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About the Institute

The Hunt Institute for Botanical Documentation, a research division of Carnegie Mellon University, specializes in the history of botany and all aspects of plant science and serves the international scientific community through research and documentation. To this end, the Institute acquires and maintains authoritative collections of books, plant images, manuscripts, portraits and data files, and provides publications and other modes of information service. The Institute meets the reference needs of botanists, biologists, historians, conservationists, librarians, bibliographers and the public at large, especially those concerned with any aspect of the North American flora.

Hunt Institute was dedicated in 1961 as the Rachel McMasters Miller Hunt Botanical Library, an international center for bibliographical research and service in the interests of botany and horticulture, as well as a center for the study of all aspects of the history of the plant sciences. By 1971 the Library's activities had so diversified that the name was changed to Hunt Institute for Botanical Documentation. Growth in collections and research projects led to the establishment of four programmatic departments: Archives, Art, Bibliography and the Library.

Copied in H. Mowley, March 26, 1942.

NOTES ON THE ROOTS OF SOME NEW ENGLAND ORCHIDS

In the course of studies of our native orchids I became deeply interested in the variety of root structure that they show. Each genus has its own characteristics and these are so distinctive that it is easy to name the genus (and usually the sub-genus) on the basis of root form alone. This paper is a preliminary study, in no sense final, of the roots of New England orchids. It makes no pretense to anything except pointing out a useful diagnostic feature which has been frequently overlooked.

Orchids are remarkable among plants for the extreme specialization of the floral structure. The roots are no less highly individualized. In the first place, orchids are quite without root-hairs. They depend upon mycorrhizal fungi to perform the functions that in other plants are usually taken care of by root-hairs. Some tropical orchids have lost their roots entirely, but all of the species of the northern U.S. have roots, which serve as anchors for the plants and as a means of carrying on the plant's life. All orchids are perennials and so they have within themselves the germ of future year's growth. This takes the form of a winter-bud, which is a conspicuous feature of the roots of many orchids. In addition to having this promise of the future, many orchids bring with them in their roots the story of the past.

In studying orchid root systems, three things should be observed:

- a. The form of the roots;
- b. The number of roots;
- c. The position of the winter-bud.

The form of the root shows the greatest variation. It ranges from the cord-like ^{rhizome} ~~sheet~~ of Pogonia to the small compact globose corn of Arethusa. In number, the roots run from the single tuberoid

of Spiranthes Beckii to the very numerous roots of Cypripedium. The position of the winter-bud varies considerably. In some species it is very close to this year's stem, so that the plant remains almost stationary, while in others it is several inches away, so that the plant "marches" slowly but steadily along.

There are in New England about 50 species of orchids in 17 genera. Of these I have found 45 species in 16 genera. I have never observed the roots of Habenaria obtusata, nor have I found Anesia (Serapias of Gray's Manual), Habenaria cristata (reported but once from New England), H. leucophaea, Listera auriculata nor L. convallarioides. The sketch of Tipularia discolor, which some older books record from New England, is based upon fresh material sent to me from Maryland by Prof. J. B. Egerton.

Presented herewith are rather careful sketches to show the salient features of the root system of each genus and sub-genus of orchid found in New England, with the exceptions noted. The drawings were made from fresh living plants, collected in the field (except Aplectrum, which is from a photograph) and all are full size. Care has been taken to select typical plants for the illustrations. Critical notes on the genera and species follow:

CYPRIPEDIUM. All N.E. species have numerous coarsely fibrous roots, about 1/8 inch in diameter. The winter-bud is at the base of the stem, within the sheath. I am not able to distinguish the species on the basis of root form alone. (Pl. 1)

ORCHIS. O. rotundifolia (Pl. 5) has a root which extends almost horizontally from the base of the stem. At the distal end is a small process or scar where the previous year's plant grew. From this root a few shoots extend. The winter-bud is near the base of the stem. Orchis spectabilis (Pl. 6) has a cluster of fleshy tubercles, very like those of many species of Habenaria. The winter-bud is borne on one of these, about 1/2 inch from the base of the stem.

branches arise

HABENARIA. The roots of habeneria consist of a number of elongated tuberoids. Some species resemble Spiranthes, but they can be told at once from that genus by the position of the winter-buds. In Habenaria the winter-buds arise from one of the tubers, whereas in Spiranthes they are found at the base of the stem under the protecting sheaths. In Habenaria the buds are plainly visible during the flowering season, but in Spiranthes they do not appear until autumn, although they may be found by stripping the leaves away carefully.

