WISCONSIN STATE UNIVERSITY--LA CROSSE

GRADUATE SCHOOL

Candidate: James Douglas Noltner

I recommend acceptance of this seminar paper to the Graduate School in partial fulfillment of this candidate's requirements for the degree Master of Science. The candidate has completed his oral seminar report.

July 28, 1965
Date

Dr. A. Vincent Weber
Seminar Paper Advisor

This seminar paper is approved for the Graduate School:

July 29, 1965
Date

James H. McEnilon
Dean, Graduate School

# THE FERNS AND FERN ALLIES OF OZAUKEE COUNTY, WISCONSIN

---

A Seminar Paper

Presented to

the Department of Secondary Education

Wisconsin State University, LaCrosse, Wisconsin

---

In Partial Fulfillment

of the Requirements for the Degree

Master of Science

---

by

James Douglas Noltner

July 1965

WS
6F
No

# THE FERNS AND FERN ALLIES OF OZAUKEE COUNTY, WISCONSIN

by

JAMES DOUGLAS NOLTNER

## ABSTRACT

This is a study of some ferns and fern allies of Ozaukee County, Wisconsin. A general discussion of the structure and reproductive patterns of the plant phylum, Pteridophyta, is presented.

Eleven species of ferns and five species of fern allies were collected, pressed, identified and mounted on herbarium paper. Photographs of these specimens may be found in Chapter III. A general description of each family and its genera is provided. A detailed description of each species collected in Ozaukee County is included.

TABLE OF CONTENTS

LIST OF FIGURES

FIGURE PAGE

# I. INTRODUCTION

The ferns and fern allies in this report have been collected from various habitats in Ozaukee County, Wisconsin. These plants comprise the plant group known as the Pteridophyta. (3) The ferns found in Ozaukee County are represented by three families, the Polypodiaceae, Osmundaceae and Ophioglossaceae: the fern allies are represented by two families, the Equesetaceae and Lycopodiaceae. A general discussion of the reproductive cycle of ferns and fern allies will be followed by a description and photograph of each specimen collected in Ozaukee County.

## Statement of the Problem

It is the intent of this study to collect and identify representatives of ferns and fern allies found in Ozaukee County. The specimens collected will be added to the herbarium collection of Homestead High School, and can then be used in helping students to identify all forms of pteridophytes in this locality.

## Purpose

The purpose of this study is to help students in the identification of ferns and fern allies that are found in Ozaukee County. The students that will be benefited from this study will be those taking courses in general science and biology in the elementary and high schools in Ozaukee County.

## Need for the Study

Although there are many books written on ferns and fern allies, including one titled "Ferns and Fern Allies of Wisconsin" by Tryon, Fasset, Diemer and Dunlop (10) there is not a specific report on the pteridophytes of Ozaukee County. This study will make the identification of ferns and fern allies in this locality much simpler for all teachers and students of general science and biology. The availability of specimens in such a collection might increase the interest and use of pteridophytes in such science courses.

## Delimitations

The results of this study will be significant only to the schools in Ozaukee County that have general science and biology in the school curriculum.

## Basic Assumptions

It is assumed that the researcher will find, collect, identify and mount on herbarium paper specimens of all species of ferns and fern allies in Ozaukee County.

## II. RELATED LITERATURE

The plant kingdom is divided into four phyla, of which one is named Pteridophyta. It includes all ferns and fern allies. The phylum in turn is grouped into four classes; Equisetinae, Lycopodiinae, Isoetinae and Filicinae. The classes are further divided into seven orders, the orders into eleven families, and the families into thirty-three genera. (3)

The ferns and fern allies of today are representatives of a form of plant life that occured in greater abundance during earlier geologic periods of time. Most of the ferns that are living today are relatives of the ferns that existed during the Mesozoic and Cenozoic Eras. The ferns that are most familiar to us today probably developed during the last one hundred million years. (4)

FERNS

The true ferns are represented by three families in Ozaukee County, Ophioglossaceae, Osmundaceae and Polypodiaceae. The family Ophioglossaceae is found in the class Filicinae, and then in the subclass Eusporangiatae. This family is then represented by two genera, Ophioglossum and Botrychium. The family Osmundaceae and Polypodiaceae are also found in the class Filicinae, however, they are classed into the subclass Leptosporangiatae. The family Osmundaceae is represented by one genus, Osmunda, while the family Polypodiaceae has twenty genera. Ozaukee County is represented by seven of the genera; Cystopteris, Onoclea, Athyrium, Camptosorus, Thelypteris, Adiantum and Pteridium.

The structures of the fern plant differ somewhat from those of the

ordinary flowering plant. Hence, a general description of a fern is necessary to a basic understanding of this plant.

The rootstock or what is commonly called the rhizome is the portion of the plant that supports the roots below ground while the stalk or stipe supports the above ground parts. Figure 1. The shape of the rhizome may vary with the species. In some species it may be short and thick, and completely buried or nearly so, while in other species it may be elongated and cylindrical, growing horizontally below the soil or on the surface of the ground. The rhizomes of most ferns are covered with scales or hairs. (9)

The roots of ferns are usually thin and wiry, and grow in the surface layers of the soil. It is most common to find roots growing laterally and basally on the rhizomes. Figure 1.

The leaf stalk, or what is more commonly referred to as the stipe in ferns is the basal portion of the leaf extending from the rhizome to the first leaflet or pinna. (3) Figure 1. The stipe supports the upper leafy part, or what is referred to as the frond of the fern. The stipe may be flat or concave on the ventral side, and convex on the reverse side. It is covered with hairs or scales, especially in younger plants. The stipe may be tan, brown, silver or black in color. (9)

The frond is the leaf of the fern plant. It is the flat, green and expanded portion of the fern. It contains chlorophyll, therefore it is the photosynthetic portion of the plant. Figure 1. The frond is also the reproductive portion of the plant. A fertile frond or sporophyll will bear spores, usually on its lower surface. Spores are typically formed by ferns as a means of reproduction. The frond may be

simple, which means it is undivided, or it may be divided into leaflets or pinnae in which case it is said to be compound. (3) Figure 2.

The leaflets or pinnae of the fern are attached and supported by the axis or rachis, that portion of the frond located above the stipe. Figure 1. If the frond is once divided it is said to be pinnate. (3) An example of this type of division would be Onoclea sensibilis L., the Sensitive Fern. If each of the pinnae are divided once again the sub-divisions are called pinnules and the frond is said to be bipinnate. Figure 2. An example of this type of frond would be Osmunda claytoniana L., the Interrupted Fern. If the pinnules are divided again, the divisions are called pinnulets. Figure 2. The frond is then said to be tripinnate. (3) An example of this type is Athyrium Filix-femina (L.) Roth, the Lady Fern.

The arrangement of the veins in the pinnae is often of importance in classifying a fern. The pinnae may have dichotomous venation which shows several veins branching from a common vein, or pinnate venation which shows one main vein with several smaller veins branching from it and extending to the margins. A third arrangement shows several veins extending parallel to each other from the base of the pinnae to the tips.

The pteridophytes differ from the familiar flowering plants in their method of reproduction. Each of the four classes of pteridophytes has its own specific characteristic behavior in producing, bearing and propagating its spores. (3)

The general life cycle appears as follows: the typical fern plants produce spores, the spores then develop into minute gametophytes and finally the gametophytes produce the new fern plants.

In an attempt to idicate the general reproductive behavior, a description of Dryopteris marginalis (L.) Gray, the Marginal Woodfern will be given.

In early summer, on the underside of the pinnules of the fertile fronds there appear very tiny green, round spots. The areas are called sori and mature rapidly, turning dark brown in color. The word sori is derived from the Greek word which means "heaps." (3) Sori are clusters of extremely tiny sporangia which bear and enclose the spores. The sori of the Marginal Woodfern are found to be covered by a very thin membrane, the indusium. It develops from the surface and functions as a protective covering for the immature sporangia. (4) Once the sporangia have reached maturity the indusium ruptures. The sporangium is a small round capsule-shaped structure composed of a single layer of sterile cells. It is attached to the frond by a tiny stalk. (3) Figure 3. Around the sporangium is a thickened ring of cells called the annulus. When the sporangium is mature the annulus ruptures it just above the stalk dispersing the spores. (3) Figure 3-A. The annulus does this by snapping the top portion of the sporangium backward and then forward again to its original position. The sporangium with its annulus are very sensitive to changes in moisture content, hence rupturing and scattering of the spores takes place only when the air is rather dry. (3)

A single fern plant produces many thousand and possibly up to millions of spores in one season. One botanist estimated fifty-two million spores were produced by one specimen of Dryopteris marginalis (L.) Gray. (3) This is possible since each sporangium usually contains

sixty-four spores, and each sorus possesses many sporangia, and each pinnule bears at least a dozen seri, and hundreds of pinnules compose a fertile frond.

The ideal environment for the germination of the spore is a shady, moist area with the proper temperature. In this environment the spore begins to develop into a prothallus or gametophyte. The one-celled spore germinates by dividing to form several cells, some of which elongate to form root-like hairs which anchor the developing prothallus in the soil. The prothallus then continues its development until it has grown into a green, membranous body about $\frac{1}{4}$ of an inch in size and the shape of a heart. (3) Figure 4. The sex organs of the plant then develop on the underside of the gametophyte plant.

The male sex organs, commonly referred to as antherida, are found near the apex of the heart-shaped structure, while the female sex organs, archegonia, are located near the notched portion. (3) An archegonium consists of a sterile neck and an enlarged base embedded in the prothallus. Figure 5. The base of each archegonium bears a single egg, however, there are usually twenty or more female organs found on each prothallus. (3) Once the female organs are fully developed they are ready to receive the sperms or antherozoids from the male organs. There are many more antheridia than archegonia. Each is rather short and spherical and produces many antherozoids. (3) Figure 6. The antherozoids are corkscrew shaped with cilia at one end. By means of the cilia the sperms may swim through the available film of moisture to the eggs located in the archegonia. (3) Figure 6-A.

When the prothallus has fully developed, the antherozoids are

released, but only when there is moisture present. At the time the antherozoids are being released, the necks of the archegonia open, releasing a sperm attracting chemical which attracts them toward the female archegonium. (3)

After one egg is fertilized, the neck closes as do the necks of all archegonia located on the prothallus. Most commonly only one plant will develop from each prothallus. However, if enough moisture is present it is possible that the antherozoids may swim to other prothalli and fertilize other eggs before closure. (3)

The fertilized egg then develops into an embryo which in turn develops into the typical fern plant. At first the young plant is anchored to the base of the female sex organ in the prothallus. (3) Roots eventually grow downward into the soil and anchor the newly forming plant, while a small frond grows upward through the notch of the prothallus. Figure 7. The prothallus supplies nourishment to the new plant until it develops chlorophyll and becomes photosynthetic. A fern plant will usually reach maturity in about seven years. (4) The reproductive pattern of most ferns follow this cycle rather closely.

## FERN ALLIES

The life cycles of the fern allies differ somewhat from that of the ferns, particularly with regard to the manner in which spores are produced.

### Clubmosses

The clubmosses belong to the family Lycopodiaceae, which is divided into two orders, Lycopodiales and Selaginellales. The order Lycopodiales is composed of one family, Lycopodiaceae, which has one genus, Lycopodium.

The order Selaginellales also is composed of one family, Selaginellaceae, which has one genus, Selaginella. This family is omitted from any further discussion since no specimens of Selaginella are included in the collection.

Clubmoss plants are small and usually evergreen, the stems being upright, or creeping in their growth habit. The leaves of these plants are small, simple and in most cases uniformly narrow and pointed. In the majority of species the leaves appear to be arranged in rows of from four to sixteen around the stem in spirals or in whorls or in an opposite pattern.

Their most common method of reproduction is asexually by means of rhizome growth. Each year the rhizome grows in length, and produce new branches. Later growth of previous years withers and dies, and consequently the newly formed rhizomes become separated from each other. In this manner colonies of individuals may be rapidly formed.

Some species of clubmosses reproduce a second way, by bulblets or plantlet, which will appear at the bases of the upper leaves. When developed they fall to the ground and start a new plant. An example is Lycopodium lucidulum, Michx., the Shining Clubmoss.

All clubmosses also possess the ability to reproduce by spores, which are found in cones or strobili, located terminally on the stem. Each fertile leaf or sporophyll in the cone produces one sporangium. The sporangia are kidney-shaped and yellow at maturity. The spores are numerous and microscopic in size, kidney-shaped and usually of a yellow color like the sporangia. (3) Spores of clubmosses mature in late summer or early fall, and are produced in enormous quantities.

The sporangium open by means of a longitudinal slit when mature and the spores are discharged usually as a fine dust-like material which is easily scattered by air currents. The gametophytes which are produced by the spores are also of minute sizes. In some species the spores germinate so that the gametophytes develop well below the surface of the ground, for others the gametophytes are found only moderately below the surface, while in still other cases the gametophytes develop on the surface of the ground. (3)

The gametophytes of the clubmosses are very difficult to find and study because of their microscopic size and subterranean location. Subterranean gametophytes are saprophytic in nutrition and are associated with an endophytic fungus. Those gametophytes that develop on the soil surface contain chlorophyll, and are thus photosynthetic in nutrition. It is believed that a spore takes approximately seven or more years to develop into the gametophyte, and an additional ten or more years to develop into a mature plant. Thus it takes a clubmoss almost twenty years to complete a life cycle, developing from a spore to a gametophyte and then to a mature plant. (3)

The gametophytes of some species are like minute, rounded tubers with tiny hair-like rhizoids at their base and lobes on their tops. (3) Most of the inner lobes bear the male sex organs, the antheridia, while the outer lobes bear the female sex organs, the archegonia. (3) Figure 8. The sperm which possess flagella swim to the eggs to effect fertilization. Hence, like the ferns, some moisture must be available in order for fertilization to occur. The embryo produced from the fertilized egg obtains its nourishment from the gametophyte until it becomes photosynthetic.

