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FERNS OF UTAH

BY

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PREFACE*

The distribution of many species of our ferns is not well known in Utah. Collectors have centered their work around certain localities and many blank spots appear on the distributional map. One might presume certain species to be present in some of these unexplored areas but specimens are still to be collected. Distributional data beyond Utah were taken mainly from Broun's Index to North American Ferns.

In citing the collections for each species the name of the collector or herbarium is given followed by the catalog numbers and localities. B. Y. designates the herbarium of Brigham Young University at Provo, and I. H. indicates the Intermountain Herbarium at the Utah State Agricultural College at Logan, Utah. Specimens collected by W. P. Cottam, A. M. Woodbury and S. Flowers are deposited in the University of Utah Herbarium. I wish to acknowledge the use of the specimens collected by Professors A. O. Garrett, Bertram Harrison and Bassett Maguire and their associates. Many of the specimens examined were identified by Drs. William R. Maxon, R. T. Clausen, F. K. Butters, K. M. Weigand and J. H. Schaffner.

S. FLOWERS.

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INTRODUCTION

CLASSIFICATION OF FERNS

The classification adopted in this manual follows that of C. Christensen's Index Filicum. The following table is taken from Broun's Index to North American Ferns (north of Mexico) and to the right is given the number of genera and species in each family occurring in North America as compared with those occurring in Utah.

	North America		Utah	
	Genera	Species	Genera	Species
I. CLASS FILICINEAE				
A. <i>Order Filicales</i>				
1. Family Hymenophyllaceae	1	6	0	0
2. " Polypodiaceae	39	234	14	33
3. " Ceratopteridaceae	1	2	0	0
4. " Gleicheniaceae	1	1	0	0
5. " Schizaeaceae	4	6	0	0
6. " Osmundaceae	1	3	0	0
B. <i>Order Ophioglossales</i>				
1. Family Ophioglossaceae	2	19	1	4
C. <i>Order Salviniaceae</i>				
1. Family Salviniaceae	2	4	1	1
2. " Marsileaceae	2	6	1	1
II. CLASS EQUISETINEAE				
A. <i>Order Equisetales</i>				
1. Family Equisetaceae	1	18	1	6
III. CLASS LYCOPODINEAE				
A. <i>Order Lycopodiales</i>				
1. Family Psilotaceae	1	1	0	0
2. " Lycopodiaceae	1	18	0	0
3. " Selaginellaceae	1	34	1	4
IV. CLASS ISOETINEAE				
A. <i>Order Isoetales</i>				
1. Family Isoetaceae	1	19	1	4
Totals	58	371	20	53

GENERAL MORPHOLOGY

Ferns are vascular plants consisting of roots, stems and leaves and reproduce by microscopic germ-cells called spores. The stems are mostly underground, usually dark colored and often covered with scales or old leaf bases. Short, thick types of stems that emerge from the ground are called *rootstocks* while longer types that are not emergent are called *rhizomes*. These terms are often loosely used, some writers using them interchangeably. Some fern allies have both underground and aerial stems. The roots are mostly slender and grow from the sides of the stems.

The leaves arise from the stems and are the most conspicuous part of the plant. A leaf consists of a *stipe* or stalk, *blade* and *veins*. The veins may be forked with free ends, or they may form a closed network.

Forms of leaves. When a leaf has a midvein with smaller veins extending from it on opposite sides it is called a *pinnate* leaf. A leaf is simple pinnate when it is not cut up into leaflets, and compound pinnate when portions surrounding the side veins are cut out as distinct leaflets. It is customary in fern terminology to use the term *pinnate* alone to denote a once-compound leaf as shown in Fig. 1a. Each leaflet is called a *pinna* (pl. *pinnae*). When a leaf is deeply cut half way to the midvein or more, but not quite compound, it is said to

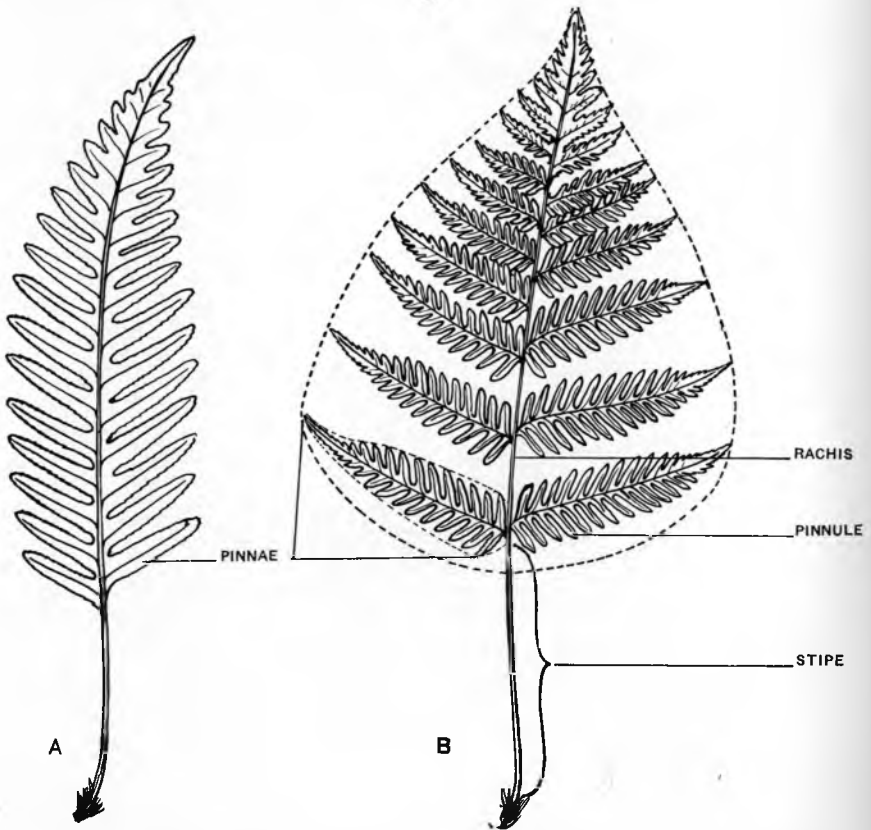


Fig. 1. Generalized fern leaves. A. A pinnate leaf; once pinnately compound; B. A bipinnately compound leaf. The dotted line shows how the shape or outline is determined.

be *pinnatifid*, that is, pinnately cut. *Bipinnate* denotes a twice-compound leaf, that is, each primary leaflet or pinna is again cut into smaller leaflets called *pinnules* as in Fig. 1-b. Tripinnate or ternate means three times compounded. Four and five times compounded leaves also occur. The term *decompound* applies to any leaf more than twice compound and it is customary to designate the smallest divisions simply as *ultimate segments*.

In compound leaves the stipe is interpreted as extending only to the base of the blade or the first pinnae, and the midvein extending from it is designated as the *rachis*. Leaves or their segments are *sessile* when they have no stipe or stalk. When their blades are narrowly prolonged at the base so as to form wings down the rachis or veins they are said to be *decurrent*. The outlines or shapes of many leaves are easily observed, but in much dissected leaves the shape is determined by the generalized outline formed when the blade is inscribed in a figure by connecting the tips of the main divisions with a line as shown in Fig. 1-b. The terms describing shapes of leaves are defined in the glossary and include orbicular, ovate, obovate, oval, elliptical, oblong, linear, lanceolate, oblanceolate, awl-shaped, deltoid, cuneate and lunate.

The apices of the leaves or their lobes vary and are described by the following terms to be found in the glossary: acute, obtuse, acumin-

ate, mucronate and spinulose. When a leaf margin is even or unbroken it is said to be *entire*. Any projections formed by various degrees of cutting of the blade are called *lobes*, and the space between the lobes are called *sinuses*. The following terms describe uneven or cut margins and are to be found in the glossary: dentate, denticulate, serrate, biserrate, crenate, crenulate, erose, lacerate, undulate, lobed, cleft, parted, divided and pinnatifid. A *recurved* leaf margin is rather widely curved backward; a *revolute* margin is closely rolled backward; and a *reflexed* margin is sharply bent backward.

The surface of leaves or other parts are *glabrous* when they are smooth and without hairs, scales or mealy secretions. The various types of surface characteristics are described by the following terms defined in the glossary: pubescent, villous, tomentose, ciliate, scabrous, hirsute, glandular, scaly, ceraceous and mealy.

Fruiting bodies. Ferns reproduce by spores which develop in minute sacs or *sporangia* borne on the leaves. In the true ferns each sporangium consists of a thin-walled, spherical or ovoid sac mounted on a stalk and encircled perpendicularly by a ring of heavily thickened cells, the *annulus*. (Fig. 2). The spores mature in the sac portion of the sporangium and when dry and ripe the cells of the annulus shrink in such a manner as to cause them to bend backward tearing the thin-walled sac open. Usually there is considerable tension on the annulus and when it finally breaks it flips backward scattering the dry powdery spores. Other types of sporangia occur among the fern allies.

The sporangia are borne in clusters on the underside of the leaves on the veins or along the margins. A single cluster is a *sorus* (pl. sori.) and it may be round, curved, elongated or continuous on the veins or along the margin. The sori may be completely exposed, protected by the recurved leaf margin or covered by a little thin tissue called an *indusium* which splits open or arches backward at maturity. The indusia are important in the classification of ferns since the form and mode of attachment differ in various genera.

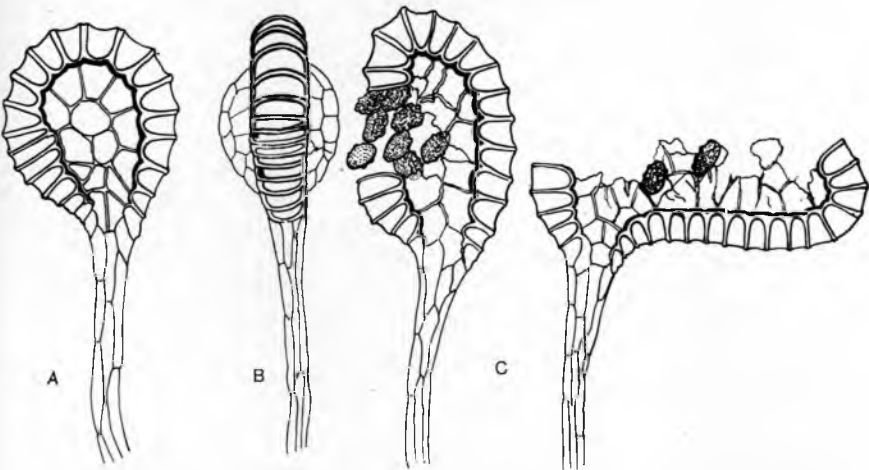


Fig. 2. Fern sporangia. A. Side view; B. View in the plane of the annulus; C. A sporangium opening by the bending backward of the annulus. X 250.

LIFE CYCLE OF A TRUE FERN

When the ripe spores are shed and fall upon suitable moist soil or humus they germinate by sprouting a little green thread that soon begins to spread out at the tip giving rise to a flat green body called a *prothallium*. This little leaf-like plant becomes an eighth to a quarter of an inch across, is deeply notched or roughly heart-shaped, six to eight cells thick at the center and tapers toward the margin to one cell in thickness.

Numerous hair-like organs, the *rhizoids*, grow from one side of the lower surface and serve to anchor the prothallium to the substratum besides aiding in the absorption of water. Male and female reproductive organs develop on the under surface; the male organs, *antheridia*, appear as minute projections among the rhizoids, and the female organs, *archegonia*, appear as more elongated projections on the surface free of rhizoids near the forward notch. (Fig. 3, a-b). Each antheridium consists of a few cells forming a tiny sac in which the male germ cells or *antherozoids* develop (Fig. 3-d). An antherozoid is a spirally coiled cell with numerous cilia on the tapering end that serve as swimming organs. At maturity the antheridium breaks open when covered with water and the antherozoids escape from the gelatinous mass that oozes out.

The archegonium consists of a basal portion partially imbedded in the prothallium, the *venter*, and a short curved neck projecting above the surface. The venter contains a single *egg*, and the neck is filled with a row of neck-canal cells (Fig. 3-c). At maturity and when covered with water, the neck-canal cells dissolve forming a sticky

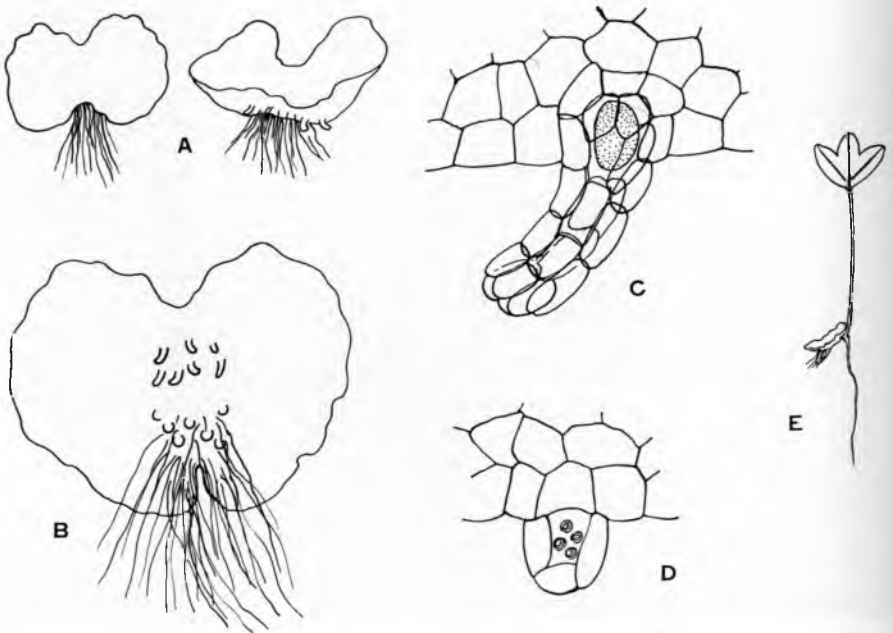


Fig. 3. A. Two prothallia from above growing naturally, one with up-turned margins X 2; B. Underside of a prothallium showing the rhizoids X 10; C. An archegonium with egg X 250; D. An antheridium with several antherozoids X 250; E. A young fern sporophyte still attached to the prothallium X 2.

gelatinous substance which absorbs water causing it to swell and burst the tip of the neck open. The sticky substance is extruded and seems to have a chemical attraction for the antherozoids which are usually abundant in the immediate neighborhood, many of them becoming entangled in it. They make their way down the neck and one of them fertilizes the egg by fusing with it. The antherozoids and eggs are sex cells jointly called *gametes*, and the fertilized egg is called a *zygote*. Plants which produce gametes are called *gametophytes* (gamete plant), and they constitute a generation in the life cycle of the fern, the gametophyte generation.

The event of fertilization introduces another generation. The zygote divides into many cells while still in the old archegonium forming an *embryo* which grows back into the prothallium by dissolving away the cells and using their products as food. This absorbing part is called a *foot*. Later a tiny leaf appears and shortly after the first root grows down into the soil. Between the leaf and the root a little projection appears which is the tip of the young stem. At first the little fern embryo is parasitic on the prothallium but after the roots are established it becomes an independent fern and the prothallium withers away (Fig. 3-e). Thus, the zygote gives rise to a plant consisting of roots, stems and leaves which later produces spores in sporangia. This plant is called a *sporophyte* (spore plant), and it constitutes a second generation in the life cycle of the fern, the sporophyte generation. With the formation of spores from spore mother-cells in the sporangia the gametophyte generation is again introduced and the two generations alternate in a regular succession.

THE FERN ALLIES

Except for differences in the form and structure of the gametophyte and sporophyte bodies the life cycles of the fern allies are essentially the same as a true fern. In *Equisetum* the rootstocks give rise to aerial, cylindrical, jointed stems with a circle of much reduced leaves at the joints. The spores are borne in terminal cones and give rise to elongated, flat, forked green prothallia. The moonwort and grape ferns (*Botrychium*) bear the sporangia on special leaves, *sporophylls*, and the prothallium is a fleshy, colorless, underground tuber which obtains most of its food from a symbiotic fungus. The heterosporous fern allies have spores of two kinds, small, numerous *microspores* borne in *microsporangia*, and much larger *megaspores*, usually three or four, borne in a *megasporangium*. These heterospores give rise respectively to two kinds of prothallia, small male prothallia which are permanently retained in the old spore coat, and female prothallia which are larger and may protrude from the old megaspore coat. In *Marsilea* the stems are submerged, or underground and have leaves that resemble a four-leaved clover. The spores are borne in small, flat, hard, bean-like organs called *sporocarps*. After prolonged soaking in water the sporocarp emits a curious gelatinous ring bearing two rows of club-shaped, pendent, transparent sori. *Azolla* is a very small plant floating on water with minute, inflated and overlapping leaves. It bears minute transparent sporocarps on the under side. *Selaginella* appears like a coarse moss growing in dry rocks and soil. The stems are slender and covered with minute overlapping leaves while the spores are borne in terminal cones. *Isoetes* is grass-like, usually submerged in shallow lakes and ponds and has the sporangia partially imbedded in the leaf bases.

Table I. Ecological relations of Utah ferns. Lines preceding or following the species indicate tendencies toward other moisture relationships.

<i>Hydrophytes</i>	<i>Mesophytes</i>	<i>Xerophytes</i>
	— <i>Botrychium lunaria</i> , Mont. Subalp.	
	<i>B. matricariaefolium</i> , Mont.	
	<i>B. mat.</i> var. <i>hesperium</i> , Mont.—	
	<i>B. simplex</i> , Mont. Subalp.—	
	— <i>B. boreale</i> var. <i>obtusilobum</i> , Mont. Subalp.	
<i>Adiantum capillus-veneris</i> , Son. Mont.—		
<i>A. pedatum aleuticum</i> , Mont.		
	<i>Asplenium adiantum-nigrum</i> , Mont.	
	<i>A. septentrionale</i> , Mont.	
	— <i>A. trichomanes</i> , Mont.	
	<i>A. viride</i> , Mont.	
<i>Athyrium filix-foemina</i> , Mont.—		
var. <i>californicum</i> , Mont.—		
	— <i>A. americanum</i> , Mont.	
<i>Azolla caroliniana</i> , Basal		
	<i>Cheilanthes siliquosa</i> , Mont.—	
		— <i>Cheilanthes feei</i> , Son. Mont.
		<i>C. eatoni</i> , Son. Mont.
	<i>C. gracillima</i> , Mont.—	
		<i>C. covillei</i> , Son. Basal
	<i>Cryptogramma acrostichoides</i> , Mont. Subalp.	
	<i>C. stelleri</i> , Mont.—	
	— <i>Cystopteris bulbifera</i> , Basal, Mont.	
	— <i>C. fragilis</i> , Son. Subalp.—	
	— <i>Dryopteris filix-mas</i> , Mont.	
	— <i>Equisetum arvense</i> , Son. Mont.	
	— <i>E. hiemale californicum</i> , Basal, Mont.	
	— <i>E. kansanum</i> , Son. Mont.	
	— <i>E. prealtum</i> , Son. Mont.	
	— <i>E. variegatum</i> , Mont.	
<i>Isoetes bolanderi</i> , Mont. Subalp.		
<i>I. braunii</i> , Mont. Subalp.		
<i>I. howellii</i> , Basal.		
<i>Marsilea vestita</i> , Son. Mont.—		
		<i>Notholaena jonesii</i> , Son.
		<i>N. limitanea</i> , Son.
		<i>N. parryi</i> , Son.
		— <i>Pellaea breweri</i> , Mont. Subalp.
		<i>P. longimucronata</i> , Son. Basal.
		<i>P. suksdorfiana</i> , Basal, Mont.
	<i>Pityrogramma triangularis</i> , Son.	
	<i>Polypodium hesperium</i> , Mont.	
	<i>Polystichum lonchitis</i> , Mont.	
	<i>P. scopulinum</i> , Mont.	
	— <i>Pteridium aquilinum lanuginosum</i> , Basal, Mont.	
		<i>Selaginella densa</i> , Mont. Subalp.
		<i>S. mutica</i> , Son. Basal.
		<i>S. underwoodii</i> , Mont.
		<i>S. watsoni</i> , Mont. Subalp.
	<i>Woodsia mexicana</i> , Basal, Mont.—	
	<i>W. oregana</i> , Mont.—	
	<i>W. scopulina</i> , Mont.—	

ECOLOGY AND DISTRIBUTION

The major aspects of fern distribution in Utah are determined by the climate which in turn is influenced greatly in local areas by the topography and physiographic features. The lowlands below 4300 feet elevation are predominately saline deserts receiving less than 10 inches annual rainfall; the basal regions skirting the mountains up to 5500 feet elevation harbour oak and sagebrush shrubs or juniper-pinyon pine forests receiving 10-15 inches annual rainfall while the montane to subalpine belts receive more than 15 inches rainfall. A chain of high mountains ranging from 10,000 to 13,000 feet elevation extends in a slightly diagonal direction through the state from the Wasatch and Uintah Mountains at the northern-eastern extremity southward and slightly westward to the mountainous area between the Aquarius Plateau and the Pine Valley Mountains, the latter being in the southwest corner of the state. The high La Sal, Abajo and Henry Mountains are isolated groups in the Colorado River Basin while the Deep Creek Mountains are far removed near the Nevada state boundary line in western Utah. The Raft River Mountains are also isolated in the northwestern corner. In these mountains igneous, sedimentary and metamorphic rocks range from Pre-Cambrian to recent with almost every geologic period being represented, and provide a wide variety of mineral conditions. The atmosphere in the mountains is more humid than in the lowlands and the annual rainfall ranges upward to 40 inches which maintains permanent springs, seepage areas, streams, ponds and lakes. Well developed mesophytic forests, wet grassy meadows, rocky cliffs and high alpine summits provide a wide variety of habitats favorable to many fern forms. Utah's fern flora is limited as compared with more humid regions but the greatest abundance and widest variety of forms grow in these mountains. The minor basin ranges isolated on the western desert areas are numerous but few have sufficient elevation or extent to harbour a well developed mesophytic vegetation or maintain permanent streams. All of them are ecologically similar and support a very meager fern flora.

Ferns of the desert regions may be roughly grouped into two classes. (1) True xerophytes represented by species of *Cheilanthes*, *Notholaena* and *Pellaea* which grow on the dry plains and slopes of southern Utah. (2) Xerophytes, meophytes and hydrophytes occurring along water courses and in box canyons traversing the desert regions. Here the delicate Venus' hair fern is abundant clinging to cliffs where trickles of water are emitted while a few feet away xerophytic *Selaginella mutica* and other desert plants grow under the most forbidding conditions of exposure and drouth. Unique and strange is the contrast. Table I gives the moisture relationship and approximate altitudinal ranges of ferns as they occur in Utah. Absolute hydrophytes and xerophytes are given in italics, and tendencies toward other water relationships are indicated by lines preceding or following the names.

The majority of Utah ferns are distributed widely in the United States and Canada and Utah usually lies at a point somewhat eccentric to their general range. Sixty per cent are essentially northern species that extend southward beyond Utah. Twenty-three

per cent are northern entrants reaching their southern limit in Utah, and seventeen per cent are southern entrants reaching their northern limit in southern Utah.

The following are northern species extending beyond Utah:

<i>Adiantum capillus-veneris</i>	<i>Equisetum laevigatum</i>
<i>A. pedatum aleuticum</i>	<i>E. prealtum</i>
<i>Asplenium septentrionale</i>	<i>Isoetes bolanderi</i>
<i>Athyrium filix-foemina</i>	<i>Marsilea vestita</i>
* <i>A. filix-foemina californicum</i>	* <i>Pellaea breweri</i>
† <i>Azolla caroliniana</i>	<i>P. suksdorfiana</i>
<i>Botrychium lunaria</i>	* <i>Pityrogramma triangularis</i>
<i>Cheilanthes feei</i>	<i>Polypodium hesperium</i>
<i>Cryptogramma acrostichoides</i>	<i>Polystichum lonchitis</i>
<i>Cystopteris fragilis</i>	<i>P. scopulinum</i>
<i>C. bulbifera</i>	<i>Pteridium aquilinum lanuginosum</i>
<i>Dryopteris filix-mas</i>	<i>Selaginella densa</i>
<i>Equisetum arvense</i>	* <i>S. watsoni</i>
<i>E. hiemale californicum</i>	<i>Woodsia oregana</i>
<i>E. kansanum</i>	<i>W. scopulina</i>

The following are northern entrants reaching their southern limit in Utah, at least in part:

<i>Asplenium trichomanes</i>	<i>Cheilanthes gracillima</i>
<i>A. viride</i>	<i>C. siliquosa</i>
<i>Athyrium americanum</i>	<i>Cryptogramma stelleri</i>
<i>Botrychium boreale obtusilobum</i>	<i>Equisetum variegatum</i>
<i>B. matricariaefolium</i>	<i>Isoetes braunii</i>
<i>B. simplex</i>	<i>I. howellii</i>

The only eastern extensions from the Pacific coast states are *Athyrium filix-foemina* var. *californicum*, *Pityrogramma triangularis*, *Pellaea breweri* and *Selaginella watsoni*. While the two latter species reach their eastern limit in Utah they are among the commonest species in the state. None is precisely a western extension of an eastern species.

The lowest elevation in Utah is in Washington County in the southwestern corner of the state. Here a relatively small area is 2800 feet in elevation and forms the northern limit of the Lower Sonoran vegetation. The lowlands and relatively low Beaver Dam Mountains harbour several ferns having southern affinities. *Cheilanthes covillei*, *Notholaena parryi* and *Pellaea longimucronata* are quite common desert xerophytes. *Notholaena jonesii* is known in Utah only from the type specimen collected in the Beaver Dam Mountains and it has not been located in the state since the original collection was made although it was taken in Arizona just across the state line. Here also is the only known station for *Pityrogramma triangularis* which extends eastward into this region from southern California. It also ranges northward into British Columbia and Idaho and may possibly be present at other points in Utah.

In the Colorado River Basin the elevation ranges downward to about 3800 feet in the deep canyons but most of the terrane is higher

* Also reach their eastern limit in Utah. † Mainly southeastern United States.

and consists of rolling country considerably cut up by ravines, box canyons and deep gorges with mesas and high terraces skirting the high surrounding cliffs. In the canyons a few southern entrants are occasionally found. *Notholaena limitanea*, *Cheilanthes eatoni* and *Woodsia mexicana* are quite rare but *Selaginella mutica* is frequent locally. In the high plateau country centering around Zion National Park *Selaginella underwoodii* is occasionally found in local abundance. It is essentially a southeastern entrant although it has been found as far north as Wyoming.

The following are essentially southern species reaching their northern limit in southern Utah, at least in part.

<i>Cheilanthes covillei</i>	<i>Pellaea longimucronata</i>
<i>C. eatoni</i>	<i>Selaginella mutica</i>
<i>Notholaena jonesii</i>	<i>S. underwoodii</i>
<i>N. limitanea</i>	<i>Woodsia mexicana</i>
<i>N. parryi</i>	

Relative abundance. Ferns regarded as common may be placed in two groups: those widely distributed in the state, mainly in the mountains, and those abundant only in certain localities. *Cystopteris fragilis* is the most generally distributed species and although it is seldom found in any great abundance it is very frequent in more localities than any other fern. *Pteridium aquilinum lanuginosum* is very abundant in certain localities but is more spotty in distribution than *Cystopteris*. Perhaps the most abundant and widely distributed *Pteridophyte* form in Utah are the *Equisteums* as a group. *E. kansanum* is the most generally distributed species although *E. arvense* is also quite common and both occur in a wider variety of habitats than the other species. Both *E. prealtum* and *E. hiemale californicum* are very abundant, but more restricted to the mountains, especially near streams. *Adiantum capillus-veneris* is abundant at widely separated stations in the southern half of the state, especially in box canyons of the dry desert regions. On the other hand it is frequent in the mountains.

The estimation of relative abundance of the fern flora rests mainly upon field observations, and herbarium specimens. Of the total fern flora 36 per cent are common generally or locally, 13 per cent frequent, 16 per cent occasional and 35 per cent rare.

