Lacs, (I) Jy. 1892, Sheldon 2709.

Rubus villosus AIT.: Kanabec, (I) Jy. 1892, Sheldon 2908; Mille Lacs, (I) Jy. 1892, Sheldon 2713.

Rubus canadensis L.: Le Sueur, (I) Je. 1891, Sheldon 52; Aitkin, (I) Je. 1892, Sheldon 2061 and 2145; Pine, (I) Je. 1899, Freeman 499.

Rubus sp. indet.: Winona, (I) Je. 1888, Holzinger 235; Cass, (I) Je. 1893; Ballard 1393; Houston, (I) Je. 1899, Lyon.

Uropyxis SCHROETER.

The puccinia on *Amorpha* species (*P. amorphæ* Curt.) has here been retained under Schroeter's genus *Uropyxis*. The differences between *Uropyxis* and typical *Pucciniæ* are no less than those between *Phragmopyxis* and *Phragmidium*. On the other hand *P. deglubens* might be included among the *Pucciniæ* without much more serious objection than can be raised against *Puccinia elymi* Westd. *Puccinia petalostemonis* Farlow has a slight gelatinous exospore which certainly indicates relationship with the *Puccinia* on *Amorpha*. *Phragmopyxis* according to Dietel * is more closely related to *Uropyxis* than to *Phragmidium*. I have seen biseptate spores in *Puccinia petalostemonis* Farl.† The forms on the Leguminosæ, therefore, seem to form a natural group with sufficient distinguishing characters to separate them generically from the typical *Pucciniæ*. This is Schroeter's genus *Uropyxis*. *Puccinia petalostemonis* Farl. connects it with the true *Puccinæ*.

1. **U. amorphæ** (CURT.) SCHROET. Hedw. **15**: 165. 1875.

On *Amorpha canescens* PURSH: Winona, (III) S. 1888, Holzinger; Otter Tail, (III) Ag. 1892, Sheldon 3650; Traverse, (III) S. 1893, Sheldon 7111 and 7180; Ramsey, (III) S. 1898, Freeman; Pope, (III) Ag. 1891, Taylor 1182.

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* l. c., 70.

† Ellis. N. A. Fungi, No. 1844.

Amorpha fruticosa L.: Traverse, (III) S. 1893, Sheldon 7243; Brown, (III) Jy. 1891, Sheldon 985; Chisago, (III) S. 1891, Sheldon 4245; Traverse, (III) S. 1893, Sheldon 7370.

The æcidial and uredo forms have not yet been collected.

Gymnosporangium De Candolle.

1. **G. globosum** Farl. Am. Mem. Bot. Soc. Nat. Hist. 18. 1880.

   On *Juniperus virginiana* L.: Dakota, (III) Ap. 1900, Lyon.

2. **G. nidus-avis** Thaxter, Bull. Conn. Ag. Ex. Sta. **107**: 6. 1891.

   On *Juniperus virginiana* L.: Wright, (III) Je. 1899, Lyon 553 and 547 and Freeman 697.

3. **G. clavariæforme** (Jacq.) Rees. Abh. Naturf. Gesell. **11**: 21. 1869.

   On branches of *Juniperus communis* L.: Hennepin, (III) A. 1901, Butters 97.

   Causes fusiform swelling of the branches.

4. **G. juniperi-virginianæ** Schw. Syn. Fung. Car. Sup. 74. No. 504. 1822. (*G. macropus* Lk.)

   On small branches of *Juniperus virginiana* L.: Wright, (III) A. 1901, Freeman 978.

   Causes swellings known as "cedar apples."

Phragmidium Link.

1. **P. potentillæ** (P.) Karst. Fungi Fen. No. 94 and 593. (Hel. Bid.) Fen. Nat. o. Folk. **19**: 1871—**23**: 1873.

   On *Potentilla pennsylvanica strigosa* Pursh: Douglas, (III) Ag. 1892, Sheldon 3481.

2. **P. rubi-idæi** (P.) Karst. Helsing. Bid. Fin. Nat. o. Folk **19**. 1871.

   On *Rubus strigosus* Michx.: Aitken, (II) Je. 1892, Sheldon 2211; St. Louis, (II, III) Jy. 1886, Holway 205.

   Rubus hispidus L.: St. Louis, (II) Jy. 1886, Holway 20.

   Rubus sp. indet.: Winona, (II) S. 1888, Holzinger.

3. **P. speciosum** Fr. Syst. Myc. **3**: 496. 1829.

   On stems of *Rosa* sp. indet.: Wright, (III) O. 1896, Washburn; Ramsey, (III) S. 1899, Wheeler.

4. **P. subcorticum** (Schrank.) Wint. Die Pilze $\mathbf{1}^1$: 228. 1884.

On *Rosa acicularis* LINDL.: St. Louis, (II, III) Jy. 1886, Holway 187 and 247; Ramsey, (III) My. 1899, Freeman 350.

Rosa blanda AIT.: Mille Lacs, (III) Je. 1890, Sheldon 2313.

Rosa sp. indet.: Hennepin, (III) O. 1898, Freeman; St. Louis, (II) Jy. 1886, Holway 3; Winona, (II, III) S. 1888, Holzinger; Hennepin, (III) O. 1898, Freeman; Houston, (III) Je. 1899, Lyon 26; (III) 1893, Sheldon 7334.

Triphragmium LINK.

1. **T. clavellosum** BERK. Gard. Chron. 1857.
   On *Aralia nudicaulis* L.: St. Louis, (III) Jy. 1886, Holway 17.

Æcidium. ISOLATED FORMS.

1. **A. uvulariæ** SCHWEIN. Syn. Fung. Car. Sup. 69, no. 453. 1822.
   On *Uvularia perfoliata* L.: Blue Earth, Je. 1891, Sheldon 295; Chisago, Je. 1892, Taylor 1255.
   Uvularia grandiflora SM.: Ramsey, Je. 1899, Freeman 403; Pine, Je. 1899, Freeman 526; Houston, Je. 1899, Lyon 96; Houston, Je. 1900, Lyon 552.
   Uvularia sessilifolia L.: Aitkin, Je. 1892, Sheldon 2066.
2. **A. iridis** GER. Rep. N. Y. St. Mus. Nat. Hist. **25**: 93. 1870.
   On *Iris versicolor* L.: Kanabec, Jy. 1892, Sheldon 2886; Houston, My. 1900, Lyon 534.
3. **A. convallariæ** SCHUM. Enum. Plant. Saell. **2**: 224. 1803.
   On *Lilium canadense* L.: Ramsey, Je. 1899, Freeman 400.
   Polygonatum commutatum (SCH.) DIETR.: Ramsey, Je. 1899, Freeman 404.
   Polygonatum sp. indet.: Houston, Je. 1899, Lyon 22.
4. **A. orobi** PERS. Röm. N. Mag. **1**: 92. 1794.
   Probably belongs to *Uromyces fabæ* (P.) DE BARY.
   (?) On *Falcata comosa* (L.) KUNTZE: Pope, Jy. 1891, MacMillan 5.
   Apios apios (L.) MACM.: Brown, Jy. 1891, Sheldon 914.
5. **A. lupini** PECK, Rep. N. Y. St. Mus. Nat. Hist. **46**: 33. 1893.
   On *Lupinus perennis* L.: Chisago, Jy. 1892, Taylor 1421.

6. **A. thalictri-flavi** (DC.) WINT. Die Pilze 1[1]: 269. 1884.
On *Thalictrum dioicum* L.: Mille Lacs, Je. 1892, Sheldon 2306.
Thalictrum purpurascens L.: St. Louis, Jy. 1886, Holway 210 (*A. thalictri* Grev.); Ramsey, Je. 1898, Freeman 71; Ramsey, My. 1899, Freeman 318.

7. **A. ranunculacearum** DC. Fl. Fr. 6: 97. 1815.
On *Anemone canadense* L.: Winona, Je. 1889, Holzinger, Ramsey, Je. 1899, Freeman.
Anemone quinquefolia L.: Aitkin, Je. 1891, Sheldon 2312 and 2108; Mille Lacs, Je. 1892, Sheldon 2566.
Ranunculus abortivus L.: Wright, My. 1899, Freeman 637½; St. Louis, Jy. 1886, Holway 212.

The æcidia on *R. abortivus* L. are not diffused over the entire surface but are aggregated on definite orbicular spots which are at first reddish but become yellow in drying. Spores finely tuberculate polygono-spherical, $20–23 \times 17\ \mu$. Not *Æcidium ranunculi* Schwein.

8. **A. punctatum** PERS. Usteri Ann. Bot. 20: 135. 1796.
On *Thalictrum dioicum* L.: Chisago, Je. 1899, Freeman 416.

9. **A. actææ** OPIZ. in Wallr. Fl. Crypt. Germ. 2: 252. 1833.
On *Actæa alba* (L.) MILL.: Blue Earth, Je. 1891, Sheldon 392.

10. **A. cimicifugatum** SCHWEIN. Syn. Fung. Am. Bor. 293. No. 2876. 1831.
On *Actæa* sp. indet.: Pope, Jy. 1891, Taylor 889.

Differs from *A. cimicifugatum* Schwein. in the long cylindrical pseudoperidia and in smooth (or almost) spores. Spores $15–17\ \mu$ in diameter.

11. **A. clematidis** DC. Fl. Fr. 2: 243. 1815.
On *Clematis virginiana* L.: Mille Lacs, Jy. 1892, Sheldon 2764; Brown, Jy. 1891, Sheldon 907; Pope, Jy. 1892, MacMillan 6; Houston, Je. 1899, Lyon 106.

12. **A. fumariacearum** KELL. & SWINGLE, Journ. Myc. 4: 95. 1888.
On *Bicuculla cucullaria* (L.) MILLSP.: Aitkin, Je. 1892, Sheldon 2203; —— 1893, Sheldon 5959.

13. **A. geranii** DC. Syn. Pl. 47. 1806.

On *Geranium maculatum* L.: Crow Wing, Je. 1892, Sheldon 2247; Meeker, Je. 1892, Frost 61; Houston, Je. 1899, Lyon 95; Ramsay, My. and Je. 1899, Freeman 329 and 419; Winona, Je. 1888, Holzinger.

Belongs probably to *Uromyces geranii* (DC.) Wint.

14. **A. impatientis** Schwein. Syn. Fung. Car. 674. No. 442. 1822.

On *Impatiens biflora* Walt.: Winona, Je. 1889, Holzinger; Pope, Jy. 1891, Taylor 826; Waseca, Je. 1891, Sheldon 520; Le Sueur, Je. 1891, Sheldon 219; Mille Lacs, Je. 1892, Sheldon 2495.

Impatiens sp. indet.: Pope, Jy. 1892, MacMillan 3; Wright, Je. 1900, Freeman 686.

15. **A. verbenæ** Speg. Fung. Argent. 1: 56. 1880.

On *Verbena stricta* Vent.: Brown, Jy. 1891, Sheldon 1080.

16. **A. jacobeæ** Grev. Fl. Edin. 445. 1824. (*A. senecionis* Desmaz.)

In European specimens connected with *Puccinia Schœleriana* Plow. et Magn.

On leaves of *Senecio aureus* L., Ramsey, My. 1899, Freeman 328.

17. **A. compositarum** Mart. Fl. Erlang. 314. 1817.

The æcidia on composites vary considerably in the form and color of the spots, the arrangement of the æcidia and in the size and form of the spores. In the absence of necessary knowledge of the life-histories of these forms only a temporary classification is possible. Their separation into varieties based on the hosts is the only convenient method.

On *Hieracium canadense* Michx.: Ramsey, Je. 1899, Freeman 396; Chisago, Je. 1899, Freeman 425.

On *Adopogon virginicum* (L.) Kuntze: Ramsey, Je. 1899, Freeman 392.

Var. **erigerontis** Wint.

On *Erigeron annuus* (L.) Pers.: Houston, Je. 1899, Lyon 85.

Var. **prenanthis** (P.) Wallr. Fl. Crypt. Germ. no. 1773. 1833.

On *Nabalus* sp. indet.: Houston, Je. 1899, Lyon 12; Chisago, Je. 1899, Freeman 423.

Var. **lactucæ** BURRILL, Bull. Ill. St. Lab. Nat. Hist. **2**: 232. 1885.

On *Lactuca canadensis* L.: Pine, Je. 1899, Freeman 475; Ramsey, Je. 1898, Freeman 69; Chisago, Je. 1899, Freeman 418.

Lactuca ludoviciana (NUTT.) DC.: Le Sueur, Je. 1891, Sheldon 29½ and 244.

Lactuca sp. indet.: Ramsey, My. Freeman 344; Wright, My. 1900, Freeman 594.

Var. **liatrii** WEBBER, Journ. Myc. **5**. 1889.

On *Laciniaria* sp. indet.: Pine, Je. 1899, Freeman 514.

Var. **helianthi** BURRILL, l. c. 232.

On *Helianthus divaricatus* L.: Blue Earth, Je. 1891, Sheldon 281.

Helianthus sp. indet.: Le Sueur, Je. 1891, Taylor 265.

Var. **eupatorii** (SCHW.) BURRILL, l. c. 231.

On *Eupatorium purpureum* L.: Ramsey, Je. 1899, Freeman 464.

Eupatorium perfoliatum L.: Brown, Ag. 1891, Sheldon 1058; Waseca, Je. 1891, Sheldon 308 and 521; Chisago, Je. 1892, Taylor 1340.

Eupatorium ageratoides L.: Ramsey, Je. 1898, Freeman 70.

18. **A. asterum** SCHWEIN. Syn. Fung. Car. Sup. 67, No. 444. 1822.

On *Solidago flexicaulis* L.: Waseca, Jy. 1891, Sheldon 657.

Solidago serotina AIT.: Mille Lacs, Jy. 1892, Sheldon 2790.

Solidago sp. indet.: St. Louis, Jy. 1886, Holway 141 (*A. compositarum*); Blue Earth, Je. 1891, Sheldon 207; Mille Lacs, Je. 1892, Sheldon 2451; Wright, My. 1900, Freeman 595.

Aster sagittifolius WILLD.: Blue Earth, Je. 1891, Sheldon 258.

Aster sp. indet.: Waseca, Je. 1891, Sheldon 566; Houston, Je. 1899, Lyon 14; Ramsey, Je. 1899, Freeman 398.

Euthamia graminifolia (L.) NUTT.: Chisago, Je. 1899, Freeman 430; Chisago, Je. 1892, Taylor 1339.

19. **A. pustulatum** CURT., Rep. N. Y. St. Mus. Nat. Hist. 23: 60. 1869.

On *Comandra umbellata* (L.) NUTT.: Winona, Je. 1888, Holzinger; Wright, Je. 1900, Freeman 691; Ramsey, Je. 1899, Freeman 394; Pine, Je. 1899, Freeman 490; Houston, Je. 1899, Lyon 90. Very abundant throughout the State.

20. **A. jamesianum** PECK, Bot. Gaz. 5: 34. 1880.

On *Asclepias syriaca* L.: Brown, Jy. 1891, Sheldon 1078.

Asclepias tuberosa L.: Brown, Jy. 1891, Sheldon 787.

Acerates viridiflora (RAF.) EATON: Houston, Je. 1899, Lyon.

21. **A. lysimachiæ** (SCHL.) WALLR. Fl. Crypt. Germ. No. 1770. 1833.

On *Steironema ciliatum* (L.) RAF.: Pine, Je. 1899, Freeman 503.

22. **A. grossulariæ** PERS. Syn. Meth. Fung. (?). 1801. (*A. grossulariæ* SCHUM. Enum. Plant. Saell. 2: 223. 1803.) Abundant everywhere.

On *Ribes gracile* MICHX.: Winona, My. 1886, Holzinger; Brown, Jy. 1891, Sheldon 826½; Ramsey, My. 1899, Freeman 315.

Ribes floridum L'HER.: Le Sueur, Je. 1891, Sheldon 233; Blue Earth, Je. 1891, Sheldon 375; Ramsey, My. 1899, Freeman 326; Wright, Je. 1900, Lyon 550; Houston, Je. 1899, Lyon.

Ribes cynosbati L.: Aitkin, Je. 1892, Sheldon 2291; Wright, My. 1900, Freeman 660; Pope, Jy. 1891, Taylor 935; Chisago, Je. 1892, Taylor 1307.

Ribes sp. indet.: Blue Earth, Je. 1891, Sheldon 375; Hennepin, My. 1891, Sheldon; Meeker, Je. 1892, Frost 33; Lake, Je. 1893, Sheldon 4928; Hennepin, 1893, Sheldon 5966; Houston, Je. 1900, Lyon 551; Wright, My. 1900, Freeman 598; Houston, Je. 1899, Lyon 13.

23. **A. hydnoideum** B. & C. Grev. 3: 61. 1874.

On *Dirca palustris* L.: Chisago, S. 1891, Sheldon, 1984½; Crow Wing, Jy. 1893, Ballard 1496 and 1646; Wright, My. 1900, Freeman 579.

24. **A. hydrophylli** PECK, Rep. N. Y. St. Mus. Nat. Hist. **26**: 78. 1874.
    On *Hydrophyllum virginicum* L.: Mille Lacs, Je. 1891, Sheldon 2475 and 2822; Ramsay, Je. 1899, Freeman 397; Wright, My. 1900, Freeman 600.

25. **A. pammelii** TREL. Trans. Wis. Acad. Sc. A. and L. **6**: 33. 1884.
    On *Euphorbia corollata* L.: Houston, Jy. 1899, Lyon.

26. **A. peckii** DETONI, Syll. Fung. **7**: 790. 1888.
    On *Onagra biennis* (L.) SCOP.: Pope, Jy. 1891, Taylor 865; Waseca, Je. 1891, Sheldon 510; Waseca, Je. 1892, Taylor 479; Ramsey, Jy. 1898, Freeman 72; Hennepin, My. 1899, Freeman 337; Pine, Je. 1899, Freeman 508 and 498.

27. **A. phrymæ** HALST. Journ. Myc. **2**: 52. 1886.
    On *Phryma leptostachya* L.: Waseca, Je. 1891, Sheldon 564; Brown, Ag. 1891, Sheldon 1000.

28. **A. fraxini** SCHWEIN. Syn. Fung. Car. Sup. 66. No. 430. 1822.
    On *Fraxinus Americana* L.: Lincoln, Ag. 1891, Sheldon 1520; Brown, Jy. 1891, Sheldon 1205.
    Fraxinus sp. indet.: Brown, Jy. 1891, Sheldon 1076; Kandiyohi, Jy. 1892, Frost 292.

Peridermium LEV.

1. **P. balsameum** PK. Rep. N. Y. St. Mus. Nat. Hist. **27**: 104. 1875.
    On *Abies balsamea* (L.) MILL.: St. Louis, Jy. 1886, Holway 208.

The spores of this specimen are uniformly smaller than those described by Peck and agree more nearly with those of *A. elatinum*. No distortion of the branches has been reported. The spores measure 14×17–$20\,\mu$.

2. **P. abietinum** (A. & S.) THÜM. var. **decolorans** THÜM.
    On *Picea mariana* (MILL.) B.S.P.: St. Louis, Jy. 1886, Holway 93.

The spores agree with those of the æcidia of *Chrysomyxa ledi*, to which this species supposedly belongs.

Uredo. ISOLATED FORMS.

1. **U. polypodii** (P.) DC. Fl. Fr. **6**: 81. 1815.
   On *Cystopteris fragilis* BERNH.: Houston, Jy. 1899, Lyon 217.

2. **U. agrimoniæ-eupatoriæ** (DC.) WINT. Die Pilze **1**^{1}: 252. 1884.
   On *Agrimonia hirsuta* (MUHL.) BICKNELL: St. Louis, Jy. 1886, Holway 209.

PLATE XXXII.

THE HELIOTYPE PRINTING CO. BOSTON

XXX. A NEW SPECIES OF ALARIA.

De Alton Saunders.

During the summer of 1896 while investigating some physiological problems in the Hopkins Sea-side laboratory, the writer collected an *Alaria* which did not seem to agree with any of the described species. No specimens of the Pacific coast *Alarias* were at hand for comparison and the writer being loath to add further to the synonymy of this variable group laid the plant aside until a favorable opportunity for study should present itself. Recently a specimen of this plant with several other species of Alaskan algæ was submitted to Dr. Kjellman who pronounced it a new species, related to his *A. prælonga* and *A. angusta*.

Alaria curtipes nov. sp. (Plate XXXIII.)

Plant of medium size, one to three or more meters long, dark olive brown, coriaceous; stipe very short (1–4 cm. long), firm, robust, black, narrowed below, but little flattened above; rachis short, somewhat compressed, gradually passing into the midrib; blade linear or narrowly lanceolate, 1–3 dcm. wide, narrowed above; midrib prominent, 1–2 cm. broad, projecting equally on both surfaces of the blade, quadrangular in cross section; sporophylls ovate, lanceolate or elliptical, obtusely rounded above, 2–3 cm. wide, 7–15 cm. long, 16–40 or more borne seriately on a distinct stalk 5–10 mm. long; fruiting area confined to the lower half of the sporophylls.

Abundant on exposed rocky points on the central Californian coast, Monterey bay, Carmel bay, and Point Sur.

A. curtipes is related to *A. prælonga* * Kjellm., and *A. angusta* † Kjellm. but according to Dr. Kjellman's comparison "Differs from *A. prælonga* in its broader midrib and its shorter

* Kjellman. Om Beringshafv. Algflora, p. 38, T. 4, Figs. 1–4.

† Ibidem, p. 38, T. 3, Figs. 1–4.

and more robust stipe. It differs from *A. angusta* especially in the form of the sporophylls."

Explanation of Plate XXXIII.

Figure 1. Mature plant reduced ½; *a*, *b*, *c*, *d*, young plants, showing different stages of development.

Figure 2. Cross section of sporophylls, × 400.

Figure 3. Section of midrib, × 2.

XXXI. A PRELIMINARY LIST OF MINNESOTA XYLARIACEÆ.

F. K. Butters.

During the past fifteen years numerous collections of Minnesota fungi have been made by E. W. D. Holway, Esq., Dr. A. P. Anderson, Messrs. E. P. Sheldon, E. M. Freeman and others. The list given below comprises records of all the Xylariaceæ which have been collected within the State and deposited in the herbarium of the University of Minnesota. In each case the county in which the collection was made is cited, with the date of collection, and such other information as is deemed of special value. A list of the fungi collected by Holway was included in Professor J. C. Arthur's report on botanical work in Minnesota for the year 1886,* but they are included in the present list for the sake of completeness. Some of Mr. Sheldon's specimens as well as the fungi included in Professor Arthur's list have been previously determined, but in all cases the fungi reported in the following list have been examined personally by the author and he takes the sole responsibility for their correct determination. In cases where the determinations as given in Arthur's list have been altered the name as it appears in that list has been inserted in parentheses after the citation of the collection.

In all cases in which the nomenclature employed departs from that found in Ellis and Everhart's North American Pyrenomycetes, the name employed in that work is inserted as a synonym.

It is to be noted that the specimens distributed by Ellis † as *Hypoxylon rubiginosum* (Pers.) Fr. are certainly of a different species from those distributed by de Thümen ‡ and other Euro-

* Geological and Natural History Survey of Minnesota, Bulletin No. 3, Oct. 1, 1887.

† Ellis & Everhart. North American Fungi, 1949, Fungi Columbiani, 1324.

‡ *Mycotheca universalis*, 1071.

pean authors. De Thümen's specimens are cited by Winter * and are probably authentic. The specimens distributed by Ellis cannot be *Hypoxylon rubiginosum* (Pers.) Fr. They agree with the fungus upon *Magnolia* described by Berkeley † as *Hypoxylon epiphæum* B. & C. (in some works spelled *epiphlœum*) and the species has been so cited in the following list.

In all, nineteen species of Xylariaceæ are included in the list given below. They are distributed among five genera as follows: *Nummularia*, 3; *Ustulina*, 1; *Hypoxylon*, 12; *Daldinia*, 2; *Xylaria*, 1.

Owing to the somewhat desultory manner in which these collections of fungi have been made, many species which doubtless occur in the State have not been collected as yet, while some of the more abundant and more noticeable species have been collected many times.

1. **Nummularia nummularia** (BULLIARD) SCHROET. Krypt. Fl. von Pilze II. 459. 1897. (*N. bulliardi* TUL.)

Hennepin, April 1890, Sheldon 14, on *Quercus*; ——‡ Sheldon 5751⅓; Wright, May 1900, Freeman 658 on *Quercus*; Hennepin, September 1900, Butters 75, on *Acer*; Hennepin, October 1900, Butters 50, on *Acer*.

2. **Nummularia repanda** (FRIES) NITSCHKE, Pyrenomycetes Germanici, p. 57. 1867.

Hennepin, May 1893, Sheldon 5428, on *Cornus?* erumpent through the bark; ——, Sheldon 5765; ——, Sheldon 5781.

3. **Nummularia lateritia** ELLIS & EVERHART, New Species of North American Fungi, Proc. Ac. Nat. Sci. Philadelphia, p. 144. 1893.

On bark.

Hennepin, May 1891, Sheldon 4193, on *Populus*; Hennepin, May 1891, Sheldon 4197; Ramsey, May 1893, Sheldon 4327, on *Acer*; ——, Sheldon 5928, on *Populus*.

4. **Ustulina maxima** (HALLER) SCHRÖTER, Kryptogamen Flora von Schlesien, Pilze II. p. 465. 1897. (*Ustulina vulgaris* TUL.)

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* Die Pilze, II., p. 860.

† Notices of North American Fungi, Grevillea, IV. 52. 1875.

‡ Mr. Sheldon's last field note-book is missing, his collections concerning which no field notes can be found are indicated as above.

Crow Wing, June 1892, Sheldon 2238; Ramsey, August 1893, Sheldon 5528; Hennepin, June 1890, Sheldon 5696; ——, Sheldon 6138⅓; Hennepin, May 1899, Freeman 306; Ramsey, June 1899, Freeman 380; Wright, May 1900, Freeman 650½.

Conidial stage: Wright, June 1900, Freeman 684.

5. **Hypoxylon petersii** BERKELEY & CURTIS, On a Collection of Fungi from Cuba, Journ. Linn. Soc., X., p. 384. 1869.

Houston, August 1899, Wheeler 476, on decayed log; Hennepin, September 1900, Freeman 702, on *Quercus*.

6. **Hypoxylon fuscum** (PERS.) FRIES, Summa Veg. Scand. p. 384. 1849.

On bark.

St. Louis, July 1886, Holway 119, on *Alnus;* St. Louis, July 1886, Holway 151, on *Alnus;* Hennepin, May 1891, Sheldon 4195; Lake, June 1893, Sheldon 4749, on *Alnus;* Dakota, July 1893, Sheldon 5372; Hennepin, October 1900, Butters 51, on *Ostrya*.

7. **Hypoxylon commutatum** NITSCHKE, Pyrenomycetes Germanici, p. 33. 1867.

On bark.

St. Louis, July 1886, Holway 144, on *Alnus;* Lake, June 1893, Sheldon 4484, on *Betula;* Hennepin, May 1891. Sheldon 5904, on *Tilia*.

8. **Hypoxylon granulosum** BULLAIRD, Champ. Fr. 176. 1791 (*H. multiforme* FR.) Summa Veg. Scand. p. 384. 1849.

St. Louis, July 1886, Holway 248, on *Alnus* (*Hypoxylon commutatum Holwayanum* Sacc. Holway); St. Louis, July 1886, Holway 262, on *Betula;* St. Louis, June 1893, Sheldon 4669; Ramsey, July 1893, Sheldon 5490, on wood; ——, Sheldon 6012, on *Betula;* erumpent through the bark.

9. **Hypoxylon morsei** BERKELEY & CURTIS, Notices of North American Fungi, Grevillea, IV., p. 51. 1875.

Erumpent through the bark.

St. Louis, July 1886, Holway 41, on *Betula* (*Hypoxylon transversum* Schw. Holway); St. Louis, July 1886, Holway 99, on *Alnus*; Le Sueur, June 1891, Taylor, 364; Hennepin, May 1891, Sheldon; Crow Wing, June 1892, Sheldon 2054, on *Quercus;* Hennepin, April 1891, Sheldon 4178, on *Quercus;* Dakota, July 1893, Sheldon 5201, on *Quercus;* Hennepin, May 1893, Sheldon 5426, on *Quercus;* ——, Sheldon 6138; ——, Sheldon 6244; on *Quercus;* Wright, June 1900, Lyon 542, on *Rhus;* Chisago, September 1900, Lyon & Butters, on *Quercus.*

10. **Hypoxylon annulatum** (Schw.) Montagne, Sylloge Cryptogramarum, p. 213. 1856.

Cass, August 1893, Anderson 674, on wood.

11. **Hypoxylon marginatum** Berkeley, On a Collection of Fungi from Cuba. Part II., Journ. Lin. Soc., X., p. 499. 1869.

Dakota, July 1893, Sheldon 5194 on bark.

12. **Hypoxylon rubiginosum** (Pers.) Fries, Summa Veg. Scand., p. 384. 1849.

On wood.

St. Louis, July 1886, Holway 193 (*Hypoxylon ferrugineum* Fr. Holway & Ellis), Ramsey, July 1893, Sheldon 5484; Wright, May 1900, Freeman 630.

13. **Hypoxylon perforatum** (Schw.) Fries, Summa Veg. Scand., p. 384. 1849.

——, Sheldon 5904½; ——, Sheldon 6133.

14. **Hypoxylon epiphæum** Berkeley & Curtis, Notices of North American Fungi, Grevillea, IV., p. 52. 1875.

Hypoxylon rubiginosum Ellis & Everhart, North American Fungi, No. 1949, not *H. rubiginosum* (Pers.) Fries.

Hypoxylon epiphlœum B. & C.

On wood.

Le Sueur, June 1891, Taylor 435; Brown, July 1891, Sheldon 1027, on *Tilia;* Ramsey, July 1893, Sheldon 5503, on *Acer?* (young form).

15. **Hypoxylon atropurpureum** (Fries) Fries, Summa Veg. Scand., p. 384. 1849.

On wood.

Le Sueur, June 1891, Sheldon 94; Brown, July 1891, Sheldon 1027½, on *Tilia;* Ramsey, August 1893, Sheldon 5669; ——, Sheldon 5751, on *Quercus;* ——, Sheldon 6236.

16. **Hypoxylon serpens** (PERS.) FRIES, Summa Veg. Scand., p. 384. 1849.
St. Louis, July 1886, Holway 265, on *Populus*.

17. **Daldinia tuberosa** (SCOP.) Voss. Myc. Carn. 180. 1891. (*D. concentrica* (BOLT.) C. & N.) Schema di Classificazione degli Sferiacei Italici aschigeri, Comment. Soc. Crittog. Ital., I., p. 198. 1863.
St. Louis, July 1886, Holway 256; Ramsey, September 1889, Sheldon, 18; Ramsey, May 1890, Sheldon 4340; Hennepin, April 1891, Sheldon 4191; Blue Earth, June 1891, Sheldon 408; Crow Wing, June 1892, Sheldon 2186; Hennepin, August 1893, Sheldon 5590; Hennepin, September 1893, Sheldon 5695; Cass, July 1893, Anderson 521; Cass, September 1898, MacMillan & Freeman 108; Wright, May 1900, Freeman 650; Wright, May 1900, Freeman, 654; Chisago, September 1900, Butters 85; Hennepin, September 1900, Butters 71; Hennepin, September 1900, Butters 73.
Conidial stage.
Waseca, July 1891, Taylor 670; Chisago, September 1900, Butters 87; Hennepin, October 1900, Butters 62.

18. **Daldinia vernicosa** (SCHW.) CESATI & DE NOTARIS, Schema di classificazione degli Sferiacei Italici aschigeri, Comment. Soc. Crittog. Ital. I, p. 198. 1863.
Ramsey, May 1890, Sheldon; Chisago, September 1900, Butters 86; Hennepin, October 1900, Butters 55; Hennepin, October 1900, Butters 88.

19. **Xylaria clavata** (SCOP.) SCHRANCK, Baierische Flora, II., p. 566. 1789. (*Xylaria polymorpha* (Pers.) Greville.)
Hennepin, April 1891, Sheldon 4170; Hennepin, April 1891, Sheldon 4182; Hennepin, August 1893, Sheldon 5581; ——, Sheldon 6138⅔; Hennepin, July 1899, Butters; Hennepin, September 1900, Freeman 784.

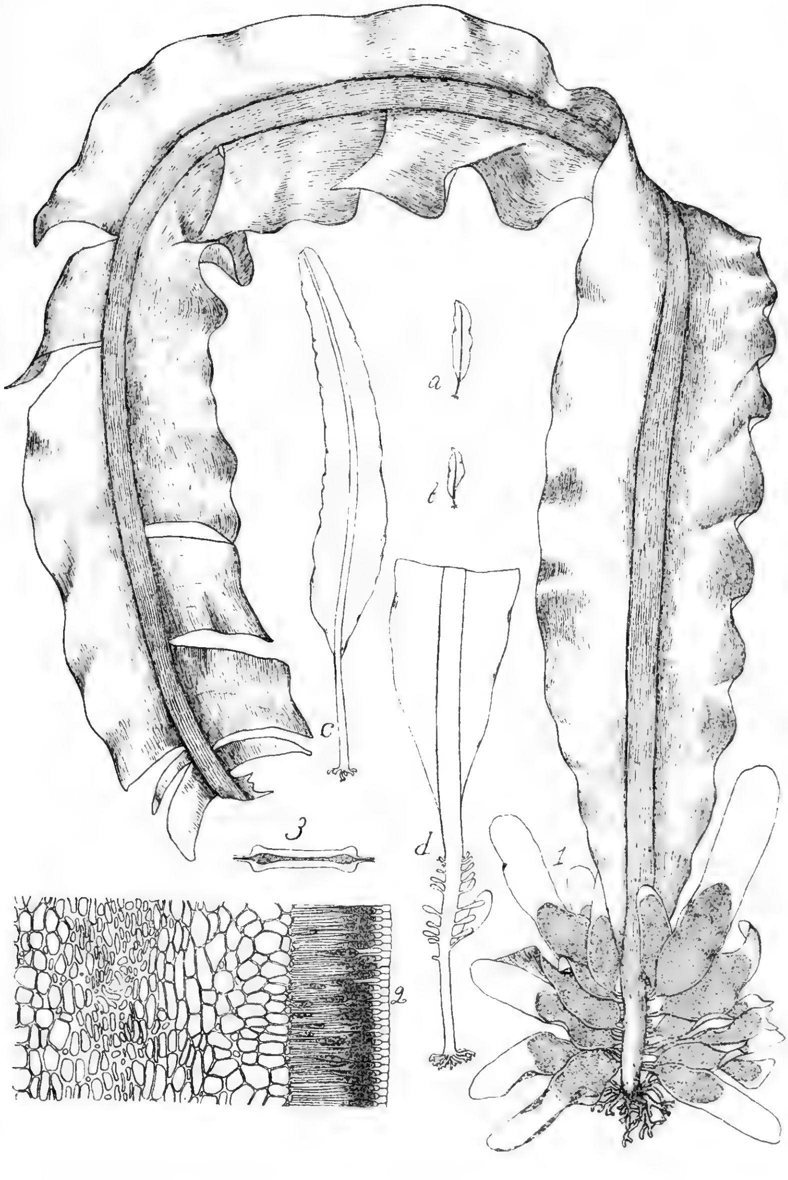

PLATE XXXIII.

THE HELIOTYPE PRINTING CO., BOSTON.

XXXII. A CONTRIBUTION TO THE KNOWLEDGE OF THE FLORA OF THE RED RIVER VALLEY IN MINNESOTA.

W. A. Wheeler.

During August, 1900, collections were made by the Botanical Survey in the valley of the Red River of the North. Professor Conway MacMillan, A. S. Skinner and C. J. Hibbard explored the region around Crookston through Polk and Red Lake counties and Professor C. A. Ballard visited Kittson, Marshall and Otter Tail counties. Professor MacMillan's party visited Crookston, Shirley, Holmes station and the region around Maple lake near Dugdale and Mentor in Polk county and Thief River Falls, Red lake Falls, St. Hilaire, Wylie and Ives in Red Lake county. Professor Ballard visited St. Vincent, Humboldt, Northcote, Hallock and Kennedy in Kittson county, Marshall in Warren county and Fergus Falls in Otter Tail county.

The collections made at these stations, scattered as they are through the Minnesota part of the Red River valley give a good representation of the late summer flora of this region.

The following plants were gathered of which there have been no definite authentic collections previously reported from Minnesota.

Puccinellia airoides (Nutt.) Wats. & Coult.
Elymus macouni Vasey.
Scirpus campestris Britton.
Juncus dudleyi Wiegand.
Rumex occidentalis S. Wats.
Chenopodium ambrosioides L.
Atriplex patula L.
Potentilla effusa Dougl.
Chamærhodos erecta (L.) Bunge.
Lappula americana (A. Gray) Rydberg.
Chrysopsis hispida (Hook.) Nutt.

As a result of the reconnoissance 325 species of flowering plants are reported below, 73 of which are monocotyledons and 252 dicotyledons.

Concerning the explorations made by Professor C. A. Ballard he wrote as follows under date of September 1, 1900:

The object of the present work was to examine certain portions of the Red River valley to determine (1) whether the soil of the sections under examination contained saline or alkaline ingredients in sufficient quantities to produce a distinctively characteristic vegetation, and (2) to note the extent of territory affected by such conditions.

I found it very difficult to obtain definite information as to the most pronounced alkaline regions of the valley, so that the territory covered is a part only of the sections under discussion.

I examined first, the vegetation, littoral and aquatic, of Mineral, Alkali and Horse Shoe lakes. These lakes are situated south and east of Fergus Falls, Otter Tail Co., and are more or less strongly alkaline. Of the three examined Mineral lake alone has a vegetation differing from that of the surrounding country. I have collected in this lake *Ruppia occidentalis*, in former years although unable to find it at this time. It is without doubt growing in the lake. Around the margin of the lake three or four chenopods grow luxuriantly. I next spent about two weeks in the northern part of the valley collecting in the vicinity of the following towns: St. Vincent, Humboldt, Northcote, Hallock and Kennedy in Kittson Co., and Warren in Marshall Co.

The monotonous dead level of the prairie is broken occasionally by small streams each with its fringe of trees. The surface wells of the region visited are alkaline, some of them decidedly so. This shows the entire soil to be alkaline to a certain extent. These wells are from 15 to 25 feet deep. Many deep wells have been sunk throughout the valley, those in Kittson Co. generally yielding a strong brine ($NaCl$) if more than 70 feet deep. I visited one such flowing well at Humboldt, the waters of which had killed all the vegetation for rods along the path of the flow. These conditions are so recent however that no marked halophytic vegetation has developed. Near a similar well at Northcote I found *Salicornia* growing abundantly within narrow limits.

Besides these localities of artificial conditions there is an occasional salt spring in the valley, notably one on "Two Rivers" some miles west of Hallock. I was unable to reach this spring. The numerous depressions in the surface of the prairie also often show slight incrustations of an alkaline salt.

At Hallock I had the good fortune to examine the herbarium of Mr. G. A. Gunnarson, the Auditor of Kittson Co. This herbarium of 200 to 300 plants represents the collections of several years in the immediate vicinity of Hallock. These plants were the ordinary types of the prairie and woodland of that region. One plant, however, *Plantago eriopoda*, is worthy of note as being a salt lover; it was collected 15 miles southeast of Hallock on sandy alkali soil. I afterwards found this plant growing sparsely six miles east of Warren.

As a result of my observations I draw the following conclusions: The soil of the entire valley is alkaline. The alkalinity is strongly marked in small localities only, which are popularly called "alkali spots." In Kittson and Marshall counties there are a few similar "salt spots," natural and artificial.

There are few halophytes in the valley; I found but two which I considered purely halophytic, these are B. 2680 *Salicornia*, growing in a coulee which had formerly drained a salt well at Northcote; and B. 2789 *Plantago*, growing in somewhat elevated sandy soil near Warren. There are also four chenopods, B. 2701, B. 2702, B. 2787, and B. 2576, which are semi-halophytic in character. These grow quite generally in many places in the valley, but are most numerous and luxuriant on the beaches of alkali lakes and ponds and in the vicinity of alkali spots.

A more thorough study of the region visited will doubtless add to the list of halophytes of the State and certainly extend the range of those already noted.

The principal object of Professor MacMillan, in his visit to the valley, was to secure a series of characteristic photographs of vegetation and portraits of plants to illustrate the flora of the region. There are presented herewith some views selected by him and made under his direction by Mr. C. J. Hibbard, Photographer of the Survey. They will serve to give an idea of the vegetation-sheet in the district covered by the list and will indicate some details of ecological distribution as suggested in the descriptions of the plates written by Professor MacMillan.

LIST OF SPECIES.

SPARGANIACEÆ.

Sparganium eurycarpum Engelm. in A. Gray, Man. Ed. 2, 430. 1856.

Coll.: MacMillan & Skinner 131, Maple lake; 398, Holmes.

Sparganium simplex Huds. Fl. Angl. Ed. 2, 401. 1788.

Coll.: Ballard 2581, Humboldt.

NAIADACEÆ.

Potamogeton perfoliatus L. Sp. Pl. 126. 1753.
Coll.: Ballard 2651, St. Vincent; MacMillan & Skinner 173, Maple lake.

Potamogeton pectinatus L. Sp. Pl. 126. 1753.
Coll.: Ballard 2652, St. Vincent; MacMillan & Skinner 172, Maple lake.

SCHEUCHZERIACEÆ.

Triglochin maritima L. Sp. Pl. 339. 1753.
Coll.: MacMillan & Skinner 112, Dugdale.

ALISMACEÆ.

Alisma plantago-aquatica L. Sp. Pl. 342. 1753.
Coll.: Ballard 2583, Humboldt; 2746, Hallock; MacMillan & Skinner 24, 417, Crookston.

Sagittaria latifolia WILLD. Sp. Pl. 409. 1806.
Coll.: MacMillan & Skinner 10, Crookston; 370, Holmes.

Sagittaria arifolia NUTT.; J. G. Smith, Ann. Rep. Mo. Bot. Gard. **6**: 32. 1894.
Coll.: Ballard 2580, Humboldt; 2657, St. Vincent.
Previously reported from Minnesota by J. G. Smith in Ann. Rep. Mo. Bot. Gard. **6**: 33. 1895.

NYMPHÆACEÆ.

Nymphæa advena SOLAND, in Ait. Hort. Kew. **2**: 226. 1789.
Coll.: MacMillan & Skinner 396, Holmes.

VALLISNERIACEÆ.

Philotria canadensis (MICHX.) BRITTON, Science (II) **2**: 5. 1895.
Coll.: MacMillan & Skinner 23, Crookston.

GRAMINEÆ.

Andropogon scoparius MICHX. Fl. Bor. Am. **1**: 57. 1803.
Coll.: MacMillan & Skinner 254, Crookston.

Andropogon furcatus MUHL.: Willd. Sp. Pl. **4**: 919. 1806.
Coll.: Ballard 2598, Humboldt; 2769, Hallock; MacMillan & Skinner 357, Shirley.

Chrysopogon avenaceus (MICHX.) BENTH. Journ. Linn. Soc. **19**: 73. 1881.
Coll.: MacMillan & Skinner 64, Crookston.

Panicum crus-galli L. Sp. Pl. 56. 1753.
Coll.: Ballard 2589, Humboldt; 2699, Northcote; MacMillan & Skinner 128, 129, Maple lake.

Panicum pubescens LAM. Encycl. **4**: 748. 1797.
Coll.: MacMillan & Skinner 138, Maple lake.

Panicum virgatum L. Sp. Pl. 59. 1753.
Coll.: MacMillan & Skinner 341, 342, Crookston.

Panicum capillare L. Sp. Pl. 58. 1753.
Coll.: Ballard 2541, Fergus Falls; 2663, St. Vincent.

Chætochloa viridis (L.) SCRIBN. U. S. Dept. Agr., Div. Agros. Bul. 4: 39. 1897.
Coll.: Ballard 2525, Fergus Falls; 2686, Northcote.

Zizania aquatica L. Sp. Pl. 991. 1753.
Coll.: MacMillan & Skinner 134, Maple lake.

Muhlenbergia racemosa (MICHX.) B.S.P. Prel. Cat. N. Y. 67. 1888.
Coll.: Ballard 2693, Northcote; 2754, Hallock; MacMillan & Skinner 99, 101, Dugdale.

Alopecurus geniculatus L. Sp. Pl. 60. 1753.
Coll.: Ballard 2584, Humboldt; 2747, Hallock; MacMillan & Skinner 305, 306, Crookston.

Sporobolus brevifolius (NUTT.) SCRIBN. Mem. Torr. Club, **5**: 39. 1895.
Coll.: MacMillan & Skinner 329, Crookston.

Sporobolus cuspidatus (TORR.) WOOD, Bot. & Fl. 385. 1870.
Coll.: MacMillan & Skinner 275, St. Hilaire; 384, Holmes.

Sporobolus heterolepis A. GRAY, Man. 576. 1848.
Coll.: MacMillan & Skinner 387, Holmes.

Agrostis alba L. Sp. Pl. 63. 1753.
Coll.: MacMillan & Skinner 233, Crookston.

Spartina cynosuroides (L.) WILLD. Enum. 80. 1809.
Coll.: Ballard 2585, Humboldt; 2695, Northcote; 2762, Hallock; 2794, Warren; MacMillan & Skinner 52, Crookston.

Bouteloua oligostachya (NUTT.) TORR.; A. Gray, Man. Ed. 2, 553. 1856.
Coll.: MacMillan & Skinner 103, Dugdale.

Bouteloua curtipendula (MICHX.) TORR. Emory's Rep. 153. 1848.
Coll.: MacMillan & Skinner 46, Crookston.

Beckmannia erucæformis (L.) HOST, Gram. Austr. **3**: 5. 1805.
Coll.: Ballard 2588, Humboldt; 2634, St. Vincent; 2714, Northcote; 2745, Hallock; 2778, Warren; MacMillan & Skinner 100, Dugdale; 361, Crookston.

Phragmites phragmites (L.) KARST. Deutsch Fl. 379. 1880–83.
Coll.: MacMillan & Skinner 394, Holmes.

Eragrostis hypnoides (LAM.) B.S.P. Prel. Cat. N. Y. 69. 1888.
Coll.: Ballard 2672, St. Vincent; 2751, Hallock.

Kœleria cristata (L.) PERS. Syn. **1**: 97. 1805.
Coll.: MacMillan & Skinner 102, Dugdale; 337, Crookston.

Panicularia americana (TORR.) MACM. Met. Minn. Val. 81. 1892.
Coll.: Ballard 2582, Humboldt.

Puccinellia airoides (NUTT.) WATS. & COULT. in A. Gray, Man. Ed. 6, 668. 1890.
Coll.: Ballard 2528, Fergus Falls.
Not previously reported from Minnesota.

Bromus ciliatus L. Sp. Pl. 76. 1753.
Coll.: Ballard 2782, Warren; MacMillan & Skinner 35, Crookston; 106, Dugdale.

Bromus purgans L. Sp. Pl. 76. 1753.
Coll.: Ballard 2666, St. Vincent; 2755, Hallock; MacMillan & Skinner 28, Crookston.

Bromus kalmii A. GRAY, Man. 600. 1848.
Coll.: MacMillan & Skinner 105, Dugdale.

Agropyron repens (L.) BEAUV. Agrost. 146. 1812.
Coll.: Ballard 2621, Humboldt; 2715, Northcote.

Agropyron tenerum VASEY, Coult. Bot. Gaz. **10**: 258. 1885.
Coll.: MacMillan & Skinner 304, 335, Crookston; Ballard 2569, St. Vincent.

Hordeum jubatum L. Sp. Pl. 85. 1753.
Coll.: Ballard 2520, Fergus Falls.

Elymus virginicus L. Sp. Pl. 84. 1753.
Coll.: Ballard 2629, St. Vincent; MacMillan & Skinner 235, Crookston.

Elymus canadensis L. Sp. Pl. 83. 1753.
Coll.: Ballard 2599, Humboldt; 2713, Northcote; MacMillan & Skinner 68, Crookston; 267, St. Hilaire.

Elymus macouni VASEY, Bull. Torr. Club, **13**: 119. 1886.
Coll.: Ballard 2570, St. Vincent.
Not previously reported from Minnesota.

Hystrix hystrix (L.) MILLSP. Fl. W. Va. 474. 1892.
Coll.: MacMillan & Skinner 107, Maple lake; 265, St. Hilaire.

CYPERACEÆ.

Cyperus diandrus TORR. Cat. Pl. N. Y. 90. 1819.
Coll.: Ballard 2537, Fergus Falls.

Cyperus speciosus VAHL, Enum. **2**: 364. 1806.
Coll.: MacMillan & Skinner 130, Maple lake.

Eleocharis acicularis (L.) R. & S. Syst. **2**: 154. 1817.
Coll.: MacMillan & Skinner 141, Maple lake.

Eleocharis intermedia (MUHL.) SCHULTES, Mant. **2**: 91. 1824.
Coll.: Ballard 2656, St. Vincent.

Scirpus lacustris L. Sp. Pl. 48. 1753.
Coll.: Ballard 2587, St. Vincent, MacMillan & Skinner 104, Maple lake.

Scirpus campestris BRITTON, in Britton & Brown, Ill. Fl. **1**: 267. 1896.
Coll.: Ballard 2539, 2544, Fergus Falls. Not previously reported from Minnesota.

Scirpus atrovirens MUHL. Gram. 43. 1817.
Coll.: MacMillan & Skinner 126, 127, Dugdale; 390, Holmes; 310, Crookston.

Carex utriculata BOOTT; Hook. Fl. Bor. Am. 2: 221. 1840.
Coll.: MacMillan and Skinner 139, Maple lake; 381, Holmes.

Carex retrorsa SCHWEIN. Ann. Lyc. N. Y. 1: 71. 1824.
Coll.: MacMillan & Skinner 423, Crookston.

Carex fusca ALL. Fl. Ped. 2: 269. 1785.
Coll.: MacMillan & Skinner 133, Maple lake.

Carex cristatella BRITTON, in Britton & Brown, Ill. Fl. 1: 357. 1896.
Coll.: MacMillan & Skinner 249, Red Lake Falls.

Carex sychnocephala CAREY, Am. Journ. Sci. (II.) 4: 24. 1847.
Coll.: MacMillan & Skinner 307, Crookston.

ARACEÆ.

Arisæma triphyllum (L.) TORR. Fl. N. Y. 2: 239. 1843.
Coll.: MacMillan & Skinner 237, Gentilly.

Calla palustris L. Sp. Pl. 968. 1753.
Coll.: MacMillan & Skinner 174, Maple lake.

Acorus calamus L. Sp. Pl. 324. 1753.
Coll.: MacMillan & Skinner 282, Thief River Falls.

LEMNACEÆ.

Lemna trisulca L. Sp. Pl. 970. 1753.
Coll.: Ballard 2654, St. Vincent; MacMillan & Skinner 410, Holmes.

Lemna minor L. Sp. Pl. 970. 1753.
Coll.: Ballard 2546, Fergus Falls.

JUNCACEÆ.

Juncus balticus WILLD. Berlin Mag. 3: 298. 1809.
Coll.: MacMillan & Skinner 136, Maple lake; 401, Holmes.

Juncus vaseyi ENGELM. Trans. St. Louis Acad. Sci. 2: 450. 1866.
Coll.: MacMillan & Skinner 135, Maple lake.

Juncus dudleyi WIEGAND, Bull. Torr. Club, 27: 524. 1900.
Coll.: MacMillan & Skinner 137, Maple lake; 276, Wylie.

Not previously reported from Minnesota. Many specimens however have been previously collected and reported as *Juncus tenuis* Willd.

Juncus nodosus L. Sp. Pl. Ed. 2, 466. 1762.
Coll.: Ballard 2741, Hallock; MacMillan & Skinner 373, Holmes.

Juncus torreyi COVILLE, Bull. Torr. Club, **22**: 303. 1895.
Coll.: MacMillan & Skinner 340, Crookston.

Juncus acuminatus MICHX. Fl. Bor. Am. **1**: 192. 1802.
Coll.: Ballard 2743, Hallock.

LILIACEÆ.

Allium stellatum KER, Bot. Mag. *pl. 1576.* 1813.
Coll.: MacMillan & Skinner 63, Crookston; 87, Dugdale.

CONVALLARIACEÆ.

Vagnera racemosa (L.) MORONG, Mem. Torr. Club, **5**: 114. 1894.
Coll.: MacMillan & Skinner 148, Maple lake.

Vagnera stellata (L.) MORONG, Mem. Torr. Club, **5**: 114. 1894.
Coll.: MacMillan & Skinner 218, Crookston.

Unifolium canadense (DESF.) GREENE, Bull. Torr. Club, **15**: 287. 1888.
Coll.: MacMillan & Skinner 147, Maple lake.

Polygonatum commutatum (R. & S.) DIETR.; Otto & Dietr. Gartenz. **3**: 222. 1835.
Coll.: MacMillan & Skinner 17, Crookston.

SMILACEÆ.

Smilax herbacea L. Sp. Pl. 1030. 1753.
Coll.: MacMillan & Skinner 18, 319, Crookston; Ballard 2758, Hallock.

IRIDACEÆ.

Iris versicolor L. Sp. Pl. 39. 1753.
Coll.: MacMillan & Skinner 308, Crookston.

SALICACEÆ.

Populus balsamifera L. Sp. Pl. 1034. 1753.
Coll.: MacMillan & Skinner 278, Ives.

Salix lucida MUHL. Neue Schrift. Ges. Nat. Fr. Berlin **4**: 239. *pl. 6. f. 7.* 1803.
Coll.: MacMillan & Skinner 366, Holmes.

BETULACEÆ.

Corylus americana WALT. Fl. Car. 236. 1788.
Coll.: MacMillan & Skinner 415, Crookston.

Betula papyrifera MARSH. Arb. Am. 19. 1785.
Coll.: MacMillan & Skinner 178, Maple lake.

Betula glandulosa MICHX. Fl. Bor. Am. **2**: 180. 1803.
Coll.: Ballard 2803, Warren.

Alnus alnobetula (EHRH.) K. KOCH, Dendr. **2**: Part 1, 625. 1872.
Coll.: MacMillan & Skinner 151, Maple lake.

FAGACEÆ.

Quercus alba L. Sp. Pl. 996. 1753.
Coll.: Ballard 2753, Hallock.

Quercus macrocarpa MICHX. Hist. Chen. Am. 2. *pl. 23.* 1801.
Coll.: MacMillan & Skinner 280, Thief River Falls.

MORACEÆ.

Humulus lupulus L. Sp. Pl. 1028. 1753.
Coll.: MacMillan & Skinner 26, Crookston.

URTICACEÆ.

Urtica gracilis AIT. Hort. Kew. **3**: 341. 1789.
Coll.: MacMillan & Skinner 199, Crookston.

Urticastrum divaricatum (L.) KUNTZE, Rev. Gen. Pl. 635. 1891.
Coll.: MacMillan & Skinner 193, Crookston.

POLYGONACEÆ.

Rumex verticillatus L. Sp. Pl. 334. 1753.
Coll.: MacMillan & Skinner 158, Maple lake.

Rumex occidentalis S. WATS. Proc. Am. Acad. **12**: 253. 1876.
Coll.: MacMillan & Skinner 270, Thief River Falls.
Not previously reported from Minnesota.

Rumex crispus L. Sp. Pl. 335. 1753.
Coll.: Ballard 2628, St. Vincent; 2777, Warren; MacMillan & Skinner 189, Crookston; 389, Holmes.

Rumex persicarioides L. Sp. Pl. 335. 1753.
Coll.: Ballard 2638, St. Vincent; MacMillan & Skinner 155, Maple lake.

Polygonum emersum (MICHX.) BRITTON, Trans. N. Y. Acad. Sci. 8: 73. 1889.
Coll.: MacMillan & Skinner 412, Crookston.

Polygonum lapathifolium L. Sp. Pl. 360. 1753.
Coll.: MacMillan & Skinner 2, Crookston; 294, Maple lake; Ballard 2590, Humboldt; 2673, St. Vincent.

Polygonum persicaria L. Sp. Pl. 361. 1753.
Coll.: MacMillan & Skinner 6, Crookston.

Polygonum punctatum ELL. Bot. S. C. & Ga. 1: 455. 1817.
Coll.: MacMillan & Skinner 293, Maple lake; Ballard 2530, Fergus Falls.

Polygonum littorale LINK in Schrad. Journ. 1: 54. 1799.
Coll.: Ballard 2643, 2670, St. Vincent; 2685, Northcote.

Polygonum erectum L. Sp. Pl. 363. 1753.
Coll.: Ballard 2720, Kennedy.

Polygonum exsertum SMALL, Bull. Torr. Club, 21: 172. 1894.
Coll.: Ballard 2786, Warren.

Polygonum ramosissimum MICHX. Fl. Bor. Am. 1: 237. 1803.
Coll.: Ballard 2551, 2636, St. Vincent; 2600, Humboldt; MacMillan & Skinner 142, Dugdale.

Polygonum convolvulus L. Sp. Pl. 364. 1753.
Coll.: Ballard 2602, Humboldt; MacMillan & Skinner 56, Crookston.

Polygonum scandens L. Sp. Pl. 364. 1753.
Coll.: MacMillan & Skinner 167, Maple lake.

CHENOPODIACEÆ.

Chenopodium album L. Sp. Pl. 219. 1753.
Coll.: Ballard 2552, 2575, St. Vincent; 2740, Hallock; 2527, Fergus Falls; 2708, Northcote; 2594, Humboldt; 2721, Kennedy; MacMillan & Skinner 19, Crookston. 119, Maple lake.

Chenopodium glaucum L. Sp. Pl. 220. 1753.
Coll.: Ballard 2529, 2531, Fergus Falls; 2576, St. Vincent.