Horsetails

The horsetails comprise the order Equisetales, which has one family, Equisetaceae and one genus Equisetum. Horsetails are found in largest numbers in the temperate zones, with the number decreasing toward the poles and equator. They will grow in just about any kind of soil, ranging from dry sandy to gravelly, wet soils as well as being found on the banks of fast moving rivers and streams. (3)

The stems of the horsetail plants are annual, the above ground portion of the plant dying back each year, but the underground portion, the rhizome, is perennial. (12) The plant is seldom more than three feet high, however, there is one species found in the tropics which reaches heights of thirty or more feet. The stem of the plant has a distinct pattern of nodes and internodes which results in a symmetrical pattern, the plant often being referred to as jointed. Any branching which takes place does so in regular whorls. (9) Horsetails contain chlorophyll in both the main stem and branches, and therefore are photosynthetic. The stems of most species of horsetails are hollow except in the node areas. The external surfaces of the stems and branches are fluted with grooves and ridges that contain gritty silicon particles. (3) Leaves of the plant are small and scale-like and are produced in whorls. The bases of all the leaves in a whorl are united laterally to form a sheath like structure which surrounds the stem. (3) Branching species produce branches from buds located on the stem inside the base of the leaf sheath, so that each branch that develops penetrates the leaf sheath. Each branch has the same pattern of leaves, leaf sheaths, nodes and internodes as the main stem. Figure 9.

Internally branches and stems have a large central canal, referred to as the centrum. The centrum is then surrounded by smaller canals, called vallecular cavities. (3) Figure 10.

Rhizomes which constitute the subterranean portion of the plant range in length from a few inches to many feet. Rhizomes have nodes and internodes as do the above ground stems and branches, and are also fluted with grooves and ridges. They also have the equivalent of leaf sheaths, but they are densely covered with hairs and lack chlorophyll. (12)

A cone-like spike or strobilis develops at the top of each fertile stem. The strobilis may develop on a stem some distance above the last node or it may be found immediately adjacent to the node. Figure 11. The surface of the strobilis is composed of hexagonal scales tightly fitted together. A stalk extends from the center of each scale to the axis of the cone. Each stalk with its scale is called a sporangiophore. Sporangia are produced beneath the scale portion of the sporangiophore and extend lengthwise along the stalk. (3) At maturity the strobilis elongates slightly so that the sporangiophores become separated from each other. Figure 12. Upon longitudinal splitting of the sporangia, spores may be released. Figure 12-A.

The spores of the horsetails, like those of the ferns, are round or oval, and minute in size. Mature spores live only a few days, and can germinate in a few hours. (3) The outer spore wall splits into four ribbon-like structures, called elaters, which remain attached to the outer spore wall in only one area. Figure 13. Elaters are extremely hygroscopic in that they are affected by changes in atmospheric moisture and consequently may curl about the spore body or uncurl and extend away

from the spore body. Figure 13-A. This twisting action may aid in the dissemination of the spores. Elaters of adjacent spores often become entangled which results in many spores developing into prothalli in close proximity to each other. This may be of selective advantage in that fertilization may be effected with greater assurance. (3)

A comparison of the male and female prothalli finds the male prothalli to be extremely small, of yellowish green color and slightly lobed. The female prothalli are a great deal larger, almost one-half inch in size, being distinctly lobed and of a dark green color. Some species produce prothalli which bear both sex organs.

The antheridia, are usually the first to develop, with each one producing several hundred sperms. (3) Figure 14. Each sperm has numerous cilia at one end, with the other end flattened and widened into the shape of a paddle. Figure 15. The archegonia develop among the lobes along the edges of prothalli. (3) A single egg is located in the base of each archegonium. Figure 16. Once the egg is fertilized by a sperm it will develop into a horsetail plant.