H. viridis var. bracteata (H. bracteata) is easily distinguished by its somewhat palmately-cleft tuberoids, with long tapering divisions. (Pl. 2) The winter-bud arises at the base of the stem.

H. flava. The winter-bud is at the base of the stem, as in the previous species, but the tuberoids are simple and undivided. (Pl. 2)

H. hypnoides. One long tapering tuberoid at the base of the stem (suggesting a tap-root) bears the winter-bud. I cannot distinguish H. dilatata. (Pl. 2)

H. clavellata (Pl. 2) bears the winter-bud on a long spindle-shaped tuberoid nearly at a right angle to the stem.

H. orbiculata (Pl. 2) ^{has roots} is very similar to H. flava, but the two large orbicular basal leaves immediately distinguish this group from all others. I am unable to separate H. Hookeri or H. macrophylla on the basis of root form. I am, incidentally, not wholly satisfied that the latter is a valid species.

H. ciliaris (Pl. 2) has two large carrot-shaped roots, one of which bears the winter-bud. H. blechnarioides is indistinguishable.

H. lacera (Pl. 4) has a cluster of tapering tuberoids with the winter-bud about 1/2 inch from the stem on one of them. H. fimbriata (Pl. 3), H. psuedos (Pl. 3), and the natural hybrids in this group show no distinctive characters.

(It may be objected that this study is useless because certain species cannot be distinguished solely by the roots. Practically, however, without some vegetative evidence, one is unlikely to discover the root at all. When the leaves are present, O. spectabilis cannot be confused with H. lacera or H. flava with H. orbiculata. Actually, if an unflowered orchid is collected, it may be named with a fair degree of accuracy-- particularly if its habitat is known.)

POGONIA. Ames (Orchidaceae, Fasc. VII) gives a good description: "From the short vertical rhizome, root-shoots extend widely in a nearly horizontal plane, and eventually produce new plants. These root-shoots may be many feet long." (Pl. 5) I have traced these cord-like root-shoots for more than 12 feet. At that point it broke off, so I do not know how much longer it may have been.

ISOTRIA. (Pogonia in Gray) (Pl. 5) Ames (l.c.) gives the best account-- "It has a vertical rhizome, covered with fuscous pubescence. The root-shoots in this species may attain extraordinary length." The root system is much like that of Pogonia, but the vegetative characteristics are very different. This description applies to

I. verticillata. I have never examined the roots of I. affinis. The only station for this species that I ever found is now wiped out.

TRIPHORA. (Pogonia in Gray's Manual) Ames (l.c.) says, "The flowering stem arises from the broad end of an obconical or egg-shaped tuber, and from the lower end of the flowering stem, above the tuber, stolons originate and grow out in a more or less horizontal direction, bearing at their end miniature replicas of the mature tuber." (Pl. 5) I have examined a great many (more than 100) root systems of our only species (T. trianthophora). The roots are extremely brittle and they grow only in the upper layers of the leaf-mould, so that it is a very ticklish job to get the roots free without damaging them. The whole root is white and translucent. The plants grow in dense colonies, which makes the task of dissection much more difficult. This species is extremely abundant in some places, but the number of flowering plants varies greatly from year to year. Thousands of plants may be found one year. Then, for a number of years, none or very few can be found. No winter-buds were observed. It is my opinion, based upon many years of observation, that the original tuber decays after flowering and that the smaller tubers take several years to attain flowering size. This would account for the dense colonies and for the remarkable periodicity of the species. The small process at the distal end of the flowering tuber would seem to bear out this hypothesis. More than a hundred flowering plants can often be found in a square foot of leaf-mould.

CALOPOGON. C. pulchellus, our only species, has a solid corm, more or less egg-shaped, at right angles to the bulbous base of the stem. (Pl. 5)

ARENHUSA. A. bulbosa has a single globose corm at the base of the stem. (Pl. 3)

SPIRANTHES. One to several spindle-shaped tuberoids. The winter-bud arises within a protective sheath formed by the bases of the old leaves. If one marks a plant of Spiranthes and then examines it late in the fall (October or November) the winter-bud will be plainly visible, as it makes rapid growth at that time. I cannot distinguish the species, except S. Beckii, which has a single tuberoid. (Pl. 35)

EPIPACTIS. Root of thick fleshy fibres from a rather fleshy jointed creeping rootstock. (Pl. 5) The evergreen leaves differ in their markings in each of our native species, so that they can be determined at any season, but I have found no diagnostic characters in the roots.

LISTERA. Slender fibrous roots, branching from a vertical rhizome. (Pl. 3) L. australis is stoloniferous and two flowering stems are frequently found on the same plant. It is less slender than L. cordata. I have not found the two other native species.