Chenopodium leptophyllum (MOQ.) NUTT.: Moq. in DC. Prodr. 13, Part 2, 71. As synonym. 1849.
Coll.: MacMillan & Skinner 332, Crookston.

Chenopodium hybridum L. Sp. Pl. 219. 1753.
Coll.: Ballard 2558, St. Vincent; MacMillan & Skinner 225, Crookston.

Chenopodium ambrosioides L. Sp. Pl. 219. 1753.
Coll.: Ballard 2635, St. Vincent; 2595, Humboldt; 2687, Northcote; 2761, Hallock; 2787, Warren; MacMillan & Skinner 424, Crookston.

No previous authentic collection reported from Minnesota.

Atriplex patula L. Sp. Pl. 1053. 1753.
Coll.: Ballard 2577, St. Vincent; 2614, 2625, Humboldt; 2702, Northcote; 2760, 2771, Hallock; 2722, Kennedy; 2772, Warren; 2532, Fergus Falls.

No previous authentic collection reported from Minnesota.

Salicornia herbacea L. Sp. Pl. Ed. 2, 5. 1762.
Coll.: Ballard 2680, Northcote.

"Growing locally along the drainage from a salt well. No other plants found growing with it." Ballard.

Dondia depressa (PURSH) BRITTON in Britton & Brown, Ill. Fl. *f. 1395.* **1**: 585. 1896.
Coll.: Ballard 2613, 2618, Humboldt; 3701, Northcote; 2759, Hallock; 2793, Warren; MacMillan & Skinner 113, Dugdale; 408, Crookston.

AMARANTHACEÆ.

Amaranthus retroflexus L. Sp. Pl. 991. 1753.
Coll.: Ballard 2632, St. Vincent; 2707, Northcote; 2717, Kennedy; MacMillan & Skinner 321, Crookston.

Amaranthus blitoides S. WATS. Proc. Am. Acad. **12**: 273. 1877.
Coll.: Ballard 2543, Fergus Falls; MacMillan & Skinner, 407, Crookston.

Amaranthus græcizans L. Sp. Pl. 990. 1753.
Coll.: Ballard 2658, St. Vincent; 2603, Humboldt; 2691, Northcote; 2718, Kennedy.

NYCTAGINACEÆ.

Allionia hirsuta Pursh, Fl. Am. Sept. 728. 1814.
Coll.: MacMillan & Skinner 91, Dugdale.

CARYOPHYLLACEÆ.

Agrostemma githago L. Sp. Pl. 435. 1753.
Coll.: MacMillan & Skinner 125, Dugdale.

Silene antirrhina L. Sp. Pl. 419. 1753.
Coll.: MacMillan & Skinner 124, Dugdale.

Vaccaria vaccaria (L.) Britton, in Britton & Brown Ill. Fl. **2**: 18. 1897.
Coll.: Ballard 2671, St. Vincent.

Alsine media L. Sp. Pl. 272. 1753.
Coll.: Ballard 2736, Kennedy.

CERATOPHYLLACEÆ.

Ceratophyllum demersum L. Sp. Pl. 992. 1753.
Coll.: Ballard 2654½, St. Vincent.

RANUNCULACEÆ.

Actæa alba (L.) Mill. Gard. Dict. Ed. 8, No. 2. 1768.
Coll.: MacMillan & Skinner 140, Maple lake.

Anemone cylindrica A. Gray, Ann. Lyc. N. Y. **3**: 221. 1836.
Coll.: Ballard 2606, Humboldt.

Anemone virginiana L. Sp. Pl. 540. 1753.
Coll.: Ballard 2526, Fergus Falls; MacMillan & Skinner 27, Crookston.

Anemone canadensis L. Syst. Ed. 12, **3**: App. 231. 1768.
Coll.: MacMillan & Skinner 39, Crookston.

Clematis virginiana L. Amoen. Acad. **4**: 275. 1759.
Coll.: MacMillan & Skinner 186, Maple lake.

Ranunculus scleratus L. Sp. Pl. 551. 1753.
Coll.: Ballard 2644, St. Vincent; 2586, Humboldt; MacMillan & Skinner 427, Crookston.

Ranunculus pennsylvanicus L. f. Suppl. 272. 1781.
Coll.: Ballard 2507, Fergus Falls; 2642, St. Vincent; 2756, Hallock; MacMillan & Skinner 22, Crookston; 288, Maple lake.

Oxygraphis cymbalaria (Pursh) Prantl, in Engl. & Prantl, Nat. Pfl. Fam. **3**: Abt. 2, 63. 1891.
Coll.: Ballard 2508, Fergus Falls; 2645, St. Vincent; 2788, Warren; MacMillan & Skinner 409, Holmes.

Thalictrum purpurascens L. Sp. Pl. 546. 1753.
Coll.: MacMillan & Skinner 32, Crookston.

BERBERIDACEÆ.

Caulophyllum thalictroides (L.) Michx. Fl. Bor. Am. **1**: 205. 1803.
Coll.: MacMillan & Skinner 286, Thief River Falls.

MENISPERMACEÆ.

Menispermum canadense L. Sp. Pl. 340. 1753.
Coll.: Ballard 2661, St. Vincent; MacMillan & Skinner 194, Crookston.

CRUCIFERÆ.

Thlaspi arvense L. Sp. Pl. 646. 1753.
Coll.: Ballard 2573, St. Vincent; 2579, Humboldt; 2690, Northcote.

Roripa palustris (L.) Bess. Enum. 27. 1821.
Coll.: Ballard 2709, Northcote; MacMillan and Skinner 214, Crookston.

Roripa hispida (Desv.) Britton, Mem. Torr. Club, **5**: 169. 1894.
Coll.: Ballard 2639, St. Vincent.

Sophia hartwegiana (Fourn.) Greene, Pittonia, **3**: 95. 1896.
Coll.: MacMillan & Skinner 363, Crookston.

Erysimum cheiranthoides L. Sp. Pl. 661. 1753.
Coll.: MacMillan & Skinner 5, 197, Crookston.

CRASSULACEÆ.

Penthorum sedoides L. Sp. Pl. 432. 1753.
Coll.: MacMillan & Skinner 231, Crookston; Ballard 2780, Warren.

PARNASSIACEÆ.

Parnassia caroliniana Michx. Fl. Bor. Am. **1**: 184. 1803.
Coll.: MacMillan & Skinner 94, Maple lake.

Parnassia palustris L. Sp. Pl. 273. 1753.
Coll.: Ballard 2512, Fergus Falls.

ROSACEÆ.

Spiræa salicifolia L. Sp. Pl. 489. 1753.
Coll.: Ballard 2706, Northcote; MacMillan & Skinner 156, Maple lake.

Rubus strigosus MICHX. Fl. Bor. Am. **1**: 297. 1803.
Coll.: MacMillan & Skinner 3, Crookston.

Potentilla leucocarpa RYDBERG, in Britton & Brown, Ill. Fl. **2**: 212. *f. 1924.* 1897.
Coll.: Ballard 2641, St. Vincent; MacMillan & Skinner 323, Crookston.

Potentilla monspeliensis L. Sp. Pl. 499. 1753.
Coll.: Ballard 2515, Fergus Falls; 2728, Kennedy; MacMillan and Skinner 72, 291, Crookston.

Potentilla pennsylvanica strigosa PURSH, Fl. Am. Sept. 356. 1814.
Coll.: MacMillan & Skinner 40, Crookston; 252 Red Lake Falls; 374, Holmes.

Potentilla effusa DOUGL.; Lehm. Stirp. Pug. **2**: 8. 1830.
Coll.: MacMillan & Skinner 385, Holmes.
No previous authentic collection reported from Minnesota.

Argentina anserina (L.) RYDBERG, Mem. Dept. Bot. Columbia Univ. **2**: 159. *pl. 98.* 1898.
Coll.: Ballard 2574, St. Vincent; 2626, Humboldt; MacMillan & Skinner 191, 221, Crookston.

Comarum palustre L. Sp. Pl. 502. 1753.
Coll.: MacMillan & Skinner 143, Maple lake.

Drymocallis arguta (PURSH) RYDBERG, Mem. Dept. Bot. Columbia Univ. **2**: 192. *pl. 102.* 1898.
Coll.: MacMillan & Skinner 90, Dugdale; 251, Crookston; 377, Holmes.

Chamærhodos erecta (L.) Bunge, in Ledeb. Fl. Alt. **1**: 430. 1829.
Coll.: MacMillan & Skinner 375, Holmes.
Not previously reported from Minnesota.

Geum virginianum L. Sp. Pl. 500. 1753.
Coll.: MacMillan & Skinner 213, Crookston; 250, Red Lake Falls; 369, Holmes; Ballard 2557, St. Vincent.

Agrimonia hirsuta (Muhl.) Bicknell, Bull. Torr. Club, **23**: 509. 1896.
Coll.: MacMillan & Skinner 354, Shirley.

Rosa arkansana Porter, Syn. Fl. Col. 38. 1874.
Coll.: Ballard 2681, Northcote; MacMillan & Skinner 328, Crookston.

POMACEÆ.

Cratægus coccinea L. Sp. Pl. 476. 1753.
Coll.: Ballard 2562, St. Vincent.
The determination of this is doubtful. It is the common form in northwestern Minnesota and Manitoba.

DRUPACEÆ.

Prunus americana Marsh, Arb. Am. 111. 1785.
Coll.: MacMillan & Skinner 192, 315, Crookston.

Prunus serotina Ehrh. Beitr. **3**: 20. 1788.
Coll.: MacMillan & Skinner 168, Maple lake.

PAPILIONACEÆ.

Lotus americanus (Nutt.) Bisch. Litt. Ber. Linnæa, **14**: 132. 1840.
Coll.: Ballard 2771½, Hallock.

Psoralea argophylla Pursh, Fl. Am. Sept. 475. 1814.
Coll.: Ballard 2608, Humboldt; MacMillan & Skinner 49, Crookston.

Amorpha fruticosa L. Sp. Pl. 713. 1753.
Coll.: Ballard 2505, Fergus Falls; MacMillan & Skinner 160, Maple lake.

Amorpha nana Nutt. Fras. Cat. 1813.
Coll.: Ballard 2800, Warren; MacMillan & Skinner 356, Shirley.

Kuhnistera candida (WILLD.) KUNTZE, Rev. Gen. Pl. 192. 1891.
Coll.: MacMillan and Skinner 247, Red Lake Falls.

Kuhnistera purpurea (VENT.) MACM. Met. Minn. Val. 329. 1892.
Coll.: Ballard 2610, Humboldt; 2765, Hallock; MacMillan & Skinner 62, Crookston.

Astragalus carolinianus L. Sp. Pl. 757. 1753.
Coll.: MacMillan & Skinner 66, Crookston.

Phaca neglecta T. & G. Fl. N. A. 1: 344. 1838.
Coll.: MacMillan & Skinner 149, 153, Maple lake.

Glycyrrhiza lepidota PURSH, Fl. Am. Sept. 480. 1814.
Coll.: Ballard 2705, Northcote; MacMillan & Skinner 273, St. Hilaire.

Meibomia canadensis (L.) KUNTZE, Rev. Gen. Pl. 195. 1891.
Coll.: MacMillan & Skinner 85, Maple lake.

Vicia americana MUHL.; Willd. Sp. Pl. **3**: 1096. 1803.
Coll.: Ballard 2767, Hallock; MacMillan & Skinner 79, Dugdale.

Falcata comosa (L.) KUNTZE, Rev. Gen. Pl. 182. 1891.
Coll.: MacMillan & Skinner 162, Maple lake; 212, Crookston.

GERANIACEÆ.

Geranium bicknellii BRITTON, Bull. Torr. Club, **24**: 92. 1897.
Coll.: MacMillan & Skinner 145, Maple lake.

OXALIDACEÆ.

Oxalis stricta L. Sp. Pl. 435. 1753.
Coll.: MacMillan & Skinner 428, Crookston.

LINACEÆ.

Linum sulcatum RIDDELL, Suppl. Cat. Ohio Pl. 10. 1836.
Coll.: MacMillan & Skinner 108, Dugdale.

RUTACEÆ.

Xanthoxylum americanum MILL. Gard. Dict. Ed. 8, no. 2. 1768.
Coll.: MacMillan & Skinner 157, Maple lake.

EUPHORBIACEÆ.

Euphorbia serpyllifolia PERS. Syn. **2**: 14. 1807.
Coll.: Ballard 2665, St. Vincent; 2682, Northcote; 2774, Warren.

Euphorbia glyptosperma ENGELM. Bot. Mex. Bound. Surv. 187 1859.
Coll.: Ballard 2604, 2605, Hallock; 2734, Kennedy.

Euphorbia maculata L. Sp. Pl. 455. 1753.
Coll.: Ballard 2664, St. Vincent.

ANACARDIACEÆ.

Rhus glabra L. Sp. Pl. 265. 1753.
Coll.: MacMillan & Skinner 195, Crookston.

ACERACEÆ.

Acer saccharum MARSH. Arb. Amer. 4. 1785.
Coll.: MacMillan & Skinner 182, Maple lake.

Acer negundo L. Sp. Pl. 1056. 1753.
Coll.: MacMillan and Skinner 422, Crookston.

BALSAMINACEÆ.

Impatiens biflora WALT. Fl. Car. 219. 1788.
Coll.: Ballard 2500, Fergus Falls.

VITACEÆ.

Vitis vulpina L. Sp. Pl. 203. 1753.
Coll.: MacMillan & Skinner 166, Maple lake.

TILIACEÆ.

Tilia americana L. Sp. Pl. 514. 1753.
Coll.: MacMillan & Skinner 320, Crookston.

HYPERICACEÆ.

Triadenum virginicum (L.) RAF. Fl. Tell. **3**: 79. 1836.
Coll.: MacMillan & Skinner 165, Maple lake.

CISTACEÆ.

Lechea stricta LEGGETT; Britton, Bull. Torr. Club, **21**: 251. 1894.
Coll.: MacMillan & Skinner 110, Maple lake.

VIOLACEÆ.

Viola obliqua Hill, Hort. Kew. 316. *pl. 12.* 1769.
Coll.: Ballard 2516, Fergus Falls; MacMillan & Skinner 382, Holmes.

Viola pedata L. Sp. Pl. 933. 1753.
Coll.: MacMillan & Skinner 279, Ives.

Viola canadensis L. Sp. Pl. 936. 1753.
Coll.: MacMillan & Skinner 351, Crookston.

ELÆAGNACEÆ.

Elæagnus argentea Pursh, Fl. Am. Sept. 114. 1814.
Coll.: Ballard 2578, Humboldt; 2801, Warren; MacMillan & Skinner 53, Crookston.

ONAGRACEÆ.

Epilobium lineare Muhl. Cat. 39. 1813.
Coll.: MacMillan & Skinner 292, Crookston.

Epilobium coloratum Muhl.; Willd. Enum. 1: 411. 1809.
Coll.: MacMillan & Skinner 115, Dugdale; 116, Maple lake; 244, Red Lake Falls; Ballard 2533, Fergus Falls; 2631, St. Vincent; 2742, Hallock.

Onagra biennis (L.) Scop. Fl. Carn. Ed. 2, 1: 269. 1772.
Coll.: MacMillan & Skinner 42, Crookston.

Œnothera rhombipetala Nutt.; T. & G. Fl. N. A. 1: 493. 1840.
Coll.: Ballard 2749, Hallock.

Anogra pallida (Lindl.) Britton, Mem. Torr. Club, 5: 234. 1894.
Coll.: MacMillan & Skinner 364, Crookston.

Meriolix serrulata (Nutt.) Walp. Repert. 2: 79. 1843.
Coll.: MacMillan & Skinner 33, Crookston; 109, Mentor.

Gaura coccinea Pursh, Fl. Am. Sept. 733. 1814.
Coll.: MacMillan & Skinner 430, Holmes.

HALORAGIDACEÆ.

Hippuris vulgaris L. Sp. Pl. 4. 1753.
Coll.: MacMillan & Skinner 230, Crookston.

Myriophyllum spicatum L. Sp. Pl. 992. 1753.
Coll.: MacMillan & Skinner 393, Holmes.

Myriophyllum verticillatum L. Sp. Pl. 992. 1753.
Coll.: Ballard 2653, St. Vincent.

ARALIACEÆ.

Aralia nudicaulis L. Sp. Pl. 274. 1753.
Coll.: MacMillan & Skinner 211, Crookston.

UMBELLIFERÆ.

Heracleum lanatum Michx. Fl. Bor. Am. **1**: 166. 1803.
Coll.: MacMillan & Skinner 202, Crookston.

Pastinaca sativa L. Sp. Pl. 262. 1753.
Coll.: Ballard 2662, St. Vincent.

Washingtonia longistylis (Torr.) Britton, Ill. Fl. **2**: 530. 1897.
Coll.: MacMillan & Skinner 238, Gentilly.

Sium cicutæfolium Gmel. Syst. **2**: 482. 1791.
Coll.: Ballard 2593, Humboldt.

Zizia aurea (L.) Koch, Nov. Act. Caes. Leop. Acad. **12**: 129. 1824.
Coll. MacMillan & Skinner 164, Maple lake; 206, 327, Crookston.

Zizia cordata (Walt.) Koch in DC. Prodr. **4**: 100. 1830.
Coll.: MacMillan & Skinner 253, Red Lake Falls.

Cicuta bulbifera L. Sp. Pl. 255. 1753.
Coll.: MacMillan & Skinner 183, Maple lake.

Deringa canadensis (L.) Kuntze, Rev. Gen. Pl. **1**: 266. 1891.
Coll.: MacMillan & Skinner 208, 325, 326, Crookston.

CORNACEÆ.

Cornus stolonifera Michx. Fl. Bor. Am. **1**: 92. 1803.
Coll.: MacMillan & Skinner 316, Crookston.

Cornus candidissima Marsh, Arb. Am. 35. 1785.
Coll.: Ballard 2752, Hallock; MacMillan & Skinner 242, Red Lake Falls.

ERICACEÆ.

Arctostaphylos uva-ursi (L.) Spreng. Syst. **2**: 287. 1825.
Coll.: MacMillan & Skinner 144, Maple lake.

VACCINIACEÆ.

Oxycoccus oxycoccus (L.) MacM. Bull. Torr. Club, **19**: 15. 1892.
Coll.: MacMillan & Skinner 185, Maple lake.

PRIMULACEÆ.

Steironema ciliatum (L.) RAF. Ann. Gen. Phys. **7**: 192. 1820.
Coll.: Ballard 2776, Warren; MacMillan & Skinner 16, Crookston.

Steironema lanceolata (WALT.) A. GRAY, Proc. Am. Acad. **12**: 63. 1876.
Coll.: MacMillan & Skinner 98, Maple lake; 345, Crookston.

GENTIANACEÆ.

Gentiana detonsa ROTTB. Act. Hafn. **10**: 254. 1770.
Coll.: MacMillan & Skinner 184, Maple lake.

Gentiana acuta MICHX. Fl. Bor. Am. **1**: 177. 1803.
Coll.: MacMillan & Skinner 330, 346, Crookston.
No previous collections from Minnesota in the Herbarium of the University.

Gentiana puberula MICHX. Fl. Bor. Am. **1**: 176. 1803.
Coll.: MacMillan & Skinner 54, Crookston; 350 Shirley.

Gentiana andrewsii GRISEB. in Hook. Fl. Bor. Am. **2**: 55. 1834.
Coll.: Ballard 2792, Warren; MacMillan & Skinner 181, Maple lake.

Gentiana flavida A. GRAY, Am. Journ. Sci. (II) **1**: 80. 1846.
Coll.: MacMillan & Skinner 81, Dugdale.

APOCYNACEÆ.

Apocynum androsæmifolium L. Sp. Pl. 213. 1753.
Coll.: MacMillan & Skinner 179, Maple lake.

ASCLEPIADACEÆ.

Asclepias incarnata L. Sp. Pl. 215. 1753.
Coll.: MacMillan & Skinner 29, Crookston; 399, Holmes.

Asclepias syriaca L. Sp. Pl. 214. 1753.
Coll.: MacMillan & Skinner 198, Crookston.

Asclepias speciosa TORR. Ann. Lyc. N. Y. **2**: 218. 1826.
Coll.: MacMillan & Skinner 58, Crookston.

CONVOLVULACEÆ.

Convolvulus sepium L. Sp. Pl. 153. 1753.
Coll.: Ballard 2566, St. Vincent; MacMillan & Skinner 403, Crookston.

CUSCUTACEÆ.

Cuscuta polygonorum ENGELM. Am. Journ. Sci. **43**: 342. 1842.
Coll.: Ballard 2674, St. Vincent.

Cuscuta gronovii WILLD.; R. & S. Syst. **6**: 205. 1820.
Coll.: MacMillan and Skinner 223, Crookston; 268, Thief River Falls; 376, Holmes.

BORAGINACEÆ.

Lappula lappula (L.) KARST. Deutsch. Fl. 979. 1880–83.
Coll.: Ballard 2770, Hallock; MacMillan & Skinner 245, Red Lake Falls.

Lappula americana (A. GRAY) RYDBERG, Bull. Torr. Club, **24**: 294. 1897.
Coll.: MacMillan & Skinner 243, Red Lake Falls.
No previous authentic collection reported from Minnesota. Previous collections of this species in this State have been made and determined as *L. floribunda* (Lehm.) Greene.

Onosmodium carolinianum (LAM.) DC. Prodr. **10**: 70. 1846.
Coll.: MacMillan & Skinner 386, Holmes.

VERBENACEÆ.

Verbena hastata L. Sp. Pl. 20. 1753.
Coll.: Ballard 2502, Fergus Falls; 2647, St. Vincent; MacMillan & Skinner 30, Crookston.

LABIATÆ.

Teucrium canadense L. Sp. Pl. 564. 1763.
Coll.: MacMillan & Skinner 118, Maple lake.

Scutellaria lateriflora L. Sp. Pl. 598. 1753.
Coll.: Ballard 2506, Fergus Falls; MacMillan & Skinner 1, Crookston.

Scutellaria galericulata L. Sp. Pl. 509. 1753.
Coll.: MacMillan & Skinner 302, Maple lake.

Agastache anethiodora (NUTT.) BRITTON, in Britton & Brown, Ill. Fl. **3**: 85. 1898.

Dracocephalum parviflorum NUTT. Gen. **2**: 35. 1818.
Coll.: Ballard 2556, St. Vincent; MacMillan & Skinner 284 Thief River Falls.

Physostegia virginiana (L.) BENTH. Lab. Gen. & Sp. 504. 1834.
Coll.: Ballard 2564, St. Vincent; 2766, Hallock; 2773, Warren; MacMillan & Skinner 21, 215, Crookston.

Galeopsis tetrahit L. Sp. Pl. 579. 1753.
Coll.: Ballard 2607, Humboldt.

Stachys palustris L. Sp. Pl. 580. 1753.
Coll.: Ballard 2640, 2650, St. Vincent; MacMillan & Skinner 232, Crookston.

Monarda fistulosa L. Sp. Pl. 22. 1753.
Coll.: MacMillan & Skinner 248, Red Lake Falls.

Koellia flexuosa (WALT.) MACM. Met. Minn. Val. 452. 1892.
Coll.: MacMillan & Skinner 96, Mentor.

Lycopus virginicus L. Sp. Pl. 21. 1753.
Coll.: MacMillan & Skinner 161, Maple lake.

Lycopus americanus MUHL.; Bart. Fl. Phil. Prodr. 15. 1815.
Coll.: Ballard 2648, St. Vincent; 2737, Hallock.

Lycopus lucidus TURCZ.; Benth. in DC. Prodr. **12**: 178. 1848.
Coll.: Ballard 2509, Fergus Falls.

Mentha canadensis L. Sp. Pl. 577. 1753.
Coll.: Ballard 2560, St. Vincent; 2592, Humboldt; MacMillan & Skinner 4, 426, Crookston.

SOLANACEÆ.

Solanum nigrum L. Sp. Pl. 186. 1753.
Coll.: MacMillan & Skinner 201, Crookston.

SCROPHULARIACEÆ.

Pentstemon gracilis NUTT. Gen. **2**: 52. 1818.
Coll.: MacMillan & Skinner 80, Maple lake.

Mimulus ringens L. Sp. Pl. 634. 1753.
Coll.: MacMillan & Skinner 224, Crookston.

Veronica americana SCHWEIN. Benth. in DC. Prodr. **10**: 468. 1846.
Coll.: Ballard 2744, Hallock.

Veronica scutellata L. Sp. Pl. 12. 1753.
Coll.: MacMillan & Skinner 395, Holmes.

Leptandra virginica (L.) NUTT. Gen. **1**: 7. 1818.
Coll.: MacMillan & Skinner 15, Crookston.

Gerardia aspera DOUGL.; Benth. in DC. Prodr. **10**: 517. 1846.
Coll.: MacMillan & Skinner 36, Crookston.

Gerardia tenuifolia VAHL, Symb. Bot. **3**: 79. 1794.
Coll.: Ballard 2510, 2536, Fergus Falls; 2748, Hallock; MacMillan & Skinner 277, Ives.

Orthocarpus luteus NUTT. Gen. **2**: 57. 1818.
Coll.: Ballard 2688, Northcote; 2719, Kennedy; MacMillan & Skinner 47, Crookston.

Pedicularis lanceolata MICHX. Fl. Bor. Am. **2**: 18. 1803.
Coll.: MacMillan & Skinner 93, Maple lake; 379, Holmes.

PHRYMACEÆ.

Phryma leptostachya L. Sp. Pl. 601. 1753.
Coll.: MacMillan & Skinner 240, Gentilly; 241, Red Lake Falls.

Plantago major L. Sp. Pl. 112. 1753.
Coll.: Ballard 2535, Fergus Falls; 2667, St. Vincent.

Plantago eriopoda TORR. Ann. Lyc. N. Y. **2**: 237. 1827.
Coll.: Ballard 2789, Warren.

RUBIACEÆ.

Houstonia longifolia GAERTN. Fruct. **1**: 226. 1788.
Coll.: MacMillan & Skinner 274, St. Hilaire.

Galium boreale L. Sp. Pl. 108. 1753.
Coll.: MacMillan & Skinner 289, Maple lake.

Galium trifidum L. Sp. Pl. 105. 1753.
Coll.: Ballard 2646, St. Vincent; MacMillan & Skinner 314, Crookston.

CAPRIFOLIACEÆ.

Viburnum opulus L. Sp. Pl. 268. 1753.
Coll.: MacMillan & Skinner 180, Maple lake.

Viburnum lentago L. Sp. Pl. 268. 1753.
Coll.: MacMillan & Skinner 272, Thief River Falls, 317, Crookston.

Symphoricarpos occidentalis Hook. Fl. Bor. Am. **1**: 285. 1833.
Coll.: Ballard 2750, Hallock; MacMillan & Skinner 20, Crookston.

Symphoricarpos symphoricarpos (L.) MacM. Bull. Torr. Club, **19**: 15. 1892.
Coll.: Ballard 2550, St. Vincent.

CUCURBITACEÆ.

Micrampelis lobata (Michx.) Greene, Pittonia, **2**: 128. 1890.

CAMPANULACEÆ.

Campanula rotundifolia L. Sp. Pl. 163. 1753.
Coll.: MacMillan & Skinner 236, Gentilly.

Campanula aparinoides Pursh, Fl. Am. Sept. 159. 1814.
Coll.: MacMillan & Skinner 163, Maple lake; 383, Holmes.

Lobelia syphilitica L. Sp. Pl. 931. 1753.
Coll.: Ballard 2503, Fergus Falls; MacMillan & Skinner 299, Crookston.

Lobelia spicata Lam. Encycl. **3**: 587. 1789.
Coll.: MacMillan & Skinner 57, 297, 298, Crookston.

Lobelia kalmii L. Sp. Pl. 930. 1753.
Coll.: MacMillan & Skinner 296, Maple lake.

CICHORIACEÆ.

Taraxacum taraxacum (L.) Karst. Deutsch. Fl. 1138. 1880–83.
Coll.: Ballard 2669, St. Vincent; MacMillan & Skinner 413, Crookston.

Sonchus arvensis L. Sp. Pl. 793. 1753.
Coll.: Ballard 2596, Humboldt.

Sonchus asper (L.) All. Fl. Ped. **1**: 222. 1785.
Coll.: MacMillan & Skinner 177, Maple lake.

Lactuca ludoviciana (Nutt.) DC. Prodr. **7**: 141. 1838.
Coll.: MacMillan & Skinner 34, Crookston.

Lactuca pulchella (PURSH) DC. Prodr. **7**: 134. 1838.
Coll.: Ballard 2547, St. Vincent; 2617, Humboldt; 2712, Northcote; 2723, Kennedy; MacMillan & Skinner 31, Crookston.

Agoseris glauca (PURSH) GREENE, Pittonia, **2**: 176. 1891.
Coll.: Ballard 2735, Kennedy; 2791, Warren; MacMillan & Skinner 43, Crookston.

Hieracium canadense MICHX. Fl. Bor. Am. **2**: 86. 1803.
Coll.: Ballard 2768, Hallock; 2799, Warren; MacMillan & Skinner 84, Dugdale; 114, Maple Lake.

Nabalus albus (L.) HOOK. Fl. Bor. Am. **1**: 294. 1833.
Coll.: Ballard 2627, St. Vincent; 2781, Warren; MacMillan & Skinner 76, Dugdale.

Nabalus racemosus (MICHX.) DC. Prodr. **7**: 242. 1838.
Coll.: Ballard 2559, St. Vincent; 2609, Humboldt; MacMillan & Skinner 59, Crookston; 263, St. Hilaire.

AMBROSIACEÆ.

Iva xanthifolia (FRESEN.) NUTT. Trans. Am. Phil. Soc. (II.) **7**: 347. 1841.
Coll.: Ballard 2659, St. Vincent; 2716, Kennedy.

Ambrosia trifida L. Sp. Pl. 987. 1753.
Coll.: Ballard 2567, St. Vincent, 2704, Northcote.

Ambrosia artemisiæfolia L. Sp. Pl. 987. 1753.
Coll.: Ballard 2513, Fergus Falls.

Ambrosia psilostachya DC. Prodr. **5**: 526. 1836.
Coll.: Ballard 2538, Fergus Falls; 2689, Northcote; 2790, Warren; MacMillan & Skinner 331, Crookston.

Xanthium canadense MILL. Gard. Dict. Ed. 8, no. 2. 1768.
Coll.: Ballard 2511, Fergus Falls; 2677, St. Vincent; 2764, Hallock; MacMillan & Skinner 217, Crookston.

COMPOSITÆ.

Vernonia fasciculata MICHX. Fl. Bor. Am. **2**: 94. 1803.
Coll.: MacMillan & Skinner 50, Crookston.

Eupatorium maculatum L. Amœn. Acad. **4**: 288. 1755.
Coll.: MacMillan & Skinner 121, Maple lake; 391, Holmes.

Eupatorium perfoliatum L. Sp. Pl. 838. 1753.
Coll.: Ballard 2522, Fergus Falls; MacMillan & Skinner 159, Maple lake.

Laciniaria punctata (HOOK.) KUNTZE, Rev. Gen. Pl. 349. 1891.
Coll.: MacMillan & Skinner 92, Dugdale.

Laciniari apycnostachya (MICHX.) KUNTZE, Rev. Gen. Pl. 349. 1891.
Coll.: MacMillan & Skinner 97, Maple lake.

Laciniaria scariosa (L.) HILL, Veg. Syst. **4**: 49. 1762.
Coll.: Ballard 2797, Warren; MacMillan & Skinner 61, 220, Crookston.

Grindelia squarrosa (PURSH) DUNAL in DC. Prodr. **5**: 315. 1836.
Coll.: Ballard 2554, St. Vincent; 2700, Northcote; 2730, Kennedy; MacMillan & Skinner 88, Dugdale.

Chrysopsis hispida (HOOK.) NUTT. Trans. Am. Phil. Soc. (II.) **7**: 316. 1841.
Coll.: MacMillan & Skinner 83, Dugdale; 388, Holmes.
Not previously reported from Minnesota.

Solidago canadensis L. Sp. Pl. 878. 1753.
Coll.: Ballard 2517, Fergus Falls; 2565, St. Vincent; 2711, Northcote; MacMillan & Skinner 303, Crookston; 397, Holmes.

Solidago nemoralis AIT. Hort. Kew. **3**: 213. 1789.
Coll.: MacMillan & Skinner 342, 344, Crookston.

Solidago rigida L. Sp. Pl. 880. 1753.
Coll.: Ballard 2504, Fergus Falls; 2611, Humboldt; 2683, Northcote; 2731, Kennedy; 2795, Warren; MacMillan & Skinner 69, 339, Crookston.

Euthamia graminifolia (L.) NUTT. Gen. 2: 162. 1818.
Coll.: Ballard 2521, Fergus Falls; 2796, Warren.

Aster sagittifolius WILLD. Sp. Pl. **3**: 2035. 1804.
Coll.: MacMillan & Skinner 25, Crookston; 256, St. Hilaire.

Aster novæ-angliæ L. Sp. Pl. 875. 1753.
Coll.: Ballard 2779, Warren; MacMillan & Skinner 78, Dugdale.

Aster puniceus L. Sp. Pl. 875. 1753.
Coll.: MacMillan & Skinner 287, Thief River Falls.

Aster lævis L. Sp. Pl. 876. 1753.
Coll.: MacMillan & Skinner 190, 196, 311, Crookston; Ballard 2518, Fergus Falls; 2561, 2622, St. Vincent; 2692, Northcote; 2738, Hallock.

Aster sericeus VENT. Hort. Cels. 1800.
Coll.: MacMillan & Skinner 82, Dugdale.

Aster ptarmicoides (NEES) T. & G. Fl. N. A. 2: 160. 1841.
Coll.: MacMillan & Skinner 60, Crookston; 154, Maple lake; Ballard 2804, Warren.

Aster salicifolius LAM. Encycl. 1: 306. 1783.
Coll.: Ballard 2785, Warren.

Aster paniculatus LAM. Encycl. 1: 306. 1783.
Coll.: Ballard 2568, St. Vincent; 2674, Northcote; MacMillan & Skinner 312, Crookston.

Aster multiflorus AIT. Hort. Kew. 3: 203. 1789.
Coll.: Ballard 2694, Northcote; 2724, Kennedy; 2802, Warren; MacMillan & Skinner, 336, Crookston.

Brachyactis angustus (LINDL.) BRITTON, in Britton & Brown, Ill. Fl. 3: 383. 1898.
Coll.: Ballard 2545, Fergus Falls; 2784, Warren.

Erigeron philadelphicus L. Sp. Pl. 863. 1753.
Coll.: MacMillan & Skinner 226, 360, Crookston; Ballard 2649, St. Vincent.

Erigeron ramosus (WALT.) B.S.P. Prel. Cat. N. Y. 27. 1888.
Coll.: MacMillan & Skinner 44, Crookston; 95, Maple lake.

Leptilon canadense (L.) BRITTON, in Britton & Brown Ill. Fl. 3: 391. 1898.
Coll.: Ballard 2633, St. Vincent; MacMillan & Skinner 37, Crookston.

Doellingeria umbellata pubens (A. GRAY) BRITTON, in Britton & Brown Ill. Fl. 3: 393. 1898.
Coll.: MacMillan & Skinner 120, Maple lake.

Heliopsis scabra DUNAL, Mem. Mus. Paris, 5: 56. 1819.
Coll.: MacMillan & Skinner 117, Maple lake; 204, Crookston.

Rudbeckia hirta L. Sp. Pl. 907. 1753.
Coll.: Ballard 2563, St. Vincent; MacMillan & Skinner 41, Crookston.

Rudbeckia laciniata L. Sp. Pl. 906. 1753.
Coll.: Ballard 2660, St. Vincent; MacMillan & Skinner 205, Crookston.

Ratibida columnaris (SIMS) D. DON; Sweet, Brit. Fl. Gard. **2**: 361. 1838.
Coll.: MacMillan & Skinner 75, Maple lake, 365, Holmes.

Helianthus annuus L. Sp. Pl. 904. 1753.
Coll.: Ballard 2675, St. Vincent.

Helianthus scaberrimus ELL. Bot. S. C. & Ga. **2**: 423. 1824.
Coll.: Ballard 2601, Humboldt; 2703, Northcote; 2739, Hallock; MacMillan & Skinner 333, Crookston; 367, Holmes.

Helianthus maximiliani SCHRAD. Ind. Sem. Hort. Goett. 1835.
Coll.: Ballard 2572, St. Vincent; 2696, Northcote; 2727, Kennedy; MacMillan & Skinner 352, 353, Shirley.

Helianthus grosse-serratus MARTENS, Sel. Sem. Hort. Loven. 1839.
Coll.: MacMillan & Skinner 295, 429, Crookston; 378, Holmes.

Helianthus tuberosus L. Sp. Pl. 905. 1753.
Coll.: MacMillan & Skinner 203, Crookston; 392, Holmes.

Bidens lævis (L.) B.S.P. Prel. Cat. N. Y. 29. 1888.
Coll.: MacMillan & Skinner 264, St. Hilaire; 362, Crookston; 371, Holmes.

Bidens cernua L. Sp. Pl. 832. 1753.
Coll.: MacMillan & Skinner 9, Crookston.

Bidens frondosa L. Sp. Pl. 832. 1753.
Coll.: Ballard 2623, Humboldt; 2678, St. Vincent; 2710, Northcote; 2733, Kennedy; 2763, Hallock; MacMillan & Skinner 11, 38, 207, Crookston.

Helenium autumnale pubescens (AIT.) BRITTON, Mem. Torr. Club, **5**: 339. 1894.
Coll.: MacMillan & Skinner 146, Maple lake.

Gaillardia aristata PURSH, Fl. Am. Sept. 573. 1814.
Coll.: MacMillan & Skinner 380, Holmes.
No previous authentic collections from Minnesota in the Herbarium of the University.

Achillæa millefolium L. Sp. Pl. 899. 1753.
Coll.: Ballard 2624, St. Vincent; MacMillan & Skinner 45, Crookston.

Artemisia caudata MICHX. Fl. Bor. Am. 2: 129. 1803.
Coll.: MacMillan & Skinner 73, Crookston.

Artemisia dracunculoides PURSH, Fl. Am. Sept. 742. 1814.
Coll.: MacMillan & Skinner 65, Crookston.

Artemisia frigida WILLD. Sp. Pl. 3: 1838. 1804.
Coll.: MacMillan & Skinner 74, Crookston; Ballard 2597, Humboldt.

Artemisia absinthium L. Sp. Pl. 848. 1753.
Coll.: Ballard 2553, St. Vincent.

Artemisia biennis WILLD. Phytogr. 11. 1794.
Coll.: Ballard 2726, Kennedy.

Artemisia gnaphalodes NUTT. Gen. 2: 143. 1818.
Coll.: Ballard 2619, Humboldt; 2698, Northcote; 2732, Kennedy; 2798, Warren; MacMillan & Skinner 55, Crookston.

Arctium lappa L. Sp. Pl. 816. 1753.
Coll.: MacMillan & Skinner 210, Crookston.

Carduus altissimus L. Sp. Pl. 824. 1753.
Coll.: Ballard 2501, Fergus Falls; MacMillan & Skinner 170, Maple lake.

Carduus discolor (MUHL.) NUTT. Gen. 2: 130. 1818.
Coll.: MacMillan & Skinner 12, Crookston.

Carduus undulatus NUTT. Gen. 2: 130. 1818.
Coll.: MacMillan & Skinner 48, Crookston.

Carduus arvensis (L.) ROBS. Brit. Fl. 163. 1777.
Coll.: Ballard 2548, St. Vincent; MacMillan & Skinner 283, Thief River Falls.

EXPLANATION OF PLATE XXXIV.

General view of prairie near Shirley, Minn. This is the characteristic aspect of mesophytic prairie in the Red River valley. The shrubs are *Salix humilis*, for the most part. The herbs in the foreground are *Asters*. The view shows a minor tension line in which *Juncus dudleyi* is an abundant plant. On the right a growth of *Polygonum* intermixed with *Andropogon* is seen. The view gives an idea of the variety of the prairie vegetation.

PLATE XXXV.

An island of *Hordeum* surrounded by a border zone of *Salix* intermingled with *Symphoricarpos* and *Solidago*. Such circular patches of squirrel-tail grass marking slight depressions in the prairie are not uncommon and often reach a considerable size,even covering several acres.

PLATE XXXVI.

Prairie near Gentilly, Minn. In the background is seen the shrubby and scanty arboreal vegetation along the Red Lake river. In the middle distance a minor tension line of *Hordeum* is apparent extending, in this case, several miles along the river. In the foreground *Nabalus racemosus*, a characteristic wand plant of the region, is seen forming an almost circular patch in the general grass vegetation.

PLATE XXXVII.

Gopher mound with characteristic vegetation. These mounds made by *Geomys bursarius* are abundant on the prairie throughout the district. Somewhat more xerophytic plants inhabit them than are found upon the level prairie where they occur. Upon this particular mound hazel-brush, *Artemisia*, *Bouteloua*, *Solidago rigida* and other semi-xerophytic or strongly xerophytic plants have secured a foothold.

PLATE XXXVIII.

A growth of silver-berry—*Eleagnus argentea*. This plant is abundant throughout the district studied, in dry declivities or on slopes of the rolling prairie. It is also abundant in pastures along the Red Lake river.

PLATE XXXIX.

View of the margin of a grass meadow in the poplar scrub near Maple lake showing three stands of *Salix lucida*, a common plant of the tension zone between the meadow and the scrub.

PLATE XL.

View of xerophilous vegetation on knolls along a coulee cut in the raised beach of the extinct Lake Agassiz near Fertile, Minn. The brows of the knolls are occupied almost exclusively by an *Artemisia* formation in which three or four species are present, *Artemisia frigida* being the most abundant. Scrub poplars, hazel and *Quercus* form a sparse "gallery wood." On the upland *Gaillardia*, *Amorpha*, *Gaura* and other xerophytic herbs and shrubs of the prairie are abundant.

Plate XLI.

Elm woods along the Red Lake river near Crookston, Minn. The bottoms being subject to overflow, show a scanty undergrowth mostly herbaceous, though with a few shrubs of *Ribes*, *Rubus* and *Corylus*. In such glades the bolls of the trees are commonly distorted and scarred owing to the battering which they receive when young by driftwood and flotsam during times of high water.

PLATE XX[illegible]III

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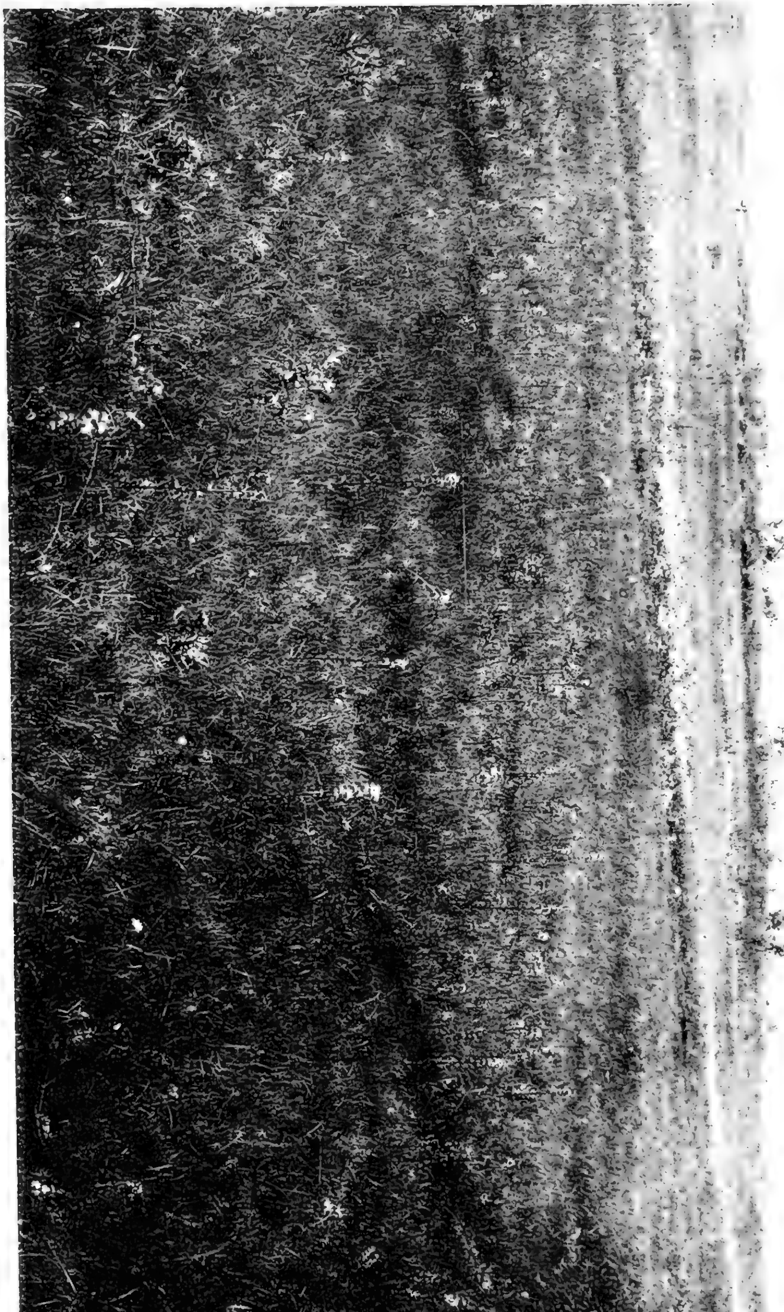

PLATE XXXVII.

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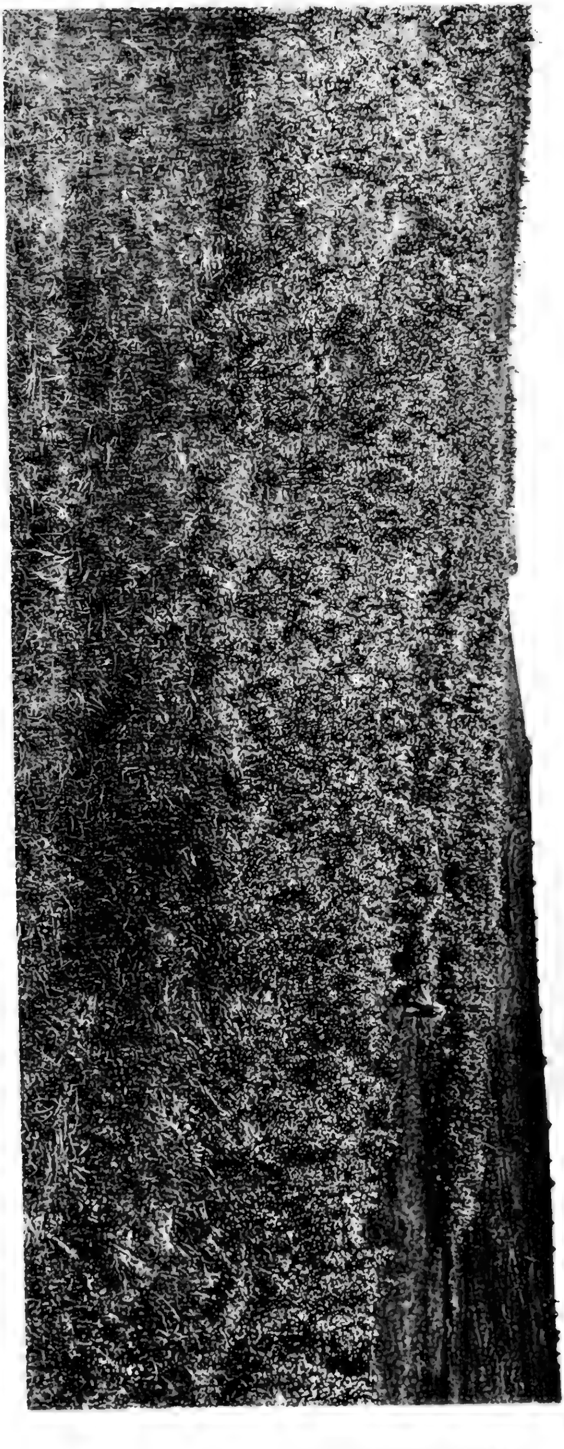

PLATE XVIII.

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PLATE XI.

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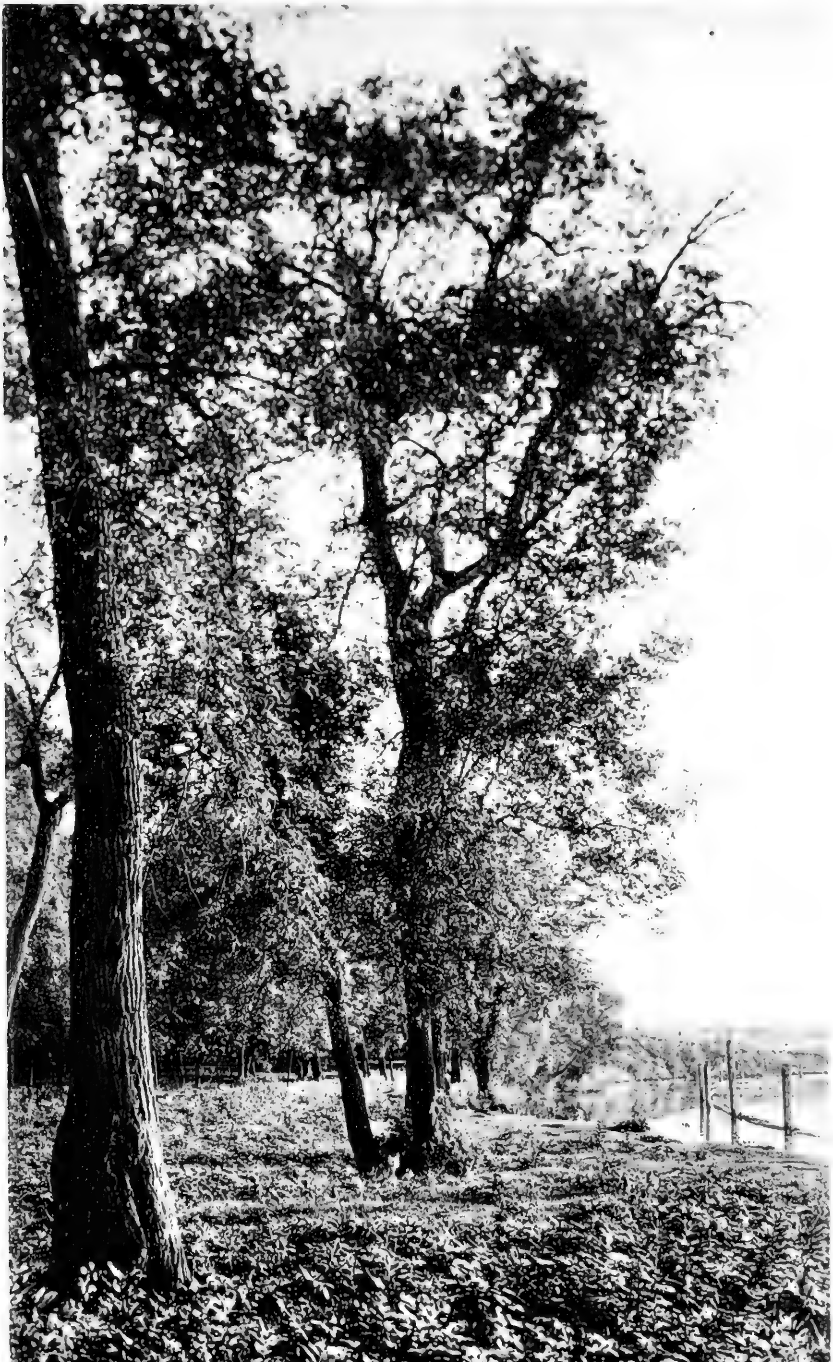

XXXIII. OBSERVATIONS ON *Gigartina exasperata* Harv.

H. B. Humphrey.

The plants used in the preparation of this paper were collected by Miss Josephine E. Tilden, in Puget Sound near Seattle, Washington, in August, 1897.

They are found growing at a depth of six fathoms though thriving in shallower water. In July, 1898, several plants were collected near Tracyton, Washington, at a depth of about four fathoms attached to rocks in quiet waters. These plants were generally large and well developed and were somewhat loosely attached to the substratum. Their position in the water was erect except in certain places where a tidal current was present. Plants found in localities washed by swift tidal currents were smaller, thicker and more firmly attached to the substratum.

The material was preserved in alcohol, consequently the plant could not be studied in its natural condition. All sections were cut by means of a freezing microtome. Material imbedded in gelatin when sectioned proved useless as the cells were swollen to such a degree as to appear unnatural. Portions of the frond were then sectioned directly from the alcoholic solution with good results.

The stains employed were Delafield's hæmatoxylin, methyl blue, methyl violet, iodine and fuchsin. Delafield's hæmatoxylin proved a good nuclear stain. Methyl blue was used in staining cell walls but was not as satisfactory as methyl violet. Iodine was used in staining carpospores and brings out very clearly the distinction between them and surrounding tissue. Fuchsin proved a very satisfactory stain used in connection with the study of protoplasmic pits, coloring them a deep red.

Sections were all treated with staining solution and then mounted directly in glycerine jelly, making a permanent mount.

Holdfast: The holdfast is a disc-shaped organ, exhibiting considerable variation in size. In the case of a single frond the holdfast is not much greater in diameter than the stipe immediately above. The under surface is smooth and somewhat flexible, though in comparison with other tissues it shows greater rigidity and strength. It is not unusual to find several fronds attached to one common holdfast which, upon close examination, presents the appearance of a compound organ, in some instances measuring nine mm. in diameter.

The tissue of the holdfast is unlike that of any other part of the plant. Pl. 42, Fig. 2, represents a longitudinal section through a portion of the holdfast showing distinctive areas from the point of attachment to the substratum to the tissue of the stipe. It was found that in removing the plant from its point of attachment the cuticle was removed from the holdfast leaving exposed those cells immediately adjacent, represented by (*a*). These cells appear to be somewhat irregular in outline, though generally quadrilateral, and are characterized by their exceedingly thick walls. Approaching the stipe these cells are slightly modified and in conjunction with them are found rather long somewhat egg-shaped cells, densely filled with contents. These cells, along with the others, are arranged approximately in rows extending vertically through the holdfast. Protoplasmic connection exists between all cells and the cell arrangement is so compact as to give great strength and rigidity to the tissue. These cells (Pl. 42, Fig. 2, *b*) are slightly modified and in conjunction with small, somewhat spherical cells closely attached and densely filled with granular contents. Abutting upon this area are the filamentous cells of the stipe, which are very similar to those found elsewhere in the frond.

Stipe.—In the early stages of the plant's growth the stipe is hardly to be distinguished from the lamina, but as the frond reaches maturity the stipe becomes a well-marked organ of deep red color. Immediately above the holdfast it is circular, but as it gradually merges into the lamina it loses its characteristic shape, becoming much expanded in one diameter and thinner in the other. The stipe seldom exceeds a length of 20 mm., while the diameter varies from 2 to 5 mm.

The stipe exhibits a structure similar to that of the lamina, though in the former the cells possess shorter diameters and the arrangement is more compact, thus affording greater rigidity and strength. The epidermal cells throughout the entire plant are enveloped by a firm cellulose sheath of variable thickness, from three to ten mic. (Pl. 42, Fig. 4, *a*.) This cuticle is somewhat elastic, smooth and highly transparent. Pl. 42, Fig. 5, *a* and *b*, represent surface views of a portion of the frond, showing epidermal cells as seen through the overlying cuticle. By focusing, deeper cells beneath the epidermal layer may be seen.

Beneath the epidermal cells and in connection with them are the pseudo-cortical cells, presenting an almost spherical outline and a somewhat loose though definite arrangement. These cells as well as the epidermal ones are densely filled with protoplasmic contents, though unlike the epidermal cells they contain no chromatophores.

The sections of the stipe were stained with an alcoholic solution of methyl blue which gave a very satisfactory cellulose reaction and revealed the fact that all the cells were imbedded in a dense gelatinous matrix between which and the cell walls it is not easy to distinguish.

Adjoining the pseudo-cortical cells and occupying the central region of the stipe is the pseudo-medullary area composed of irregular cells. Pl. 42, Fig. 3, and Pl. 42, Fig. 4, represent transverse and longitudinal sections of the stipe. In Pl. 42, Fig. 3, *c*, a network of somewhat filamentous cells is seen to be interwoven with other cells of different form forming altogether a rather loose arrangement.

Lamina.—The general shape of the lamina is almost invariably cuneate, attaining its greatest diameter a little way from the apex. In all cases the frond is flat and not greater than three mm. in thickness, and when dry is quite translucent.

It commonly grows from 30 to 50 cm. in length and from 6 to 18 cm. in width, thus showing considerable variation in size. In shape it is quite as variable; some fronds being branched profusely while others show little or no branching whatever.

New fronds arise from the base of the stipe forming at first somewhat club-shaped or pointed bodies, but later expand and assume the characteristic shape of the mature frond. (Pl. 42, Fig. 1.) Both sides of the frond, including the margin, are thickly studded with cystocarps and numerous epidermal proliferations. Near the base of the frond on each side is a small area totally void of proliferations. Here the frond is thicker than elsewhere, more deeply colored and possesses a glossy smoothness.

The cystocarps sometimes appear as surface elevations though commonly they are developed in the marginal and surface proliferations. They are most numerous and attain greatest size in the marginal area while at the center they are scattering and poorly developed, numbering from 8 to 10 per sq. cm. as compared with 15 to 18 near the margin.

The broad flat branches of the lamina, owing to extreme thinness and position, bear few cystocarps though the number of proliferations may be great.

The epidermal cells of the lamina are very similar in every respect to those of the stipe except that the arrangement is less compact. The same may be said regarding the pseudo-cortical area, but a difference is seen in the pseudo-medullary cells; these are all filamentous, densely filled with granular protoplasmic contents (Pl. 42, Figs. 6 and 7) and so joined as to form a complete network.