The species in each group are as follows:

COMMON GENERALLY (mostly in the mountains)

<i>Cystopteris fragilis</i>	<i>Equisetum prealtum</i>
<i>Equisetum arvense</i>	<i>Pteridium aquilinum lanuginosum</i>
<i>E. hiemale californicum</i>	<i>Selaginella watsoni</i>
<i>E. kansanum</i>	

COMMON LOCALLY

<i>Adiantum capillus-veneris</i>	<i>Notholaena parryi</i>
<i>A. pedatum aleuticum</i>	<i>Pellaea breweri</i>
<i>Athyrium filix-foemina</i>	<i>P. longimucronata</i>
<i>A. filix-foemina californicum</i>	<i>Selaginella mutica</i>
<i>Cheilanthes covillei</i>	<i>Woodsia oregana</i>
<i>Cryptogramma acrostichoides</i>	<i>W. scopulina</i>
<i>Isoetes bolanderi</i>	

FREQUENT

Cheilanthes feei	Polypodium hesperium
Dryopteris filix-mas	Polystichum lonchitis
Equisetum laevigatum	P. scopulinum

OCCASIONAL

Asplenium trichomanes	Cystopteris bulbifera
Athyrium americanum	Marsilea vestita
Azolla caroliniana	Selaginella densa
Botrychium lunaria	S. underwoodii

RARE

Asplenium adiantum-nigrum	Cryptogramma stelleri
A. septentrionale	Equisetum variegatum
A. viride	Isoetes braunii
Botrychium boreale obtusilobum	I. howellii
B. matricariaefolium	Notholaena jonesii
B. matricariaefolium hesperium	N. limitanea
B. simplex	Pellaea suksdorfiana
Cheilanthes siliquosa	Pityrogramma triangularis
C. gracillima	Woodsia mexicana

The rare species are known only from one or two localities and some of them are known only from single collections. Two outstanding rarities are *Asplenium adiantum-nigrum* from Zion National Park, known elsewhere in North America only from Northeastern Colorado and Northeastern Arizona, and *Asplenium septentrionale*, known from the Black Hills of South Dakota, and Wyoming to western Oklahoma, Arizona and Lower California. With the exception of *Botrychium lunaria*, the other species of this genus are known only from single collections thus far. Some of these so-called rare species may later prove to be occasional or even frequent with further exploration. Those suspected of being more frequent are *Asplenium viride*, *Cheilanthes siliquosa*, *Pellaea suksdorfiana*, *Cryptogramma stelleri*, *Athyrium americanum* and *Equisetum variegatum*.

DESCRIPTIVE CATALOG OF UTAH PTERIDOPHYTES

(FERNS AND FERN ALLIES)

Plants with true roots, stems and leaves, and propagating by asexual spores; the asexual spores in turn giving rise to inconspicuous, thalloid sexual plants (prothallia) which develop antherozoids in antheridia, and eggs in archegonia. The antherozoids fertilize the egg to form a zygote, the latter giving rise to the asexual leafy fern plant.

KEY TO THE FAMILIES

Plants having broad leaves, entire or variously dissected (minute in our Salviniaceae).

Spores borne in sporangia on the green leaves.

Spore-bearing leaves strikingly different from the vegetative leaves, sporangium without an annulus, opening by a transverse gaping slit.....1. Ophioglossaceae, p. 15

Spore-bearing leaves (in our species) much like the vegetative leaves, at most having narrower segments; sporangium with an annulus 2. Polypodiaceae, p. 21

Spores borne in sporocarps.

Leaves palmately divided into four leaflets (in our species) clover-like with long stipes; plants rooting in mud, often in shallow ponds or lakes with leaves floating 3.
Marsileaceae, p. 67

Leaves entire or two-lobed, sessile; plants small, branched, 0.5-2 cm. long, floating on water.....4. Salviniaceae, p. 68

Plants having scale-like or long slender leaves.

Stems jointed and fluted; leaves reduced to a circle of confluent scales at the joints; spores borne in a terminal cone. 5. Equisetaceae, p. 70

Stems not jointed; leaves green, imbricated.

Plants growing in dry rocks and crevices, moss-like; leaves small, oblong to linear (in our species); spores borne in terminal cones6. Selaginellaceae, p. 76

Plants submerged in shallow ponds or lakes, occasionally on exposed mud, grass-like; leaves long and slender, awl-shaped, from a broadly clasping base; sporangium imbedded in the base of the leaf.....7. Isoetaceae, p. 81

Family 1. OPHIOGLOSSACEAE Lindl

THE ADDER-TONGUE FAMILY

Plants with simple or compound leaves; sporangia either continuous in form of a band on the margin of a slender sporophyll (*Ophioglossum*), or distinct, ovoid to globose, without a true annulus, but opening by a transverse split, each sporangium gaping at maturity; prothallia subterranean or emergent, fleshy and mostly colorless. Mostly tropical ferns.

BOTRYCHIUM Sw. Jour. Bot. Schrad. 1800² : 110. 1801.

MOONWORTS AND GRAPE FERNS

Plants growing on soil from clustered, fleshy roots; stem simple, erect, fleshy, surrounded by a sheath of brown scaly leaf bases; leaf single with a common stalk bearing one sterile blade and one fertile

blade (sporophyll), the latter bearing a spike-like or panicle-like cluster of globose sporangia in two rows. Leaves entire to pinnately or palmately divided to compound. Morphologically the fertile portion consists of the two lowermost segments or pinnae of the leaf blade that are nondivergent and apparently arising from the adaxial (upper) surface of the leaf stalk. The vegetative lamina is suppressed and the sporangia are borne on the principal veins. The base of the common stalk contains the bud of the next year's leaf.

The name, *Botrychium* (Greek), alludes to the grape-like cluster of sporangia.

This is a difficult genus that requires considerable specialized study in order that one may form trustworthy opinions. Except for specialists, one is obliged to have fully developed specimens in order to fit them satisfactorily to a key or description. Even among our authorities opinions are some times at variance concerning the limits of species, subspecies and varieties. (See St. John, H., Notes on Northwestern Ferns, *Amer. Fern Jour.* 19: 11-14. 1929; Hall, Carlotta C., Observations on Western *Botrychiums*, *Ibed.* 33: 119-130. 1943; Clausen, R. T., Monograph of the *Ophiglossaceae*, *Mem. Torr. Bot. Club*, 19: No. 2. 1938.)

It is unfortunate that the Utah specimens collected to date are few and some of them so young that it is uncertain as to their precise identity. Thus, it is with considerable reservation that this treatment is offered.

Leaves with distinct petioles, often short; plants mostly slender.

Petiole half the length of the blade or longer; pinnae rhomboidal to narrowly fan-shaped, entire to crenate; plants small, mostly 3-5 cm. tall (up to 16 cm. in large specimens); blade simple to pinnately divided 1. *B. simplex*

Petiole short, mostly 2-4 mm. long; pinnae oblong, crenate to lobed, obtuse, usually distant; plants larger, mostly 7-10 cm. tall (up to 28 cm. in large specimens); blade oblong, pinnately divided 2. *B. matricariaefolium*

Leaves sessile or nearly so, plants stouter with ample foliage.

Pinnae ovate, rhomboidal to oblong, not or only slightly overlapping, lobed to pinnately divided.

Blades deltoid or deltoid-ovate in outline; lower pinnae distant, conspicuously larger and longer than the upper ones.

Sterile blade inserted above the middle of the whole plant; lower pinnae mostly oblong; in the bud the apex of the sterile blade bent over and clasping the straight or inclined fertile blade 3. *B. matricariaefolium* var. *hesperium*

Sterile blade inserted higher, near the summit of the whole plant; lower pinnae oblong to lanceolate; in the bud both sterile and fertile portions are completely reflexed 6. *B. lanceolatum*

Blades ovate to oblong in outline; lower pinnae approximate, not conspicuously larger or longer than the upper ones, broadly ovate to ovate-oblong, obtuse; in the bud the apex of the sterile blade bends over but does not clasp the fertile portion

4. *B. boreale* var. *obtusilobum*

Pinnae lunate or fan-shaped, mostly overlapping, entire or upper ones lobed; blade oblong; sterile leaf merely bent over the fertile segment in venation 5. *B. lunaria*

1. **Botrychium simplex** Hitchc. Amer. Jour. Sci. 6 : 103. pl. 8 1823.

LITTLE GRAPE FERN

- Botrychium virginianum* var. *simplex* (Hitchc.) A. Gray. Man. ed. 3 : 602. 1856.
B. lunaria var. *simplex* (Hitchc.) Watt. Can. Nat. II. 3 : 160. 1866.
B. simplex var. *cordatum* (Fries) Wherry, Amer. Fern Jour. 27 : 58. 1937.
B. simplex var. *typicum* Clausen, Mem. Torr. Bot. Club, 19²: 70. 1938.

Plants 3-10 cm. high (up to 16 cm. high in large specimens); common stalk 0.5-6 cm. long; sterile leaf diverging from the middle or below the middle of the plant; petiole up to 4 cm. long, half as long as the blade or longer; blade 0.3-4 cm. long, ovate to ovate-oblong, simple to pinnately divided (occasionally bipinnate); segments fan-shaped, oblong or rhomboidal, broadly inserted and decurrent on the indeterminate rachis, entire, crenate or divided above, distant or overlapping above; fertile segment on a long stalk usually exceeding the sterile leaf, simple or 1-2 pinnately divided.

This species is not definitely known in Utah, but since it has been collected in the surrounding states it seems likely that it may some day be found here. The description and illustration are included for convenient reference. Rydberg cites it for Utah in his Flora of the Rocky Mountains but it appears that the collection in question does not represent this species.

In dry woods and on open slopes. Newfoundland to New Jersey, westward to northern Indiana, Wisconsin and British Columbia, southward in the mountains of Montana, Colorado, New Mexico, Oregon and California.

ILLUSTRATION: Figs. 4-5.

2. **Botrychium matricariaefolium** A. Br. in Koch, Syn. Fil. Germ. ed. 2. 972. 1845.

MATRICARY GRAPE FERN

- Osmunda lunaria* y L. Flor. Suec. ed. 2. 369. 1755.
Botrychium rutaceum Sw. Jour. Bot. Schrad. 1800^o: 110. 1801.
B. lunaria var. *matricariaefolium* A. Br. in Doll, Rhein. Fl. 24. 1843.
B. neglectum Wood, Class-book Bot. ed. 2. 635. 1847.
B. tenellum Angstrom, Bot. Not. Nos. 5 and 6 : 69. f. 1-4, 1854.
B. ramosum (Roth) Aschers. Fl. Brandenb. 1 : 906. 1864.
B. matricariaefolium subsp. *typicum* Clausen. Mem. Torr. Bot. Club. 19²: 85. 1938.

Plants mostly 7-15 cm. tall (up to 28 cm.); roots fleshy, brown; common stalk usually 4-5 cm. long (up to 16 cm.), slender or fleshy; sterile leaf diverging above the middle of the plant, petiole usually evident, 3-4 mm. long (up to 2.5 cm.); blade oblong in outline 0.5-5 cm. long, pinnately divided, occasionally the lower pinnae again divided; pinnae diverging at a wide angle, often at right angles, oblong, crenate to lobed, obtuse, broadly decurrent on the indeterminate rachis, usually distant but sometimes overlapping, especially above. Fertile segment equalling or exceeding the sterile leaf, stalk 0.5-3 cm. long, 1-2 pinnately divided, fruiting portion paniculate, 0.5-8 cm. long. In veneration the sterile leaf is bent down over and clasping the erect fertile segment.



Figs. 4-5. *Botrychium simplex*. 4. Habit sketches X 1; 5. leaf X 2.
Figs. 6-7. *B. matricariaefolium*. 6. Habit sketches X 1; 7. leaf X 2.
Fig. 8. *B. matricariaefolium* var. *hesperium*. habit sketches. X 1.
Fig. 9. *B. boreale* var. *obtusilobum*. habit sketches X 1.
Figs. 10-11. *B. lunaria*. 10. habit sketches X 1; 11. leaf X 2.

Not definitely known in Utah. A single small specimen collected at Brighton by Mr. A. O. Garrett approaches this species but Dr. Clausen expressed the opinion that its identity is doubtful and probably represents the following variety. The description and illustration are included for convenient reference.

In rich humus soil in woods and bordering thickets. Labrador and Newfoundland south to Maryland, westward to Ohio, Michigan, Wisconsin, Nebraska, North Dakota, Alberta and northern Idaho.

ILLUSTRATION: Figs. 6-7.

3. *Botrychium matricariaefolium* var. *hesperium* (Maxon & Clausen)

M. Broun, Index to North Amer. Ferns, 39, 1938.

Botrychium matricariaefolium subsp. *hesperium* Maxon & Clausen, Mem. Torr. Bot. Club, 19²: 88. 1938.

WESTERN MATRICARY GRAPE FERN

Plants usually stout and fleshy, mostly 5-10 cm. tall (up to 20 cm.); roots fleshy, brown; common stalk mostly 3-6 cm. long, 2-3 mm. thick; sterile leaf diverging above the middle of the plant, petiole usually very short or sessile (sometimes evident, up to 15 mm. long), blade rather thick, deltoid-ovate to ovate-oblong in outline, 1-5 cm. long, pinnately divided, the lower pinnae sometimes again divided; pinnae 6-8, oblong to rhomboidal or ovate, the lower ones often conspicuously larger and more distant than the smaller upper ones which are more closely disposed and often overlapping, margins lobed or cleft, tips bluntly acute or obtuse. Fertile segment usually exceeding the sterile leaf, stalk 0.5-6 cm. long, fruiting portion paniculate, 1-6 cm. long. In veneration the sterile leaf bends down and clasps the fertile segment.

Differs from typical *B. matricariaefolium* in that the leaves are coarser and thicker, nearly sessile, the pinnae larger, the lower lobes conspicuously larger and diverging at a more acute angle, the whole leaf tending toward a deltoid-ovate outline.

A single specimen was collected by Mr. A. O. Garrett in a grassy meadow at Brighton. It was originally named *B. lanceolatum* until Maxon and Clausen gave the present name to similar specimens from the Colorado Rockies. Thus far it is known only from Colorado and Utah.

ILLUSTRATION: Fig. 8.

COLLECTION: Garrett 1519 (3), Brighton, Salt Lake County.

4. *Botrychium boreale* var. *obtusilobum* (Rupr.) M. Broun,

Index to North Amer. Ferns, 33, 1938.

NORTHERN GRAPE FERN

Botrychium crassinervium var. *obtusilobum* Rupr. Beitr. sur Pfl. des Russ. Reich. 11: 42. 1859.

B. pinnatum H. St. John, Amer. Fern Jour. 19: 11. 1929.

B. boreale subsp. *obtusilobum* (Rupr.) Clausen, l. c. p. 81. 1938.

Plants stout and fleshy, mostly 8-13 cm. tall (up to 25 cm.); roots dark brown, 1 mm. or less thick; common stalk one-third to one-half above ground; 3-7 cm. long; sterile leaf almost sessile, yellowish-green, up to 3 cm. long, ovate to oblong in outline, once pinnate (sometimes bipinnate in large plants); pinnae approximate or slightly overlapping, 6-10, sessile or decurrent, rhombic, ovate or elliptical, 4-12 mm. long, lobed or divided, tips obtuse, rounded. Fertile segment exceeding the sterile leaf, fruiting portion racemose to paniculate, up to 3 cm. long. In vernation the sterile leaf bends over the fertile segment but does not clasp it.

Collected by Dr. Robert Snell on sloping open meadows southeast of Mirror Lake in the Uintah Mountains. Open grassy places, Alaska and Aleutian Islands southward through British Columbia, Alberta to Washington, Montana, and Oregon to Utah. Siberia.

ILLUSTRATION: Fig. 9.

COLLECTION: I. H. 32912. Southeast of Mirror Lake, Summit County.

5. *Botrychium lunaria* (L.) Sw. Jour. Bot. Schrad. 1800²:110. 1801.

MOONWORT

Osmunda lunaria L. Sp. Pl. 1064. 1753.

Ophioglossum pinnatum Lam. Flore Francoise, 1 : 9. 1779.

Osmunda ramosa Roth, Tent. Fl. Germ. 1 : 444. 1788.

O. lunata Salisb. Prodr. 401. 1796.

Botrypus lunaria Richards in Marthe, Cat. Jard. Med. Paris, 120. 1801.

Botrychium lunatum S. F. Gray, Nat. Arrangement of Brit. Plants, 2 : 19. 1821.

B. racemosum (Fuchs) Bubani, Fl. Pyr. 4 : 438. 1901.

Plants 3-28 cm. high; roots fleshy, dark brown; common stalk short, sheathed with old scaly leaf bases; sterile leaf sessile, from a long sheathing leaf base, diverging below the middle of the plant; blade 2-10 cm. long, ovate-oblong to oblong in outline, once pinnately divided; segments 5-15, lunulate, reniform or fan-shaped, mostly overlapping, entire or upper ones crenate to incised. Fertile segment exceeding the sterile leaf, long stalked, fruiting portion simple, racemose or paniculate. In vernation the sterile leaf merely bends over the fertile segment.

In grassy meadows and edges of woods above 7000 feet elevation in Utah. Meadows, barrens and open woods, usually limestone regions, Labrador and Newfoundland to Alaska, Northern Michigan and Minnesota, and southward in the mountains to Colorado, Arizona and southern California; Maine, Greenland, Argentina; Eurasia; Australia; New Zealand.

ILLUSTRATION: Figs. 10-11.

COLLECTIONS: Cottam 6376. Spirit Lake, Daggett County; Garrett 1519. Silver Lake, Brighton, Salt Lake County. Also reported from Mirror Lake region in Summit County and from Iron County.

Var. *minganense* (Victorin) Dole should be found in Utah since it has been reported from surrounding states.

6. *Botrychium lanceolatum* (S. G. Gmel.) Angstrom, Bot. Not.
1854 : 68. 1854.

LANCE-LEAVED GRAPE FERN

Osmunda lanceolata S.G. Gmel. Nov. Comm. Acad. Sci. Petrop. 12 : 5-6. 1768.

Botrychium palmatum Presl, Suppl. Trent. Pterid. 43. 1845.

Botrychium lunaria var. *lanceolatum* (S.G. Gmel.) Rupr. Distr. Crypt. Vasc. Ross.
332. 1845.

B. rutaceum var. *lanceolatum* (S.G. Gmel.) Moore, Ind. Fil. 211. 1857.

B. matricariaefolium var. *lanceolatum* (S.G. Gmel.) Watt. Can. Nat. II. 3 : 160.
1866.

B. lanceolatum subsp. *typicum* Clausen, Mem. Torr. Bot. Club, 19²: 90. 1938.

Plants 6-40 cm. tall, stout and fleshy; common stalk long, 4-15 cm. long; sterile blade sessile or nearly so, inserted near the summit of the plant, broadly deltoid in outline, 1-6 cm. long, 1-8 cm. wide at the base, apex acute, pinnately divided, the lower pinnae or segments distant, lanceolate, conspicuously longer and larger than the upper ones which are oblong-lanceolate to ovate, variously lobed, cleft or divided, the lobes bluntly acute. Fertile segment with a short stalk about 1 cm. long or shorter, fruiting portion paniculate, 1-5 cm. long; spores 29-42 μ in diameter. Sterile blade and fertile segment both reflexed in veneration.

This species resembles *Botrychium matricariaefolium* var. *hesperium* in appearance but the sterile blade is more constantly sessile and borne much higher on the plant while the fertile segment is shorter-stalked. The blade is also more broadly deltoid while the pinnae or segments are narrower. The plant was discovered since the plates were engraved and therefore an illustration could not be included.

Known in Utah only from a single plant collected by Prof. A. H. Holmgren in the Deep Creek Mountains.

COLLECTION: Maguire and Holmgren, Field number 21990A, Indian Farm Canyon, 10,000 feet elevation, Deep Creek mountains, Juab Co. Deposited in the Herbarium of the New York Botanical Gardens.

Meadows, open woods and slopes. Labrador south to Quebec and Maine, west to Alaska and the Aleutian Islands, south to Washington and in the mountains to Utah and Colorado. Greenland; Iceland; northern Europe and Asia.

Family 2. POLYPODIACEAE Presl.

FERN FAMILY

Plants with rhizomes or rootstocks; leaves coiled in the bud, all alike, except *Cryptogramma* which has longer fertile leaves with narrower segments; sori naked or covered by an indusium or by the recurved leaf margin with or without a membranaceous false indusium; sporangium with an annulus; spores all alike; prothallia flat, green, aerial.

- Sori on the veins, not marginal..... A
- Sori marginal, without true indusia, exposed or protected by the reflexed or recurved leaf margin..... G
- A. Sori round in outline..... B
- A. Sori elongated, horseshoe-shaped or continuous on the veins..... F
- B. Indusia arising from under the sori (inferior)..... C
- B. Indusia lacking, or present and attached above the sori on a little hump (superior)..... D
- C. Indusia attached all around, at maturity splitting from the top and center into spreading segments, star-like..... 1. Woodsia, p. 22
- C. Indusia attached on one side only, covering the sori like hoods which bend backward at maturity..... 2. Cystopteris, p. 26
- D. Indusia lacking..... 3. Polypodium, p. 30
- D. Indusia present, superior..... E
- E. Indusia shield-shaped, attached at the center and spreading over the sori..... 4. Polystichum, p. 33
- E. Indusia attached by a notch at one side, lunate..... 5. Dryopteris, p. 36
- F. Sori curved across the veins, indusium hood-like, sometimes lacking or weak..... 6. Athyrium, p. 37
- F. Sori straight, on the sides of the veins, oblique to the margin and midvein, indusium hood-like..... 7. Asplenium, p. 42
- F. Sori continuous on the veins, indusium lacking..... 8. Pityrogramma, p. 47
- G. Leaf margins strongly reflexed or recurved..... H
- G. Leaf margins flat or only slightly recurved, blades glabrous, hairy, scaly or mealy (ceraceous) beneath..... 14. Notholaena, p. 63
- H. Sori attached to and covered by the thin, membranaceous, strongly reflexed tips of the leaflet lobes..... 9. Adiantum, p. 47
- H. Sori more or less continuous, marginal or submarginal, on the leaf proper and more or less covered by the recurved margin, membranaceous false indusium present in some species..... I
- I. Leaves of two kinds, the fertile ones longer than the sterile ones and with narrower segments..... 11. Cryptogramma, p. 51
- I. Leaves all alike..... J
- J. Plants not tufted, leaves single, 1-6 feet long, from a horizontal rhizome, growing in soil..... 10. Pteridium, p. 51
- J. Plants densely tufted, small to medium-sized, mostly growing in crevices or among rocks..... K
- K. Leaves glabrous or nearly so, ends of veins not thickened, membranaceous false indusium wanting..... 12. Pellaea, p. 55
- K. Leaves densely hairy or scaly beneath, ends of the veins thickened, membranaceous false indusium present in some species..... 13. Cheilanthes, p. 57

1. WOODSIA R. Br. Prodr. Fl. Nov. Holl. 1 : 158. 1810.

Small to medium-sized ferns growing in the crevices of dry rocks, often under rocks on soil; rootstocks short and thick, clothed with brown scales; roots fibrous, brown tomentose; leaves 5-32 cm. long (in our species), bi-tripinnate, oblong-lanceolate to lanceolate in outline; pinnae triangular to oblong, pinnately divided, the pinnules crenate or dentate, margins flat or irregularly recurved; sori on the veins of the pinnules, round, indusium arising from below the sorus (inferior) and splitting at maturity into slender stellate segments which are often inconspicuous or completely obliterated in older sori.

Named for Joseph Woods, 1776-1864, an English botanist.

It is often difficult to distinguish species of *Woodsia* and *Cystopteris*, especially when they are very young or very mature so that the characteristics of the sori and indusia cannot be made out. Usually they may be distinguished by the texture and color of the leaves. *Cystopteris* has thinner and more transparent leaves in which the veins stand out distinctly while in *Woodsia* the leaves are usually thicker, opaque green with the veins obscure or not distinct. They may also be distinguished by the form and position of the vascular bundles in the base of the stipes. "Sections are made by cutting the stipe squarely across just above the basal part using a sharp razor. The vascular bundles appear as dots and must be observed with a hand lens. Both genera have two vascular bundles in the stipe that are rounded or oval in cross section. In *Woodsia* the bundles soon flatten out above and become united in form of a "V" or "X" while in *Cystopteris* the bundles do not become united into "V" or "X" forms or if they do so, it is only in the upper half of the stipe." (From Waters, C. E., Amer. Fern Jour. Suppl. vol. 18, 1928.)

- Leaves smooth, not hairy or glandular 1. *W. oregana*
 Leaves glandular.
 Leaf margins hyaline or ciliate, surface minutely glandular but not
 hairy 2. *W. mexicana*
 Leaf margins not hyaline or ciliate, surface glandular hairy 3. *W. scopulina*

1. *Woodsia oregana* D. C. Eaton, Can. Nat. II, 2 : 90. 1865.

OREGON WOODSIA

Physematium oreganum (D. C. Eat.) Trev. Nu. Giorn. Bot. It. 7 : 162. 1875.

Leaves, including stipes, up to 25 cm. long, lanceolate or oblong-lanceolate in outline, stipes yellowish or straw-colored, darker at the base, smooth. Fertile leaves longer than the sterile ones, pinnae ovate-oblong or triangular, pinnatifid, the apex obtuse, smooth; pinnales crenulate, often lobed or cleft near the base, margins often slightly recurved. Indusia split into slender, hair-like segments, becoming obscured as the sori spread at maturity.

In Utah frequent in moist or dry shaded cliffs and ledges, in talus or on soil under rocks. It is more common at elevations between 5000 and 9000 feet in limestone regions. Quebec to British Columbia south in mountains to Lower California, New Mexico and northern Oklahoma.

ILLUSTRATION: Figs. 12-14.

COLLECTIONS: Flowers 3255, Lake Blanche, Big Cottonwood Canyon, Salt Lake County; 3237, Pittsburg Lake, American Fork Canyon, Utah County, 3238, above Alta, Salt Lake County; 3239, Mt. Olympus, Salt Lake County, 3240, Mt. Timpanogos, Utah County, Cottam 6442, Aquarius Plateau, Garfield County, 8903, Pine Valley Mountains, Washington County; I. H. 40695 and 40697, Big Cottonwood Canyon, Salt Lake County; B. Y. Pilot Mt., Boxelder County, 4282, Long Canyon, Kane County; Garrett 1998 and 2673, Big Cottonwood Canyon, Salt Lake County, 7264, Little Cottonwood Canyon, Salt Lake County, 5651, Mt. Timpanogos, Utah County.



13



14



12

Figs. 12-14. *Woodsia oregana*. 12. Habit sketches X $\frac{1}{2}$; 13. pinna X 2; 14. pinnule X 10.



Figs. 15-17. *Woodsia mexicana*. 15. Habit sketches X $\frac{1}{2}$; 16. pinna X 2; 17. pinnules X 10.

2. *Woodsia mexicana* Fee, Mem. Fam. Goug. 66. 1854.

MEXICAN WOODSIA

Tufted; leaves up to 25 cm. long, lanceolate in outline, stipes glandular above; pinnae triangular-lanceolate to ovate; pinnules oblong to ovate, contracted to a broad decurrent base forming a wing on the indeterminate rachilla; lobed or cleft, the lobes in turn sparingly crenate-dentate, glandular dotted but not hairy, margins hyaline ciliate when young; indusium usually conspicuous, large and splitting into irregularly fringed segments.

In moist or dry cliffs, ledges and rock slides in southern Utah. Western Texas to Arizona, Colorado and Mexico.

ILLUSTRATION: Figs. 15-17.

COLLECTION: Garrett 9669. Montezuma Canyon, San Juan County; Woodbury, near Blanding, San Juan County.

3. *Woodsia scopulina* D. C. Eaton, Can. Nat. II. 2 : 90. 1865.

ROCKY MOUNTAIN WOODSIA

Tufted, similar in appearance to the last species; leaves up to 28 cm. long including stipe, mostly lanceolate in outline, stipes usually darker at the base and hairy above; pinnae narrower, oblong-lanceolate, pinnatifid, acute, glandular hairy on the under side; pinnules oblong, crenate-serrate to lobed, obtuse, base broadly decurrent, not at all or only slightly contracted; indusium splitting into narrow segments, usually inconspicuous at maturity.

Throughout the state in cliffs and ledges, talus and under rocks on soil. Quebec to Alaska south to central California, western Oklahoma, Tennessee, and North Carolina.

ILLUSTRATION: Figs. 18-20.

COLLECTIONS: Flowers 3241. Bear River Mountains, Cache County; Cottam 8298. Lake Blanche, Big Cottonwood Canyon, Salt Lake County; Jones, Alta, Salt Lake County; B. Y. 2231. La Sal Mountains, San Juan County, 3681. Bald Mountain, Summit County, 3773. Soapstone Canyon, Summit County, 7735. Moon Lake, Uintah County, 10096. Mt. Emmons, Duchesne County; I. H. Talus slopes, Garfield County, 35520. Moon Lake, Uintah County.

2. *CYSTOPTERIS* Bernh. Neu. Jour. Bot. Schrad. 1²: 26. 1806.

Small to medium-sized ferns from short creeping rhizomes. Leaves variable in size. 3-50 cm. long including stipe, bipinnate to decomposed, mostly thin and delicate; sori on the underside of the pinnules, in two rows on the veins, round in outline; indusia hood-like, attached at one side and arching backward at maturity, small, arose on the free margin, disappearing early.

Some forms of *Cystopteris* are difficult to distinguish from *Woodsia*. For additional contrasts see notes under *Woodsia*, p. 23.

Cystopteris means Bladder fern (Greek) alluding to the thin, inflated indusium.

Leaves up to 40 cm. long, ovate-lanceolate to oblong-lanceolate, the lowest pinnae shorter 1. *C. fragilis*
 Leaves larger, up to 100 cm. long, triangular-lanceolate, the lowest pinnae the longest 2. *C. bulbifera*



Figs. 18-20. *Woodsia scopulina*. 18. Habit sketches X $\frac{1}{2}$; 19. pinna X 2; 20. pinnules X 10.