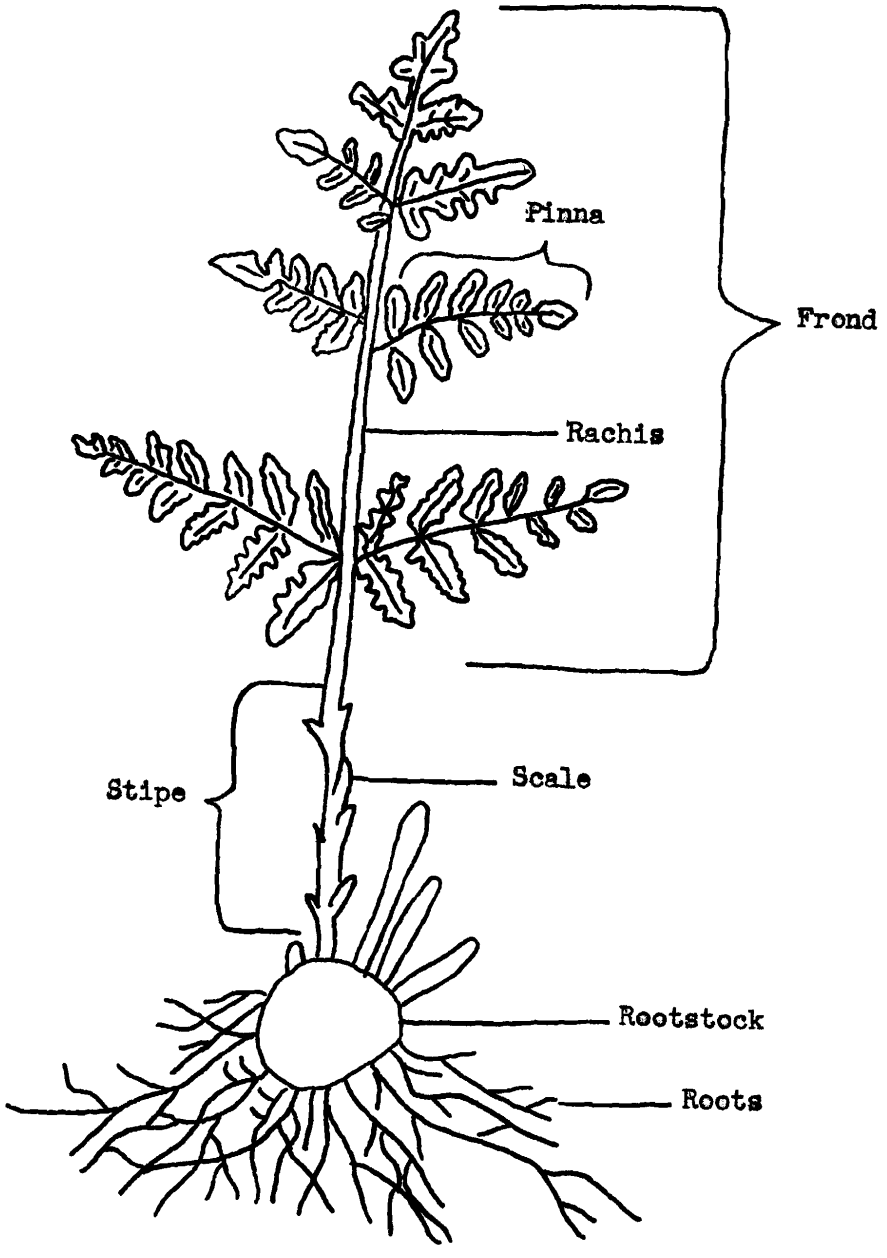



Figure 1
Fern Morphology

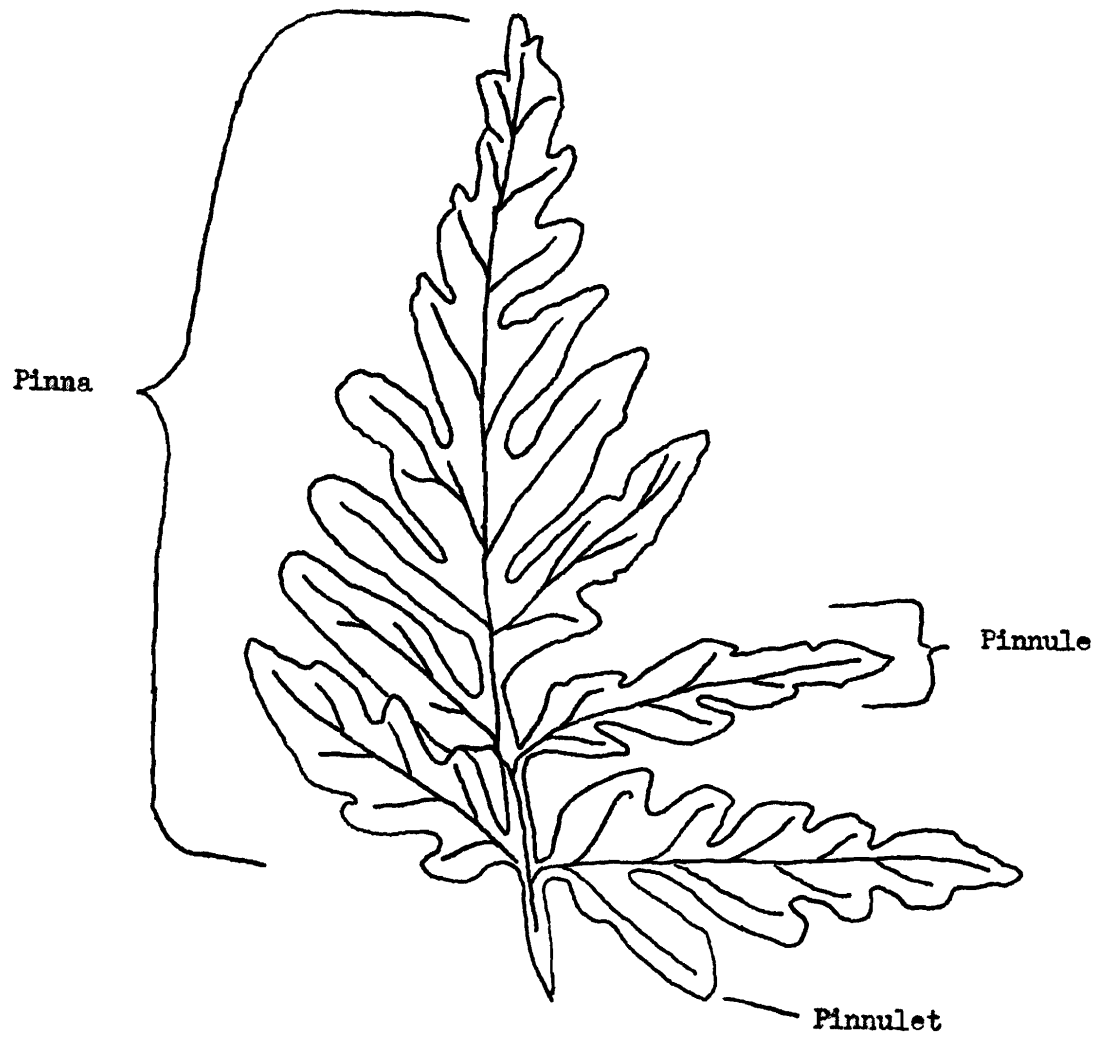



Figure 2
Pinna, Pinnules, Pinnulets

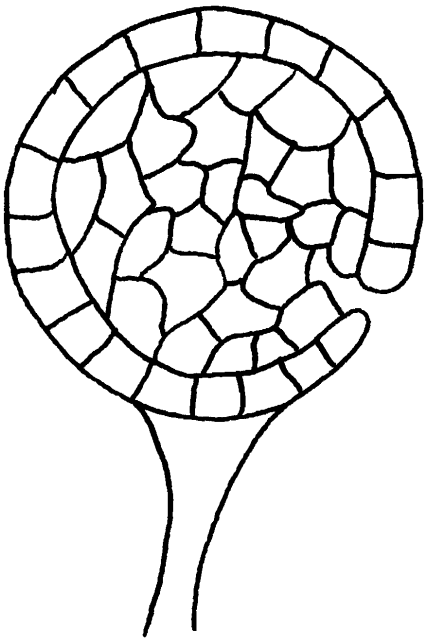


Figure 3
Fern Sporangium

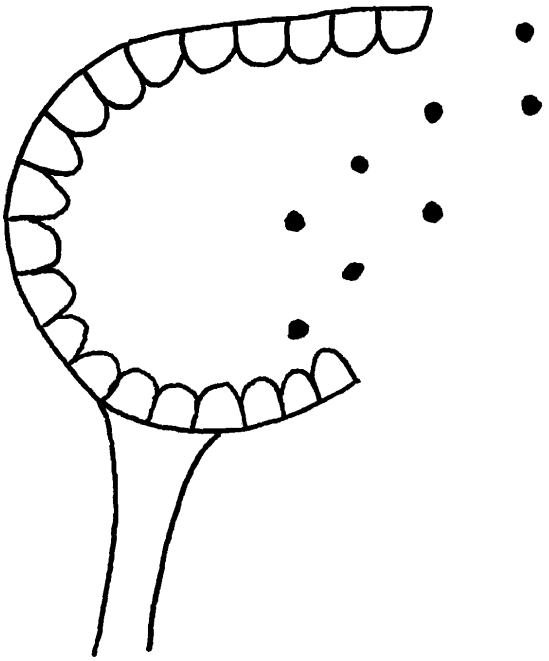


Figure 3-A
Ruptured Sporangium

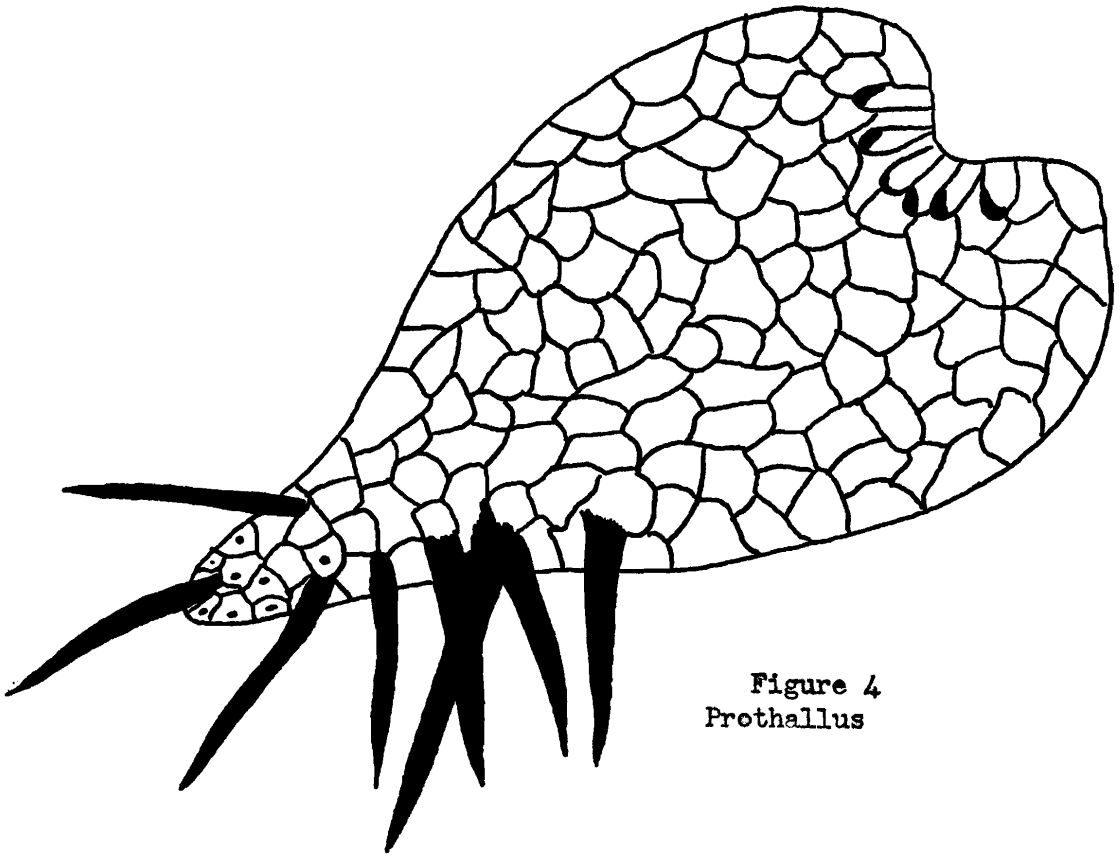


Figure 4
Prothallus

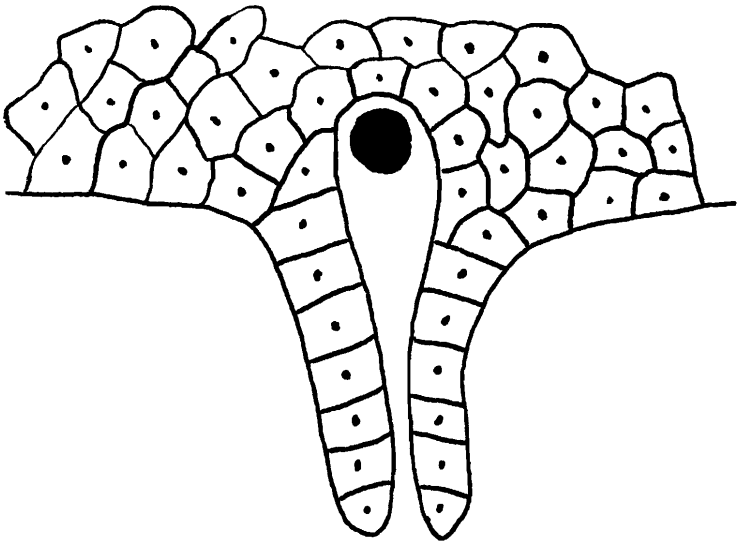


**Figure 5**
Archegonium

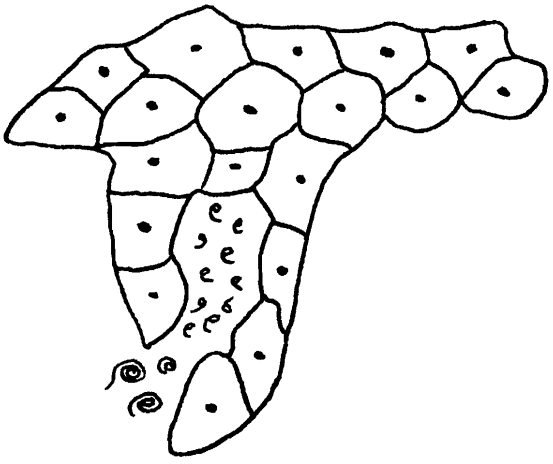


**Figure 6**
Antheridia and Antherozoids

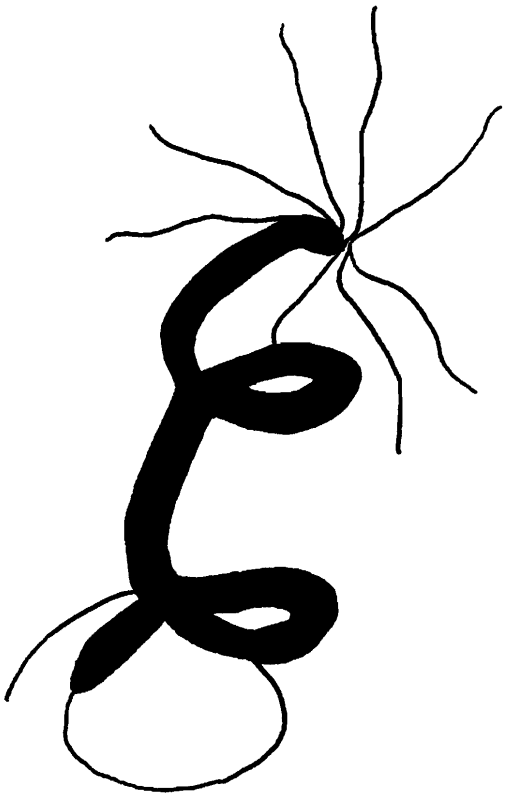


**Figure 6-A**
Sperm

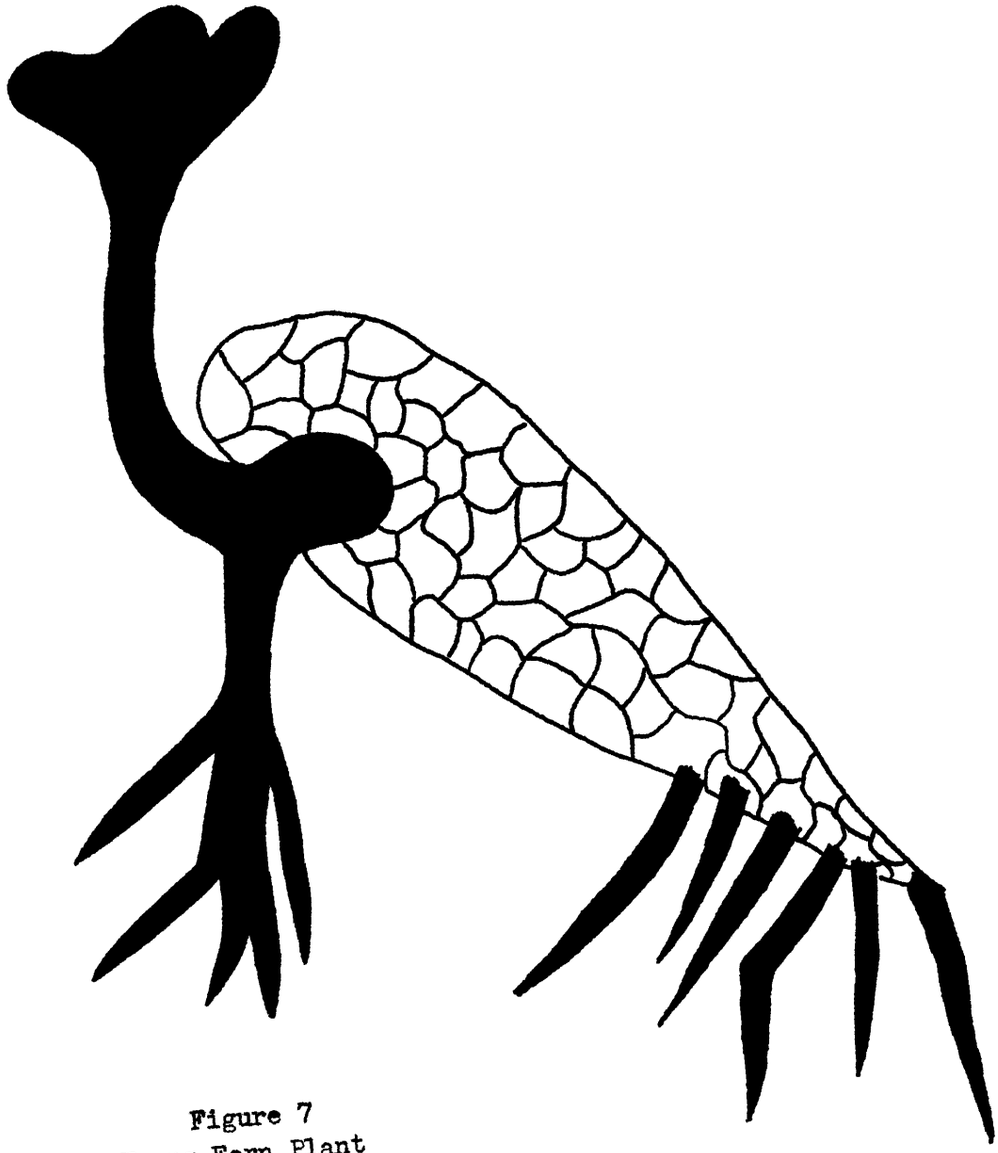


Figure 7
Young Fern Plant

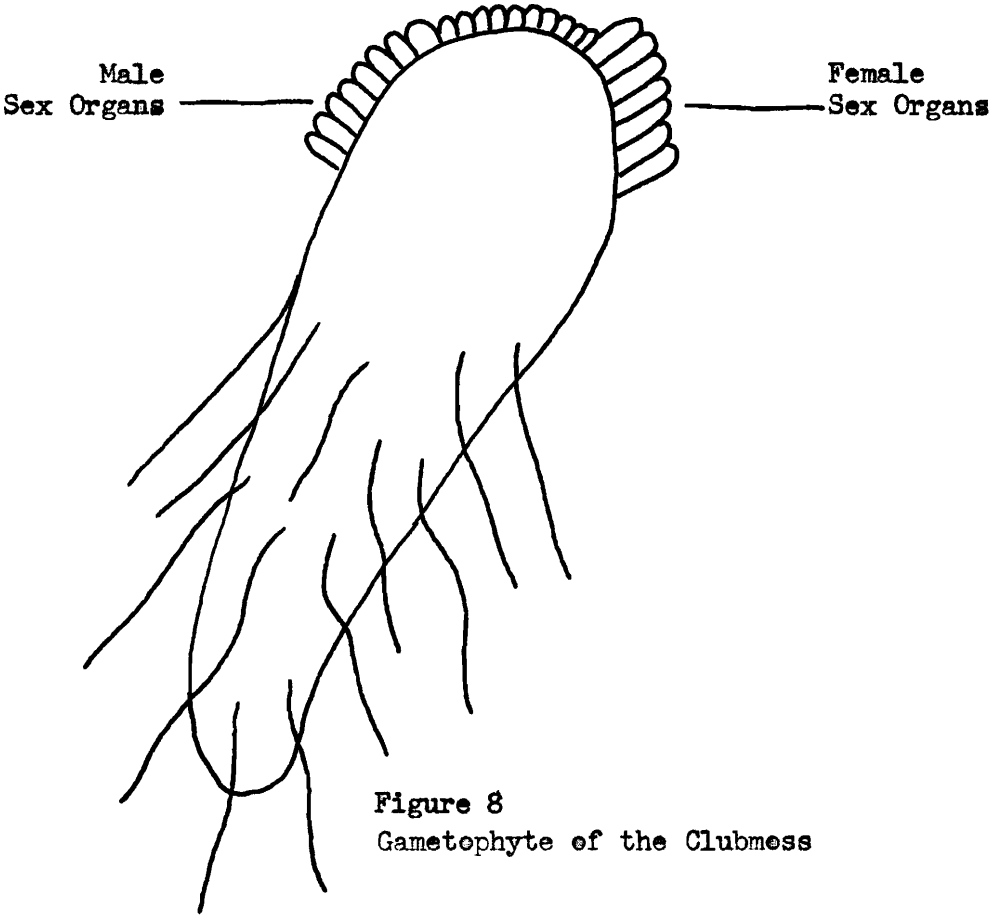



Figure 8
Gametophyte of the Clubmoss

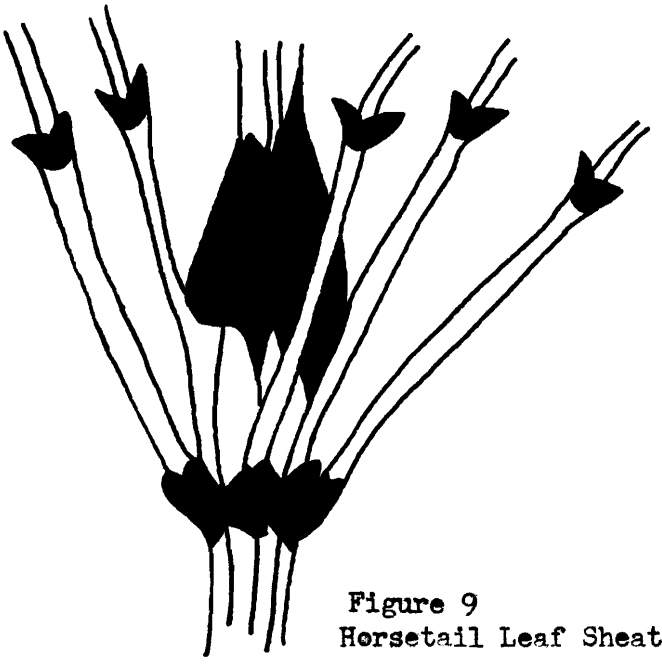


Figure 9
Horsetail Leaf Sheath and Nodes

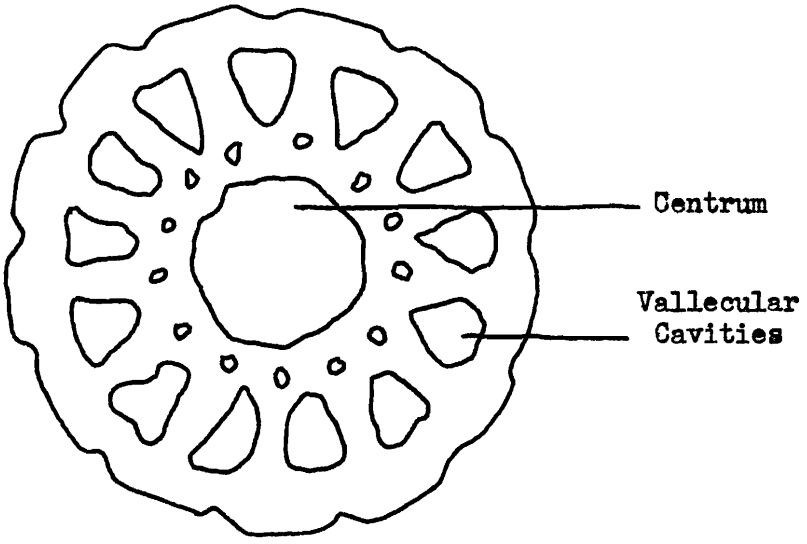



Figure 10
Stem of the Horsetail

Figure 11
Horsetail Strobilus

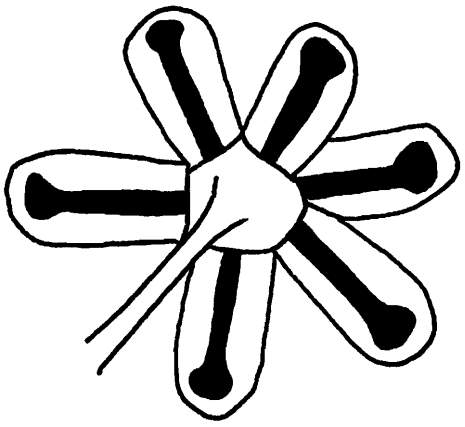


Figure 12
Horsetail Sporangiophore

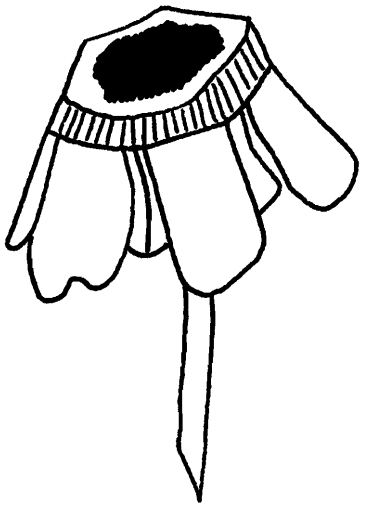


Figure 12-A
Release of Spores from Sporangia

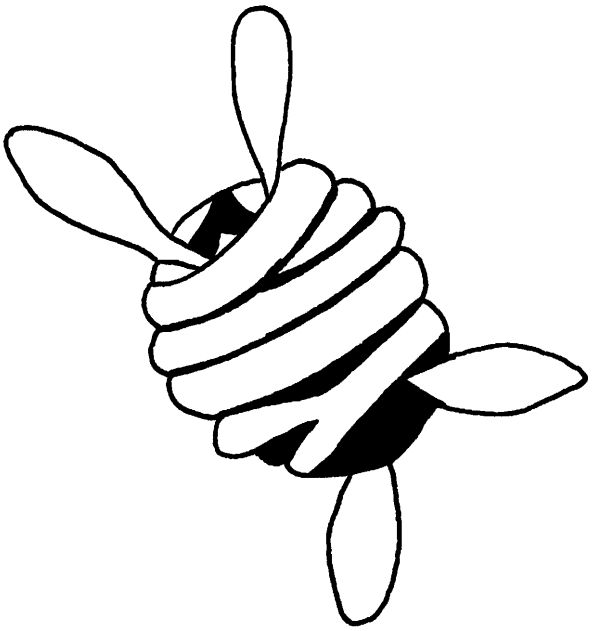


Figure 13
Elaters of the Horsetail

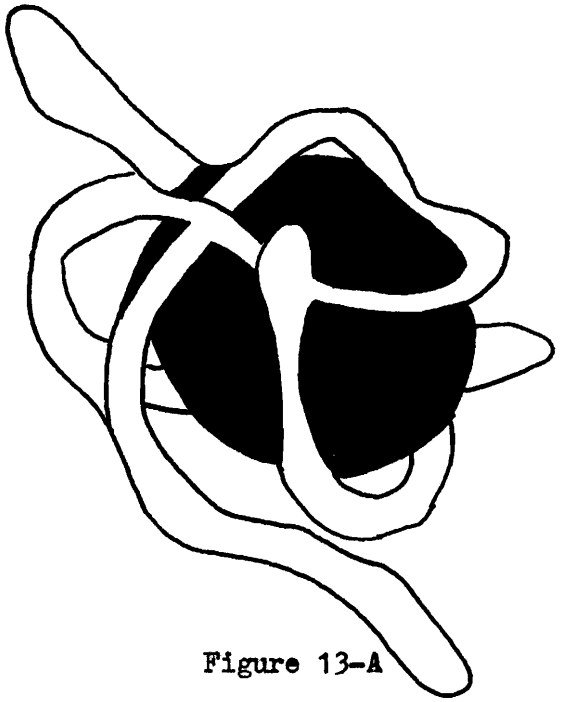


Figure 13-A
Movement of the Elaters

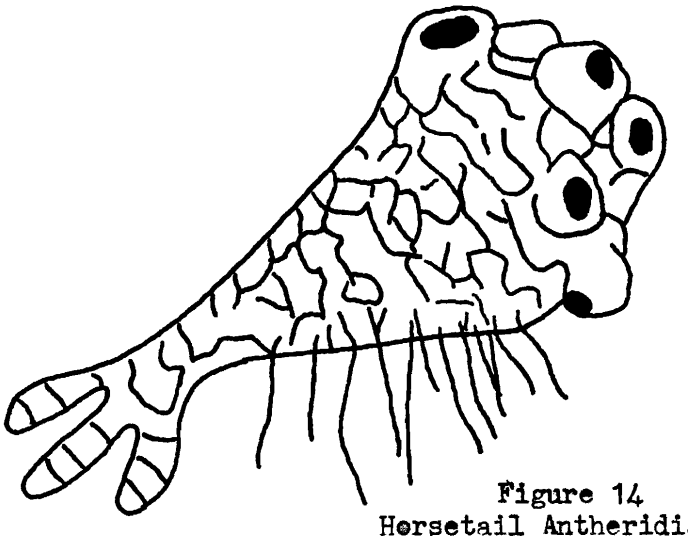


Figure 14
Horsetail Antheridia

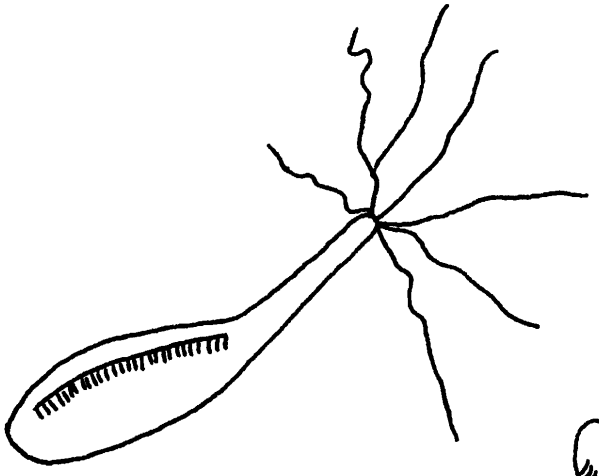


Figure 15
Sperm of the Horsetail

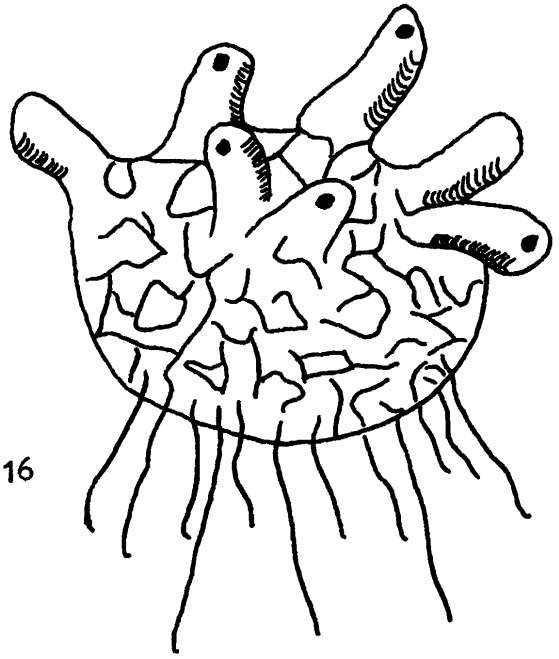


Figure 16
Horsetail Archegonium

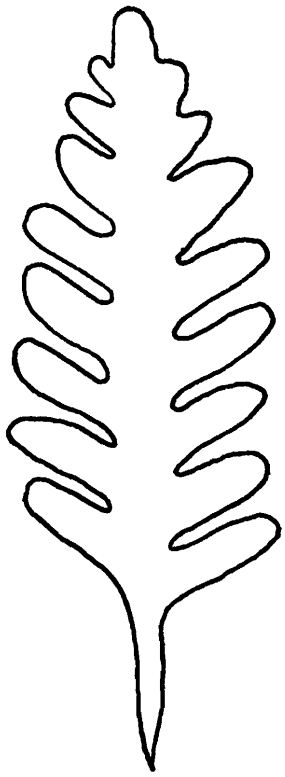


Figure 17
Once-Cut Fronds

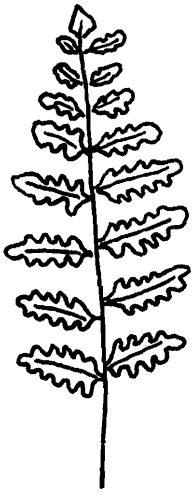


Figure 18
Twice-Cut Fronds

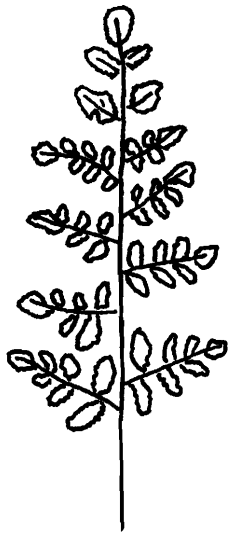


Figure 19
Thrice-Cut Fronds

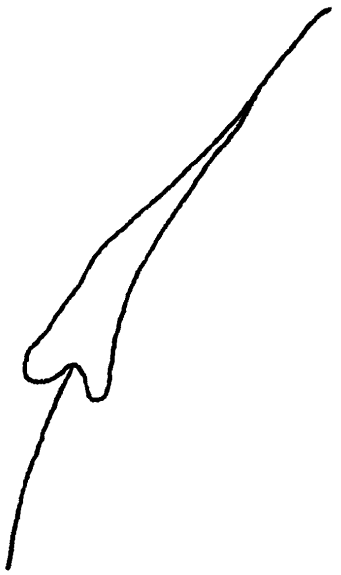


Figure 20
Simple Leaves

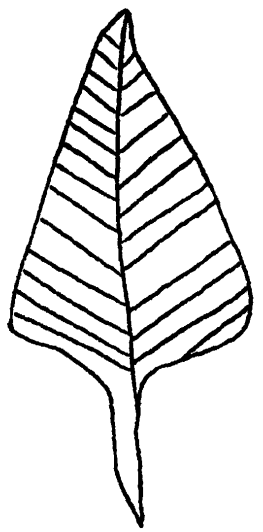


Figure 21
Fronds Broadest at the Base

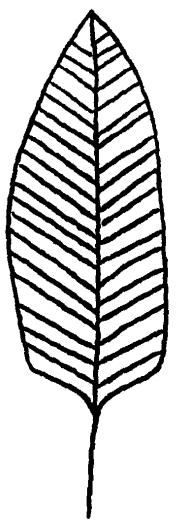


Figure 22
Fronds Semi-Tapered to the Base

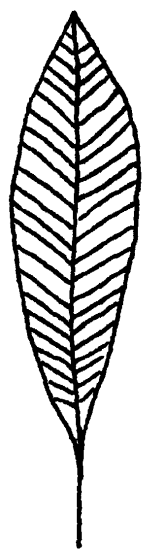


Figure 23
Fronds Tapered to the Base

## HOW TO USE THE KEY

This key is a tabular arrangement of the chief characteristics of a group of plants so arranged to help in determining the names of the plants, both scientific and common.