Through the use of certain staining reagents it was found that a protoplasmic connection existed between the several cells of the frond, best seen in the pseudo-medullary region of the lamina. (Pl. 42, Fig. 8.) On further examination, using alcoholic solution of fuchsin as a staining reagent, protoplasmic pits were seen to exist between the several cells. These pits were composed in every case of two minute callous plates which when stained were found to give a reaction similar to that of protoplasm. It was not possible to determine the function of these connections, but no doubt they serve as paths of communication between cells. In Schmitz's discussion of the protoplasmic pits he shows that they are traversed by plasma-cords which serve for conduction of dynamic influences from cell to cell. He believes a transfer of dissolved food material possible because of the pores in the pit, but does not regard as probable the transfer of protoplasm.

Proliferations and cystocarp.—Pl. 42, Fig. 9, represents an early stage in the development of a proliferation. Certain of the epidermal cells become slightly modified in shape, cell division takes place vertically and apparently transversely. This increase in the number of cells causes an elevation to develop and as it continues a well-developed proliferation eventually prevails which may or may not bear a cystocarp.

In the material at hand the writer was unable to secure any sections showing tetraspores.

The development of the cystocarp, however, was quite clearly brought out. As the proliferation advances in its development there arises an irregular cellular formation of gonimoblast filaments and sterile tissue in the interior of which groups of branched filaments develop the carpospores. This entire formation is surrounded by a definite area of cells forming the cystocarpic wall. As the cystocarp advances towards maturity a perforation occurs through the breaking down and gradual dissolution of certain cells, thus furnishing the mature spores an avenue of escape (Pl. 42, Fig. 11). The tissue of the proliferation surrounding the spore cavity is similar to that of the lamina proper, except that the cells are more compactly arranged.

Sections of this tissue were treated with Delafield's hæmatoxylin which proved to be a good nuclear stain revealing in several cells well-marked nuclei. (Pl. 42, Fig. 12.)

Several sections were made in order to determine the structure and characteristics of the mature cystocarp. Pl. 42, Fig. 13, represents such a cystocarp showing the spores arranged in groups surrounded by apparently empty filamentous cells, thus forming a compound cystocarp. Previous to the maturity of the spores they are all attached to the gonimoblastic filaments of which they were originally a part. They are evidently attached by means of protoplasmic threads, though no evidence of pits occurred. (Pl. 42, Fig. 15.) The carpospores, when mature, measure from 10 to 12 μ along one diameter and 11 to 13 μ along the other, while the cystocarp measures from two to three mm. in diameter through the conceptacle.

Bibliography.

Harvey, W. H. Notice of a collection of algæ made on the northwest coast of North America, chiefly at Vancouver's Island, by David Lyall in 1859–61. (Jour. Proc. of Linn. Soc. **6**: 172, 173. 1862.

Cocks, J. Observations on the growth and time of appearance of some of the marine algæ. Jour. Proc. of Linn. Soc. **4**: 101–106. 1860.

Stromfelt, H. F. G. Untersuchungen über die Haftorgane der Algen. Bot. Cent. **33**: 381, 382, 395–400. 1888. Hedwigia, **27**: 143. 1888.

Harvey, W. H. Characters of new algæ chiefly from Japan and adjacent regions. Proc. Am. Acad. **4**: 332. 1857–1860.

Schmitz, Fr. Untersuchungen über die Befruchtung der Florideen. Bot. Zeit. **41**: 608–613, 14s. 1883.

Schmitz, Fr. Knöllchenartige Auswuchse an den sprozzen einiger Florideen. Bot. Zeit. **38**: 624. 1892.

Möbius, M. Morphologie der haarartigen Organe bei den Algen. Biol. Cent. **12**: 73. 1892.

Jönsson, B. Beiträge zur Kenntniss des Dickenzuwachses der Rhodophyceen. Lunds. Univers. Aarskr. **27**: 41. *2 pl.* 1890–91.

Wille, N. Beitrag zur Entwicklungsgeschichte der physiologischen Gewebsysteme bei einigen Florideen. Nova Acta. Acad. Leop. Carol. **52**: 49–100. *pl. 3–8.* 1887.

Osterhout, W. J. V. A Simple Freezing Device. Bot. Gaz. **21**: 195–201. 1896.

Moore, L. Le M. Studies in Vegetable Biology—Observations on the Continuity of Protoplasm. Journ. Linn. Soc. **21**: 595–621. *pl. 19–21.* 1886.

Description of Plate XLII.

Figure 1. A typical frond of *Gigartina exasperata* one-fourth natural size.

Figure 2. Longitudinal section of holdfast. × 450.

Figure 3. Cross section of stipe. *a*, Epidermal cells; *b*, pseudo-cortical cells; c, pseudo-medullary cells. × 450.

Figure 4. Longitudinal section of stipe. *a*, Epidermal cellulose sheath. × 450.

Figure 5. (*a*) Surface view of frond, showing epidermal cells through the transparent epidermal sheath. (*b*) Surface view of frond showing cells beneath the epidermal cells. × 900.

Figure 6. Cross section of frond. × 450.

Figure 7. Filamentous cells of the pseudo-medullary area showing granular contents. × 900.

Figure 8. Protoplasmic connections between cells of pseudo-medullary area. × 900.

Figure 9. An early stage in development of a proliferation showing growing point (*a*). × 450.

Figure 10. A portion of the margin of a frond showing proliferations and cystocarps.

Figure 11. Longitudinal section of mature cystocarp. *O*, carpostome; *a*, conceptacle.

Figure 12. Portion of tissue surrounding a conceptacle showing cell nuclei. × 700.

Figure 13. Cross section of mature cystocarp showing spores.

Figure 14. Two groups of spores separated by elongated sterile cells. × 150.

Figure 15. Immature carpospores still attached to the gonimoblastic filaments; (*a*) a spore separating from filaments. × 480.

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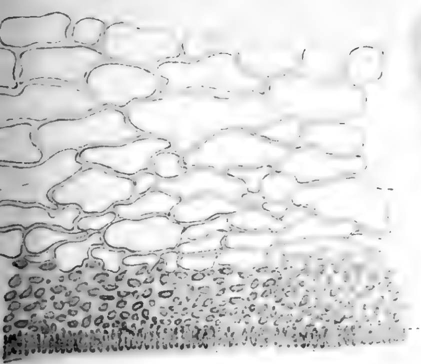

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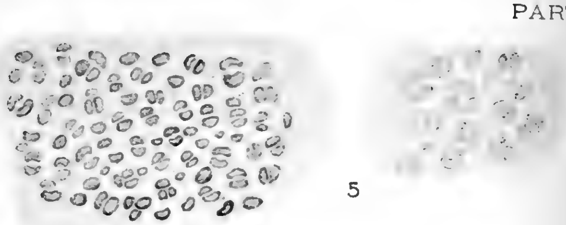

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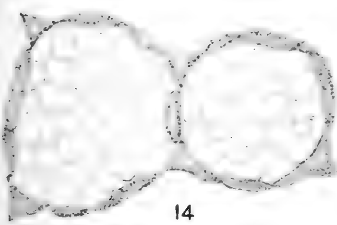

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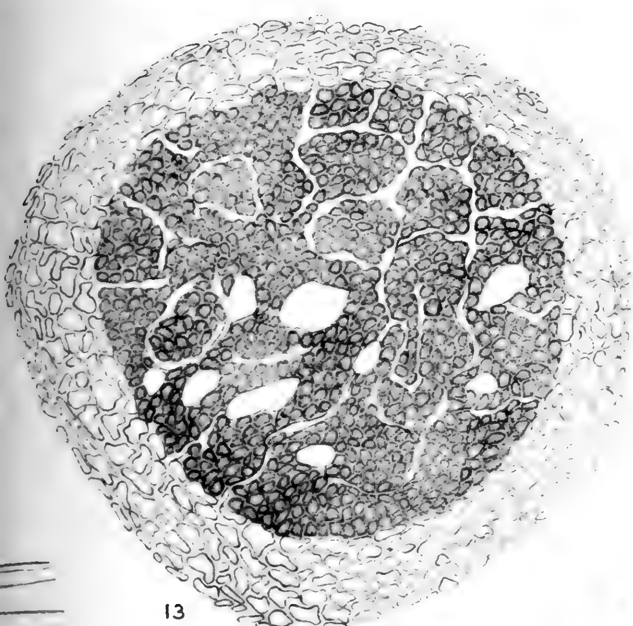

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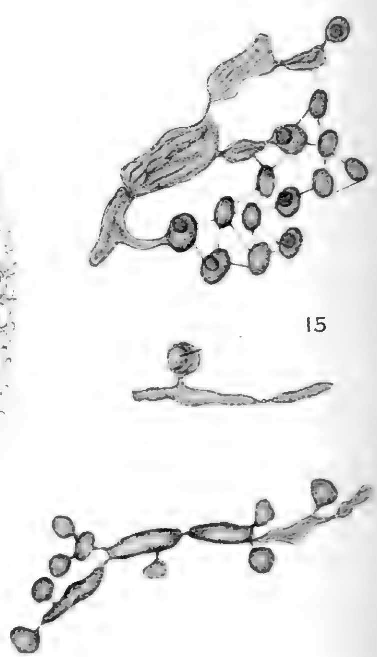

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XXXIV. OBSERVATIONS ON THE ALGÆ OF THE ST. PAUL CITY WATER.

M. G. Fanning.

St. Paul receives its water supply from twenty-two lakes north of the city which are situated on both sides of a divide or watershed. The area from which the water is received extends about twenty miles north of the city. The greater part of the water comes immediately from Lake Vadnais, which in return receives its supply from chains of lakes through brooks, artificial canals, conduits, etc. As these lakes are separated by a divide pumping stations are provided at Centreville lake and Baldwin's lake to force the water over the divide. Besides the lakes, groups of artesian wells add to the supply and help to lower the temperature of the water during the summer months. There are nine wells at Lake Vadnais and twenty-eight at Centreville lake, making thirty-seven in all with depths varying from sixty-three to eight hundred and sixty-five feet.

Pleasant lake receives the water from the north slope of the watershed; from here the water flows from Lake Vadnais, then it is conveyed four and one-half miles through a conduit to the pumping station. The elevated portions of the city receive the water directly from the pumping station. Other parts are supplied by gravity with water from Lakes Gervais and Phalen. In order to get sufficient pressure to supply the higher areas, the water is forced into a reservoir one mile west of the pumping station. This reservoir is 290 feet above the water level of the Mississippi river and has a capacity of 18,000,000 gallons. There is another reservoir on the West Side to supply the elevated district across the river.

At the pumping station and also at the entrance of the conduit leading from Lake Vadnais, a series of graduated wire screens strain from the water the coarser vegetable growth.

Method of collection.—The method of collection is practically the one suggested by Dr. Smith Ely Jelliffe * and is as follows: A piece of absorbent cotton four or five inches square and one inch thick is attached by means of a twelve-inch square of unbleached muslin to the water faucet. The water is then turned on sufficiently to insure a constant stream and is allowed to run from ten to twelve hours, after which the cotton is removed. The cotton, which is usually quite brown from the organisms, is divided into pieces and rubbed and rinsed in five beakers each containing 200 c.c. of water. The water is then poured into one vessel and allowed to settle, after which the deposit is put into a glass containing 25 c.c. A few drops of this is transferred to a slide by means of a pipette and examined microscopically. At least ten mounts from each week's collection of material was examined in this way. The rest was then preserved in 2 per cent. formaline for future reference.

For the records, Dr. Jelliffe's method of computation was adopted. In computing the numbers the following schedule was used:

Abundant,	25 + in one c.c. of water.
Common,	10–25 in one c.c. of water.
Few,	5–10 in one c.c. of water.
Scarce,	1–5 in one c.c. of water.
Present,	Less than five in one c.c. of water.

Since November, 1899, weekly collections have been made of the plant life in the St. Paul water supply and the organisms identified (as far as possible) and their number computed.

The vegetable organisms found were all algæ if we except the pollen grains and Fungi spores that appeared occasionally. The Algæ found were as follows:

1. *Diatomaceæ*,	13 varieties.
2. *Cyanophyceæ*,	11 varieties.
3. *Chlorophyceæ*,	32 varieties.
4. *Peridiniæ*,	2 varieties.

Of these some forms of Diatoms were present almost constantly, especially *Melosira*, *Stephanodiscus*, two varieties of

*Jelliffe, S. E. A preliminary report upon the microscopical organisms found in the Brooklyn water supply. Brooklyn Med. Journ. 7: 595. O. 1893.

Synedra and *Asterionella*. Of the Chlorophyceæ, *Scenedesmus* and *Raphidium* were present most of the time. Among the Cyanophyceæ, *Oscillatoria* and *Cœlosphærium* were practically constant.

The effect of the cold on some of the varieties is shown by the accompanying plates (Pl. XLIII. and XLIV.). It will be seen that a fall in temperature coincides with a decrease in the numbers of all except *Oscillatoria*, which shows a gradual increase with the cold and is abundant for several weeks during the severest weather.

The desmids, more plentiful in the fall than at any other time, although never abundant, disappeared after the cold wave of the third week in December. Another fall in temperature about the fourth week in January banished most of the Chlorophyceæ and cleared the field of *Cœlosphærium*, but some of the diatoms persisted until the zero weather in February, when most of them disappeared. *Fragilaria* was abundant in January and about January 30th, when *Oscillatoria* and *Fragilaria* were practically the only forms seen, the water contained considerable sandy débris and entangled in it were quantities of resting spores of *Glœotrichia*.

The observations vary from year to year so that a record should be kept for several years before one could find what forms were both constant and abundant. For example, in the fall of 1898, *Anabæna* was "common," but in the following year it is only marked "present."

I wish to thank Mr. P. F. Lyons, of the St. Paul Weather Bureau and Mr. John Caulfield, Secretary of the Water Board, St. Paul, for their kind assistance.

Explanation of Plates XLIII. and XLIV.

Table showing relation between abundance of certain forms and temperature. XLIV. is a continuation of XLIII.

Plate XLV.

1. *Cœlastrum microporum* Naeg. var. *speciosum* Wolle. Freshw. Algae U. S. 170. *pl. 156. f. 4.* 1887.

2. *Pediastrum duplex* Meyen Beob. über Algenformen. in Nova Acta Acad. Leop. Carol. 772. 1829.

3. *Scenedesmus quadricauda* (Turp.) Bréb. Alg. Falais. 66. 1835.

4. *Scenedesmus bijugatus* (Turp.) Kg. Syn. Diat. 607. 1833.

5. *Rhaphidium polymorphum* Fresen. var. *aciculare* (A. Br.) Rabenh. Fl. Eur. Algar. **3**: 45. 1868.

6. *Rhaphidium polymorphum* Fresen. var. *falcatum* (Corda) Rabenh. Fl. Eur. Algar. **3**: 45. 1868.

7. *Nephrocytium agardhianum* Naeg. Gatt. einz. Alg. 80. *pl. 3 C.* 1849.

8. *Dictyosphærium pulchellum* Wood. Freshw. Algæ U. S. 84. 1873.

9. *Eudorina elegans* Ehrenb. in Monatsb. der Akad. d. wiss. zu Berlin. 78, 152. *pl. 2. f. 10.* 1831.

10. *Pandorina morum* (Muell.?) Bory in Ehrenb. Infus. 53. *pl. 2. f. 33.* 1838.

11. *Glœocystis gigas* (Kg.) Lagerh. Bidrag. till Sveriges Algfl. 63. 1883.

12. *Micrasterias truncata* (Corda) Bréb. in Ralfs Brit. Desmid. 75. no. 9. *pl. 8. f. 4.* and *pl. 10. f. 5.* 1848.

13. *Staurastrum sebaldi* Reinsch. Algenf. von Franken. 175. *pl. 11. f. 1.* 1867.

14. *Staurastrum minneapoliense* Wolle in Bull. Torr. Bot. Club, **12**: 5. *pl. 47. f. 11–13.* 1885.

15. *Staurastrum paradoxum* Meyen. var. *longipes* Nordst. Sydlig. Norg. Desm. 35. *f. 17.* 1873.

16. *Arthrodesmus incrassatus* Lagerh. var. *cycladatus* Lagerh. Bidrag till Amer. Desm.-Flora. 242. *pl. 27. f. 19.* 1885.

17. *Pleurotæniopsis quaternaria* (Nordst.) De Toni. Syll. Algar. **1**: 914. 1889.

18. *Cosmarium nitidulum* De Not. Element. 42. *pl. 3. f. 26.* 1867.

19. *Closterium parvulum* Naeg. Gatt. einz. Alg. 106. *pl. 6. C. f. 2.* 1849.

20. *Nostoc* sp. und.

21. *Anabæna flos-aquæ* (Lyngb.) Bréb. Algues des environs de Falaise 36. 1835.

22. *Lyngbya majuscula* Harv. in Hooker, Eng. Fl. **5**: 370. 1833.

23. *Merismopedia glauca* Naeg. Gatt. einz. Alg. 55. *pl. 1. D. f. 1.* 1849.

24. *Cœlosphærium kützingianum* Naeg. Gatt. einz. Alg. 54. *pl. 1. C.* 1849.

25. *Anacystis marginata* Menegh. Consp. 6. 1837.

26. *Peridinium tabulatum* Ehr. in Kent. Manual of the Infusoria. 1: 448.

PLATE XLVI.

1. *Amphora ovalis* (Bréb.) Kg. Bac. 107. *pl. 5. f. 35, 39.* 1844.

2. *Cymbella lanceolata* (Ehr.) Kirchn. Alg. Schles. 188. 1878.

3. *Asterionella formosa* Hass. in Micr. Exam. 10.

4. *Synedra ulna* (Nitzsch.) Ehr. Infus. 211. *pl. 17. f. 1.* 1836.

5. *Synedra pulchella* (Ralfs.) Kg. Bacill. 68. *pl. 29. f. 37.* 1844.

6. *Fragilaria capucina* Desmaz. Crypt. de France (ed. 1), no. 453. 1825.

7. *Tabellaria fenestrata* Lyngb. Kg. var. *intermedia* Grün. in., V. H. Syn. *pl. 52. f. 6–8.* 1880–81.

8. *Cyclotella comta* (Ehr.) Kg. Spec. Algar. 20. 1849.

9. *Stephanodiscus niagaræ* Ehr. in Berl. Akad. 80. 1845.

10. *Melosira granulata* (Ehr.) Ralfs. in Pritch. Inf. 820. 1845–61.

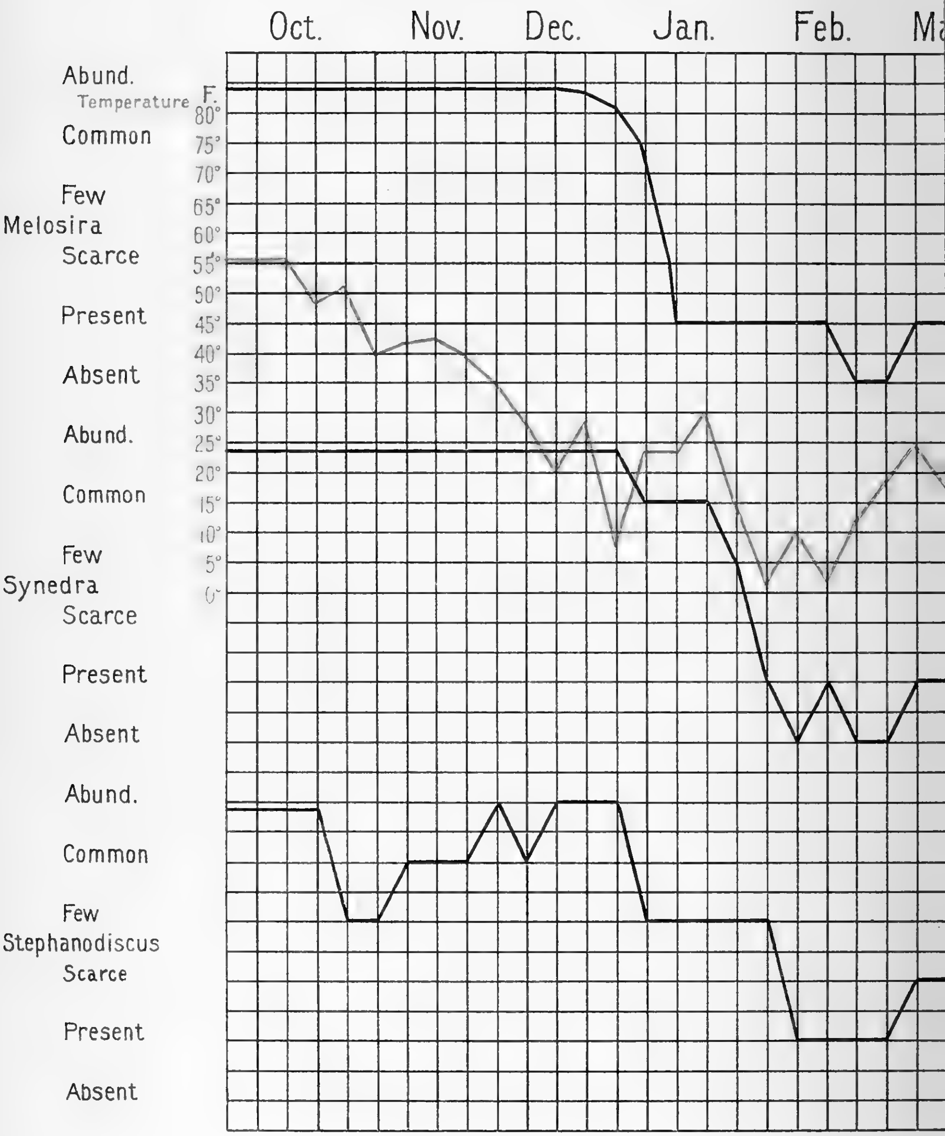
11. *Ceratium longicorne* Carter.

	November 7.	November 14.	November 21.	November 28	December 5.	December 12.	December 19.	December 26.	January 2.	January 9.	January 16.	January 23.	January 30.	February 6.	February 13.	February 20.	February 27.	March 6.	March 13.	March 20.	March 27.	April 3.	April 10.	April 17.	April 24.
CYANOPHYCEÆ.																									
1. Anacystis																									
2. Anabæna	sc	sc	pr	sc	pr	pr	pr	pr																	
3. Chroococcus														pr	pr		pr								
4. Clathrocystis																									
5. Cœlosphærium	c	c	c	fw	sc	fw	fw	pr	pr	pr	fw	sc				fw	c	c	c	c	c	sc	sc	sc	sc
6 Glœotrichia													ab												
7. Lyngbya																									
8. Merismopedia	ab	c	c	fw	fw	fw	pr			pr	pr						pr	pr	pr	pr					
9. Nostoc	pr	sc	pr																						
10. Oscillatoria	pr	sc	sc	fw	ab	c	c	c	c	ab	ab	ab	ab	ab	ab	c	c	c	c	c	fw	fw	ab	ab	ab
11. Phormidium										pr		pr	pr	pr	fw	fw	c	pr	pr						
DIATOMEÆ.																									
1. Amphora		pr					pr		pr				pr												
2. Asterionella	sc	sc	sc	sc	pr	pr	pr		p	pr	fw	fw	pr	pr			pr	pr	pr	c	c	c	fw	fw	pr
3. Cyclotella														pr		pr	pr	pr		pr			sc	sc	fw
4. Cymbella																					pr	pr			
5. Encyonema				pr																pr		pr			
6. Fragilaria																		pr		pr		pr	fw	sc	sc
7. Melosira	ab	ab	ab	ab	ab	ab	ab	ab	c	pr		pr	pr	pr	pr			pr	pr	pr	c	fw	fw	sc	sc
8. Navicula											fw														
9. Stephanodiscus	c	c	c	ab	c	ab	ab	ab	fw	c	c	fw	fw	pr	pr	pr	pr	sc	sc	c	c	c	sc	pr	pr
10. Synedra pulchella	ab	ab	ab	ab	ab	ab	ab	ab	c		fw	fw	pr		pr			pr	pr	pr	sc	fw	fw	fw	pr
11. " ulna	c	fw	c	c	fw	fw	fw	fw	pr	fw		fw	pr	pr	fw	sc	sc	fw	fw	fw	fw	fw	fw	fw	pr
12. Tabellaria fenestrata			pr		pr			pr	pr		fw	fw		pr	pr				fw	fw	fw	fw	sc	pr	pr
13. " flocculosa											fw	fw	pr		pr				pr	pr	pr	pr	sc	pr	fw
CHLOROPHYCEÆ.																									
1. Arthrodesmus																									
2. Botryococcus																									
3. Cerasterias																									
4. Cladophora																									
5. Closterium								pr			pr	pr		pr											
6. Cœlastrum	pr	pr		pr																					

	November 7.	November 14.	November 21.	November 28.	December 5.	December 12.	December 19.	December 26.	January 2.	January 9.	January 16.	January 23.	January 30.	February 6.	February 13.	February 20.	February 27.	March 6.	March 13.	March 20.	March 27.	April 3.	April 10.	April 17.	April 24.
7. Cosmarium		pr	pr			pr	pr		pr	pr															
8. Dictyosphærium	sc	fw	fw	fw	fw	c	fw	fw	pr	pr	fw		pr												
9. Dimorphococcus																									
10. Eudorina																									
11. Glœocystis																							pr	pr	pr
12. Micrasterias		pr		pr																					
13. Nephrocytium																							pr		pr
14. Pandorina	sc	sc	pr	pr																					
15. Pediastrum boryanum	pr	pr								pr	pr											pr			
16. " duplex	pr	pr	pr	pr			pr	pr					pr												
17. Pleurotæniopsis																									
18. Protococcus						pr												pr							
19. Raphidium polymorphum var. aciculare					pr				pr	pr	pr		pr					pr	pr						
20. Raphidium polymorphum var. falcatum	pr	pr	pr	pr	sc	pr	pr	fw	fw	fw	fw	c			pr	fw	c	c	c	c	c	fw	fw	c	fw
21. Raphidium polymorphum var. sigmoidea						pr	pr	pr	fw	fw	fw	fw	fw	pr			fw	c	c	c	c	c	c	fw	pr
22. Scenedesmus bijugatus																									
23. " quadricauda	ab	ab	ab	ab	ab	ab	ab	fw	pr	pr	c	c	sc	sc	sc	sc	sc	fw	c	c	c	c	c	c	fw
24. " obliquus	pr																								
25. Spirogyra	pr																								
26. Staurastrum crenulatum		pr		pr																					
27. " minneapoliense	pr																pr				pr				
28. " paradoxum																							pr		
29. " sebaldi	pr			pr																					
30. Stigeoclonium																									
31. Tetraspora																									
32. Volvox globata	pr	pr																		pr	pr	pr			
PERIDINEÆ.																									
1. Peridinium																		pr	pr		pr	sc	sc	sc	c
2. Ceratium tripos	pr	pr		pr	pr																				

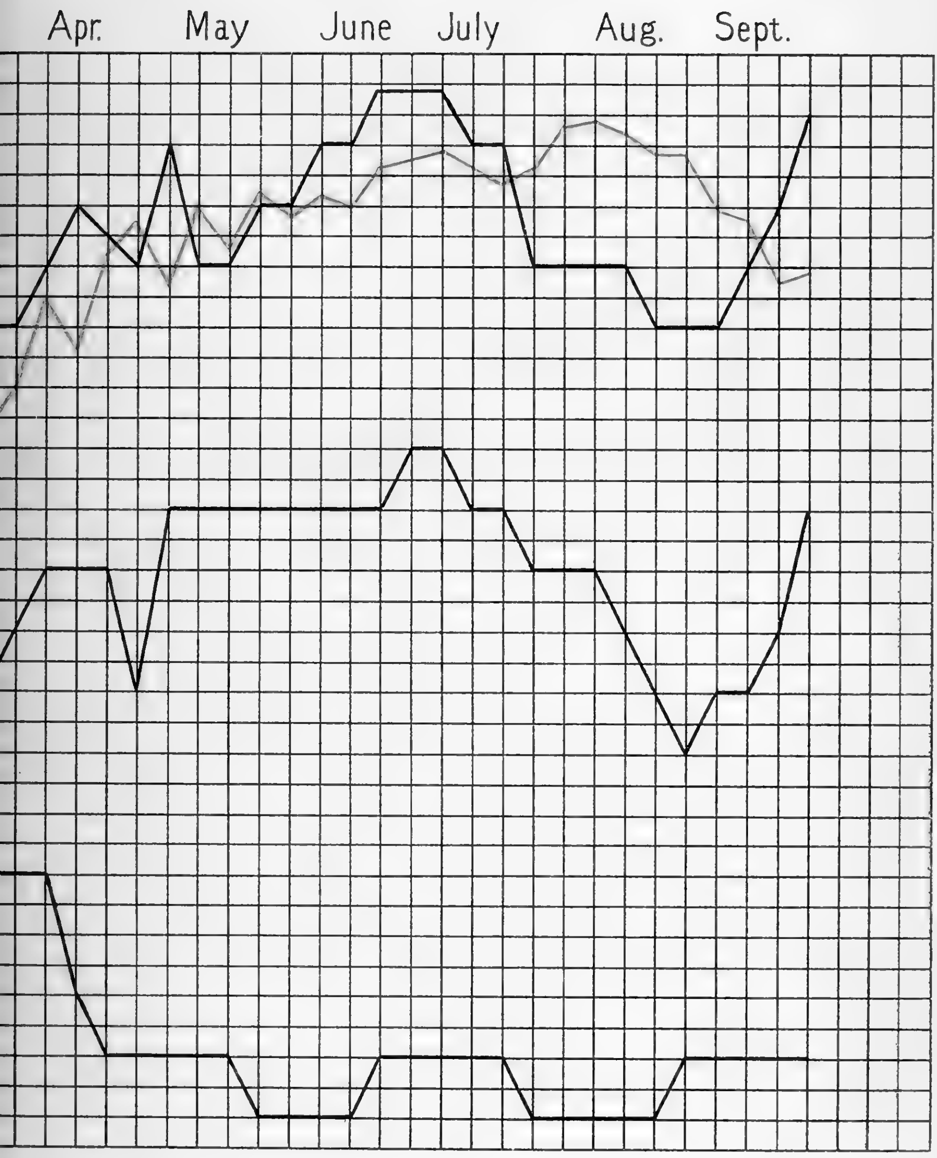
	May 1.	May 8.	May 15.	May 22.	May 29.	June 5.	June 12.	June 19.	June 26.	July 3.	July 10.	July 17.	July 24.	July 31.	August 7.	August 14.	August 21.	August 28.	September 4.	September 11.	September 18.	September 25.	October 2.	October 9.	October 16.	October 23.	October 30.
CYANOPHYCEÆ.																											
1. Anacystis	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	pr	. .	. .	pr	. .	. .	. .	. .
2. Anabæna	. .	. .	. .	. .	. .	. .	. .	. .	pr	pr	pr	pr	pr	. .	pr	sc	sc	fw	pr	. .	. .	. .	. .	. .	. .	pr	pr
3. Chroococcus	. .	pr	pr	pr	pr	pr	. .	. .	pr	pr	pr	pr	pr	. .	sc	sc	fw	fw	fw	pr	. .	. .	. .	. .	. .	. .	. .
4. Clathrocystis	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	pr	. .	pr	pr	fw	fw	fw	fw	fw	fw	fw	sc	pr	pr	pr
5. Cœlosphærium	c	sc	fw	fw	c	c	c	c	c	c	c	c	fw	. .	c	c	fw	c	c	ab	ab	ab	ab	ab	ab	ab	ab
6. Glœotrichia	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .
7. Lyngbya	. .	pr	pr	pr	pr	pr	fw	sc	sc	fw	sc	pr	pr	. .	sc	sc	fw	fw	fw	ab	c	sc	pr	pr	pr	. .	. .
8. Merismopedia	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	pr	pr	. .	pr	pr	. .	pr	pr	sc	. .	. .	. .
9. Nostoc	. .	. .	. .	. .	. .	. .	. .	pr	sc	fw	fw	fw	sc	. .	sc	fw	fw	fw	fw	fw	sc	sc	c	c	sc	sc	sc
10. Oscillatoria	c	fw	pr	. .	. .	. .	pr	. .	pr	pr	. .	pr	pr	. .	. .	pr	pr	pr	pr	sc	sc	sc	c	c	sc	sc	sc
11. Phormidium	. .	. .	. .	. .	. .	pr	. .	. .	. .	pr	. .	pr	. .	. .	. .	. .	. .	. .	. .	pr	pr	pr	. .	. .	. .	. .	. .
DIATOMEÆ.																											
1. Amphora	. .	. .	. .	. .	. .	. .	. .	. .	. .	pr	pr	. .	. .	. .	. .	. .	pr	. .	. .	pr	. .	. .	. .	. .	pr	. .	. .
2. Asterionella	fw	fw	fw	fw	sc	. .	pr	pr	. .	. .	. .	pr	pr	. .	. .	. .	. .	. .	. .	pr	pr	pr	. .	pr	sc	fw	. .
3. Cyclotella	sc	c	sc	c	ab	ab	. .	c	c	pr	pr	pr	pr	. .	pr	. .	pr	. .	. .	pr	. .	. .	. .	. .	. .	. .	. .
4. Cymbella	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	pr	. .	. .	. .	. .
5. Encyonema	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .
6. Fragilaria	. .	. .	fw	fw	pr	. .	. .	. .	pr	pr	pr	pr	pr	. .	. .	. .	. .	. .	. .	. .	. .	pr	. .	. .	pr	. .	. .
7. Melosira	c	sc	sc	fw	fw	c	c	ab	ab	ab	c	c	sc	. .	sc	sc	pr	pr	pr	sc	fw	c	. .	ab	ab	ab	ab
8. Navicula	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	pr	. .	pr	. .	. .	. .	. .	. .	. .	. .	. .	. .
9. Stephanodiscus	pr	pr	pr	. .	. .	. .	. .	pr	pr	pr	pr	pr	. .	. .	. .	. .	. .	pr	pr	pr	pr	pr	pr	pr	pr	pr	pr
10. Synedra pulchella	c	c	c	c	c	sc	c	c	ab	ab	c	c	fw	. .	fw	sc	pr	. .	pr	pr	sc	c	ab	ab	ab	ab	ab
11. Synedra ulna	pr	fw	fw	fw	fw	pr	. .	pr	pr	pr	fw	fw	sc	. .	pr	pr	pr	pr	. .	pr	pr	pr	pr	fw	fw	fw	fw
12. Tabellaria fenestrata	ab	ab	ab	ab	ab	ab	ab	ab	ab	c	c	c	c	. .	sc	pr	pr	pr	. .	. .	. .	. .	. .	pr	pr	. .	. .
13. Tabellaria flocculosa	fw	fw	fw	sc	sc	pr	pr	pr	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .
CHLOROPHYCEÆ.																											
1. Arthrodesmus	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	pr	. .	. .	pr	. .
2. Botryococcus	pr	pr	pr	pr	pr	pr	pr	pr	pr	pr	pr	pr	pr	. .	pr	. .	. .	. .	pr	pr	pr	pr	. .	. .	. .	. .	. .
3. Cerasterias	pr	. .	. .	. .	. .	. .	. .	. .	. .	pr	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .
4. Cladophora	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .
5 Closterium	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	pr	pr	. .	. .	. .
6. Cœlastrum	pr	fw	. .	. .	. .	pr	pr	pr	pr	pr	pr	pr	pr	. .	pr	pr	fw	sc	sc	fw	fw	fw	sc	pr	pr	pr	. .

	May 1.	May 8.	May 15.	May 22.	May 29.	June 5.	June 12.	June 19.	June 26.	July 3.	July 10.	July 17.	July 24.	July 31.	August 7.	August 14.	August 21.	August 28.	September 4.	September 11.	September 18.	September 25.	October 2.	October 9.	October 16.	October 23.	October 30.
7. Cosmarium	pr	pr	pr	sc	sc	pr	pr	pr															pr				
8. Dictyosphærium			pr	pr	pr	fw	sc	sc	sc	sc	fw	fw	fw		sc	sc	pr	pr			pr	fw	fw	sc	sc		
9. Dimorphococcus						pr											pr										
10. Eudorina			pr	pr	pr	pr	fw						pr		pr		pr	pr		pr	pr	pr	fw	fw	pr		
11. Glœocystis					pr	pr	fw						pr				pr	pr	pr	pr	pr						
12. Micrasterias.																							pr	pr	pr		
13. Nephrocytium.	pr	pr	pr		pr	pr	pr	pr	pr				pr					pr									
14. Pandorina						pr	pr		pr	fw	fw	fw	sc		pr	fw	fw	sc			pr	pr				pr	
15. Pediastrum boryanum.	sc	sc	sc		pr	pr	pr	pr	pr	pr		pr	pr		pr	pr					pr	pr		pr			
16. " duplex					pr	fw	fw	pr	pr	pr							pr							pr			
17. Pleurotæniopsis.																											
18. Protococcus.			pr	pr	pr	pr		pr	pr						pr									pr	pr		
19. Raphidium polymorphum var. aciculare.	pr					pr																					
20. Raphidium polymorphum var. falcatum	fw	pr	• pr					sc	sc	sc	pr	sc					pr	pr						pr			
21. Raphidium polymorphum var. sigmoidea																											
22. Scenedesmus bijugatus						pr													pr				pr				
23. " quadricauda	sc	pr	pr	pr		pr	pr	sc	sc	pr	pr	sc	fw		sc	pr		pr	pr		pr	pr			sc	sc	pr
24. " obliquus.																											
25. Spirogyra						pr										pr											
26. Staurastrum crenulatum.																											
27. " minneapoliense																											
28. " paradoxum.		pr			pr														pr	pr	pr			pr	pr		
29. " sebaldi.																				pr							
30. Stigeoclonium					pr																						
31. Tetraspora																		pr		pr	pr						
32. Volvox globata																											
PERIDINEÆ.																											
1. Peridinium	c	sc	fw	fw	fw	fw	pr	pr	pr		pr	sc	fw		fw	fw	c	c	ab	sc	sc	pr		pr			
2. Ceratium tripos	pr	pr	pr	pr	pr	pr	pr		pr				pr		fw	fw	sc	sc	sc	sc	pr	pr	pr		pr		



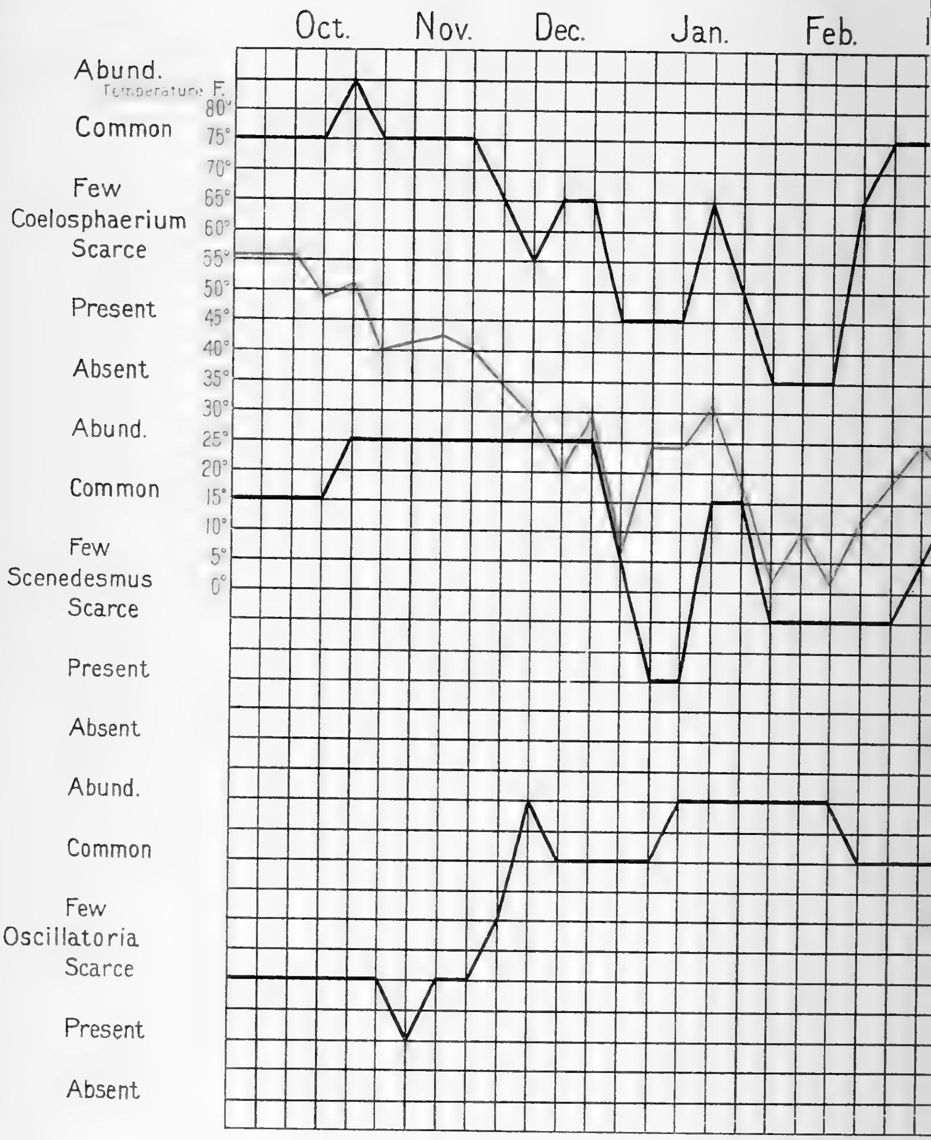
PLAT

THE HELIOTYPE P



EL III.

CO., BOSTON.



PLAT

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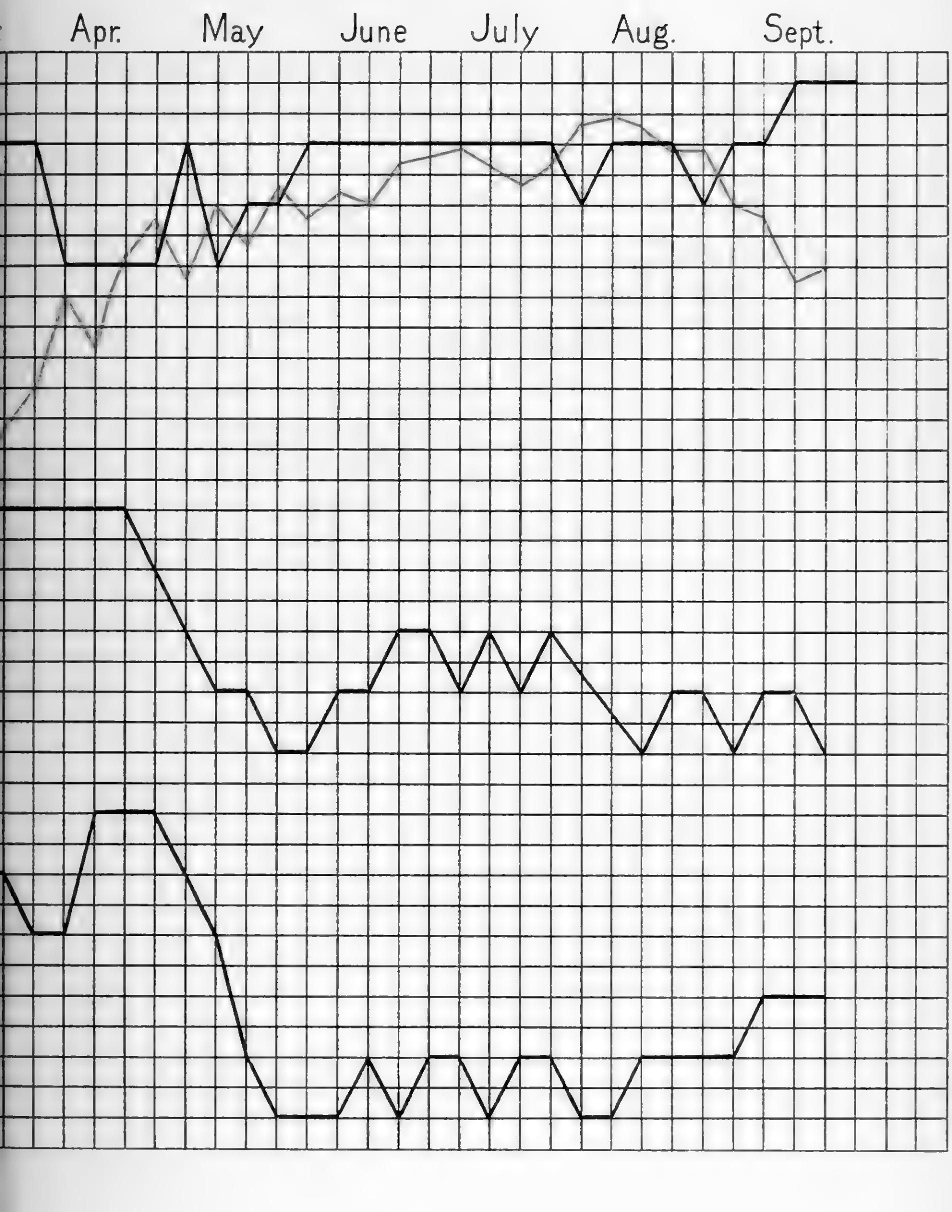

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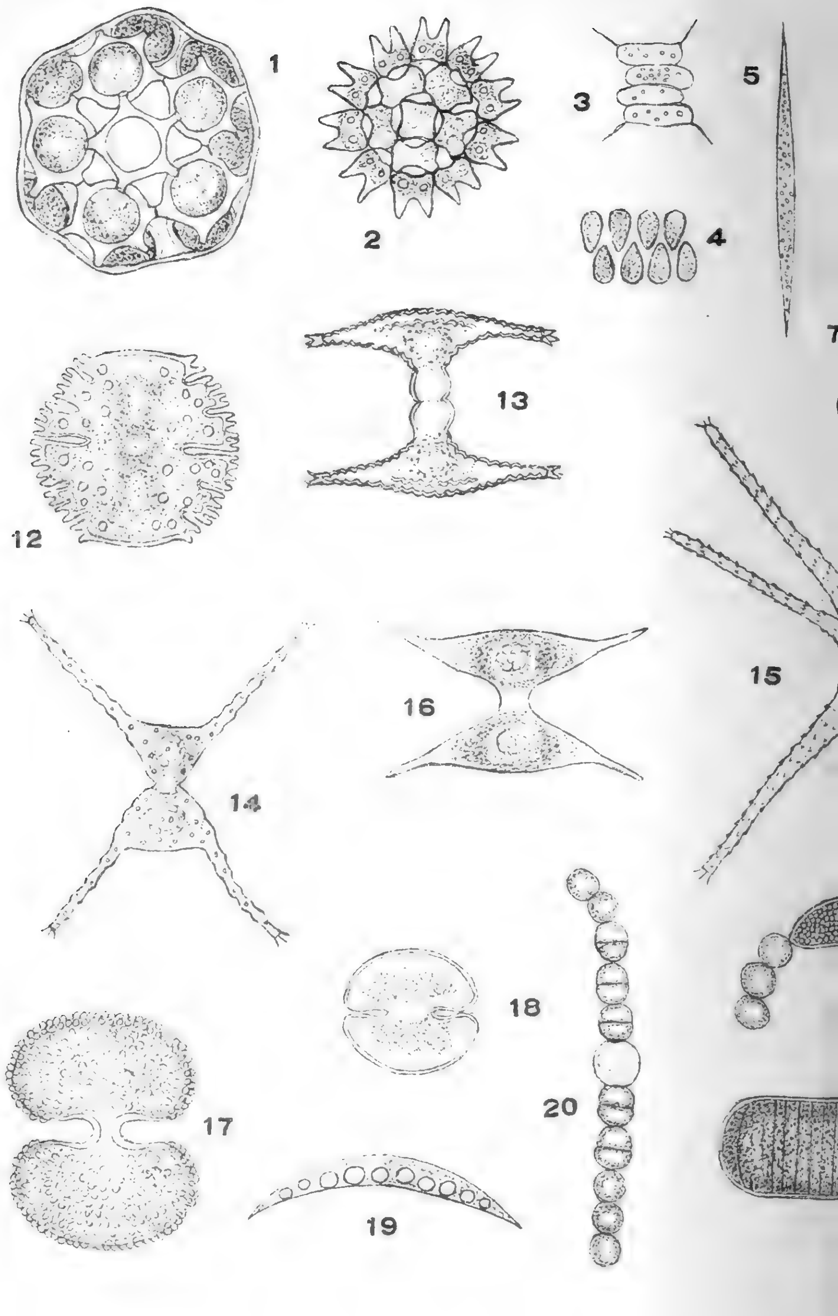

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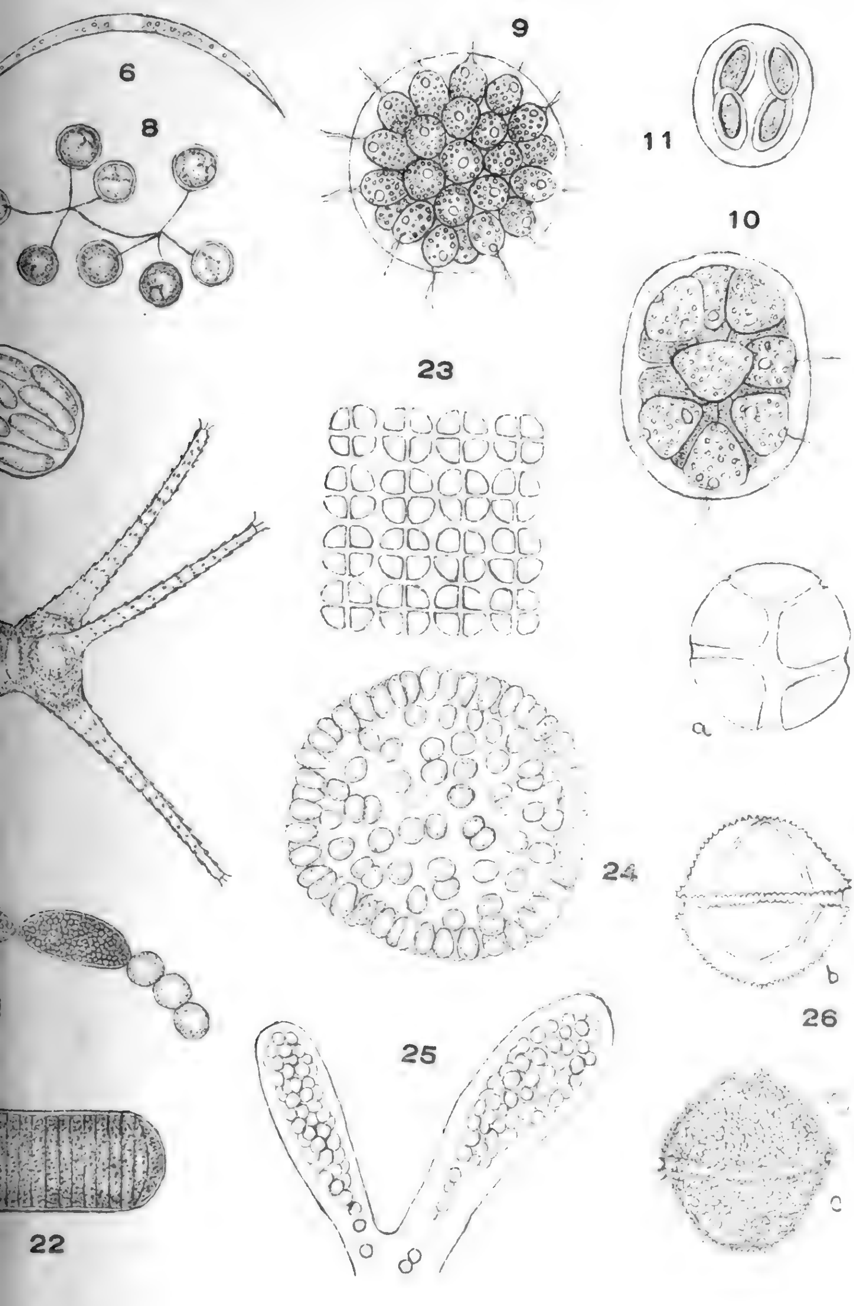

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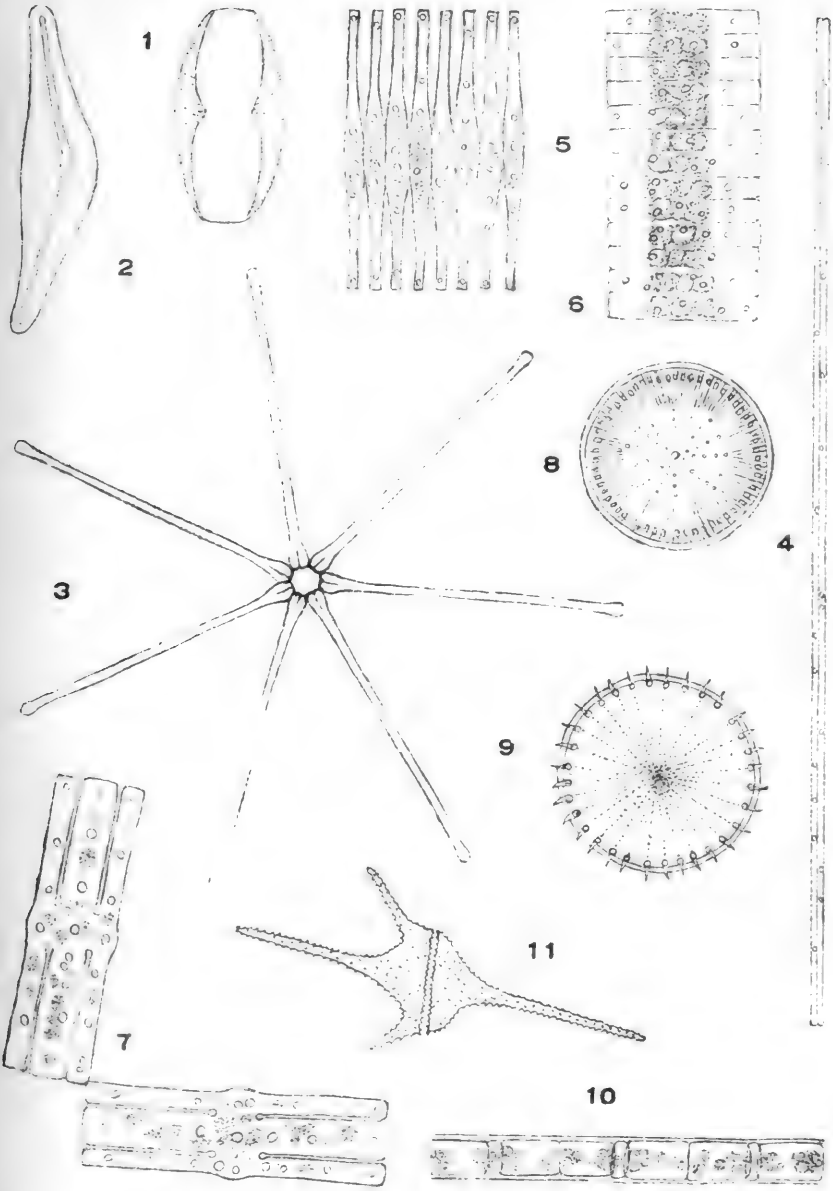

PLATE XLVI.

THE HELIOTYPE PRINTING CO., BOSTON.

XXXV. NOTES ON SOME PLANTS OF ISLE ROYALE.

W. A. WHEELER.

During August, 1900, I spent about two weeks at Tobin Harbor on the eastern end of Isle Royale, Mich. At this time I made a collection of plants numbering about 150 species, of which the following seem to be worthy of note.

Botrychium lunaria (L.) SW. Schrad. Journ. Bot. **2**: 110. 1800.
Rare in moist woods and thickets.

Botrychium virginianum (L.) SW. Schrad. Journ. Bot. **2**: 111. 1800.
Prothallia and young sporophytes were collected in a thicket near the shore of the lake on Aug. 30. Previous collections of the prothallia of this species have been made only by Professor Douglas H. Campbell at Grosse Isle, Michigan, in 1893 and by Professor E. C. Jeffrey at Little Metis, Quebec, Canada, in 1895.

Woodsia ilvensis (L.) R. BR. Trans. Linn. Soc. **11**: 173. 1812.
Very common on exposed rocks along the lake shore.

Dryopteris fragrans (L.) SCHOTT, Gen. Fil. 1834.
Common on exposed rocks with *Woodsia ilvensis*.

Cryptogramme acrostichoides R. BR. App. Franklin's Journ. 767. 1823.
Infrequent on rocks. This is probably one of the rarest ferns of the Great Lake region.

Lycopodium selago L. Sp. Pl. 1102. 1753.
Frequent on rocks near the shore.

Selaginella selaginoides (L.) LINK, Fil. Hort. Berol. 158. 1841.
Frequent on moist, shaded rocks near the water's edge on the shore of the harbor.

Calamagrostis langsdorfii (LINK.) TRIN. Unifl. 225. 1824.

Previously collected from Isle Royale in 1865 by T. C. Porter. This may be the collection reported in Beal & Wheeler's Flora of Michigan as *C. lapponica* Trin.

Carex abacta BAILEY, Bull. Torr. Club, **20**: 427. 1893.

Carex limosa L. Sp. Pl. 977. 1753.

Juncus articulatus L. Sp. Pl. 327. 1753.

Sagina nodosa (L.) FENZL, Verbr. Alsin. 18. 1833.

Infrequent on moist rocks.

Sisymbrium humile MEYER, in Ledeb. Fl. Alt. **3**: 137. 1831.

Rare on rocks.

Echinopanax horridum (SMITH) DEC. & PLANCH. Rev. Hortic. 105. 1854.

The occurrence of this plant in a locality so far removed from what had been considered its native home is certainly remarkable. No collections of it have been reported farther east than the Rocky Mountains of Montana and British Columbia. On Isle Royale it occurs on the rocky cliffs at two places near Tobin's Harbor, *i. e.*, Passage Island and Black's Point and has the appearance of being indigenous.