1. *Cystopteris fragilis* (L.) Bernh. l. c.

BRITTLE FERN

Polypodium "F. fragile" (a misprint) L. Sp. Pl. 1091. 1753.

Polypodium fragile L. Fl. Svecica, ed. 2. 374. 1755.

Filix fragilis (L.) Gilib. Exerc. Phyt. 558. 1792.

Cyathea fragilis (L.) J. Sm. Mem. Acad. Turin. 5 : 419. 1793.

Aspidium fragile (L.) Sw. Jour. Bot. Schrad. 1800²: 40. 1801.

Athyrium fragile (L.) Spreng. Anleit. 3 : 136. 1804.

Cyclopteris fragilis (L.) F. S. Gray, Nat. Arr. Brit. Pl. 2 : 9. 1821.

Cystea fragilis (L.) J. Sm. Engl. Fl. 4 : 298. 1828.

Cystopteris filix-fragilis (L.) Chiov. Ann. Bot. Pirota, 1 : 210. 1903.

Plants loosely tufted from a short creeping rhizome, 15-40 cm. high; leaves oblong-lanceolate to ovate-lanceolate in outline, tripinnate, thin and delicate in texture, stipes brown below, yellowish above, smooth, with a groove in front except at the base, and with two lateral grooves (often lacking in small specimens); pinnae ovate to oblong-lanceolate; pinnules or segments glabrous, oblong, broadly decurrent, confluent above, dentate to incised, the lower ones often pinnatifid, tips obtuse or a few acute; indusia small, attached to one side and arching backward at maturity like a hood, free margin rounded or elongated, erose, disappearing early.

Our commonest fern. It grows in many places, in crevices of cliffs and ledges, on soil under rocks or roots of shrubs and trees. It may be found in early spring on exposed hillsides which later become very dry. It reaches its best growth in cool shaded ravines and around wet places at elevation from 5000 to 9000 feet. Labrador and Newfoundland to Alaska, south to northern New England, Pennsylvania, Missouri, western Texas and southern California; Greenland, Iceland and Eurasia.

ILLUSTRATION: Figs. 21-25.

COLLECTIONS: Flowers 3015. Big Cottonwood Canyon, Salt Lake County, 3016. Logan Canyon, Cache County, 3017. Price Canyon, Carbon County, 3020. Huntington Canyon, Emery County, 3022. Soapstone Canyon, Summit County, 3023. Swasey Gulch, House Mountains, Juab County, 3034. City Creek Canyon, Salt Lake County, 3037. South Fork, Ogden Canyon, Weber County, 3042. Recapture Canyon, San Juan County, 3043. Cedar Mt. Kane County, 3047. La Sal Mountains, San Juan County, 3049. Birch Creek, Deep Creek Mountains, Juab County, 3055. Wasatch Plateau, San Pete County; Cottam 1202. Mt. Timpanogos, Utah County, 2981. Rosvere Creek, Raft River Mountains, Boxelder County, 6937. Zion National Park, Washington County, Pine Valley Mountains, Washington County; B. Y. 3680. Bald Mt., Summit County, 3243 and 3246. Deep Creek Mountains, Juab County, 2836. Blue Creek, Raft River Mountains, Boxelder County, 7903. Twelve miles south of Manila, Daggett County, 7705. Moon Lake, Uintah County, 4822. Henry Mountains, Garfield County, 4281. Long Canyon, Kane County, 3873. Lost Lake, Summit County; I. H. 40703. Head of Beaver Canyon, Beaver County, 40704. Maple Canyon, San Pete County, 68. White Pine Canyon, Cache County, 18199. Base of Haystack Mountain, Grand County, 18200. Mt. Hobbs, Grand County, 76. South peak, Abajo Mountains, San Juan County, 40701. Mt. Leidy, Uintah Mountains, 41125. Iron Mine Canyon, Duchesne County, and many others.



Figs. 21-25. *Cystopteris fragilis*. 21. Habit sketch X $\frac{1}{2}$; 22. leaf of form having ample foliage X $\frac{1}{2}$; 23. leaf of extremely slender form X $\frac{1}{2}$; 24. pinnae of two forms X 2; 25. pinnule X 10.

2. *Cystopteris bulbifera* (L.) Bernh. l. c.

BULBLET BLADDER FERN

Polypodium bulbiferum L. Sp. Pl. 1091. 1753.

Aspidium bulbiferum (L.) Sw. l. c.

Nephrodium bulbiferum (L.) Michx. Fl. Bor. Amer. 2 : 268. 1803.

Aspidium astomarium Muhl. in Willd. Sp. Pl. 5 : 279. 1810.

Athyrium astomarium (Muhl.) Presl, Rel. Haenk. 1 : 40. 1835.

Cystopteris astomaria Presl, Tent. Pterid. 93. 1836.

Cysteu bulbifera (L.) Watt. Can. Nat. II. 13 : 160. 1867.

Filix bulbifera (L.) Underw. Our Nat. Ferns, ed. 6. 119. 1900.

Larger and firmer in texture than the last species, tufted, 30-100 cm. high; leaves lanceolate to long triangular-lanceolate in outline, tripinnate; pinnae deltoid-lanceolate to oblong-lanceolate; pinnules oblong, broadly decurrent, pinnatifid or deeply incised, the segments more or less obtuse and sparingly dentate, minutely glandular on under surface; stipe flat in front below, becoming grooved above with traces of lateral grooves. Rachis and midribs often bearing bulblets on the undersides.

Uncommon in Utah. It grows in crevices of cliffs and ledges, in talus and under rocks on soil. It is favored by limestone but grows in regions of other rocks. Newfoundland to Manitoba south to northern Georgia, central Arizona and New Mexico.

ILLUSTRATION: Figs. 26-28.

COLLECTIONS: Flowers 3040. Brighton, Salt Lake County, 3041. Little Cottonwood Canyon, Salt Lake County, Garrett 9343. Elk Mountain, San Juan County, Woodbury; Zion National Park, Washington County.

3. *POLYPODIUM* (Tourn.) L. Sp. Pl. 1082. 1753.

Small to medium-sized ferns from creeping, nodulose, branched, scaly rhizomes; leaves simple to pinnatifid or nearly pinnately compound, up to 15 dm. long (2 dm. long in our species), veins free; sori round in outline, on the veins, indusia lacking.

The name, *Polypodium* (Greek), means many footed, alluding to the numerous nodulose protuberances on the rhizome.

Polypodium hesperium Maxon, Proc. Biol. Soc. Wash. 13 : 200. 1900.

WESTERN POLYPODY

Polypodium vulgare var. *columbianum* Gilbert, List of N. Am. Pterid. 19 : 38. 1901.

Polypodium vulgare var. *hesperium* (Max.) Nels. & Macb. Bot. Gaz. 41 : 30. 1916.

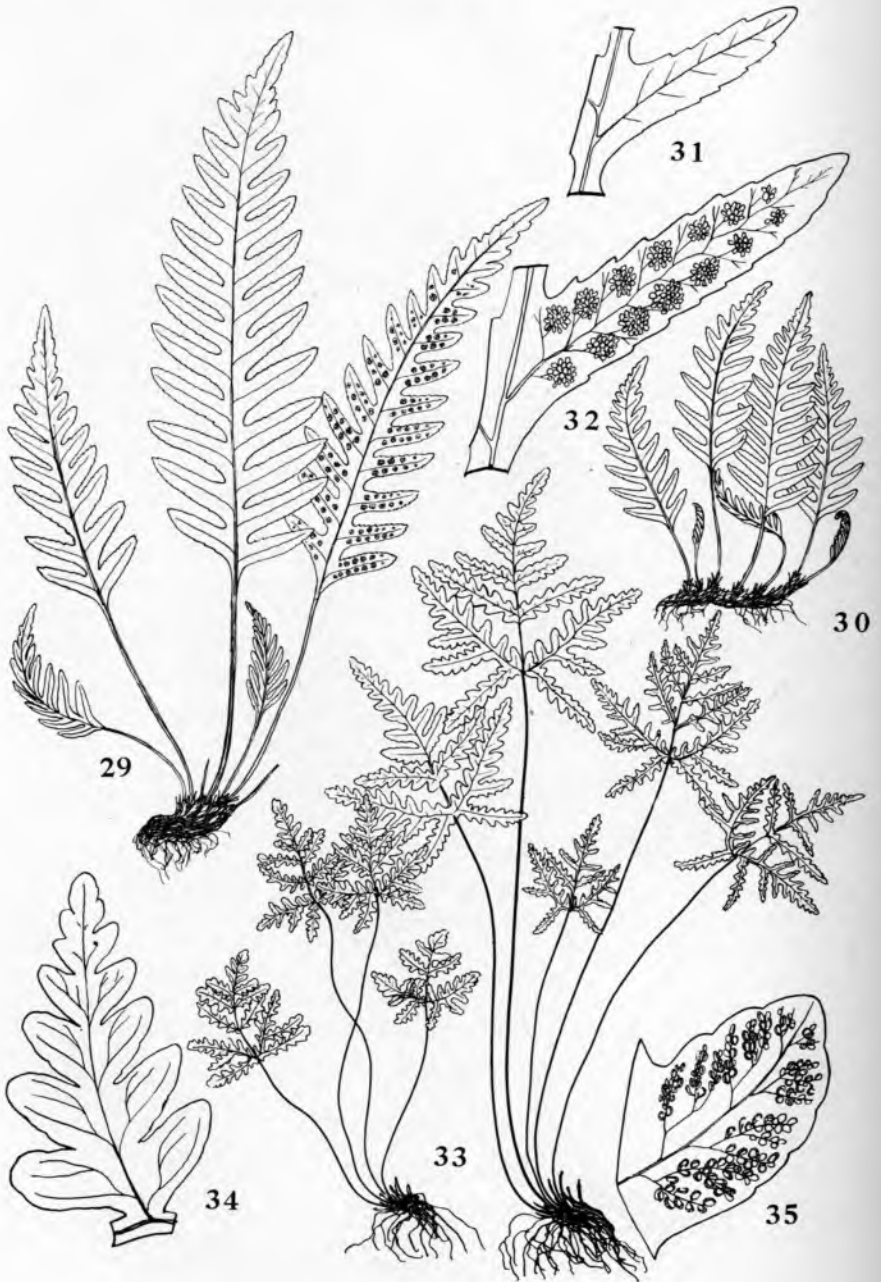
Polypodium prolongilobum Clute, Fern Bull. 18 : 97. 1910.

Polypodium amorphum Suksdorf, Werdenda, 1 : 16. 1927.

Rhizomes densely brown scaly; leaves oblong-ovate to oblong-lanceolate in outline, 10-25 cm. long including stipes; stipes yellowish or green except at the extreme base which is often brown; blades deeply parted, divided or pinnatifid; segments oblong to linear-oblong, obtuse or acute, margins serrate to nearly entire; sori midway between the margins of the segments and the midvein, indusium lacking.



Figs. 26-28. *Cystopteris bulbifera*. 26. Habit sketch X $\frac{1}{2}$; 27. pinnae of two forms X 2; 28. pinnule X 10.



Figs. 29-32. *Polypodium hesperium*. 29-30. Habit sketches of large and small forms X $\frac{1}{2}$; 31-32. pinnae X 10.

Figs. 33-35. *Pityrogramma triangularis*. 33. Habits sketches X $\frac{1}{2}$; 34. pinna X 2; 35. an ultimate segment showing sori continuous on the veins X 10.

In crevices of cliffs and ledges or under rocks in soil, usually in shaded canyons and ravines. High mountains throughout Utah. British Columbia to South Dakota, southward to New Mexico and southern California.

ILLUSTRATION: Figs. 29-32.

COLLECTIONS: Flowers 3198. Pittsburg Lake, American Fork Canyon, Utah County, 3199. Little Cottonwood Canyon, Salt Lake County, 3200 and 3201. Big Cottonwood Canyon, Salt Lake County; Cottam 8842. Oak Grove, Washington County, 8934. Zion National Park, Washington County; Garrett 2648. Little Cottonwood Canyon, Salt Lake County.

4. **POLYSTICHUM** Roth, Fl. Germ, 3¹: 69. 1799.

Small to medium-sized ferns; tufted, growing from short, stout rhizomes, usually with copious brown scales; leaves coarse, evergreen, pinnate, oblong to lanceolate in outline; stipes brown at the base, yellowish or green above, smooth or brown scaly, very short to medium in length; sori round, prominent, on the veins, indusium attached at the center on a little hump (superior) and spreading over the sorus, margin fringed.

The name, *Polystichum* (Greek), means many rows, referring to the many rows of sori.

Stipe very short, pinnae extending nearly to the rhizome; pinnae long spinulose dentate or serrate, the base truncate, unsymmetric, auricled on the upper side1. *P. lonchitis*

Stipe one-fifth as long as the blade or longer; pinnae sharply serrate, the lower ones deeply cleft or parted at the base, only the upper ones auricled2. *P. scopulinum*

1. **Polystichum lonchitis** (L.) Roth in Rom. Arch. Bot.

2¹: 106. 1899.

HOLLY FERN

Polypodium lonchitis L. Sp. Pl. 1088. 1753.

Aspidium lonchitis (L.) Sw. Jour. Bot. Schrad. 1800²:30. 1801.

Hypopeltis lonchitis (L.) Todaro. Syn. Pl. Acot. Vasc. Sicil. 32. 1866.

Dryopteris lonchitis (L.) Kuntze. Rev. Gen. Pl. 2 : 813. 1891.

A coarse evergreen fern with numerous dark green leaves on a short thick rhizome; leaves pinnate, 20-40 cm. long, very short stipitate, rachis scaly, yellowish-green; blade oblong-lanceolate to linear-lanceolate in outline; pinnae extending nearly to the rhizome, triangular to oblong-lanceolate, falcate, margins spinulose serrate, base auricled on the upper side; indusia entire.

Frequent in the mountains throughout the state growing in cliffs, talus or in soil in open woods. Newfoundland to Alaska, Great Lakes region and south in the mountains to California and New Mexico. Greenland.

ILLUSTRATION: Fig. 36.

COLLECTIONS: Flowers 3210 and 3211. Mt. Timpanogos, Utah County, 3212. Above Lake Blanche, Big Cottonwood Canyon, Salt



Fig. 36. *Polystichum lonchitis*. habit sketch X $\frac{1}{2}$; pinna X 2; sorus and indusium X 10.



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Fig. 37. *Polystichum scopulinum*. habit X $\frac{1}{2}$; pinnae of various sizes X 2.

Lake County, 3213. Wasatch Plateau, San Pete County, 3214. Bear River Mountains, Cache County, 3215. Hades Canyon, Duchesne County, 3216. Pittsburg Lake, American Fork Canyon, Utah County; Garrett 1682 and 2675. Big Cottonwood Canyon, Salt Lake County; B. Y. 1200 and 1201. Mt. Timpanogos, Utah County; I. H. 29899 and 30380. White Pine Lake, and 29898 above Tony Lake, Cache County.

2. *Polystichum scopulinum* (D. C. Eaton) Maxon, Fern Bull.

8 : 29. 1900.

ROCK POLYSTICHUM

Aspidium aculeatum var. *scopulinum* D. C. Eaton, Ferns of N. Amer. 2 : 125. 1800.

Polystichum aculeatum var. *scopulinum* (D. C. Eat.) Gilbert, List of N. Amer. Pterid. 20. 1901.

Polystichum lonchitis var. *scopulinum* (D. C. Eat.) M. E. Jones, Bull. Univ. Mont. Biol. Ser. 15 : 7. 1910.

Polystichum mohrioides var. *scopulinum* (D. C. Eat.) Fernald, Rhodora 25 : 92. 1924.

Less coarse and rigid than the last species, and usually of lighter green color, less densely tufted; leaves usually long stipitate, the stipe green and scaly, brownish at the base; rachis scaly; 20–40 cm. long, blades ovate-lanceolate to linear-lanceolate in outline; pinnae ovate to oblong, obtuse or acute, margin sharply crenate-serrate, the lower ones deeply cleft at the base, the upper ones auricled on one side; indusia large, ciliate or erose on the margin.

Throughout the state in the mountains. In crevices of cliffs and ledges, in talus or in soil in open wooded slopes. Quebec to Washington southward in the high mountains to California and Arizona.

ILLUSTRATION: Fig. 37.

COLLECTIONS: Garrett 1683a. Big Cottonwood Canyon, Salt Lake County; B. Y. 5658. Zion National Park, Mt. Carmel, Washington County; I. H. 35519. Zion National Park, Washington County.

5. *DRYOPTERIS* Adans. Fam. Pl. 2 : 20, 550. 1763.

Medium-sized ferns from thick rhizomes; leaves bipinnate to decomposed, stipes not articulated with the rhizome but continuous with it, sheathed at the base with large fimbriate scales, upper portion often scaly and glandular; pinnae mostly lanceolate; pinnules numerous; veins pinnate and forked; sori round in outline, on the veins, two rows to each pinnule; indusium attached at one side by a deep notch, lunate or horseshoe-shaped, large and conspicuous.

Dryopteris (Greek) means oak fern.

A large family of about 150 species of which only one occurs in Utah.

Dryopteris filix-mas (L.) Schrott, Gen. Fil. Pl. 67. 1834.

MALE FERN

Polypodium filix-mas L. Sp. Pl. 1090. 1753.*Polystichum filix-mas* (L.) Roth, Rom. Arch. 2¹: 106. 1799.*Aspidium filix-mas* (L.) Sw. Jour. Bot. Schrad. 1800²: 38. 1801.*Tectaria filix-mas* (L.) Cav. Desc. 251. 1802.*Nephrodium filix-mas* (L.) L. C. Rich in Desv. Mem. Soc. Linn. 6 : 60. 1827.*Lastrea filix-mas* (L.) Presl, Tent. Pterid. 76. 1836.*Lophodium filix-mas* (L.) Newman, Phytologist, 4 : 371. app. xx. 1851.*Thelypteris filix-mas* (L.) Nieuwl. Am. Mid. Nat. : 226. 1910.

Rhizome very stout, densely brown scaly; leaves 25–90 cm. long (mostly 30–50 cm. long in our plants), bipinnate to decompose, mostly tripinnate, oblong-lanceolate in outline; stipes densely scaly at the base, the rachis with slender scattered scales; pinnae lanceolate, pinnatifid; ultimate segments oblong, very obtuse, serrate at the tip, sparingly so on the sides, inserted at a sharply acute angle, broadly decurrent below, becoming confluent above, only the lower ones narrowed at the base or not at all, glabrous on both sides; sori on the veins in two rows on each segment; indusia attached by a deep notch on one side.

Throughout the state in mountains. In cool shaded ravines and woods or growing in cliffs or talus. Newfoundland to British Columbia, Vermont, western South Dakota, California in San Bernardino Mountains, to western Texas and Oklahoma. Greenland, Iceland and northern Eurasia.

ILLUSTRATION: Figs. 38-40.

COLLECTIONS: Flowers 1385-89 and 1390-91. Various points in Big Cottonwood Canyon, Salt Lake County; 1388. Zion National Park, Washington County; Cottam 6976. Zion National Park; B. Y. 4382. East of Escalante, Garfield County.

6. ATHYRIUM Roth, Fl. Germ. 3¹: 58, 1799.

Ferns of medium size, up to 100 cm. high, from short, stout, creeping rhizomes; densely scaly; leaves forming a dense cluster at the ends of the rhizome, bi-tripinnate, mostly thin and delicate, veins free; sori on the veins, oblong to linear-oblong, curved at one end or horseshoe-shaped, sometimes merely rounded; indusia round to lunate, thin and fragile, soon disappearing or sometimes lacking, attached by the inner curved edge, free outer edge erose or nearly entire. The indusia may be much reduced and very difficult to observe.

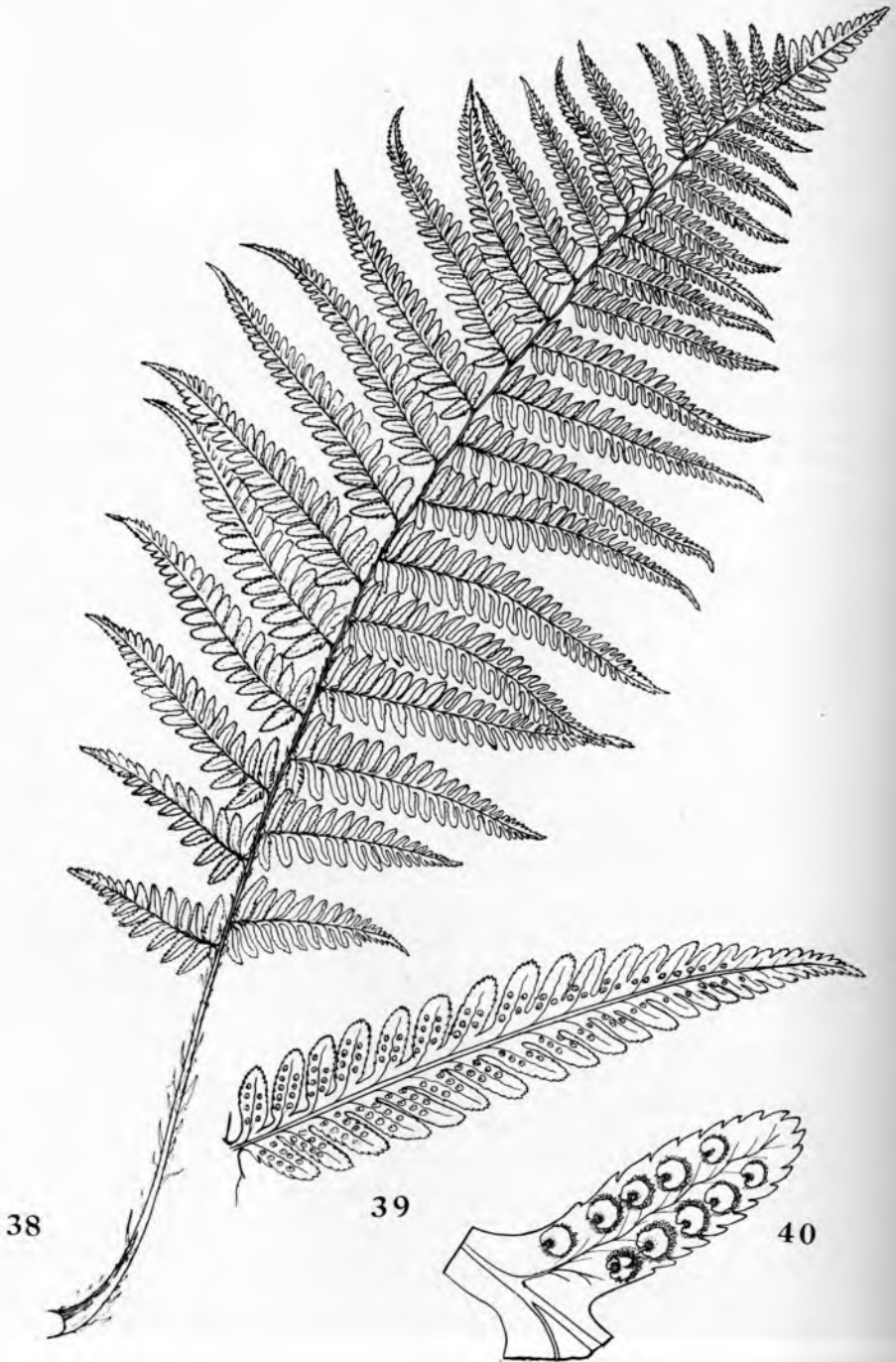
The name *Athyrium* (Greek) means shieldless which does not seem to be very well fitted to the genus.

Leaves ample, pinnae spreading, often at right angles; pinnules close, narrowly to broadly decurrent, sori oblong to elongate, curved or hooked, indusium present.

Leaves gracefully spreading, broadly ovate-lanceolate to oblong-lanceolate, pinnules oblong to oblong-lanceolate, strongly contracted at the base or distinct 1. *A. filix-foemina*

Leaves strict, mostly erect or slightly spreading above, mostly oblong-lanceolate; pinnules mostly oblong, less tapering, broadly inserted at the base, decurrent. la. var. *californicum*

Leaves skeleton-like with prominent midribs, pinnae strongly oblique; pinnules distant, segments narrow with wide sinuses, narrowly decurrent; sori round, indusium lacking 2. *A. americanum*



Figs. 38-40. *Dryopteris filix-mas*. 38. Single leaf X $\frac{1}{2}$; 39. pinna X 2; 40. pinnule with sori and indusia X 5.

1. **Athyrium filix-foemina** (L.) Roth, in Mertens, Arch. Bot.

2': 106. 1799.

LADY FERN

Polypodium filix-foemina L. Sp. Pl. 1090. 1753.

Athyrium cyclosorum Rupr. Beitr. Pfl. Russ. Reich. 3 : 41. 1845.

Rhizomes stout; leaves gracefully spreading, up to 100 cm. long, stipes yellowish, brown and scaly at the base; blades broadly ovate-lanceolate to oblong-lanceolate in outline, bi-tripinnate; pinnae oblong-lanceolate; pinnules oblong to oblong-lanceolate, often slightly curved forward, inserted at almost right angles or slightly oblique; margins obliquely serrate to deeply incised with the ultimate segments serrate, insertion strongly contracted, distinct or narrowly decurrent; sori slightly curved, hooked or horseshoe-shaped; indusium with free margin long ciliate or erose, often much reduced and inconspicuous.

In moist woods, wet places in soil and among rocks. Throughout Utah in mountains. Quebec to British Columbia to Wyoming, Colorado and Oregon. Eurasia.

ILLUSTRATION: Fig. 41.

COLLECTIONS: Flowers 3066-68. North Fork, City Creek Canyon, Salt Lake County, 3069. Above Alta, Salt Lake County; Cottam 8266. Deep Creek Mountains, Juab County, 105. North Fork, Ogden Canyon, Weber County; I. H. 17354. Twin Lakes, above Brighton, Salt Lake County.

la. Var. californicum Butters, Rhod. 19 : 201. 1917.

Differs from the species in the more erect habit; usually only the upper half of the blade spreading outward; leaves narrower, mostly oblong-lanceolate; pinnae shorter, often less tapered; pinnules mostly oblong, less tapering, acute to rounded at the apex, not contracted at the base, broadly inserted and more or less confluent by their narrowly decurrent bases.

This variety is more common in the state than the species. It is variable. The illustration shows a narrow-leaved form with rather strict pinnae and pinnules that taper more than some forms which are less strict and have less tapered and even blunt pinnules as the inserted variations show.

Around springs, rivulets and wet rocks in cool mountain ravines throughout the state. California, southern Idaho, western Wyoming; southward to New Mexico and Chihuahua.

ILLUSTRATION: Fig. 42.

COLLECTIONS: Flowers 3070-71. Big Cottonwood Canyon, Salt Lake County; Garrett, Big Cottonwood Canyon; Cottam 8884. Pine Valley Mountains, Washington County; B. Y. 3582. Beaver Creek, Summit County, 3525. Little Cottonwood Canyon, Salt Lake County; I. H. Santa Clara Creek, Pine Valley Mountains, Washington County.

Some authorities do not recognize this variety, but in Utah the two seem to be quite constantly distinct and are easily distinguished.

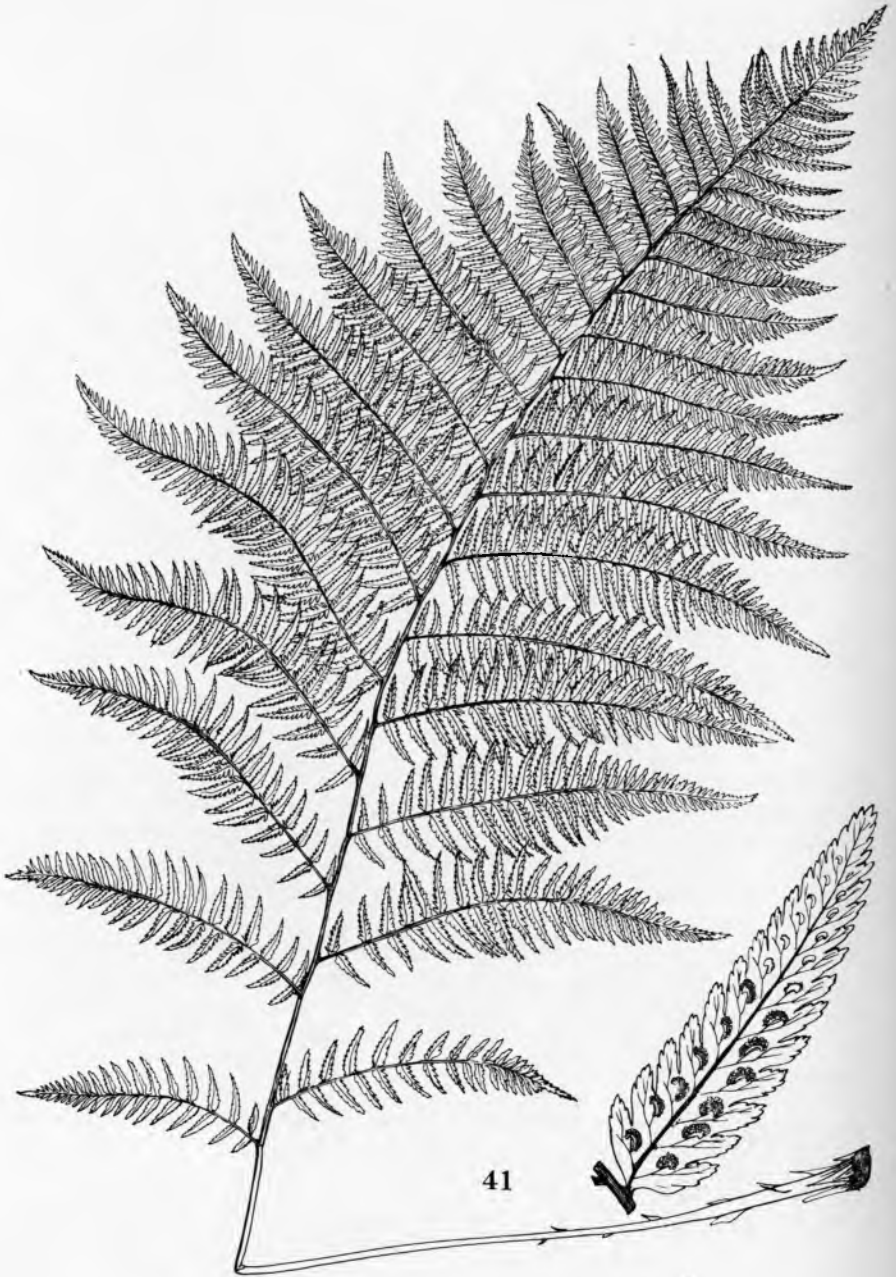


Fig. 41. *Athyrium filix-foemina*. Single leaf X $\frac{1}{2}$; and pinnule X 5.