Sometimes

CORALLORRHIZA. Gray's Manual says "Much branched and toothed coral-like underground stems". C. trifida blooms in May. C. odontorrhiza may be distinguished from the other fall-blooming species (C. maculata) by the bulbous-thickened base of its stem. (Pl. 3)

MICROSTYLIS. M. unifolia has a dense orbicular corm, with the stem arising from its summit. The previous year's corm is persistent. (Pl. 5) Our second species, M. monophyllos, is very similar.

LIPARIS. In both of our species the corms are covered with shaggy sheaths, the corms of the previous years persisting. (Pl. 5)

CALYPSO. Our only species (C. bulbosa) has neat chestnut-shaped corms, with that of the past year persisting. The winter bud is at the base of this year's corm. (Pl. 5)

APICTERUM. A. hyemale has several corms, strung like beads along a slender root-stock. The leaves are produced in autumn and stay green all winter, but die in the spring just before the flowers are produced. Gray's Manual mentions that the corms are "filled with exceedingly glutinous material", but I did not happen to observe this fact on the only occasion that I collected this plant. (Pl. 4)

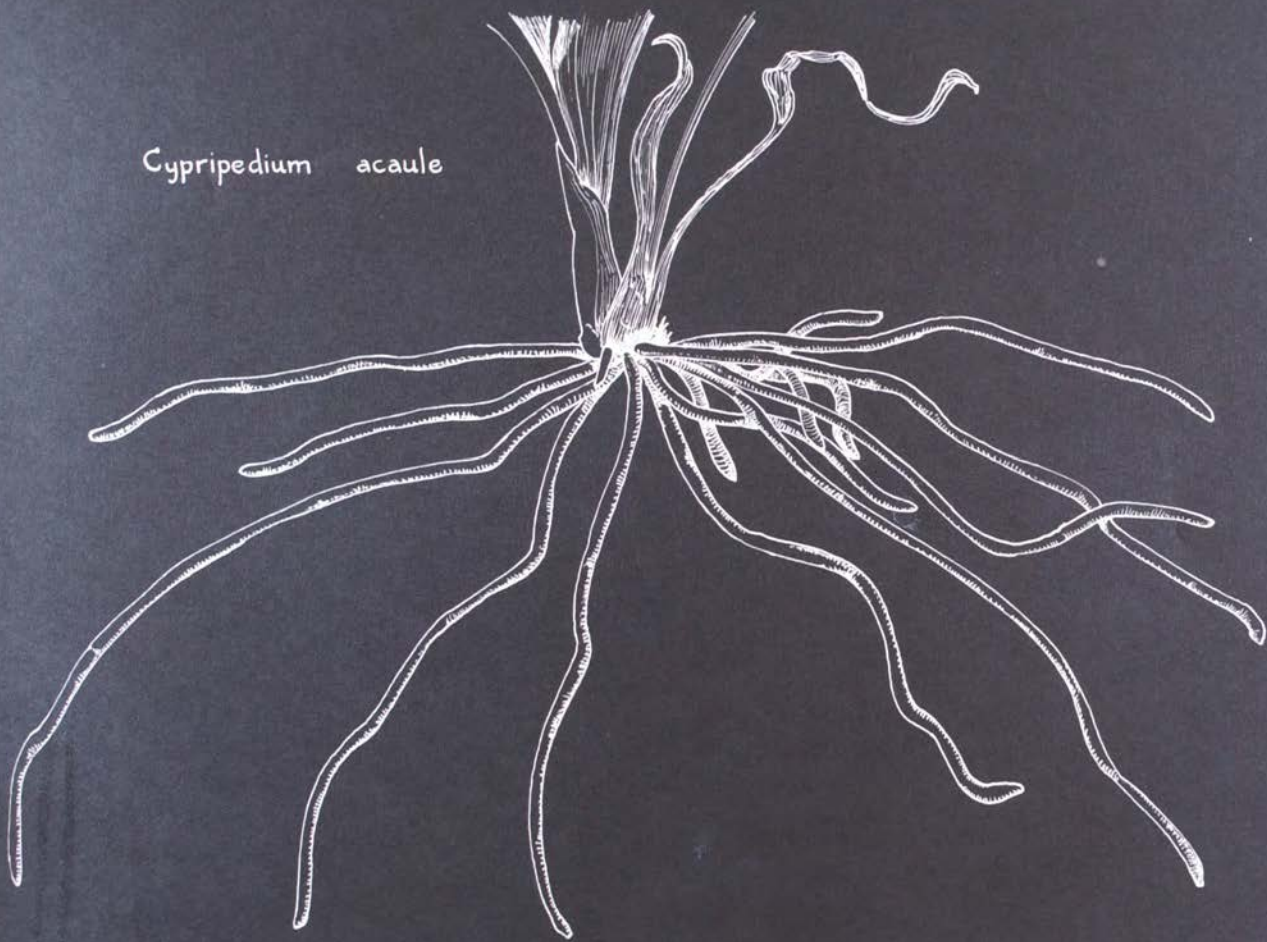
(T. discolor)