Gentiana rubricaulis SCHWEIN, in Keating's Narr. Long's Exp. **2**: 384. 1824.

Frequent in moist open places and on protected rocks.

Castilleja acuminata (PURSH) SPRENG. Syst. **2**: 775. 1825.

Euphrasia americana WETTST. Mon. Euph. 127. 1896.

Aster lindleyanus T. & G. Fl. N. A. **2**: 122. 1841.

Erigeron acris droebachianus (O. F. MUELLER) BLYTT. Norg. Fl. **1**: 562. 1861.

Senecio discoideus (HOOK.) BRITTON, in Britton & Brown, Ill. Fl. **3**: 479. 1898.

XXXVI. REVEGETATION OF TRESTLE ISLAND.

D. LANGE.

The piece of land I have named Trestle island lies in the southwest part of Lake Phalen, near St. Paul, Minnesota. The island consists of an East and a West section separated from each other by a twenty-five foot embankment of the St. Paul & Duluth Railroad.

THE SEASON OF 1898.

Up to the spring of 1898, the road maintained a trestle over the shallow southeast bay of Lake Phalen in place of the present embankment. When the trestle was filled in between April 10, and June 1, 1898, the gradually increasing weight of the dumped material caused the soft lake bottom marl which, according to the statement of the road's engineer, is from 6 to 35 feet thick, to slip out laterally; and with many folds, wrinkles and fissures it rose from a few inches to ten feet above low water level of the lake. Although the engineer in charge tried to prevent the slipping of the marl by means of pontoons, the movement did not cease until about 2500 square yards of lake bottom had risen and become dry land. Of this land about 1500 square yards rose east of the track out of 6 inches to 3 feet of water, and will be called the East section in this paper, the other 1000 square yards rose West of the track out of 3 to 5 feet of water and will be referred to as the West section. Both sections have been under the writer's observation from April 1898, to October 15, 1900, and it is intended to show in this paper the most marked changes in the vegetation of Trestle island.

Early in June, 1898, both sections presented a curious system of curved ridges and crevices running generally parallel to one another and looking like miniature mountain ridges, valleys, and gaping faults; and even small lakes with snails and other aquatic creatures were to be seen. Many of the crevices were over two feet deep and while the opposite walls approached each other below, the gap at the surface was in many cases eight inches wide. The West section was an expanse of mud ridges entirely bare of vegetation, and was at first too soft to admit of a man passing over it; the East section, however, having risen out of shallower water and partly out of a marsh, exhibited specimens of yellow pond lilies (*Nymphea advena*), cattails, water plantain, and common rush lifted out of the water and struggling under adverse conditions.

In the early part of July, 1898, the East section looked already green from the distance. The aquatic plants just mentioned still lived, but showed the effects of changed conditions. The leaves of *Nymphea advena*, for instance, were all very short-petioled, and were below normal size, appeared more or less brownish and the younger ones were rolled from both margins inward and upward. On the other hand, the number of true land plants growing vigorously was already bewildering and although most of them were still too young for a reliable indentification, the following were found in bloom about July 5, 1898;*

1. White clover (*Trifolium repens*).
2. Red clover (*Trifolium pratense*).
3. Wild mustard (*Brassica nigra*).
4. Peppergrass sp.
5. Mayweed (*Anthemis cotula*).
6. Crucifer sp.
7. Black nightshade (*Solanum nigrum*).
8. Mustard sp.
9. *Polygonum* sp.
10. Timothy grass (*Phleum pratense*).
11. Grass sp.
12. Kentucky bluegrass (*Poa pratensis*), out of bloom.

The southern part of this section was covered with a compact layer of fine silt from the railroad embankment and on this firm soil little else but young mosses were growing. Scattered over the higher part of the whole section were young cottonwoods and willows.

The most interesting plants found, however, were the prothallia of horsetails, probably of *Equisetum arvense*, as that

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* The botanical nomenclature of this paper follows the "Illustrated Flora" of Britton and Brown.

species is very common along the railroad track south of the island. These prothallia were little green clumps from ⅛ to ¼ of an inch in diameter and grew mostly on the walls of the shaded mud cracks. From many of them one or more thin young horsetails were protruding. Although I carefully searched the cracks for these prothallia in the springs of 1899 and 1900, I did not again find a single specimen. In 1898 they were abundant on both sections of the island, but they did not grow on the marl, but only on silt and in silt cracks. This silt consisted of a brownish clay and of very fine quartz sand, making a compact damp soil.

The West section was still quite bare early in July, 1898. The creviced marl ridges had dried in the sun and exhibited white streaks like limestone. These little crags and points were bare, but in shaded and sheltered depressions mosses covered much of the damp marl; and small cottonwoods, aspens and willows were scattered over the whole West section.

About September 10th the aspect of both sections had changed, but most markedly that of the East section, which was a veritable wilderness of weeds. Its lower portion was covered with wild rice, over six feet high. Under the rice and also on the higher ground water hoarhound (*Lycopus americanus*), skullcap (*Scutellaria laterifolia*) and American wild mint (*Mentha canadensis*) formed dense tangles and grew with a luxuriance I had never seen before. There were present in great confusion nearly all the plants mentioned in the count of August 16, 1899, and a few not found at that day. In this weeds' paradise the young willows could be seen, but they were not at all conspicuous. No bare ground was now visible on this section, but in walking through the weeds, one could not avoid frequent stumbling into the cracks. The West section at this time presented the appearance of a loose growth of young cottonwoods, aspens and willows, with the cottonwoods most and the willows least conspicuous, but much bare soil could still be seen even from a distance.

On both sections all the young trees remained green and continued to grow until late in the fall. On October 22d they were still green but had evidently ceased growing on account of the cool weather that had prevailed since the third of the month. Of the East section my notes for October 22d say: "A great wilderness of dead weeds."

THE SEASON OF 1899.

Although Trestle island was visited during the winter of 1898–99 and was also observed during the spring and early summer of 1899, I shall at once proceed to a midsummer sketch of it, as it appeared from August 14 to 16, 1899.

Compared with the preceding season, the West section had this time changed most rapidly and radically. The mud flat of fourteen months ago was now a thicket of young peach-leaved willows (*Salix amygdaloides*). The cottonwoods (*Populus deltoides*) and the aspens (*Populus tremuloides*) so conspicuous last year were now hidden by the willows, which had grown so large that a herd of cattle or horses would have been completely concealed. Although the high railroad embankment was not more than forty feet from the spot where I wrote up my notes, I could only get glimpses of it along the sky line. Within fourteen months there had grown from the tiny, wind-carried willow seeds a thicket of trees that were large enough to completely shade my paper and exclude the southwest breeze, while two of the young trees were stout enough to afford me a secure and comfortable back rest. One of them, by actual measurement, was 11 feet 3 inches high and had a diameter of 1¼ inches at a distance of four inches above the ground. All the larger trees of this species were approximately of that size and showed a growth of about five feet for the season. A few of the cottonwoods not standing very close to any *Salix amygdaloides* were about as tall, but not as thick as the *Salix*, while the aspens and three or four other species of willow were much smaller and showed only a growth of about three feet for the season. It was clear that the peach-leaved willow would be the dominant plant on this section. It has clearly won the battle against the cottonwoods; and other trees and herbs will occupy a subordinate position. The West section is a willow island.

Lack of space forbids to enlarge upon the herbs and grasses on this section, but it should be mentioned that a fringe of cattails (*Typha latifolia*) and arrowheads (*Sagittaria latifolia*) is forming on the lake side of the West section. These plants grow there in 6 to 12 inches of water, where the whitish marl was not raised above low water level although it was elevated considerably.

The East Section from August 14 to 16, 1899.—The great diversity of plant life on this section already referred to continued for this season. In this diversity and in the comparative paucity of trees it presented a striking contrast to the West section, where all true land herbs struggled under the over-shadowing trees.

On the East section, peach-leaved willows dominated the south corner. A crescent, which under the effect of higher water, formed last year a dense rice marsh, with a thick tangled undergrowth of water hoarhound and mad-dog skullcap is now a meadow of tangled rice cut-grass (*Homolocenchrus oryzoides*). The remainder of the section is covered by a very much mixed vegetation, amongst which peach-leaved willows, slender pink persicaria, giant sunflower, a few specimens of wild rice, and cattail are most conspicuous although not most numerous.

The most notable changes, besides the one of the rice marsh to a cut-grass meadow, are the complete disappearance of water-lilies, wild rice, and common rush from the higher ground, the appearance of slender pink persicaria on well-marked areas, and the establishment of willow domination in the south corner.

Not a hand's breadth of bare soil is any longer visible on either section, except in deep crevices. To show clearly the distribution of plant life on this section in midsummer of 1899, I give here the result of a count made on August 16, 1899.

I. Plants established in large numbers and forming the bulk of the vegetation.

1. Peach-leaved willow (*Salix amygdaloides*). In the south corner.

2. Rice cut-grass (*Homolocenchrus oryzoides*). On an east crescent.

3. Slender pink persicaria (*Polygonum incarnatum*). In well-defined patches.

4. Mad-dog skullcap (*Scutellaria laterifolia*). General under the taller plants.

5. Cut-leaved water hoarhound (*Lycopus americanus*). General under taller plants.

6. American wild mint (*Mentha canadensis*). General under taller plants.

7. Common ragweed (*Ambrosia artemisiæfolia*). On highest ridges, where common rush grew in '98.

8. Horseweed (*Leptilon canadense*). On the higher ridges, where common rush grew in '98.

II. Aquatics, marsh plants and cryptogams which were still struggling along in a few spots. July of this year, the most important month of growth for annual and perennial herbs in this region was unusually dry, showing a monthly deficiency in precipitation of 1.75 inches.* This condition was unfavorable for aquatics and marsh plants, but favorable for such plants as horseweeds and common ragweeds.

1. Wild rice (*Zizania aquatica*).
2. Water plantain (*Alisma plantago-aquatica*).
3. Common rush (*Juncus effusus*).
4. Broad-leaved cattail (*Typha latifolia*).
5. Tuberous white water lily (*Castalia tuberosa*). Identified from leaves only.
6. Large yellow pondlily (*Nymphea advena*). Leaves only, a flower bud found an inch deep in wet soil.
7. Horsetails; mosses, amongst them *Funaria hygrometrica;* liverworts, with *Marchantia polymorpha* fairly common.

III. Plants of which only a few scattered specimens were found.

1. Slender nettle (*Urtica gracilis*).
2. Swamp milkweed (*Asclepias incarnata*).
3. Smooth bur-marigold (*Bidens lævis*).
4. Marsh skullcap (*Scutellaria galericulata*).
5. Blue vervain (*Verbena hastata*).
6. White vervain (*Verbena urticifolia*).
7. Beggarticks (*Bidens frondosa*).
8. Aster-like boltonia (*Boltonia asteroides*).
9. Rough cinquefoil (*Potentilla monspeliensis*).
10. Great ragweed (*Ambrosia trifida*).
11. American cocklebur (*Xanthium canadense*).
12. Prickly lettuce (*Lactuca scariola*).
13. *Lactuca* sp.
14. Heart-leaved willow (*Salix cordata*).
15. *Salix* sp.
16. Cottonwood (*Populus deltoides*).
17. American aspen (*Populus tremuloides*).
18. Sullivant's milkweed (*Asclepias sullivantii*). Identified from leaves only.

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*The rainfall data of this paper are taken from the Monthly Meteorological Summary of the United States Weather Bureau for St. Paul, Minn.

19. Water pepper (*Polygonum hydropiper*).
20. Climbing false buckwheat (*Polygonum scandens*).
21. Lamb's quarter (*Chenopodium* sp.).
22. Dock (*Rumex* sp.).
23. Giant sunflower (*Helianthus giganteus*).
24. Black-eyed Susan (*Rudbeckia hirta*).
25. Common thoroughwort (*Eupatorium perfoliatum*).
26. Late goldenrod (*Solidago serotina*).
27. Canada goldenrod (*Solidago canadensis*).
28. Prairie mugwort (*Artemisia gnaphaloides*).
29. Bushy aster (*Aster dumosus*). Identified from leaves only.
30. Red clover (*Trifolium pratense*).
31. Peppergrass (*Lepidium* sp.).
32. Tall sisymbrium (*Sisymbrium altissimum*).
33. Black mustard (*Brassica nigra*).
34. Black nightshade (*Solanum nigrum*).
35. Bristly buttercup (*Ranunculus pennsylvanicus*).
36. Swamp willow-herb (*Epilobium palustre*).
37. Common evening primrose (*Onagra biennis*).
38. Canada thistle (*Carduus arvensis*).
39. Common thistle (*Carduus lanceolatus*).
40. Water hemlock (*Cicuta maculata*).
41. Nodding wild rye (*Elymus canadensis*).
42. Squirrel-tail grass (*Hordeum jubatum*).
43. Grass sp.
44. Grass sp.
45. Grass sp.
46. Grass sp.
47. Sedge (*Cyperus* sp.).

THE SEASON OF 1900.

The last half of October, 1899, was quite dry and at the end of the month the United States Weather Bureau reported an accumulated deficiency in precipitation since January first of .73 inch. On some day between October 29 and November 4, 1899, a prominent factor in plant distribution appeared on the East section of Trestle island. Fire changed the wilderness of dead, dry weeds into a black, ashy waste.

On May 6, 1900, the East section looked, on the whole, still barren and black. All the over-ground parts of the young trees that had grown scattered amongst the weeds were found to have been fire-killed, but about one-half of their number had grown out again near the ground. The larger ones in the south corner had not been killed, because there the weeds had not grown as thick.

Patches of the perennials, *Elymus canadensis* and a few other grasses, as well as goldenrods, sunflowers and nettle were coming out vigorously. The rice cut-grass, however, although it seems to be perennial, had a very poor start. On close examination numerous seedlings of annuals were found, but all looked brownish and sickly on account of the dry weather and the glaring sunlight. Although most of them were not readily identified, I recognized the following without difficulty:

1. *Polygonum* sp.
2. *Mentha* sp.
3. *Carduus lanceolatus*, the seedlings of which looked quite green and vigorous.
4. *Lactuca* sp.
5. *Brassica nigra*.
6. *Chenopodium* sp.

The spring and summer of 1899 were excessively dry in this region so that, since January 1st a continued accumulated deficiency of rain of over 4 inches was reported from May 31st to August 31st. About June 10th another new factor, one that is able to destroy all plant life not perennial or not armed in some way, appeared on the scene—*cattle*, a large herd of hungry dairy cows. In their search for green grass they had passed over the dried-up marsh and along at the foot of the embankment and had discovered the East section of Trestle island.

In the end, however, bovine instinct for plant selection proved of some interest, for, when after an absence of over two months, I visited the place again about Sept. 10th, there was a closely cropped, rough, much trampled piece of pasture. Where a year ago about 60 different plants had grown in wild exuberance, only about 40 cropped and crippled trampled species were to be found* and only a single one of these bloomed and flourished in large numbers, the formidable armed thistle, *Carduus*

* About 30 species of the list of August 16, 1899, had survived fire and cattle and about 10 species were found that do not appear on the list of August 16, 1899.

lanceolata. It has occupied nearly one third of the section and next summer, I think, the thistle will keep the cows off the grass, and as the West section is a willow island, the East section will be a thistle island.

During September, 1900, there was over 5 inches of rain and now water once more surrounds the East section and the cows have not been there since about October 1st.

The West Section in the Season of 1900.—The lake has risen about two feet since September 15th this year and the south half of the section is under water. Fire and cattle have thus far never invaded this section. The willows are thriving. There are probably five species of them, but *Salix amygdaloides* forms the thicket. There are a few thrifty cottonwoods, and aspens, one balsam poplar, and one slippery elm, *Ulmus fulva.* Although sumac, hazel, box-elder, silver maple, wild haw, flowering dogwood and three species of oak grow within half a mile and most of them within a stone's throw of the island, not one individual of all these has been found on either section of Trestle island.

Last spring several of the willow species, when they were only about 24 months old, bloomed for the first time and produced fruit. A count on May 11th revealed 38 staminate individuals and 27 pistillate individuals of *Salix amygdaloides* in flower. The count was then made to include older trees of the same species along the cycle path near the island and of a total of 135 trees counted 74 bore male and 61 bore female flowers. Although a number of the trees were measured last year, only a few recent measurements of October 12, 1900, can be given here.

Number.	Diameter at 4 inches above the ground.	Height measured along the stem.	Growth of this season.
1. *Salix amgydaloides.*	3 inches	15 ft. 2 in.	7 ft. 2 in.
2. *Salix amygdaloides.*	3 "	16 ft. 10 in.	Uncertain.
3. *Salix amygdaloides,*	2½ "	18 ft.	7 ft. 3½ in.
4. *Populus deltoides.*	1½ "	14 ft. 3½ in.	6 ft. 9½ in.
5. *Populus deltoides.*	1¼ "	15 ft. 9 in.	6 ft. 6 in.
6. *Populus tremuloides.*	1 "	10 ft. 7 in.	4 ft. 2 in.
7. *Ulmus fulva.*	½ "	4 ft. 8 in.	2 ft. 9 in.

There are many willows on this section of the size of those measured, while the two cottonwoods and the aspen measured are the largest that could be found and the elm is the only individual present. The average size of the large vigorous *Salix* *amygdaloides* individuals is about 2½–3 inches in diameter at four inches from the ground, and 16 feet in height. The largest cottonwood, No. 5, shows a horizontal spread of its top of 2½ feet, while a willow (*S. amygdaloides*) near it spreads its branches 8 feet in a horizontal diameter. A number of trees have been marked and their study as well as that of the whole island is being continued. The willows are now so large that for some time a flock of English sparrows regularly roost in them and they seem to prefer the part of the section that is flooded.

Animal Life of the Island.

Did the limits of this paper permit, an interesting chapter might be added under this heading. Crayfish, voles, mice, and muskrats burrow under and in the island, since the summer of 1898, the cottontails resort to it, and in August of 1899 some minks had made their home under the old ties, which once formed the engineer's pontoon. Near the mink's home a song-sparrow had hatched its young on a thistle bush. Some of the young trees on the West section have been infested with the spotted willow aphid, *Melanoxanthus saliciis*,* since the summer of 1899 and their secretions attract swarms of flies and wasps. That the frogs are there is self-evident, but I also captured a fine green tree-frog, and a bunch of prickly caterpillars of the morning-cloak butterfly, *Euvanessa antiopa*, found their table spread on the willows.

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* Identified by Dr. Otto Lugger.

XXXVII. VIOLET RUSTS OF NORTH AMERICA.

J. C. Arthur and E. W. D. Holway.

A rust of violets, in its three forms of æcidium, uredo and teleutospore, is common throughout North America upon nearly all indigenous species of the genus *Viola*. For the most part it belongs to a single species, *Puccinia Violæ* (Schum.) DC., which is also the common violet rust of Europe and of some other regions. This, at least, is the conclusion to which we have arrived after a rather extended study of considerable material. Beside the one common rust there is a peculiar *Æcidium* throughout the eastern part of North America, and one species of *Puccinia* in the western part, both distinctly American.

In this connection we desire to acknowledge the kindness of the New York Botanical Garden, the Botanical Department of the University of Illinois, and of the Iowa State College, in loaning material from their herbaria, and to extend our thanks to their representatives. We wish also to thank Dr. J. J. Davis, of Racine, Wis., and Mr. E. Bartholomew, of Rockport, Kans., for aiding us with specimens and information. We are furthermore grateful to Mr. Stewardson Brown, curator of the herbarium of the Philadelphia Academy of Sciences, for the privilege of examining material in the Schweinitz collection, and to the custodians of the Gray Herbarium of Harvard University and of the New England Botanical Club, from the examination of whose phanerogamic collections of *Viola*, five specimens of rust were obtained in the former instance and three in the latter.

In this article for conciseness we have used in addition to the usual I, II and III for designating the æcidium, uredo and teleutospore stages, the sign O for the spermogonial stage. In citing specimens these signs are put into large type when the stage is present in abundance, and into small type when subordinate and in small amount.

Æcidium pedatatum (Schw.) nom. nov.

Syn.:

1834. *Cæoma* (*Æcidium*) *pedatatum* Schw. Trans. Amer. Phil. Soc. **4**: 293, no. 2885.

1834. *Cæoma* (*Æcidium*) *sagittatum* Schw. Trans. Amer. Phil. Soc. **4**: 293, no. 2886.

1672. *Æcidium Mariæ-Wilsoni* Pk. 24th Rep. N. Y. Mus. for 1870: 92.

1874. *Æcidium Petersii* B. & C. Grev. **3**: 61.

Exsicc.:

Carleton, Ured. Amer. no. 28.

Heterœcious, inhabiting species of *Viola*, and also of some other genus of plants not yet determined.

O. Spermogonia preceding the æcidia.

I. Æcidia hypophyllous, seated on small, pale, circumscribed, unthickened spots; cups usually sub-circinating, small, shallow or short cylindrical, white, border narrow, often much split and somewhat recurved; spores subglobose, in part angular from compression, epispore thin, minutely verrucose, 11 to 18 μ, averaging 14 μ.

Throughout the United States east of the Rocky mountains, from March to June on the blades of various species of violets, and less often on the petioles, pedicels and calyx. Specimens have been examined as follows:

On *Viola obliqua* Hill. Pennsylvania (*Schweinitz*), Maine (*Blake*), Indiana (*Arthur*), Illinois (*Seymour*, *Arthur*), Iowa (*Holway*), Kansas (*Bartholomew*, *Carleton*).

On *Viola ovata* Nutt. New Jersey (*Ellis*).

On *Viola sagittata* L. Pennsylvania (*Schweinitz*), Massachusetts (*Asa Gray*).

On *Viola pedata* L. Pennsylvania (*Schweinitz*), Alabama (*Baker*), Iowa (*Holway*).

On *Viola pedatifida* Don. Kansas (*Kellerman*), Iowa *Holway*).

On *Viola primulæfolia* L. District of Columbia (*Greene*), Mississippi (*Tracy*).

On *Viola Nuttallii* Pursh. Kansas (*Bartholomew*).

On *Viola striata* Ait. North Carolina (*Biltmore Herbarium*).

On *Viola tricolor* L. Kansas (*Popenoe*).

The form here described is undoubtedly part of an heterœcious species, having the alternate forms possibly upon carices. It occurs in open woodlands from the last of March to the beginning of June, but is rather infrequent and local. It is distingished from the æcidium of *Puccinia Violæ* by the markedly smaller cups and spores, and by a greater tendency to form small, round groups seated on the mesophyll of the blade, rather than on the midrib or veins. The peridium is usually conspicuously white; the cylindrical elongation noted in the description by Berkeley and Curtis is occasionally to be seen, but must be considered as accidental, depending upon conditions of growth. The same kind of development is met with in other forms of æcidia (see notes on *Æcidium pulcherrimum* Rav. in Bull. Lab. Nat. Hist. of Univ. Iowa **4**: 399–400).

Examination of specimens in the Schweinitz collection at the herbarium of the Philadelphia Academy of Sciences shows that both species which he described as new, occurring on *Viola pedata* and *V. sagittata* respectively, belong here. The name coming first on the page is taken as the authentic name of the species. The Schweinitz specimens on both hosts are ample, but neither shows the æcidia in so characteristic a form as does the specimen in the same collection on *Viola obliqua*, which Schweinitz referred to *Æcidium Violarum*. The last has very small, compactly clustered æcidial cups, in small round groups, while both the former have the cups somewhat larger, and sparsely scattered or solitary. The difference in habit is doubtless due to the influence of the host and the atmospheric conditions affecting the development, in part, combined with the accidental distribution of the infection over the leaf surface.

Spermogonia have not been seen by the writers, but Burrill (Par. Fung. Ill., p. 223) states that they precede the æcidia, although he does not describe them.

Puccinia Violæ (SCHUM.) DC. 1815. Flore Francaise **6**: 62.

SYN.:

1803. *Æcidium Violæ* SCHUM. Fl. Sæll. **2**: 224.
1803. *Uredo Violæ* SCHUM. Fl. Sæll. **2**: 233.
1805. *Æcidium Violarum* DC. Fl. Franc. **2**: 240.
1825. *Puccinia Violarum* LINK. Sp. Plant. **2**: 80.
1875. *Puccinia hastatæ* COOKE, Grev. **3**: 179.
1888. *Puccinia Fergussoni hastatæ* DeT. Sacc. Syll. Fung. **7**: 682.
1897. *Puccinia densa* D. & H. Hedw. **26**: 298.
1898. *Dicæoma Violæ* KUNTZE, Rev. Gen. Pl. **3**: 471.

EXSICC.:

Jaczewski, Komarov, Tranzschel, Fungi Ross. no. 16^{III}.
Ellis and Everhart, N. Am. Fungi, nos. 254^{III}, 1007^{I}, 2411^{III}.
Seymour and Earle, Econ. Fungi, no. 456^{III}.
Thueman, Myc. Univ., no. 430^{I}.
Linhart, Fungi Hung., no. 33^{I}.
Krieger, Fungi Sax., nos. 110^{I}, 111^{III}, 472^{II}, 561^{I}, 562^{II}, 1006^{I}.
Rabenhorst, Fungi Europ., no. 2194^{I}.
Sydow, Mycotheca Marchica, no. 468^{III}.
Sydow, Ured. Exsicc., nos. 33^{III}, 82^{I}, 117^{II}, 286^{II}, 335^{I}, 378^{II}, 640^{I}, 935^{I}, 1136^{III}, 1184^{I}, 1229^{I}.
Shear, N. Y. Fungi, no. 321^{III}.
Vize, Fungi Brit., no. 77^{I}, 112^{III}.

Autæcious, inhabiting species of *Viola*.

O. Spermogonia preceding or accompanying the æcidia, amphigenous, punctate, honey yellow; spores elliptical or nearly globose, 3 to 5 μ broad by 4 to 6.5 μ long.

I. Æcidia hypophyllous and also on petioles, pedicels and calyx, substratum moderately thickened, in indefinite and irregular clusters, often covering nearly the whole leaf, especially noticeable on the veins and stalks, crowded; cups broad and low, rather coarsely lacerate and irregularly recurved; spores subglobose, somewhat angular from compression, minutely verrucose, 14 to 18 μ broad by 15 to 22 μ long (European) or 16 to 20 μ broad by 18 to 26 μ long (American); wall thin.

II. Uredo chiefly hypophyllous; sori at first in small groups on discolored spots, later sparsely and indefinitely scattered, soon naked, cinnamon brown, pulverulent; spores subglobose, echinulate, 17 to 28 μ in diameter, brownish yellow; wall varying from thin to thick; pores four, equatorial.

III. Teleutosori hypophyllous, indefinitely scattered, round, small, soon naked, pulverulent, chocolate brown; spores brown, usually broadly elliptical, less often oblong-ovoid or irregular, slightly or not at all constricted at the septum, smooth, or finely tuberculate especially on the upper half, 15 to 23 μ broad by 21 to 30 μ long (European), or 16 to 26 μ broad by 28 to 44 μ long (American); apex obtuse, somewhat thickened, with a pale and broad apicuous, while a similar projection often occurs on one side of the lower cell near the septum; pedicel hyaline, fragile, not as long as the spore, somewhat deciduous.

Throughout North America, occurring upon nearly every indigenous species of *Viola*. Spermogonia and æcidia from April to

June, uredo and teleuto stage from June to November and later along the Gulf region. Specimens of American origin have been examined as follows:

On *Viola obliqua* HILL. 1879? Newton, Mass. III. (*W. G. Farlow*); 1882, Decorah, Iowa III (*E. W. D. Holway*); 1883, Madison, Wis. I (*L. H. Pammel*); 1885, Oregon, Ill. III (*M. B. Waite*); 1885, Decorah, Iowa, ii. III (*E. W. D. Holway*); 1886, Manhattan, Kans. I and ii. III (*W. A. Kellerman*); 1890, Greencastle, Ind. O. I (*J. C. Arthur*); 1893, Terre Haute, Ind. I (*J. C. Arthur*); 1897, Auburn, Ala. I (*Ala. Biol. Surv.*); 1898, Lafayette, Ind. O. I (*J. C. Arthur*).

On *Viola rotundifolia* MICHX. 1890, Bradley, Me. II (*F. L. Harvey*); 1891, Gunflint lake, Minn. i. II. III (*L. S. Cheney*); 1899, St. Louis river, Wis. i. II. iii (*L. S. Cheney*.

On *Viola renifolia* A. GRAY. 1896, Orono, Me. I (*E. D. Merrill*).

On *Viola septentrionalis* GREENE. 1898, Ottawa, Ont. I (*J. M. Macoun*).

On *Viola blanda* WILLD. 1885, Lansing, Mich. ii. III (*J. C. Arthur*); 1886, Vermilion lake, Minn. II. iii (*E. W. D. Holway*); 1892, Oakland Co., Mich. II. iii (*G. H. Hicks*); 1899, Isle au Haut, Me. ii. III (*J. C. Arthur*).

On *Viola primulæfolia* L. 1892, Lake City, Fla. II. iii (*P. H. Rolfs*); 1899, Isle au Haut, Me. ii. III (*J. C. Arthur*).

On *Viola lanceolata* L. 1897, Sault Ste. Marie, Mich. II. (*E. T. Harper*); 1899, Isle au Haut, Me. ii. III (*J. C. Arthur*).

On *Viola cognata* GREENE. 1894, North Yakima, Wash. ii. III (*C. V. Piper*); 1894, Sisson, Calif. ii. III (*W. C. Blasdale*).

On *Viola adunca* SMITH. 1887, Provo, Utah, ii. III (*S. M. Tracy*); 1889, Deer Lodge, Mont. I (*F. D. Kelsey*); 1892, Pullman, Wash. I and ii. III (*W. R. Hull*); 1894, Pullman, Wash. II. iii (*C. V. Piper*); 1894, Pine Creek, Calif. i. II. iii (*F. P. Nutting*); 1894, Sisson, Calif. I (*E. W. D. Holway*); 1894, Sisson, Calif. II. iii (*W. C. Blasdale*); 1899, Gunnison Co., Colo. ii. III (*E. Bartholomew*).

On *Viola glabella* NUTT. 1885, Falcon Valley, Wash. ii. III (*W. N. Suksdorf*); 1895, Skamania Co., Wash. III

(*W. N. Suksdorf*); 1897, Bingen, Wash. I. II. III (*W. N. Suksdorf*).

On *Viola ocellata* Torr. & Gr. 1894, Ukiah, Calif. ii. III (*E. W. D. Holway*).

On *Viola Montanensis* Rydb. 1888, Helena, Mont. II. III (*F. D. Kelsey*); 1897, Spanish Basin, Mont. ii. III (*P. A. Rydberg*); 1898, Montesanes, Wash. ii. III (*A. A. Heller*).

On *Viola Canadensis* L. 1889, Bozeman, Mont. O. I (*Mrs. Alderson*).

On *Viola striata* Ait. 1882, Pine Hills, Ill. I. ii. III (*A. B. Seymour*); 1882, Carbondale, Ill. I (*A. B. Seymour*); 1893, Ell River Falls, Ind. ii. III (*L. M. Underwood*).

On *Viola rostrata* Pursh. 1886, Syracuse, N. Y. I (*L. M. Underwood*).

On *Viola Labradorica* Schrank. 1883, Granville, Mass. ii. III (*A. B. Seymour*); 1885, Racine, Wis. ii. III (*J. J. Davis*); 1886, Racine, Wis. I (*J. J. Davis*); 1888, Racine, Wis. ii. III (*J. J. Davis*); 1896, St. Remi, Quebec, ii. III (*Wm. Stuart*).

On *Viola arenaria* DC. 1880, Franklin Falls, N. H. II (*Mrs. Harrison*).

On *Viola hastata* L. 1820? Salem, N. C. I (*L. v. Schweinitz*).

On *Viola pubescens* Ait. 1882, Decorah, Iowa, I (*E. W. D. Holway*); 1883, Madison, Wis. ii. III (*L. H. Pammel*); 1883, Devil's Lake, Wis. III (*L. H. Pammel*); 1883, Decorah, Iowa ii. III (*E. W. D. Holway*); 1885, Madison, Wis. ii. III (*A. B. Seymour*); 1885, Racine, Wis. ii. III (*J. J. Davis*); 1886, Racine, Wis. O. I (*J. J. Davis*); 1886, Decorah, Iowa, O. I (*E. W. D. Holway*); 1889, Greensburg, Ind. I (*J. C. Arthur*); 1898, Lafayette, Ind. O. I (*J. C. Arthur*); 1898, Pownal, Vt. O. I (*J. R. Churchill*).

On *Viola scabriuscula* (T. & G.) Schw. 1898, Franconia, N. H. I (*E. & C. E. Faxon*); 1898, Masardis, Me. I (*M. L. Fernald*).

On *Viola sp.* 1884, Jamestown, N. D. II. III (*A. B. Seymour*); 1893, Three Lakes, Wis. I (*J. J. Davis*); 1895, Mt. Washington, N. H. ii. III (*E. T. Harper*); 1897, Sault Ste. Marie, Mich. I (*E. T. Harper*); 1899, Pachuca, Mexico II. III (*E. W. D. Holway*).

This species shows remarkable variability, especially in size of the spores, and in the thickness and markings of their walls. These differences come out most strikingly when comparing a series of specimens. There is also considerable variability in the form of the spores, as shown in Figs. 5 and 6, both taken from the same specimen, but it is such as one may expect to find in many other species of rusts.

If almost any specimen of violet rust be compared critically with an European specimen, the greater size of the teleutospores in the former is likely to attract attention. This is the basis of the species proposed by Cooke, *Puccinia hastatæ*. A specimen collected by W. C. Blasdale on *Viola cognata* at Sisson, Calif. (Figs. 5 and 6), has been compared with the type material of *P. hastatæ* at the Kew Herbarium, through the kindness of Mr. Massee, and found to agree very closely. The greater size of the teleutospore in the American material generally is noticeable, and this difference extends to the uredo and æcidial stages as well, although not usually so pronounced. In the case of an æcidium on *Viola pubescens*, collected at Decorah, Iowa, in 1882, Farlow has made the comment:—"Spores somewhat larger than in the European specimens; this *may* be the Æcidium of *Puccinia hastatæ* Cke." (on the label in Ellis' N. Amer. Fungi, no. 1007). If size of spores is to be taken as valid basis for separating species, there is no question that the American form shows a strong claim to rank as autonomous. The claim, even on that assumption, is much weakened, however, by the great range between the smallest and largest of the American specimens, indicating a decided capacity for variability rather than a fixed form.

A peculiarity of the American violet rust, that in the case of European specimens we have not seen mentioned and have not observed, is the frequently tuberculate sculpturing of the teleutospores. Burrill (Paras. fungi Ill.: 174) makes this a diagnostic character, but in a wide series of specimens one does not always meet with it. With most observers the spores would generally be rated as smooth like the European form. The true character of surface markings can be best studied by observing the spores without addition of fluids. In this way it is easy to see that the markings are small papillæ, sparingly distributed, and chiefly appearing on the upper half of the spore. A closer study reveals the interesting fact that when no elevations above the general surface of the spore can be detected, there may yet be observed almost the usual appearance when the spore is examined in face view. Instead of papillæ, their places seem to be supplied by translucent dots. Now the most interesting outcome of this study is the observation that the European specimens, while having what are always rated as smooth teleutospores, yet show when looked at dry and in face view, the same appearance of translucent dots and in the same abundance and distribution as do American specimens. The American form, therefore, simply accentuates characters that are primitive in the trans-Atlantic form.

The uredospores also have interesting, but less significant, characters showing variability. As a rule they do not much exceed in size those from European specimens, although the tendency toward largeness is apparent. But in many American specimens the walls are greatly thickened (compare uredospores in Figs. 5 and 7), and give a striking appearance under the microscope. These thick-walled uredospores are sometimes small, and sometimes large. They occur on various species of violets and range from the Atlantic coast to the Pacific. Fine illustrations are found in material on *Viola primulæfolia* collected at Isle au Haut, Me. (Fig. 8), the uredospores being small, and on *Viola glabella* collected at Bingen, Wash. (Fig. 7), the uredospores being large. After all, the form is only occasionally met with. If it is an adaptation to some particular environment, it is difficult to see what that may be. The form on *Viola primulæfolia* from Maine was collected within a few hundred feet of the open ocean among rocks, yet in the same situation and intermixed grew *Viola lanceolata* with rust showing uredospores having almost normally thin walls.

It is possible that these interesting variations belong in some way to obscure species, but our study has shown no morphological boundaries. It is more likely that they indicate races, or possibly so-called biological species. A well-directed series of cultures would undoubtedly yield important results.

A few words regarding the American synonymy may be helpful. Cooke described *Puccinia hastatæ* in the third volume of *Grevillea* from material collected in Maine by E. C. Bolles. The host was *Viola hastata*. The uredo and teleuto stages are described, but the only distinctive characters are the measurements which are given as 20–22 μ for the uredospores, and

20–25 μ by 35–40 μ for the teleutospores. The name has been very little used by American or other botanists. The assignment of the name to a place under the wholly distinct *Puccinia Fergussoni*, as done by De Toni in the seventh volume of Saccardo's *Sylloge fungorum*, was far from being a shrewd guess as to its relationship. It is even more inexplicable how Dietel could have fancied a resemblance to *Puccinia Fergussoni* in the type material of his *Puccinia densa*. His material of the latter species was collected in 1895 by W. N. Suksdorf in the State of Washington. It was on *Viola glabella*, and yielded only teleutospores. The characters which he drew up for the proposed new species agree perfectly with those of large-spored forms of *Puccinia Violæ*. Beside the type collection we have examined material on the same host from other localities in the same State, and secured by the same collector. This ample material includes all three spore stages, and leaves no doubt of the identity of *P. densa* Diet. with *P. Violæ*.

All the hosts of the specimens cited under *Viola Montanensis*, and part of those under *V. adunca*, have been determined or verified by Dr. P. A. Rydberg of the New York Botanical Garden.

An error in the thirteenth volume of Saccardo's *Sylloge fungorum*, page 1313, should be pointed out here. *Puccinia Mariæ-Wilsoni* Clint. is said to occur on *Viola cucullata* Ait. and *V. delphinifolia* Nutt. The error is due to a confusion of names. *Æcidium Mariæ-Wilsoni* Peck is found on these hosts but *Puccinia Mariæ-Wilsoni* Clinton is only found on *Claytonia*, and both species are widely different from *Puccinia Violæ*.

Puccinia effusa D. & H. 1895. Erythea 3: 81.

I. Æcidia amphigenous, but chiefly hypophyllous, in large indefinite clusters, often covering much of the leaf, noticeably extending along the veins and petioles; substratum somewhat thickened; cups broad and low, border white, irregularly and coarsely lacerate, somewhat recurved; spores subglobose, somewhat angular from compression, minutely verrucose, 20–27 μ in diameter.

III. Teleutosori for the most part arising from the cups of the æcidia, uncovered, elliptical, nearly black; spores dark brown, elliptical or oblong, slightly if at all constricted at the septum, inconspicuously verrucose, 23–31 μ broad by 37–50 μ long; wall moderately thick; apex rounded, usually not thickened; base rounded or occasionally slightly narrowed; pedicel hyaline, deciduous.

The western coast of the United States in spring and early summer. The following specimens have been examined, the first being the type collection:

On *Viola lobata* BENTH. 1894, Dunsmuir, Calif. I. iii (*E. W. D. Holway*).

On *Viola Nuttallii* PURSH. 1897, Falcon Valley, Wash. I. iii (*W. N. Suksdorf*).

The species is very characteristic. It probably possesses spermogonia, but they have not yet been observed; it is, however, without uredo, although erroneously included in the original description of the species. Two specimens are cited (*Erythea* 3: 82) as type material, the first on *Viola lobata*, referred to above, and the second on *Viola ocellata*. The latter specimen has been examined and proves to be *Puccinia Violæ*, and is cited above under that species. The original description of the species is accordingly emended to omit the supposed uredo.

The difference in the shape of the spores, shown in the photographs of spores taken from the two hosts, is doubtless due to some accident of growth, such as more or less compression in the young sorus, and is without diagnostic value. It is of the same nature as the difference shown in two mountings from the same collection of *P. Violæ* on *V. cognata*. The more regular spores are to be accepted in each case as the normal development under favorable conditions.

Four additional species of violet rusts occur in Europe, and it is possible that they may eventually be found in this country. *Uredo alpestris* Schrœt. inhabits *Viola biflora* L., and as this host is a native of the Rocky Mountains, the rust may possibly accompany it. *Puccinia alpina* Fckl. also occurs on *V. biflora* L., and *P. Fergussoni* Berk. & Br. occurs on *V. palustris* L., and *V. mirabilis* L., and *V. epipsila* Led. Both of these species belong to the section of Micropuccinia, and are notably distinct from the other rusts on violets. A specimen of rust collected by Marcus E. Jones at San Diego, Calif., in 1882, was erroneously referred to the latter species, and distributed by him as No. 3040. *Puccinia ægra* Grove is an autœcious species found on the cultivated pansy and its close relatives. It will probably be brought to America after a time through commercial channels, as the rusts of asparagus, chrysanthemum, carnation, hollyhock, and of some other cultivated plants have been. As the hosts of these four species of violet rusts are found in this country, the rusts may not unreasonably be expected also.

Explanation of Plate XLVII.

All figures photographed and engraved to the same scale, × 250 diameter. Each millimeter on the plate equals 4 μ of original dimensions.

Figures 1, 2 and 3. *Puccinia Violæ* showing three sizes of teleutospores: 1, on *V. elatior* from Germany, Sydow's Uredineen, No. 33; 2, on *V. adunca* from Gunnison, Colo.; 3, *Viola* sp. from Mexico, Holway No. 3573.

Figures 4, 5 and 6. *Puccinia Violæ* showing especially large teleutospores: 4, on *V. blanda* from Lansing, Mich.; 5 and 6, both on *V. cognata* from Sisson, Calif., taken from different sori.

Figures 7 and 8. *Puccinia Violæ* showing especially thick-walled uredospores: 7, on *V. glabella* from Bingen, Wash.; 8, on *V. primulæfolia* from Isle au Haut, Me.

Figures 9 and 10. *Puccinia effusa* showing regular and irregular spores; 9, on *V. Nuttallii* from Falcon Valley, Wash.; 10, on *V. lobata* from Dunsmuir, Calif.

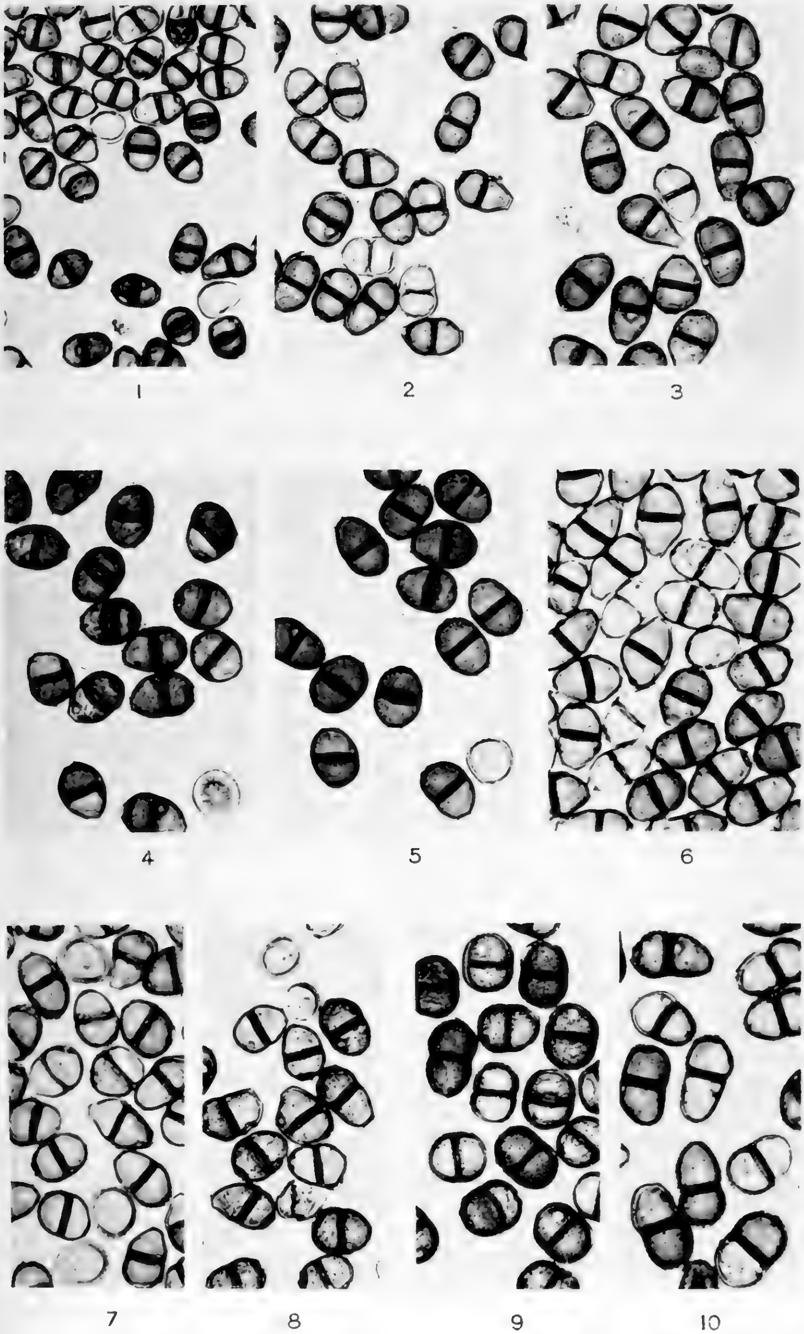


PLATE XLVII.

THE HELIOTYPE PRINTING CO., BOSTON.

XXXVIII. OBSERVATIONS ON THE EMBRYOGENY OF NELUMBO.

H. L. Lyon.

Introduction.

The peculiar and seemingly inconsistent characters of *Nelumbo* have given rise to a variety of opinions regarding its proper systematic position and in attempts to settle the points in dispute the plant has again and again been subjected to careful investigation, the recorded observations forming a considerable literature.

In anatomy the plant seems to conform more nearly to the type of the Monocotyledons, as in fact do all the Nymphæaceæ, the vascular bundles being closed and irregularly placed through the stem. On the other hand the large peltate leaves with their reticulate venation are perhaps more suggestive of a dicotyledonous plant, while the flowers might easily belong to one of either class. Thus far can investigators agree, but the anomalous character of the fruit has made it a subject for controversy, and the interpretations offered are numerous and at great variance. Briefly stated the fruit presents the following peculiarities. Each carpel of the apocarpous gynœcium contains a single ovule and matures as a spherical one-seeded fruit. The thick sclerenchymatous pericarp lined by the thin testa is closely filled by two large white fleshy bodies hemispherical in shape and joined to each other at the stigmatic end of the pericarp. In an elongated oval chamber formed by opposed concavities in the inner surfaces of these fleshy bodies, and attached to them at their point of continuity is a green structure—a stem bearing a large and small leaf and an apical bud containing two more. The free leaves are fully formed and already green and together with the stem are enclosed by a thin delicate structureless membrane. Imbedded in the common tissue of the two fleshy bodies opposite the insertion of the stem of the green structure is found a vestigial radicle. Upon the germination of the seed the fleshy bodies remain within the pericarp wall while the green structure develops into the extraseminal plant body. The radicle does not function, the first roots springing from the stem of the green structure.

The first careful description of the seed seems to have been given by Gaertner (1788, 73–74). He termed the large fleshy bodies the vitellus which he considered a transition between the endosperm and cotyledon. The green structure he considered the embryo and in *Nymphæa* he describes it as monocotyledonous, but of *Nelumbo* he says: "Ambigit Nelumbo inter plantas mono- & dicotyledones: nom ad posteriores, ex fabrica seminis, omnino spectare videtur; sed verissime ad priores pertinet, quum constantissime unicum duntaxat sub germinatione promat foliolum, nec alterum prodeat, donec prius penitus evolutum & super aqua explicatum sit:" Jussieu (1789, 68, 453) considers the green structure a monocotyledonous embryo and describes the large fleshy bodies as endosperm. Poiteau ('09, 382, 383) interprets the large fleshy bodies as cotyledons and the membrane as a stipule, but denies the presence of a radicle. Mirbel ('09) accepts Poiteau's interpretation of the large fleshy bodies but notes the presence of a radicle. Richard ('11) describes the embryo as monocotyledonous. The little sac which surrounds the green structure he considers a reduced cotyledon and the large fleshy bodies an outgrowth of the radicle. Mirbel ('15, 59, 60, *footnote*) writes: "Je ne suis pas éloigné de croire que le Piper, le Saurus———, le Nymphæa, le Nelumbo et peutêtre quelques autres genres que l'on regarde mal-a-propos comme Monocotylédons, doivent prendre place non loin les uns des autres, parmi les Dicotylédons, dans la série des familles naturelles." Mirbel's declaration seems to have settled the question as to the character of the large fleshy bodies, his interpretation having been generally accepted except by Barthélemy ('76) who asserts: (1) that the green structure is the one which arises in the embryo-sac and hence is to be considered as the embryo, (2) that the two fleshy bodies imitating cotyledons arise through the division of the exosperm.

Concerning the little colorless sac which surrounds the green structure, however, no opinion seems to have been given which could meet with general approval. In addition to those above cited De Candolle ('21) considered it a stipule, Brongniart ('27) the embryo-sac, Trecul ('54, 2) a concretion of a homogeneous substance containing numerous small, acicular crystals, and finally Wigand-Dennert ('87) in a monograph on *Nelumbium speciosum* wrote: "Es ist unzweifelhaft der Ueberrest von Endospermzellen, welche sich in der Höhlung zwischen den Cotyledonen erhalten und gleichsam auf der Oberfläche der Plumula niedergeschlagen und dadurch das Ansehen einer Membran erhalten haben."

From the above survey of literature it will be seen that modern knowledge of the seed is based on investigations made upon mature or nearly mature fruits. That alone which will determine the correct interpretation of the structures (*i. e.*, a knowledge of their origin) is entirely wanting. It was in recognition of this fact that the present embryological study was undertaken. In a preliminary note, published in *Science*, the more important conclusions were announced. 1. The embryo of *Nelumbo* is genuinely monocotyledonous in its development. The plumule arises laterally and at first there is but one cotyledon which later bifurcates to form the two fleshy bodies. 2. The membrane surrounding the plumule is, as conjectured by Wigand, a true endosperm arising within the embryo-sac.

Collection and Methods.

The material for the investigation in hand was collected by the author in August, 1899, and August, 1900, in southeastern Minnesota while working on the botanical survey of that region. There, *Nelumbo lutea* grows in great luxuriance in the sloughs and bayous of the Mississippi river, the soft muddy bottoms and quiet waters of these bayous affording an ideal habitat for the plant, where it often forms beds many acres in extent to the exclusion of other vegetation.

In collecting, each carpel was removed from the torus, the lower end cut away and the upper portion with the attached ovule placed in the fixing fluid. One-half and one per cent. chromic acid and chrom-acetic acid were used as killing reagents. The material was thoroughly washed and passed gradually into 70 per cent. alcohol in which condition it was brought into the laboratory. The ovules were imbedded in paraffine and serial sections cut with a Minot microtome. The sections were stained on the slide, a variety of stains being used; the photomicrographs and drawings, however, which accompany the present paper were made from sections stained with aniline-water-safranin or acid fuchsin.

At the present time the material at hand is insufficient for the full demonstration of certain points, especially in the development of the embryo-sac. Therefore, the present paper will be limited to a discussion of the embryogeny, the development of the embryo-sac and the cytology of reproduction being reserved for future treatment.

RESEARCH.

The embryo-sac is ovoid at its micropylar end and tapers down to a narrow attenuation which extends deeply into the nucellus. As the embryo-sac matures the nucellar tissue directly in contact with it begins to break down. There also appears in the antipodal region a club-shaped cellular structure which obliterates the lower portion of the sac (Figs. 1 and 2). The precise origin of this peculiar antipodal body remains yet to be determined. To facilitate description the embryogeny may be considered in a series of stages.

Stage A. Spherical stage.—The young embryo is usually found in the upper end of the embryo-sac among the débris resulting from the disintegration of the synergidæ. The surrounding protoplasm makes it difficult to observe the first division of the oösperm and at the present time the youngest embryo which can be described with certainty is one in the eight-celled stage represented in Fig. 3. As seen here the embryo is nearly spherical, no suspensor being evident, although there may be one present but obscured by the disorganizing synergid "a." This is not probable, however, judging from the position of the first wall in the segmenting embryo. If a suspensor cell is cut off at all, it very early loses its identity as there is no evidence of it in embryos of the age represented in Figs. 4–6. Cell division apparently takes place uniformly throughout the embryo, the result being the building up of a spherical body (Figs. 4–7). The embryo retains its spherical shape until composed of several hundred cells. At about this time the nucellar tissue in the micropylar end of the ovule has entirely broken down, so that the embryo now lies in a cavity which is bounded by the inner integument of the ovule. Simultaneously with the division of the embryonal cell the endosperm nucleus divides and the young embryo is soon surrounded by endosperm nuclei between which thin cell walls are very early apparent (Figs. 1, 4–7).

Stage B. Monocotyledonous stage.—The spherical embryo begins to evidence a maximum growth in the horizontal direction, its greater dimension being diagonal or nearly at right angles to the longer axis of the ovule. At this time it can perhaps best be described as a flattened mass or button of tissue lying in the upper end of the ovular cavity. The surface in contact with the ovular wall conforms to the shape of the latter. The free surface is more or less flattened and slightly inclined to the plane of the horizontal. The plumule (*a*, Fig. 8) now arises as a small protuberance on the inclined free surface in a median line near its lower side. The axis of the plumule is from the first about parallel with the axis of the ovule, and as it grows straight down into the ovular cavity it causes this side of the embryo, which we will term the front side, to become flattened. The future cotyledon is now evident as a crescent-shaped mound of tissue (*bb*, Fig. 8) around the rear of the embryo, its wings extending forward even with the plumule. This stage culminates in an embryo as represented in Fig. 8. The endosperm, during the monocotyledonary stage, forms a columnar mass of tissue which stands centrally in the cavity, extending from the embryo to the persistent nucellar tissue in the lower portion of the ovule.

Stage C. "Dicotyledonous" stage.—The cotyledon becomes bilobed through the localization of growth at the foci, *b* and *b*, Fig. 8. From each of these points a cotyledonary lobe grows rapidly downward outside the endosperm, the tissue of the nucellus disorganizing before it (Fig. 10). In cross section these lobes are crescent-shaped (Fig. 16) and simultaneously with their elongation growth takes place in both radial and tangential directions, each lobe at its base growing forward around the plumule. An idea of the relative positions occupied by the different structures may be derived from Figs. 13–16; cross sections of embryos which were, however, considerably older than the one represented in Fig. 9.

The growth of the plumule is slow during this stage, it being a simple dome-shaped mound of tissue (Figs. 9, 10 and 18) which comes to occupy a central position through the growing forward of the cotyledonary lobes.

At about this time the plerome first becomes apparent as a strand of somewhat smaller cells running from the plumule directly through to the base of the embryo (Figs. 12–18). From this main axis, at a point just above its middle (Fig. 18), lateral strands radiate outward and traverse the lobes of the cotyledon. This stage culminates in an embryo as represented in Fig. 9.

Stage D. Mature embryo.—This stage which is reached with the completion of intraseminal growth may be discussed under the following captions:

1. *Maturation of the Plumule.*—The first foliage leaf arises on the axis of the plumule morphologically opposite the cotyledon (*b*, Fig. 14) (*i. e.*, on the front side of the plumule axis). The second foliage leaf arises opposite the first (*c*, Fig. 19). The stipules of the first and second leaves grow over and around the apex of the stem and enclose the next two leaves, which are also preformed in the seed (Fig. 23). The lysigenous cavities of the stem and leaf petioles very early appear, as seen in Figs. 19 and 22. The structure of the mature plumule has been many times described and needs no further treatment here. Its development, however, may be well understood by a comparison of Figs. 10, 14, 17, 19, 22 and 23.

2. *Origin and Maturation of the Radicle.*—The radicle (*r*, Fig. 22) originates opposite the insertion of the plumule and is but a vestigial structure not developing into a functional primary root upon the germination of the seed. It only becomes apparent at a late stage in the development of the embryo and is usually completely enclosed by an outgrowth of the cotyledonary tissue. Fig. 24 shows a longitudinal section of the hypocotyl of a seedling which had already developed secondary roots from the epicotyl.

3. *Maturation of the Cotyledon.*—The edges of the cotyledonary lobes soon meet through tangential growth, thus forming a tube in which the plumule stands surrounded by the endosperm. The cells directly beneath the epidermis near the apex of the lobes remain densely protoplasmic and differentiate into a distinct palisade tissue (Figs. 20, 21). This undoubtedly forms a nursing area, being in contact with the lower portion of the nucellus which persists for some time and is still evident in the seed as a thicker, more distinct portion of the testa (*a*, Fig. 11). The lobes through more rapid elongation soon reach their maximum length and then by somewhat slower tangential and radial growth the embryo acquires its ultimate spherical form.

The integuments of the ovule keep pace with the growth of the embryo and form the thin testa of the seed which lines the thick pericarp.

4. *Fate of the Endosperm.*—The endosperm reaches its maximum growth early in Stage C when it forms a considerable mass of tissue lying between the lobes of the cotyledon (Fig. 16). The cell walls are never firm and offer little resistance to the growing plumule which forces its way into the center of the mass. The nuclei soon after begin to disappear and the cells to lose their definite outline. The resulting débris is crowded around the plumule by the growth of the cotyledonary lobes and is apparent in the seed as a colorless structureless sheath nearly or quite surrounding the plumule.