Fig. 42. *Athyrium filix-foemina* var. *californicum*. Single leaf X $\frac{1}{2}$, and two pinnules X 5.

2. *Athyrium americanum* (Butters) Maxon, Am. Fern Jour. 8 : 120. 1918.

WESTERN LADY FERN

Athyrium alpestre var. *americanum* Butters, Rhod. 19 : 204. 1917.

Phegopteris alpestris var. *americana* (Butters) Jepson, Man. Fl. Pl. Calif. 29. 1925.

A very slender fern with prominent rachises and midribs giving it a skeleton-like appearance; leaves up to 90 cm. long, oblong-lanceolate to lanceolate in outline; stipes yellowish, scaly and furrowed; pinnae strongly oblique, distant below, crowded above, triangular to lanceolate; pinnules deeply incised or pinnatifid, the sinuses wide and giving the leaf a spindling appearance; sori round, small; indusia lacking.

In west places, around springs, talus slopes and wet meadows. In Cache and Weber Counties in Utah, probably elsewhere. Alaska to Colorado and California.

ILLUSTRATION: Figs. 43-45.

COLLECTIONS: Flowers 3072. Tony Grove Canyon, Logan Canyon, Cache County, 3073. Upper Ogden Canyon, Weber County.

7. *ASPLENIUM* L. Sp. Pl. 1078. 1753.

Small evergreen ferns growing in moist crevices of cliffs and ledges or in soil, usually in cool shaded canyons. Rhizomes short and creeping, usually covered with scales and old stipe bases; leaves simple or pinnately compound, up to 35 cm. long including stipe; sori oblique, on the veins, oblong to linear, straight or slightly curved; Indusia attached by one edge on the outer side of the fertile vein, opening toward the midvein; sometimes the sori are double with the two indusia attached back to back on the veins.

The name *Asplenium* (Greek) applies to the supposed medicinal properties of the plants as curatives of spleen diseases.

A large genus containing about thirty species in North America.

Leaves irregularly forking, segments slender, plants grass-like 1. *A. septentrionale*
Leaves pinnately compound.

Singly pinnate compound.

Stipes brown below, green or yellowish above 2. *A. viride*

Stipes dark reddish-brown and shiny throughout 3. *A. trichomanes*

Bi-tripinnately compound or pinnatifid 4. *A. adiantum-nigrum*

1. *Asplenium septentrionale* (L.) Hoffm. Deutsch. Fl. 2 : 12. 1795.

FORKED SPLEENWORT

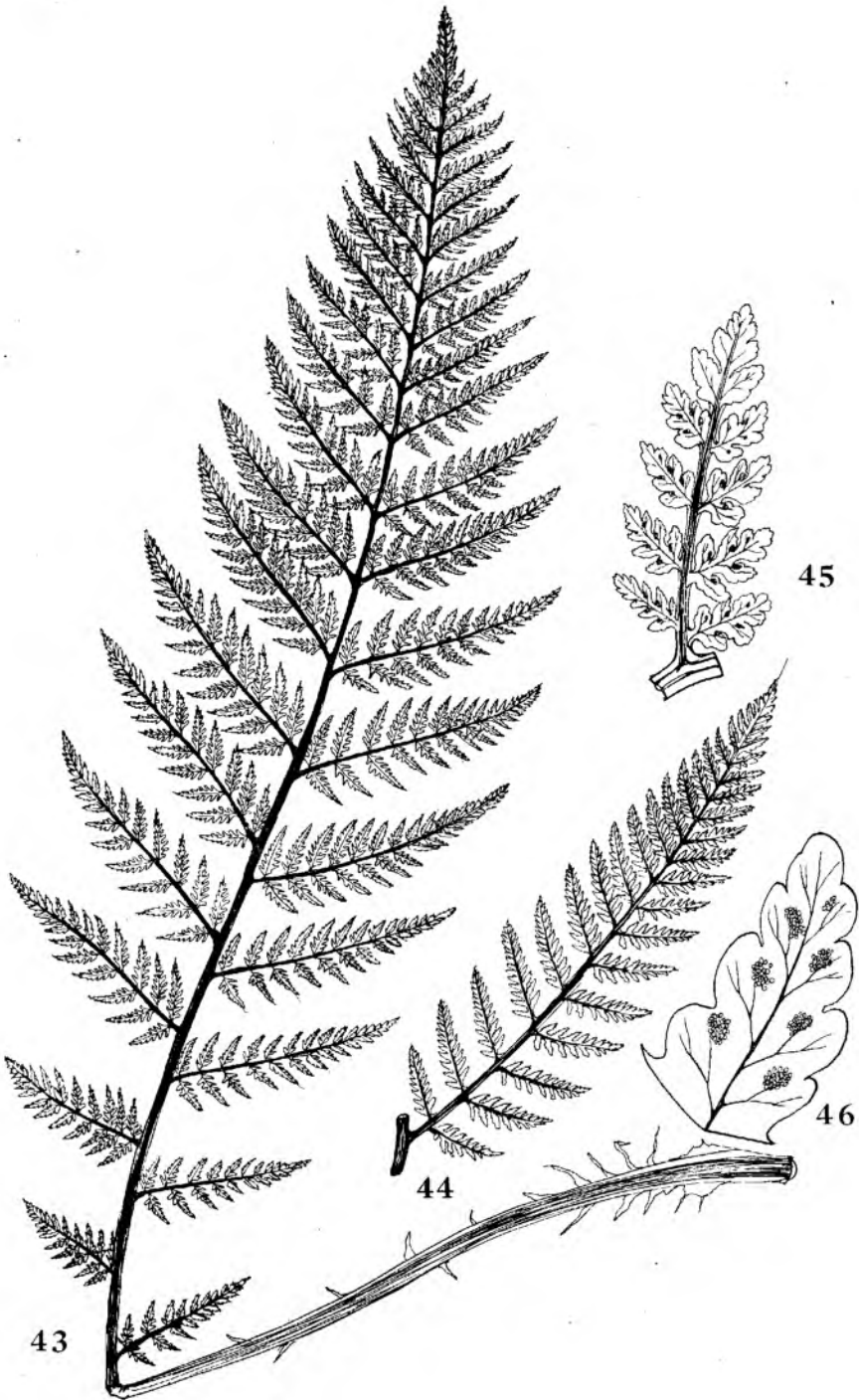
Acrostichum septentrionale L. Sp. Pl. 1068. 1753.

Plants grass-like and tufted, from short rhizomes; leaves 5-20 cm. long, stipes brown below, pale above; blades forked-pinnatifid, segments 2-5, linear to oblong-lanceolate, oblique and tapering at both ends, entire or with a few slender oblique teeth; sori few to each segment, in pairs, the indusia back to back on the fertile veins, free margins entire or ciliate.

In crevices of rather dry rocks or in moist places. First collected in Utah by Dr. Maguire in the La Sal Mountains in Grand County, our only record thus far. Black Hills of South Dakota, Wyoming to western Oklahoma, Arizona and Lower California. British Isles, Europe, northern Asia and Himalaya Mountains.

ILLUSTRATION: Fig. 47-49.

COLLECTION: I. H. 4341. La Sal Mountains, Grand County.



Figs. 43-46. *Athyrium americanum*. 43. A single leaf X $\frac{1}{2}$; 44. pinna X 1; 45. pinnule X 5; 46. ultimate segment showing naked sori X 15.

2. *Asplenium viride* Huds. Fl. Angl. 385. 1762.

GREEN SPLEENWORT

Asplenium viride var. *robustum* Goode, Can. Nat. II. 9 : 300. 1881.

Plants densely tufted, 15-20 cm. high, rhizome short and creeping with numerous fibrous roots; leaves pinnate, linear-lanceolate in outline, stipes brown below, greenish or yellowish above, sparingly hairy below; pinnae mostly rhombic-ovate, a few ovate or rounded, margins crenate-dentate or lobed, base oblique, lower pinnae very shortly stalked or with a very narrow insertion, upper ones somewhat decurrent; sori near the margins, oblique, 3-8; indusia oblong, pale, entire or undulate.

In cool shaded crevices in mountains, favored by calcareous rocks. Rare in Utah. It has been collected at Mt. Timpanogos and in the Bear River Mountains. Newfoundland to Vermont, west to Alaska, south to Washington and Colorado. Europe and Asia.

ILLUSTRATION: Figs. 50-52.

COLLECTIONS: Flowers 3075. Mt. Timpanogos, Utah County; I. H. 29903-4. Mt. Naomi and White Pine Lake, Cache County.

3. *Asplenium trichomanes* L. Sp. Pl. 1080. 1753.

MAIDENHAIR SPLEENWORT

Tufted ferns from short creeping rhizomes; roots fibrous, dark; leaves 10-24 cm. long including stipes, pinnately compound, linear-lanceolate in outline; stipes and rachises dark reddish-brown and shiny, slightly winged, mostly smooth; pinnae rhombic-ovate to ovate-oblong, oblique at the base, somewhat decurrent above, terminal pinnae small, margins crenate; sori oblique, oblong; indusia pale, free margin undulate.

In crevices in cliffs, ledges and in caves. Occasional in Utah but probably in the mountains throughout the state. Nova Scotia to Alaska southward to Georgia and Arizona; Europe and Asia.

ILLUSTRATION: Figs. 53-55.

COLLECTIONS: Flowers 3074. Above Pittsburg Lake, American Fork Canyon, Utah County; Cottam 6260. Above Lake Blanche, Big Cottonwood Canyon, Salt Lake County.

4. *Asplenium adiantum-nigrum* L. Sp. Pl. 1081. 1753.

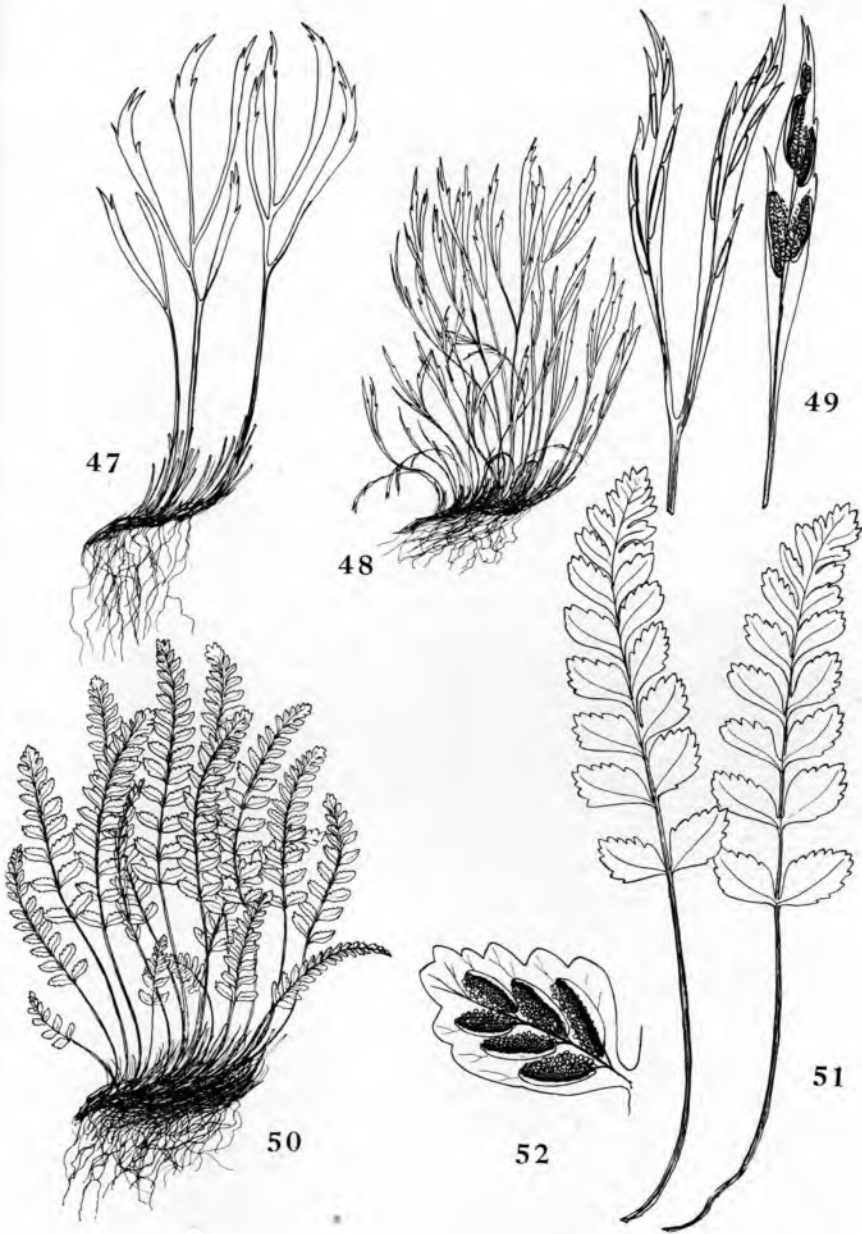
Asplenium andrewsii Nelson, Proc. Biol. Soc. Wash 17 : 174. 1904.

Tufted ferns from short creeping rhizomes covered with dark scales and numerous fibrous roots; leaves 10-30 cm. long including stipes; ovate-lanceolate to triangular-ovate in outline, bipinnate below becoming pinnatifid above; pinnae deltoid-ovate to oblong-lanceolate, obliquely inserted, the lower ones narrowed at the base; lower pinnales pinnatifid, segments various, ovate to oblong or cuneate, margins sharply serrate; sori oblique, at very acute angles, oblong; indusia pale, free margin entire.

In shaded crevices in cliffs and ledges. Rare. It has been collected in northeastern Colorado, northeastern Arizona, and Dr. A. M. Woodbury collected it in Zion National Park in southern Utah. Eurasia and Africa.

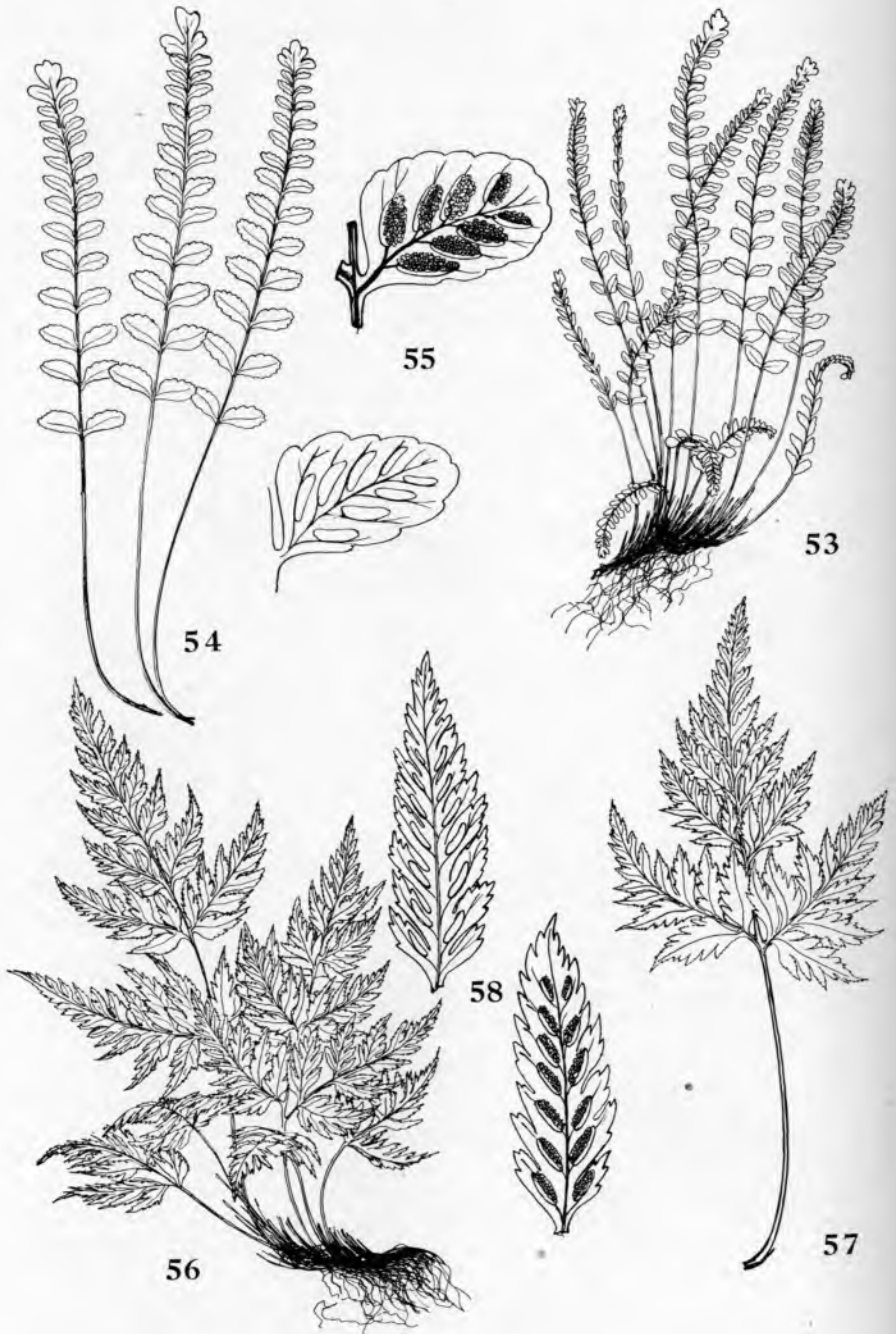
ILLUSTRATION: Figs. 56-58.

COLLECTION: Garrett 1506, and Woodbury, Zion National Park, Washington County.



Figs. 47-49. *Asplenium septentrionale*. 47-48. Habit sketches X $\frac{1}{2}$;
49. pinnules showing indusia and sori X 10.

Figs. 50-52. *Asplenium viride*. 50. Habit X $\frac{1}{2}$; 51. leaves X 2; 52.
pinna showing sori and indusia X 10.



Figs. 53-55. *Asplenium trichomanes*. 53. Habit X $\frac{1}{2}$; 54. leaves X 1; 55. pinnae X 10.

Figs. 56-58. *Asplenium adiantum-nigrum*. 56. Habit X $\frac{1}{2}$; 57. leaf X $\frac{1}{2}$; 58. pinnules X 10.

8. PITYROGRAMMA Link, Handb. Gewächs. 3 : 19. 1833.

Plants medium-sized to small, tufted, from short rootstocks; roots fibrous, brown; stipes slender, blades 3-5 angled in outline, pinnate, the lower pinnae again divided with the segments lobed, white or yellow mealy beneath; sori continuous on the veins, extending from the midvein to the margin, forked, indusium wanting.

The name, *Pityrogramma*, refers to the scurfy appearance of the sori.

***Pityrogramma triangularis* (Kaulf.) Maxon, Contrib. U. S. Nat. Herb. 17 : 173. 1913.**

GOLD FERN. SILVER-BACK FERN

Gymnogramma triangularis Kaulf. Unum. Fil. 73. 1824.

Gymnogramme triangularis (Kaulf.) Hook. & Grev. Icon. Fil. 2 : pl. 153. 1831.

Gymnogramme oregana Nutt. in D. C. Eaton, Ferns of the Southwest, 305. 1878.

Neurogramme triangularis (Kaulf.) Diels in Engler & Prantl, Pflanzenfam. 1⁴: 264. 1899.

Ceropteris triangularis (Kaulf.) Underw. Bull. Torr. Club, 29 : 630. 1902.

Plants densely tufted, 10-30 cm. high; stipes chestnut brown, shiny, not scaly at the base; blades 3-5-angled in outline, about as broad as long, pinnate; lower pinnae bipinnatifid, unequally lobed, the segments on the lower side much longer than the ones on the upper side roughly forming a right-triangle in outline; upper segments oblong to oblong-lanceolate, lobed; upper surface glabrous or granular, lower surface densely white or yellow mealy.

In crevices of rocks or in talus, usually where it is humid. Known in Utah only from Santa Clara Creek, Washington County. Independently discovered the same month in 1940 by Dr. Walter P. Cottam and Robert Pendleton. Alaska to California, Idaho and Arizona. Lower California.

ILLUSTRATION: Figs. 33-35.

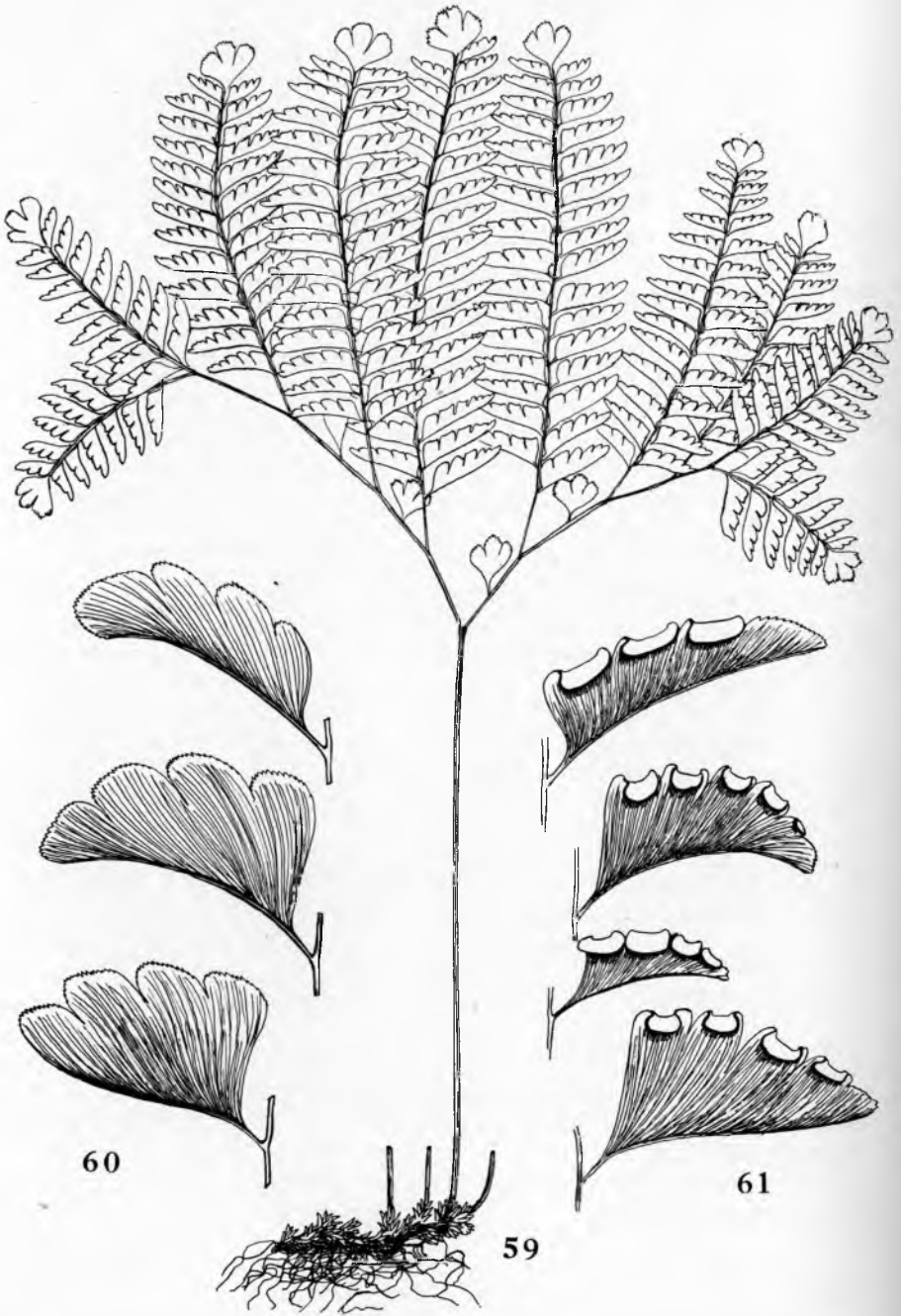
COLLECTION: Cottam 7500, Washington County.

9. ADIANTUM (Tourn.) L. Sp. Pl. 1094. 1753.

Ferns with slender creeping rhizomes; leaves widely spreading, compound; stipes slender, purplish-black or dark reddish-brown, smooth and shiny; pinnules in form of distinct leaflets with main veins on one margin, veinlets forked; sori marginal, at the tips of the lobes; indusium false, formed by the strongly reflex tips of the leaflet lobes.

The name, *Adiantum*, means "difficult to wet," referring to the manner in which the leaves shed water (Greek).

Leaves orbicular or reniform in outline, primary divisions
dichotomous 1. *A. pedatum* var.
Leaves ovate to ovate-lanceolate in outline, primary divisions
pinnate 2. *A. capillus-veneris*



Figs. 59-61. *Adiantum pedatum* var. *aleuticum*. 59. Habit X $\frac{1}{2}$;
60. sterile segments X 2; 61. fertile segments X 2.

**1. *Adiantum pedatum* var. *aleuticum* Rupr. Beitr. Pfl. Russ.
Reich. 3 : 49. 1845.**

ALPINE MAIDENHAIR

Adiantum pedatum var. *rangiferinum* Burgess, Proc. Roy. Soc. Can. 4 : 11. 1887.

Adiantum pedatum var. *praeflexum* Copeland in C. F. Baker, West Am. Pl. II. 7. 1903, nomen nudum.

Adiantum pedatum forma *aleuticum* (Rupr.) Clute, Our Ferns, 298. 1938.

Leaves up to 50 cm. long including stipes, primary divisions forked; stipes reddish-brown to purplish-black, smooth and shiny, sparingly scaly at the base; pinnules (leaflets) numerous, short stalked, oblong to ovate-deltoid, base oblique, main vein marginal, upper margin incised, the lobes in turn sharply and deeply serrate; indusia (reflexed lobes) transversely elongated, thin and pale yellowish, becoming brown with age, margin hyaline and undulate.

In rich moist soil or around wet places in mountains, dripping cliffs or along cold rivulets. Wasatch Mountains and southward to Zion National Park. Newfoundland to Vermont, west to Ontario, northern Wisconsin, Alaska, south to Utah and California.

ILLUSTRATION: Figs. 59-61.

COLLECTIONS: Flowers 3024-27. Big Cottonwood Canyon, 3028-30. Little Cottonwood Canyon, 3031. Bell's Canyon, Salt Lake County; Garrett 2649 and 2665. Big Cottonwood Canyon; B. Y. 3461. Zion National Park, Washington County.

2. *Adiantum capillus-veneris* L. Sp. Pl. 1096. 1753

VENUS'-HAIR FERN

Adiantum capillus Sw. Jour. Bot. Schrad. 1800²:83. 1801.

Adiantum modestum Underw. Bull. Torr. Bot. Club, 28 : 46. 1901.

Adiantum rimicola Slosson, Bull. Torr. Bot. Club, 41 : 308. 1914.

Rhizomes creeping, brown scaly; leaves up to 40 cm. long including stipes, pinnately compound, rachis slightly flexuous; stipes scaly at the base or white dotted, black below, chestnut brown above, shiny and smooth; pinnules (leaflets) broadly obovate-cuneate to rhomboidal, symmetric or unsymmetric, often oblique at the base, stalks short, brown, main vein marginal, margins lobed or cleft, the lobes in turn serrate-dentate; indusia false, often transversely elongated or curved, greenish, becoming brown with age, margins thin and hyaline, entire or undulate, becoming erose.