Most botanical keys are based on matching word descriptions to the ones made by observation of the specimen. General descriptions are then broken down into more specific descriptions of each species.

To identify plants with the keys included in this report, the "General Key To Families" must first be used to determine the particular family to which the specimen belongs. Then proceed to the "Specific Family Key" for that family to identify the specimen to its scientific and common name.

Keys are usually structured so that a series of alternative choices exists. From each set of alternative choices one must select that statement or description of characteristics which best applies to the specimen. Then one proceeds to the next number immediately under the previous choice. For example, in the "General Family Key" if the first number one statement does not describe the specimen then proceed to the second number one statement. If this statement describes the specimen then proceed to the number two statement immediately under it. Continue on in this manner until the name of the plant is given.

The procedure for identifying the fern allies is exactly the same as that followed in identifying the ferns. The only difference is that instead of being concerned primarily with the fronds as is true with the ferns, more emphasis is placed on the stems, internal as well as external

characteristics, and the arrangement of the sporophylls.

One aid in the identification of ferns is the frond shape. In most cases it is the first clue as to the identification of a specimen. The following descriptive terms are applied to fronds depending on the number of leaflets or pinnae which compose them.

a. Pinnate leaves or simple leaflets: those in which the frond is divided into numerous simple pinnae; once-cut fronds. (3) Figure 17.

b. Bipinnate leaves: those where the frond is divided into pinnae, and the pinnae are further divided into pinnules; twice-cut fronds. (3) Figure 18.

c. Tripinnate leaves: those with lacy pinnae where the frond is divided into pinnae, the pinnae are divided into pinnules and the pinnules are divided into pinnulets; thrice-cut fronds. (3) Figure 19.

d. Simple leaves: those with leaves not divided into pinnae, hence ferns without typical fronds. An example is the Walking Fern. Figure 20.