5. *The Embryo of the Seed.*—A carful study of the embryo of the seed without reference to its development brings to light many conditions not to be found in a dicotyledonous seed. The lobes of the cotyledon are not separate structures, but have a common tissue at the base of the embryo upon which the plumule stands (Figs. 11, 22). The sinuses between the lobes are not of equal depth, the front sinus being deeper than the rear, so that the common tissue of the lobes (*b*, Fig. 11) extends higher up in the rear of the plumule than it does in front of it. This peculiarity is even more noticeable in the seed of *N. nelumbo* than in that of *N. lutea* illustrated in the figure, and it is so distinct that it is remarkable that it has not been described before. The radicle is to a greater or less extent imbedded in tissue of cotyledonary origin, in this respect conforming to well-known monocotyledonous types.

The Embryogeny of Nelumbo Compared with That of Other Monocotyledons.

In its early development the embryo of *Nelumbo* is strikingly similar to that of *Pistia* described by Hegelmaier ('74, 681–686. *pl. 11. fig. 45–52*). The oösperm of *Pistia*, Hegelmaier finds, does not cut off a suspensor cell but by uniform divisions builds up a spherical embryo as in *Nelumbo*. The bifurcation of the cotyledon is not so inexplicable a deviation from the ordinary course of development as it may at first appear. It is rather to be considered as a modification brought about through the adaptation of the embryo to the available space within its investments.

As the embryo departs from its primitive spherical form it is evident that its axis lies more or less directly across the ovular cavity. As the plumule develops superficially near one side of this flat expanse of tissue the remaining larger surface is to be considered as that of the young cotyledon. The cotyledon soon meets obstruction to its further growth in the horizontal plane and hence turns down into the ovular cavity. Its later bifurcation is undoubtedly the result of its having to adjust itself to the cylindrical cavity in which it grows. That the shape of the cavity does to some extent affect the shape of the cotyledon seems to be evidenced by the fact that the cotyledonary lobes are at all times closely appressed to their enclosing investments. The bifurcation extends along a line of mechanical stress.

The mature embryo of *Nelumbo* can perhaps best be compared with those of the grasses, especially one having but a small amount of cotyledonary tissue below the junction of the plumule and cotyledon. The embryo of the wild rice, *Zizania aquatica*, as figured by Kennedy ('99, *pl. 3. fig. 22–24*) affords such an example. It has a long epicotyl and a very short hypocotyl which is imbedded in a small amount of cotyledonary tissue. The cotyledon grows around and nearly encloses the plumule with a uniform thickness of tissue. In *Nelumbo* the conditions are almost exactly similar, except that the cotyledon in addition to growing around the plumule has become divided lengthwise nearly to the base into two equal parts.

The Systematic Position of the Nymphæaceæ.

As indicated above the one character which has led to the placing of the Nymphæaceæ among the Dictotyledons is the structure of the embryo in the seed. In their other characters they conform more nearly to the Monocotyledons. The embryo of *Nelumbo* has been shown to be monocotyledonous in its development. Although in the other genera there is present in the seed a functional endosperm and perisperm, a careful examination of the mature embryos shows them to be in all essential respects quite similar to that of *Nelumbo*. Those common characters, then, which have previously united these plants into a family justify the conclusion that they agree in embryogeny. In order to remove all possible doubt the embryogeny of a number of Nymphæaceæ will be studied during the coming summer. The Nymphæaceæ should be classified, in the natural system, in a subseries Nymphæineæ coördinate with the Potamogetonineæ, Alismineæ and Butomineæ in the series Helobiæ.

Recapitulation and Summary.

1. *Nelumbo* both in its anatomy and embryogeny conforms to the type of the Monocotyledons.
2. The two fleshy bodies of the embryo arise through the bifurcation of the originally single cotyledon.
3. The membrane surrounding the plumule is, as conjectured by Wigand, a true endosperm arising within the embryo-sac.
4. The family of the Nymphæaceæ should be classified among Monocotyledons in the series Helobiæ.

The writer wishes to express his obligations to Professor Conway MacMillan who has carefully followed the present investigation, offering many suggestions which have been incorporated in the general discussion.

Literature.

The following bibliography includes the more important works dealing with the anatomy, morphology or affinities of *Nelumbo*, which have been found of value in the present research.

1. **Baillon, H.** ('71). Monographie des Nymphæacées. Histoire des Plantes, **3**: 77–104. 1871.
2. **Barthélemy, A.** ('74). De la respiration et de la circulation des gaz dans les végétaux. Ann. Sci. Nat. Bot. V. **19**: 131–175. 1874.
3. **Barthélemy, A.** ('76). Du développement de l'embryon dans le *Nelumbium speciosum* et de sa germination. Rev. Sci. Nat. **5**: 40–44. 1876.
4. **Brongniart, A.** ('27). Memoire sur la Génération et le Développement de l'Embryon dans les végétaux phanérogames. Chap. iv. Ann. Sci. Nat. **12**: 225–296. 1827.
5. **Caspary, R.** ('78). Nymphæaceæ in v. Martius. Fl. brasiliensis. Fasc. 77. 130. 1878.
6. **Caspary, R.** ('91). Nymphæaceæ in Die Natürl. Pflanzenfam. III. Teil. 2 Abt. 1–10. 1891.
7. **Caspary, R.** ('57). Flora 717–718, also Bot. Zeit. 791. 1857.
8. **Clos, M. D.** ('91). Interpretation des Parties Germinatives du *Trapa natans*, de quelques Guttifères et des *Nelumbium*. B. S. B. de France, **38**: 271–276. 1891.

9. **De Candolle, A.** ('05). Sur la graine des *Nymphæa*. Paris. Soc. Philom. Bull. III. 68. 1805.

10. **De Candolle, A.** ('21). Sur les affinités naturells de la famille des Nymphéacées. Genève. Mem. Soc. Phys. I. 208–244. 1821.

11. **Engelmann, G.** ('60). Remarks on *Nelumbium luteum*. Trans. St. Louis Acad. Sci. (Proc.) 2. 1860.

12. **Gaertner, J.** (1788). De Fructibus et Seminibus Plantarum, **1**: 73–74. 1788.

13. **Gwynne-Vaughan, D. T.** ('96, 1). A new case of polystely in Dicotyledons. Ann. of Bot. **10**: 289–291. 1896.

14. **Gwynne-Vaughan, D. T.** ('96, 2). The arrangement of vascular bundles in certain Nymphæaceæ. Ann. of Bot. **10**: 624–625. 1896.

15. **Gwynne-Vaughan, D. T.** ('97). On some points in the morphology and anatomy of the Nymphæaceæ. Trans. Linn. Soc. of London, **5**: 287–299. 1897.

16. **Heckel, E.** ('79). Des poils et des glandes pileuses dans quelques genres de Nymphéacées. Comp. Rend. **89**: 758–759. 1879.

17. **Hegelmaier** ('74). Zur Entwicklungsgeschichte monokotyledoner Keime nebst Bemerkungen über die Bildung der Samendeckel. Bot. Zeit. 631, 648, 657, 673, 689, 705. 1874.

18. **Heritage, B.** ('95). Preliminary notes on *Nelumbo lutea*. Bull. Torr. Bot. Club, **22**: 266–271. 1895.

19. **Jeffrey, E. C.** The morphology of the central cylinder in the Angiosperms. Nymphæaceæ. 24–27.

20. **Klebs, G.** ('83). Beiträge zur Morphologie und Biologie der Keimung. Untersuch. aus dem Bot. Inst. zu Tübingen, **1**: 536–614. Nymphæaceæ, 555–556. 1883.

21. **Kennedy, P. B.** ('99). The structure of the caryopsis of Grasses with reference to their morphology and classification. Bull. No. 19, U. S. Dept. Agric. Div. of Agrostology. 1899.

22. **Lindley, J.** ('36). A natural system of botany. Nymphæaceæ, 10–14. 1836.

23. **Lyon, H. L.** (1901). Preliminary note on the embryogeny of *Nelumbo*. Science, **13**: 470. 1901.

24. **Mirbel, C. F. B.** ('09). Observations anatomiques ou physiologiques sur le *Nelumbo nucifera*. Paris, Mus. Nat. Hist. Annal. **13**: 465–481. 1809.

25. **Mirbel, C. F. B.** ('15). Élémens de Physiologie Végétale et de Botanique, **1**: 59–60.

26. **Planchon, J. E.** ('53). Études sur les Nymphéacées. Ann. Sci. Nat. Bot. III. **19**: 17–63. 1853.

27. **Poiteau, A.** ('09). Sur l'embryon des Graminées des Cypéracées, et du *Nelumbo*. Paris, Mus. Hist. Nat. Annal. **13**: 381–400. 1809.

28. **Raciborski, M.** ('94). Beiträge zur Kenntniss der Cabombeen und Nymphæaceen. Flora, 92–108. 1894.

29. **Richard, L. C.** ('11). Analyze botanique des embryons endorhizes ou monocotylédonés, et particuliérement de celui des Graminées. Paris Mus. Hist. Nat. Annal. **17**: 223–251, 442–487. 1811.

30. **Solereder, H.** ('99). Systematische Anatomie der Dicotyledonen. Nymphæaceæ. 54–59. 1899.

31. **Trécul, A.** ('45). Recherches sur la structure des Nymphæacées. Journ. de Pharm. **7**: 465–467. 1845.

32. **Trécul, A.** ('53). Memoir sur la Formation des Feuilles. Ann. Sci. Nat. Bot. III. **20**: 235–314. 1853.

33. **Trécul, A.** ('54, 1). Etudes anatomiques et organagéniques sur la Victoria regia, et anatomie comparée du Nelumbium, du Nuphar et de la Victoria. Ann. Sci. Nat. Bot. IV. **1**: 145–172. 1854.

34. **Trécul, A.** ('54, 2). Végétation du Nelumbium codophyllum et disposition anomale de ses Feuilles et de ses Stipules. Ann. Sci. Nat. Bot. IV. **1**: 291–298. 1854.

35. **Trécul, A.** ('54, 3). Disposition des Stipules et des Feuilles du Nelumbium codophyllum et Végétation singuliére de cette Plante. B. S. B. de France, **1**: 18–22, 60–63. 1854.

36. **Van Tieghem, P.** ('86, 1). Sur l'apareil sécréteur et les affinités de structure des Nymphéacées. B. S. B. de France, **33**: 72–76. 1886.

37. **Van Tieghem, P.** ('86, 2). Sur la croissance terminale de la Racine dans les Nymphéacées. B. S. B. de France, **33**: 264–265. 1886.

38. **Van Tieghem, P., and Douliot, H.** ('88). Recherches comparatives sur l'origine des membres endogénes dans les plantes vasculaires. Ann. Sci. Nat. Bot. VII. **8**: (Nymphæaceæ) 127–132, 435–438. 1888.

39. **Warming, E.** ('79–'80). Forgreningen og Bladstillingen hos Slägten Nelumbo. Vidensk. Meddelelser fra den Naturhistoriske Forening i Kjöbenhavn. 443–455. 1879–80.

40. **Weberbauer, A.** ('94). Beiträge zur Samenanatomie der Nymphæaceen. Bot. Jahr. **18**: 213–258. 1894.

41. **Wettstein, R. V.** ('88). Beobachtungen über den Bau und die Keimung des Samens von Nelumbo nucifera Gärtn. Verhandl. d. k. k. zool.-bot. Gesellsch. in Wien. **38**: 41–47. 1888.

42. **Wigand, A.** ('71). *Nelumbium speciosum* W. Bot. Zeit. 812–826. 1871.

43. **Wigand–Dennert** ('88). *Nelumbium speciosum* W. Eine monographische Studie. Bibl. Bot. Heft. 11. 1888.

Description of Plate XLVIII.

Figure 1. Longitudinal section of ovule containing young embryo and endosperm ($\times 50$). The nucellar tissue about the middle of the embryo-sac has broken down. The antipodal body is seen at the lower end of the sac.

2. Antipodal body ($\times 160$).

3. Eight-celled embryo ($\times 770$). (Outlined with camera lucida.) *a* = disorganizing synergid.

4, 5, 6. Longitudinal sections of ovules containing spherical embryos and endosperm ($\times 240$).

7. Cross section of ovule containing a spherical embryo closely surrounded by endosperm ($\times 240$).

8. Front view of an embryo at end of stage B. *a*=plumule, *bb*=cotyledon. This figure was reconstructed from careful micrometer measurements of serial cross sections; a proceeding found necessary in order to get the correct orientation of the embryo.

9. Front view of an embryo at end of stage C. *a*=plumule. *bb* =cotyledonary lobe. Figure obtained in same manner as Fig. 8.

10. Longitudinal section of an embryo in Stage C ($\times 50$). The endosperm is shrunken by reagents into the center of the ovular cavity.

11. A fruit with one side of the pericarp and a cotyledonary lobe cut away ($\times 2$). *a*=thicker portion of the testa. *b*=common base of the cotyledonary lobes.

Plate XLIX.

12. Cross section of the hypocotyl of an embryo just completing Stage C ($\times 50$).

13. Cross section of the same embryo through base of plumule ($\times 50$).

14. Cross section of the same embryo through apex of plumule (450). *a*=apex of stem. *b*=first leaf. *e*=endosperm.

15. Cross section of an embryo, cutting plumule a short distance above its base ($\times 50$). *e*=endosperm.

16. Cross section of same embryo through cotyledonary lobes ($\times 50$). e=endosperm.

17. Longitudinal section of an embryo early in stage D ($\times 65$). The fundament of the first leaf is already evident, also the invagination at the base of the embryo, which marks the position of the radicle.

18. Shows a sectional view of the base of an embryo in stage C. ($\times$ 190).

19. Shows the plumule of a young embryo in stage D in longitudinal section ($\times$ 50). a=apex of stem. b=first leaf. c=second leaf. e=endosperm. s_1 =stipule of first leaf. s_2 =stipule of second leaf.

20. Vertical section through apex of cotyledonary lobes showing differentiation of a nursing area ($\times$ 50).

21. A portion of the same under a higher magnification showing the densely protoplasmic palisade tissue of the nursing area.

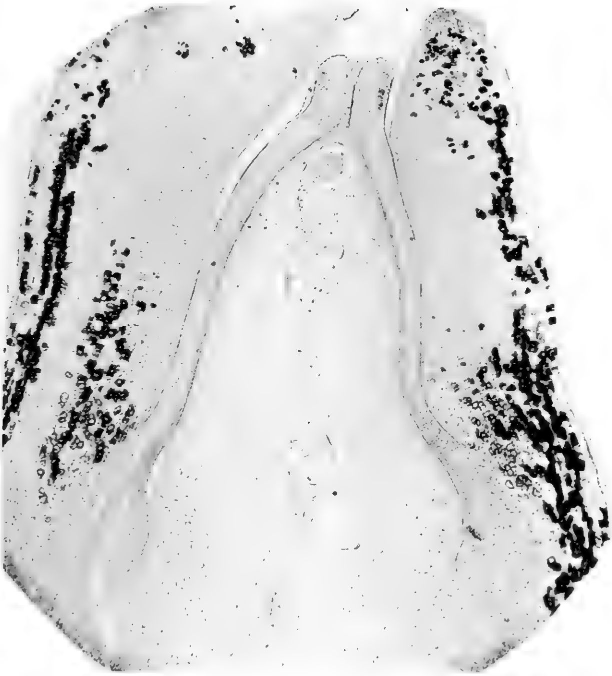
PLATE L.

22. Longitudinal section of the plumule of the seed ($\times$ 15). The first and second foliage leaves are cut off, their basal portions only showing in the figure. r=radicle.

23. The apical bud in the same section ($\times$ 50) showing the third and fourth foliage leaves enclosed by the stipules of the first and second. a=apex of stem. s_1=stipule of first leaf. s_2=stipule of second leaf.

24. Longitudinal section of the hypocotyl of a seedling showing the vestigial radicle ($\times$ 50).

25. Cross section through the epicotyl of a young seedling showing the adventitious roots, the first to function, ($\times$ 50).



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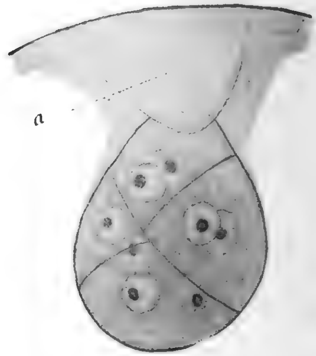

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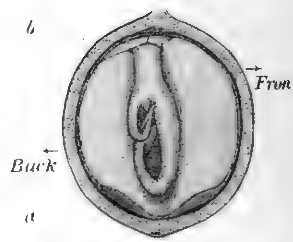

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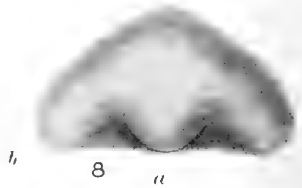

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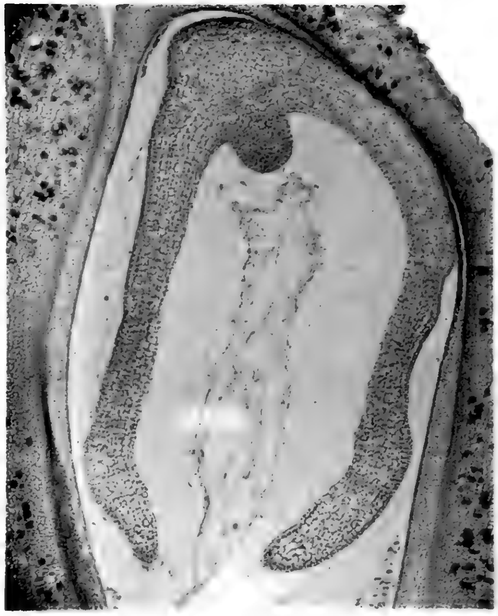

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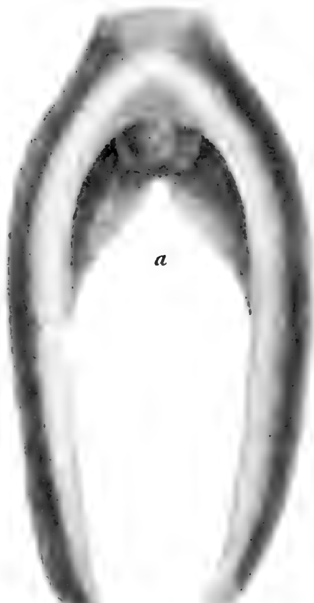

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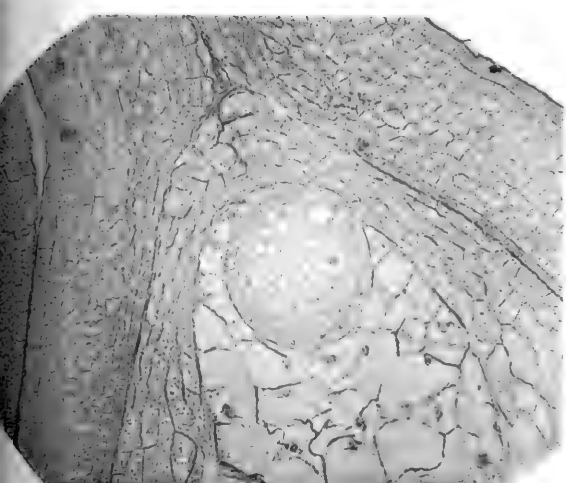

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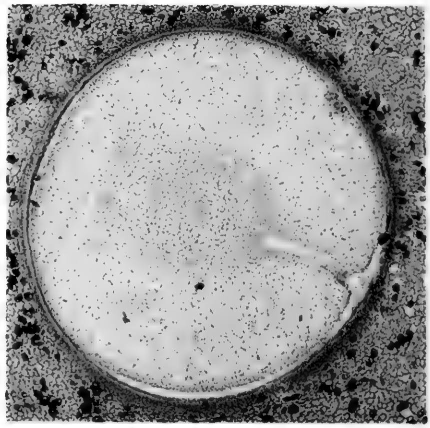

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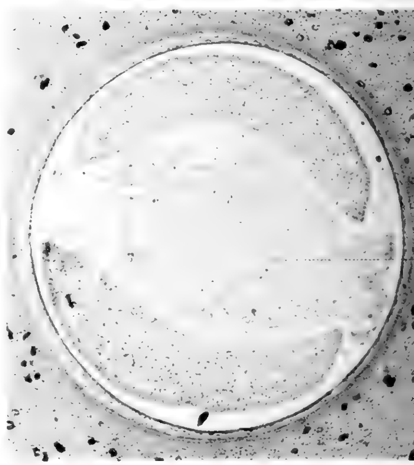

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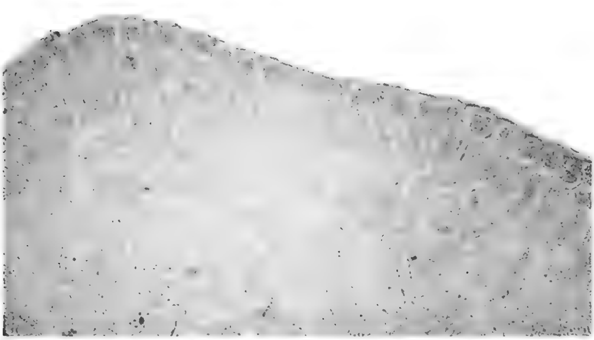

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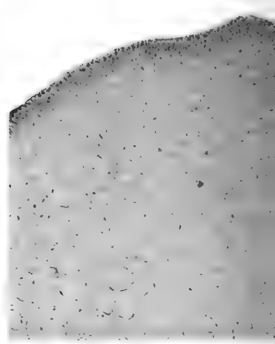

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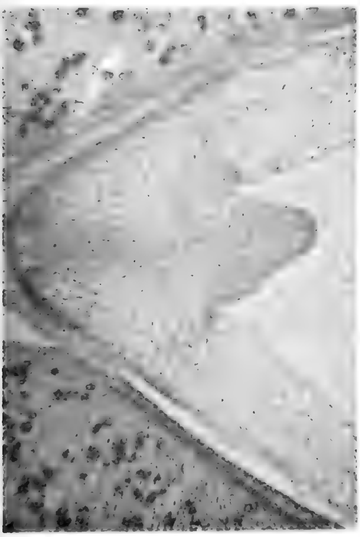

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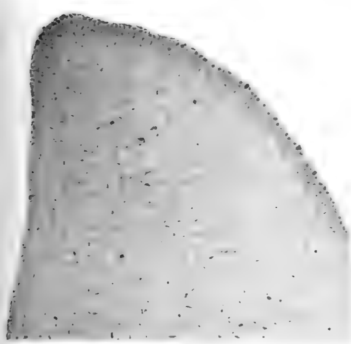

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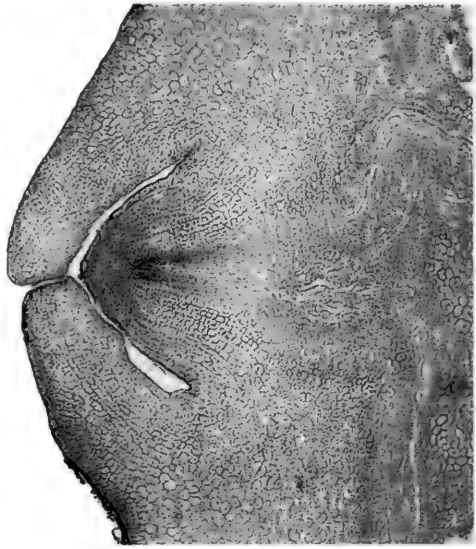

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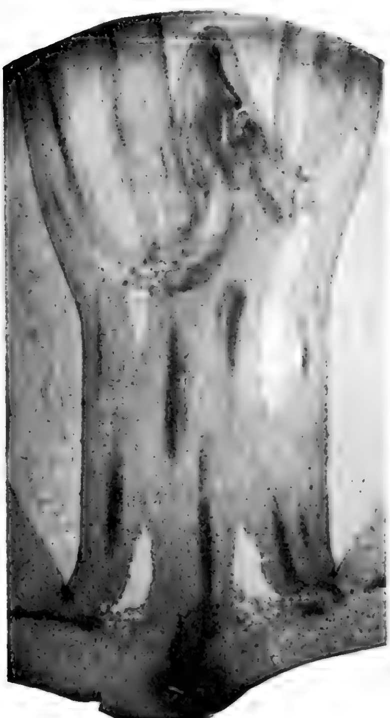

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PLATE L.

THE HELIOTYPE PRINTING CO., BOSTON.

XXXIX. CONTRIBUTIONS TO A KNOWLEDGE OF THE LICHENS OF MINNESOTA.—VI. LICHENS OF NORTHWESTERN MINNESOTA.

Bruce Fink.

CONSIDERATIONS OF DISTRIBUTION AND HABITAT.

The collections upon which this paper is based were made during the last half of June and all of July, 1900. The region traversed comprises parts of Ottertail, Beltrami and Red lake counties in northwestern Minnesota. This region was not supposed, previous to its study, to be a rich field for a lichenist, but because of its relationship to other portions of the state as to lichen flora * it seemed necessary that it should be investigated. Consequently the collection of somewhat more than 200 species as a result of the most extended collecting trip that I have yet made in Minnesota fully met my expectations as to probable results.

The itinerary was so planned as to include regions furnishing the greatest possible variety of substrata, moisture and other conditions calculated to cause variations as to lichen flora. Thus the most southern and western points reached were entirely devoid of conifers and possessed an arboreal flora quite similar to that of the southern portion of the state. These areas too were near the border between the wooded region to the east and the prairie to the west. The areas thus briefly characterized are those about Battle lake and Thief River Falls. The southern portion of the territory traversed, studied at Battle lake and Henning, gave a good view of the high morainic area of the state with its numerous rounded hills covered with granitic bowlders and calcareous soil and pebbles and possessing a scant growth of trees here and there. This southern portion was

* Fink, B. Contributions to a knowledge of the Lichens of Minnesota.—IV. Lichens of the Lake Superior Region. Minnesota Bot. Stud. 2: 234. 29 D. 1899.

also selected to furnish a connecting link with the lichen flora already studied farther south in the state. To ascertain the relationship of northwestern with northeastern Minnesota, previously studied, as to lichen flora, two regions, Bemidji and Red lake, were chosen, having an abundance of conifers and swamps. These two regions lie to the north and east of the others previously named and well within the pineries. It is to be regretted that none of the area studied possessed rock exposures of any sort, similar either to those in southern or in northern and northeastern Minnesota. These have since been reached in a study of the northern boundary of the state directly north of the area now under consideration.

The first area studied was that about Battle lake, about 150 miles northwest of Minneapolis, on the border between the wooded and prairie regions. The lichen habitats here are granitic and lime bowlders, earth and trees. The absence of rock exposures here, as well as elsewhere in the area studied during the summer, detracted much from the richness of the flora. The trees in the region about Battle lake are much the same as those about Minneapolis and in the portions of southwestern Minnesota studied in 1899. This similarity as to arboreal flora, as well as the presence of the granitic and calcareous bowlders gave a lichen flora quite similar to that of the more southern regions named above. A careful consideration of these resemblances, such as was undertaken for two regions in the second paper of this series,* would of itself lead to a long and laborious article, and must be omitted to give space for more important ecologic considerations. A noticeable feature of the lichen flora about Battle lake is that nearly all the trees growing lichens are common near the lakes and in heavy woods back from the lakes, but rare in woods back from the lakes and not heavy. All this is much like the conditions about Minneapolis, as discussed in the second paper of this series.† However, turning to the rocks, they were found literally covered with lichens even up to the very hill-tops in the morainic area south of the town. The whole number of species of lichens collected about Battle lake is 111. Comparing this with the numbers

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* Fink, B. Contributions to a Knowledge of the Lichens of Minnesota.—II. Lichens of Minneapolis and Vicinity. Minn. Bot. Stud. 1 : 703–716. 31 My. 1897.

† Fink, B. l. c., 705.

hitherto recorded for various well-studied localities in the state in this series of papers, we find the region slightly poorer in lichens than any other region in Minnesota having as much variety as to substrata.

The next collecting station was at Henning, about 35 miles to the northeast. This area was selected especially for the study of the flora of the Leaf hills to the south of the town and for that of the tamarack and spruce swamps, which were not found farther southwest. Prominent among the floral elements of the swamps are species of *Usnea*, *Parmelia caperata* (L.) Ach., *Parmelia saxatilis* (L.) Fr., *Alectoria jubata* (L.) Tuck. and *Cetraria ciliaris* (Ach.) Tuck. Other species will be listed toward the close of these considerations in the discussion of formations. Passing from the swamps to the Leaf hills three miles away, all of the above species become rare or entirely wanting, though the two *Parmelias* are more frequent where large trees extend, in a few places, to the tops of the morainic hills. *Rinodina sophodes* (Ach.) Nyl. and *Arthonia lecideella* Nyl., become abundant on the shrubs of oak, poplar and birch in the hills. These hills probably reach an elevation of 1,800 feet south of Vining and form the hightest morainic area in the state. The drift bowlders and pebbles of granite and limestone extend to the very summits of the hills and furnish an excellent field for the study of lichen formations, especially of granitic bowlders. The calcareous matter of the drift has been ground fine as powder or left as small pebbles. The soil contains enough lime so that the lichen formation characteristic of calcareous earth is well developed, and the limy pebbles also support a well developed calcareous rock-lichen formation. Black peak about four miles south of Vining is an especially good place for the study of the last two formations, which will receive careful consideration later in this paper. It may be noted in passing that the lichen flora of this second region is a much richer one than that first studied near the border of the wooded region, where the morainic hills are less developed, where trees are less numerous and of fewer species and where the tamarack swamps are wanting. In the region about Henning 140 species and varieties were collected in about the same time as was required to find the 111 at Battle lake.

Passing on to the next area studied at Bemidji 75 miles north of Henning and well within the pineries where there is more variety as to trees, 154 species were collected, though the calcareous formations were entirely absent and the granitic only poorly developed. The disadvantage due to absence of granitic and calcareous lichen formations seemed to be more than offset by the unusual richness of the formations of the tamarack and the cedar swamps and the earth under the pines. As this was my first opportunity for a careful study of these three formations, and the tree formations were also especially rich as well there, somewhat more time was taken for the collecting at Bemidji than elsewhere. However, notwithstanding the scarcity of any kind of bowlders and the absence of rock exposures, the Bemidji region may be regarded as one of the richest lichen floral areas in Minnesota, while Henning with its greater variety of substrata and favorable conditions is scarcely inferior.

From Bemidji I passed to Thief River Falls, about 80 miles to the northwest. Here I found a territory composed for the most part of low flat prairie, but with good woods along the banks of Red lake and Thief rivers. The trees are mostly birches, poplars, oaks and elms, forming a monotonous arboreal flora by no means favorable to the production of a large number of lichens. Inspection of the list of species and varieties recorded for this region will show that only 43 lichens were found on these trees to compare with more than twice as many on trees at Bemidji, and that these 43 are in general the most common of Minnesota lichens growing on trees. Marshes are frequent, and devoid of trees; or having the same species as grow on the higher ground, sustain no peculiar lichen species. Both granitic and lime bowlders are frequently seen in the region, but they are almost totally bare of any sort of plant life. Doubtless this is due partly to fires which frequently run over the prairies. In places pastured for several years so that fires have not occurred, lichens are beginning to take possession of the rocks. Yet it is difficult to explain the absence of lichens along high bowlder-strewn river banks, as in certain localities toward St. Hilaire, on any supposition. It will be very interesting to note the increase of lichen flora on the rocks of this region as the country becomes settled more densely and fires are kept out. In order that this may be done, I record the few lichens now occurring rarely on these rocks.

Rinodina oreina (Vill.) Mass.
Lecanora varia (Ehrh.) Nyl.

Lecanora varia (EHRH.) NYL. var. **polytropa** NYL.
Placodium murorum (HOFFM.) DC.
Placodium elegans (LINK) DC.
Physcia cæsia (HOFFM.) NYL.
Parmelia conspersa (EHRH.) ACH.

The earth lichen flora is as poorly developed as that of the trees and rocks, and the whole known lichen population of the area comprises only 78 species and varieties and is the most scanty yet studied in the state, except that at Pipestone, where trees are almost wholly absent.

The last collecting ground was at Red lake, some 65 miles east and somewhat south of Thief River Falls. This area is about 36 miles north of the one previously studied at Bemidji and has a lichen community very similar. Here the only bowlders that gave any noteworthy results were those along the lake shore, and the lichens on them were, all but three or four, of the same species as those growing upon the adjacent trees. With this dearth of rock lichens the territory, probably not quite so thoroughly studied as the one to the south about Bemidji, gave only 120 lichen species and varieties.

Compared with other portions of the state of equal size, whose lichen floras have been investigated, this one is somewhat the poorest in lichens. The number collected is little larger than that found in southwestern Minnesota, but should be considerably larger, as fully one-third more time was taken for the collecting. The Lake Superior region gave 258 lichen forms in about the same time as was spent in making the collections in northwestern Minnesota. However, this is what would be expected since the former area is more diversified as to climate, the portion near the lake having many arctic and subarctic species, while the northern and western portions yielded essentially the same species as the region now under consideration. Then too the absence of the great exposures of igneous rocks of the Superior region has already been noted for the present one, in which only 58 species and varieties of lichens, or about 28 per cent. of the whole lichen flora, were found on rocks, whereas nearly 50 per cent. of these plants in the former region were collected on the rocks. The occurrence of about three-fourths of the entire number of lichens of the whole area under consideration in one small area about Bemidji demonstrates that little of the difference in the composition of the flora of various portions of the territory is due to edaphic causes. What variety exists is due for the most part to the partial extension of the conifers, tamarack swamps and calcareous soil, bowlders and pebbles over the region.

The comparative richness of different collecting grounds as to lichen species has been noted in passing. It may be added that the number of species occurring in each place and not elsewhere found bears some relation to the whole number of species found in each area studied. Thus Battle lake with a total of 111 collected has 7 not collected elsewhere. The numbers for other collecting grounds are: Henning 140 and 18, Bemidji 154 and 31, Thief River Falls 78 and 2 and Red lake 120 and 14. Comparison of the numbers shows, as would be expected, that the number of rare lichens collected in the best collecting grounds is in much larger proportion to the total number collected than in the areas less favored as to lichen flora, where one finds only the commonest species.

Of the 41 lichen species recorded in the fourth paper of this series as arctic or subarctic,* the following seven occur in the region considered in this paper, while no new northern forms were discovered.

Ramalina pusilla (Prev.) Tuck.
Usnea cavernosa Tuck.
Stereocaulon paschale (L.) Fr.
Cladonia deformis (L.) Hoffm.
Cladonia digitata (L.) Hoffm.
Biatora leucophæa (Flk.) Tuck.
Buellia petræa (Flot., Kbr.) Tuck.

The other species not new to Minnesota are in general those found farther south in the state. Thus the prediction, as to resemblance of the present flora to that farther south in Minnesota, made in the fourth paper of this series,† seems to be fairly well established, though the extreme northern boundary of the state west of the Snowbank lake area remains to be considered in the next paper. Of the genera having northern species in northeastern Minnesota, *Solorina*, *Heterothecium*, *Bæomyces* and *Umbilicaria* were not found in the area now under consideration, nor was there found more than a single genus, *Melaspilea*, new to the state. Moreover, the paucity of lichens in northwestern

* Fink, B. l. c., 227–232.
† Fink, B. l. c., 233–234.

as compared with northeastern Minnesota extends to genera as well as to species, so that 36 genera were found in the former area and 39 in the latter. This would be expected when we notice that all the seven northern species recorded above belong to genera occurring in the southern half of Minnesota, while the four genera named above as not occurring in northwestern Minnesota also have no representatives in the southern half of the state, being for the most part the most strictly northern genera thus far found in Minnesota.

The summer's collecting brought to light 48 species and varieties new to the state, of which 9 are new to North America and 3 new, while another 3 are yet undetermined. The discovery of so large a proportion of new material nearly one-fourth of all species collected, after other parts of the state had been for the most part, well studied, is somewhat of a surprise, and seems to indicate that there is yet a good number of lichens to be found in Minnesota. As to forms new to North America, this paper adds a larger number than all the previous lists published for the state.

The genus *Calicium* deserves special mention because of the interesting facts disclosed when the material collected was carefully studied. Previously nine species and varieties had been recorded for the state, and though the genus is not an arctic or subarctic one, I had not expected to find it well represented in territory otherwise closely related to the southern half of Minnesota as to lichen population. Consequently, I was not a little surprised to find ten species in my collection, one more than had hitherto been reported for the state, and yet more when I found that six of the species were new to the state, thus raising the number of *Caliciums* in Minnesota to 15 species and varieties. We now have found within the state about half of the forms of the genus recorded for North America, and *Calicium* can no longer be regarded as a genus peculiar to the Atlantic region. The cause of the extension of members of the genus into a region closely related with southern Minnesota as to lichen flora is to be found in the circumstance that the *Caliciums* seem to follow the conifers regardless of slight climatic changes. While some other genera furnish each a few species new to the state, or not found further south in Minnesota, there is nothing especially noteworthy about the distribution of any of them, as the species are in general such as could be expected to occur farther south, and may have been overlooked.

It now remains to follow out the ecologic study begun in the fifth paper of this series,* pursuing the general plan of study introduced there. First of all I shall consider some of the formations therein recorded and draw some comparisons. As in the former paper I shall consider especially the more common lichens, which give character to the flora and lichen formations of the state. Beginning with the lichen formation of the exposed granitic bowlders about Battle Lake, the formation may be designated as follows:

LECANORA LICHEN FORMATION OF EXPOSED GRANITIC BOWLDERS (BATTLE LAKE).

Physcia stellaris (L.) TUCK. var. **apiola** NYL., C.
Physcia cæsia (HOFFM.) NYL., CX.
Placodium elegans (LINK.) DC., C.
Placodium cinnabarrinum (ACH.) ANZ., C.
Placodium aurantiacrm (LIGHTF.) NAEG. and HEPP., B.
Placodium cerinum (HEDW.) NAEG. and HEPP., B.
Placodium cerinum (HEDW.) NAEG. and HEPP. var. **sideritis** TUCK., CX.
Placodium vitellinum (EHRH.) NAEG. and HEPP., CX.
Lecanora rubina (VILL.) ACH., CX.
Lecanora muralis (SCHREB.) SCHAER. var **saxicola** SCHAER., C.
Lecanora hageni ACH., C.
Lecanora varia (EHRH.) NYL., B.
Lecanora varia (EHRH.) NYL. var. **polytropa** NYL., B.
Lecanora cinerea (L.) SOMMERF., CX.
Lecanora calcarea (L.) SOMMERF. var. **contorta** FR., C.
Lecanora xanthophana NYL., CX.
Lecanora cervina (PERS.) NYL., C.
Lecanora fuscata (SCHRAD.) TH. FR., C.
Rinodina oreina (ACH.) MASS., C.
Rinodina sophodes (ACH.) NYL., CX.
Rinodina sophodes (ACH.) NYL. var. **exigua** FR., B.
Buellia pullata TUCK., C.
Buellia petræa (FLOT., KBR.) TUCK., CX.
Buellia petræa (FLOT., KBR.) TUCK. var. **montagnæi** TUCK., C.

* Fink, B. Contributions to a Knowledge of the Lichens of Minnesota.—V. Lichens of the Minnesota Valley and Southwestern Minnesota. Minn. Bot. Stud. 2: 283–308. 29 D. 1899.

This formation may be compared est with the si milar one upon the exposed granite at Granite Falls.* As might be expected the Battle lake formation confined to the bowlders suffers somewhat in comparison with that at Granite Falls, which is developed upon extensive exposures of granite. The number of lichens in the formation at the former place is 24 and the number at the latter 31. Species common to the two similar formations I have marked (C), and those found at Battle lake only are marked (B). Of the ten species found at Granite Falls and not at Battle lake, *Parmelia conspersa* (Ehrh.) Ach. deserves special mention as being unaccountably rare in the region covered by this paper. The entire absence of another of the ten, *Biatora rufonigra* Tuck., from the region is quite as remarkable. The other eight are lichens either not widely distributed in the state, or not common on granitic rocks. Eight of the species of the formation recorded above have occurred in all of the four localities in the state in which similar formations have been recorded. These may be considered the most constant elements of such formations in Minnesota, and I have marked them (X). The formation is also well developed in the Leaf hills, but nothing would be gained by recording it.

As to the general character of the lichens of the formation, all but the first three and the first *Lecanora* are strictly crustaceous, and this last plant, as well as the foliaceous *Placodium*, is nearly as closely adnate to the substratum as the crustaceous forms. The less adnate foliaceous species have a well-developed cellular cortex on all sides for support and for protection against too rapid evaporation of moisture in their exposed and dry habitat. Of the crustaceous species, the *Placodiums* have good upper and some of them a lower cortex, the *Lecanoras* have either an upper only or none, while the *Rinodinas*, except possibly the first, have no cortical layers; and the last statement applies to the *Buellias* as well. The forms, having no cortex or a poorly-developed one and growing in such a dry, exposed habitat, have very small thalli. A large foliaceous lichen with no cortex, as a *Collema* for instance, could hardly exist in the present formation. Finally the lichens of the formations are a few foliaceous species with well-developed cortex above and below, but still quite closely adnate, and a much larger number with no cortex or an upper one only, but having

* Fink, B. l. c., 286, 287.

very small thalli, and though epilithic yet very closely adnate, so that moisture easily passes into them from the rocky substratum below.

Next may naturally follow the mixed lichen formation of shaded granitic bowlders.

MIXED LICHEN FORMATION OF SHADED GRANITIC BOWLDERS (RED LAKE).

A. Probably naturally belonging to the rocks.

Biatora inundata FR.
Verrucaria nigrescens PERS.
Verrucaria viridula ACH.
Verrucaria muralis ACH.

B. Near trees and probably migrated from them.

Theloschistes lychneus (NYL.) TUCK., C.
Parmelia borreri TURN., C.
Parmelia saxatilis (L.) FR., C.
Parmelia olivacea (L.) ACH.
Parmelia caperata (L.) ACH., C.
Physcia speciosa (WULF., ACH.) NYL., C.
Physcia pulverulenta (SCHREB.) NYL., C.
Physcia stellaris (L.) TUCK.
Physcia stellaris (L.) TUCK. var. **apiola** NYL.
Physcia astroidea (FR.) NYL.
Physcia hispida (SCHREB., FR.) TUCK.
Physcia obscura (EHRH.) NYL., C.

Of the 12 species of the formation probably having migrated from trees near by, seven marked (C) are common to all of the six similar formations studied in the state,* but none of the four elements naturally belonging to the rocks are common to the similar formations.

Comparing these lichens with those of the exposed rock formation above, we find an entirely different type of thallus to prevail, viz., the foliaceous type of the *Parmelias* and *Physcias* with thalli having well developed cortical layers. And as would be expected in an ombrophytic lichen formation having such thalli, the plants are not so closely adnate to the substratum as those of the exposed rock formation, but are

* Fink, B. l. c., 290–293.

more loosely attached by rhizoids. However, those undoubtedly belonging to the rocks have poorly developed thalli with no cortex or an upper pseudo-cortex, and *Verrucaria muralis* Ach., an intruder usually growing upon calcareous rocks in exposed places, is essentially hypolithic. That the three forms having poorly developed and epilithic thalli should seek ombrophytic associations is, of course, natural enough.

The *Cladonia-Peltigera* formation of shaded earth was found remarkably well developed under the pines at Bemidji. The table of species below shows 20 forms. The formation here, though containing the same genera as the similar one farther south,* is twice as well developed, being especially rich in *Cladonias*, which flourish under the pines. I have marked (C) the five species common to the similar formations noted for the state, as being the most constant elements of such formations, at least in Minnesota. I shall now record the formation and follow with a discussion of structure of the lichens composing it.

CLADONIA-PELTIGERA LICHEN FORMATION OF SHADED EARTH (BEMIDJI).

Peltigera horizontalis (L.) HOFFM.
Peltigera canina (L.) HOFFM., C.
Peltigera canina (L.) HOFFM. var. **spuria** ACH.
Peltigera canina (L.) HOFFM. var. **sorediata** SCHAER., C.
Collema pulposum (BERNH.) NYL., C.
Collema limosum ACH.
Collema crispum BORR.
Cladonia cariosa (ACH.) SPRENG.
Cladonia pyxidata (L.) FR., C.
Cladonia degenerans FLK.
Cladonia gracilis (L.) NYL., C.
Cladonia gracilis (L.) NYL. var. **symphycarpia** TUCK.
Cladonia gracilis (L.) NYL. var. **verticillata** FR., C.
Cladonia gracilis (L.) NYL. var. **elongata** FR.
Cladonia gracilis (L.) NYL. var. **hybrida** SCHAER.
Cladonia cornuta (L.) FR.
Cladonia furcata (HUDS.) FR.
Cladonia rangiferina (L.) HOFFM.
Cladonia rangiferina (L.) HOFFM. var. **alpestris** L.
Cladonia uncialis (L.) FR.

* Fink, B. l. c., 294–295.

Comparing the lichens of this formation with those of the shaded rock formation above, we find that, as a result of the more moist habitat of the forms, growing on earth in shade and usually on an abundance of decaying vegetable remains which hold moisture, the formation consists of plant individuals even less closely attached to the substratum, except perhaps the *Collemas*, which have no cortex and which, therefore, even in their shaded situation, remain close to the substratum to absorb the moisture which is rapidly evaporated from their non-cellular surfaces. The *Peltigeras* with a well developed upper cortex hold moisture better and rise somewhat higher. The podetia of the *Cladonias* have a surrounding pseudo-cortex of densely interwoven hyphæ, which serves for protection against too rapid evaporation of moisture as well as for mechanical support. Hence the *Cladonias* rise vertically and are especially numerous as to species and individuals in this moist and shaded formation, as well as unusually luxuriant. Thus it appears that we have in this formation, as in those already considered plants adapted in very different ways to the environment.

The remarkable constancy of occurrence of certain floral elements in certain environments can scarcely be better illustrated than by comparing the calcareous earth lichen formation given below with similar ones recorded in the fifth paper of this series for Granite Falls, Minnesota, and Fayette, Iowa.*

BIATORA DECIPIENS LICHEN FORMATION OF EXPOSED CALCAREOUS EARTH (LEAF HILLS).

Heppia despreauxii (MONT.) TUCK., C.
Urceolaria scruposa (L.) NYL., C.
Biatora decipiens (EHRH.) FR., C.
Biatora decipiens (EHRH.) FR. var. **delabata** AUCT., C.
Biatora muscorum (SW.) TUCK., C.
Endocarpon hepaticum ACH., C.

All of the six floral elements recorded in the present formation and marked (C) are also listed in the formation at Granite Falls and Fayette, and each of these last two contains a single rare species not discovered in the Leaf hills formation. As in the localities previously studied, the formation in the hills is best developed on the hill-sides where the plants are washed with the lime-impregnated water which flows down the slope during

*Fink, B. l. c., 295–296.

rains, and it may be regarded as well established that such a sloping surface is best adapted to the development of the formation.

As to structural adaptations to an exposed and usually dry habitat, the lichens of the formation all have small thalli and are closely adnate. The rudimentary thallus of *Biatora muscorum* (Sw.) Tuck. has no cortex, and the somewhat better developed one of the *Urceolaria* has only a poorly developed pseudo-cortex above. Of the larger and better developed thalli, that of *Biatora decipiens* (Ehrh.) Fr. has a very heavy cellular cortex above, the *Endocarpon* has a well-developed cortex on all sides while the *Heppia* is cellular throughout. In these larger thalli growing in exposed dry places, the cellular areas serve of course not only for support, but also for protection of the algæ within and against excessive evaporation; nor must it be supposed that any of these thalli are large for a really large thallus is seldon seen in such a formation, and if present at all, should be considered an accident in plant distribution not to be recorded. The four better developed thalli are then only large in comparison with the other two and average about 3 to 6 mm. in diameter. The two rudimentary thalli of the formation are able to persist because very small and closely adnate.

Comparing next the lichen formation of the calcareous pebbles of the same area with the same two for the Minnesota and Iowa localities used above,* we find that the adding of another Minnesota locality still leaves the same five species common (C) to such formations for the two states. This third formation of the kind recorded below, establishes a general resemblance of such formations in widely separate localities.

LECANORA CALCAREA CONTORTA LICHEN FORMATION OF EXPOSED LIMESTONE (LEAF HILLS).

Placodium vitellinum (EHRH.) NAEG. and HEPP. var. **aurellum** ACH., C.

Lecanora muralis (SCHREB.) SCHAER. var. **versicolor** FR.

Lecanora subfusca (L.) ACH.

Lecanora calcarea (L.) SOMMERF. var. **contorta** FR., C.

Lecanora privigna (ACH.) NYL., C.

Lecanora privigna (ACH.) NYL. var. **pruinosa** AUCT.

Rinodina bischoffii (HEPP.) KBR.

* Fink, B. l. c., 297

Endocarpon pusillum HEDW., C.
Verrucaria nigrescens PERS.
Verrucaria muralis ACH., C.

The lichens of the above formation have small thalli, closely adnate or even more or less strictly hypolithic. All except the last *Verrucaria*, which is hypolithic, and *Lecanora privigna* (Ach.) Nyl., which has a very rudimentary and evanescent thallus have more or less of a cellular or pseudocellular cortex above. None except the first *Lecanora*, which has the largest thallus in the formation, showed any indication of such structure below. The upper cortex gives these better developed but still small thalli sufficient protection against evaporation and adapts them to their dry station.

The lichen formation for trees with rough and smooth bark at Bemidji are in general quite like the corresponding ones recorded for Mankato and Granite Falls,* but are rather richer in species. I record them below as they may be of use in the further study of the lichens of northern Minnesota.

PARMELIA LICHEN FORMATION OF TREES WITH ROUGH BARK (BEMIDJI).

Ramalina calicaris (L.) FR. var. **fastigiata** FR.
Ramalina calicaris (L.) FR. var. **fraxinea** FR.
Usnea barbata (L.) FR. var. **florida** FR.
Theloschistes chrysopthalmus (L.) NORM.
Theloschistes polycarpus (EHRH.) TUCK.
Theloschistes lychneus (NYL.) TUCK.
Theloschistes concolor (DICKS.) TUCK.
Theloschistes concolor (DICKS.) TUCK. var. **effusa** TUCK.
Parmelia crinita ACH.
Parmelia borreri TURN.
Parmelia tiliacea (HOFFM.) FLK.
Parmelia saxatilis (L.) FR.
Parmelia saxatilis (L.) FR. var. **sulcata** NYL.
Parmelia olivacea (L.) ACH.
Parmelia olivacea (L.) ACH. var. **sorediata** (ACH.) NYL.
Parmelia caperata (L.) ACH.
Physcia speciosa (WULF., ACH.) NYL.
Physcia hypoleuca (MUHL.) TUCK.

* Fink, B. l. c., 302-305.

Physcia pulverulenta (SCHREB.) NYL.
Physcia stellaris (L.) TUCK.
Physcia hispida (SCHREB., FR.) TUCK.
Physcia obscura (EHRH.) NYL.
Collema pycnocarpum NYL.
Collema flaccidum ACH.
Collema nigrescens (HUDS.) ACH.
Leptogium myochroum (EHRH., SCHAER.) TUCK.
Placodium aurantiacum (LIGHTF.) NAEG. and HEPP.
Placodium cerinum (HEDW.) NAEG. and HEPP.
Lecanora subfusca (L.) ACH.
Lecanora varia (EHRH.) NYL.
Lecanora verrucosa (ACH.) LAUR.
Pertusaria finkii A. ZAHLB.
Biatora turgidula (FR.) NYL.
Biatora arthropurpurea (MASS.) HEPP.
Biatora rubella (EHRH.) RABENH.
Biatora fuscorubella (HOFFM.) TUCK.
Biatora atrogrisea (DELIS.) HEPP.
Lecidea enteroleuca FR.
Buellia alboatra (HOFFM.) TH. FR.
Buellia parasema (ACH.) TH. FR.
Opegrapha sp.
Graphis scripta (L.) ACH.
Graphis scripta (L.) ACH. var. limitata ACH.
Graphis scripta (L.) ACH. var. recta (HUMB.) NYL.
Arthonia lecideella NYL.
Calicium lucidum (TH. FR.) FINK.
Coniocybe pallida (PERS.) FR.
Melaspilea arthonioides (FÉE) NYL.
Pyrenula leucoplaca (WAHL.) KBR.
Pyrenula leucoplaca (WAHL.) KBR. var. pluriloculata var. nov.

I shall now record the smooth bark formation and then consider the adaptations of the two groups together.

PYRENULA FORMATION OF TREES WITH SMOOTH BARK (BEMIDJI).

Theloschistes polycarpus (EHRH.) TUCK.
Theloschistes concolor (DICKS.) TUCK.
Parmelia olivacca (L.) ACH.
Placodium cerinum (HEDW.) NAEG. and HEPP.

Lecanora subfusca (L.) Ach.
Lecanora varia (Ehrh.) Nyl.
Rinodina sophodes (Ach.) Nyl.
Biatora atropurpurea (Mass.) Hepp.
Biatora rubella (Ehrh.) Rabenh.
Lecidea enteroleuca Fr.
Buellia parasema (Ach.) Th. Fr.
Graphis scripta (L.) Ach.
Arthonia lecideella Nyl.
Arthonia radiata (Pers.) Th. Fr.
Sagedia oxyspora (Nyl.) Tuck.
Pyrenula punctiformis (Ach.) Naeg. var. **follax** Nyl.
Pyrenula cinerella (Flot.) Tuck. var. **quadriloculata** Fink.
Pyrenula leucoplaca (Wahl.) Kbr.
Pyrenula leucoplaca (Wahl.) Kbr. var. **pluriloculata** var. nov.

Inspection of the list of plants given above for the rough bark formations based on characters of substratum, shows lichens varying widely structurally and adapted to the formation in very different ways. There are the *Biatoras*, which usually occur in the more moist and shaded spots in this scattered formation and have small thalli usually without cellular cortex. The same may be said of the *Buellias* and the *Acolium*, while the *Lecanoras*, *Placodiums*, and *Pertusarias* usually have somewhat larger thalli and some indication of an upper cortex at least. Even more rudimentary than any of the above are the thalli of the *Opegraphas*, *Graphies*, *Pyrenulas* and the *Coniocybe* which are hypophlœodal and thus protected. However the *Collemas* without cellular cortex rise to the foliaceous type, but seek very damp and well shaded habitats. The *Leptogium*, with upper cortex only, seeks damp places also. Next may be considered the *Theloschistes*, *Parmelias* and *Physcias* with foliaceous thalli having good cortex on all sides, and which are not so closely adnate to the substratum as the crustaceous forms. Finally we have the fruticulose type of structure represented in the formation in the *Ramalinas* and *Usneas*. These plants have a good cortex on all sides though not cellular at least in the first genus, and in well shaded and moist portions of the formation are quite common. This formation furnishes the most variety as to methods of adaptation of any herein recorded.

The lichens composing the smooth bark formation are not so various in type, including only the more crustaceous and rudimentary types of those given above. The more developed forms with more specialized rhizoids usually fail to gain a foothold on the smooth bark.

Next in order may be considered the formation of old wood.

CALICEI LICHEN FORMATION OF DEAD WOOD (BEMIDJI).

Placodium cerinum (HEDW.) NAEG. and HEPP. var. **pyracea** NYL., C.

Placodium ferrugineum (HUDS.) HEPP.

Lecanora varia (EHRH.) NYL., C.

Lecanora varia (EHRH.) NYL. var. **sæpincola** FR.

Lecanora varia (EHRH.) NYL. var. **symmicta** ACH.

Rinodina sophodes (ACH.) NYL., C.

Biatora uliginosa (SCHRAD.) FR.

Lecidea enteroleuca FR. var. **ambigua** ANZ.

Buellia parasema (ACH.) TH. FR., C.

Buellia myriocarpa (DC.) MUDD.

Acolium tigillare (ACH.) DN.

Calicium lucidum (TH. FR.) FINK.

Calicium sp.

Calicium trabinellum (SCHAER.) KBR.

Calicium parietinum ACH.

Calicium trichiale ACH. var. **cinereum** NYL.

This formation is given a slightly different designation from the similar ones previously recorded for Mankota and Granite Falls * because of the absence of old boards in the new country about Bemidji. The formation recorded in this paper is similar to the two formerly recorded, but much richer, especially in *Calicei*, for which group the formation is named. Yet the three *Calicei* formations recorded for the state show more variation than other related formations and have only four (C) common species of a total of 23. Moreover, not a single member of the *Calicei* is common to the three formations. From some hasty observations made in 1897 in the Lake Superior region,† I had come to believe that certain *Caliciums* normally grow on rotting wood. Careful observation in 1900 showed that all

* Fink, B. l. c., 305–306.

† Fink, B. l. c., 306.

found during that summer at least belong to living or to dead wood formations though occasionally the plants on dead wood may persist after the wood has begun to decay perceptibly at the surface.

The lichens of this formation are of the small, closely adnate or hypophœodal crustaceous type with upper cortical protection in the *Lecanoras* and *Placodiums* and none in the *Rinodina*, the *Lecidea*, the *Buellias* and the *Caliciums*. The substratum is a dry one usually, as I have not concluded the more damp and more frequently rotting logs of the tamarack swamps, which have their own peculiar formation recorded below. Hence, the crustaceous type of thallus is especially adapted to the formation. True the *Caliciums* put up the minute erect podetia, but these are solid cylinders of hyphæ running in a longitudinal direction and usually quite devoid of the algal symbionts which might suffer from dryness.

The last of the formations to be compared with those studied in 1897 in southwestern Minnesota is the following.

CLADONIA LICHEN FORMATION OF ROTTEN WOOD (BEMIDJI).

Peltigera canina (L.) HOFFM., C.
Peltigera canina (L.) HOFFM. var. **sorediata** SCHAER.
Cladonia mitrula TUCK.
Cladonia pyxidata (L.) FR.
Cladonia pyxidata (L.) FR. var. **neglecta** (FLK.) MASS.
Cladonia fimbriata (L.) FR. var. **tubæformis** FR., C.
Cladonia fimbriata (L.) FR. var. **simplex** (WEIS.) FLOT.
Cladonia gracilis (L.) NYL., C.
Cladonia gracilis (L.) NYL. var. **hybrida** SCHAER.
Cladonia gracilis (L.) NYL. var. **symphycarpia** TUCK.
Cladonia gracilis (L.) NYL. var. **verticillata** FR., C.
Cladonia gracilis (L.) NYL. var. **anthocephala** FLK.
Cladonia macilenta (EHRH.) HOFFM.
Cladonia bacillaris NYL.
Cladonia cristatella TUCK.