In moist soil or talus, often in crevices of cliffs and ledges where limestone is plentiful. It is also abundant in sandstone region in Utah. In mountains or in wet exposed cliffs and box-canyons. Throughout the state but especially abundant in the Colorado River basin and southern Utah. Southern British Columbia, western South Dakota, Missouri, Virginia, Florida, west to Texas, Arizona and California. Subtropics of both hemispheres.

ILLUSTRATION: Figs. 62-64.

COLLECTIONS: Flowers 3080. Box Canyons, Garfield County, 3081. Near Orderville, Kane County, 3082. San Rafael River and 3083. Muddy River, Emery County, 3085. Near Moab, Grand County, 3088. Warm Spring near Gandy, Juab County, 3090. Near



Figs. 62-64. *Adiantum capillus-veneris*. 62. Habit X $\frac{1}{2}$; 63 sterile segment X 1; 64. fertile segment X 1.

St. George, Washington County; Garrett, Dark Canyon and Cataract Canyon, San Juan County, 9422. (As *A. rimicola*, co-type) White Canyon, San Juan County; B. Y. 3456. Zion National Park, 5785. Near St. George, Washington County, 3265. Warm Springs, Millard County.

10. PTERIDIUM Scop. Fl. Carn. ed. 1, 169. 1760.

Large coarse ferns from stout creeping rhizomes; leaves pinnate to decompose, veins pinnate, margins of the segments revolute and covering the sori which are continuous along the margins; true indusium present, on side toward blade, inconspicuous.

Pteridium is an old Greek name for ferns.

Pteridium aquilinum* var. *lanuginosum (Bong.) Fernald, Rhod.

37 : 247. 1935.

COMMON BRAKE OR BRACKEN

Pteris aquilina var. *lanuginosa* Bong. Mem. Acad. St. Petersb. VI 2 : 176. 1832. not Bory 1810.

Pteris feei W. Schaffner in Fee, Mem. Foug. 8 : 73. 1857.

Pteridium aquilinum var. *pubescens* Underw. Our Nat. Ferns, ed. 6. 91. 1900.

Plants medium sized to large; leaves decompose, broadly triangular in outline, becoming 20 dm. long including stipes (mostly 6-12 dm. long in our region); stipes green or yellowish; primary divisions with stalks; ultimate segments with pinnate veins, oblong, obtuse, decurrent at the base; margins mostly entire, the lower ones often variously lobed to pinnatifid at the base; surfaces with fine white hairs; sori marginal, continuous, partially covered by the revolute margins of the segments, true indusium narrow.

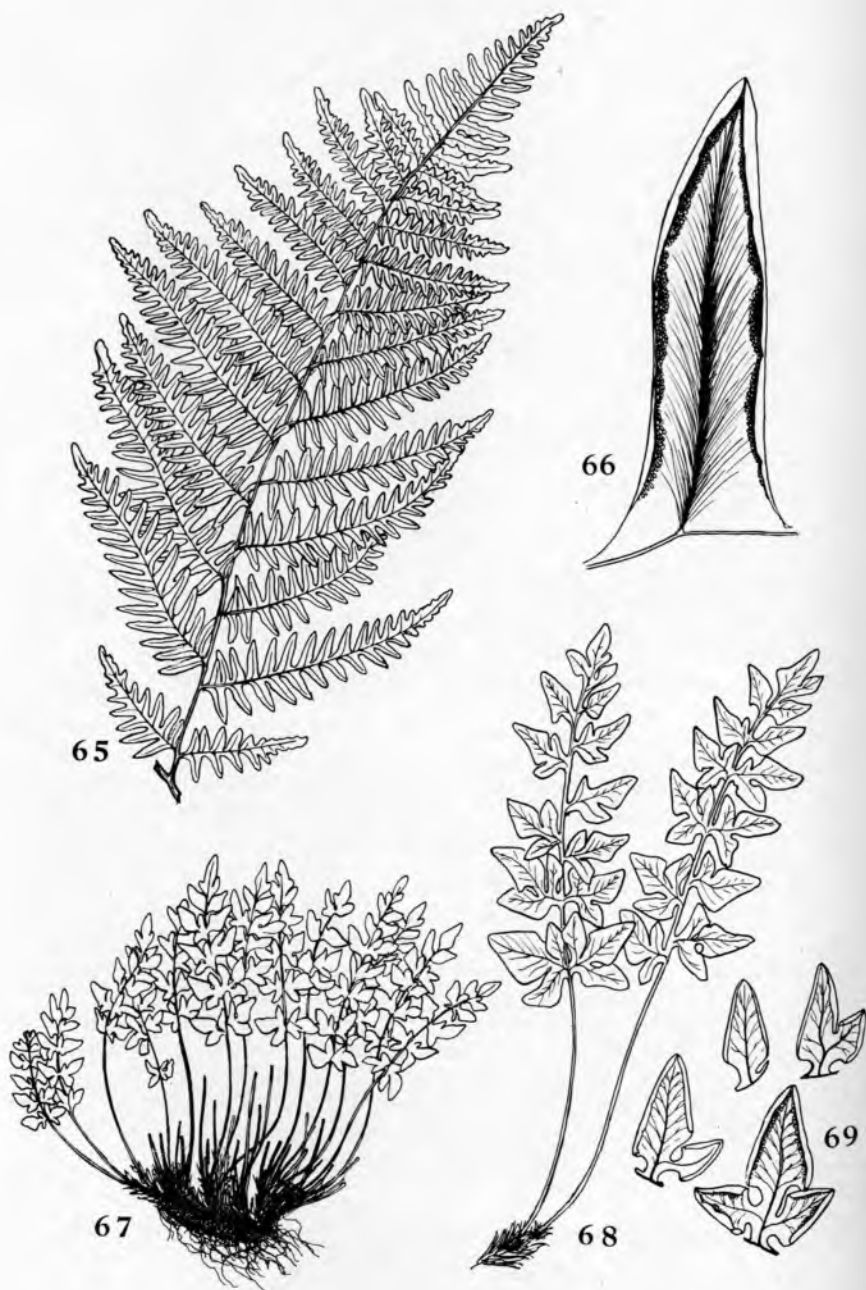
One of our commonest ferns and common throughout northern United States; Quebec to Alaska southward to California and Texas. In dry or moist soil, in open woods and grassy places.

ILLUSTRATION: Figs. 65-66.

COLLECTIONS: Flowers 3056. Kanab Canyon, Kane County, 3057. Little Cottonwood Canyon, 3058. Aspen Grove, Mt. Timpanogos, Utah County, 3059. Ogden Canyon, Weber County, 3060. American Fork Canyon, Utah County, 3061. Bear Lake, Rich County, 3062. North Fork, Ogden River, Weber County, 3063. Big Cottonwood Canyon, Salt Lake County; Cottam 8830. Oak Grove, Washington County; Garrett 9525. Elk Mountain, San Juan County; B. Y., Pine Mountains, Washington County; I. H. 40691. Tony Grove, Logan Canyon, Cache County, 40689. Five miles south of Cedar Breaks, Iron County, 49050. Bott's Canyon, near Brigham City, Boxelder County.

11. CRYPTOGRAMMA R. Br. App. Franklin's Jour. 767. 1823.

Plants densely tufted, mostly small, growing in crevices of rocks; rootstalks short and thick, usually covered with brown scales and old stipes; leaves of two kinds, the fertile ones much longer and larger than the sterile ones, bi-tripinnate; pinnules oblong to linear with more or less confluent marginal sori borne on the tips of the veins and somewhat decurrent on them, covered by the strongly revolute margins of the segments. Sterile leaves shorter but with broader blades, flat, bi-tripinnate.



Figs. 65-66. *Pteridium aquilinum* var. *lanuginosum*. 65. Portion of a leaf X $\frac{1}{2}$; 66. ultimate segment with marginal sori X 10.

Figs. 67-69. *Pellaea breweri*. 67. Habit X $\frac{1}{2}$; 68. leaves X 1; 69. pinnae X 2.

The name, *Cryptogramma*, alludes to the hidden sporangia under the reflexed margins of the segments (Greek).

Cheilanthes siliquosa Maxon, formerly known as *Cryptogramma densa* Diels., may be sought under this genus. See notes under *Cheilanthes*.

Stipes yellowish, leaves firm and thick, densely tufted 1. *C. acrostichoides*
Stipes chestnut brown, at least below, leaves thin and delicate, usually
tufted 2. *C. stelleri*

**1. *Cryptogramma acrostichoides* R. Br. in Franklin Jour. App.
ed. 1. 754. 1823.**

PARSLEY FERN OR AMERICAN ROCK BRAKE

Allosorus foveolatus Rupr. Distr. Crypt. Vasc. Ross. in Beitr. Pfl. Russ. Reich.
3 : 46. 1845.

Allosorus sitchensis Rupr. l. c. 47. 1845.

Cryptogramma crispa forma *americana* Hook. Sp. Fil. 2 : 130. 1858.

Allosorus crispus var. *acrostichoides* (B. Br.) Milde, Fil. Eir. et Atl. 24. 1867.

Cryptogramma crispa var. *acrostichoides* (R. Br.) C. B. Clarke, Trans. Linn. Soc.
II, 1 : 460. 1880.

Plants in dense tufts up to 35 cm. high; sterile leaves firm, dark green, stipes yellow or straw-colored to the base, blades ovate to ovate-oblong in outline, tripinnate, the ultimate segments coarsely crenate, obtuse. Fertile leaves much larger and longer, tripinnate, the segments much longer, linear, strongly and broadly recurved on the margins or subtubulose, extreme margins hyaline, erose, apex blunt.

Throughout the mountains of Utah in crevices of cliffs and ledges or in talus. Ontario and Michigan to Alaska, southward to southern California, New Mexico and Nebraska. Kamchatka.

ILLUSTRATION: Figs. 70-72.

COLLECTIONS: Flowers 3093. Above Granddaddy Lakes, Duchesne County, 3094. Bald Mountain, Summit County, 3096. Mt. Timpanogos, Utah County, Wolf Creek Summit, Wasatch County; Cottam 7047. Brighton, Salt Lake County, 6259. Lake Blanche, Salt Lake County, Garrett 8883. La Sal Mountains, San Juan County, 3391a. Mt. Timpanogos, Utah County; B. Y. 4451. Aquarius Plateau, Wayne County; I. H. 1802-04. La Sal Mountains, Grand County, 2738. Hayden Peak, Summit County.

**2. *Cryptogramma stelleri* (S. G. Gmel.) Prantl, Engler's Bot.
Jahrb. 3 : 413. 1882.**

STELLER'S OR SLENDER CLIFF BRAKE

Pteris stelleri S. G. Gmel. Nov. Comm. Acad. Sci. Petrop. 12 : 519. 1768.

Pteris gracilis Michx. Fl. Bor. Am. 2 : 262. 1803.

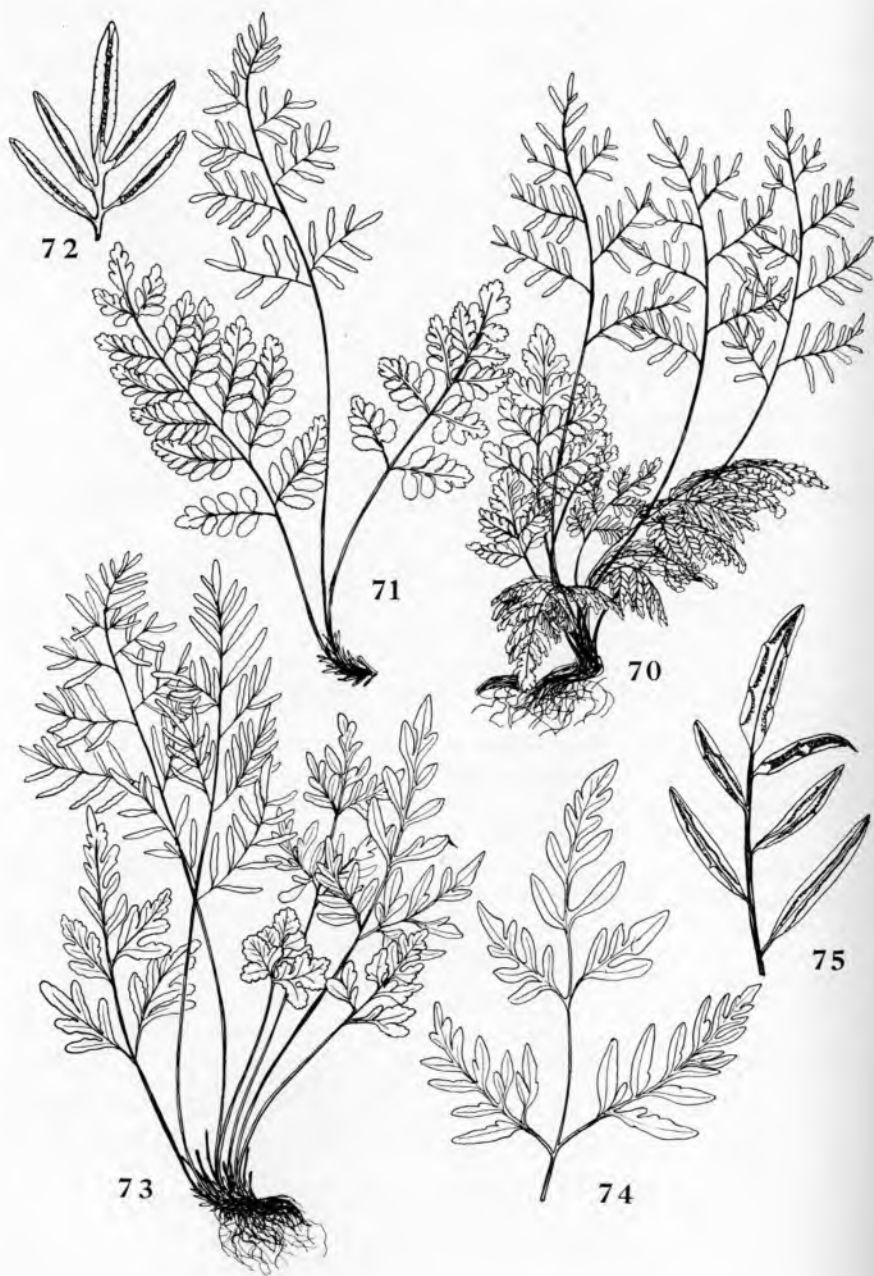
Cryptogramma gracilis (Michx.) Torr. Rep. Bot. Sur. N. Y. Assembly, No. 50. 196.
1839.

Allosorus stelleri (S. G. Gmel.) Rupr. Distr. Crypt. Vasc. Ross. 47. 1845.

Pellaea gracilis (Michx.) Hook Sp. Fil. 2 : 138. 1858.

Pellaea stelleri (G. S. Gmel.) Watt, Can. Nat. II. 3 : 158. 1866.

Plants open and spreading in habit, scarcely tufted, pale or bright green; sterile leaves thin and delicate, up to 10 cm. long including



Figs. 70-72. *Cryptogramma acrostichoides*. 70. Habit X $\frac{1}{2}$; 71. sterile and fertile leaves X $\frac{1}{2}$; 72. fertile segments X 5.

Figs. 73-75. *Cryptogramma stelleri*. 73. Habit X $\frac{1}{2}$; 74. sterile leaf X 1; 75. fertile segments X 5.

stipes; stipes brown, at least below; blades ovate to triangular-ovate in outline, tripinnate; pinnae divided into obovate or cuneate segments with crenate or undulate margins, often unsymmetric, sometimes lobed or cleft. Fertile leaves much longer, up to 25 cm. long, tripinnate, segments oblong to linear, margins strongly revolute, entire or slightly erose, scarcely hyaline; apex blunt.

In limestone crevices or in calcium bearing rocks, usually in moist shady places. Known in Utah only from Mt. Timpanogos thus far. Labrador to Alaska southward to Washington, Colorado, Iowa and New Jersey.

ILLUSTRATION: Figs. 73-75.

COLLECTIONS: Flowers 3092; Cottam 3813; Garrett 5662; B. Y. 15161, all from Mt. Timpanogos, Utah County.

12. PELLAEA Link, Fil. Sp. Hort. Berol. 59. 1841.

Small tufted ferns growing in the crevices of rocks, up to 50 cm. high; rhizomes short and thick, creeping, densely brown scaly and covered with old stipes; leaves singly pinnate or bipinnate; stipes dark reddish-brown, smooth or wrinkled, dull or shiny; segments oblong, oblong-linear or deltoid-ovate, smooth, green on both sides, margins revolute; sori submarginal, more or less continuous or confluent at the tips of the free veins; true indusium lacking, sori covered by the revolute margin of the segments.

Pellaea (Greek) means dusky, referring to the color of the stipes.

Leaves bi-pinnate segments narrowly oblong, spine-tipped 2. *P. longimucronata*
Leaves pinnate, segments broader, not spine-tipped.

Segments oblong, rhomboidal or deltoid-ovate, unsymmetric,
mitten-shaped, cleft or divided 1. *P. breweri*

Segments oblong, thin, entire, or the lower ones cleft or
parted 3. *P. suksdorfiana*

1. *Pellaea breweri* D. C. Eaton, Proc. Am. Acad. 6 : 555, 1865.

BREWER'S CLIFF BRAKE

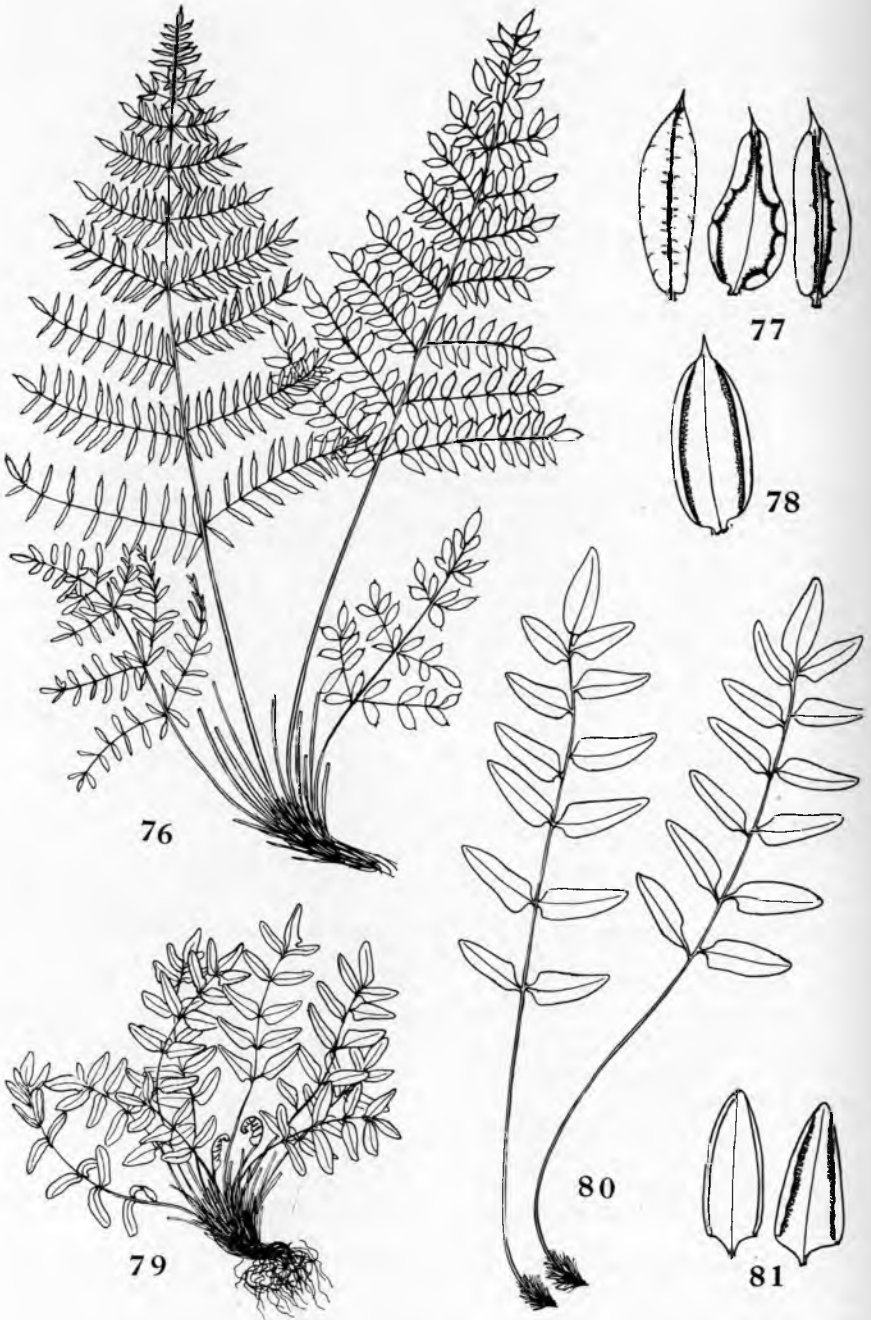
Allosorus breweri (D. C. Eat.) Kuntze, Rev. Gen. Pl. 2 : 806. 1891.

Plants densely tufted with ample foliage; rhizomes usually short and thick, covered with brown scales and old stipes; leaves pinnate, oblong to oblong-lanceolate in outline, 10-20 cm. long including stipes; stipes brittle, reddish-brown, scaly at the base, wrinkled and shiny above; rachis green or yellowish-green above; pinnae deltoid or rhomboidal above, becoming lobed or cleft below on one or both sides near the base, somewhat mitten-shaped; margins revolute except in the sinuses.

In crevices of cliffs and ledges, usually in shaded places. Throughout Utah in the mountains. Western Wyoming, Utah to Washington and California.

ILLUSTRATION: Figs. 67-69.

COLLECTIONS: Flowers 3206. Above Alta, Salt Lake County, 3208. Mt. Timpanogos, Utah County, 3209. Logan Canyon, Cache County; Garrett 1610. Big Cottonwood Canyon, 6959. City Creek



Figs. 76-78. *Pellaea longimucronata*. 76. Habit showing dry leaf left X $\frac{1}{2}$; 77. pinnules dry X 2; 78. pinnule fresh X 2.

Figs. 79-81. *Pellaea suksdorfiana*. 79. Habit X $\frac{1}{2}$; 80. leaves X 1; 81. pinnae X 2.

Canyon, Salt Lake County; B. Y. 7979. Beaver Creek, Weber County, 4537. Pilot Mountain, Boxelder County, 3810. Mt. Timpanogos, Utah County, 3610. Beaver Creek, Summit County; I. H. 31666. 31668. Above Toney Grove Lake, Cache County, 18196. La Sal Mountains, Grand County.

2. *Pellaea longimucronata* Hook. Sp. Fil. 2 : 143. 1858.

SPINY CLIFF BRAKE

Pellaea wrightiana var. *longimucronata* Davenp. Cat. Davenp. Herb. Suppl. 46. 1883.

Pellaea truncata Gooding, Muhlenbergia, 8 : 94. 1912.

Plants loosely or densely tufted, often open in habit; leaves bipinnate, up to 50 cm. long including stipes; triangular-ovate in outline; stipes dark brown, dull or shiny, scaly at the base; pinnae oblong in outline; pinnules distant, oblong to linear-oblong, sessile or nearly so, spine-tipped, margins strongly revolute, often becoming subtubulose when dry.

Growing in crevices of dry rocks or on soil under rocks in the southern half of the state. Common in Washington County. When dry the margins of the segments roll backward so strongly that the leaf as a whole assumes a much more open appearance than when fresh. Colorado to Nevada, New Mexico and Arizona.

ILLUSTRATION: Figs. 76-78.

COLLECTIONS: Flowers 3217-23; Cottam 8774, 8783, 8843a, 8775; I. H. 17236-36. All from various points in Washington County.

3. *Pellaea suksdorfiana* Butters, Amer. Fern Jour. 11 : 40. 1921.

SUKSDORF'S CLIFF BRAKE

Pellaea glabella var. *simplex* Butters, Amer. Fern Jour. 7 : 84. 1917.

Plants tufted, more or less open in habit, somewhat lax; leaves pinnate, oblong in outline, 10-20 cm. long including stipes; stipes dark chestnut-brown, smooth, dull or shiny, scaly at the base; pinnae thin, oblong, a few of the lower ones cleft or parted at the base, mostly short-stalked, a few of the upper ones often sessile.

In crevices of rocks and ledges in mountains. Rare but probably widely distributed throughout Utah. Western New Mexico, Arizona to central British Columbia.

ILLUSTRATION: Figs. 79-81.

COLLECTIONS: Woodbury 1037; B. Y. 3458. Zion National Park, Washington County, 3221. Kanab Canyon, Kane County.

13. CHEILANTHES Sw. Syn. Fil. 126. 1806.

Small ferns growing in the crevices of dry rocks or on soil under rocks; more or less tufted, from short thick rhizomes covered with brown chaffy scales and old stipes; roots fibrous, dark brown, often tomentose; leaves bi-quadripinnate, oblong-lanceolate to linear-lanceolate in outline, 5-35 cm. long including stipes; stipes brown, glabrous, tomentose or scaly; pinnae oblong, oblong-lanceolate or triangular-ovate in outline; ultimate segments various, obovate to linear, margins revolute; sori at the ends of the free veins, rounded,

separate or more or less confluent, submarginal and partially covered by the recurved margins of the segments; vein tips thickened.

In *Cheilanthes siliquosa* the leaves are often dimorphic, the fertile ones having narrower segments than the sterile ones. It was formerly placed in the genus *Cryptogramma* as *C. densa* (Brack.) Diels. where it may be sought. In some plants, however, the leaves are not strongly differentiated, all of them being more or less fertile.

In dry plants the exact shape of the leaves and the position of the sori are often disguised by shrinkage or curling, or by the dense hairy covering. If a leaf or pinna is boiled in water a few minutes, the blade will relax and the characteristics may be observed to better advantage.

The name, *Cheilanthes* (Greek), refers to the marginal sori.

- Leaves glabrous 1. *C. siliquosa*
 Leaves hairy or with scales, or both.
 Leaves with dense white or brown scales only 2. *C. covillei*
 Leaves distinctly hairy, scales often present.
 Leaves densely tomentose, scales lacking; ovate to oblong-lanceolate, ultimate segments oblong-oval to obovate 3. *C. feei*
 Leaves with both hairs and scales, lanceolate to oblong-lanceolate.
 Ultimate segments oblong, distant 4. *C. gracillima*
 Ultimate segments rounded or obovate, close together 5. *C. eatoni*

1. *Cheilanthes siliquosa* Maxon, Am. Fern Journ. 8 : 116. 1918.

INDIAN'S DREAM

Onychium densum Brack. in Wilkes, U. S. Expl. Exp. 16 : 120. 1854.

Pellaea densa (Brack.) Hook. Sp. Fil. 2 : 150. 1858.

Allosorus densus (Brack.) Kuntze, Rev. Gen. Pl. 2 : 806. 1891.

Cryptogramma densa (Brack.) Diels. in Engler & Prantl, Nat. Pfl. 14 : 280. 1899.

Cheilanthes densa (Brack.) H. St. John, Am. Fern Jour. 19 : 14. 1929. not Fee.

Plants densely tufted, 4-25 cm. high, with numerous chestnut-brown stipes; sterile leaves smaller and shorter than the fertile ones, 4-10 cm. long including stipes, blades ovate to triangular in outline, tripinnate, the segments broadly lanceolate or narrower, coarsely serrate to incised. Fertile leaves longer, up to 25 cm. long, broadly ovate to ovate-oblong in outline, the segments linear to linear-lanceolate, margins strongly revolute, with a broad and very distinct membranaceous false-indusium which is erose or sharply dentate. In some fertile leaves the margins are somewhat lobed, each lobe having a single submarginal sorus with a single false indusium. This is especially true of smaller leaves and partially sterile leaves.

This plant has been referred to as *Pellaea* and *Cryptogramma* as well as *Cheilanthes*. For a discussion of its generic relationships see Maxon, l. c. and for nomenclature H. St. John, l. c.

In crevices of cliffs and ledges, and in talus. Wasatch and Uintah Mountains, and probably throughout the state in the mountains. Quebec to British Columbia, California and New Mexico.

ILLUSTRATION: Figs. 82-83.

COLLECTIONS: Flowers 3095. Mt. Timpanogos, Utah County; Garrett 2663. Lake Blanche, Big Cottonwood Canyon, Salt Lake County.



Figs. 82-83. *Cheilanthes siliquosa*. 82. Habit sketches X $\frac{1}{2}$; 83. fertile segments X 5.

Figs. 84-88. *Cheilanthes covillei*. 84. Habit X $\frac{1}{2}$; 85. pinna X 5; 86. fertile pinnule showing marginal sori X 6; 87. side view of dry segment showing scales X 10; 88. Cluster of scales X 20.

2. *Cheilanthes covillei* Maxon, Proc. Biol. Soc. Wash. 31 : 147. 1918.

BEAD FERN OR COVILLE'S LIP FERN

Plants loosely or densely tufted, 20-30 cm. high; stems short, brown scaly with age, when young paler and white-scaly, rachises ovate-lanceolate to lanceolate in outline; scapes dark brown, shiny, brown scalybrown scaly, when young paler and white-scaly, rachises the same; pinnae oblong-ovate to ovate-lanceolate, ultimate segments very small, rounded to obovate, usually unsymmetric, when dry bead-like or resembling tiny clusters of grapes, green above, densely brown scaly below (whitish when young), margins widely recurved, crenate, the lower ones often lobed on one side.