Sometimes the overall form of the frond will be of help in classifying ferns. Following are descriptions of the appearance of the frond. A diagram of each is provided as indicated by the figure.

a. Those which are broadest at the base. Figure 21.

b. Those which are semi-tapered to the base. Figure 22.

c. Those which are tapered to the base. Figure 23.

Another useful characteristic is the type of spore case, or sporangium, and the way they are formed on the fertile fronds. Ferns in the reproductive

stage are easiest to identify.

The two classification keys which follow are for use in identifying ferns and fern allies which were collected in Ozaukee County.

## General Key to Families of Ferns and Fern Allies in this Report (8)

1. Leaves mor or less broad, usually compound, not scale-like or quill-like, leaves may be simple but never four-foliate.....2
   2. Sporangia in groups on the margin or lower surface of the expanded part of a pinna.....POLYPODIACEAE
   2. Sporangia born on leaves, segments, or pinnae without an expanded part.....3
      3. Plants with 1 or 2 leaves, no apparent rootstock, sterile segment or portion of leaf unilateral to the fertile portion.....OPHIOGLOSSACEAE
      3. Plants with several leaves in a clump, from a rootstock, sterile pinnae several, attached bilaterally to the rachis of the leaves.....OSMUNDACEAE
1. Leaves narrow, simple, scale-like or quill-like, leaves small, cauline.....2
   2. Leaves whorled, forming sheaths at the nodes of the jointed stems.....EQUISETACEAE
   2. Leaves not whorled, stems not hollow or jointed....LYCOPODIACEAE

Once you have located the correct family for the specimen proceed to the "Specific Family Key" and follow through the key as previously directed until the specimen is identified to species.

## Specific Keys for Families of Ferns and Fern Allies in this Report (8)

FAMILY: POLYPODIACEAE

1. Fronds simple, entire; sori elongated, dorsal
   Camptosorus rhizophyllus--(Walking Fern)
1. Fronds pinnatifid or compound.....2
   2. Fertile fronds without without flat green pinnae; sori inclosed in pod-like pinnae.....3
      3. Sterile fronds 1 pinnatifid; fertile fronds 2 pinnate; rootstock creeping.....Onoclea sensibilis--(Sensitive Fern)

3. Sterile fronds 2 pinnatifid; fertile fronds 1 pinnate; rootstock erect *Pteretis nodulosa*--(Ostrich Fern)

2. Fertile fronds with at least some of the pinnae flat and green; sori marginal or dorsal on green pinnae.....4

4. Sori marginal; indusium usually appearing to consist of the reflexed margin of the frond; rootstock creeping.....5

5. Fronds ternate or forked.....6

6. Sorus appearing continuous along the margin; pinnules elongated..... .....*Pteridium latiusculum*--(Brake Fern)

6. Sori several, distinct; pinnules fan-shaped..... .....*Adiantum pedatum*--(Maidenhair Fern)

5. Fronds 1 pinnate or 2 pinnatifid.....7

7. Fronds 30-60 cm. long; sori distinct, as broad as long...*Dennstaedtia punctilobula*--(Hay-scented Fern)

7. Fronds 5-20 cm. long; sori apparently continuous along the margin.....8

8. Fronds herbaceous, delicate; stalk pale, at least above *Cryptogramma Stelleri*--(Rock Fern)

8. Fronds leathery; stalk glossy black or brown.... *Pellaea atropurpurea*--(Cliff Brake)

4. Sori on back of the frond; indusium independent of the margin.....9

9. Sori elongated.....10

10. Sori parallel to the axis of the pinnae, also along the oblique lateral veins; rootstock creeping.....*Woodwardia virginica*--(Chain Fern)

10. Sori not parallel to the axis of the pinnae, only along the oblique lateral veins; rootstock not creeping.....11

11. Stipe black; fronds evergreen, 1 pinnate.....a

a. Fronds prostrate or ascending, 5-25 cm. long; pinnae 3-8 mm long, not auricled .....*Asplenium Trichomanes*--(Maidenhair Spleenwort)

a. Frond erect, 20-50 cm. long; pinnae 1-4 cm. long, auricled at least on one side .*Asplenium platyneuron*--(Ebony Spleenwort)

11. Stipe pale, at least above; fronds not evergreen.....a

a. Fronds 1 pinnate..... ..*Athyrium pycnocarpon*--(Blade Spleenwort)

a. Fronds 2 pinnate or 2 pinnatifid.....b

b. Sori straight; fronds 2 pinnatifid.... ....*Athyrium thelypteroides*--(Silvery Spleenwort)

b. Sori curved; fronds 2 pinnatifid..... .....*Athyrium angustum*--(Lady Fern)

9. Sori orbicular or nearly so.....12
12. Fronds 1 pinnatifid or 1 pinnate.....13
13. Fronds 1 pinnate....Polystichum acrostichoides (Christmas Fern)
13. Fronds 1 pinnatifid.....Polypodium virginianum (Polypody)
12. Fronds 2-3 pinnatifid or 2-3 pinnate.....14
14. Sori without indusium; fronds triangular.....a
a. Basal pinnae distinctly stalked.....Dryopteris Linneana--(Oak Fern)
a. Basal pinnae sessile or nearly so.....b
b. Fronds are broad as long; lower pinnae in plane of rest of frond Dryopteris hexagonoptera--(Beech Fern)
b. Fronds longer than broad; lower pinnae not in plane of rest of frond..... Dryopteris Phegopteris--(Beech Fern)
14. Sori with indusium; fronds elongated.....15
15. Indusium surrounding the base of the sorus.....16
16. Indusium splitting into 2 segments .....Dennstaedtia punctilobula--(Hay scented Fern)
16. Indusium splitting into several segments.....a
a. Stipe jointed just above base; fronds 5-25 cm. long; indusium segments hair like.....Woodsia ilvensis
a. Stipe not jointed; fronds 20-50 cm. long, indusium segments broader.....Woodsia obtusa
15. Indusium not surrounding the base of the sorus.....17
17. Sporangium attached at one side of the indusium.....a
a. Fronds lanceolate, attenuate, often bearing bulblets on the lower surface.....Cystopteris bulbifera--(Bladder Fern)
a. Fronds ovate oblong, acute, without bulblets.....Cystopteris fragilis--(Fragile Fern)
17. Sporangia projecting from all sides of the stalk of the indusium.....a
a. Fronds in clusters on a short ascending rootstock, evergreen.b
b. Fronds 2 pinnatifid or 2 pinnate.....c

c. Sori near the margin of pinnules.....Dryopteris marginalis--(Marginal Shield Fern)
c. Sori not near the margin of pinnules.....d
d. Frond broadest at middle, 18-40 cm. wide.....Dryopteris Goldiana--(Goldie's Fern)
d. Frond broadest at base 6-18 cm. wide Dryopteris cristata (Swamp Shield Fern)

b. Fronds 3 pinnatifid or 3 pinnate.....e
e. Indusium glabrous ....Dryopteris spinulosa (Spiny-toothed Shield Fern)
e. Indusium glandular ....Dryopteris spinulosa var. intermedia

a. Fronds scattered on a creeping rootstock, not evergreen.....f
f. Frond truncate at base; indusium glandless..... Dryopteris Thelypteris-- (Marsh Shield Fern)
f. Frond tapering at base; indusium glandular..... Dryopteris noveboracensis-- (New York Fern)

FAMILY: OSMUNDACEAE

1. Leaves 2 pinnate Osmunda regalis var. spectabilis-(Royal Fern)
1. Leaves 2 pinnatifid.....2
2. Sporangia on all pinnae of fertile leaves; tufts of hairs on the under surface of sterile leaves where pinnae join the rachis .....Osmunda cinnamomea--(Cinnamon Fern)
2. Sporangia on middle pinnae of fertile leaves; no distinct tufts of hairs where sterile pinnae join the rachis..... Osmunda Claytoniana--(Interrupted Fern)

FAMILY: OPHIOGLOSSACEAE

1. Sterile blade entire, net veined; sporangia united in 2 rows on side of fertile segment Ophioglossum vulgatum--(Adder's Tongue Fern)

1. Sterile blade lobed or compound, not net veined; sporangia distinct.....2
   2. Sterile blade long stalked, attached near the base of the plant .....Botrychium obliquum--(Grape Fern)
   2. Sterile blade short stalked or sessile, attached at or above the middle of the plant.....3
      3. Plants large 25-60 cm. high, base of leaf inclosing bud, but open at side..Botrychium virginianum--(Rattlesnake Fern)
      3. Plants smaller 5-20 cm. high, base of leaf inclosing bud, but not open at side.....4
         4. Sterile portion ternate, with narrow, lanceolate, pointed divisions; fertile portion short stalked or sessile..... .....Botrychium angustisegmentum
         4. Sterile portion pinnate, rarely ternate with oblong, blunt divisions; fertile portion distinctly stalked..... .....Botrychium matricariaefolium

FAMILY: EQUISETACEAE

1. Plants producing 2 kinds of stems, fertile ones appearing first, usually not green, terminated by a strobilus, sterile ones appearing later, green and much branched.....2
   2. Fertile stems simple, unbranched, branches of sterile stems ascending; leaves black.....Equisetum arvense--(Field Horsetail)
   2. Fertile stems with 1 or 2 whorls of branches; branches of fertile stems drooping; leaves brown.....Equisetum sylvaticum (Wood Horsetail)
   2. Fertile stems first appear without branches, branching of fertile stems after cones disappear, fine horizontal branches of sterile stems, teeth of sheaths have white edges..... .....Equisetum pratense--(Meadow Horsetail)
1. Plants producing 1 kind of stem, green, unbranched or with a few simple branches, some bearing a strobilus at the tip.....3
   3. Stems perennial, evergreen.....a
      a. Stems erect, 2-10 dm. high, hollow.....Equisetum hiemale (Rough Horsetail)
      a. Stems wiry, 5-15 cm. high, solid; plants forming low grass-like mats.....Equisetum scirpoides
   3. Stems annual; dying at the end of the season.....b
      b. Leaf sheaths on main stem with 8-12 teeth..... .....Equisetum palustre--(Scouring Rush)
      b. Leaf sheaths on main stem with 15 teeth..... .....Equisetum limosum--(Pipes)

FAMILY: LYCOPODIACEAE

1. Sporophylls not arranged in strobili; all stems with older parts horizontal, their tips ascending or erect.....Lycopodium lucidulum (Shining Clubmoss)

1. Sporophylls grouped in terminal strobili; plants with horizontal stems bearing erect or ascending branches.....2
   2. Erect stems unbranched, 3-10 cm. high; horizontal stem less than 10 cm. long; strobili sessile, sporophylls green..... .....Lycopodium inundatum
   2. Erect stems more or less branched; horizontal stem long and creeping, sometimes subterranean; mature sporophylls yellowish and scale-like.....3
      3. Horizontal stem on or near the surface of ground.....4
         4. Leaves of erect branches radiating equally in all directions from the stem.....a
            a. Soft bristle tipped; strobili in clusters of 2-4 on long peduncle...Lycopodium clavatum--(Creeping Pine)
            a. Leaf stiff pointed bristle tipped; strobili solitary, sessile.....Lycopodium annotinum (Stiff Clubmoss)
         4. Leaves of erect branches closely flattened against stem; branching fan like; strobili 2-5, on long peduncle Lycopodium complanatum var. flabelliforme--(Running Pine)
      3. Horizontal stem deeply buried, usually 5-10 cm.....a
         a. Leaves of erect branches closely flattened against stem; strobili in clusters of 2-4 on long peduncle..... .....Lycopodium tristachyum
         a. Leaves of erect branches not closely flattened against stem, strobili solitary, sessile....Lycopodium obscurum (Tree Clubmoss)

## III. Descriptions of the Family, Genus and Species

### Family Osmundaceae

The ferns of this family are represented by the largest and coarsest of the native ferns. This is considered as the least specialized of the fern families.

The chief characteristics of this family are the sporangia. They are produced on modified portions of the fertile fronds. (3) The sporangia are large and globular, extremely thin-walled, and possessing a short as well as stout stalk. The annulus which develops from thickened cells of the sporangia is not a complete ring. It extends from the stalk at one side, over the top of the sporangia to the stalk on the opposite side. When mature, the sporangia opens by a vertical slit of the annulus, thus allowing for spore dispersal.

### Genus Osmunda

The rootstocks of this genus are massive and extremely hard, often being found at the surface of the soil. (3) Older specimens may have heavy rootstocks rising a foot or more above the ground. Rootstocks which are creeping increase in length each year by a constant renewal at one end, while at the opposite end the oldest parts will die. Roots are found to be numerous, black in color, very wiry and tightly matted.

The sori of this genus do not possess indusia, or protective coverings. The spores are green, thus they contain chlorophyll. The gametophytes which develop from the spores are also green and they are semi-heart shaped, consequently they will be longer and more narrow than

the gametophytes of the true ferns. (3)

The stalk and rachis of the frond are smooth, and in most cases are grooved on the ventral surface. They are normally green in color, but may also be a pale straw color. (3)

Species: Osmunda claytonia L. -- Interrupted Fern -- Figure 24

Fronds:

The fronds are large and rather coarse in appearance. They are broadest at the middle, tapering to a point at the top and to a lesser extent at the base of the rachis. The frond averages thirty-six inches in height and six to eight inches in width. The sterile fronds curve outward, while the fertile fronds are erect and taller as well as being more numerous. They bear the sporangia laterally on non-green pinnae in the center area. Four or more pairs of such non-green pinnae are found in the center of the sporophyll, while typical green pinnae are on either end of the fertile frond.

Pinna:

The pinnae are broadest at the rachis and taper gradually to a rather blunt tip or rounded lobe. They are arranged in pairs on the rachis with a minimum number of eighteen pairs per frond. Green pinnae located below the fertile ones are widely spaced, and often much smaller than those found above the fertile area.

Fertile Pinna:

In the center of each fertile frond are located four or more pairs of dark green pinnae. These pinnae produce sporangia in a cylindrical cluster that eventually turn to a dark brown color. The sporangia mature

rather rapidly. As a result the fertile frond has green pinnae above and below the fertile central area. The fertile central area gives the appearance of interrupting the green pinnae, hence the species is easy to identify by this means.