Comparing this formation with the corresponding ones at Mankato and Granite Falls,* we find that the formations are constant at least as regards genera, the one herein recorded for a region, especially rich in *Cladonias*, being of course richer in species than the two formerly studied. The addition of a third

*Fink, B. l. c., 306-307.

locality has only diminished the number of common species (C) by one. Like the very similar *Cladonia-Peltigera* formation recorded above, this one is especially developed under the pines. Indeed, it hardly seems necessary to separate them in the region now under consideration.

The adaptations of the plants of the formation are similar to those fully discussed under the *Cladonia-Peltigera* formation. Briefly then, the *Peltigeras*, having only an upper cellular cortex, lie flat on the substratum, while the *Cladonias*, protected on all sides by a pseudo-cortex, rise vertically and become luxuriant in the moist and shaded habitat.

Next in order I shall consider a number of formations somewhat studied in the Lake Superior region in 1897, but not yet recorded for the state, as it was then found impossible to take sufficient data in the rapid survey of a region fully one fourth of whose lichen flora the writer had previously known only through herbarium specimens or not at all. In the second survey of a somewhat similar region, I was able to take sufficient field notes upon which to base an ecologic study of lichen formations peculiar to the region as well as those previously known. These formations, new to the state, will be recorded for more than one place as far as possible.

First of all I shall record the formation of the pine trees, naming it for the *Usnei* group which give character to this plant community:

USNEI LICHEN FORMATION OF THE PINES (RED LAKE).

Cetraria ciliaris (ACH.) TUCK. (cones).
Cetraria juniperina (L.) ACH. var. **pinastri** ACH.
Evernia prunastri (L.) ACH. (cones).
Usnea barbata (L.) FR. var. **florida** FR.
Alectoria jubata (L.) TUCK. var. **chalybeiformis** ACH.
Theloschistes chrysopthalmus (L.) NORM.
Parmelia physodes (L.) ACH.
Physcia tribacia (ACH.) TUCK.
Physcia hispida (SCHREB., FR.) TUCK.
Lecanora varia (EHRH.) NYL. (cones).
Lecanora subfusca (L.) ACH. var. **argentata** (ACH.) (cones).
Buellia parasema (ACH.) TH. FR. (cones).
Calicium lucidum (TH. FR.) FINK.

On approaching a pine woods one is impressed with an apparent dearth of lichens, but after a careful study he becomes convinced that the plants are common enough when the trees, the fallen branches and the earth are carefully observed. The foliaceous *Parmelias*, *Physcias*, etc., so common on the deciduous trees, are not so frequently seen, but the pines certainly have their own peculiar formations, composed of lichens found of course on other substrata in various parts of the state. The variety of *Cetraria juniperina* (L.) Ach. and the *Calicium lucilium* (Th. Fr.) Fink are perhaps the most characteristic elements of the formation, as they are seldom seen elsewhere than on the conifers, though by no means common even in this formation. The similar formation was studied at Bemidji, and the only difference is that *Lecanora subfusca* (L.) Ach. replaces the variety. As indicated in the list of species, a number of the plants are as common or more so on the old cones as on other portions of the trees. Careful comparison of this formation with the *Parmelei* formation of trees with rough bark will demonstrate that the two are quite distinct, though resembling each other in some respects.

The adaptations of the lichens of this formation are somewhat various. They have been discussed somewhat under the rough bark formation above and will be further noticed under the *Usnea* formation below. However, while it is apparent that the fruticulose lichens of the *Usnei* group seem well adapted to the swamp *Usnea* formation given below where moisture is abundant, I have not been able to satisfy myself that the pines of the higher ground furnish more moisture than the deciduous trees of similar grounds. I suspect that the plants in this instance and in the formation given below for the swamps are quite as much influenced in their choice of habitat by an adaptation to coniferous wood as by amount of moisture. And I may add here that in other portions of this paper I have not taken into account any adaptations of the lichens to substrata of certain physical or chemical composition. The subject is a difficult one as yet little understood, and moreover I am convinced from observation that, beyond the well-known fact that some lichens prefer rocks, calcareous in some instances and granitic, etc., in others, while others prefer trees and in some instances a particular species or genus, the conditions as to shade, moisture, etc., are the important ones in determining the habitats of lichens and the composition of lichen formations.

I studied the lichens of the earth and rotting wood under the pines with a view to establishing a formation; but the plants were found to be so similar to those of the *Cladonia* lichen formation of rotten wood and the *Cladonia-Peltigera* lichen formation of shaded earth previously established that I have recorded them above in these formations, though possibly I have done violence in not separating them in this region for the sake of correlating results with former work in another area.

Because of close relationship to the above formation, I shall next consider the *Usnea* formation.

USNEA LICHEN FORMATION OF TAMARACKS IN SWAMPS (HENNING).

Cetraria ciliaris (ACH.) TUCK., C.
Evernia prunastri (L.) ACH., C.
Usnea barbata (L.) FR. var. **florida** FR., C.
Usnea barbata (L.) FR. var. **ceratina** SCHAER.
Usnea barbata (L.) FR. var. **dasypoga** FR.
Usnea cavernosa TUCK., C.
Alectoria jubata (L.) TUCK. var. **chalybeiformis** ACH., C.
Parmelia physodes (L.) ACH., C.
Parmelia olivacea (L.) ACH., C.
Parmelia caperata (L.) ACH., C.
Physcia hispida (ACH.) TUCK., C.
Calicium trichiale ACH. var. **cinereum** NYL.

The formation was afterward carefully examined at Bemidji and Red lake and was found to be a very characteristic one. At Bemidji were found all of the above-marked (C) and *Ramalina pusilla* (Prev.) Tuck., *Cetraria juniperina* (L.) Ach. var. *pinastri* Ach., *Alectoria jubata* (L.) Tuck. and *Calicium chrysocephalum* Ach. in addition. The Red lake formation contained all of the species found at Bemidji except the last two, so that those marked (C) are the ones common to the three similar formations.

The dominant elements in this formation are the *Usneas*, the *Evernia* and the *Alectoria*, which in the moist swamps and protected on all sides by a pseudo-cortex of closely arranged hyphæ, hang suspended or grow up from the substratum in fruticulose fashion. With these occur the less characteristic elements whose structure has been fully discussed and whose adaptations may be easily inferred. Though, as stated in the discussion of the *Usnei* formation of the pines, the plants may be adapted to the coniferous wood as well as to the moist habitat, it remains to be stated that the same species are both more numerous and more luxuriant in the swamps than on the upland pines.

The following formation must be regarded as somewhat doubtful till further studied.

STICTA PULMONARIA LICHEN FORMATION OF CEDAR SWAMPS (BEMIDJI).

Sticta pulmonaria (L.) ACH.
Nephroma lævigatum ACH.
Lecanora pallida (SCHREB.) SCHAER.
Lecanora pallescens (L.) SCHAER.
Pertusaria communis DC.
Calicium chrysocephalum ACH.

There is no doubt of the distinctness of the formation in the region as none of the plants were found elsewhere during the summer than in the cedar swamps, except the last which was also found in the tamarack swamps. The plants of the formation grow in dryer places in other regions and seem to be as well adapted to upland woods as many other lichens recorded for the tree formations of higher ground.

The swamps afford yet one other characteristic formation well developed in the area studied wherever tamaracks and cedars flourish. It may appropriately be designated as follows:

THE CALICIUM LICHEN FORMATION OF OLD LOGS AND STUMPS IN TAMARACK SWAMPS (HENNING).

Ramalina pusilla (PREV.) TUCK., C.
Cetraria ciliaris (ACH.) TUCK., C.
Parmelia saxatilis (L.) FR., C.
Cladonia mitrula TUCK., C.
Cladonia fimbriata (L.) FR. var. **tubæformis** FR., C.
Cladonia gracilis (L.) NYL., C.
Cladonia gracilis (L.) NYL. var. **hybrida** SCHAER., C.
Calicium trichiale ACH. var. **cinereum** NYL., C.
Calicium trachelinum ACH.
Calicium sp.
Calicium curtum TURN. and BORR.

Calicium trabinellum (SCHAER.) KBR.

Calicium parietinum ACH.

The similar formations were studied at Bemidji and Red lake, and the species marked (C) were found in each of the three formations. For Bemidji may be added *Biatora viridescens* (Schrad.) Fr. and for both Bemidji and Red Lake, *Cetraria juniperina* (L.) Ach. var. *pinastri* Ach. Although occurring in the same area as the second formation above on the living tamaracks, the present one will be found by comparison to be quite distinct both as to genera and species.

Growing in moist areas, the lichens of the formation are almost uniformly those which rise more or less from the substratum. Nearly all are the *Cladonias* and *Caliciums*, which have podetia rising erect from the substratum and are protected on all sides by a pseudo-cortex of densely interwoven hyphæ running in a longitudinal direction.

The earth lichen formations of the swamps were carefully noted and were found to be essentially like those of *Cladonia* formations of rotten wood recorded above, at least as to genera. I shall record the formation provisionally that it may be further studied and shall name it for a variety of *Peltigera* thus far found in the state only in the swamps.

PELTIGERA CANINA LEUCORRHIZA LICHEN FORMATION OF EARTH IN TAMARACK SWAMPS (BEMIDJI).

Peltigera canina (L.) HOFFM., C.

Peltigera canina (L.) HOFFM. var. **leucorrhiza** FLK., C.

Cladonia cariosa (ACH.) SPRENG., R L.

Cladonia pyxidata (L.) FR., C.

Cladonia gracilis (L.) NYL. var. **verticillata** FR., C.

Cladonia gracilis (L.) NYL. var. **hybrida** SCHAER., C.

Cladonia cenotea (ACH.) SCHAER., R L.

Cladonia furcata (HUDS.) FR., B and H.

Cladonia rangiferina (L.) HOFFM., C.

The similar formations were studied at Henning and Red lake. Those marked (C) are common to the three formations, those marked (R L) were found at Red lake only and the one marked (B and H) at Henning as well as at Bemidji. The adaptations of the plants of these formations are, of course, the same as those of the lichens of the *Cladonia* formations of rotten wood.

The following formation was distinctly discernible in the low woods about the tamarack swamps near Henning, the species composing it being unusually abundant. From the frequence of *Pertusarias* rare elsewhere in the region studied during the summer, I shall name it as follows:

PERTUSARIA LICHEN FORMATION OF TREES IN LOW WOODS (HENNING).

Physcia obscura (EHRH.) NYL.
Collema flaccidum ACH.
Collema nigrescens (HUDS.) ACH.
Leptogium myochroum (EHRH., SCHAER.) TUCK.
Pertusaria velata (TURN.) NYL.
Pertusaria pustulata (ACH.) NYL.
Biatora glauconigrans TUCK.
Biatora rubella (EHRH.) RAB.
Biatora varians (ACH.) TUCK.

I failed to find such a formation elsewhere in the territory explored. The plants in the formation grow on the common deciduous trees of the area, whereas at Bemidji and Red lake the swamps were surrounded for the most part by pines. As a whole the various adaptations of the plants are not difficult to detect. It is a little peculiar that the species of *Physcia*, belonging to this damp formation, belongs to the section of the genus having a well developed parenchymatous cortex rather than to the one having a non-cellular cortex of closely packed hyphæ. The *Collemas* with their non-cortical thallus and the *Leptogium* with a cortex of a single layer of cells are, of course, quite at home in such a damp habitat, as are the *Biatoras* with their thallus devoid of cortex. The *Pertusarias* have a fairly developed upper cortex.

The last formation to be recorded is a scattered one detected in shaded places at Bemidji, which may be designated as follows:

BIATORA LICHEN FORMATION OF MOSSES (BEMIDJI).

Pannaria languinosa (ACH.) KBR.
Biatora vernalis (L). Fr.
Biatora sphæroides (DICKS.) TUCK.
Biatora hypnophila (TURN.) TUCK.

The first and last *Biatoras* are the common elements of the formation and may be found in this habitat commonly at Bemidji. The last *Biatora* is the only plant of the formation noticed elsewhere in such environment, nor were the other two *Biatoras* found elsewhere during the summer. The formation was observed in the Lake Superior region at Gunflint, where the second *Biatora* was wanting, and in the Snowbank lake area, where the first one did not occur. The plants of the formation all have rudimentary thalli devoid of cortical layers and are well adapted to the moist shaded habitat on the damp shaded sides of tree bases where they spread over the mosses.

Nearly all of the formations herein recorded are more or less *scattered* in the sense explained in the fifth paper of this series.* In this paper as in the others I have avoided attempting too close analysis as to amount of illumination, roughness of bark, amount of moisture, and have omitted from the lists of plants of the various formations those rarer lichens whose adaptations seemed most doubtful. Yet in attempting a detailed study of a single group of plants, I feel sure that, if I have erred at all, it has been in including some doubtful elements in a few of the formations. In general, I have found that one can attempt an amount of minute detail in such a study which could only be carried out by a long study of a single locality and which would probably not be more helpful than such general survey as I feel that I have been able to conduct in the field with some degree of success.

Notwithstanding the recording of 16 distinct formations for the region now under consideration and only 14 for southwestern Minnesota, I still adhere to the statement already recorded in this paper that the conditions of lichen growth are more uniform in the former area. The greater diversity in the latter territory may be seen in the fact that there is a larger amount of difference between similar formations in the various parts of the region, due to more variation in amount of moisture, shade, etc., and in the circumstance that some of the formations bearing different names in the former region are very much alike. On account of this greater uniformity of conditions under which similar formations seems to have developed, it has been even more difficult than in the preceding papers to ascertain why certain species are found in a formation at one place and not in the

* Fink, B. l. c., 307.

similar formation at another. I have, consequently, seldom attempted such explanations in this paper.

In the present paper, after a more extended study of lichen formations in the field, I have attempted a more minute discussion of structural adaptations based upon careful study of thalli in the laboratory. This analysis has not in most instances detracted from the apparent genuineness of the formations, though in some it has not been possible to show that every plant is structurally adapted to the formation in which it occurs.

Throughout this paper I have referred only once to the influence of physical structure and chemical composition of substrata as influencing the distribution of lichens and the composition of lichen formations. In the beginning, doubtless, lichen species were influenced in their choice of substrata by their adaptations to light, shade, moisture and other conditions, though of course such physical conditions of substrata as influence transfer of moisture are also to be considered as they have been in my discussicns, as have also roughness and smoothness of surface. No doubt both physiological and anatomical changes frequently result in lichens from adoption of certain substrata, but it is well known that the conditions of life in lichens are such that they are not so much dependent upon or influenced by their substrata as are most other plants. Thus a large proportion of lichens occur commonly upon substrata of the most varied chemical composition and physical structure, provided the conditions of light, moisture, etc., named above are favorable. Therefore these factors must, for the present at least, receive chief attention in the study of ecologic distribution of lichens, though the more difficult and less important subject of the influence of physical and chemical make up of substrata is well worth attention. Doubtless in the struggle of lichen species for possession of substrata, adaptations to chemical composition of substrata sometimes play an important part. For instances, the crustaceous lichens of the calcareous rocks and earth produce a fat which is probably utilized by the plants for purposes of nutrition. Hence, as these plants can build up the fats from material obtained wholly or in part from the calcareous substrata, they would have an advantage over lichens which can not thus utilize the carbon of the rocks, in the struggle for possession. Lichens produce other chemical compounds, some of which are doubtless dependent upon the nature of the substratum. To what extent these compounds are of use to the plant, or in what degree they are derived from the substratum is little known. Till these problems are solved we can hardly hope to discuss intelligently the influence of chemical composition upon distribution.

I am under obligations to Dr. A. Zahlbruckner, of Vienna, Austria, for aid in the determination of several of the species listed below, and also to Dr. E. Wainio, of Helsingfors, Finland, for examination and determination of the larger part of the *Cladonias*.

LIST OF SPECIES AND VARIETIES.

1. **Ramalina calicaris** (L.) FR. var. **fraxinea** FR.

On trees, infrequent. Battle lake, June 20, 1900, no. 39. Henning, June 28, 1900, no. 328 and July 2, 1900, no. 412. Thief River Falls, July 18, 1900, no. 796 and July 23, 1900, no. 869. Red lake, July 26, 1900, no. 882 and July 31, 1900, no. 1018.

2. **Ramalina calicaris** (L.) FR. var. **fastigiata** FR.

On trees, frequent. Battle lake, June 18, 1900, no. 2. Leaf hills, June 26, 1900, no. 209 and June 27, 1900, no. 246. Henning, June 28, 1900, no. 330 and 332 and July 2, 1900, no. 411. Bemidji, July 5, 1900, no. 471. Thief River Falls, July 17, 1900, no. 762. Red lake, July 26, 1900, no. 879 and July 31, 1900, no. 1006.

3. **Ramalina pusilla** (PREV.) TUCK.

On tamarack in swamps, rare. Henning, June 30, 1900, no. 370. Bemidji, July 7, 1900, no. 517 and July 8, 1900, no. 531. Red lake, July 31, 1900, no. 1012.

4. **Cetraria ciliaris** (ACH.) TUCK.

Common on pines and on tamaracks in swamps. Battle lake, June 20, 1900, no. 71. Henning, June 25, 1900, no. 188, June 28, 1900, nos. 315 and 323 and June 30, 1900, no. 378. Bemidji, July 4, 1900, no. 427, July 5, 1900, nos. 472, 476 and 490, July 7, 1900, nos. 522 and 526, July 12, 1900, no. 680 and July 14, 1900, no. 730. Red lake, July 28, 1900, no. 463, July 30, 1900, nos. 985 and 988, August 2, 1900, no. 1050 and August 3, 1900, no. 1070.

5. **Cetraria juniperina** (L.) ACH. var. **pinastri** ACH.

On pines and on tamaracks in swamps, rare. Bemidji, July

7, 1900, no. 516, July 9, 1900, no. 543 and July 12, 1900, no. 665. Red lake, July 27, 1900, no. 925 and August 4, 1900, no. 1083.

6. **Evernia prunastri** (L.) ACH.

Common on pines and abundant on tamaracks in swamps. Battle lake, June 23, 1900, no. 140. Henning, June 25, 1900, no. 187 and June 28, 1900, no. 312. Bemidji, July 4, no. 428, July 6, 1900, no. 518 and July 7, 1900, no. 531. Thief River Falls, July 19, 1900, no. 827. Red lake, July 28, 1900, no. 970.

7. **Usnea barbata** (L.) FR.

On trees, frequent. Henning, June 28, 1900, no. 513.

8. **Usnea barbata** (L.) FR. var. **florida** FR.

On trees, frequent. Battle lake, June 19, 1900, no. 27. Henning, June 25, 1900, no. 174. Leaf hills, June 27, 1900, no. 248. Bemidji, July 4, 1900, no. 425, July 7, 1900, no. 532 and July 12, 1900, no. 666. Thief River Falls, July 20, 1900, no. 838. Red lake, July 28, 1900, no. 945 and August 2, 1900, no. 1053.

9. **Usnea barbata** (L.) FR. var. **ceratina** SCHAER.

On trees, frequent. Henning, June 30, 1900, no. 375.

10. **Usnea barbata** (L.) FR. var. **dasypoga** FR.

On trees, abundant. Henning, June 25, 1900, no. 191.

11. **Usnea cavernosa** TUCK.

On trees, frequent. Henning, June 25, 1900, nos. 182, 192 and 193, June 28, 1900, nos. 298 and 337 and July 2, 1900, no. 410. Bemidji, July 5, 1900, nos. 469, 470 and 488, July 7, 1900, nos. 505, 513 and 519, July 8, 1900, nos. 534, 536 and 544, July 9, 1900, no. 546 and July 13, 1900, no. 715. Red lake, July 27, 1900, nos. 910, 912 and 920, July 28, 1900, no. 942 and July 30, 1900, nos. 978, 987 and 990.

11. **Alectoria jubata** (L.) TUCK.

On cedars, frequent. Bemidji, July 6, 1900, nos. 515 and 520 and July 13, 1900, no. 701.

13. **Alectoria jubata** (L.) TUCK. var. **chalybeiformis** ACH.

On pines and tamaracks, infrequent. Henning, June 28, 1900, no. 338. Bemidji, July 4, 1900, no. 426, July 5, 1900, no. 473, July 7, 1900, no. 512, July 8, 1900, no. 543 and July

12, 1900, no. 683. Red lake, July 28, 1900, no. 959 and July 30, 1900, no. 999.

14. **Theloschistes chrysophthalmus** (L.) NORM.

On trees, rare. Battle lake, June 18, 1900, no. 6. Bemidji, July 11, 1900, no. 619. Red lake, August 1, 1900, no. 1047.

15. **Theloschistes polycarpus** (EHRH.) TUCK.

On trees, frequent. Battle lake, June 19, 1900, no. 35 and June 20, 1900, no. 40. Leaf hills, June 26, 1900, no. 206. Bemidji, July 5, 1900, nos. 468 and 489, July 11, 1900, no. 653 and July 12, 1900, no. 675. Thief River Falls, July 18, 1900, no. 786. Red lake, July 27, 1900, no. 926.

16. **Theloschistes lychneus** (NYL.) TUCK.

On trees, abundant and rarely on rocks. Battle lake, June 19, 1900, no. 34. Bemidji, July 11, 1900, nos. 628 and 654. Thief River Falls, July 17, 1900, no. 773 and July 20, 1900, no. 842. Red lake, July 26, 1900, no. 884, July 28, 1900, no. 964 and August 1, 1900, no. 1045.

17. **Theloschistes concolor** (DICKS.) TUCK.

On trees, frequent. Battle lake, June 18, 1900, no. 16a. Leaf hills, June 27, 1900, no. 265. Thief River Falls, July 19, 1900, no. 826. Red lake, July 27, 1900, no. 930.

18. **Theloschistes concolor** (DICKS.) TUCK. var. **effusa** TUCK.

On trees, rare. Henning, June 25, 1900, no. 175. Bemidji, July 5, 1900, no. 460.

19. **Parmelia crinita** ACH.

On trees, rare. Bemidji, July 12, 1900, no. 691.

20. **Parmelia tiliacea** (HOFFM.) FLK.

In trees, infrequent. Battle lake, June 18, 1900, no. 16. Leaf hills, June 26, 1900, no. 208. Bemidji, July 4, 1900, no. 449. Red lake, July 31, 1900, no. 1003.

21. **Parmelia borreri** TURN.

On trees, frequent and rarely on rocks. Battle lake, June 20, 1900, no. 43 and June 21, 1900, no. 114. Leaf hills, June 27, 1900, nos. 281 and 286. Bemidji, July 11, 1900, nos. 647 and 658. Thief River Falls, July 19, 1900, no. 824. Red lake, July 26, 1900, nos. 891 and 893.

22. **Parmelia saxatilis** (L.) FR.

Common on trees and rare on rocks. Battle lake, June 21, 1900, no. 112. Henning, June 25, 1900, no. 190 and June 30, 1900, no. 379. Bemidji, July 4, 1900, no. 447, July 6, 1900, no. 514, July 7, 1900, no. 521, July 10, 1900, no. 583, July 11, 1900, nos. 646 and 660. Thief River Falls, July 19, 1900, no. 820 and July 23, 1900, no. 874. Red lake, July 26, 1900, no. 891a and August 1, 1900, no. 1038.

23. **Parmelia saxatilis** (L.) FR. var. **sulcata** NYL.

On trees and rocks, and more frequently on old logs, frequent. Battle lake, June 22, 1900, no. 134. Bemidji, July 4, 1900, no. 525 and July 7, 1900, no. 525. Thief River Falls, July 19, 1900, no. 813. Red lake, August 1, 1900, no. 1034 and August 2, 1900, no. 1049.

24. **Parmelia physodes** (L.) ACH.

On pines and tamarack, rare. Henning, June 28, 1900, no. 331. Bemidji, July 4, 1900, no. 429 and July 7, 1900, no. 514. Red lake, July 27, 1900, no. 913 and August 3, 1900, no. 1071.

25. **Parmelia olivacea** (L.) ACH.

On trees, frequent, and rarely on rocks. Battle lake, June 19, 1900, no. 31. Leaf hills, June 26, 1900, no. 243. Bemidji, July 4, 1900, nos. 443 and 446 and July 7, 1900, no. 513. Thief River Falls, July 20, 1900, no. 830. Red lake, July 26, 1900, no. 885, July 30, 1900, no. 991 and August 1, 1900, no. 1039.

26. **Parmelia olivacea** (L.) ACH. var. **aspidota** ACH.

On trees, common locally. Leaf hills, July 2, 1900, no. 385.

Not previously reported from Minnesota.

27. **Parmelia conspurcata** (SCHAER.) WAINIO.

On trees, locally common. Bemidji, July 12, 1900, nos. 672, 682 and 700.

Not previously reported from Minnesota.

28. **Parmelia caperata** (L.) ACH.

Common on trees and rare on rocks. Battle lake, June 19, 1900, no. 26. Henning, June 25, 1900, no. 195 and July 2, 1900, no. 409. Bemidji, July 7, 1900, no. 527 and July 11, 1900, no. 659. Thief River Falls, July 20, 1900, nos. 832, 833 and 841. Red lake, July 26, 1900, no. 898 and August 1, 1900, no. 1033.

29. **Parmelia conspersa** (EHRH.) ACH.
On granitic bowlders, rare. Bemidji, July 16, 1900, no. 745. Thief River Falls, July 10, 1900, no. 832a.

30. **Physcia speciosa** (WULF., ACH.) NYL.
On bowlders and trees, rare. Bemidji, July 11, 1900, nos. 598 and 613.

31. **Physcia hypoleuca** (MUHL.) TUCK.
On trees, rare. Bemidji, July 5, 1900, no. 484.

32. **Physcia granulifera** (ACH.) TUCK.
On trees, rare. Battle lake, June 21, 1900, no. 115.

33. **Physcia pulverulenta** (SCHREB.) NYL.
On trees and rocks, frequent. Battle lake, June 18, no. 9. Bemidji, July 9, 1900, no. 556 and July 11, 1900, nos. 618 and 657. Thief River Falls, July 17, 1900, no. 777, and July 18, 1900, no. 793. Red lake, July 26, 1900, no. 900, August 1, 1900, no. 1044 and August 2, 1900, no. 1051.

34. **Physcia stellaris** (L.) TUCK.
Abundant on trees and rare on rocks. Battle lake, June 19, 1900, no. 23 and June 20, 1900, no. 93. Leaf hills, June 26, 1900, no. 245. Bemidji, July 4, 1900, no. 445 and July 11, 1900, nos. 614 and 656. Thief River Falls, July 18, 1900, nos. 708 and 803 and July 29, 1900, nos. 836 and 859. Red lake, July 26, 1900, no. 886.

35. **Physcia stellaris** (L.) TUCK. var. **apiola** NYL.
On rocks, rare. Leaf hills, June 26, 1900, no. 212 and Red lake, August 1, 1900, no. 1029.

36. **Physcia astroidea** (FR.) NYL.
On rocks, once collected. Red lake, August 1, 1900, no. 1032.
Not previously reported from Minnesota.

37. **Physcia tribacia** (ACH.) TUCK.
On pines, rare. Bemidji, July 11, 1900, nos. 627 and 661. Red lake, July 27, 1900, no. 917.

38. **Physcia hispida** (SCHREB., FR.) TUCK.
On trees and rocks, rare. Henning, June 28, 1900, no. 335. Bemidji, July 11, 1900, nos. 632 and 655. Thief River Falls, July 18, 1900, nos. 781 and 791. Red lake, July 28, 1900, no. 972 and August 2, 1900, no. 1064.

39. **Physcia cæsia** (HOFFM.) NYL.

On rocks, rare. Battle lake, June 23, 1900, no. 154. Leaf hills, June 26, 1900, nos. 203 and 239. Thief River Falls, July 18, 1900, no. 787. Red lake, August 4, 1900, no. 1078.

40. **Physcia obscura** (EHRH.) NYL.

On trees, common, and rarely on rocks. Battle lake, June 18, 1900, no. 4 and June 21, 1900, no. 121. Leaf hills, June 26, 1900, no. 211 and June 27, 1900, no. 270. Henning, June 29, 1900, no. 347 and June 30, 1900, no. 380. Bemidji, July 5, 1900, no. 461, July 11, 1900, no. 622 and July 12, 1900, no. 690. Thief River Falls, July 18, 1900, no. 782, July 19, 1900, no. 828 and July 28, 1900, no. 952. Red lake, Aug. 1, 1900, nos. 1027 and 1043 and Aug. 2, 1900, no. 1065.

41. **Physcia adglutinata** (FLK.) NYL.

On trees, infrequent. Red Lake, Aug. 1, 1900, no. 1048.

42. **Sticta pulmonaria** (L.) ACH.

On cedars in swamp, rare. Bemidji, July 14, 1900, no. 727.

43. **Nephroma lævigatum** ACH.

On old cedars, in swamp, rare. Bemidji, July 14, 1900, no. 723.

44. **Peltigera horizontalis** (L.) HOFFM.

On earth in woods, rare. Bemidji, July 11, 1900, no. 645. Thief River Falls, July 17, 1900, no. 752.

Spores occasionally more than four-celled and frequently narrower than usual.

45. **Peltigera refuscens** (NECK.) HOFFM.

On earth, rare or infrequent. Battle lake, June 21, 1900, no. 118. Henning, June 30, 1900, no. 372. Thief River Falls, July 21, 1900, no. 862.

46. **Peltigera canina** (L.) HOFFM.

On earth, common. Battle lake, June 18, 1900, no. 14 and June 20, 1900, no. 81. Henning, June 25, 1900, no. 186. Leaf hills, June 26, 1900, no. 237. Thief River Falls, July 17, 1900, no. 751. Red lake, July 27, 1900, no. 933.

47. **Peltigera canina** (L.) HOFFM. var. **spuria** ACH.

On earth, frequent. Battle lake, June 20, 1900, no. 69. Leaf hills, June 26, 1900, no. 223. Bemidji, July 9, 1900, nos. 533 and 545. Thief River Falls, July 19, 1900, no. 809. Red lake, July 27, 1900, no. 909.

48. **Peltigera canina** (L.) Hoffm. var. **sorediata** Schaer.

On earth, frequent. Battle lake, June 23, 1900, no. 152. Leaf hills, June 26, 1900, no. 216. Bemidji, July 4, 1900, no. 439. Thief River Falls, July 17, 1900, no. 765. Red lake, July 27, 1900, nos. 921 and 931.

49. **Peltigera canina** (L.) Hoffm. var. **leucorrhiza** Flk.

On earth in tamarack swamps, infrequent. Henning, June 25, 1900, no. 194 and June 29, 1900, no. 342. Bemidji, July 9, 1900, nos. 534 and 546. Red lake, July 28, 1900, no. 941.

Not previously reported from Minnesota.

50. **Heppia despreauxii** (Mont.) Tuck.

On calcareous earth, infrequent. Battle lake, June 20, 1900, no. 57. Leaf hills, June 26, 1900, no. 232, June 27, 1900, no. 264 and July 2, 1900, no. 394. Thief River Falls, July 17, 1900, no. 773.

51. **Pannaria languinosa** (Ach.) Kbr.

On mossy tree bases, rare. Henning, June 28, 1900, no. 300. Bemidji, July 5, 1900, no. 458, July 9, 1900, no. 549 and July 11, 1900, no. 625. Thief River Falls, July 17, 1900, no. 763. Red lake, July 28, 1900, no. 946.

52. **Pannaria petersii** Tuck.

On calcareous pebbles, rare. Leaf hills, July 2, 1900, no. 399. With thallus nearly obsolete, the same condition occurring occasionally in northern Iowa.

Not previously reported from Minnesota.

53. **Collema pycnocarpum** Nyl.

On trees, rare. Battle lake, June 19, 1900, no. 33 and June 21, 1900, no. 110. Bemidji, July 5, 1900, no. 467, July 11, 1900, no. 607, July 12, 1900, no. 686 and July 14, 1900, no. 724. Red lake, August 3, 1900, no. 1069.

54. **Collema flaccidum** Ach.

On trees, infrequent. Battle lake, June 23, 1900, no. 155. Henning, June 29, 1900, no. 351. Bemidji, July 12, 1900, no. 668.

55. **Collema nigrescens** (Huds.) Ach.

On trees, frequent. Henning, June 29, 1900, nos. 349 and 359. Bemidji, July 12, 1900, no. 693. Red lake, August 3, 1900, no. 1074.

56. **Collema ryssoleum** TUCK.

On *Populus*, rare. Bemidji, July 12, 1900, no. 686.

Not previously reported from Minnesota.

57. **Collema pulposum** (BERNH.) NYL.

On earth, rare. Battle lake, June 20, 1900, no. 77. Leaf hills, June 26, 1900, no. 207. Henning, June 29, 1900, no. 352. Leaf hills, July 2, 1900, no. 400. Bemidji, July 5, 1900, no. 477. Thief River Falls, July 17, 1900, nos. 769 and 770.

58. **Collema crispum** BORR.

On earth, frequent. Bemidji, July 11, 1900, no. 605.

59. **Collema limosum** ACH.

On earth, infrequent. Bemidji, July 10, 1900, no. 568, July 11, 1900, no. 637 and July 14, 1900, no. 736.

Not previously reported from Minnesota.

60. **Leptogium lacerum** (SW.) FR.

On earth, rare. Leaf hills, June 27, 1900, no. 287. Thief River Falls, July 18, 1900, no. 795.

61. **Leptogium myochroum** (EHRH., SCHAER.) TUCK.

On trees and rocks, rare. Battle lake, June 21, 1900, no. 123 and June 23, 1900, no. 156. Henning, June 30, 1900, nos. 381 and 382. Bemidji, July 5, 1900, no. 485 and July 13, 1900, no. 710.

62. **Placodium elegans** (LINK.) DC.

On granite and limestone, rare. Battle lake, June 20, 1900, nos. 60 and 66. Bemidji, July 11, 1900, no. 638. Thief River Falls, July 17, 1900, no. 776.

63. **Placodium murorum** (HOFFM.) DC.

On lime bowlders, rare. Thief River Falls, July 9, 1900, no. 825. With deficient thallus.

64. **Placodium cinnabarrinum** (ACH.) ANZ.

On granite rocks, infrequent. Battle lake, June 20, 1900, nos. 45 and 50. Leaf hills, June 27, 1900, nos. 276 and 282.

65. **Placodium aurantiacum** (LIGHTF.) NAEG. and HEPP.

On trees and granites, infrequent. Battle lake, June 19, 1900, no. 37. Leaf hills, June 27, 1900, no. 253. Bemidji, July 11, 1900, no. 643. Thief River Falls, July 19, 1900, no.

819 and July 21, 1900, no. 855. Some have very heavy thallus.

66. **Placodium cerinum** (HEDW.) NAEG. and HEPP.

On trees and granite rocks, frequent or infrequent. Battle lake, June 18, 1900, no. 13, June 19, 1900, no. 30, June 20, 1900, no. 73 and June 23, 1900, no. 164. Henning, June 25, 1900, nos. 177 and 199. Leaf hills, June 26, 1900, no. 244 and June 27, 1900, nos. 267 and 271. Henning, June 28, 1900, no. 321. Bemidji, July 4, 1900, no. 454, July 5, 1900, nos. 459 and 465 and July 11, 1900, no. 644. Thief River Falls, July 17, 1900, nos. 756 and 775, July 19, 1900, nos. 817, 818 and 823, July 20, 1900, no. 835 and July 21, 1900, no. 861. Red lake, July 26, 1900, no. 883, July 28, 1900, no. 953, July 30, 1900, no. 979, Aug. 1, 1900, no. 1025 and Aug. 2, 1900, no. 1061.

67. **Placodium cerinum** (HEDW.) NAEG. and HEPP. var. **sidiritis** TUCK.

On granite rocks, infrequent. Battle lake, June 20, 1900, no. 68, and June 23, 1900, nos. 149 and 157. Leaf hills, June 27, 1900, nos. 247 and 263. Red lake, July 31, 1900, no. 1011.

68. **Placodium cerinum** (HEDW.) NAEG. and HEPP. var. **pyracea** NYL.

On pine logs, frequent. Red lake, July 30, 1900, no. 983.

69. **Placodium ferrugineum** (HUDS.) HEPP.

On old pine, frequent. Bemidji, July 15, 1900, no. 705. Red lake, July 30, 1900, no. 976.

70. **Placodium vitellinum** (EHRH.) NAEG. and HEPP.

On old wood and granite rocks, rare. Battle lake, June 20, 1900, no. 104. Leaf hills, June 26, 1900, no. 240 and June 27, 1900, no. 278. Bemidji, July 10, 1900, no. 559. Red lake, July 28, 1900, no. 960 and July 30, 1900, no. 982.

71. **Placodium vitellinum** (EHRH.) NAEG. and HEPP. var. **aurellum** ACH.

On trees and granite rocks, infrequent. Battle lake, June 20, 1900, no. 56. Leaf hills, June 26, 1900, no. 251a and June 27, 1900, no. 257. Bemidji, July 11, 1900, no. 639.

72. **Lecanora rubina** (VILL.) ACH.

On granitic rocks, infrequent or rare. Battle lake, June 20, 1900, nos. 46, 49 and 51. Leaf hills, June 27, 1900, no. 284. Bemidji, July 11, 1900, no. 594.

73. **Lecanora muralis** (SCHREB.) SCHAER.

On rocks, rare. Red lake, August 1, 1900, no. 1030.

74. **Lecanora muralis** (SCHREB.) SCHAER. var. **saxicola** SCHAER.

On granitic rocks, locally frequent. Battle lake, June 20, 1900, no. 107. Leaf hills, June 26, 1900, no. 201.

75. **Lecanora muralis** (SCHREB.) SCHAER. var. **versicolor** FR.

On lime rocks, locally frequent. Battle lake, June 20, 1900, nos. 83, 97 and 102.

76. **Lecanora pallida** (SCHREB.) SCHAER.

On cedar in swamp, rare. Bemidji, July 13, 1900, no. 717.

77. **Lecanora subfusca** (L.) ACH.

On trees and rocks, common in last two localities only, Battle lake, June 20, 1900, nos. 54 and 75. Henning, June 25, 1900, no. 198. Leaf hills, June 27, 1900, no. 279. Bemidji, July 4, 1900, no. 457, July 5, 1900, nos. 471 and 499 and July 11, 1900, no. 606. Thief River Falls, July 20, 1900, no. 839. Red lake, August 3, 1900, no. 1075.

No. 54 is a peculiar form on rocks with scant thallus. No. 606 has border of exciple much raised.

78. **Lecanora subfusca** (L.) ACH. var. **argentata** ACH.

On pines, rare. Red lake, August 3, 1900, no. 1066.

79. **Lecanora subfusca** (L.) ACH. var. **coilocarpa** ACH.

On pine logs, rare. Red lake, July 30, 1900, no. 993.

80. **Lecanora variolascens** NYL.

On trees, common in Minnesota and Iowa, but usually sterile and hence not determinable. Battle lake, June 20, 1900, no. 76. Henning, June 29, 1900, no. 358. Thief River Falls, July 18, 1900, no. 800. Red lake, July 28, 1900, no. 975.

Not previously reported from Minnesota and new to North America.

81. **Lecanora hageni** ACH.

On rocks, rare. Battle lake, June 20, 1900, no. 109. Bemidji, July 11, 1900, no. 640.

82. **Lecanora varia** (EHRH.) NYL.

On trees, dead wood and rocks, infrequent. Battle lake, June 23, 1900, nos. 136 and 139. Henning, June 25, 1900, no. 184. Leaf hills, June 27, 1900, no. 252. Henning, June 28, 1900, nos. 309 and 333. Bemidji, July 5, 1900, nos. 492, 498 and 500 and July 12, 1900, nos. 695 and 697. Thief River Falls, July 17, 1900, no. 758 and July 18, 1900, nos. 784, 785 and 804. Red lake, July 27, 1900, no. 919 and August 1, 1900, no. 1022.

83. **Lecanora varia** (EHRH.) NYL. var. **polytropa** NYL.

On granitic rocks, rare. Battle lake, June 20, 1900, no. 84. Thief River Falls, July 21, 1900, no. 864. Red lake, July 27, 1900, no. 905.

Not previously reported from Minnesota.

84. **Lecanora varia** (EHRH.) NYL. var. **symmicta** ACH.

On dead wood, rare but widely distributed. Battle lake, June 23, 1900, nos. 138 and 142. Henning, June 28, 1900, no. 336. Bemidji, July 6, 1900, no. 545. Thief River Falls, July 18, 1900, no. 806 and July 21, 1900, no. 867. Red lake, July 28, 1900, nos. 954 and 966 and August 2, 1900, no. 1060.

85. **Lecanora varia** (EHRH.) NYL. var. **sæpincola** FR.

On old wood, rare. Battle lake, June 23, 1900, no. 150. Red lake, July 28, 1900, no. 957.

86. **Lecanora pallescens** (L.) SCHAER.

On trees in swamp, rare. Bemidji, July 13, 1900, no. 708.

87. **Lecanora verrucosa** (ACH.) LAUR. var. **mutabilis** TH. FR.

On trees, rare. Henning, June 29, 1900, no. 350. Bemidji, July 11, 1900, no. 609, July 13, 1900, no. 713 and July 14, 1900, no. 735. Red lake, August 3, 1900, no. 1067.

Not previously reported from Minnesota, but confused with *Pertusaria leioplaca* (Ach.) Schaer.

88. **Lecanora cinerea** (L.) SOMMERF.

On granitic bowlders, frequent. Battle lake, June 20, 1900, nos. 91, 99 and 101. Leaf hills, June 26, 1900, no. 233 and June 27, 1900, nos. 249, 260 and 295. Bemidji, July 10, 1900, no. 573, July 11, 1900, nos. 592 and 599 and July 14, 1900, no. 737.

89. **Lecanora calcarea** (L.) SOMMERF. var. **contorta** FR.

On bowlders, especially calcareous, rare. Battle lake, June 20, 1900, nos. 48, 92 and 100. Leaf hills, June 27, 1900, no. 296.

90. **Lecanora gibbosa** (ACH.) NYL. var **microspora** A. ZAHLB.

On exposed granitic bowlders, frequent. Leaf hills, July 2, 1900, no. 388.

Not previously reported from Minnesota and new to North America. Synonymy uncertain.

91. **Lecanora cervina** (PERS.) NYL.

On granitic bowlders, infrequent. Leaf hills, June 26, 1900, nos. 205 and 238, June 27, 1900, no. 251 and July 2, 1900, no. 397. Bemidji, July 16, 1900, no. 744.

92. **Lecanora fuscata** (SCHRAD.) TH. FR.

On granitic bowlders, infrequent. Battle lake, June 20, 1900, no. 80. Leaf hills, June 26, 1900, no. 218 and June 27, 1900, no. 280. Bemidji, July 10, 1900, no. 560. Red lake, July 27, 1900, no. 924.

93. **Lecanora privigna** (ACH.) NYL.

On bowlders, especially calcareous, rare. Leaf hills, June 27, 1900, nos. 259, 288 and 292 and July 2, 1900, no. 393. Bemidji, July 10, 1900, no. 584.

The last is a peculiar clustered form on granitic bowlders.

94. **Lecanora privigna** (ACH.) NYL. var. **pruinosa** AUCT.

On calcareous bowlders, rare. Leaf hills, July 2, 1900, no. 404.

95. **Lecanora xanthophana** NYL.

On granitic bowlders, locally frequent on high hills. Battle lake, June 20, 1900, no. 47 and June 23, 1900, no. 167.

96. **Rinodina oreina** (ACH.) MASS.

On granitic rocks, common in first locality. Battle lake, June 20, 1900, nos. 90 and 106. Leaf hills, June 26, 1900, no. 202. Thief River Falls, July 21, 1900, no. 865. Red lake, August 1, 1900, no. 1021.

97. **Rinodina sophodes** (ACH.) NYL.

On trees, old wood and rocks, common. Battle lake, June 18, 1900, no. 19, June 21, 1900, no. 119 and June 23, 1900, no. 162. Leaf hills, June 26, 1900, nos. 222 and 231. Henning, June 28, 1900, no. 339. Bemidji, July 5, 1900, nos. 464 and 478, July 7, 1900, no. 529 and July 11, 1900, no. 651. Thief River Falls, July 18, 1900, no. 808, July 19, 1900, no. 811 and July 21, 1900, no. 847. Red lake, July 26, no. 888 and July 28, 1900, nos. 935 and 969.

Spores commonly smaller than Tuckerman's measurements.

98. **Rinodina sophodes** (ACH.) NYL. var. **atrocinerea** NYL.

On tamarack in swamps, rare. Bemidji, July 6, 1900, nos. 538 and 547.

Not previously reported from Minnesota.

99. **Rinodina sophodes** (ACH.) NYL. var. **exigua** FR.

On granitic rocks, rare. Battle lake, June 23, 1900, no. 153. Leaf hills, June 26, 1900, no. 217.

100. **Rinodina bischoffi** (HEPP.) KBR.

On calcareous rocks, rare. Leaf hills, June 27, 1900, no. 291.

101. **Rinodina nigra** sp. nov.

On granitic rocks, infrequent. Battle lake, June 23, 1900, no. 146.

Thallus thin (12–22 mm.), indeterminate or subdeterminate, tartareous-areolate, ecorticate; the areoles densely crowded, angular, .5–1.25 mm. wide, dark slate color; upon a black hypothallus, which also borders the thallus more or less; algal cells globose, green (Cystococcus?), 8–14 mic. in diameter. Apothecia minute, .25–.50 mic. in diameter, immersed in the thallus, one, two or three in each areole; disk black, usually somewhat depressed, circular, with an entire thalline exciple, concolorous with the thallus; hymenium 75–90 mic. deep. Spores brown, 2-celled, oblong and frequently somewhat constricted at the septum, 9–15 mic. long and 5–8 mic. wide, 8 in asci. Paraphyses distinct, slender, unbranched, colorless throughout or brownish at tips. Asci 50–60 by 13–17 mic.

102. **Pertusaria multipuncta** (TURN.) NYL.

On trees, frequent. Bemidji, July 13, 1900, no. 711 and July 14, 1900, nos. 723, 725 and 726.

103. **Pertusaria communis** DC.

On trees in swamp, frequent. Bemidji, July 13, 1900, nos. 702 and 704.

104. **Pertusaria pustulata** (ACH.) NYL.

On trees, infrequent. Battle lake, June 22, 1900, no. 129. Henning, June 29, 1900, no. 361 and June 30, 1900, no. 383. Bemidji, July 13, 1900, nos. 707 and 719.

105. **Pertusaria finkii** A. ZAHLB. in litt.

On trees, rare or infrequent. Battle lake, June 20, 1900, no. 74, June 21, 1900, no. 113 and June 26, 1900, no. 128. Henning, June 30, 1900, no. 366. Bemidji, July 5, 1900, no. 480. Thief River Falls, July 18, 1900, no. 801. Red lake, July 31, 1900, nos. 1014 and 1019.

Thallus white or whitish, thin (0.2–0.28 mm.), determinate or subdeterminate, margin continuous, center unequal-verrucose and rimose, ecorticate, medullary hyphæ slender, algal cells globose, green, 10–15 mic. in diameter, disposed in more or less discrete clusters. Apothecia plentiful, clustered, immersed or finally becoming open-lecanoroid, about 0.75 mm. in diameter, irregular or subrotund, fuscescent or blackish, flat, rough; thalline margin persistent, thin, whitish, crenulate to sublacerate. Hymenium 320–370 mic. deep. Epithecium rufescent or fuscescent. Paraphyses slender, somewhat conglutinate. Asci elevate-saccate, containing 2 (rarely 1) spores, straight or somewhat curved, apex rounded and thickened, 170–190 mic. long and 42–46 mic. wide. Spores oval, ellipsoid or oblong, occasionally somewhat constricted along the sides, simple, colorless, 88–140 mic. long and 28–53 mic. wide, spore walls thick (9–12 mic.).

106. **Urceolaria scruposa** (L.) NYL.

On calcareous earth, rare. Battle lake, June 20, 1900, nos. 52 and 96. Leaf hills, June 27, 1900, no. 255.

107. **Stereocaulon paschale** (L.) FR.

On granitic bowlders, rare. Bemidji, July 10, 1900, no. 569 and July 16, 1900, no. 750. Red lake, August 4, 1900, nos. 1079 and 1082.

108. **Cladonia mitrula** TUCK.

On earth, rare. Battle lake, June 20, 1900, no. 53. Henning, June 28, 1900, no. 308. Leaf hills, July 2, 1900, no. 402.

109. **Cladonia botrytes** (HAG.) WILLD.

On coniferous stumps and logs, infrequent. Bemidji, July 4, 1900, no. 430 and July 6, 1900, no. 526. Thief River Falls, July 17, 1900, no. 771. Red lake, July 28, 1900, no. 974.

Not previously reported from Minnesota.

110. **Cladonia cariosa** (ACH.) SPRENG.

On earth, infrequent. Leaf hills, June 26, 1900, nos. 226, 227 and 229. Bemidji, July 7, 1900, no. 503, July 10, 1900, nos. 565 and 566 and July 16, 1900, no. 741. Red lake, August 3, 1900, nos. 1075 and 1080.

111. **Cladonia pyxidata** (L.) FR.

On earth and old logs, frequent. Henning, June 25, 1900, no. 180 and June 27, 1900, no. 255. Thief River Falls, July 17, 1900, no. 766. Red lake, July 27, 1900, no. 907.

112. **Cladonia pyxidata** (L.) FR. var. **neglecta** (FLK.) MASS.

On old logs, frequent. Battle lake, June 18, 1900, no. 12. Thief River Falls, July 17, 1900, no. 757. Red lake, August 2, 1900, no. 1055.

Not previously reported from Minnesota.

113. **Cladonia pyxidata** (L.) FR. var. **chlorophæa** FLK.

On old stumps, infrequent. Bemidji, July 6, 1900, no. 519.

Not previously reported from Minnesota.

114. **Cladonia fimbriata** (L.) FR. var. **tubæformis** FR.

On old wood, common. Battle lake, June 20, 1900, no. 78. Henning, June 25, 1900, no. 185 and June 28, 1900, no. 306. Bemidji, July 4, 1900, no. 438 and July 7, 1900, nos. 551 and 552.

115. **Cladonia fimbriata** (L.) FR. var. **simplex** (WEIS.) FLOT.

On rotten wood, rare. Henning, July 2, 1900, no 407. Bemidji, July 6, 1900, no. 533. Apparently a synomym for above according to Wainio, but specimens very different.

Not previously reported from Minnesota.

116. **Cladonia fimbriata** (L.) FR. var. **subulata** (L.) WAINIO.

On earth in pine woods, infrequent. Bemidji, July 10, 1900, no. 574. Red lake, July 26, 1900, no. 902.

Not previously reported from Minnesota.

117. **Cladonia fimbriata** (L.) FR. var. **fibula** ACH.

On earth usually under conifers, infrequent. Leaf hills, June 26, 1900, no. 230. Bemidji, July 5, 1900, nos. 462, 504 and 509, July 9, 1900, no. 535 and July 10, 1900, nos. 564, 571 and 585. Red lake, August 3, 1900, no. 1076.

Not previously reported from Minnesota.

118. **Cladonia fimbriata** (L.) Fr. var. **apolepta** (Ach.) Wainio.

On old wood, especially tamarack, frequent. Henning, June 28, 1900, no. 303. Bemidji, July 6, 1900, no. 521. Thief River Falls, July 19, 1900, no. 815.

Not previously reported from Minnesota and new to North America.

119. **Cladonia fimbriata** (L.) Flk. var. **ceratodes** (Flk.) Wainio.

On earth under pines, common. Bemidji, July 6, 1900, no. 486. Red lake, July 28, 1900, no. 950.

Not previously reported from Minnesota and new to North America.

120. **Cladonia degenerans** Flk.

On earth under pines, rare. Bemidji, July 5, 1900, no. 510.

121. **Cladonia gracilis** (L.) Nyl.

On earth and old wood, frequent. Battle lake, June 20, 1900, no. 79. Henning, June 28, 1900, nos. 311 and 319. Bemidji, July 4, 1900, no. 431. Red lake, July 30, 1900, no. 987.

122. **Cladonia gracilis** (L.) Nyl. var. **verticellata** Fr.

On earth and old wood, frequent. Battle lake, June 18, 1900, no. 11. Leaf hills, June 26, 1900, nos. 219, 220 and 221. Henning, June 28, 1900, no. 320. Bemidji, July 5, 1900, no. 572 and July 14, 1900, no. 732. Red lake, July 27, 1900, nos. 922 and 934a.

123. **Cladonia gracilis** (L.) Nyl. var. **anthocephala** Flk.

On old logs, usually coniferous, frequent. Henning, June 28, 1900, no. 314. Bemidji, July 6, 1900, nos. 524 and 528 and July 10, 1900, no. 582. Thief River Falls, July 19, 1900, no. 797. Red lake, July 28, 1900, no. 968.

Not previously reported from Minnesota and new to North America.

124. **Cladonia gracilis** (L.) Nyl. var. **hybrida** Schaer.

On earth and old logs, common. Henning, June 28, 1900, nos. 302 and 304. Bemidji, July 4, 1900, no. 437, July 5, 1900, nos. 507 and 508 and July 6, 1900, nos. 515 and 550. Red lake, July 27, 1900, no. 934.

125. **Cladonia cenotea** (Ach.) Schaer.

On earth, rare. Bemidji, July 9, 1900, nos. 534 and 536.

126. **Cladonia squamosa** HOFFM.

On old stumps in tamarack swamp, locally common. Bemidji, July 6, 1900, no. 516.

127. **Cladonia furcata** (HUDS.) FR.

On earth, rare. Bemidji, July 12, 1900, no. 684 and July 13, 1900, no. 720.

128. **Cladonia furcata** (HUDS.) FR. var. **scabriuscula** (DEL.) CEON.

On earth or old logs, rare. Henning, July 2, 1900, no. 416. Bemidji, July 13, 1900, no. 720.

Not previously reported from Minnesota and new to North America.

129. **Cladonia furcata** (HUDS.) FR. var. **paradoxa** WAINIO.

On earth or old wood under conifers, frequent. Henning, June 30, 1900, no. 371. Bemidji, July 4, 1900, no. 432, July 6, 1900, no. 522, July 10, 1900, nos. 562, 570, 567, and 586 and July 12, 1900, no. 677. Red lake, July 27, 1900, no. 906.

Not previously reported from Minnesota and new to North America.

130. **Cladonia rangiferina** (L.) HOFFM.

On earth and logs, common under pines in second locality. Henning, June 25, 1900, no. 181, June 28, 1900, no. 327 and June 29, 1900, no. 340. Bemidji, July 5, 1900, no. 505, July 7, 1900, no. 509, July 10, 1900, no. 587 and July 14, 1900, nos. 729 and 738. Thief River Falls, July 17, 1900, no. 761. Red lake, July 26, 1900, no. 903 and July 27, 1900, no. 923.

131. **Cladonia rangiferina** (L.) HOFFM. var. **sylvatica** (L.) RABENH.

On earth under conifers, common. Bemidji, July 5, 1900, nos. 503 and 511, July 6, 1900, no. 517 and July 14, 1900, no. 739. Red lake, July 27, 1900, nos. 908 and 915.

132. **Cladonia rangiferina** (L.) HOFFM. var. **alpestris** L.

On earth, infrequent. Bemidji, July 6, 1900, no. 517 and July 14, 1900, no. 739. Red lake, July 27, 1900, no. 915.

133. **Cladonia uncialis** (L.) FR.

On earth in pine woods, rare. Bemidji, July 9, 1900, no. 538.

134. **Cladonia deformis** (L.) HOFFM.

On old logs, rare. Bemidji, July 14, 1900, no. 734.

135. **Cladonia digitata** (L.) HOFFM.

On tamarack log in swamp, rare. Bemidji, July 6, 1900, no. 525.

136. **Cladonia bacillaris** NYL.

On old logs under pines, infrequent. Bemidji, July 4, 1900, no. 419 and July 9, 1900, nos. 540 and 541.

Not previously reported from Minnesota, but included under the next.

137. **Cladonia macilenta** (EHRH.) HOFFM.

On old logs, infrequent. Bemidji, July 9, 1900, no. 540. Red lake, July 28, 1900, no. 937.

138. **Cladonia cristatella** TUCK.

On old wood and earth, common. Battle lake, June 20, 1900, nos. 41 and 42. Leaf hills, June 26, 1900, no. 225. Henning, June 28, 1900, nos. 422 and 433, July 7, 1900, no. 435, July 8, 1900, no. 474, July 9, 1900, nos. 537 and 549 and July 10, 1900, no. 577. Thief River Falls, July 18, 1900, no. 778. Red lake, July 27, 1900, no. 904 and July 28, 1900, no. 956.

139. **Biatora decipiens** (EHRH.) FR.

On calcareous earth, frequent. Battle lake, June 20, 1900, no. 59. Leaf hills, June 27, 1900, no. 275 and July 2, 1900, no. 391.

140. **Biatora decipiens** (EHRH.) FR. var. **dealbata** TUCK.

On earth, infrequent. Leaf hills, June 27, 1900, no. 261 and July 2, 1900, no. 392.

141. **Biatora viridescens** (SCHRAD.) FR.

On tamarack logs in swamp, frequent. Bemidji, July 7, 1900, no. 528.

142. **Biatora vernalis** (L.) FR.

On mossy trees and on tamarack, infrequent. Bemidji, July 7, 1900, nos. 506, 508, 527 and 537 and July 13, 1900, no. 718.

143. **Biatora turgidula** (FR.) NYL.

On elms, rare. Bemidji, July 9, 1900, no. 553.