In dry crevices or on soil under rocks, Abundant in southern Utah in Washington and Kane Counties. Western Arizona, southern Nevada, California and Lower California.

ILLUSTRATION: Figs. 84-88.

COLLECTIONS: Flowers 3108, 3110. Near Kanab, Kane County, 3107, 3109, 3111, 3112; Cottam 3893, 8773, 4103; I. H. 17233, all from various points in Washington County.

3. *Cheilanthes feei* Moore, Ind. Fil. 38. 1857.

SLENDER LIP FERN

Myriopteris gracilis Fee, Gen. Fil. 150. 1850-52.

Cheilanthes lanuginosa Nutt. in Hook. Sp. Fil. 2 : 99. 1858. as synonym.

Cheilanthes gracilis (Fee) Mett. Abh. Senck. Nat. Gesell, 3 : 80. 1859-61, not Kaulf. 1824.

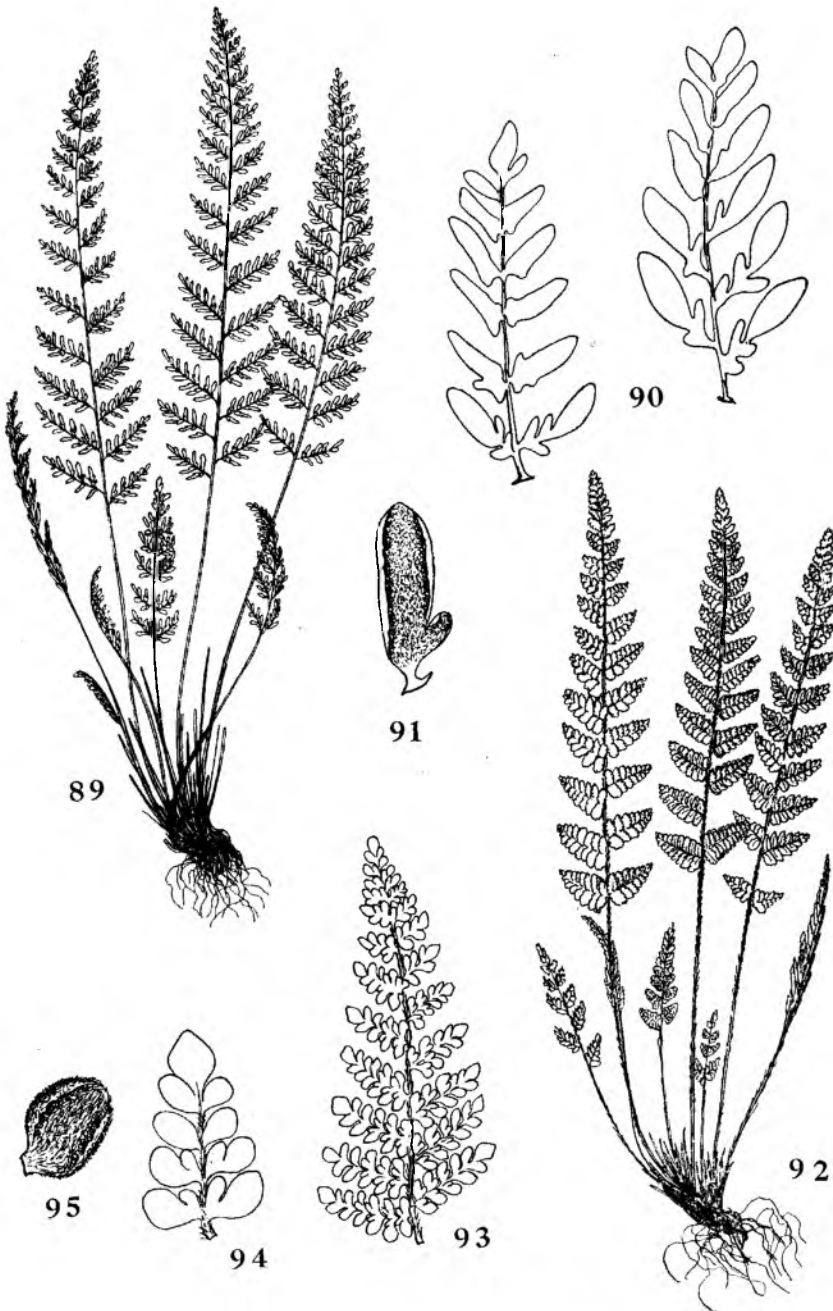
Myriopteris lanuginosa (Nutt.) J. Sm. Hist. Fil. 280. 1875.

Plants tufted, 6-30 cm. high (mostly 6-15 cm. high in our region); rhizomes short, covered with brown scales; leaves ovate-lanceolate to triangular in outline, tripinnate, rarely bipinnate; stipes brown, with whitish hairs; pinnae deltoid-ovate; ultimate segments small, oblong-ovate to obovate, the lower ones lobed or cleft at the base, often unsymmetric, margins entire or crenulate, terminal segment the largest, green above, densely white or brown tomentose below, margins broadly recurved, somewhat interrupted or nearly continuous, without a membranaceous false indusium or with merely a hyaline edge; sori submarginal on the ends of the thickened veins, more or less continuous.

In crevices of dry cliffs and ledges, and in talus. Throughout Utah but most abundant in the Colorado River drainage basin. It is said to be favored by limestone, but in our region it is most abundant in sandstone rocks, probably of calcareous phases.

ILLUSTRATION: Figs. 96-100.

COLLECTIONS: 6496, 6715; G-4919; H-5609, 6915, 9803. Flowers 3098, Buckhorn Gulch, 3100. San Rafael River, 3101. Near Emery, 3106. Straight Canyon, Emery County, 3099. Recapture Canyon, 3010a. Near Verdure, San Juan County, 3103. City Creek Canyon, Salt Lake County, 3104. Above Tony Lake, Logan Canyon, Cache County; Cottam 6715. Cedar Canyon, Iron County, 4479. Fruita, Wayne County, 6495. Five miles north Escalante, Garfield County;



Figs. 89-91. *Cheilanthes gracillima*. 89. Habit X $\frac{1}{2}$; 90. pinnae X 5; 91. underside of segment X 10.

Figs. 92-95. *Cheilanthes eatoni*. 92. Habit X $\frac{1}{2}$; 93. pinna X 5; 94. small pinna X 10; 95. underside of segment X 10.

Garrett 9419. White Canyon, San Juan County; B. Y. 2327. Church Rock, 5915. Augusta Natural Bridge, San Juan County, 2080. Green River, Emery County, 3457. Zion National Park, Washington County; I. H. 42. Dry Canyon, 43. Logan Canyon, 20178. Providence Canyon, Cache County, 18205. La Sal Mountains, 28084. One mile east of Moab, Grand County.

4. **Cheilanthes gracillima** D. C. Eaton in Torr. Rep. U. S. and Mex. Bound. Surv. 2 : 234. 1859.

LACE FERN

Myriopteris gracillima (D. C. Eat.) J. Sm. Hist. Fil. 280. 1875.

Plants in loose tufts, 20–35 cm. high; rhizomes short, covered with dark brown scales; roots brown tomentose; leaves mostly tri-pinnate, linear-lanceolate to lanceolate in outline; scapes dark brown with whitish or brown slender scales and hairs; pinnae oblong-ovate; ultimate segments oblong to obovate, distant, some of them unsymmetrical at the base, the lower ones often pinnatifid, upper surface green, lower surface densely brown tomentose and scaly, margins widely recurved with a narrow membranaceous false indusium.

In crevices of dry cliffs and ledges of igneous and metamorphic rocks. Known in Utah from a single collection in the Bear River Mountains, Cache County. California to British Columbia, Idaho, northern Utah and eastern Nevada.

ILLUSTRATION: Figs 89-91.

COLLECTION: Flowers 3243. Cliffs above Tony Lake, Logan Canyon, Cache County.

5. **Cheilanthes eatoni** Baker, in Hooker & Baker, Syn. Fil. 140. 1867.

EATON'S LIP FERN

Cheilanthes tomentosa var. *eatoni* (Baker) Davenp. Cat. Davenp. Herb. Suppl. 49. 1883.

Plants loosely or densely tufted, 8–36 cm. high; rhizomes short, covered with pale brown scales with darker centers; leaves lanceolate to oblong-lanceolate in outline; stipes and rachises dark brown but appearing hoary due to the dense covering of very slender white or tawny scales; pinnae deltoid-ovate to ovate-oblong; segments rounded to obovate, approximate, the lower ones once or twice lobed or cleft, terminal segment the largest, rhomboidal, densely white tomentose above, lower surface brown or tawny with both hairs and scales, the latter mainly on the veins; margins widely revolute, crenulate, with a narrow membranaceous false-indusium; sori in groups, submarginal at the ends of the thickened veins.

In crevices of dry cliffs and ledges, in talus or on soil under rocks. Rare in southeastern Utah. Colorado to central Texas, Mexico and Arizona.

ILLUSTRATION: Figs. 92-95.

COLLECTIONS: One collection in New York Botanical Gardens herbarium from San Juan County.

14. **NOTHOLAENA** R. Br. Prod. Fl. Nov. Holl. 145. 1810.

Small rock ferns growing from short scaly rhizomes with wiry, brown tomentose roots; leaves 2-25 cm. long, tri- to quadripinnate, ovate to lanceolate in outline; segments tomentose or with powdery or mealy scales, at least on the under side; margins recurved or nearly flat, not forming a false indusium over the sporangia, becoming flattened with age; sori submarginal at the ends of the veins, rounded or oblong, becoming more or less confluent with age.

The name *Notholaena* (Greek) refers to the false indusium or cloak.

Dry leaves boiled in water a few minutes will relax them so that their characteristics may be observed more readily.

- Leaves densely white tomentose, not mealy I. *N. parryi*
 Leaves glabrous or mealy with a waxy powder, hairs lacking.
 Leaves entirely glabrous, green, segments few and large 2. *N. jonesii*
 Leaves abundantly mealy beneath, segments small and numerous.
 Rachises sharply flexuous 3. *N. fendleri*
 Rachises straight or nearly so 4. *N. limitanea*

Notholaena sinuata (Lagasca) Kaulf. [*Cheilanthes sinuata* (Lagasca) Domin] may possibly be found in Utah since it has been collected by Dr. Cottam at Tuweep, Arizona which is north of the Grand Canyon, and at Betatakin cliff dwelling ruins close to the Utah border. Also *N. standleyi* Maxon may occur in Utah as its range extends from western Oklahoma and Texas to Colorado and Arizona.

1. **Notholaena parryi** D. C. Eaton, Am. Nat. 9: 351. 1875.

PARRY'S CLOAK FERN

Cheilanthes parryi (D. C. Eat.) Domin, Bibl. Bot. 85: 133. 1913.

Plants tufted, up to 23 cm. high; rhizomes short and covered with reddish-brown scales with darker midribs; leaves 4-5 cm. long; stipes dark reddish-brown to purplish-colored, scaly at the base, loosely hirsute-tomentose above and on the rachises, often glabrate with age; blades ovate-oblong to oblong-lanceolate in outline, tripinnate; pinnae ovate, triangular or ovate-lanceolate in outline; ultimate segments, often obscured by the dense hairs, obovate to oblong when moist, with rounded lobes, white hirsute-tomentose above, densely brown tomentose beneath, margins crenate and widely recurved, becoming flattened with age; sori rounded and naked, on the ends of the veins, more or less confluent or interrupted.

In crevices of dry rocks or on soil under rocks. Common in southwestern Utah, Arizona, southern Nevada and California.

ILLUSTRATION: Figs. 101-103.

COLLECTIONS: Flowers 3192. West of Kanab, Kane County, 3193, 3194; Cottam 8447, 10047; B. Y. 1140, 4235; I. H. 35515, 49045, all from various points in Washington County.

2. **Notholaena jonesii** Maxon, Am. Fern Jour. 7: 108. 1917.

JONES' CLOAK FERN

Plants tufted, rhizome short, oblique, conspicuously chaffy, the scales linear, very long attenuate, thin, bright brown; leaves 3-10 cm. long, spreading, the stipes curved, closely fasciculate, reddish-brown,



Figs. 96-100. *Cheilanthes feei*. 96. habit fresh X $\frac{1}{2}$; 97. habit dry X $\frac{1}{2}$; 98. pinna X 5; 99. pinnule X 10; 100. underside of segment X 20.

Figs. 101-103. *Notholaena parryi*. 101. Habit sketches X 1; 102. pinna upper surface X 10; 103. pinna lower surface showing marginal sori. X 10.

sublustreus; blades mostly twice as long as stipes, oblong-ovate to narrowly triangular, bipinnate; pinnae few, opposite to alternate, with one or two pairs of distant, entire to crenately lobed, roundish or subcordate pinnules and a similar, but larger terminal segment; pinnules mostly short-stalked, the stalks flat and greenish-brown; leaf tissue apparently fleshy, herbaceous, glabrous, somewhat glaucous, not at all pulverulent; sporangia borne toward the ends of the once or twice forked veins in a broad submarginal band, dark, nearly globose. (Original description.)

Growing in the crevices of very dry rocks. Known in Utah only from Washington County, the type locality. Arizona to southern California.

ILLUSTRATION: Figs. 108-109.

COLLECTIONS: Type in U. S. National Herbarium.

3. *Notholaena fendleri* Kuntze, Farnkr. 2: 87. 1851.

FENDLER'S CLOAK FERN

Cincinnatia fendleri (Kuntze) Fee, Gen. Fil. 160. 1850-52.

Gymnogramme fendleri (Kuntze) Mett. Cheil. 7. 1859.

Pellaea fendleri (Kuntze) Prantl, Engler Jahrb. 3: 417. 1882.

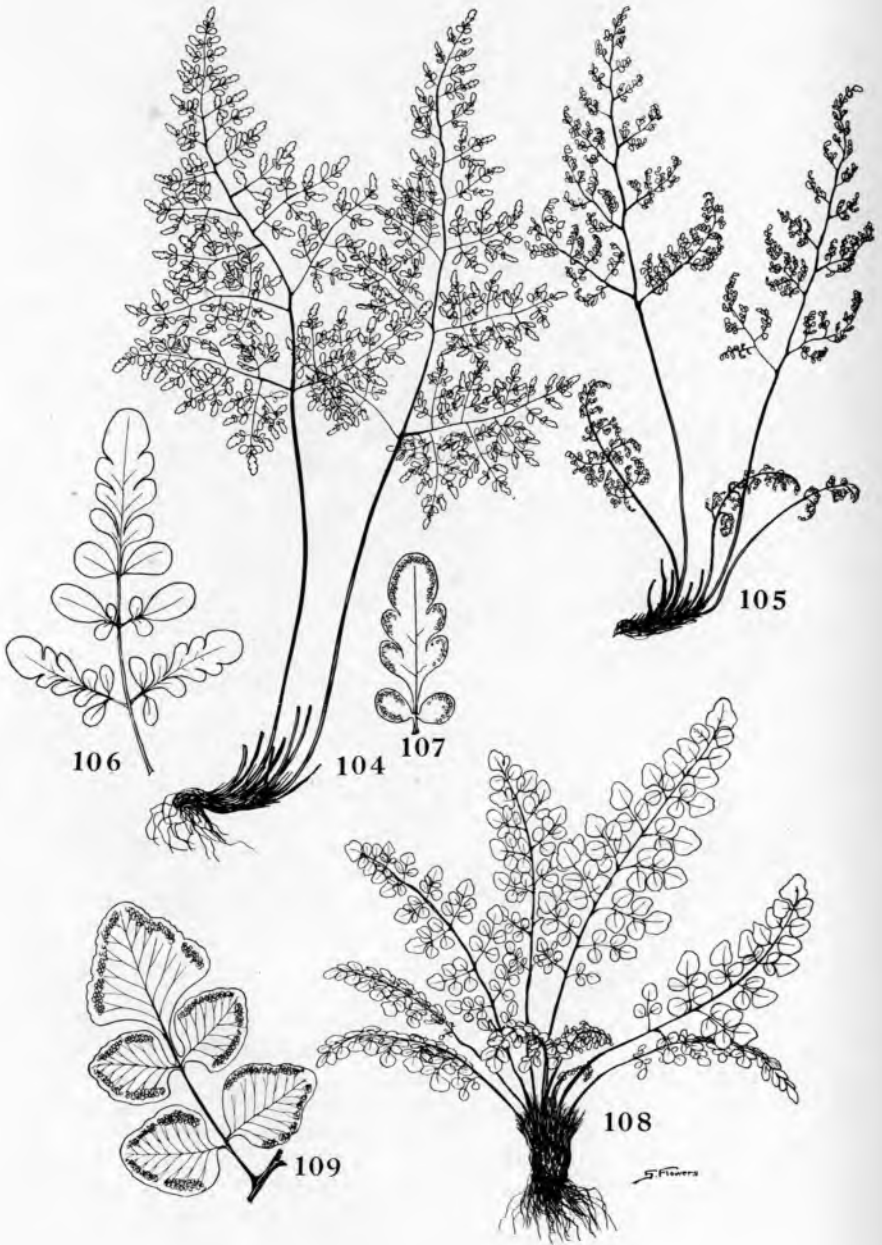
Scales of the rhizome bright reddish-brown, one-colored; leaves tufted, 7.5-23 cm. long; stipes and rachises dark brown, the latter sharply flexuous; blades broadly deltoid-ovate in outline, 4-5 times pinnate below, gradually simpler above; ultimate segments oval or elliptical simple or three-lobed, densely white mealy below, hairs lacking. (From Slosson in Rydberg's Flora of the Rocky Mountain, 1922.)

Growing in dry rocky cliffs and slopes. Known in Utah only from San Juan County. Wyoming to New Mexico and Arizona.

This species is said to have been collected in San Juan County by Dr. P. A. Rydberg but the specimen cannot be found. It is highly possible that it occurs in eastern or southeastern Utah since this area is within the known range.

4. *Notholaena limitanea* Maxon, Am. Fern Jour. 9: 70. 1919.

Rhizome decumbent or horizontal, woody, relatively large, 1-4 cm. long, 1-1.5 cm. thick, conspicuously chaffy at the apex, scales loosely tufted, light castaneous, linear-attenuate, 7-10 mm. long, about .5 mm. wide, lightly flexuous, subentire, with a few stalked, turgid, marginal glands. Leaves numerous, caespitose, erect or ascending, 8-25 cm. long; stipes 4-14 cm. long, very dark chestnut brown or purplish black, usually rather slender, naked above the curved base, glaucous; blades deltoid-ovate, subpentagonal, acute, 5-15 cm. long, 4-11 cm. broad, four to five times pinnate, the rachises blackish, delicate, the minor ones almost capillary; pinnae about six pairs, slightly ascending, subopposite, long-stalked, deltoid, contiguous; basal pinnae much the largest, about half as long as the blade, conspicuously long-stalked, subternate with the basal pinnules long-stalked, subternate, deltoid, the other pinnules smaller, less decomposed, and with shorter stalks; ultimate segments sessile or nearly so, mostly 2-3 mm. long, linear-oblong, appearing slightly broadest



Figs. 104-107. *Notholaena limitanea*. 104. Habit fresh X $\frac{1}{2}$; 105. habit dry X $\frac{1}{2}$; 106. portion of a pinnule X 5; 107. ultimate segment showing marginal sori X 10.

Figs. 108-109. *Notholaena jonesi*. 108. Habit X $\frac{1}{2}$; 109. underside of pinna showing submarginal sori. X 5.

at the obliquely truncate or subcordate, inequilateral base, or at maturity often broadly oblong or bluntly ovate-oblong by the thrusting back of the widely revolute margin, the segments thus often plane; under surface thickly but flocculently whitish mealy; sporangia numerous, extending at least half the length of the veinlets from the tip, only partially concealed at any stage. Leaf tissue spongiose-herbaceous, glaucous above. (From original description.)

In crevices of limestone cliffs and ledges, and in talus. Rare in Utah, known only from San Juan County, but probably in surrounding counties. New Mexico and Arizona.

ILLUSTRATION: Figs. 104-107.

COLLECTIONS: Garrett 9386, White Canyon; Clover and Jotter 2183. Near mouth of Dirty Devil River, San Juan County.

Family 3. **MARSILEACEAE** R. Br.

PEPPERWORT FAMILY

Plants anchored in water with floating leaves or rooting in mud with aerial leaves. Rhizomes slender and creeping; leaves long slender stipitate, palmately 4-foliolate (in our species), segments triangular or cuneate, veins forking, surface smooth or hairy; sporocarps borne on short stipes, subglobose or oval to oblong and flat like a small bean, greenish when young and often hairy, becoming brown and glabrate with age, coats hard and bony, opening in water by two valves and emitting a hyaline gelatinous ring bearing pendent club-shaped sori in two rows; spores of two kinds: microspores producing male prothallia, and megaspores producing female prothallia, both more or less retained in the old spore wall which splits open.

MARSILEA L. Sp. Pl. 1099. 1753.

With characters of the family. Named in honor of Giovanni Marsigli, an Italian botanist.

Marsilea vestita Hook. & Grev. Icon. Fil. 2: pl. 159. 1831.

HAIRY PEPPERWORT

Marsilea mucronata A. Br. Am. Jour. Sci. II. 3 : 55. 1847.

Zaluzianskya vestita (H. & G.) Kuntze, Rev. Gen. Pl. 2 : 823. 1891.

Marsilea oligospora Gooding, Bot. Gaz. 33 : 66. 1902.

Plants assuming two general forms: the water form and aerial form. Plants growing in water widely spreading with leaf blades floating on the surface, pale to dark green, smooth and often shiny, rarely slightly hairy, segments 15-18 mm. long; stipes variable depending upon the depth of the water, up to 50 cm. long, greenish, becoming brown with age; sporocarps pale brown when young, becoming blackish-brown with age, smooth, submerged. Aerial form growing on mud densely tufted, up to 10 cm. high; leaves pale green, stipes shorter, blades smaller, segments 9-12 mm. long, densely hairy all over; sporocarps green and densely hairy when young, becoming dark brown and glabrous with age, oval-oblong, flat, 4-5 mm. long, deflexed with two teeth near the base of attachment separated by a broadly rounded sinus, the upper tooth slightly longer and often curved.

Shallow lakes and ponds or muddy places. Uncommon in Utah but abundant locally. It occurs in Dry Lake in Cache County, around Bear Lake in Rich County and at Green River, Emery County. Arkansas and Texas to Saskatchewan, British Columbia, and California; Mexico. (Introduced in central peninsular Florida.)

ILLUSTRATION: Figs. 112-116.

COLLECTIONS: Flowers 3197. West side, Bear Lake, Rich County, 3195-96, I.H. 36622-23, Cottam 6382, Dry Lake, Cache County, 5876. B. Y. 2167, Banks of the Green River, Green River, Emery County. Flowers 32427, Cottam 9448. In ditch crossing saline plain, West of Salt Lake City, Salt Lake County.

Family 4. SALVINIACEAE

Plants small, floating on water, stem branched; leaves very small (in our species), $\frac{1}{2}$ -2 mm. long, in two opposite rows. Sporocarps very small globose or ovoid, very soft and thin, one-celled, 2-several on a common stalk, heterosporous, each containing a simple or branched receptacle bearing either megasporangia containing a single megaspore, or microsporangia containing many microspores.

AZOLLA Lam. Encyc. 1: 343. 1783.

Plants very small, floating on the surface of ponds, streams and ditches, green or strongly tinged with red, especially in autumn, more or less deltoid in outline, 5-25 mm. long, obscurely pinnately branched; leaves very small, imbricated, consisting of two lobes, an upper inflated lobe with large air cavities, and a lower thin lobe which is inconspicuous. Adventive roots long; sporocarps in pairs beneath the stem.

The name, *Azolla* (Greek), means killed by drouth!

Azolla caroliniana Willd. Sp. Pl. 5: 541. 1810.

MOSQUITO FERN

Azolla microphylla Kaulf. Enum. Fil. 273. 1824.

Azolla cristata Kaulf. l. c. 274. 1824.

Salvinia azolla Raddi, Pl. Bras. 1: 2. 1825.

Azolla densa Desv. Mem. Soc. Linn. Paris, 6: 178. 1827.

Azolla portoricensis Spreng. Syst. Veg. 4: 9. 1827.

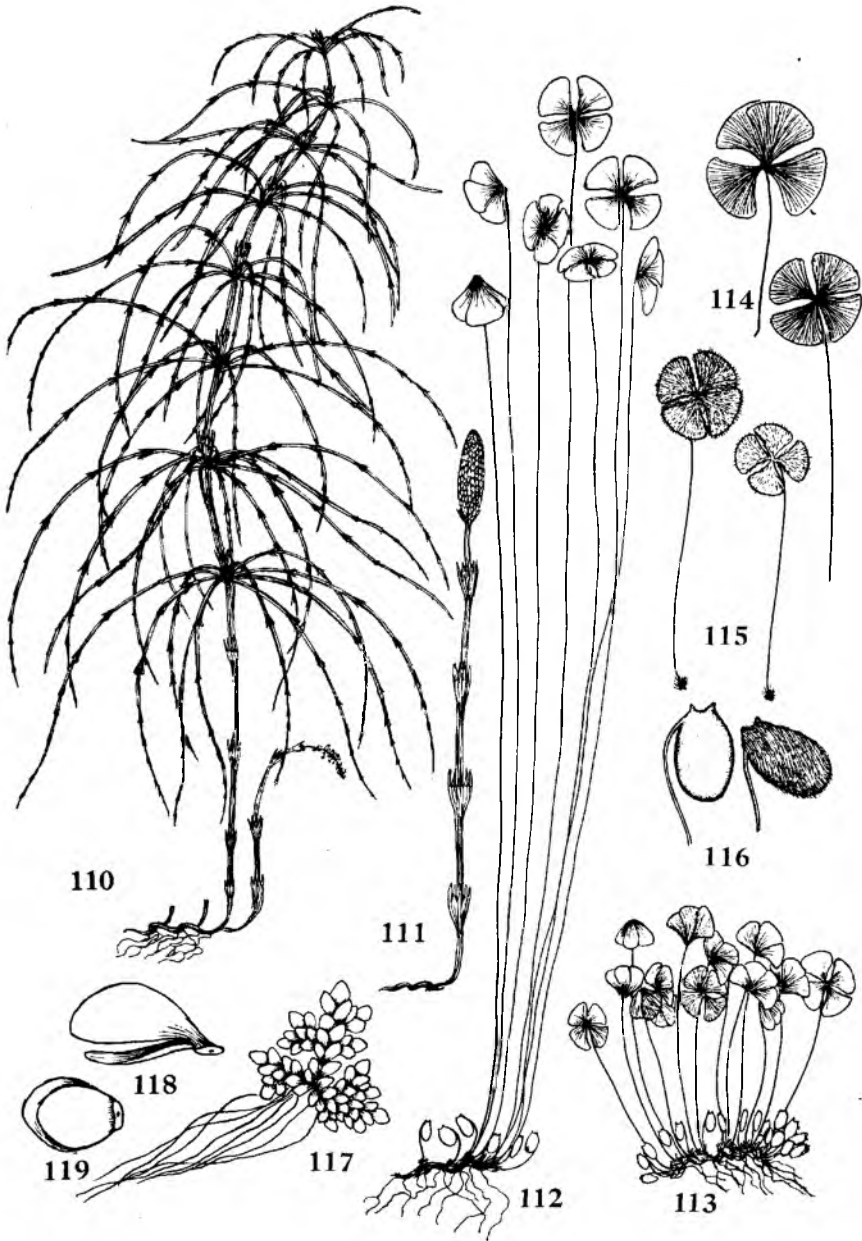
Azolla mexicana Schlecht. & Cham. Linnaea, 5: 625. 1830.

Small and moss-like, deltoid in outline, upper surfaces very resistant to water, glistening; leaves $\frac{1}{2}$ -2 mm. long, green or green with a red border which becomes more intense as the season progresses.

Uncommon in Utah but abundant locally. It occurs in ponds and ditches around Utah Lake and in Jordan Valley, in ponds west of Centerville, in Weber Canyon and Cache Valley. Florida to eastern North Carolina, west to Ohio, Arizona and Alaska; West Indies; Mexico to Patagonia.

ILLUSTRATION: Figs. 117-119.

COLLECTIONS: Flowers 3243. Pine Lake, Salt Lake City, 3244. West Centerville, Davis County, 3245. Stoddard, Weber Canyon, Weber County; Cottam 3919. Ditches, Utah Lake at Geneva, Utah County; I. H. 20266. Pools, $\frac{1}{2}$ -mile north of State Hatchery, Cache County.



Figs. 110-111. *Equisetum arvense*. 110. Habit of sterile shoot and 111. fertile shoot X $\frac{1}{2}$.

Figs. 112-116. *Marsilea vestita*. 112. Habit of aquatic form X $\frac{1}{2}$; 113. habit of aerial form X $\frac{1}{2}$; 114. blades of aquatic leaves X 1; 115. leaves of aerial form X 1; 116. sporocarps, smooth and hairy X 5.