Rachis and Stalk:

The rachis and stalk are smooth and green with a semi-grooved ventral side. The stalks of the fertile fronds are a great deal longer and more erect.

Roots and Rootstock:

The roots are black, tangled and found growing in all directions. The rootstock is rounded and usually rather stout. Stubble or old withered broken stalks are usually present on older rootstocks.

Location and Habitat:

This species was found growing along the roadside, one mile south of Grafton on highway 57. T-10-N R-21-E Sec. 25 Figure 40. The specimen for this report was found growing in dry, rather stony soil.

Family Ophioglossaceae

The family Ophioglossaceae is commonly referred to as the succulent fern group. It is the opinion of some that they are among the most primitive of ferns. (3)

This group of ferns is perennial in nature, smooth, lacking scales and is found to have soft and fleshy stems with the roots lacking in hard tissue. The sizes of the ferns vary a great deal, with some of them very small and difficult to find, while others are large and easy to recognize in nature. Botrychium virginianum (L.) Sw. is one of the

largest growing to heights of at least one foot, while Botrychium simplex (E.) Hitchc. is found to possess fronds of only one-half inch in length.

Genus Botrychium

A fleshy stalk usually supports one sterile frond, sometimes two, as is evident in some species, and one fertile stalk which bears the sporangia. The gametophytes are tuberous and develop below ground level, therefore they contain no chlorophyll, and cannot produce their own food during this period of development. The gametophytes are extremely small and difficult to find before the plant develops. Some people in the field are of the opinion that the gametophytes exist underground for a period of eight years. (3) The sporangia which develop are round and do not possess an annulus. When they mature, they open by a transverse slit much like the true ferns of the family Polypodiaceae.

The pinnae also vary in appearance from the fan-shaped to lacy-cut. They are most often found to be blunt tipped or rounded, with most species having toothed margins. Commonly, the basal pinnae are the largest.

Species of this genus are not found growing in one type of soil, as some are found in cool, moist, rich soils, while others grow well in dry, sandy and even acidic soils.

The roots generally are smooth and rather fleshy, some being numerous while others tend to be few in numbers. Some species tend to have one main root growing down, similar to a tap root, while in other species the roots are horizontal and branching.

Species: Botrychium virginianum (L.) Sw. -- Rattlesnake Fern -- Figure 25

Frond:

The frond is the largest found in the Genus Botrychium, having an average length of twelve inches and an average width of ten inches. It is triangular in shape, and it is divided into pinnae on small stalks.

Pinnae:

The pinnae range in shape from oblong to narrow oblong, and are tripinnate, having semi-blunt to semi-pointed tips, depending on the specific plant. The veins in the pinnae are few in number and simple.

Stalk:

The average length of the stalk is twelve inches. It is erect, smooth, fleshy textured, round and tends to be pink at the base. The stalk on which the sporangia develop is about twelve inches in length also, however, it is considerably more slender, and grows above the fronds.

Sporangia:

The sporangia are of a bright yellow color, which appear in midsummer. They develop on a stalk which extends above the frond of this species.

Roots and Rootstock:

The roots tend to be fleshy, of medium size, matted and spreading about two inches below the surface of the ground. They also possess numerous vertical budlike sppendages. The rootstocks are erect and subterranean.

Location and Habitat:

This species was found growing in an extremely moist wooded area

approximately one-half mile west of highway 57 on Freistadt Road in Mequon. T-9-N R-21-E Sec. 15 Figure 40. The area was well shaded from sunlight.

Family Polypodiaceae

This family is the largest family of true ferns. In Ozaukee County seven genera of ferns have been found which belong to this family. The differences between some genera and species in this family are so slight, that in some cases species have been moved from one genus to another. The classification in this report is taken from "A Field Guide to the Ferns" by Boughton Cobb. (3)

This family has the characteristic long stalk supporting the sporangia, and an annulus which is vertical and interrupted by the stalk. Upon maturing the sporangium ruptures at the annulus just above the stalk and disperses the spores. The sporangia are found to develop in sori located on the lower surface of the fertile pinnae. Some of the species possess a covering called an indusium, over the sori, while others do not have this protective covering. The prothallus is a heart-shaped body that contains chlorophyll, consequently it is a green color.

Genus Camptosorus

The most noticeable characteristic of this genus is the appearance of the frond, it is not typically fern-shaped. This frond is rather long and narrow with a very sharp point. When this point comes in contact with the soil, it develops roots and another plant begins to grow. The fronds are triangular, with a heart-shaped base.

Species: Camptoserus rhizophyllus (L.) Link -- Walking Fern -- Figure 26

Fronds:

The frond of the Walking Fern rarely exceeds twelve inches in length, and averages one inch in width at the base. The veins in the fronds are freely areolate, or in a netted pattern. (3)

Sori:

The sori are scattered over the entire under surface of the frond from the base to the tip. They do not take a definite pattern as some are found parallel to the midrib, while others may be found in pairs. The indusium is very inconspicuous.

Stalk:

The stalk is extremely short when compared to the stalks of other ferns. It has a grooved ventral side, and is a dark brown color, and rather scaly at the base. A short distance from the base it changes to a green color and is smooth.

Roots and Rootstock:

The roots are rather short and very compact. They are usually few in number, and found close to the surface of the soil and creeping. The rootstocks are also short, and tend to be slender. They are erect and brown, with scales that are well spaced.

Location and Habitat:

This specimen was found growing on the north side of a limestone quarry just outside of Thiensville on highway 57. T-9-N R-21-E Sec. 14 Figure 40.

Genus Athyrium

The Genus Athyrium is a relatively large plant, and it is not evergreen as many other genera of ferns. The rootstocks of this genus are thick and short and are of the creeping type. The stalks are found to be stout physically and straw colored. The sori found on the fertile fronds are narrow. (3) There are three types of pinnae or pinnules present in this genus. There are the once-cut and pointed pinnae, the narrow and pointed pinnae and those that have lacy-cut or tripinnate pinnules.

Species: Athyrium Filix-femina (L.) Roth -- Lady Fern -- Figure 27

Frond:

The average frond measures about thirty inches in length and approximately ten inches wide at the broadest point. It is smooth in appearance, slightly reduced in size towards the base. It is divided into about twenty-four pairs of alternate pinnae, that tend to point upward.

Pinna:

The pinnae average eight inches in length and about one and one-half inches in width. They have extremely narrow and pointed tips. The pinnae are divided into approximately twelve pairs of pinnules. The pinnules are further divided or toothed, making the fronds tripinnate. The veins of the pinnae are found to be once or twice forked in the majority of the plants.

Sori:

The sori of the Lady Fern often help in its identification because

they are curved to such an extent that they become horseshoe-shaped. The indusia of the sori are hairy in appearance, arching and prominent.

Stalk and Rachis:

The stalk, in most cases, is shorter than the frond. It is flat or grooved toward the ventral side, and it is smooth, with a scattering of scales near the base. The rachis is a pale color, only slightly grooved or possibly flat toward the front and smooth.

Roots and Rootstock:

The roots are abundant, wiry in nature and black in color. The rootstock is surprisingly small in comparison to the size of the plant. It averages about 3/8 of an inch thick, and approximately four inches long. It tends to be exceedingly scaly and creeping in habit and growing just beneath the surface of the soil. Occasionally it is found to be semi-erect. Rootstocks often are found with old dead stalks still attached.

Location and Habitat:

The Lady Fern collected was found in a field approaching the Cedarburg swamp just off highway 60. T-10-N R-21-E Sec. 20 Figure 40. The soil was moist, however, the specimen was found growing in a semi-shaded area.

Genus Onoclea

These are rather large plants with fronds measuring two or more feet in height. Spores of this plant are produced on a separate fertile frond. The stalk of this genus is usually longer than the frond, and possesses a few scales. The plant is rather difficult to remove from

the ground because of the numerous roots which are present.

Species: Onoclea sensibilis L. -- Sensitive Fern -- Figure 28

Sterile Frond:

The sterile fronds are usually a minimum of two feet tall, of a leathery texture and light green in color. The frond is divided into approximately twelve nearly opposite pairs of pinnae. The lower pair of pinnae or next to lowest pair being the longest, each tapering at both ends. The pinnae at the upper most end of the frond are winged at the rachis with very little or no tapering towards the rachis. The margins of the pinnae are wavy, giving the edges a smooth appearance. The veins are depressed, and very prominent as well as being arranged in a conspicuous network.

Fertile Frond:

The fertile frond seldom exceeds twelve inches in height, and is erect in habit. It is quite different than the vegetative fronds. The sporangia are found in small round structures on the fertile pinnae. When mature they become dark brown.

Stalk and Rachis:

The stalk of this species is usually of greater length than the rachis of the sterile frond. It is yellow in color near the basal pinnae, and brown in color towards the rootstock. The stalk possesses a few scales, with a very shallow groove on the ventral side. The rachis of this plant is smooth and of a pale tan or yellow color.

Roots and Rootstock:

The roots of this fern are fibrous, numerous and tightly matted.

The rootstocks tend to be of a brown color, usually very smooth. They are of the creeping nature and branching. It is also found very close to the surface of the ground.

Location and Habitat:

This specimen was found near the covered bridge, north of Cedarburg. T-10-N R-21-E Sec. 10 Figure 40. It was found close to the creek which flows under the bridge in a semi-shaded area.

Genus Cystopteris

This genus contains ferns which appear to be delicate in form, that is, thin or filmy. The rootstocks are scaly in appearance and creeping in habit. The stalks are usually smooth, often polished in appearance and light in color. The fronds may tend to be yellow-green in color. The veins of the pinnae may be simple or forked, but in both cases they extend to the margins of the pinnae. The indusium is a very distinguishing characteristic of the genus. It is round in shape, and deeply convex.

Species: Cystopteris bulbifera L. -- Bladder Fern -- Figure 29

Frond:

The fronds often extend from three to five feet in length. Although this species has exceeding long fronds they are very narrow, usually not more than three or four inches. The frond is triangular in shape being broadest at the base, the tips drooping towards the ground. The specimen that was collected was young and rather short.

Pinna:

The pinnae of this fern average about two inches in length, and

extend at a slight upward angle from the rachis of this fern. They vary in shape from triangular to almost linear. The pinnae are alternate in arrangement along the rachis, occasionally opposite.

Pinnules:

The pinnules are divided to the midrib of the pinna, and are linear in appearance. The lowest pair of pinnules are conspicuously parallel to the axis of the frond.

Sori:

The sori are scattered on the underside of the pinnules away from the margins. The spores mature in early summer. Bulblets are also produced on the lower side of the pinnae. When they mature, they drop off and may germinate into new plants.

Stalk and Rachis:

The stalk is much shorter than the remainder of the frond and is usually of a yellow shade. The base of the stalk tends to be swollen and blackish in color. The rachis is extremely slender and of a shining yellow color.

Roots and Rootstock:

The roots are black and irregular in size, some being very small, while in other cases they may grow to a rather large size. The rootstock is short, rarely exceeding two inches in length. It is black and scaly in appearance.

Location and Habitat:

This specimen was collected in a wooded area one-half mile south of Grafton on Green Bay Road. T-10-N R-21-E Sec. 25 Figure 40. The area was rather moist with a small stream close to its location.

Species: Cystopteris fragilis (L.) Bernh. -- Fragile Fern -- Figure 30

Frond:

The fronds average about ten inches in length and approximately three inches in width, with sharp pointed tips. The appearance varies a great deal, depending on the width and divisions of the pinnae.

Pinna:

There are usually twelve pairs of pinnae attached at right angles or at a slight ascending angle to the rachis. The divisions of the pinnae are variable depending on the variety of the species.

Sori:

The sori are few and scattered on the pinnules. The indusium tends to dry up in early summer and may soon become inconspicuous.

Stalk:

The stalk in most cases is erect and slightly shorter than the frond. It is especially brittle and breaks rather easily, particularly at or near the base. The stalk varies in color from a deep brown to black near the rootstock, becoming straw colored to green toward the rachis. It is smooth and slender, possessing only a few scales near the base, occasionally none.

Roots and Rootstock:

The roots of this species are rather numerous, heavy and black in appearance. The rootstock is slender and usually creeping, ranging in color from light brown to black. It can be simple or branched with a few scales present or it may have an abundance of brown hairs.

Location and Habitat:

This specimen was found about one-half mile south of Grafton on

Green Bay Road. T-10-N R-21-E Sec. 25 Figure 40. It was found in moist soil close to stumps of decaying trees.

Genus Thelypteris

Species of this genus range from very small to medium in size. The fertile and sterile fronds are very similar in appearance. The pinnae and pinnules are not toothed. The roots are most often slender and creeping, while the rootstocks are also slender and straw colored as well as being slightly scaly. The sori are round and are found at the margins of the pinnules. The veins are usually forked and extend to the margins of the pinnules, except the New York Fern, where the veins are simple.

Five species of this genus are very common. These can be divided into two groups. The first group includes the Beech Ferns, which have triangular-shaped fronds and sori without indusia. The second group includes the Marsh Ferns, Massachusetts Fern and the New York Fern, which have upright, narrow and oblong fronds. Each sorus possess a pale and delicate kidney-shaped indusium.

Species: Thelypteris phegopteris (L.) Slosson — Long Beech Fern
Figure 31

Frond:

The fronds average twelve inches in length and are somewhat reflexed. It is a rather narrow and triangular-shaped frond with the tips tapering rapidly. The basal most pair of pinnae characteristically droop toward the ground. They are distinctly spaced from the next upper pair of pinnae. The fronds are often hairy and appear yellow-green in color.

It is divided into approximately twelve pairs of pinnae, which are almost opposite and sessile.

Pinna:

The pinnae are rather long and quite narrow with long pointed tips. All pinnae are semi-tapered at the rachis. The pinnae closest to the stalk are tapered only at the rachis. The veins in the pinnae are forked and possess scales or hairs.

Sori:

The sori are small, and are located at the base of the pinnules on the under surface. They may be found on the entire underside of the frond.

Stalk and Rachis:

The stalk varies in length and is covered with scales or hairs. The rachis is rather stout in appearance and is covered with hairs or scales also.

Roots and Rootstock:

The roots are black and wiry. They are quite numerous and are often found deep in the soil. The rootstock is slender and scaly. It is creeping, branching and black in color. It produces fronds all summer.