144. **Biatora leucophæa** (FLK.) TUCK.

On granite rocks, infrequent. Leaf hills, June 27, 1900, no. 277. Bemidji, July 11, 1900, no. 602. Thief River Falls, July 18, 1900, no. 792. Red lake, August 1, 1900, nos. 1031 and 1042.

145. **Biatora uliginosa** (SCHRAD.) FR.

On pine logs or earth under pines, infrequent. Bemidji, July 4, 1900, no. 440, July 5, 1900, no. 487 and July 9, 1900, nos. 539 and 542. Red lake, July 28, 1900, no. 971, July 30, 1900, nos. 977 and Aug. 1, 1900, no. 1046.

146. **Biatora myriocarpoides** (NYL.) TUCK.

On old pine and granite, infrequent. Bemidji, July 4, 1900, no. 424, July 10, 1900, no. 561 and July 16, 1900, nos. 743 and 749. Thief River Falls, July 20, 1900, no. 840, July 21, 1900, no. 851 and July 23, 1900, nos. 870 and 873. Red lake, July 28, 1900, nos. 959 and 967, July 30, 1900, no. 1002, Aug. 2, 1900, no 1058 and Aug. 4, 1900, no. 1077.

Part of the material here referred to has a colorless hypothecium and will doubtless be referred elsewhere after further study.

147. **Biatora varians** (ACH.) TUCK.

On trees, infrequent. Battle lake, June 18, 1900, no. 1 and June 23, 1900, no. 163. Leaf hills, June 26, 1900, no. 214. Henning, June 29, 1900, no. 356. Thief River Falls, July 21, 1900, no. 860.

148. **Biatora mixta** FR.

On poplars, frequent. Henning, June 29, 1900, no. 434. Bemidji, July 11, 1900, no. 629. Thief River Falls, July 21, 1900, no. 854. Red lake, Aug. 2, 1900, no. 1062.

Not previously reported from Minnesota.

149. **Biatora mixta** FR. var. **atlantica** TUCK.

On poplars, rare. Battle lake, June 20, 1900, no. 70.

Not previously reported from Minnesota and new to the interior of North America.

150. **Biatora atropurpurea** (MASS.) HEPP.

On poplars, infrequent. Bemidji, July 4, 1900, no. 455 and July 9, 1900, no. 551, Thief River Falls, July 21, 1900, nos. 777 and 846.

151. **Biatora prasina** FR. var. **byssacea** TH. FR.

On old logs in swamps, rare. Bemidji, July 7, 1900, no. 520.

Not previously reported from Minnesota.

152. **Biatora glauco-nigrans** TUCK.

On trees in low woods, infrequent. Henning, June 29, 1900, no. 355.

153. **Biatora sphæroides** (DICKS.) TUCK.

On mossy bases, rare. Bemidji, July 12, 1900, no. 663.

Not previously reported from Minnesota.

154. **Biatora hypnophila** (TURN.) TUCK.

On mossy earth, rare. Henning, June 29, 1900, no. 346 and June 30, 1900, no. 365. Bemidji, July 4, 1900, no. 452, July 5, 1900, no. 483, July 11, 1900, nos. 612 and 617 and July 14, 1900, no. 731. Thief River Falls, July 17, 1900, no. 768 and July 23, 1900, no. 871. Red lake, July 30, 1900, no. 998 and July 31, 1900, no. 1008.

155. **Biatora rubella** (EHRH.) RABENH.

On elms, ashes, poplars, infrequent. Battle lake, June 20, 1900, no. 72. Henning, June 25, 1900, nos. 171, 172 and 173. Bemidji, July 9, 1900, no. 554, July 11, 1900, no. 616, July 12, 1900, no. 681 and July 13, 1900, nos. 706 and 712. Thief River Falls, July 18, 1900, no. 783 and July 21, 1900, no. 868. Red lake, July 26, 1900, no. 892.

156. **Biatora fusco-rubella** (HOFFM.) TUCK.

On trees, infrequent. Henning, June 29, 1900, no. 345. Red lake, July 28, 1900, no. 936, July 31, 1900, no. 1015 and Aug. 1, 1900, no. 1041.

157. **Biatora suffusa** FR.

On trees, rare. Red lake, July 27, 1900, no. 918.

158. **Biatora atrogrisea** (DELIS.) HEPP.

On trees, infrequent. Henning, June 30, 1900, no. 376. Bemidji, July 11, 1900, no. 596. Thief River Falls, July 21, 1900, no. 858.

Not previously reported from Minnesota.

159. **Biatora inundata** FR.

On pines and rocks, rare. Battle lake, June 20, 1900, nos. 65 and 103. Bemidji, July 10, 1900, no. 575. Red lake, July 30, 1900, nos. 981 and 984 and July 31, 1900, no. 1040.

160. **Biatora akompsa** TUCK.

On trees, common. Battle lake, June 18, 1900, no. 3.

Not previously reported from Minnesota and new to the interior of North America.

161. **Biatora muscorum** (Sw.) Tuck.

On earth, frequent. Battle lake, June 19, 1900, nos. 24 and 36 and June 20, 1900, no. 98. Leaf hills, June 27, 1900, no. 285.

162. **Lecidea enteroleuca** Fr.

On trees, common. Battle lake, June 18, 1900, no. 7, June 20, 1900, nos. 38 and 61, June 22, 1900, no. 130 and June 23, 1900, nos. 151 and 165. Leaf hills, June 27, 1900, nos. 250 and 274. Henning, June 29, 1900, no. 341 and June 30, 1900, nos. 363 and 369. Bemidji, July 4, 1900, no. 450, July 5, 1900, nos. 466 and 475, July 11, 1900, no. 633 and July 12, 1900, nos. 674 and 688. Thief River Falls, July 17, 1900, nos. 759, 764 and 774, July 19, 1900, no. 812 and July 20, 1900, no. 843. Red lake, July 27, 1900, nos. 928 and 932, July 28, 1900, no. 962, July 31, 1900, nos. 1004 and 1020 and August 1, 1900, no. 1026.

163. **Lecidea enteroleuca** Fr. var. **achrista** Sommerf.

On trees, infrequent. Battle lake, June 19, 1900, no. 25. Red lake, July 28, 1900, no. 973 and July 31, 1900, no. 1009.

164. **Lecidea enteroleuca** Fr. var. **flavida** Fr.

On tamarack stumps in swamps, rare. Bemidji, July 11, 1900, no. 610. Red lake, July 28, 1900, no. 949.

Not previously reported from Minnesota.

165. **Lecidea enteroleuca** Fr. var. **ambigua** Anz.

On old wood, rare. Battle lake, June 23, 1900, no. 143. Henning, June 25, 1900, no. 200. Bemidji, July 7, 1900, no. 518. Thief River Falls, July 18, 1900, no. 807.

Not previously reported from Minnesota.

166. **Lecidea acclinis** Flot.

On trees, infrequent. Battle lake, June 21, 1900, no. 120. Thief River Falls, July 19, 1900, no. 810 and July 21, 1900, no. 844.

167. **Lecidea** sp.

On dead tamaracks in swamp, rare. Henning, June 25, 1900, no. 178. Thallus grayish and evanescent, apothecia medium sized; hymenium pale; exciple and hypothecium brownish black; paraphyses distinct, colorless, filiform, brown-tipped; spores oblong, colorless, 4-celled, straight or slightly curved, 13–16 mic. long by 3½–5 mic. wide.

168. **Buellia alboatra** (HOFFM.) TH. FR.

On trees, rare. Battle lake, June 21, 1900, no. 117 and June 25, 1900, no. 158. Bemidji, July 11, 1900, nos. 679 and 687. Thief River Falls, July 23, 1900, no. 872. Red lake, July 27, 1900, no. 965.

169. **Buellia parasema** (ACH.) TH. FR.

On trees, infrequent. Leaf hills, June 27, 1900, no. 272. Bemidji, July 4, 1900, no. 434, July 7, 1900, nos. 510, 511 and 542 and July 12, 1900, nos. 662 and 696. Thief River Falls, July 20, 1900, no. 831. Red lake, July 28, 1900, no. 939, July 30, 1900, no. 939 and August 2, 1900, no. 1056.

170. **Buellia myriocarpa** (DC.) MUDD.

On pines, rare. Battle lake, June 19, 1900, no. 23. Bemidji, July 5, 1900, no. 488. Red lake, August 2, 1900, no. 1059.

171. **Buellia myriocarpa** (DC.) MUDD. var. **polyspora** WILLEY.

On cedar in swamps, rare. Bemidji, July 13, 1900, no. 714.

172. **Buellia pullata** TUCK.?

On granitic rocks, infrequent. Leaf hills, June 26, 1900, no. 241.

Spores 9–14 mic. long by 6–7.5 mic. wide, and thallus scanty.

173. **Buellia petræa** (FLOT., KBR.) TUCK.

On exposed granitic rocks, locally frequent. Battle lake, June 23, 1900, no. 158. Leaf hills, July 2, 1900, no. 386.

174. **Buellia petræa** (FLOT., KBR.) TUCK. var. **montagnæi** TUCK.

On exposed granitic rocks, locally common. Battle lake, June 20, 1900, no. 62 and June 23, 1900, no. 169. Leaf hills, June 27, 1900, nos. 283 and 294 and July 2, 1900, no. 396.

175. **Melaspilea arthonioides** (FEE) NYL.

On trees, rare. Battle lake, June 21, 1900, no. 122 and June 22, 1900, no. 133. Bemidji, July 11, 1900, no. 604. Thief River Falls, July 21, 1900, no. 849.

Not previonsly reported from Minnesota.

176. **Opegrapha varia** (PERS.) FR.

On trees, common. Battle lake, June 18, 1900, nos. 15 and 17 and June 19, 1900, nos. 29 and 32. Henning, June 25, 1900, no. 176 and June 30, 1900, no. 362. Bemidji, July 4, 1900, no.

448. Thief River Falls, July 18, 1900, nos. 779 and 790. Red lake, July 26, 1900, nos. 881 and 894 and August 1, 1900, no. 1040.

177. **Graphis scripta** (L.) ACH.

On trees, frequent, Battle lake, June 22, 1900, no. 124. Henning, June 24, 1900, no. 179. Bemidji, July 4, 1900, no. 453, July 11, 1900, nos. 603 and 648. Red lake, July 26, 1900, no. 880 and July 30, 1900, nos. 995 and 997.

178. **Graphis scripta** (L.) ACH. var. **limitata** ACH.

On trees, rare. Henning, June 30, 1900, no. 367. Bemidji, July 12, 1900, no. 667.

179. **Graphis scripta** (L.) ACH. var. **recta** (HUMB.) NYL.

On trees, rare. Bemidji, July 12, 1900, no. 664 and July 14, 1900, no. 728. Red lake, August 1, 1900, no. 1037.

180. **Arthonia lecideella** NYL.

On trees, infrequent. Battle lake, June 18, 1900, no. 5 and June 23, 1900, no. 161. Leaf hills, June 26, 1900, no. 242. Bemidji, July 4, 1900, no. 456, July 5, 1900, nos. 463 and 481 and July 9, 1900, no. 552. Thief River Falls, July 20, 1900, no. 837 and July 21, 1900, no. 856. Red lake, July 31, 1900, no. 1013.

181. **Arthonia patellulata** NYL.

On elms, rare. Bemidji, July 12, 1900, no. 699.

182. **Arthonia dispersa** (SCHRAD.) NYL.

On trees, probably common. Battle lake, June 20, 1900, nos. 44 and 67, June 22, 1900, no. 131 and June 23, 1900, no. 160. Henning, June 25, 1900, no. 183. Red lake, July 26, 1900, nos. 895 and 899, July 28, 1900, no. 958 and August 2, 1900, no. 1057.

183. **Arthonia** sp.

On trees, rare. Leaf hills, June 26, 1900, no. 213. Spores 4-celled in pyriform asci, 18–21 mic. long by 6–7 mic. wide. Apothecia differently disposed than in the next.

Not previously reported from Minnesota.

184. **Arthonia radiata** (PERS.) TH. FR.

On trees, rare. Battle lake, June 21, 1900, no. 116 and June 22, 1900, no. 135. Henning, June 29, 1900, no. 360. Red lake, July 26, 1900, no. 889 and July 31, 1900, nos. 1005 and 1017.

185. **Acolium tigillare** (ACH.) DN.

An old wood, rare. Battle lake, June 23, 1900, no. 137. Bemidji, July 5, 1900, no. 497 and July 6, 1900, no. 530.

186. **Calicium lucidum** (TH. FR.) FINK.

On pines, tamaracks and dead wood, rare. Henning, July 2, 1900, no. 413. Bemidji, July 6, 1900, nos. 530 and 539 and July 11, 1900, no. 595. Red lake, July 30, 1900, no. 994 and August 3, 1900, no. 1072.

Not previously reported from Minnesota and new to North America.

187. **Calicium trichiale** ACH. var. **cinereum** NYL.

On living and dead wood in swamps, rare. Henning, June 28, 1900, nos. 301 and 334. Bemidji, July 13, 1900, no. 709. Red lake, July 26, 1900, no. 901 and July 28, 1900, no. 938.

Not previously reported from Minnesota and new to the interior of North America.

188. **Calicium chrysocephalum** ACH.

On cedars in swamp, rare. Bemidji, July 6, 1900, nos. 507 and 535.

189. **Calicium trachelinum** ACH.

On old wood in tamarack swamp, locally common. Henning, June 28, 1900, no. 325 and July 2, 1900, no. 406.

Not previously reported from Minnesota.

190. **Calicium polyporæum** NYL.

On *Polyporus versicolor*, rare. Bemidji, July 14, 1900, no. 736. Thief River Falls, July 19, 1900, no. 823. Red lake, July 28, 1900, no. 955.

Not previously reported from Minnesota.

191. **Calicium** sp.

On dead wood, especially in swamps, rare. Battle lake, June 23, 1900, no. 159. Henning, June 30, 1900, no. 374. Bemidji, July 7, 1900, no. 524 and July 12, 1900, no. 692.

Spores simple and compound. Referred to *C. quercinum* Pers. in no. IV. of this series of papers.

Not previously reported from Minnesota.

192. **Calicium curtum** TURN. and BORR. ?

On old stumps of conifers, especially in swamps, frequent. Henning, June 28, 1900, no. 317. Red lake, July 27, 1900, no. 911 and August 2, 1900, no. 1063.

Apothecia are large for the species and not pruinose at margin.

Not previously reported from Minnesota.

193. **Calicium trabinellum** (SCHAER.) KBR.

On old stumps of conifers, common at first locality. Henning, June 28, 1900, no. 310. Bemidji, July 11, 1900, no. 631.

Not previously reported from Minnesota and new to the interior of North America.

194. **Calicium parietinum** ACH.

On dead stumps of conifers, common especially in swamps. Henning, June 28, 1900, nos. 299 and 316. Bemidji, July 7, 1900, no. 523 and July 12, 1900, no. 678. Thief River Falls, July 21, 1900, no. 866. Red lake, July 27, 1900, no. 916 and August 1, 1900, no. 1035.

195. **Calicium pusillum** FLK.

On dead tamarack in swamps, rare. Henning, June 25, 1900, no. 196.

Not previously reported from Minnesota and new to North America.

196. **Calicium turbinatum** PERS.

On *Pertusaria communis*, rare. Bemidji, July 13, 1900, no. 703.

197. **Coniocybe pallida** (PERS.) FR.

On elms, infrequent. Henning, June 30, 1900, no. 368. Bemidji, July 11, 1900, no. 630 and July 13, no. 708. Thief River Falls, July 19, 1900, no. 716. Red lake, July 31, 1900, no. 1007.

198. **Endocarpon fluviatile** DC.

On rocks by water, infrequent. Red lake, August 2, 1900, no. 1052.

199. **Endocarpon hepaticum** ACH.

On earth, usually calcareous, abundant at second locality. Battle lake, June 20, 1900, no. 95. Leaf hills, June 27, 1900, nos. 256 and 273 and July 2, 1900, nos. 389 and 398. Bemidji, July 16, 1900, no. 742.

200. **Endocarpon pusillum** HEDW.

On calcareous pebbles, locally frequent. Leaf hills, June 27, 1900, no. 258 and July 2, 1900, no. 398.

201. **Staurothele umbrina** WAHL.)TUCK. var. **colpima**(WHNBL.), NYL.

On granitic rocks in damp places and usually near water, locally common. Bemidji, July 11, 1900, nos. 593, 636, 641 and 642.

This plant was recorded in no. IV. of this series of papers and also in no. V. as *S. drummondii* Tuck. However, it agrees more nearly with European specimens of the present variety.

Not previously reported from Minnesota.

202. **Verrucaria nigrescens** PERS.

On rocks, frequent. Battle lake, June 20, 1900, nos. 86 and 87 and June 23, 1900, nos. 144 and 168. Leaf hills, July 2, 1900, nos. 387 and 403. Thief River Falls, July 17, 1900. no. 754. Red lake, July 27, 1900, no. 929 and July 28, 1900, no. 947.

203. **Verrucaria viridula** ACH.

On rocks along lake, common. Red lake, July 28, 1900, no. 943.

Not previously reported from Minnesota.

204. **Verrucaria muralis** ACH.

On rocks, especially calcareous, infrequent. Battle lake, June 23, 1900, no. 166. Leaf hills, June 27, 1900, nos. 289 and 293 and July 2, 1900, no. 404. Red lake, July 28, 1900, no. 940.

205. **Verrucaria fuscella** FR.

On calcareous drift pebbles, frequent. Leaf hills, June 27, 1900, nos. 262 and 297.

A peculiar form.

206. **Verrucaria conoidea** FR.

On lime pebbles, rare. Bemidji, July 11, 1900, no. 626.

Not previously reported from Minnesota and probably new to North America.

207. **Lagedia oxyspora** (NYL.) TUCK.

On birch trees, probably abundant. Henning, June 25, 1900, no. 189. Bemidji, July 11, 1900, no. 608 and July 12, 1900, no. 671.

208. **Pyrenula punctiformis** (ACH.) NAEG.

On trees, rare. Battle lake, June 18, 1900, no. 18.

209. **Pyrenula punctiformis** (ACH.) NAEG. var. **fallax** NYL.

On birch trees, common. Henning, June 25, 1900, no. 170 and June 29, 1900, no. 353. Bemidji, July 11, 1900, nos. 601 and 624 and July 12, 1900, no. 670. Red lake, August 1, 1900, no. 1036.

The more I see of this plant, the more likely it seems that it will finally have to be separated entirely from this species.

210. **Pyrenula gemmata** (ACH.) NAEG.

On trees, rare. Thief River Falls, July 18, 1900, no. 798.

211. **Pyrenula hyalospora** (NYL.) TUCK.

On trees, locally frequent. Red lake, July 26, 1900, no. 887.

212. **Pyrenula cinerella** (FLOT.) TUCK.

On birch, locally common. Henning, June 29, 1900, no. 348.

213. **Pyrenula cinerella** (FLOT.) TUCK. var. **quadriloculata** FINK.

On birch, common. Bemidji, July 11, 1900, nos. 600 and 632. Red lake, July 26, 1900, no. 897.

214. **Pyrenula leucoplaca** (WAHL.) KBR.

On trees, especially poplars, common. Leaf hills, June 27, 1900, nos. 268 and 269. Henning, June 29, 1900, no. 344. Bemidji, July 9, 1900, no. 555, July 11, 1900, no. 611 and July 12, 1900, no. 676. Thief River Falls, July 17, 1900, no. 767, July 18, 1900, nos. 789 and 802 and July 19, 1900, no. 821. Red lake, July 28, 1900, no. 961.

215. **Pyrenula leucoplaca** (WAHL.) KBR. var. **pluriloculata** var. nov.

On trees, infrequent. Battle lake, June 18, 1900, no. 10 and June 21, 1900, no. 111. Henning, June 29, 1900, no. 357. Bemidji, July 11, 1900, no. 597. Thief River Falls, July 18, 1900, no. 799 and July 19, 1900, no. 829. Red lake, August 3, 1900, no. 1073.

Spores 5–8-celled.

XL. CORALLINÆ VERÆ OF PORT RENFREW.

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I had the opportunity of studying seaweeds during the summer of 1901, at the Minnesota Seaside Station at Port Renfrew, Vancouver Island, B. C. The vicinity of the laboratory is extremely rich in marine life and afforded a good number of examples. I paid special attention to calcareous algæ, in which branch I have been deeply interested. Returning with the specimens to the Botanical Institute of the University of Tokyo, I carefully examined the Corallinæ (veræ) and prepared the present paper. Other specimens belonging to the subfamily Melobesiæ have been sent to Mr. M. Foslie, of Norway; his paper should also appear in a short time.

The material was partly dried and partly preserved in alcohol, the accompanying photographs being taken from the latter. The sections were made from alcoholic material by microtome, after decalcifying in Pereny's fluid. *Amphiroa tuberculosa* and a few other thick plants were not satisfactorily decalcified by the solution and the author found the following mixture specially suited for the purpose:

Hydrochloric acid, 5 per cent.........40 c.cm.
Alcohol, absolute.....................30 c.cm.
Chromic acid, 0.5 per cent...........30 c.cm.

The sections were stained after my usual method. One brings down the sections to pure water, and stains with Boemer's hæmatoxylin for 20–40 minutes; treat with acetic acid if necessary, and then dip in fuchsin (0.3 gr. in 100 c.cm. of 50 per cent. alcohol for one hour; 90 per cent. alcohol, abs. alcohol, xylol, balsam. The spores and spore-forming cells stain in red and the cell-walls of the vegetative cells in purple.

The author expresses his deepest thanks to Professor Conway MacMillan and Miss J. E. Tilden, who cared for him very kindly in every way during his stay at their private station; and to Professor J. Matsumura, of Tokyo, who offered many valuable suggestions on this work.

Synoptical Key of Corallinæ Enumerated in the Present Paper.

A. Conceptacles wart-like protuberances, on a surface of an articulus.

o. Branches not pinnated.

a. Articuli cylindrical.....*Amphiroa cretacea* f. *tasmanica.*

b. Articuli of the upper and the middle portions cylindrical, subcompressed or compressed. *Amphiroa tuberculosa.*

c. Articuli of the upper and middle portions approximate, with depressed wings........*Cheilosporum californicum.*

oo. Branches pinnated.

a. With short and thick stipes; upper articuli of the branches cordate or sagittate with round lobes; external margins of the ultimate articuli thick. *Cheilosporum frondescens.*

b. With long and thin stipes; upper articuli of the branches sagittate with acute lobes; external margins of the ultimate articuli thin..............*Cheilosporum planiusculum.*

c. With long and thick stipes; articuli of the axial branches hexagonal, without evident rib; conceptacles sometimes stalked............................*Cheilosporum MacMillani*

B. Conceptacles stalked, taking place of segments.

o. Branches regularly pinnated, flabellate. *Corallina officinalis* var. *chilensis.*

oo. Branches irregularly pinnated, several pinnules around the top of an articulus.

a. Pinnules not confusedly ramous. *Corallina vancouveriensis.*

b. Pinnules confusedly ramous and prickly. *Corallina aculeata.*

Habitat of Corallinæ at Port Renfrew.

The coast near the Minnesota Seaside Station chiefly consists of sandstone beds spreading horizontally. The beds are covered with water at high tide, and drained at low tide, leaving a good number of pools. The Corallinæ are mostly found between the tidal marks as well as in the pools. *Amphiroa tuberculosa* and *Amp. cretacea* f. *tasmanica* are found at the depth of 2–5 ft. below the low-water mark or the surface of the pools: the former species assumes very diverse forms when it is found at the margins of the pools, or between tidal marks. So also do *Corallina officinalis* var. *chilensis*, and *Cheilosporum MacMillani;* but the latter two are not infrequently found in more shallow water. *Cor. vancouveriensis* and its variety, on the contrary, are in most cases found at the margins of the pools, and in the region a little above the low-tide mark. They are also found epiphytic on the shells of Mya which cover the enormous area of the drained beds, thus making it easy to collect the entire bunch of the plants. *Cheil. frondescens* is also found in similar positions. *Cheil. planiusculum* is also an inhabitant of the pools, but slightly below the margins. When it grew above the water mark the frond is mostly stunted, apparently forming a granular mass. In the tide pools high above the water-level *Cor. aculeata* is generally found; water in such pools is mostly brackish, at least during the ebb tide hours; and the plant seemed to be able to adapt itself to it. This might be the probable cause why the ultimate articuli of the branches of this species are insufficiently calcified. Nevertheless, *Cor. vancouveriensis*, *Cheil. californicum*, *Cheil. planiusculum*, etc., may also be found in these brackish pools without any apparent modification in the characters of their fronds. Briefly speaking, *Cor. vancouveriensis* is an inhabitant of the shallowest water, and *Amp. tuberculosa*, as it were, of the deepest. The latter view may be corroborated by the fact that we often find the fragments of *Amp. tuberculosa* growing attached to the holdfast of *Nereocystis Lütkeana* hauled up out of water 20–50 feet deep.

Cor. pilulifera and its varieties which are abundantly found in Kamtchatka and in the northern part of Japan could not be found at Port Renfrew. Their places seem to be taken by *Cor. vancouveriensis* and *Cheil. planiusculum*. The habitat of these is much like that of the typical form of *Cor. officinalis* or *Cor. squamata*.

Cheil. frondescens which was described by Ruprecht* collected in Unalaska is common at this coast. Areschoug † re-

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* Post. et Rupr.: Illustr. alg., p. 20.

† Aresch.: in J. Ag. Spec. alg., II., p. 549.

marked Ruprecht's plant to be probably a dwarfed form. This remark is true so far as my determination is correct; our plant is little larger than Ruprecht's f. *maxima mihi* being twice or more as large as his plant.

No specimens of *Jania* could be found. The water at Port Renfrew seems to be too cold to admit any member of this group. We are able to give only one datum here: the temperature of the water ½ ft. below the surface of a tidal pool, 10°.4 C.; 1 ft. below the surface of open sea 10°.2 C.; Atm. temp. 11°.55 C.

CORALLINÆ VERÆ OF PORT RENFREW.

1. **Amphiroa cretacea** Endl. f. **tasmanica** (Sond.). Pl. LI., Fig. 1.
   = *Amphiroa tasmanica* Sond. in Plant Müll. (Linnæa, XXV.).
   2d: in Müll. Frag. Phyt. Austr. Suppl.
   Kützing: Tab. Phyc., VIII. Taf. 47, Fig. 11.

The plant found at Port Renfrew is identical with the Tasmanian form and not with *Amp. cretacea*, which was collected in Unalaska by Ruprecht. As has been already remarked by Kützing (*l. c.*, p. 23), *Amp. tasmanica* Sond. is quite similar to *Amp. cretacea* Endl. and it might better be reduced as above.

Not rare: 2–5 ft. below low-water mark, also in pools.

2. **Amphiroa tuberculosa** Endl. Pl. LI., Fig. 2; Pl. LVI., Figs. 1 and 2.
   Aresch: in J. Ag. Spec. Alg., II., p. 538.
   Harv: Ner. Bor. Am., p. 86.
   = *Corallina tuberculosa* Post. et Rupr. Ill., p. 20, t. 40.
   Kütz: spec. alg., p. 704.
   ? = *Amphiroa* (*Arthrocardia*) *epiphlegnoides* J. Ag. in Harvey's Notes on N.W. Am. Alg. (Journ. of Linn. Soc., VI., p. 169).
   = *Amphiroa californica* in Prov. Museum at Victoria, B. C.

Judging by the figure delineated by Postels and Ruprecht (*l. c.*) our plant may be readily referred to the present species. It attains to 3–5 inches in its height with subdichotomous or lateral patent branches. The articuli are extremely variable in their form: those of the basal portion are invariably subcylindrical; those of the upper and the middle portions, cordate or sagittate, sometimes cylindrical or clavate; the cordate or sagittate articuli are more or less compressed and generally with subevident rib on the shaded surface: the terminal articuli are normally subcompressed obovate but sometimes globular or linear. The conceptacles are slightly bulged out, two to several, mostly immersed in the shaded side of a cordate articulus. Geniculi lineæform.

A branch is often simple with homogeneous cylindrical articuli. Plants with lots of this sort of branch are likely to be confounded with *Amp. cretacea* Endl. or the preceding forma. But the occurrence of the cordate articuli is the character upon which to separate the present species. *Amp. epiphlegnoides* seems to me quite similar to this plant. I mention it here as a synonym, however, with doubt, as I have not seen any authentic specimen of Agardh's plant.

Common: 2–5 ft. below low water mark, not seldom found, several fathoms deep.

3. **Cheilosporum californicum** (Dcne.). Pl. LIV., Fig. 2; Pl. LVI., Fig. 3.

Frond 3–5 cm. alta, stipitata, irregulariter di-trichotome ramosa: articulis stipitis cylindraceis diametro sesqui- 2- plo longioribus sursum latioribus et compressis; ramorum approximatis, adpressis mediis costatis, obreniformibus vel sagittatis lobis rotundis, longitudine inter genicula distantiam loborum 4-plo brevioribus; apicalium obovatis compressis: conceptaculis hemisphericalibus binis vel quatuor in utraque facie articuli instructis.

Amphiroa californica Dcne., Class f. d. Alg. et Cov., p. 112.
Kütz: Spec. Alg., p. 704.
Aresch: in J. Ag. Spec. Alg., II., p. 542.
Harv: Ner. Bor. Americ, p. 86.

As the original description of this plant was given somewhat briefly, a few other species have been mistakenly identified with it; and Areschoug counted it under the "species inquirendae" (*l. c.*). We have a specimen of *Amp. californica* Dcne., collected at Oregon and determined by Dr. Farlow. Our plant is exactly similar to this specimen and at once accords very well with Decaisne's description.

Not rare: low-water mark, also in tide pools.

4. **Cheilosporum frondescens** (Post. et Rupr.), f. **typica**. Pl. LII., Fig. 1; Pl. LVI., Figs. 4, 5 and 8.

Corallina frondescens Post. et Rupr., Ill. p. 20, t. XL., f. 103.

Arthrocardia ? frondescens (Post. et Rupr.) Aresch. in J. Ag. Spec. Alg., II., p. 549.

f. **maxima,** f. nov. Pl. LII., Fig. 3.

Fronde majore et crassiore; articulis pinnarum lobis latissimis saepe crenulatis, apicalium compressis obovatis vel spatulatis.

f. **intermedia,** f. nov. Pl. LII., Fig. 2.

Fronde tenuiore; articulis pinnarum compressis deltoideo-obcordatis lobis nonnunquam acutis.

f. **polymorpha,** f. nov. Pl. LII., Fig. 4; Pl. LVI., Figs. 6, 6a and 7.

Fronde minore; crassiuscula, polymorpha: tum articulis pinnarum obcordatis, obreniformibus vel sagittatis, apicalium obovatis vel globosis; tum articulis pinnarum axiumque cylindraceis, linearibus vel globosis.

Ruprecht's illustrations and description *l. c.* precisely coincide with f. *typica*. Areschoug remarked in J. Ag. Spec. Alg. *l. c.* that the original plant might have been a tiny form of the species. We have at Port Renfrew plants often attaining to several centimeters in height.

f. *typica* is a densely cæspitose plant, irregularly pinnated; the lowermost pinnæ attain to the length of the main stem, and thus give the appearance of trichotomy. The articuli are compactly arranged, the lower margin of an articulus in contact with the upper margin of the subsequent one. Conceptacles are mostly found two to four in number and placed on the shaded surface, often, however, solitarily immersed at the angles of a deltoid articulus.

f. *maxima* is distinguished from the other formæ by its large and compressed articuli at the upper portion of the branches. These articuli measure 2–5 mm. broad, 1.5–2 mm. long and are often cleft at their lobes. The branches are not so dense as in f. *typica*.

f. *intermedia* is characterized by having the upper portions of the fronds revoluted downwards while it is yet young. The articuli are rather less wide than those of f. *typica* and in every part thin. The lobes of the articuli are angled and consequently more loosely arranged.

f. *polymorpha* attains to a length of scarcely one inch and has its articuli thick and rough. Its form is very variable, sometimes assuming quite an aberrant appearance (Pl. LVI., Fig. 6, 6a) so that we could not suppose it to belong to this species, had it not been provided with some normal branches in a portion of the frond (Pl. LII., Fig. 4).

Although I distinguish these four formæ, intermediate forms between them are naturally met with. Especially f. *intermedia* and f. *polymorpha* are likely to be confounded with the abnormal forms of *Cheil. planiusculum*. In this case the external thick margin of the apical articuli and the robust stipes are the important characters of this species to separate it from the latter. The apical articuli of *Cheil. planiusculum* are mostly thin and compressed, and the stipes are delicate filiform. Nevertheless, it would not be an unreasonable supposition that the hybrid between *Cheil. frondescens* and *Cheil. planiusculum* may occur in nature.

Common: between tide marks, also in pools.

5. **Cheilosporum planiusculum** (Kütz.). Pl. LIII., Figs. 1–3; Pl. LVI., Figs. 9 and 10.

Fronde dense cæspitosa suberecta, 3–7 cm. alta, superne complanata, bi-tripinnata; articulis axium inferioribus tenuioribus cylindraceis mediis superioribusque compressis late triangularibus subcostatis, pinnarum sagittatis lobis acutis sæpe cordatis, pinnularum ancipitibus lanceolatis vel linearibus, ultimis obovatis compressis; geniculus brevissimis; conceptaculis hemisphæricalibus, 2–5 in articulo instructio.

Corallina planiuscula Kütz., Tab. Phyc., VIII., p. 31, taf. 63, Fig. 3.

The present plant is extremely variable in the shape of its articuli, and sharp definition is hard to give. Kützing counted four formæ in the original description (*l. c.*) though I could not find any form referable to *f. laciniata*. The other three formæ may be found mixed together in one bunch of the plant, often branches of different forms occurring in one individual. In an extreme instance, especially in a plant growing at high-tide mark, the frond becomes a moniliform filament with a few articuli of the normal shape (Plate LII., Fig. 3). Generally speaking, the articuli of the upper and middle portions are sagittate, with lobes thin, delicate and sharp at the upper angles, and with evident ribs at the middle; the pinnules are thin, spatulate or lanceolate. As the consequence, an articulus is not approximate with its adjacent ones as in *Cheil. frondescens* f. *typica* (comp. Pl. LVI., Fig. 4, and Pl. LVI., Fig. 10).

The delicate moniliform stipes, and the thin external margin of the apical articuli are the important characters of this species to distinguish it from the preceding species.

Comparatively common; low tide mark, also in pools.

6. **Cheilosporum MacMillani** sp. nov. Plate LII., Figs. 4 and 5; Pl. LVI., Figs. 11–14.

Fronde crassa nudusculo-stipitata, 4–10 cm. alta, inferne subteretibus superne flabellata bi-tripinnata; pinnis pinnulisque creberrimis erecto-patentibus sursum sensim brevioribus: articulis stipitum cylindraceis diametrum subæquantibus, mediis et superioribus compressis medio ventro elevatis, hexagonis vel cuneato-deltoideis diametro sesquibrevioribus, pinnarum ancipitibus lineari-sagittatis vel lanceolatis, ultimio ellipsoideis sæpe incrassatis; conceptaculis verrucæformibus in utraque facie instructis vel subcompressis in apicibus pinnularum immersis, nonnunquam pyriformibus pedunculatis.

This plant has its articuli of the upper part of the main branches more highly elevated on the ventral side than on the dorsal. The articuli of the lower portion are thick and moniliform, gently compressed upwards: in the upper and middle portion they become hexagonal or truncated, shorter than the breadth.

According to the description* of *Amphiroa wardii* Harv. and *Amp. mallardiæ* Harv., the present species has some common characters with them so that I hesitated for a time to name it as a new species. But the attachment of the conceptacles of our plant is rather peculiar, only one similar example being hitherto known in *Cheil. maximum.*† The eramiferous articuli of the pinnæ of ours are lineari-sagittate with lobes projected upwards; and the articuli of the upper portions of the main branches are hexagonal, much broader than the height. These various characters may easily distinguish ours from Harvey's plants. Not common; low-tide mark.

7. **Corallina officinalis** var. **chilensis** Kütz. Pl. LIV., Fig. 1; Pl. LVI., Fig. 15.

Fronde erecta, 5–10 cm. alta, inferne teretiuscula, superne flabellata bi-tripinnata: articulis inferioribus compressiusculis,

* Harvey: Nereis Austr., p. 99.

† Yendo: Cor. verae Japan. (Journ. of Sci. Coll. Tokyo, vol. XVI., art. III.)

mediis superioribusque oblongo-cuneatis compressis, pinnarum sterilium linearibus vel lanceolatis ancipitibus, ultimis compressis obovatis; conceptaculio pedunculatis subcompressis sæpe corniculatis. Color rubro-violaceus.

Corallina officinalis chilensis Kütz., Tab. phyc., VIII., p. 32, *taf. 66, Fig. 1.*

Cor. officinalis L. f. δ Yendo. Cor. veræ Japan., Pl. VII., Fig. 13 (Journ. Sc. Coll. Tokyo, Vol. XVI.).

The sterile specimens of this variety have been collected at Hakodate, a port in the northern part of Japan. As they lacked the conceptacle I was not able to satisfactorily determine the species and included them under the *Cor. officinalis* L. The specimens collected at Port Renfrew are fortunately fertile and accord very well with the description and figures of Kützing's Tab. Phyc. and at the same time correspond with the Hakodate specimens.

As I before noted (*l. c.*), this plant is a somewhat variable form to be counted under the species *Cor. officinalis* L.

Not very common; low-water mark, also in pools at the depth of 2–3 ft. below the surface.

8. **Corallina vancouveriensis** sp. nov. Pl. LIV., Fig. 3; Pl. LV., Figs. 1 and 2; Pl. LVI., Figs. 16–17.

Fronde 5–15 cm. alta, multicipite, longe stipitata, ramis bi-tripinnatis, sæpe pinnulis ex apice articuli egredientibus; articulis infinis globosis, mediis superioribusque subclavatis diametro æqualibus vel 2-plo longioribus tereti-compressis, ultimis obovatis subcompressis; articulis pinnarum cylindraceis linearibus vel alato-projectis digitatis; conceptaculis globosis vel pyriformibus stipitatis, sæpe corniculatis.

f. **typica,** f. nov. (Pl. LIV., Fig. 3; Pl. LVI., Fig. 16.)

Fronde plena articulorum linearum vel alato-projectorum digitatorum, conceptaculis globosis longe stipitatis.

f. **densa,** f. nov. (Pl. LV., Fig. 1; Pl. LVI., Fig. 17.)

Fronde dense ramosa, conceptaculis pyriformibus pedunculatis.

Both formæ approach one another and a sharp boundary is hard to draw. But f. *typica* is thicker and larger than the other and has abundance of linear or lanceolate long pinnæ in the upper part of the frond. The high tide form of this species assumes a diverse appearance; its stipes are thick and stunted, the pinnules in the upper portion are robust and fan-shaped, generally crenulated at the external margin.

Most common between tide marks on the margins of the pools.

9. **Corallina aculeata** sp. nov. Pl. LV., Fig. 3; Pl. LVI., Figs. 18–19.

Fronde 5–10 cm. alta, stipitata, irregulariter bi-tripinnata, sæpe pinnulis ex apice articuli egredientibus; articulis inferioribus diametro sesquilongioribus, pinnarum pinnularumque fragilissimis digitato-laciniatis aculeatio, sæpe cylindraceis vel linearibus; conceptaculis subcompressis cornibus aculeatis.

The pinnules of this plant are characteristic: they are brittle, delicate and confusedly branched. The ultimate articuli of the main branches as well as some of the young pinnules are always weakly calcified; and the apices of these articuli are liable to shrink in the exsiccation. In other respects it is closely allied to *Cor. vancouveriensis* f. *typica*, so that it might be taken as a local form caused by the mode of habit. Indeed a young and sterile frond of this species is hardly separable from it, if the apical articuli were not weakly calcified.

Common; high-tide pools.

Explanation of Plates.

The figures in Plates LI.–LV. are all in natural size, taken from the alcoholic specimens.

Plate LI.

1. *Amphiroa cretacea* Endl. var. *tasmanica* Sond.
2. *Amphiroa tuberculosa* Endl.

Plate LII.

1. *Cheilosporum frondescens* (Post. et Rupr.) f. *typica*.
2. do. f. *intermedia*.
3. do. f. *maxima*.
4. do. f. *polymorpha*.

Plate LIII.

1. *Cheilosporum planiusculum* (Kütz.) f. *regularis*.
2. do. f. *normalis*.
3. An abnormal form of the same species found at high-tide mark. The fronds are filamentous with moniliform articuli; a few sagittate articuli are to be found in some parts.

4 and 5. *Cheilosporum MacMillani.* In figure 4 wart-like conceptacles as well as pyriform ones are to be found on the same branch.

Plate LIV.

1. *Corallina officinalis* L. var. *chilensis* Kütz
2. *Cheilosporum californicum* (Dcne.).
3. *Corallina vancouveriensis* f. *typica.*

Plate LV.

1. *Corallina vancouveriensis* f. *densa.*
2. A high-tide form of *Corallina vancouveriensis.*
3. *Corallina aculeata.*

Plate LVI.

Figures 1 and 2. *Amphiroa tuberculosa* Endl.

1. Diagrammatic figure of the longitudinal section of an articulus showing four conceptacles, three of which are cut in meridional direction, the remaining one in crosswise. × ca. 15.

2. A conceptacle cut in meridional direction showing the tetrasporangia. Zeiss 2 × BB.

Figure 3. *Cheilosporum californicum* (Dcne.).

A portion of branch showing the conceptacles. The scars of broken conceptacles are seen as deep excavations. × ca. 3.

Figures 4–8. *Cheilosporum frondescens* (Post. et Rupr.).

4. f. *typica;* a portion of frond. × ca. 4.

5. " a fertile branch. × ca. 5.

6 and 6*a*. f. *polymorpha;* portion of frond. × ca. 3½.

7. " a fertile branch. × ca. 4.

8. Cross section of a fertile articulus of f. *typica.* The dotted line indicates the boundary between the cortical part and the medullary.

Figures 9–10. *Cheilosporum planiusculum* (Kütz.).

9. f. *normalis.* × ca. 5.

10. f. *regularis.* × ca. 5.

Figures 11–14. *Cheilosporum MacMillani.*

11–12. Portions of the fertile branches showing pyriform conceptacles taking places of the pinnules (11), or one or more immersed in the pinnules (12). × ca. 2.

13. Portions of a fertile branch, showing wart-like conceptacles, one of them are found inserted at the apex of a pinnule. × ca. 2.

14. Meridional section of a pyriform conceptacle, showing an antheridium: the granular mass in the cavity is an aggregation of spermatozoids. Zeiss 2 × BB.

Figure 15. *Corallina officinalis* L. var *chilensis* (Kütz.). Meridional section of a conceptacle, showing the tetrasporangia. Zeiss 2 × BB.

Figures 16–17. *Corallina vancouveriensis.*

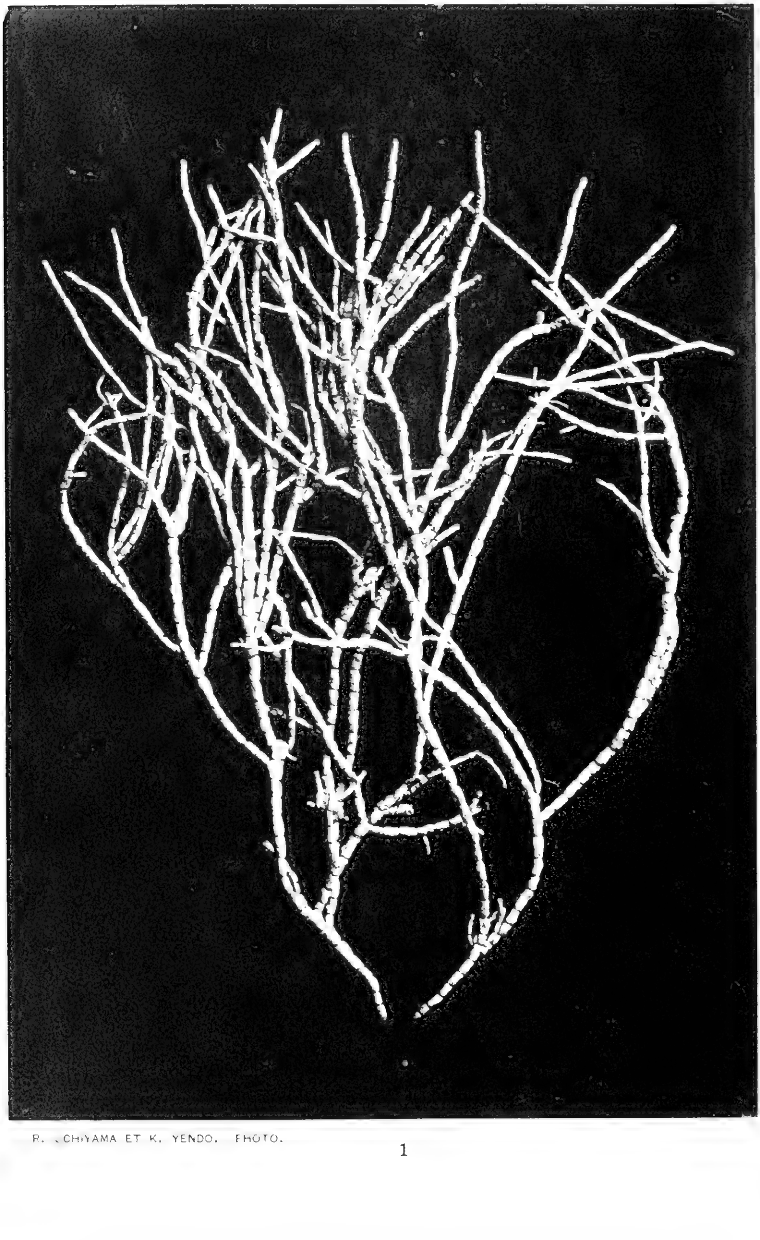
16. f. *typica.*

17. f. *densa.*

Figures 18–19. *Corallina aculeata.*

18. A portion of frond. × ca. 4.

19. A young frond found in a brackish pool high above the tidal mark.



R. YCHIYAMA ET K. YENDO. PHOTO.

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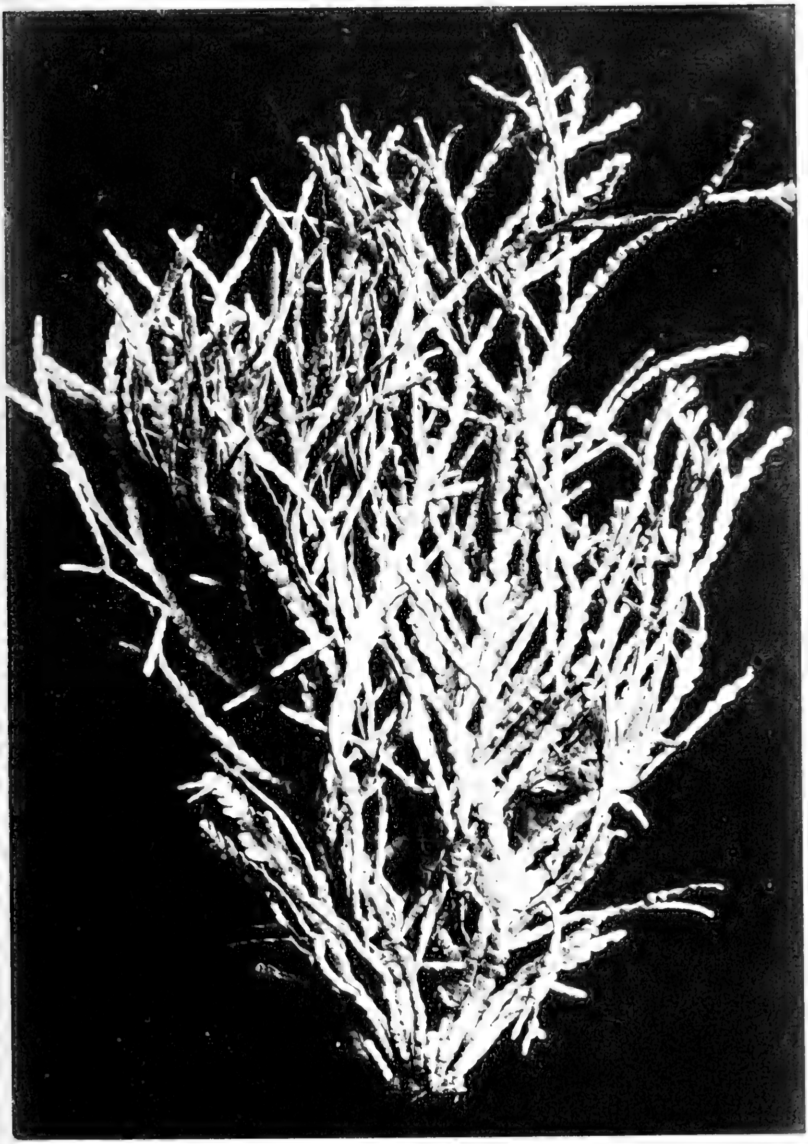


HELIOTYPE CO., BOSTON.

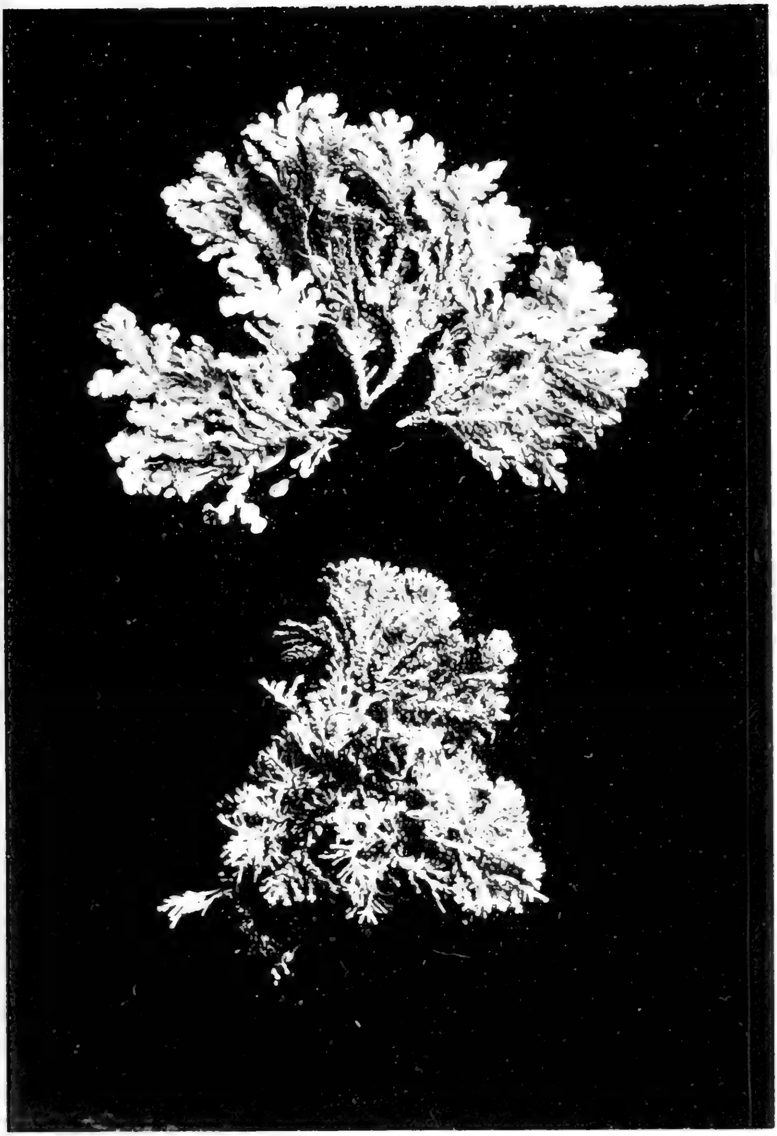
2

L1.

1

2

R. UCHIYAMA ET K. YENDO. PHOTO.



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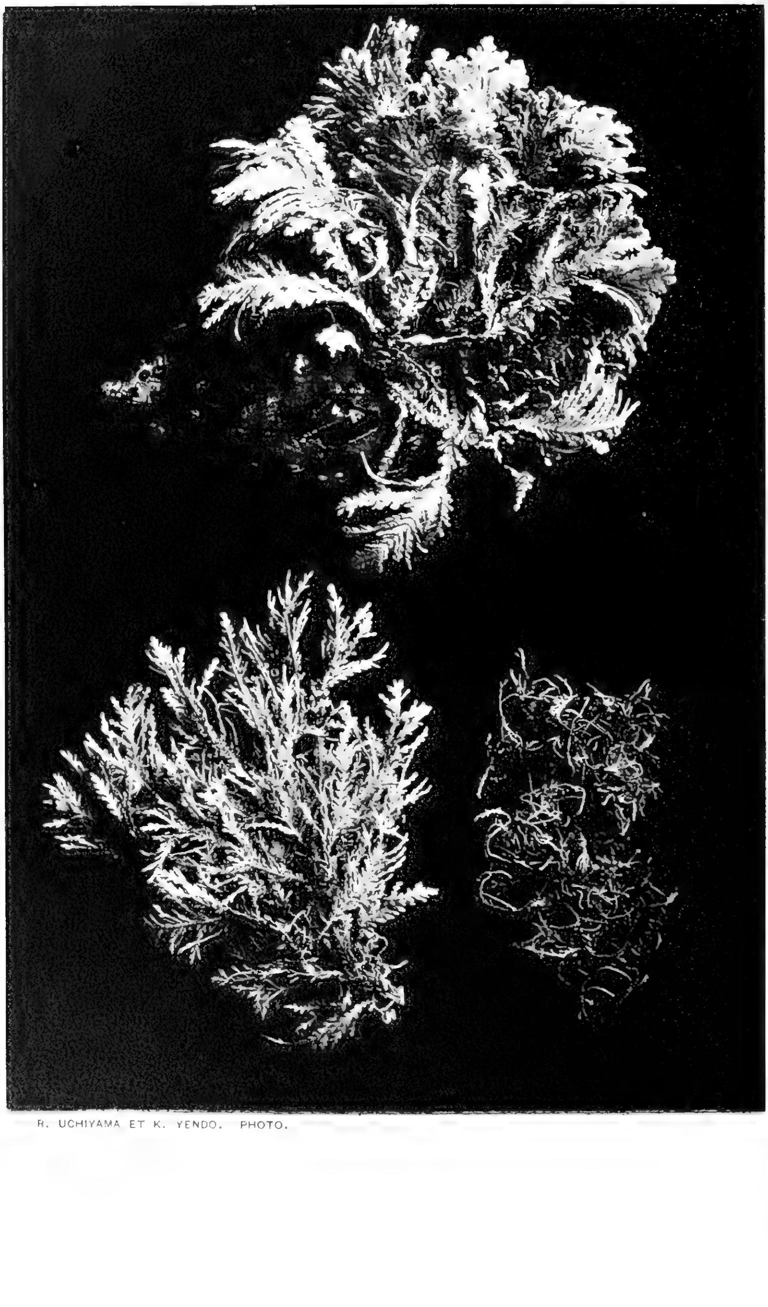
HELIOTYPE CO., BOSTON.

LII.