Figs. 117-119. *Azolla caroliniana* 117. habit X 4; 118. side view of leaf showing dorsal and ventral lobes X 15; 119. ventral view of leaf X 15.

Family 5. **EQUISETACEAE** Mx. 1803.

Plants erect or decumbent from horizontal or erect root stocks that are hard, dark brown or blackish; aerial stems annual or perennial, jointed, simple or verticillately branched, solid or hollow, except at the joints, the internodes strongly grooved with alternating ridges which bear rows of siliceous tubercles or transverse bands of closely disposed tubercles; stomata in the grooves; leaves reduced to a ring of confluent scales forming sheaths at the nodes, each sheath segment ending in a slender tooth; teeth persistent or early deciduous. Spores in terminal cones, borne in 6-8 elongated sporangia on the inner face of peltate sporophores. Spores homosporous, ovoid with or without elators, green, appearing grayish-purple in masses; prothallia minute flat, elongated and forked.

EQUISETUM (Tourn.) L. Sp. Pl. 1061. 1753.**HORSETAILS AND SCOURING-RUSHES**

With characters of the family. The name, *Equisetum*, comes from the Latin *equus*, horse, and *seta*, bristle, hence, horsetail.

Some species are distinguished by the rows of tubercles or silex bands on the ridges of the stems, and it is often difficult to make accurate observations of them using an ordinary hand lens. If the ridges are smeared with India ink the blackened tubercles or bands can be seen more distinctly. Under the most favorable conditions a hand lens is often inadequate. However, if a binocular magnifier is available no difficulty will be encountered in observing the blackened structures.

Most species that normally have simple stems may show sporadic branching when old or injured. These branches may even bear cones. The species vary greatly in size and robustness according to habitat.

- Stems of two kinds, sterile ones profusely branched, slender and weak, fertile ones, short, erect, unbranched, fleshy and flesh-colored, appearing in the spring before the sterile ones 1. *E. arvense*
- Stems of one kind, normally strict and unbranched, often sporadically branched when old or following injury.
- Cones bluntly rounded or tip acute; leaf sheaths longer than broad, appressed, green; stems annual 2. *E. kansanum*
- Cones rigid apiculate; stems annual or perennial.
- Leaf sheaths longer than broad, dilated, funnellform to campanulate, annual or perennial.
- Plants small and tufted, stems less than 12 ridged, ridges with 2 rows of tubercles; sheaths with persistent teeth 3. *E. variegatum*
- Plants tall and large, not tufted, stems with 20-30 ridges, with low transverse silex bands, nearly smooth, pale green, evergreen but delicate, teeth deciduous 4. *E. laevigatum*
- Leaf sheaths about as long as broad or shorter, cylindrical, appressed, gray at maturity, often split when old, with 1 or 2 dark bands.
- Ridges of the internodes with 1 row of tubercles, or with transverse silex bands, not angled, sheath segments usually 3-carinate, but often with a very narrow central groove in the central ridge 5. *E. prealtum*
- Ridges with two more or less distinct rows of tubercles with a narrow groove between them, sharply 2-angled (or rounded in some), sheath segments 4-carinate, the central ones close together with a narrow groove 6. *E. hyemale* var.

1. *Equisetum arvense* L. Sp. Pl. 1061. 1853.

MEADOW HORSETAIL

Equisetum arvense granulatum Lawson, Trans. Bot. Soc. Edinb. 7: 561. 1863.

Equisetum saxicola Suksd. Deuts. Bot. Monatss. 19: 93. 1901.

Fertile stems soft and flesh-colored, erect, 10–25 cm. high, with spreading leaf sheaths, 8–12-toothed; cones oblong, 2–4 cm. long, blunt; sterile stems erect or decumbent, 10–40 cm. high, slender, 2–3 mm. thick, sheaths loose and spreading, segments lanceolate, acuminate; branches 8–14 at the nodes, slender, drooping, 3–4-angled, solid; sheaths slender, lanceolate.

Occasionally the sterile shoots will develop cones at the apex during the summer and fall. These have been called forma *serotinum* (C. F. Schlutze) Klinge.

Common throughout the state in wet or damp places. Widely distributed in the north temperate and subarctic regions.

ILLUSTRATION: Figs. 110–111.

COLLECTIONS: Flowers 3138, Aspen Grove, Mt. Timpanogos, Utah County, 3139. East Canyon, Summit County, 3140. Weber Canyon, Weber County, 3141. Little Cottonwood Canyon, Salt Lake County; Cottam 5928. La Sal Mountains, San Juan County; Garrett 2224, Salt Lake City; B. Y. 7660. Moon Lake, Duchesne County, 679. Mt. Timpanogos, Utah County, 3891. Soapstone Creek, Summit County, 8153. Huntington Canyon, Emery County; Posey Lake and Boulder Mountain, Garfield County; I. H. 191. White Canyon, San Juan County, 35524. Pine Valley Mountains, Washington County, 40671. Experimental Station, Manti Nat. Forest, Sanpete County, and many others.

2. *Equisetum kansanum* Schaffner, Ohio Nat. 13: 21. 1912.

KANSAS SCOURING-RUSH

? *Equisetum fontinale* Copeland, Madrono, 3: 367. 1936.

Equisetum laevigatum sensu A. A. Eaton, not A. Br.

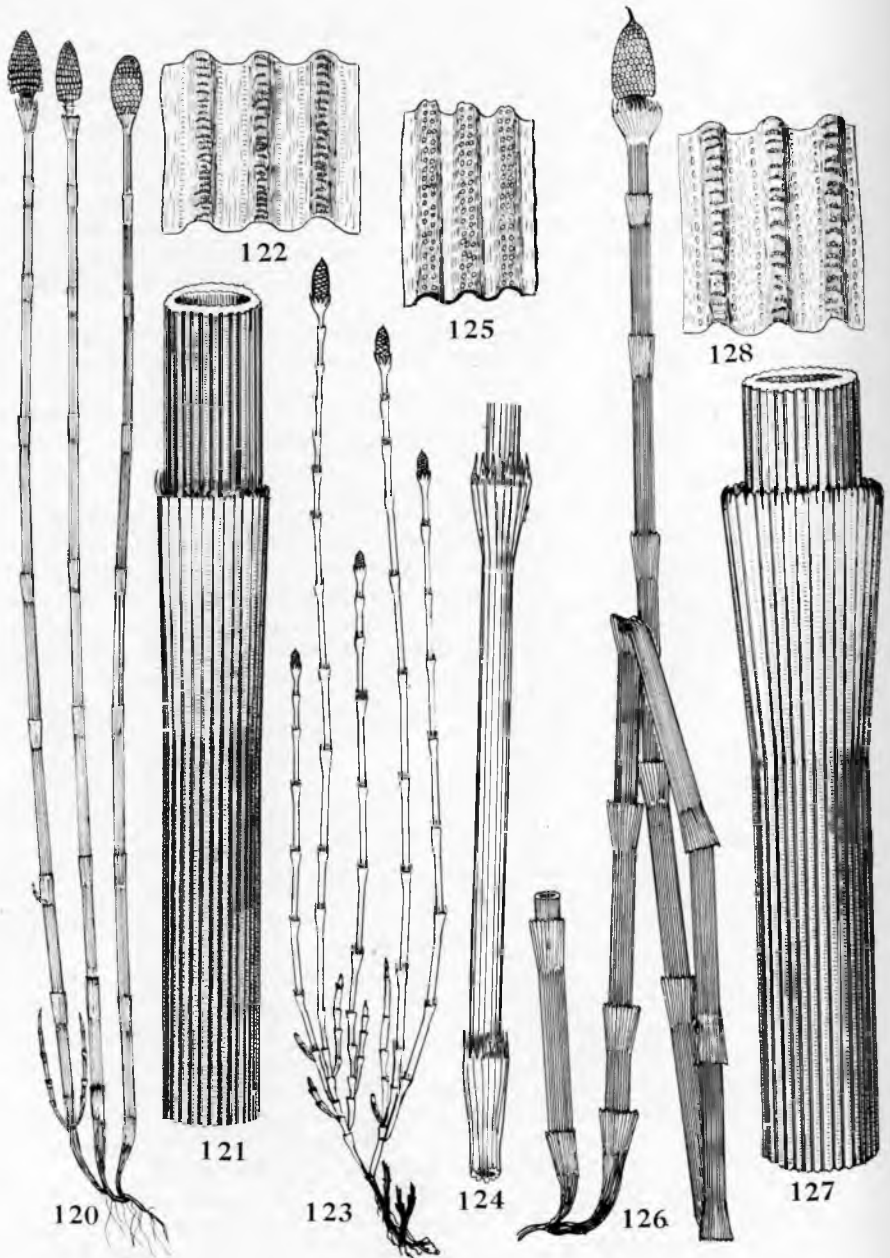
Aerial stems erect, annual, pale green, 2–5 dm. high, 1–5 mm. thick, 15–30-ridged, more or less smooth, ridges with a single row of tubercles or with low transverse silex bands, 2 rows of stomata in the grooves; sheaths longer than broad, appressed or slightly dilated upwards, not incurved, with a narrow black band above, rarely with one below, sheath segments tricarinate, teeth early deciduous; cones on a short pedicel, ovate to oblong, 1.5–2.5 cm. long, mostly pale yellowish, tip round, obtuse or with a black acute point.

Variable in size according to habitat. In moist soil it may become large and robust, but delicate in texture while in dry soil it often becomes much smaller and often tufted. The small forms may occur in wet places, especially at high elevations.

Very common throughout the state in woods and meadows, along stream banks and ditches. Ohio to British Columbia, Texas to Southern California.

ILLUSTRATION: Figs. 120–122.

COLLECTIONS: Flowers 3143. Emigration Canyon, 3144. Parley's Canyon, 3145. Big Cottonwood Canyon, Salt Lake County, 3146.



Figs. 120-122. *Equisetum kansanum*. 120. Habit X $\frac{1}{2}$; 121. portion of stem showing sheath X 5; 122. surface of the stem showing the silex bands on the ridges X 20.

Figs. 123-125. *Equisetum variegatum*. 123. habit X $\frac{1}{2}$; 124. portion of stem showing sheaths X 5; 125. surface of the stem showing the double row of tubercles on the ridges. X 20.

Figs. 126-128. *E. laevigatum*. 126. habit X $\frac{1}{2}$; 127. portion of the stem show a sheath X 5; 128. surface of the stem showing the silex bands on the ridges X 20.

Near Moab, Grand County, 3151. Upper Provo River, Wasatch County, 3152. Beaver Creek, Summit County, 3154. Upper Duchesne River, Duchesne County, 3156. Price Canyon, Carbon County, 3164. Near Nephi, Juab County, 3165. Near Beaver, Beaver County, 3169, South Willow Creek, Tooele County; Cottam 3221. Deep Creek Mountains, Juab County, 6863. Near Gunlock, Washington County; B. Y. 3360. Mountain Meadows, Washington County, 8125. Buckhorn Wash, Emery County; I. H. 208. West Logan, Cache County, 209. Near Flaming Gorge, Daggett County, 18195. Cottonwood Canyon, Bluff, San Juan County, 40672. Five miles north Glendale, Kane County, 49052. Pine Valley Mountains, Washington County, and many others.

3. *Equisetum variegatum* Schleich. Cat. Pl. Helvet. 27. 1807.

MOTTLED SCOURING-RUSH

Equisetum reptans Wahl. Fl. Lappon. 398. 1812, in part.

Equisetum arenarium Newm. Hist. Brit. Ferns, 41. 1844, in part.

Equisetum hyemale var. *variegatum* (Schl.) Newm. Phytologist, 337. 1843.

Hippochaete variegata (Schl.) Farwell, Mem. N. Y. Bot. Gard. 6 : 466. 1916.

Aerial stems annual or perennial, small, slender and tufted, dark green, simple, rarely branched, with 12 ridges or less, each ridge with 2 rows of tubercles with a narrow groove between them; sheaths longer than broad, dilated, funnelform or campanulate, dark above; segments becoming 4-carinate above; teeth persistent, not strongly differentiated from the segments, gray with a dark median point. Cones small, ovoid to oblong, 3-4.5 mm. thick and up to 10 mm. long, apex strongly apiculate.

Rare in Utah. It has been collected once in a meadow near Cedar Breaks, Iron County, by Dr. Maguire. The slender, dark green tufted habit together with dilated sheaths, persistent teeth and apiculate cone makes it easily recognized. In wet calcareous soil and gravelly beaches, Alaska to Labrador, Connecticut, New Jersey, Pennsylvania westward to Colorado and California. Greenland, Europe and northern Asia.

ILLUSTRATION: Figs. 123-125.

COLLECTIONS: I. H. 20213. Meadows at Cedar Breaks, 40669. Fifteen miles east of Cedar City, 40670. One mile east of Cedar Breaks Lodge, Iron County.

4. *Equisetum laevigatum* A. Br. Amer. Jour. Sci. & Arts, 46: 87. 1844

SMOOTH SCOURING-RUSH

Equisetum hyemale var. *intermedium* A. A. Eaton, Fern Bull. 10 : 120. 1902.

Hippochaete laevigata (A. Br.) Farwell, Mem. N. Y. Bot. Gard. 6 : 469. 1916.

Equisetum intermedium (A. A. Eat.) Rydb. Fl. Rocky Mts. 1053. 1922.

Equisetum hyemale var. *affine forma intermedium* (A. A. Eat.) Victorin, Equis. du Quebec, 89. 1927.

Equisetum prealtum laevigatum (A. Br.) Bush, Am. Mid. Nat. 12 : 111. 1930.

Aerial stems annual or perennial, evergreen but delicate, erect, simple, often with sporadic branches after fruiting or when injured, light green when young, becoming dark green with age, 1-10 dm. high, 3-4 mm. thick, often very robust, ridges 20-30, rather smooth

with a single row of tubercles or transverse bands of silex; sheaths longer than broad, dilated above, often funnel-like, green the first season with a dark ring above, becoming ashy and often with a dark ring below the second season; sheath segments tricarinate, teeth black with hyaline margins, early deciduous; cones short and thick, 1-1.5 cm. long, 4-6 mm. thick, sessile, tip rigid spinulose, black.

Growing in wet places or damp situations along streams, ditches, in meadows or boggy areas. Common throughout Utah. Massachusetts to Georgia, British Columbia, Texas, California, Mexico to Guatemala.

ILLUSTRATION: Figs. 126-128.

COLLECTIONS: Flowers 3133, 3135. Big Cottonwood Canyon, 3136. Mill Creek Canyon, 3117. Parley's Canyon, Salt Lake County, 3116, 3122. Near Moab, Grand County, 3118. Spanish Fork Canyon, Utah County; Provo River at Hailstone, Wasatch County; B. Y. 178. Provo River at Provo, Utah County; Cottam 8185. Queen of Sheba Mine, Deep Creek Mountains, Juab County, 3360. Mountain Meadows, Washington County.

5. *Equisetum prealtum* Raf. Fl. Ludov. 13. 1817.

TALL SCOURING-RUSH

Equisetum robustum A. Br. Am. Jour. Sci. and Arts, 46 : 88. 1844.

Equisetum hyemale var. *robustum* (A. Br.) A. A. Eaton, Fern Bull. 11 : 75. 1903.

Equisetum hyemale var. *suksdorfi* A. A. Eaton, l. c. 1903.

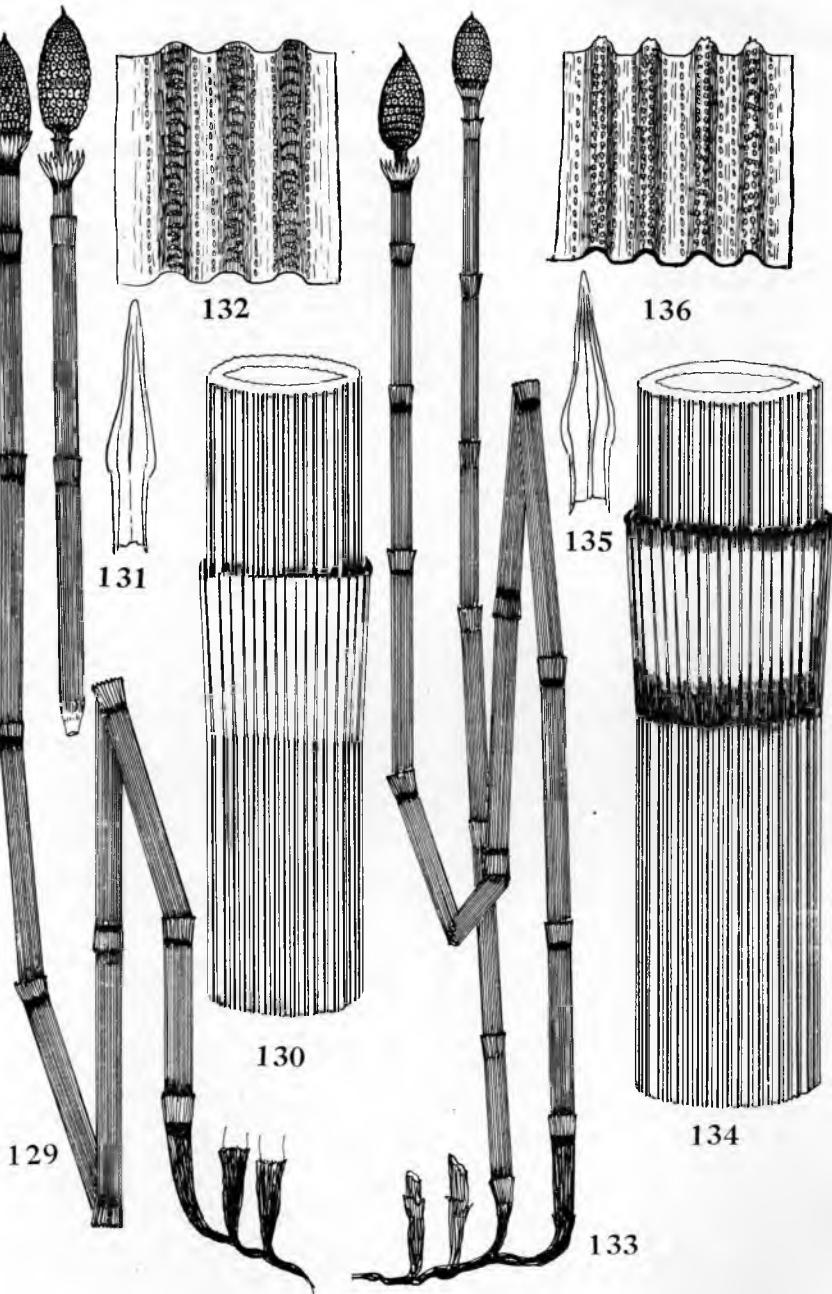
Equisetum ferrissi Clute, Fern Bull. 12 : 20. 1904.

Hippochaete prealta (Raf.) Farwell, Mem. N. Y. Bot. Gard. 6 : 467. 1916.

Equisetum hyemale of American authors, not L.

Plants robust, often large and coarse, aerial stems perennial, erect, up to 3 M. high, usually 6-8 dm. high in our region, 7-12 mm. thick, dark green, 20-50-ridged, ridges more or less rounded with a single row of tubercles or transverse bands consisting of closely disposed tubercles; sheaths cylindrical, appressed, about as long as broad or shorter, black banded above and below, becoming ashy and splitting with age, segments tricarinate, the central ridge with a single row of tubercles or with 2 rows which sometimes show a narrow groove between them; teeth usually early deciduous, occasionally persistent the first season; cones sessile, short, 1.5-2.5 cm. long, 6-8 mm. thick, ovate to shortly oblong, tip strongly apiculate, black.

This species and *E. hyemale* are often confused. Most authorities agree that *E. hyemale* shows two distinct rows of tubercles on each ridge with a distinct groove between them although the rows may be somewhat irregular with some of the tubercles oblique. These rows extend to tips of the sheath segments which are 4-carinate, the two central ridges close together. In contrast, *E. prealtum* is said by some writers to have a single row of tubercles on each ridge while others say a single row of transverse silex bands. The latter consist of 3-5 tubercles more or less confluent or very close together, and this condition occurs in all of the Utah specimens examined. The single row of silex bands extends to the tips of the sheath segments which may be definitely tricarinate, or the central ridge may have two



Figs. 129-132. *Equisetum prealtum*. 129. Habit X $\frac{1}{2}$; 130. portion of the stem showing a sheath X 5; 131. leaf segment showing three carinae X 20; 132. surface of the stem showing silex bands X 20.

Figs. 133-136. *E. hiemale* var. *californicum* 133. Habit X $\frac{1}{2}$; 134. portion of the stem showing a sheath X 5; 135. leaf segment showing four carinae X 20; 136. surface of the stem showing two rows of tubercles on the ridges. X 20.

rows of tubercles with a very narrow groove between them as in *E. hyemale*, although not quite as pronounced. Some specimens are confusing because the internodes show two rows of tubercles on the upper part of a ridge and the banded condition on the lower part of the same ridge. Also, the upper internodes of some specimens show tubercles in two rows while the lower internodes are predominately banded.

Growing in damp places in sandy or rocky soil along stream sides, in woods or open places. Common in Utah and probably widely distributed. Nova Scotia to Florida, northward into Canada, British Columbia, south to southern California and Mexico.

ILLUSTRATION: Figs. 129-132.

COLLECTIONS: Flowers 3142. City Creek Canyon, Salt Lake County; Cottam 7162. Deep Creek Mountains, Juab County; I. H. 35525. Huntington Canyon, Emery County.

6. *Equisetum hyemale* var. *californicum* Milde, Monogr. Equis. 517. 1865.

WESTERN SCOURING-RUSH

Hippochaete hyemale var. *californicum* (Milde) Farwell, l. c. 1916.

Aerial stems perennial, evergreen; erect, up to 2 M. high, mostly 6-8 dm. high in our region, 7-12 mm. thick, dark green, 18-46-ridged, each ridge sharply 2-angled and with a double row of tubercles; sheaths short, usually as long as broad or shorter, dark-banded above and sometimes below, becoming ashy and split with age; segments 4-carinate, the 2 middle ridges close together and continuous with the 2 rows of tubercles extending upward from the internodal ridge; cones sessile, ovate to oblong, 1.5-2.5 cm. long, 6-8 mm. thick, tip sharply apiculate, black.

In moist soil along streams, ponds and lakes or in open thickets and meadows, common throughout Utah and the western states, Alaska to California.

The 2 rows of tubercles on the ridges may be variable in some plants. Usually they are quite regular but in some cases they may be oblique, slightly irregular or banded here and there. For comparison with *E. prealtum* see notes under that species.

ILLUSTRATION. Figs. 133-136.

COLLECTIONS: Flowers 3181. Lamb's Canyon, 3184. Emigration Canyon, 3182. City Creek Canyon, Salt Lake County, 3183. Birch Creek, Deep Creek Mountains, Juab County; Cottam 2954. Clear Creek, Raft River Mountains, Boxelder County, Garrett 6686. Big Cottonwood Canyon, Salt Lake County; B. Y. 2133. Thompson, Grand County, 4909. Crescent Creek, Garfield County, 8159. Huntington Canyon, Emery County; I. H. 210, 212. Providence Canyon, 211. Logan Canyon, Cache County.

Family 6. **SELAGINELLACEAE** Underw.

Plants low and creeping, forming loose mats or dense tufts among rocks (in our region), moss-like in habit and appearance; stems branched, slender, prostrate with erect branches or spreading;

leaves numerous, small, oblong to lanceolate, up to 3 mm. long, with a small ligule at the base of the ventral (upper) side, sessile and imbricated, all alike and spirally arranged (in our species); heterosporous, sporophylls green, ovate-triangular, slightly larger than the vegetative leaves, arranged in four rows, sharply keeled and forming a 4-angled terminal cone that is not conspicuously different from the vegetative stems; micro- and megasporangia axillary and variously disposed in the cone, orange or yellowish; microspores numerous, yellowish or orange-colored; megaspores usually 3-4 in a megasporangium, orange-colored. Prothallia minute, retained in the old spore walls.

SELAGINELLA Beauv. Prodr. Aetheog. 101. 1805.

SPIKEMOSS OR LITTLE CLUBMOSS

With characters of the family. The name, *Selaginella*, is the diminutive of *Selago*, an ancient name for some species of *Lycopodium*.

Plants densely tufted or matted, branches short.

Leaves tapering to the apex, bristle tip long and slender, white, 1-1.5 mm. long 1. *S. densa*

Leaves abruptly acute, bristle tip shorter, yellowish-green, 0.3-0.4 mm. long 2. *S. watsoni*

Plants loosely matted, branches distant, long and spreading.

Stems 2-3 mm. thick; leaves gradually tapered to the apex, loosely imbricated, 2.5-3 mm. long, bristle tip 0.3-0.4 mm. long 3. *S. underwoodii*

Stems 1 mm. thick; leaves abruptly contracted at the apex, appressed and closely imbricated, 1 mm. long, bristle tip lacking or very short 4. *S. mutica*

NOTE: Other species of *Selaginella* that may possibly be found in Utah since there known ranges either include this state or border closely on it are *S. scopulorum* Maxon, *S. selaginoides* (L.) Link, *S. standleyi* Maxon and *S. wallacei* Hieron.

1. *Selaginella densa* Rydb. Mem. N. Y. Bot. Gard. 1 : 7. 1900.

Selaginella rupestris densa (Rydb.) Clute, Fern Allies, 142, 264. 1905.

Plants in dense tufts, caespitose, stems becoming 10-12 cm. long, creeping, with numerous short, closely disposed and ascending branches; leaves densely imbricated, 2-3 mm. long, .25-.35 mm. wide, pale green, brownish below, lanceolate to linear-oblong, tapering toward the apex, rounded and boat-shaped at back above with a narrow groove down the back, margin short ciliate (often sparingly so), apex with a long whitish bristle, 1-1.5 mm. long. Cones erect, 1-2.5 cm. long (sometimes longer), sharply 4-angled; sporophylls triangular-ovate, 1.5-2 mm. long, bristle tip about 1 mm. long, margin ciliate; megaspores 335-450 μ in diameter, low undulate in outline, surface closely reticulate with broad ridges or irregularly verrucose.

In dry rocky ledges and talus slopes in high mountains. Probably throughout the state but not common. It has been collected in the Uintah mountains and in Zion National Park. Alberta and Washington southward through South Dakota, Nebraska to New Mexico.

ILLUSTRATION: Figs. 137-140.

COLLECTIONS: Flowers 3246. Mt. Agassiz, Duchesne County; Cottam 5644. Zion National Park, Washington County; B. Y. 7891. Twelve miles south of Manila, Daggett County.

2. *Sellaginella watsoni* Underw. Bull. Torr. Club, 25 : 127. 1898.

Plants in dense tufts or somewhat matted; stems 5–15 cm. long, creeping; branches erect or ascending, up to 4 cm. long, 2 mm. thick; leaves crowded, imbricated, dark green, brownish below, oblong-lanceolate, 2–3 mm. long, .5–.75 mm. wide, concave, boat-shaped at back above, with a narrow groove down the back, margins sparingly ciliate, apex with a short yellowish-green bristle, .2–.35 mm. long; cones erect or diverging from the tips of the stems, sharply 4-angled, up to 2.5 cm. long (often much shorter); sporophylls triangular-lanceolate to ovate-lanceolate, sharply keeled, 2 mm. long, 1 mm. wide at base, margins smooth or finely ciliate; megaspores 360–485 μ in diameter, smooth or slightly undulate in outline, surface with low reticulate ridges.

In dry rocky ledges and talus slopes. Our commonest species in high mountains throughout the state. Western Montana, Utah and California.

ILLUSTRATION: Figs. 141-144.