Location and Habitat:

The specimen for this collection was found on highway 167 on the shaded banks of the Milwaukee River. T-9-N R-21-E Sec. 25 Figure 40.

Species: Thelypteris noveboracensis (L.) Niewl. -- New York Fern

Figure 32

Frond:

The fronds are rather tall, most of them averaging more than eighteen inches, while the width averages six inches. The fronds taper from the middle towards either end. Because of this characteristic they are readily identified. The fronds develop in tufts along the rootstock. The fertile fronds are found to be larger and more upright than the sterile fronds. It is divided into at least twenty pairs of alternate pinnae, which are sessile.

Pinna:

The pinnae are rather long and pointed being divided nearly to the midvein into narrow rounded pinnules. The lowest pinnae are usually minute in size.

Sori:

The sori are few in number on the pinnae, they are small and found close to the margins of the pinnules. The indusium is slightly hairy.

Rachis and Stalk:

The rachis of this fern is usually a pale green color and smooth or possessing a few scattered hairs. The stalk is seldom over eight inches tall and light green in color. It is slightly hairy near the lowest pinnae and brown and slightly scaly near the rootstock.

Roots and Rootstock:

The roots are rather sparse in numbers, black, wiry and growing shallow in the soil. The rootstock tends to be dark brown and scaly.

Location and Habitat:

The New York Fern collected for this report was found in a wooded area at the intersection of County Trunks B and D twelve miles west of

Belgium, Wisconsin. T-12-N R-22-E Sec. 20 Figure 40. The soil in this area was rather moist.

Genus Adiantum

This is a large and widely distributed genus. Typical of this genus is the stalk which is red-black, extremely thin, smooth and brittle. The pinnules are delicate and lacy being fan-shaped in appearance and often overlapping. The sori are found on the underside of the pinnules, a short distance from the margins. The outer margins then curl over the sori forming false indusia. The veins are free, having a distinct pattern, forking many times.

Species: Adiantum pedatum L. — Maidenhair Fern — Figure 33

Frond:

The fronds reach a size which averages sixteen inches high and ten inches wide. All pinnae are in the same plane, consequently the frond appears flat.

Pinna:

The pinnae are bluish-green in color, and usually number between five and eight on each stalk. The longest pinnae are located closest to the top of the stalk.

Pinnules:

The pinnules vary in shape and have very short stalks. They are fan-shaped or oblong and alternately arranged. The lower margins are entire and the upper margins somewhat incised.

Sori:

The sori are located on the upper margins of the pinnae. The

indusium varies in color from white to a yellowish green. They are extremely thin and are found to be linear in shape.

Rachis and Stalk:

The rachis is recurved and extremely slender. The color may vary from black to a chestnut brown and occasionally green. The stalk is usually about twenty inches in length and of a shining black or dark brown color. It is smooth with the exception of a few scales which are usually found near the base. The stalks are often conspicuous on the ground after the fronds have died.

Roots and Rootstock:

The roots tend to be slender and of a grayish color. The rootstock is the creeping type and grayish brown in color. It is frequently found with the remains of old and broken stalks and light brown scales near the growing end.

Location and Habitat:

This specimen was found near the bank of Gough Lake, approximately twelve miles northwest of Saukville on highway 33. T-11-N R-21-E Sec. 17 Figure 40. The soil was on the moist side with many rocks present.

Genus Pteridium

The members of this genus are course ferns. Their rootstocks are found to be widely creeping over large areas and often deep in the soil. They are less affected by extremes of heat and cold and drought or extensive moisture. Reproduction of the Genus Pteridium is primarily by rootstock growth, new plants from spores is quite rare.

Species: Pteridium aquilinum (L.) Kuhn — Braken Fern — Figure 34

Frond:

The fronds are extremely large. Mature plants average three feet in height and two feet in width. Fronds are triangular in shape and reflexed to the point of almost being horizontal to the ground. The frond is usually divided into three nearly equal parts, the two lower parts being almost opposite and distinctly stalked. These two parts are divided into pinnae and pinnules. The upper most part of the frond is ovate, and is also divided into pinnae. The pinnae of this portion are usually divided to a lesser degree and are simple, rather narrow and blunt-tipped, with the upper most portions not even being cut to the midrib.

Pinna:

The pinnae are oblong, distinctly narrow with rather blunt tips. The lower pinnae are again cut into pinnules at the rachis.

Pinnules:

The pinnules are very close together and vary considerably in their division and shape. They are also found to possess slightly hairy tips and midveins.

Sori:

The sori make this genus rather easy to identify. They are in a narrow row near the margins of the pinnae, and are covered or partially covered by the margin of the pinnae which curl over them. Immature sori are silver-colored, mature ones dark brown.

Stalk:

The stalk is rather tall being of about the same length as the

frond. It is rather smooth and rigid. Immature ones are green, but as the plant matures it turns to a dark brown color.

Roots and Rootstock:

The roots are black and wide spreading although they are sparsely scattered along the rootstock. The rootstock is approximately one-half of an inch in diameter. It is dark brown in color and scaleless, but occasionally covered with hair. The rootstock is deep growing, sometimes being found at depths of ten feet.

Location and Habitat:

This specimen was found in pasture land approaching a wooded area at the junction of Wausaukee Road and highway 167. T-9-N R-21-E Sec. 19 Figure 40.

Family Lycopodiaceae

The fern allies which belong to this family usually do not grow very tall. The leaves tend to be flat and scale-like in appearance, relatively small, and are found to be alternate or opposite in arrangement. (10) The spores develop in yellow sporangia which are produced on the upper surface of a sporophyll. Frequently the sporangium is found near the axil of the sporophyll. The stems of the plants in this family are creeping in nature.

Genus Lycopodium

The members of this genus generally have bright green leaves. Some species are evergreen. The stems of most species of this genus are erect, and usually less than twelve inches in height. The leaves are small, not exceeding one-half inch in length, but they are numerous.

The sporangia may be rounded or kidney-shaped. The spores are either concave or convex.

Species: Lycopodium lucidulum Michx. -- Shining Clubmoss -- Figure 35

Stems:

The stems average about six inches in length, branched or unbranched. The erect stems develop from short obliquely rising horizontal stems or rhizomes. The stems that are erect are densely covered with bristly leaves.

Leaves:

The leaves of this species are small, averaging only 3/8 of an inch in length. They are narrow and lance-shaped, the margins slightly toothed. The upper leaves are ascending while the lower leaves are irregularly spreading or reflexed.

Sporophyll:

The sporophylls are slightly smaller than the vegetative leaves. The sporangia are kidney-shaped and are quite prominent. They are orange to yellow in color and are found on the upper surface of the upper most leaves in the axillary area.

Location and Habitat:

This specimen was found on the south side of Freistadt Road in Mequon. T-9-N R-21-E Sec. 22 Figure 40. It was found on the banks of the stream which runs past the Lutheran Seminary.

Species: Lycopodium obscurum L. -- Tree Clubmoss -- Figure 36

Stems:

The horizontal stems are found creeping and branching well below

the ground level. The upright stems may grow to heights of twelve inches and they are distinctly erect. A single stem which rises about two inches above the ground, branches and rebranches to form a miniature bush-like plant.

Leaves:

The numerous leaves are extremely short, seldom extending over one-fourth of an inch in length. They are flattened, narrow, lance-shaped and with entire margins which taper to a sharp point.

Strobilus:

The cylindrical strobilus averages one and one-half inches in length. They are yellow in color and located immediately above the vegetative leaves at the tips of the upper branches.

Sporophyll:

The sporophylls are nearly round with a flat base and a sharply pointed tip. They overlap each other in the strobilus. The sporangia are rounded or bean-shaped.

Location and Habitat:

This specimen was found in a damp area approaching a wooded area at the junction of Wausaukee Road and highway 167. T-9-N R-21-E Sec. 19 Figure 40.

Species: Lycopodium complanatum L. — Running Pine -- Figure 37

Stems:

The horizontal stems are on the surface of the ground or slightly below the surface, and creeping in habit. The upright stems average about ten inches in height. They tend to be less erect than the Tree

Clubmoss. As a result of branching and rebranching of the stems, the plant is semi-rounded and irregular in form. The branchlets are flattened with the lower surfaces being slightly concave.

Leaves:

The leaves are tiny, scale-like and united laterally for more than half of their length. The margins of the leaves are sharp, spreading and pointed, while the top leaves are broader and tightly pressed together.

Strobilus:

The strobilus, averaging two and one-half inches in length, is found terminally on stems which extend about three inches above the rest of the plant. These strobilus bearing stems possess a few scale-like leaves.

Sporophyll:

The sporophylls, light yellow in color, have abrupt bases and sharp-pointed tips. The sporangia are almost round.

Location and Habitat:

The Running Pine collected for this paper was found on the north side of Freistadt Road, one-half mile west of highway 57. T-9-N R-21-E Sec. 15 Figure 40. The area was shaded, but moist.

Family Equisetaceae

Members of this family annually produce new erect stems which do not persist. The erect stems rarely grow over three feet in height. If the upright stems branch, they do so in regular whorls. The erect stems contain chlorophyll and function photosynthetically. The stems

are cylindrical, and frequently hollow and contain vallecular canals. The external surface of the stems and branches is grooved and ridged. The stems are rough and contain silicon. The leaf sheaths snuggly surround the node areas so that when a section of the stem in the node area is pulled off a "popping" noise results. The strobili, may be sharp pointed or blunt-tipped. The rootstock is commonly found branching and widely creeping.

Genus Equisetum

Many of the species classified in this genus have branches, however, there are also species found lacking branches or having branches decumbent. Some species always branch, in some cases branching occurs at regular intervals on the main stem, in whorls. (10) These plants have an extensive underground system of rootstocks which bear roots at the nodes. The spores are formed in terminal strobili or cones on the main stem.

Species: Equisetum hiemale L. -- Rough Horsetail -- Figure 38

Stems:

The stems average five inches in height and about one-half inch in diameter. They are slender, erect, but seldom branched. They are rough in texture and contain silicon. The leaf sheaths which cover the nodes are cylindrical, and green at first, turning gray in color at maturity. The teeth of the sheaths are pointed and brown.

Cavities:

The central cavity of the stem is about two-thirds of the diameter of the stem. The vallecular channels are very small when compared to the large central cavity. Figure 10.

Strobilus:

The strobilus terminates a very short stem, and has a rather sharp-pointed tip.

Rootstock:

The rootstock is widely creeping and branches considerably.

Location and Habitat:

This specimen was found on the north side of Freistadt Road, one-half mile west of highway 57. T-9-N R-21-E Sec. 15 Figure 40. It was located in a wooded area, close to a stream which runs through this area.

Species: Equisetum pratense Ehrh. -- Meadow Horsetail -- Figure 39

Fertile Stems:

The fertile stems average fifteen inches in height and they stand erect. When they first appear in the spring, they are unbranched. However, after the strobili disappear branching begins.

Sterile Stems:

The sterile stems average eighteen inches in height. These stems are erect and they are annual. Stomata are borne on the stem in two distinct bands. The internodes are approximately one inch apart with the first internode being slightly shorter. The leaf sheath which covers the nodes are cup-shaped and clasping. They possess sharp pointed teeth with dark centers and white margins. Branches which develop are approximately five inches long and in whorls around the stem.

Cavities:

The central cavity is about one-third the diameter of the stem, with the vallecular cavities being much smaller.

Strobilus:

The strobilus is about one inch long and possesses a blunt-tip.

Rootstock:

The rootstock is slender and black. It is a horizontally creeping structure found rather deep in the soil. The roots are black, and wiry in structure.

Location and Habitat:

This specimen was located on the north side of Freistadt Road, one-half mile west of highway 57. T-9-N R-21-E Sec. 15 Figure 40. It was found in an area close to the stream running through this area. The soil was extremely rich.