1



2 3

R. UCHIYAMA ET K. YENDO. PHOTO.

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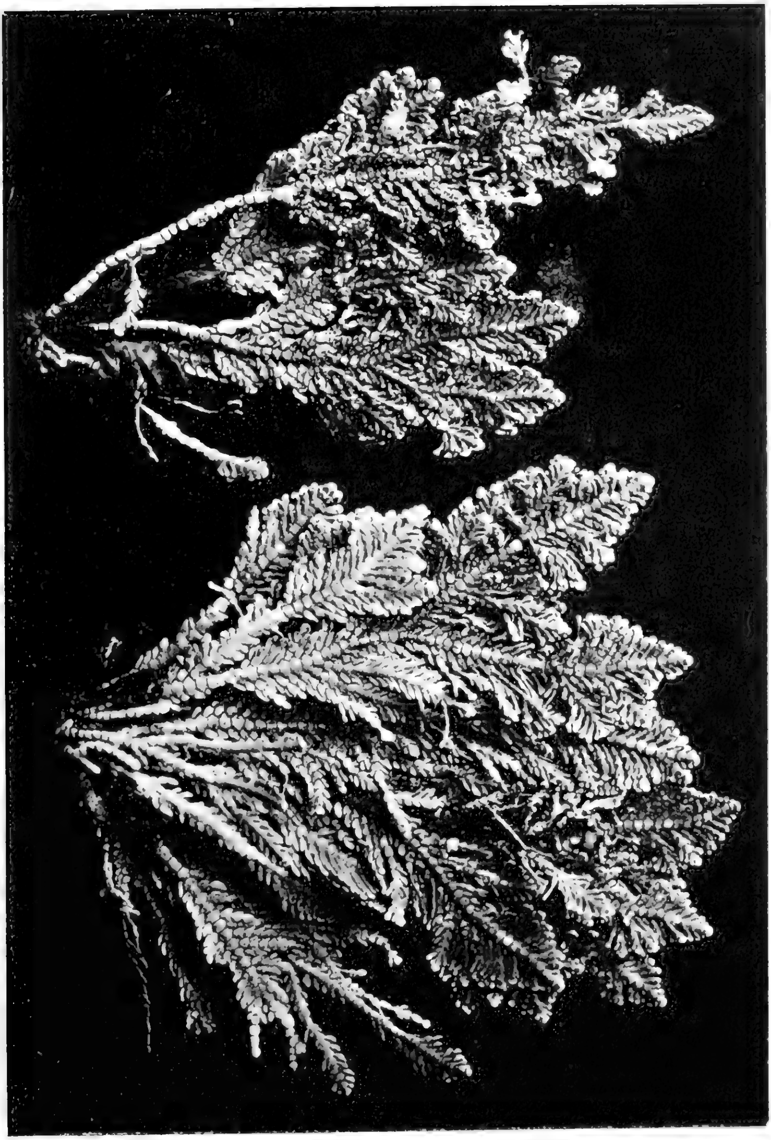

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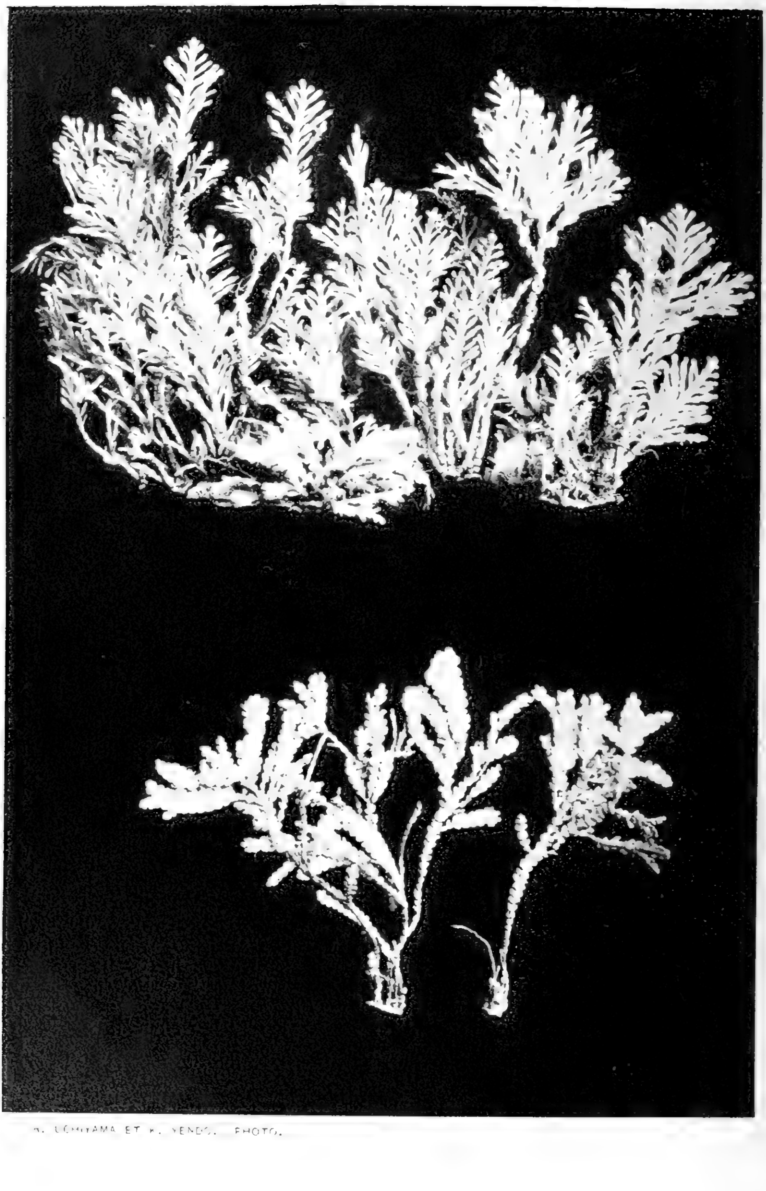
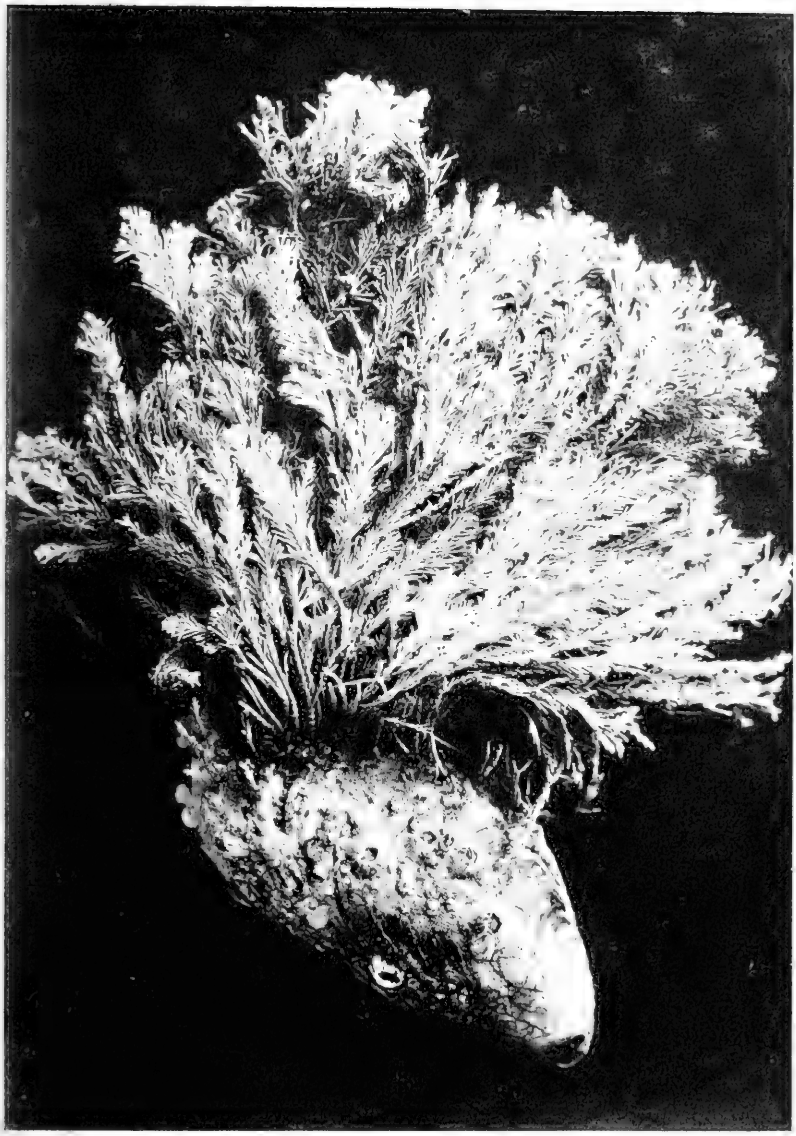


S. UCHIYAMA ET K. YENDO. PHOTO.



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R. UCHIYAMA ET K. YENDO. PHOTO.

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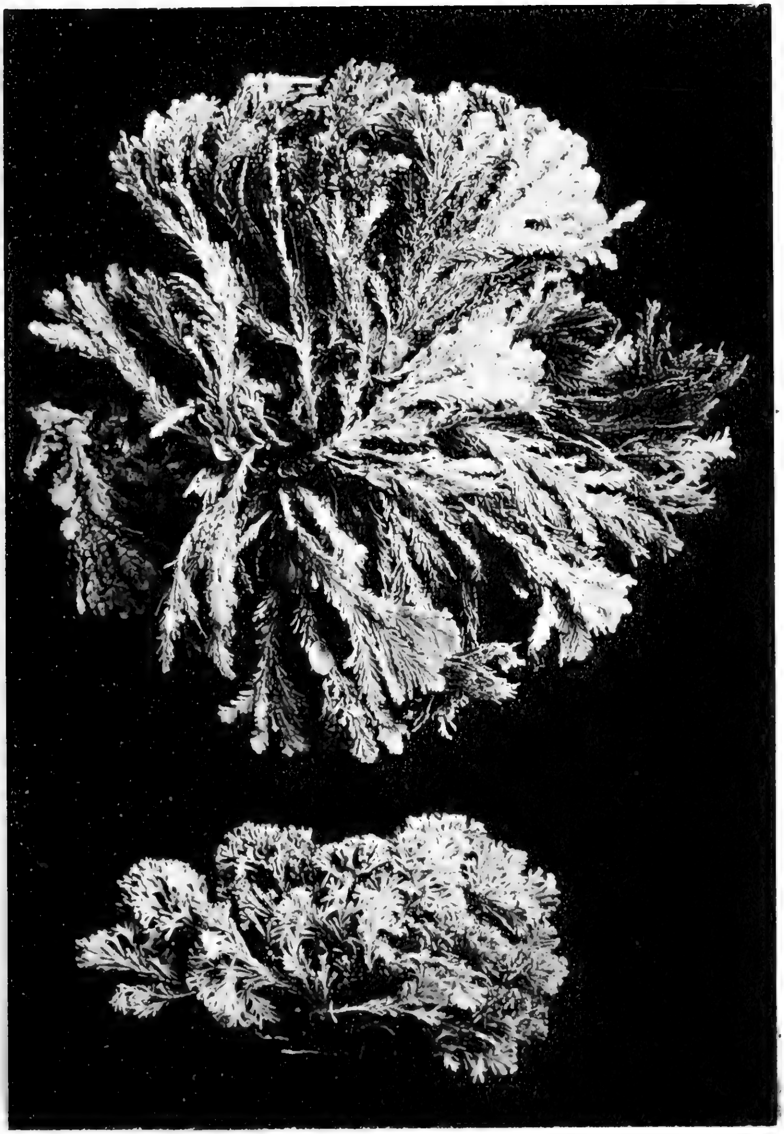

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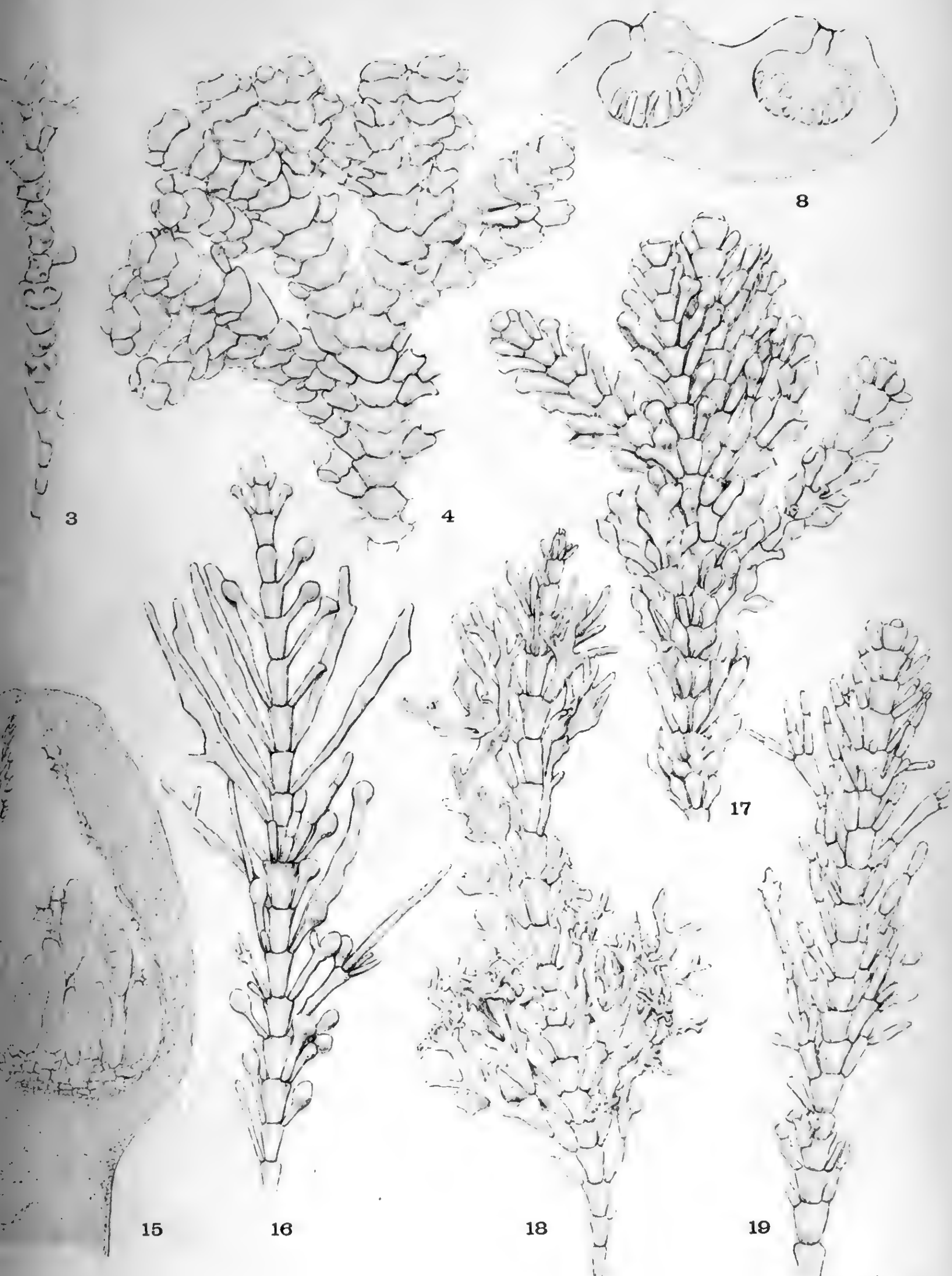

HELIOTYPE CO., BOSTON.

E LVI.

XLI. OBSERVATIONS ON PTERYGOPHORA.

CONWAY MACMILLAN.

Among the larger and less thoroughly studied kelps of the Pacific coast, *Pterygophora californica* Ruprecht has seemed worthy of some attention. A fine series of specimens was secured during the summer of 1901 at the Minnesota Seaside Station on the west coast of Vancouver Island, and while all points in the anatomy and life-history cannot be elucidated from the material in hand, it has seemed best to present an account of such structural and developmental facts as have been observed.

The name, *Pterygophora californica*, appears for the first time in botanical literature in Ruprecht's Algen-Stämme,* in 1848. In this work no description is given of the genus and species, Ruprecht contenting himself with the statement that the new genus is intermediate between *Capea* (*Ecklonia*) and *Alaria*—a point of view which has been but slightly modified by later study—and that it will be elsewhere described. In this work, however, there is given some account of the anatomy of the stem and the characteristic annular structure seen in the cross section is mentioned in the following phrase: "Alle (zuweilen bis 9) Ringe deutlich und gleich stark sind." It is in this paper, also, that Ruprecht announces the presence of mucilage ducts in *Pterygophora*, an observation which has since been questioned by Areschoug.

The formal description of *Pterygophora californica*, together with a plate which leaves something to be desired, is presented by Ruprecht in his "Pflanzen aus dem nördlichen Theile des Stillen Oceans," † published four years later. The specimens upon which the description of Ruprecht was based were col-

* Ruprecht, F. J. Bemerkungen ueber den Bau und das Wachsthum einiger grossen Algen-Stämme. Mem. Acad. Imp. Sci. Nat. Petersb. **6**: 64, 70. 1848.

† Ruprecht, F. J. Neue oder umvollständig bekannte Pflanzen aus dem nördlichen Theile des Stillen Oceans. Mem. Acad. Imp. Sci. Nat. Petersb. **7**: 17–19 (73–75). *t. 5, 8.* 1852.

lected by Wosnessenski in the vicinity of "Ross" (that is, near San Francisco) on the coast of California in July, 1840. The material communicated to Ruprecht comprised some middle-sized plants and some younger specimens, but did not, apparently, enable him to see either the sporelings and unilaminate stage or the mature, full-grown form. Consequently his measurements need modification and the specific description should be revised to include much larger plants. Anderson is the only one who has written on the plant in whose account a knowledge of full-sized plants is indicated. In his Natural History of Santa Cruz county * it is stated that the stem is from one to six feet in length and that the leaves are from one to five feet long, "all without a midrib except the central one into which the flattened stem seems to be lost, giving it the look of a midrib."

It was from Anderson that Areschoug received his specimens of *Pterygophora* upon which, together with those of Ruprecht sent him from the collections of the Academy at St. Petersburg, he based his brief study as set forth in Observationes Phycologicæ.† In this paper Areschoug gives in compact form the generic and specific description and adds some observations and corrections to the earlier account of the Russian botanist. Areschoug observes that the number and nature of the growth-rings in the trunk seem difficult to define. He is skeptical concerning the lacunæ muciferæ, although he retains in his revised description of the genus the phrase "ad peripheriam internam annuli intimi collocata, interdum biseriata," crediting the observation to Ruprecht. He reëxamined the younger specimens upon which Ruprecht's original account was based and gives a condensed description of them. The youngest plant seen appears to have had a stipe 20 cm. long and 2–5 mm. broad with a lamina 35 cm. long and 6–7 cm. broad. As will be seen later my own plant, "B", indicates that these measurements, based upon dried material, need correction. Areschoug received material from "Vera Cruz," California (meaning *Santa* Cruz), sent him by Dr. Anderson and notes, doubtless upon the authority of Anderson, that the plant grows also at San Francisco. In

* Anderson, C. L. The natural history of Santa Cruz county, Oakland, Cal., 24. No date. (1892?)

† Areschoug, J. E Observationes Phycologicæ, Part 5: De Laminariaceis Nonnullis, 11. 1884.

Anderson's List of California marine algæ,* *Pterygophora californica* is recorded as "common or occasional to all the California coasts." The southernmost record of its occurrence that I have happened to find is in Orcutt's Flora of Southern and Lower California.† The plant is here credited to San Diego, based upon collections by Daniel Cleveland. The northernmost point from which specimens have been taken seems to be Port Renfrew, Vancouver Island, B. C., giving the plant a range of over 16° of latitude. It very probably, however, extends up the Alaskan coast. In some observations upon the distribution of *Pterygophora*, Setchell ‡ notes that the characteristic Laminarieæ, Agarieæ and Alarieæ of the North Pacific "stop at about Puget Sound which is the terminus of the isothere of 15°, but *Costaria turneri* Grev. and *Alaria esculenta* (L.) Grev. continue to Monterey, nearly to the 20° line, although they are found only at 'exposed points.' . . . An interesting case is that of *Pterygophora californica* Rupr. which is reported by Dr. C. L. Anderson as growing at Monterey all the year round, but is reported by Mr. Daniel Cleveland as occurring at San Diego only from February until May and in deep water." This statement seems to be based upon the account of *Pterygophora* given by Hervey § in his Sea Mosses in the preparation of which he had the assistance of Dr. Anderson. *Pterygophora*, therefore, seems to have a somewhat wider range than the majority of the North Pacific Laminariaceæ. The plants collected at Port Renfrew were so abundant and robust that I am inclined to think that the region of maximum development may be along the British Columbian rather than along the Californian coast. Ruprecht's plants were Californian; those of Areschoug were from the vicinity of Monterey, as was also the specimen of Hervey: the specimens of Cleveland from San Diego do not seem to have been recorded as of unusual size. The plants of Port Renfrew, some of them with trunks nearly three inches in diameter and eight feet in length, exceed the recorded measurements and indicate thus a particularly luxuriant growth in that

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* Anderson, C. L. List of California marine algæ, with notes. Zoe, 2: 220. 1891.

† Orcutt, C. R. Flora of Southern and Lower California, 13. 1885.

‡ Setchell, W. A. On the classification and geographical distribution of the Laminariaceæ. Trans. Conn. Acad. 9: 370. 1893.

§ Hervey, A. B. Sea Mosses. A collector's Guide and an introduction to the study of marine algæ, 88. 1881.

region. The measurements given by different authors are as follows: Ruprecht (l. c.), stipe 6–9 inches long, laminæ up to 2 feet long; Areschoug (l. c.), stipe 30 cm. long, lamina up to one meter in length; De Toni,* stipe 30 cm. long, lamina up to one meter in length (measurements evidently quoted from Areschoug); Hervey (l. c.), stipe 2 or 3 feet long, lamina 2 feet or more long; Setchell (l. c.), stipe 1 to 2 feet long, measurement of leaves not given; Anderson (l. c.), stipe 1 to 6 feet long, lamina 1 to 4 feet long. Of these measurements, Anderson's is the only one that is approximately correct for the average plant as observed on the Straits of Fuca.

The first specimen of *Pterygophora* seen on the Vancouver coast was a battered and eroded stem which had been cast up by the tide. It was between six and seven feet in length and 2.5 inches in thickness near the base. Later another specimen, not quite so large, was extracted from a pile of wrack at the head of a little cove and this had a few dilapidated leaves still attached. Examination of the shore yielded several specimens, some of which were in an excellent state of preservation, but a few days later some growing beds were discovered and the plant was observed in more detail. Its selection of an habitat is interesting. A favorite place for its development seemed to be on the bottom of deep, narrow chasms in which there was from twelve to fifteen feet of water at low tide. It occurred abundantly on the bottom of a circular hole communicating with the sea by a narrow deep inlet and exposed to heavy surge. It was afterwards found that this was its characteristic position and that it habitually came closer to the rocks than either *Nereocystis* or *Macrocystis*. It preferred stations where the water was constantly in motion and did not seem so abundant in quiet coves. As a surge plant it grew lower than *Lessonia* and it may, perhaps, be described as occupying the lowest position of the surge kelps along this coast. To this precise locality the plant shows certain structural adaptations. The holdfast is massive, enabling it to cling firmly to the rocks, notwithstanding the strong movement of the sea. The stem is exceedingly stout—being indeed one of the strongest algal structures known—and is capable of resisting great tensile strain. While not particularly elastic it is bent from side to side without difficulty or damage to its structure. The

* De Toni, J. B. Sylloge Algarum, 3: 352. 1895.

long leaves, often as many as forty in the tuft, hang down beside the stem and as the plant bends from side to side they are swept along the bottom, thus accounting for the erosion of their ends so characteristic of this species. The central lamina is invariably eroded, and only the younger and shorter pinnæ are perfect, all the older ones having lost their tips through the constant brushing back and forth on the rocky bottom. The relative lengths of the leaves and of the stem are regulated by this habit of the growing plant and where the surge was most violent plants were to be found with comparatively long stems and short leaves, but where the surge was less violent the leaves and stem were more nearly the same length, or the leaves might some of them even exceed the stem.

The general appearance of young *Pterygophora* plants as seen upon the bottom is not unlike that of *Nereocystis*. Their attitudes with the erect stem and the dependent leaves are very similar. The older *Pterygophora* plants, from their much more massive stem and shorter leaves, can be distinguished at a glance.

In order to collect an abundant series of *Pterygophora californica* use was made of a tool which may be described as a combination of chisel and hook on the end of a long slender pole, by which the holdfasts were cut and the plant dragged to the surface. In this way a sufficient quantity of material was obtained from which four plants of different ages are selected for description.

Plant "A." This is the youngest specimen seen. It measures 12 mm. in length, of which the stipe and primitive disk constitute but 2 mm., the rest being lamina. In this plant the lamina is already eroded distally. It measures 5 mm. across at its broadest part and narrows down abruptly to the stipe, which is 5 mm. in diameter. The primitive disk, almost exactly circular in shape, measures 2 mm. in diameter. At first the growth of the stipe in length is decidedly slow, but when the lamina has become about 20 mm. in breadth the stipe begins to elongate. In plants under 30 mm. in length the poorly defined midrib of *Pterygophora* has not begun to develop and the lamina seems perfectly homogeneous throughout. In this respect the plant is in marked contrast with *Alaria* sporelings, for in them the midrib will have already strongly developed in plants of corresponding size. The young forms of *Pterygophora californica* show the characteristic shape and developmental sequence of the Laminariaceæ, resembling particularly young plants of *Laminaria saccharina.*

Plant "B." This specimen was collected by Mr. K. Yendo and was kindly presented to me by him. It is apparently of about the same age as Ruprecht's youngest plant. The whole plant is 35 cm. in length, of which 10 cm. is holdfast and stipe, and 25 cm. lamina. The lamina is 8 cm. in breadth at its broadest part. The tip is eroded, as usual, and in this particular specimen the margin is imperfect. The stipe is 8 mm. in diameter, 3 cm. below the base of the lamina, and 5 mm. in diameter just above the holdfast, where it is circular in cross-section. It is, however, elliptical in cross section near the base of the lamina, the stipe being flattened in the plane of the lamina. In this specimen the midrib is beginning to differentiate and is well-marked for a distance of 5 cm. above the base of the lamina and faintly marked for 10 cm farther towards the tip. Distally it quite disappears. Certain hapteric outgrowths are decidedly long and slender in this plant—much more developed than ordinarily.

In plant "B," less than 1 cm. below the base of the lamina, are seen two small emergences, opposite each other on the sides of the stipe. These are the growing points destined to produce the first pair of pinnæ.

Plant "C." This is a somewhat older individual in which twelve pinnæ have been developed. The whole plant is 45 cm. in length from the holdfast to the eroded tip of the central lamina. From the holdfast to the lowest pinna is 15 cm. In this plant the four lower pinnæ are of a deep chocolate brown color and very much eroded and perforated. They present some points of anatomical interest as will be indicated later. The upper pinnæ are olive brown in color and the four uppermost have perfect tips, characteristically rounded, giving to the whole young pinna a distinctly spatulate shape. In texture these young pinnæ in the fresh plant are quite unlike the sporophylls of *Alaria* with which they have been compared. To the touch they feel not unlike thin sheets of celluloid. The central lamina has a more leathery feel, like *Laminaria* or *Lessonia.*

In this plant the stipe is 8 mm. in diameter, midway between the holdfast and the pinnæ. In the region of pinnæ it is decidedly flattened, measuring 9 mm. in width by 3 mm. in thickness. The pinnæ do not stand always directly opposite each other, although this in general is their position. Abortion of one pinna of the pair may be observed in this plant at two points. The base of the pinnæ is more attenuate than that of the central lamina. The holdfast is partly cut away, but is flattened out and compacted much more than in plant B.

Plant "D." This plant was collected in July, preserved in formalose, and brought to Minneapolis for study. It was found growing with several others about twelve feet below the surface of the water at low tide. The stipe from the holdfast to the lowest pinnæ is 2 meters in length. From the lower pinnæ to the base of the central lamina is 1 dm. while the central lamina is 1.5 meters in length. On each side of the stipe, extending along its margin for a little less than a decimeter, are the tufts of lateral pinnæ, twenty on each side. The longest pinna with uneroded end measures 1 meter, but pinnæ with eroded ends are present, 1.5 meters in length. The breadth of the central lamina is 1 dm., the midrib being 4 cm. broad. The broadest pinna measures 7.5 cm. from margin to margin. All margins of full grown pinnæ are undulate. This character is especially marked in the central lamina. One difference between a plant of the age of "D" and a younger form such as "C" lies in the distance between the adjacent pairs of pinnæ. In plant "C," for example, the upper pinnæ are three cm. apart along the stipe and this character is also indicated in Ruprecht's plate. In an older plant, such as "D," the pinnæ are very much crowded together, so much so, indeed, that they crowd each other out of a strictly marginal position. The fully developed pinnæ, in "D" are all massed within a linear distance of 5 cm., while in "C" they are distributed over twice as much space.

The stipe in this specimen is 5 cm. in diameter, 2 dm. above the holdfast. Near the holdfast it is 1 dm. in diameter. Nearer the pinnæ it becomes flattened in cross section, first appearing as elliptical, then as lenticular, the edges becoming sharp 2 dm. below the lowest pinnæ. Along the sharp edges the scars of pinnæ which have been sloughed off are abundant. The stipe in the region of pinna attachment is 3 cm. broad and 7.5 mm. thick. The stipes of the full-grown pinnæ are 4 mm. in diameter and the base of the central lamina is 1 cm. broad and 3 mm. in thickness. A transsection through the stipe of this plant shows 24 concentric rings of growth not all of which were of equal thickness. The pith at the center has the lenticular outline characteristic of arborescent Laminariaceæ and was 8 mm. by 2 mm. in cross section. The pith occupies a greater portion of the cross section nearer the region of pinnæ. Just below the pinna scars a cross section showed it to be 3 cm. in length by 3 mm. in width.

From the measurements of this plant, by no means the largest seen, it becomes apparent that the size of *Pterygophora californica* has been much underestimated, previous descriptions of it having been made from immature material. There seems to be no reason to doubt that this plant is perennial. It gives every structural indication of persisting for a series of years and replenishing its pinnæ with the recurring seasons. Its massive stipe and the base of the central lamina survive the winter storms and in the spring fresh pinnæ are produced and the central lamina is extended by the well-known basal growth characteristic of the family to which it belongs. In this way, doubtless, very large plants may develop. There is one fragment in our collection comprising the pinna region of a plant which by comparative measurements must have been four meters or more in length. The flattened stipe between the pinnæ is 6 cm. broad and the base of the central lamina measures 3 cm. in width.

The relation of the genus *Pterygophora*, to the other genera of the Laminariaceæ has been a matter of some uncertainty. Ruprecht regarded it as intermediate between *Ecklonia* and *Alaria*. Agardh* associates *Pterygophora* with *Alaria*. Areschoug takes it up between *Lessonia* and *Ecklonia*, but this perhaps can scarcely be regarded as an expression of his opinion regarding its true position. By the older systematists the genus has been connected closely with *Laminaria* and it occupies a position next to *Laminaria* in De Toni's Sylloge Algarum and also in Kjellman's Laminariaceæ (l. c.) where *Pterygophora* is placed between *Laminaria* and *Ecklonia* in Tribe VI., Laminarieæ. Setchell (l. c.) connects the genus with *Alaria* under the Tribe Alariideæ. The mid-lamina of *Pterygophora* is strongly suggestive of certain species of the genus *Laminaria*, so much so that when Areschoug described *Laminaria*

* Agardh, J. G. De Laminarieis, Lund Univ. Arsskr. 4: 1.

japonica,* Agarth † suggested that the type specimen was nothing other than a mid-lamina of *Pterygophora*. While this notion of Agardh's was incorrect, a comparison of specimens or reference to Suringar's‡ plate of *Laminaria japonica* will make it clear how natural might have been such a supposition on his part. One also finds in the genus *Laminaria* forms suggesting the pinnate disposition of laminæ in *Pterygophora*. Such a plant is figured and described by Kjellman§ under the name of *Laminaria radicosa*. In this plant lateral outgrowths occur upon the stipe below the lamina in quite the same position in which they are developed in *Pterygophora*. They are not, however, functional as additional laminæ, nor do they particularly increase the photosynthetic vigor of the plant. *Laminaria radicosa* may, nevertheless, be regarded perhaps as showing a transition to the type of *Pterygophora*.

There are some objections to the classification of *Pterygophora* with *Alaria*. Among these, the character of the young plant should be given weight. In *Alaria* the midrib is differentiated at an early stage and is exceedingly distinct in plants only two centimeters in length, while in *Pterygophora* plants 35 centimeters in length show the midrib but indistinctly in the basal portion of the lamina. Anatomically *Pterygophora* conforms to the type of the Laminarieæ in the general character of its tissues, differing in some marked particulars from *Alaria*, although resembling the latter in absence of mucilage canals—structures which are present in most species of *Laminaria*. The distinction of outer and inner cortex which is not always to be made out in *Alaria* is very clear in *Pterygophora*. Upon the whole there would seem to be little objection to the classification of *Pterygophora* in the tribe Laminarieæ. Taking everything into account, however, it will perhaps be best to consider the genus as transitional between the Laminarieæ and the Alariideæ.

An examination of the anatomy of *Pterygophora* seems further to strengthen the view of its close relation to *Laminaria*, while the differentiation of its organs no doubt makes it readily

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* Areschoug, J. E. Phyceae Capenses, 29.

† Agardh, J. G. Proc. Soc. Phys. Lund. Bot. Notiser, 1883: 108. 1883.

‡ Suringar, W. F. R. Algae Japonicae, *pl. 11*. 1870.

§ Kjellman, F. R., and Petersen, J. V. Om Japans Laminariaceer. Ur Vega-Expeditionens Vetensk. Iakttagelser., 4: 259, *pl. 10*. 1885.

comparable with *Alaria*. The structure of the stipe differs decidedly from that of *Lessonia* which I have previously examined.* In both genera there are strongly marked growth-rings which, as will be seen, do not arise in precisely the same way. A detailed account of the anatomy follows. From it some notion may be derived of the histological interrelation of *Pterygophora*, *Laminaria* and *Lessonia*.

The most important literature on the anatomy of the Laminariaceæ has been previously cited † and it will not be necessary to refer to it further at this time except as some particular point may require elucidation. To the papers of Wille, Grabendörfer, Reinke, Rosenthal, Oliver, Ruprecht and others students are indebted for researches which have laid the foundation for a knowledge of the anatomy of the Laminariaceæ.

The holdfast.—The study of this structure as of the other organs of *Pterygophora* is based upon a series of slides prepared from material collected at the Minnesota Seaside Station, killed in chromic acid, and transferred into 70 per cent. alcohol in which condition it was brought to Minneapolis for study. Most of the sections have been cut freehand, treated with various reagents and stains and mounted in glycerine-jelly. Russow's callus reagent, chlor-zinc iodide and a variety of stains, including particularly the fuchsin and iodine-green combination and aniline water safranin, have been employed to bring out details of structure.

The primitive disc shows no points of special interest, not differing particularly in structure from that already described for *Nereocystis*,‡ nor at first do the hapteric branches in their origin and structure show characters worthy of especial comment. The haptere originates through the activity of a circular cambial area at the edge of the primitive disc or from the lower rhizogenous area of the stipe. Callosities on the stipe, such as those described for *Nereocystis* and there believed to be equivalent to hapteric branches, have not been discovered in *Pterygophora*, though on one specimen some curious gall-like swellings, doubtless teratological or pathological in their nature, were observed. The numerous hapteric outgrowths of *Ptery-*

* MacMillan, C. Observations on *Lessonia*, Bot. Gaz. **30**: 318. *pl. 19–21.* 1900.

† MacMillan, C. l. c.

‡ MacMillan, C. Observations on *Nereocystis*, Bull. Torr. Club, **26**: 273. *pl. 361, 362.* 1899.

gophora branch dichotomously and build a strong holdfast resembling that of *Lessonia* rather than that of *Nereocystis*. Each young hapteric branch, in cross section, shows the characteristic structure, a great central mass of parenchymatous tissue surrounded by an ill-defined cortical area with an hypodermal cambium. No pith is present and the growth in length and thickness of the hapteres proceeds solely by cambial activity. In older holdfasts distinct growth-rings appear—something that was not seen in the holdfasts of *Lessonia*, and seems not to occur in the hapteric branches of *Nereocystis*, the individuals of which are shorter-lived. The appearance of these rings of growth in the secondary cortical tissues of the holdfast seems to be due rather to rhythmic changes in the character of the cell contents than to regular successions of larger and smaller cells, concentrically arranged. As will appear, this character serves to distinguish to some extent between the growth-rings of the holdfast and of the stipe. In both organs the elements of the secondary cortex are arranged in extremely regular rows, as seen in cross section. This regularity of arrangement does not extend to the primary parenchymatous tissue of the hapteric branch, so that the appearance of a cross section of the older hapteres may be described as follows: At the center is a large more or less circular group of parenchymatous elements regularly hexagonal in outline, varying in size between rather narrow limits. Towards the periphery this central tissue imperceptibly merges with the secondary tissue, the cells of which become more quadrate in outline and assume the characteristic position in rows which can be followed without break directly to the cambial zone which lies near the periphery of the organ. In the secondary tissue there are numerous rings of growth and the cross section of an old haptere, a centimeter or more in diameter, looks not unlike a section of stipe, save for the absence of the characteristic lenticular pith. This is altogether wanting in the hapteres. The growth-rings do not, however, appear to arise consistently through quite the same anatomical conditions as those of the stipe. Well-marked rings in the holdfast may exist without difference in the size of the elements of which they are composed. The optical appearance, therefore, is in all hapteres examined determined by difference in the cell contents. A zone of cells will be formed in which the contents seem to be more dense. Outside a zone, in which the contents are less dense, will appear, and this alternation continues even into the cambial zone where single layers of cells will be found with the denser contents alternating with layers showing the opposite appearance. Besides this difference others have not been discovered to account for the ringed appearance of old hapteres.

As to the substance in the cells which by its greater density gives the ringed appearance it does not seem to differ from the material which has been studied by a number of observers, especially in the Fucaceæ. It has been described by Reinke * as a fatty oil, in which view Hansen † practically coincides and considers that the Phæophyceæ in general produce fat instead of starch by their assimilation. The same material, however, has been described as Phæophyceenstärke by Schimper, as fucosan by Schmitz and Hansteen, as showing a tannin reaction by Berthold, as phloroglucin-containing material by Bruns, as connected with physodes by Crato and as polysaccharids, in constitution allied to mucine, by Koch. In the holdfast of *Pterygophora* the material sometimes fills the whole cell with a homogeneous refringent mass, which in the denser parts of the ring has decidedly the same appearance optically that is shown by the polysaccharid granules of the lamina and stipe to be described later. In other instances the refringent bodies may be distinguished from a generally granular protoplasmic slime which encloses them. Without going into the disputed question of the true chemical character of the cell-contents of Laminariaceæ, it may be said that the ringed appearance of hapteric branches in *Pterygophora* is due to the alternately more vigorous and less vigorous production of certain substances connected with the assimilative processes of the plant. These substances occur in the stipe and lamina as well as in the hapteres, but are there not invariably the cause of a ringed appearance, being disposed in special cells without any apparent reference to the rhythm of secondary growth.

The stipe.—Sections were taken first from plant "B," the unilaminate stage and then from mature plants. In none of them could the mucilage ducts of Ruprecht be discovered and

* Reinke, J. Beitraege zur Kenntniss der Tange. Pringsh. Jahrb. für wissensch. Bot. 10: 317. 1876.

† Hansen. Ueber Stoffbildung bei den Meeresalgen. Mitth. Zool. Stat. Neap. 11: 276.

Pterygophora may safely be described as devoid of these canals. The cross section of a young stipe shows the characteristic lenticular pith-web, composed of anastomosing filaments with numerous trumpet hyphæ intermingled. Chloroplasts are abundant in this tissue and occur more or less sparingly in the perimedulla. Surrounding the pith one finds the cells of the cortical tissue very regularly hexagonal in shape, arranged in remarkably perfect radial rows and diminishing gradually in size towards the periphery. Chloroplasts are absent from most of the cells of this tissue, but appear again, in the smaller cells near the periphery. At about the depth at which chlorophyll becomes abundant the tissue is lacuniferous and the outer cortex readily separates from the inner. The cells of the outer cortex are generally not hexagonal, but cambial conditions cause them to assume the rectangular outline in cross section. The small densely colored cells of the epidermis and hypodermis are uniformly quadrangular. Longitudinal sections through material of this age show the inner cortex to be made up of prosenchymatous elements not pitted or armed and the walls comparatively thin in the region near the pith, but becoming thicker-walled and beginning to present the pitted structure closer to the periphery. The cells of the outer cortex seem to have a special capacity for dividing transversely and periclinally in young material, but in older stipes they divide radially with equal ease. In mature stipes the extraordinarily regular radial rows of cells seen in cross sections may be observed to originate from rows of cambial cells which have divided radially in the outer cortex and have there established the general radial arrangement of the tissues.

Sections through the mature stipe show a structure of the organ in cross section reminding one very much of the tracheids and their arrangement in the Coniferæ. The pits, however, are not upon the radial faces of the elements, but upon the concentric. The cells are all of about the same size and stand in rows radiating in a most regular fashion from the pith to the circumference. There is often not the slightest difficulty in observing that the appearance of growth-rings is due to the gradual diminution in the diameter of the cells until they have become distinctly flattened, followed abruptly by the production of cells of slightly larger lumina. That is to say, the occasion for the ringed appearance of the stipe is structurally quite comparable with that condition so fully studied in the stems of Coniferæ and woody Dicotyledons. In other instances, however, the rings in the stipe seem to arise quite as in the hapteres.

There is in the stipe of *Pterygophora* a plain distinction between the first or primary structure of the cortex and the secondary structure which is established in the lacuniferous period of growth. It is at this time, during the first year, that the outer cortex readily peels from the inner. Later, with the resumption of growth in thickness, the lacunæ are filled by the radially dividing cambial tissue. The tissue of the first or innermost ring, surrounding the pith, differs in appearance from that of subsequent rings. The cells diminish in diameter towards the periphery of the ring until they have the look of stereome in cross section. In this part of the ring the cells are very strongly pitted, in marked contrast to the inner cells of the primary cortex where the pits are but occasional. All the cells, however, of the secondary cortex as displayed in subsequent growth-rings are strongly pitted. Another distinction between the cells of the innermost ring and those of subsequent rings is that the elements of the first ring are slenderer, more prosenchymatous, almost approaching the fibrous shape peripherally, while the elements of later rings are shorter, more parenchymatous and not at all suggestive of fibrous tissue.

In older stipes the pith web is decidedly solid, in marked contradistinction to this tissue in young material. As the stipe matures the interstices between the elements of the pith web become obliterated by the repeated branching and interlacing of the filaments. The chlorophyll also disappears and the cells become filled with densely granular contents. There remain, however, in even the oldest pith, numerous interstitial passages which, in cross section or longitudinal section, present much the same appearance and are, perhaps, what were mistaken for mucilage ducts by Ruprecht.

A cross section of the mature stipe shows then the following characters. At the center is the solidly interwoven tissue of the pith web. This is surrounded by the clearly marked, sclerenchymatous tissue of the primary cortex passing insensibly into the tracheid-like tissue of the secondary cortex which is arranged in concentric rings, resulting from the succession of elements with larger cell-lumina in apposition upon those with smaller. Outside of the rings will be found the cambial zone in which regular divisions take place in all three planes of space. Exterior to the cambial zone lies a thin outer cortex composed of cells very much smaller than those of the inner area, provided with thick walls and constituting a kind of bark for the trunk. In some material the general cambial zone can be very distinctly seen, ten or twelve cells in thickness and separated from the epidermis by twenty or more layers. Not infrequently the cells at the periphery of a ring of growth have more densely granular contents than those of the general secondary cortex tissue. Thus, occasionally in the stipe there may arise the anatomical conditions which seem to be more normally characteristic of the holdfast. The photographs of different cross and longitudinal sections which are presented will serve to make these points clear where the description is necessarily difficult to follow.

The lamina.—As before stated only the central lamina is provided with a midrib, the pinnæ being quite devoid of such a structure. The midrib of the central lamina arises through an hypertrophy of the cortical tissue, in which th; pith-plate does not seem to partake. The general structure of the lamina as seen in cross section does not present many peculiar features, but is much like that already described for other genera. There is on each surface an isomorphic epidermis composed of small quadrate chlorophyll-containing cells, and these merge insensibly into the subepidermal tissue, which in some instances is two or more layers in depth. The cells then become much larger in diameter and the contents less dense. Among these cortical cells occasional very large polysaccharid idioblasts are found, and in the chocolate-colored pinnæ of plant "C," these cells are very numerous and densely packed with spherical bodies, doubtless belonging to the category of reserve carbohydrates. Owing to the nutritious character of such pinnæ, they are very commonly perforated by animals, sometimes giving a colander appearance like that of *Agarum*, and covered with epiphytic and endophytic vegetation, a further study of which should be made. These reservoir cells may perhaps be packed with food materials previous to the production of sori and the polysaccharids utilized in the elaboration of the sporangia and paraphyses. In any event they seem to be emptied of their contents underneath most of the soral areas that I have examined. Within the layer of idioblasts the cortical cells become smaller on each side of the pith plate. This latter is composed of anastomosing filaments with occasional trumpet-hyphæ and does not differ particularly from the same tissue as displayed in the stipe. The cortex of the mid-lamina and of the pinnæ seems to show some fairly constant differences. In the pinnæ the cells are often uniformly larger and the layer of idioblasts is frequently almost continuous.

The sorus.—I do not find anywhere in the literature of *Pterygophora* an account of its fruiting area. The first fruiting material that reached me was collected near Port Renfrew by Miss Josephine E. Tilden during December, 1901. Shortly afterwards Professor Setchell kindly sent me some dried pinnæ collected at Whidby Island, Washington, by Mr. N. L. Gardner, and said to display sori. My observations are made from the fresh material collected by Miss Tilden. The soral patches occur upon the lateral pinnæ and not upon the mid-lamina. In this respect they remind one of the soral distribution of *Alaria;* but while in *Alaria* the entire pinna, except a very small marginal region, is soriferous, in *Pterygophora* the sori form somewhat irregular patches upon both surfaces of the pinna and much of its area fails to develop them. In this respect *Pterygophora* approaches more nearly to *Laminaria.*

The sori are composed of numerous elongated, saccate gonidangia, each bearing from fifty to two hundred spherical gonidia. The gonidangial surface is surmounted by the intermingled paraphyses, averaging half as long again as the gonidangia and their clavate distal ends capped with cuticular masses, suggesting those already described for *Lessonia* and indicating that in this plant, as in *Lessonia*, the cuticular layer does not separate in a plate, as described for *Laminaria* by Thuret and as known to occur also in *Nereocystis*, but divides into individual paraphysal calyptra. Some gonidangia measured indicated an average length of 50 mic. and diameter of 10 mic. The gonidia are nearly 2 mic. in diameter and in a double-stained preparation, made for me by Mr. H. L. Lyon, take Delafield's hæmatoxylin while the paraphyses and cuticular substance take the safranin. The gonidangia and paraphyses stand upon a floor-layer such as is found in all Laminariaceous sori, and their development does not differ from that which has already been described for other genera.

I desire to express my thanks to Miss Josephine E. Tilden for the winter fruiting material which she kindly collected for me and for the series of slides from which most of my description has been made, and to Mr. H. L. Lyon for the photo-micrographs reproduced in plate LXI and prepared by him at my request.

SUMMARY.

1. *Pterygophora californica* grows to a larger size than generally known. Specimens ten feet in length with trunks three inches in diameter have been seen.

2. As displayed in the Straits of Fuca, *Pterygophora* is a surge plant, growing below the zone of *Lessonia* and above that of *Nereocystis*.

3. *Pterygophora* may be classified either in the Laminarieæ or the Alariideæ. Its characters are in many respects intermediate between these tribes.

4. The holdfast shows distinct rings of growth and these in most instances arise, not through morphological differences between adjacent cell-layers, but through differences in the cell contents. The substances, which produced in greater or less amount give the ringed appearance, are regarded as polysaccharids allied to mucine, as described by Koch.

5. The stipe is devoid of the mucilage ducts of Ruprecht and shows distinct rings of growth, due in most instances, to the juxtaposition of a layer of cells with larger lumina, upon a layer with smaller. In some cases the ringed appearance of the stipe seemed to be due to the same condition described for the holdfast.

6. In the cortex of the lamina large polysaccharid idioblasts are abundantly developed. These are most numerous in the pinnæ and are often exhausted of their contents during the process of soral formation.

7. The sori are distributed in irregular patches toward the base of the pinna and in the disposition of the cuticular caps upon the paraphyses suggest *Lessonia*. The plant fruits in the latitude of Port Renfrew during the month of December.

DESCRIPTION OF PLATE LVII.

Young plants of *Pterygophora*, about one-half natural size.

1. Plant "A" of text.

2, 3, 4. Somewhat older plants; in 4 the midrib is just beginning to appear in the base of the lamina.

5. Plant "B" of text; the midrib is more distinct and the two opposite growing points of the first pair of pinnæ may be seen just below the junction of lamina with stipe.

Plate LVIII.

Plant "C" of text. The plant is shown a little more than one-third the natural size. It presents the loosely arranged pinnæ characteristic of young plants and as shown in Ruprecht's plate. The lower pinnæ are perforated by marine animals and are the ones in which the reserve material is the most abundant. The mid-lamina alone shows a midrib.

Plate LIX.

Plant "D" of text. The size is indicated by the hat placed in the field of view. It is about one-tenth natural size and was photographed on the shore a few moments after collection. It is somewhat foreshortened, being between three and four meters in length. The central lamina is shown in line with the stipe.

Plate LX.

Pinna-region of full-grown specimen, one-half natural size. The very much crowded position of pinnæ in old plants is indicated in this plate. Below the pinnæ may be seen scars left by pinnæ of previous seasons.

Plate LXI.

Cross sections through the stipe, natural size. The lower figure is taken near the base of the stipe, while the upper is cut just below the region of pinnæ. The great difference in the extent of the pith and in its shape, in the two sections, is noticeable. The characteristic rings of growth are apparent in both figures.

Plates LVII. to LXI. are from photographs made under the direction of the author, by Mr. C. J. Hibbard, Photographer of the Department of Botany in the University of Minnesota.

Plate LXII.

The anatomical detail of *Pterygophora*.

1. Cross section through secondary cortex of stipe, showing rings of growth ($\times$ 50).

2. Cross section through stipe, showing secondary cortex above and primary cortex below ($\times$ 50).

3. Longitudinal section through secondary cortex showing flattening of cells towards the right. This would appear as a ring in the cross section ($\times$ 50).

4. Tangential section through secondary cortex, showing the somewhat fusiform outline of the cells in this section ($\times$ 50).

5. Longitudinal section through region of Fig. 3. On the left is seen the tissue of the secondary cortex, in the middle the flattened cells of the transition zone, and on the right the cells of the primary cortex. This first ring of growth, caused by the superposition of secondary upon primary tissue, is the most prominent of all the growth rings in the stipe ($\times$ 50).

6. A portion of the secondary cortex tissue shown in Fig. 5, magnified to demonstrate the pits in the vertical walls of the tracheid-like elements. To the right the cells become compressed, passing into the transition zone ($\times$ 250).

7. A portion of the primary cortex tissue shown in Fig. 5, magnified to demonstrate the different arrangement of primary and secondary cortical cells. The secondary stand in long rows at the same level. This is not true of the primary ($\times$ 250).

8. Cross section through one of the rings shown in Fig. 1 and magnified to demonstrate the flattening of cells in the region of the ring and their denser contents. The appearance of small cells interpolated between the larger ones can be understood by referring to Fig. 4 ($\times$ 250).

9. Cross section through pith web of stipe, showing anastomosing filaments and trumpet hyphæ embedded in a gelatinous matrix ($\times$ 250).

10. Cross section through haptere. The cells of the outer cortical region are crowded with contents, and do not differentiate clearly. Near the middle of the section are seen two of the characteristic growth-rings of the haptere ($\times$ 50).

11. Longitudinal section through haptere, showing the development of secondary tissues, the cells of which are shorter upon the primary tissue towards the bottom of the figure. Below the black outer cortex a growth-ring in section may be seen ($\times$ 60).

12. Section through sorus, showing floor-cells, gonidangia with gonidia and paraphyses capped with cuticular knobs characteristic of this genus and of *Lessonia* ($\times$ 320).

All the figures in Plate LXII. are from original photomicrographs by Mr. H. L. Lyon.

PLATE LVII.

PLATE LVIII.

HELIOTYPE CO., BOSTON.

PLATE LIX

PLATE LX.

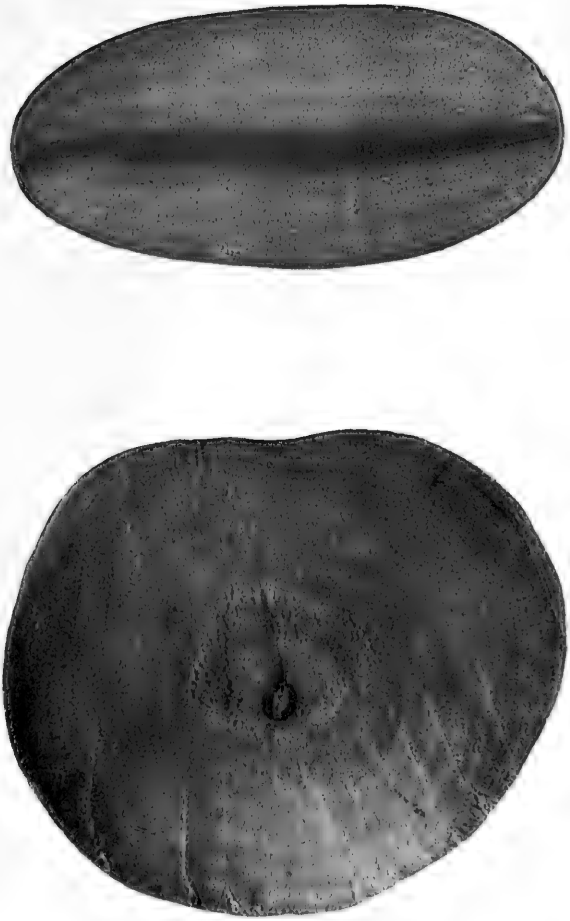
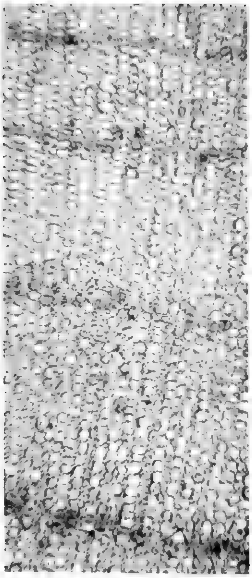


Plate LXI.

HELIOTYPE CO., BOSTON.



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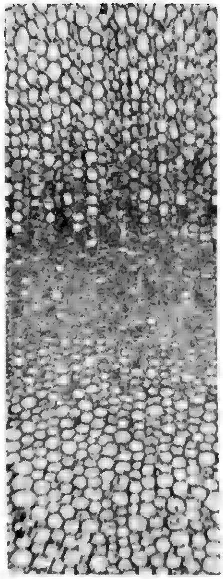

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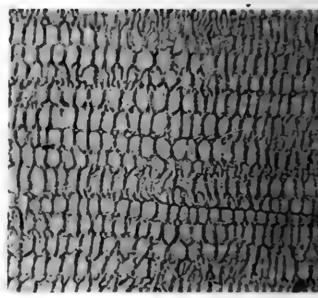

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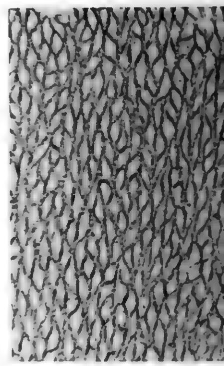

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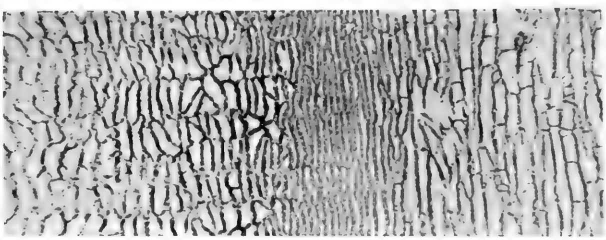

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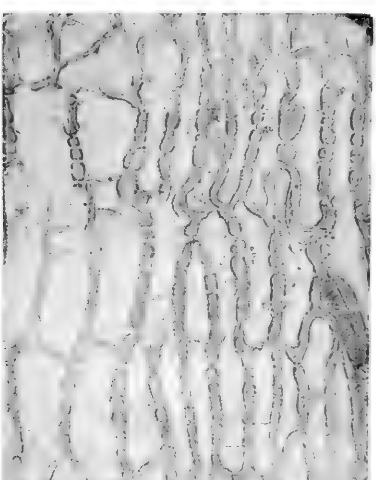

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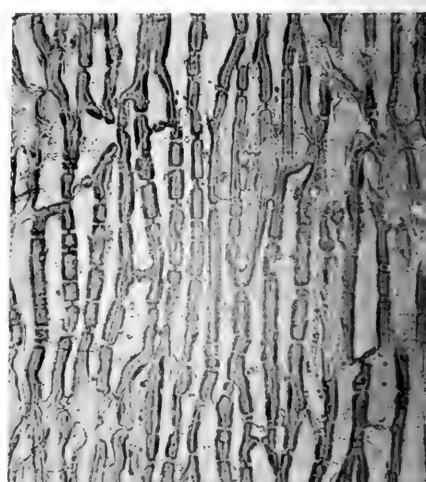

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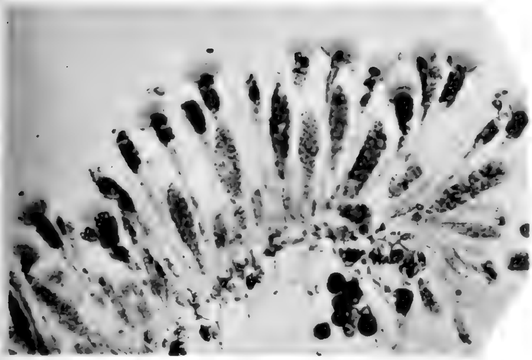

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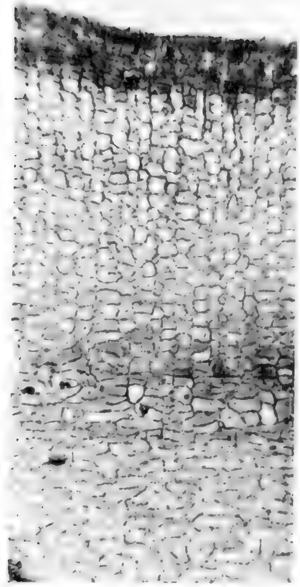

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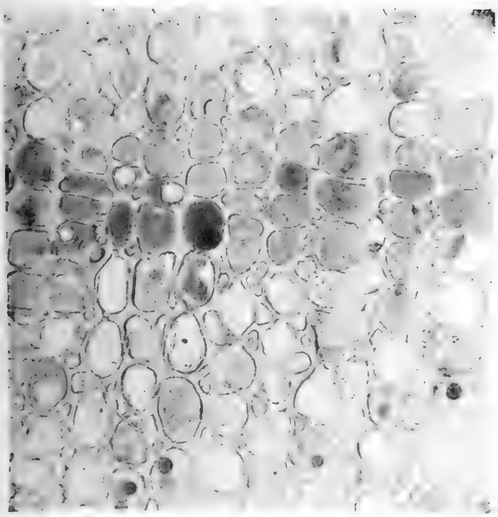

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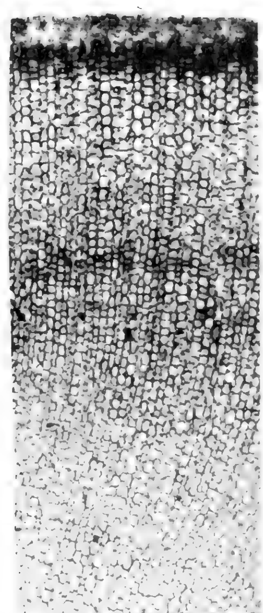

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9

XII.

OSTON.

INDEX OF PLANT NAMES.*

* The index was prepared by Miss Josephine E. Tilden.