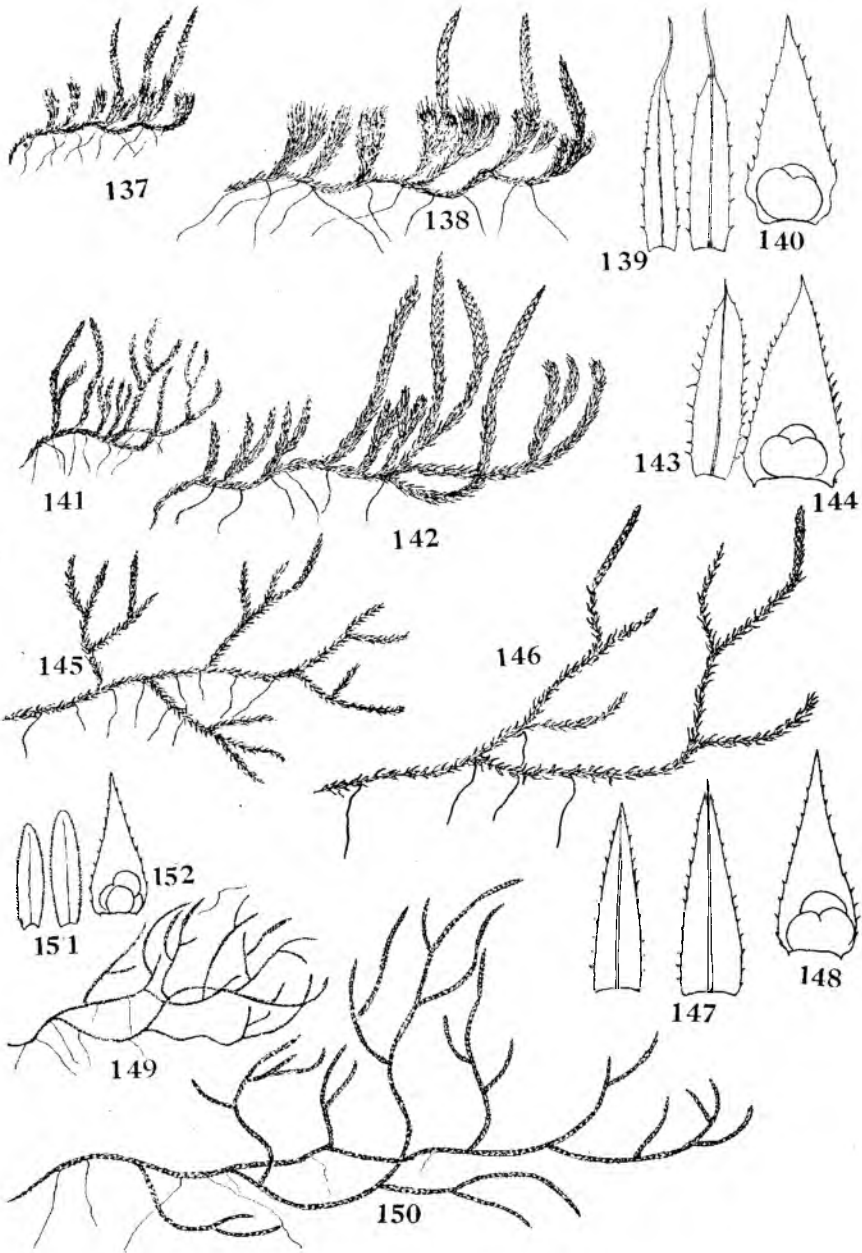
COLLECTIONS: Flowers 3224. Big Cottonwood Canyon, 3229. Above Lake Blanche, Salt Lake County, 3227. Pittsburg Lake, American Fork Canyon, Utah County, 3225, 3228. Above Granddaddy Lakes, Duchesne County, 3226. Wolf Creek Summit, Wasatch County; Cottam 3732. Mt. Agassiz, Duchesne County, 7164. Ibapah, Deep Creek Mountains, Tooele County, 8082. Zion National Park, Washington County, 9139. Aquarius Plateau, Garfield County; Garrett 1397. Big Cottonwood Canyon, Salt Lake County, 3754. Mt. Timpanogos, Utah County; B. Y. Summit of Rosvere Mountain, Boxelder County, 7634. Moon Lake, Duchesne County, 3498. Puffer's Lake, Beaver County, 4458. Aquarius Plateau, Wayne County; I. H. 20080. Pine Valley, Washington County, 40666. Mt. Ellen, Henry Mountains, Garfield County, 17238. Zion National Park, 40665. Santa Clara Creek, Washington County.

3. *Selaginella underwoodii* Hieron. in Engler & Prantl, Pflansenfam. 1 : 714, 1901.

Selaginella rupestris fendleri Underw. Bull. Torr. Club 25 : 127. 1898.

Selaginella fendleri (Underw.) Heiron. Hedwigia, 39 : 303. 1900, not Baker, 1887.

Plants in spreading tufts or mats, stems slender, becoming 20–30 cm. long, creeping; branches long and distant, spreading, up to 8 cm. long, prostrate or ascending; leaves rather loosely imbricated, dark green, 2–3 mm. long, lanceolate, oblong-lanceolate to triangular-lanceolate, tapering at the apex, tipped with a pale yellowish bristle .4–.9 mm. long, margins shortly and distantly ciliate. Cones ascending or erect, up to 3 cm. long; sporophylls triangular-ovate to triangular-lanceolate, 1.5–2.5 mm. long, apex shortly mucronate, margins sparingly ciliate; megaspores 350–450 μ in diameter, nearly smooth in outline, surface with low, wide ridges, reticulate or verrucose, often merely wrinkled with low irregular ridges.



Figs. 137-140. *Selaginella densa*. 137. Habit X 1; 138. habit X 2; 139. vegetative leaves X 15; 140. sporophyll with megasporangium X 15.
Figs. 141-144. *S. watsoni*. 141. Habit X 1; 142. habit X 2; 143. a vegetative leaf X 15; 144. sporophyll with megasporangium X 15.
Figs. 145-148. *S. underwoodii*. 145. Habit X 1; 146. habit X 2; 147. vegetative leaves X 15; 148. sporophyll with megasporangium X 15.
Figs. 149-152. *S. mutica*. 149. Habit X 1; 150. habit X 2; 151. vegetative leaves X 15; 152. sporophyll with megasporangium X 15.

In rocky ledges and crevices, usually in shaded places. Southern Utah, probably in the eastern portion also. Wyoming to western Texas and Arizona.

ILLUSTRATION: Figs. 145-148.

COLLECTIONS: Flowers 3232, 3233, 3234, Mt. Carmel, Zion National Park; Cottam 4768, 6993. Zion National Park, Washington County.

4. *Selaginella mutica* D. C. Eaton, in Underw. Bull. Torr. Club
25 : 128. 1898.

Selaginella watsoni mutica Clute, Fern Allies, 144, 264. 1905.

Plants very slender, in widely spreading mats and masses; stems becoming 40 cm. long, distantly and somewhat pinnately branched, 1 mm. thick; leaves closely imbricated, in 6 distinct rows, 1 mm. long, 0.25-0.3 mm. wide, oblong to oblong-ovate, obtuse, the upper ones with very short hyaline points, margins with spreading cilia; cones slightly broader than the vegetative branches, sharply 4-angled, long and slender, 1-3 cm. long, often curved; sporophylls ovate-triangular, 1.5-1.8 mm. long, concave and keeled, margins ciliate, apex short bristle-tipped; megaspores 387-465 μ in diameter, undulate to nearly smooth in outline, surface with very broad, low ridges, nearly smooth or sometimes vaguely reticulate or pitted.

In crevices of rocks, often widely spreading over the surface. In cliffs and ledges. In our region it occurs mainly in sandstones and shale. Southeastern Utah from Carbon and Grand counties southward and across southern Utah to Washington county. Western Texas, southern Colorado, New Mexico and Arizona.

ILLUSTRATION: Figs. 149-152.

COLLECTIONS: Flowers 3230. Buckhorn Wash, Emery County, 3231. Below Verdure, San Juan County; Cottam 5617. San Raphael Swell, Emery County, 6509. North of Escalante, Garfield County; B. Y. 9802. Buckhorn Wash; I. H. 35523, 40667, Calf Spring Wash, San Raphael Swell, Emery County.

Family 7. ISOETACEAE Underw.

Plants submerged in shallow lakes and ponds or growing in air on muddy banks (in our region); stem a short thick corm, 2-3 lobed; roots slender, fibrous; leaves grass-like and forming a dense cluster on the apex of the corm, slender, linear or acicular, 3-4-angled, from expanded bases with broad membranaceous margins, each with a single scale-like ligule borne just above the sporangium; sporangia round, oval or oblong, flattened or thick, partially embedded in the leaf base and partially invested (in our species) by a thin overlapping lip-like margin, the velum; spores of two kinds borne in separate sporangia on the same plant; each season the outer (lower) leaves bear microsporangia with small granular, gray or fawn-colored microspores which are oblong, reniform or ovoid, while the inner (upper) leaves bear megasporangia. Megaspores with a prominent ridge forming an equator which is joined by three ridges at right angles, the latter meeting at the apex; surface smooth, low-crested, tuberculate, spiny or reticulate, white or gray; prothallia minute, wholly or more or less retained in the old spore coats which split open at maturity.

ISOETES L. Sp. Pl. 1100. 1753.

With characters of the family. The name, *Isoetes* (Greek), apparently refers to the persistent green leaves, since the word means equal year, that is, equal at all seasons of the year.

Three species are definitely known in Utah and a fourth may occur in the state. The species are variable and often difficult to match with descriptions. In Utah specimens the megaspore size seems to be less than that given for typical plants while the relative number of stomata and the degree of development of periferal strands in leaves vary widely. The various combinations in which these characteristics appear in certain specimens obscures the exact relationships. Dried plants must be soaked in water before they are examined. Portions of leaves heated a few moments in lactic acid show the stomata better and cross sections of the leaf assume a more natural shape. The megaspores show the surface markings better when examined dry and by reflected light against a dark background. For this purpose a shaded reading lamp placed close to the stage of the microscope is satisfactory. The apical faces of the megaspore are those bounded by the three ridges extending from the equator and converging at the apex while the basal face is the larger rounded surface opposite the apex.

- Megaspores 525-640 μ in diameter, marked with irregular crests on the apical faces and forming irregularly branched ridged or a network on the basal face; plants submerged. 1. *I. paupercula*
- Megaspores 280-580 μ in diameter, low-crested to densely spiney, often with short branched ridges but not forming a noticeable network.
- Plants amphibious, submerged or growing in air; stomata usually numerous (few), periferal strands usually 4 (2-3 in ours), ligule elongate triangular or acuminate; megaspores 420-520 μ in diameter (350-420 μ in ours) with low crests or branched ridges in vague designs. 2. *I. howellii*
- Plants submerged; stomata none or few (often numerous in ours), periferal strands lacking; megaspores smaller.
- Megaspores 300-400 μ in diameter with blunt papillae or short ridges in vague designs; ligule cordate, small. 3. *I. bolanderi*
- Megaspores 420-580 μ in diameter (300-400 μ in ours), strongly papillose to densely spiny, often ridged. 4. *I. braunii*

1. *Isoetes paupercula* (Engelm.) A. A. Eaton in Maxon,

Proc. U. S. Nat. Mus. 23 : 649. 1901.

I. lacustris var. *paupercula* Engem. Trans. St. Louis Acad. Sci. 4 : 377. 1882.

I. occidentalis Henderson, Bull. Torr. Club, 27 : 358. 1900.

Corm 2-lobed; leaves commonly 9-30, rarely 60, 5-20 cm. long, dark green, rigid, gradually tapering, with wide membranaceous border at the base, extending 2-3 times the length of the sporangium above the level of the latter; periferal strands and stomata lacking; ligule short-triangular; sporangia almost orbicular, 5-6 mm. long with narrow velum (covering about one-third of sporangium); megaspores cream-colored, 525-640 μ in diameter, marked with low conspicuous irregular crests, chiefly simple on the apical faces, branching to form an irregular network on the basal face; microspores 24-42 μ long, spinulose. (From Pfeiffer, Norma E., Monogr. of the Isoetaceae, Ann. Missouri Bot. Gard. 9 : 79-232. 1922.)

Submerged in mountain lakes, Washington to Colorado and California. Not definitely known in Utah. Certain small specimens collected in Utah were formerly referred to this species but they have megaspores 300–350 μ in diameter and the leaves show numerous stomata. This description is included for convenient reference.

**2. *Isoetes howellii* Engelm. Trans. St. Louis Acad. Sci.
4 : 385. 1882.**

HOWELL'S QUILLWORT

I. nuda Engelm. l. c.

I. underwoodii Henderson, Bot. Gaz. 23 : 124. 1897.

I. melanopoda var. *californica* A. A. Eaton in Gilbert, List N. Amer. Pterid. 10, 27. 1901.

Corm 2-lobed; leaves 10–35, or more, 5–24 cm. long, erect to slightly spreading, aerial leaves tapering to slender points, submerged form with blunt points, basal membranaceous margin wide, extending 1–5 cm. above the sporangium, often abruptly narrowed; stomata numerous (few in many of our plants); periferal strands 4 (1–3 in ours), often weak; ligule elongate-triangular, often acuminate; sporangium orbicular to oblong, 3–7 mm. long or slightly longer, often spotted, about one-third covered by the velum; megaspores white, 420–520 μ in diameter (350–420 μ in ours), marked with low indistinct tubercles or low slightly branched ridges, crowded or distant; micros-pores 25–33 μ long, ovoid, fawn-colored, finely spinulose to smooth.

Submerged or growing in mud exposed to the air. Known in Utah only from Dry Lake in Cache County, Washington to Montana and Lower California.

Our specimens differ from the typical form in having smaller megaspores and few stomata. Submerged forms might be taken for *I. bolanderi* on these bases. Also the periferal stands are often weaker and fewer than typical, usually the upper (inner) angles of the leaf showing them. The ligule is usually typical but often some shorter ones may be found.

ILLUSTRATION: Figs. 153–158.

COLLECTIONS: Flowers 3000, 3001, 3010, 3012; Garrett 6298. Dry Lake, Cache County.

3. *Isoetes bolanderi* Engelm. Amer. Nat. 8 : 214. 1874.

BOLANDER'S QUILLWORT

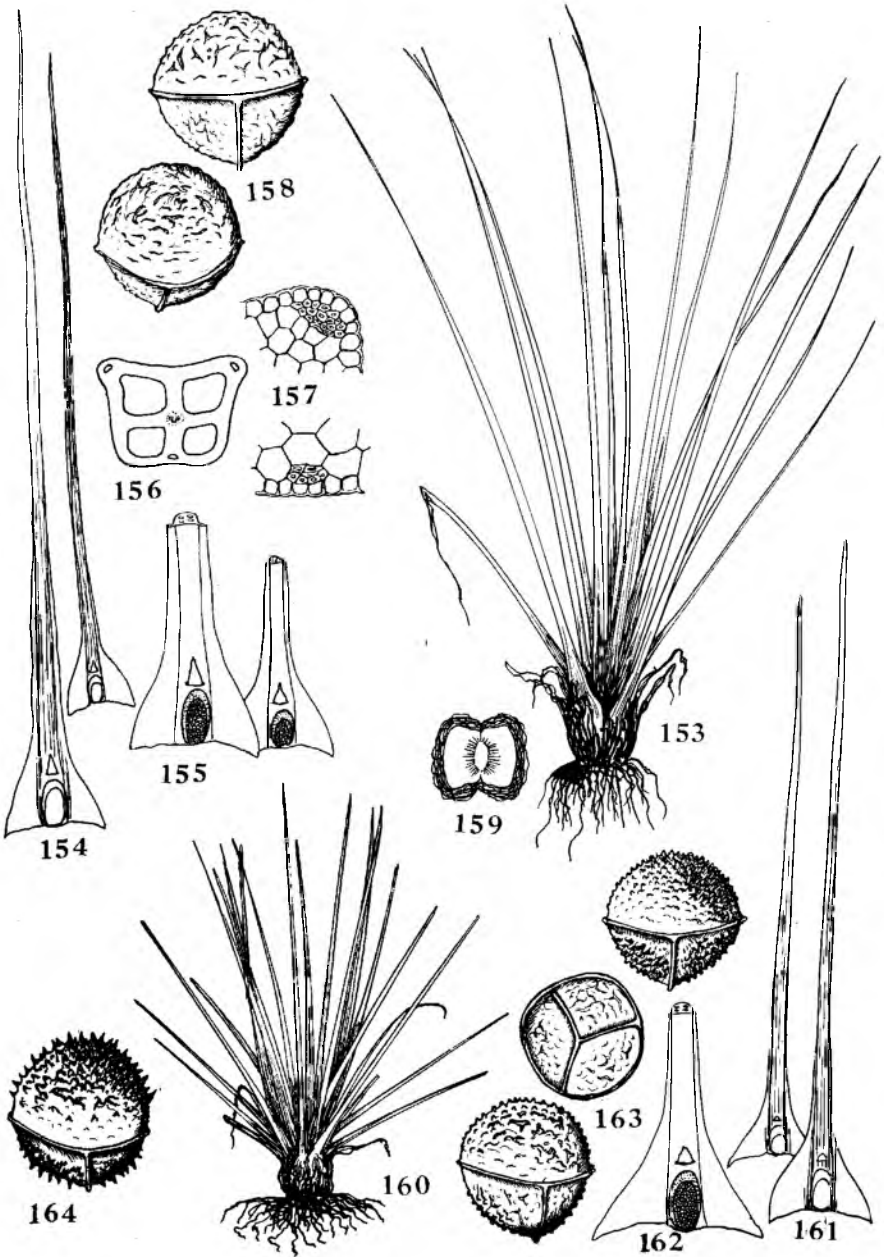
Isoetes californica Engelm. in Gray, Man. ed. 5. 677. 1867.

I. bolanderi var. *parryi* Engelm. Amer. Nat. 8 : 214. 1874.

Calmaria bolanderi (Engelm.) Kuntze, Rev. Gen. Pl. 2 : 828. 1891.

Isoetes bolanderi var. *sonnei* Henderson, Bull. Torr. Club, 27 : 349. 1900.

Corm 2-lobed; leaves 6–25, up to 25 cm. long, mostly 4–15 cm. long, slender and tapering to very fine points, usually weak and somewhat flaccid; stomata few (numerous in some of our plant); periferal strands usually lacking (1–2 very weak ones present in the upper [inner] angles in some plants); ligule small, cordate; basal membranaceous border extending 1–3 cm. above the sporangium, usually narrow; sporangium 3–6 mm. long, orbicular to oval, one-third or less covered by the velum; megaspores white or slate-colored, 300–



Figs. 153-159. *Isoetes howellii*. 153. Habit X $\frac{1}{2}$; 154. leaves X 1; 155. leaf bases showing sporangia X 2; 156. cross section of leaf showing position of the periferal strands X 20; 157. portions of the leaf tissue showing the periferal strands X 100; 158. megaspores X 50; 159. cross section of the corm X 2.

Figs. 160-163. *I. bolanderi*, 160. Habit X $\frac{1}{2}$; 161. leaves X 1; 162. leaf base showing sporangium X 2; 163 Megaspores X 50.

Fig. 164. *I. braunii*, megaspore X 50. (Note: the general habit is like that of *I. bolanderi*).

440 μ in diameter, marked with low or medium-sized papillae or crests, often converging in short ridges forming vague designs; microspores 23–32 μ long, ovoid, fawn-colored, finely spinulose.

Submerged in mountain lakes or ponds. Wasatch and Uintah mountains in Utah; British Columbia to Wyoming, Colorado, Arizona and California.

ILLUSTRATION: Figs. 160-163.

COLLECTIONS: Flowers 3007, City Creek Canyon, Salt Lake County, 3005. Pittsburg Lake, American Fork Canyon, Utah County, 3002, 3003, 3004, Lily Lake, and Trial Lake, Uintah Mountains, Summit County; Garrett 1928. Lake Phoebe, Salt Lake County, 4052. Pool near Mirror Lake, Summit County; I. H. 2734. Mirror Lake, 2737. Lily Lake, 3085, 3086, Henry's Fork Lake, Summit County, 3084. Fish Lake, Sevier County, 40735. Lake Martha, Salt Lake County.

4. *Isoetes braunii* Durieu, Bull. Soc. Bot. France, 11 : 101. 1864.

BRAUN'S QUILLWORT

Isoetes echinospora var. *braunii* (Dur.) Engelm. in A. Gray, Man. ed. 5, 676. 1867.

I. echinospora var. *bootii* Engelm. l. c. 1867.

I. echinospora var. *muricata* (Dur.) Engelm. l. c. 1867.

I. ambigua A. Br. in Engelm. Trans. St. Louis Acad. Sci. 4 : 380. 1882.

I. echinospora var. *truncata* A. A. Eaton in Gilbert, List of N. Amer. Pterid. 10, 27. 1901.

I. truncata (A. A. Eaton) Clute, Fern Allies, 222, 260. 1905.

I. echinospora var. *brittoni* Cockerell, Muhlenbergia 3 : 9, 1907.

Corm 2-lobed; leaves 10–35, up to 55 in robust forms, 8–25 cm. long, straight and strict, the outer ones recurved, tapering to a blunt point, basal membranaceous border narrow, extending 1–2 cm. above the sporangium, stomata usually few (lacking or rather abundant in some plants); periferal strands lacking; ligule deltoid; sporangium ovoid to oblong, 3–8 mm. long, spotted, velum covering $\frac{1}{4}$ – $\frac{1}{2}$ of it (completely covering it in eastern forms); megaspores 420–580 μ in diameter (300–420 in most of our plants), marked with prominent and often very dense spines, sharply or bluntly tipped, sometimes converging in toothed ridges; microspores 23–33 μ long, ovoid, fawn-colored, smooth or very finely papillose.

Submerged in mountain lakes and ponds. In the Wasatch and Uintah Mountains in Utah; Alaska to Newfoundland, New Jersey, Indiana, Colorado and California.

ILLUSTRATION: Fig. 164.

COLLECTIONS: Watson 1371. U. S. National Herbarium, N. Y. Botanical Gardens Herbarium and Missouri Botanical Gardens Herbarium. Lake near head of Bear River, Uintah Mountains, Summit County.

GLOSSARY

- Acuminate:** Curving inward and tapering to a point.
- Acute:** Coming to an angular point at the tip.
- Annulus:** A band or ring of heavily thickened cells on a sporangium which thicken when dry, tearing the spore sac open.
- Antheridium:** The male reproductive organ; a sac bearing antherozoids or male gametes.
- Antherozoid:** Male germ cell or gamete.
- Apiculate:** Ending in a minute point.
- Archegonium:** The female reproductive organ bearing the egg.
- Ascending:** Curving upward from the ground.
- Awl-shaped:** Like an awl; very slender and evenly tapered to a sharp point.
- Bi-:** Prefix meaning two, double or twice.
- Bipinnate:** Twice pinnate (Fig. 1-b).
- Carinate (carinae):** Having longitudinal ridges; keeled.
- Ceraceous:** Waxy on the surface; either smooth or appearing as if sprinkled with waxy meal.
- Chlorophyll:** The green coloring matter in plants.
- Ciliate:** Having a fringe of hairs along the margin.
- Circinate:** Rolled inward; curved like a sickle.
- Cleft:** Cut about half way to the base or middle.
- Compound:** Divided into secondary units.
- Confluent:** Non-diverged; not separated; as if grown together.
- Cordate:** Heart-shaped.
- Corm:** A thick, fleshy stem.
- Crenate:** Scalloped; having rounded tips and angular notches.
- Cuneate:** Wedge-shaped.
- Deciduous:** Falling away, either soon after formed or at the end of the growing season.
- Decomound:** Twice or more times compound.
- Decurrent:** Winged at the base; having the base prolonged down the stem, rachis or stalk in wing-like fashion.
- Decumbent:** Bending over and touching the ground or nearly so.
- Deltoid:** Shaped like an equilateral triangle.
- Dentate:** Toothed; having the teeth at right angles.
- Dichotomous:** Forked or repeatedly forked.
- Dimorphic:** Of two forms or sizes.
- Divided:** Cut to the base or middle, or nearly so.
- Echinulate:** Spiny, with sharp projections.
- Egg:** The female germ cell or gamete.
- Elator:** Appendages or specialized cells which aid in scattering spores.
- Elliptical:** 2-4 times as long as broad, both ends about equally pointed, and broadest in the middle.
- Erose:** Ragged at the margin.
- Falcate:** Curved to one side.
- False indusium:** The reflexed or recurved margin of a leaf covering the sori. Not a true indusium but serves a similar purpose.
- Fertile:** A fern bearing spores when collected or observed.
- Fluted:** Having alternate longitudinal ridges and furrows.
- Fronde:** A fern leaf (an older term).
- Fruiting:** Same as fertile; producing spores.
- Gamete:** A sex cell or germ. Antherozoid or egg.
- Gametophyte:** A plant bearing gametes or sex organs only. Prothallus.
- Glabrous:** Without hairs or scales; naked; smooth.
- Glandular:** Having glands; surfaces or swellings secreting fluids.

- Globose: Like a little globe or sphere.
- Heterospory: Having spores of two sizes.
- Hirsute: Having stiff hairs.
- Hyaline: Pale whitish, translucent; like frosted glass.
- Hydrophyte: A plant growing in or near water.
- Hygrosopic: A plant or a part responding markedly to changes in the amount of water or moisture present. Sudden swelling or shrinking with changes in moisture.
- Imbricated: Having the leaves or other parts closely overlapping like shingles.
- Incised: Sharply and deeply cut.
- Indusium: A hood or covering over the sori.
- Inferior: Borne below or under a given organ.
- Isospory (isospores): All spores alike; same size and form.
- Keel: Sharply ridged at the back like the keel of a boat.
- Lanceolate: Lance-shaped; like the head of a spear.
- Ligule: A leaf-like appendage at or near the base of sporophylls.
- Linear: Long and slender with the margins more or less parallel.
- Lobe: A segment or part of any cut organ.
- Lobed: Cut about one fourth the way to the base or middle.
- Lunate: Crescent-shaped.
- Mealy: Surfaces appearing as if sprinkled with meal.
- Megaspore: A large spore giving rise to a female plant (prothallus).
- Microsporangium: A sac bearing microspores only.
- Megasporophyll: A leaf bearing only megaspores, usually modified.
- Mesophyte: A plant growing in moderately moist or damp places during its fruiting season.
- Microspore: A small spore giving rise to a male plant (prothallus).
- Microsporangium: A sac bearing microspores only.
- Microsporophyll: A leaf bearing only microspores, usually modified.
- Montane: Pertaining to the mountains; growing in mountains.
- Mucronate: Ending with a short abrupt point; sharp tip of the midrib.
- Oblanceolate: Lanceolate reversed, the narrow end lowermost.
- Oblique: Lop-sided at the base; At an angle of 45°.
- Oblong: 3-6 times longer than broad, margins more or less parallel.
- Obovate: Ovate reversed, the narrow end lowermost.
- Obtuse: Rounded or blunt at the apex.
- Orbicular: Round in outline.
- Oval: 2-3 times longer than broad, rounded equally at both ends.
- Ovate: Like a longitudinal section of a hen's egg, the broad end lowermost.
- Ovoid: Egg-like; usually applied to solid figures.
- Palmate: Divided like the palm of the hand; segments radiating from a common center.
- Papillose: Beset with little projections.
- Parted: Cut about $\frac{3}{4}$ the distance to the base or middle.
- Pedicel: The stalk of a fruit or a fruiting organ, i.e. sporangium.
- Peltate: Shield-shaped; attached at the center.
- Pinna: The primary division of a compound leaf (Fig. 1).
- Pinnate: A leaf with a midvein like a feather; applied to fern leaves that are once compound pinnate (Fig. 1).
- Pinnatifid: Pinnately cut; variously lobed, cleft, parted, divided.
- Pinnule: Secondary division of bi- or decomposed leaves (Fig. 1-b).
- Prothallus (-ium): The sexual fern plant; gametophyte generation.
- Puberulent: Ashy; with very fine hairs.
- Pubescent: With moderately soft hairs; hairy.
- Quadripinnate: 4 times pinnate.

- Rachilla: A little rachis; secondary rachises.
- Rachis: The midvein of a compound leaf; naked prolongation of the stripe belonging to the leaf blade (Fig. 1.)
- Recurved: Curved backward rather widely.
- Reflexed: Sharply bent backward.
- Reticulate: Having net-like or branched ridges.
- Revolute: Rather closely curved or rolled backward.
- Rhizoids: Root-like hairs on the prothallium.
- Rhizome: An underground stem, the tip horizontal and never arising.
- Rootstock: An underground stem, the tip erect, often arising.
- Scabrous: Rough to the touch.
- Segment: A lobe or division.
- Serrate: Saw-toothed; with teeth directed forward.
- Sessile: Sitting; without an evident stalk.
- Silex: Silica; local accumulations in plants as in the tubercles and bands on the stem ridges of *Equisetum*.
- Simple: Single; not cut or divided in any way; not branched.
- Sinus: The notch or angle between lobes or segments.
- Sorus: A fruiting dot or band of ferns; a cluster of sporangia.
- Spinulose: Spine-tipped; spiny.
- Sporangium: A spore sac or capsule.
- Spore: A minute, usually microscopic, asexual germ cell.
- Sporocarp: A seed-like spore-bearing organ; a highly modified sporophyll enclosing the sori.
- Sporophyll: A specialized leaf bearing spores; may be similar to or very different from the sterile leaves.
- Sterile: Not fruiting; not producing spores; vegetative.
- Stripe: A leaf stalk; petiole of fern leaves (Fig. 1).
- Stomata: Microscopic pores in the surfaces of leaves and stems.
- Strobilus: A cone: a cluster of sporophylls closely disposed.
- Terete: Round in cross section; round.
- Ternate: Three times divided.
- Tomentose: With dense woolly, tangled hairs.
- Tripinnate: Three times pinnate.
- Truncate: Cut off sharply.
- Tuberculate: Beset with coarse irregular projections.
- Tubercle: A small rounded projection.
- Ultimate segment: The last or smallest lobes or divisions.
- Undulate: Wavy on the margins or in outline.
- Velum: A thin, overlapping tissue partially covering the sporangium in *Isoetes*.
- Vernation: The mode of unfolding of a leaf. Coiled in ferns.
- Verrucose: Warty; beset with coarse projections or ridges; rough.
- Villous: Surfaces bearing long and soft hairs.
- Xerophyte: A plant growing in a dry situation.