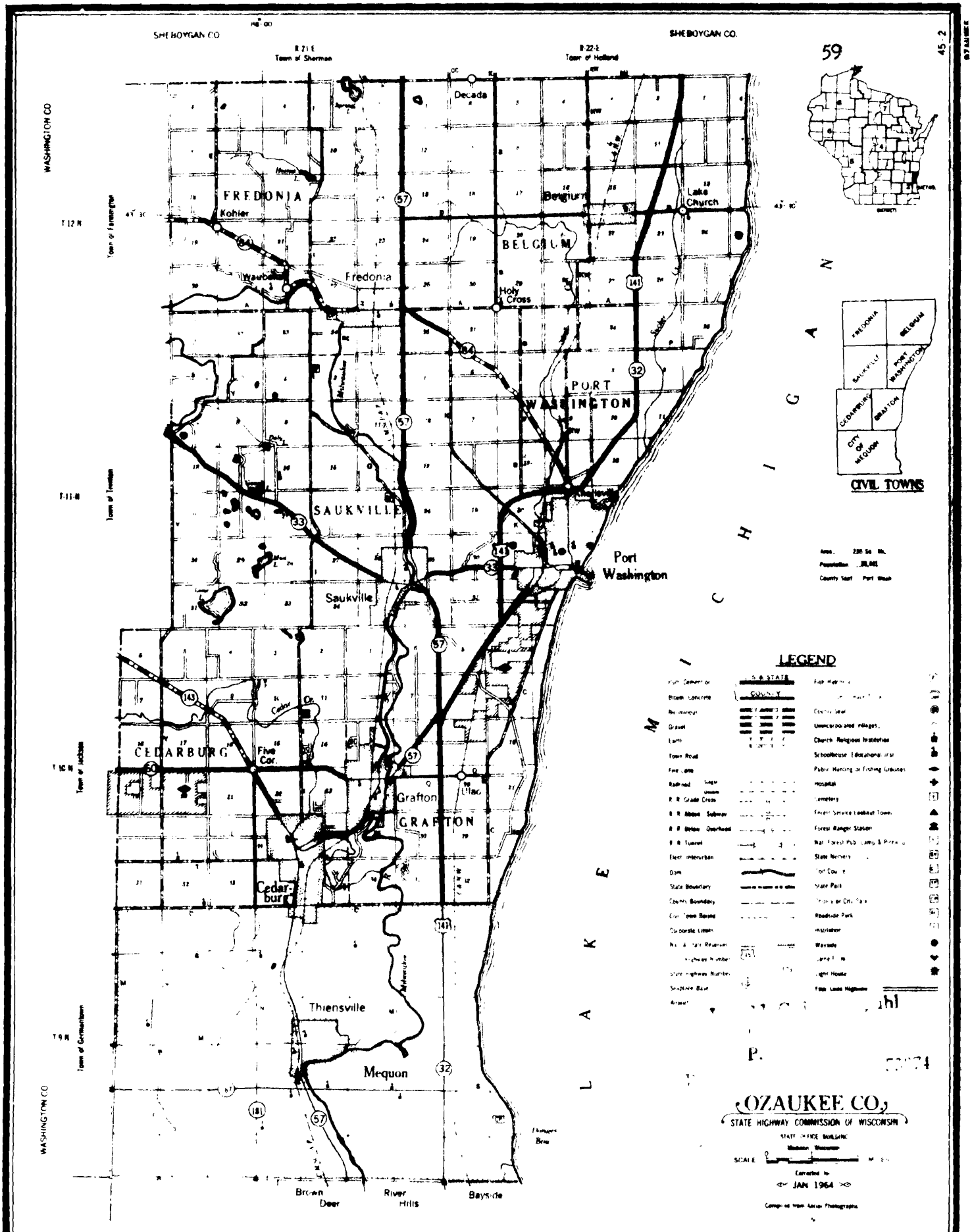

SHEBOYGAN CO
SHEBOYGAN CO.
R 21 E
Town of Sherman
R 22 E
Town of Holland
59
45-2
WASHINGTON CO
T 12 N
Town of Farmington
T 11 N
Town of Trenton
T 10 N
Town of Jackson
T 9 N
Town of Germantown
WASHINGTON CO
MILWAUKEE CO
MILWAUKEE CO
OZAUKEE
Decada
FREDONIA
Kohler
Waubeka
Fredonia
BELGIUM
Belgium
Lake Church
Holy Cross
PORT WASHINGTON
Port Washington
SAUKVILLE
Saukville
CEDARBURG
Five Cor.
Cedar-burg
Grafton
GRAFTON
Thiensville
Mequon
Brown Deer
River Hills
Bayside
MICHIGAN
LAKE
CIVIL TOWNS
FREDONIA
BELGIUM
SAUKVILLE
PORT WASHINGTON
CEDARBURG
GRAFTON
CITY OF MEQUON
LEGEND
OZAUKEE CO.
STATE HIGHWAY COMMISSION OF WISCONSIN
JAN 1964

Figure 40


Figure 24

Osmunda claytonia L.

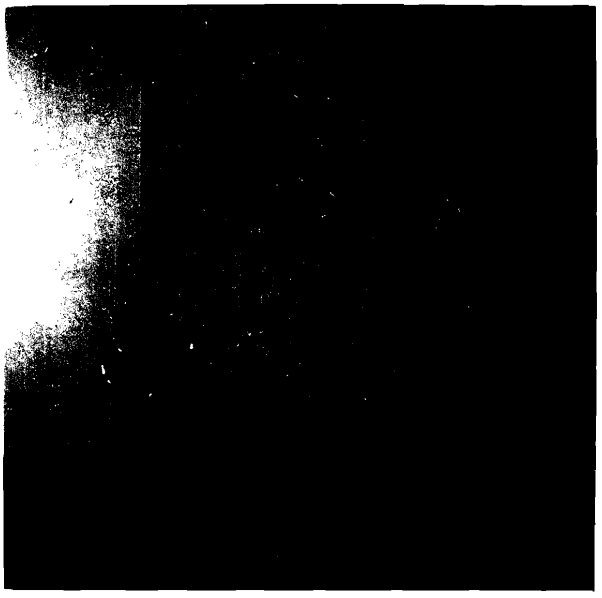
Interrupted Fern


Figure 25

Botrychium virginianum

(L.) Sw.

Rattlesnake Fern



MAY · 65

Figure 26

Camptoserus rhizophyllus

(L.) Link

Walking Fern

MAY · 65

Figure 27

Athyrium Filix-femina

(L.) Roth

Lady Fern

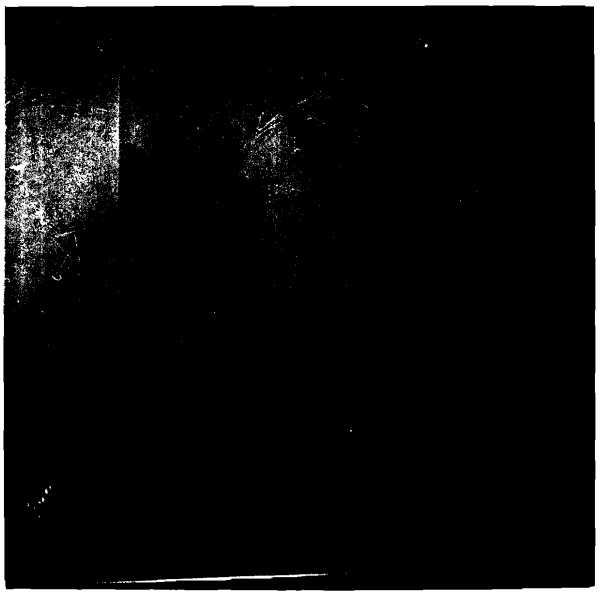


Figure 28

Onoclea sensibilis L.

Sensitive Fern

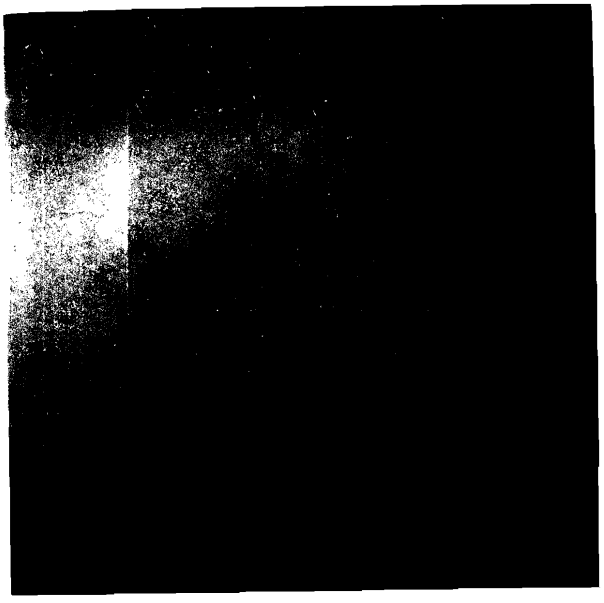


Figure 29

Cystopteris bulbifera L.

Bladder Fern

Figure 30

Cystopteris fragilis

(L.) Bernh.

Fragile Fern

Figure 31

Thelypteris phegopteris

(L.) Slosson

Long Beech Fern


Figure 32

Thelypteris noveboracensis

(L.) Niewl.

New York Fern


Figure 33

Adiantum pedatum L.

Maidenhair Fern


Figure 34

Pteridium aquilinum

(L.) Kuhn

Braken Fern


Figure 35

Lycopodium lucidulum Michx.

Shining Clubmoss

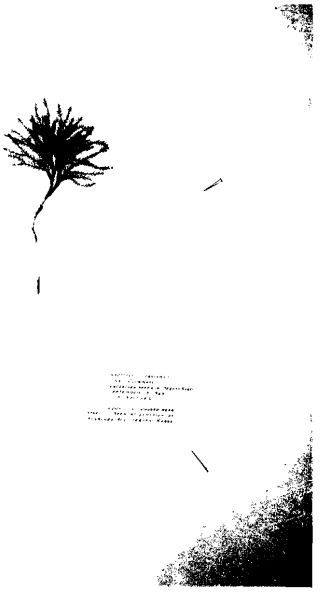



Figure 36

Lycopodium obscurum L.

Tree Clubmoss


Figure 37

Lycopodium complanatum L.

Running Pine

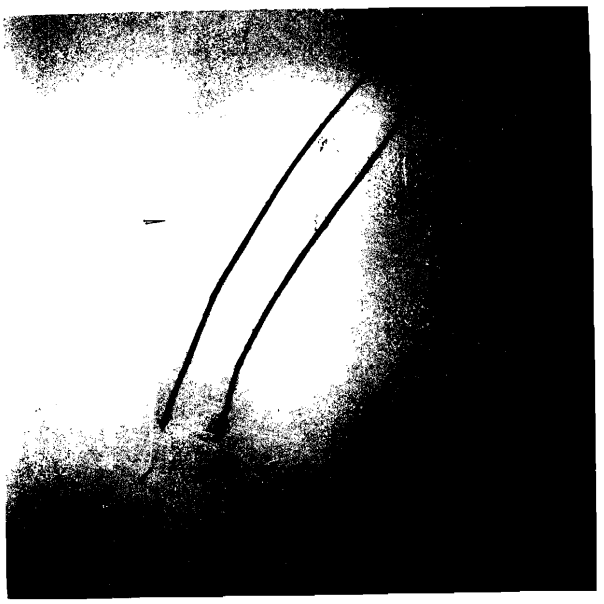


Figure 38

Equisetum hiemale L.

Rough Horsetail

Figure 39

Equisetum pratense Ehrh.

Meadow Horsetail

## IV. SUMMARY

The purpose of this report was to collect, press, identify and mount on herbarium paper specimens of the phylum, Pteridophyta, which are found in Ozaukee County. Family and genus descriptions are presented as aids for identification. The detailed descriptions given for the eleven species of ferns and five species of fern allies collected will help in the identification of such specimens found. The reproductive patterns and morphology will give students a better understanding of the organisms included in this phylum.

## CONCLUSION

It is the opinion of the writer of this report that students will derive greater benefit from their study of this group of plants because they will have the opportunity to observe representative species of ferns and fern allies available in Ozaukee County before going into the area to obtain specimens from their natural habitat. The students will have had previous experience with an identification key so that in the event a specimen is found that has not been identified, the key may be employed for identification purposes. Understanding family and genus descriptions will help in the identification of species which possibly were not found and collected for this report.

## RECOMMENDATIONS

It is the recommendation of the writer that this report on pteridophytes be used in the high schools of Ozaukee County in the general science and biology classes.

It is also recommended that similar studies for the other plant groups be conducted in Ozaukee County. These could also be used as aids in teaching plant biology to students of general science and biology in this county.

## V. GLOSSARY (10)

Ascending - Directed upward in relation to the axis.

Axil - The point just above the base of a leaf, between it and the main stem.

Blade - The leaf-like usually flattened part of a fern frond, as opposed to the stipe which is the stem-like stalk.

Chlorophyll - The green coloring matter visible in leaves of plants.

Cone - An aggregation of spore-bearing leaves on an elongated stem.

Crenulate - With fine rounded teeth.

Dorsal - The underside of the frond.

Elaters - A filament or filamentous appendage for dispersing spores.

Entire - Not toothed or divided.

Frond - The leaf of a fern, usually consisting of the blade and stipe.

Glandular - With glands, which are often spherical and raised on a stalk.

Indusium - (Plural indusia) The covering of a sorus, usually formed by the margin of the frond.

Linear - Long and narrow, with parallel margins.

Node - The level of a stem where a leaf is borne, or in Equisetum, a joint of the stem.

Oblong - Two or three times as long as broad and with parallel sides.

Pedicel - The stalk of a flower or of a cone.

Pinna - (Plural pinnae) A primary division of a frond.

Pinnate - Cut into pinnae.

Pinnate-pinnatifid - Pinnate, with the pinnae deeply lobed.

Pinnatifid - Deeply lobed but with the lobes connected at the base.

Pinnule - The secondary division of a frond.

Rachis - The main axis of a blade.

Recurved - Curved backward or downward.

Rhizome - An underground root-like stem, sending up leafy shoots from the upper surface and emitting roots from the lower side.

Serrate - With teeth on the margin.

Sessile - Without a stalk at the base.

Sheath - The collar-like structure at the base of each joint of the stem in Equisetum.

Silex - Silica, $SiO_2$.

Sorus - (Plural sori) Fruit-dots, made up of a collection of sporangia.

Sporangium - (Plural sporangia) A globular case in which spores are produced. A microscope or hand lens is normally needed to see the sporangia clearly.

Spore - The usually microscopic reproductive bodies of lower plants.

Stipe - The stalk of a frond from the rootstock to the first pair of pinnae.

Strobili - An aggregation of sporophylls resembling a cone, found in clubmosses and horsetails.

Ternate - With three nearly equal divisions.

Whorl - An arrangement of leaves or branches, where several radiate from one level of the main stem.

# BIBLIOGRAPHY

# BIBLIOGRAPHY


1. Benson, Lyman. Plant Classification. Boston: D.C. Heath and Company, 1957. 280 pp.

2. Bold, Harold C. The Plant Kingdom. Englewood Cliffs: Prentice-Hall Inc., 1960. 114 pp.

3. Cobb, Boughton. A Field Guide to the Ferns. Cambridge: Houghton Mifflin Company, 1960. 281 pp.

4. Durand, Herbert. Field Book of Common Ferns. New York: G.P. Putnam and Sons, 1928. 218 pp.

5. Fernald, M.L. Gray's Manual 8th Edition. New York: American Book Company, 1950. 1632 pp.

6. Gleason, Henry A. The New Britton and Brown Illustrated Flora of the Northeastern United States and Adjacent Canada. Lancaster: Lancaster Press Inc., 1952. 3 vol.

7. Hylander, Clarence J. The World of Plant Life. New York: The MacMillan Company, 1939. 722 pp.

8. Muenscher, W.C. and Petry, L.C. Keys to Spring Plants. Ithaca: Comstock Publishing Associates, 1949. 32 pp.

9. Slosson, Margaret. How Ferns Grow. New York: Henry Holt and Company, 1906. 156 pp.

10. Tryon, R.M., Fasset, N.C., Dunlop, D.W., Diemer, M.E. The Ferns and Fern Allies of Wisconsin. Madison: The University of Wisconsin Press, 1953. 158 pp.

11. Underwood, Lucien M. Our Native Ferns and Their Allies. Bloomington: Leader Publishing Company, 1882. 134 pp.

12. Wherry, Edgar T. The Fern Guide. New York: Doubleday and Company Inc., 1961. 318 pp.