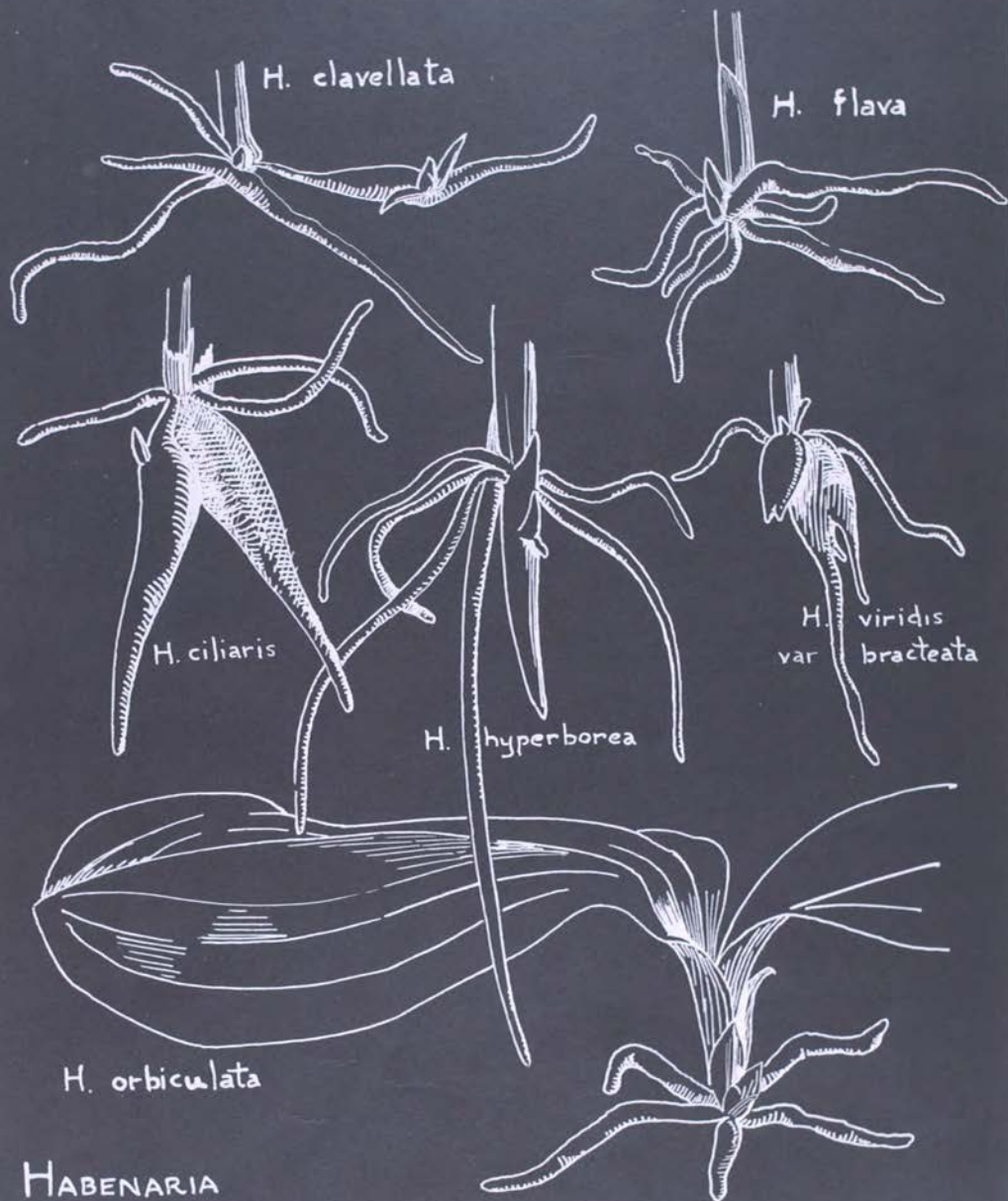
TIPULARIA. Some of the older books record this species from New England, but I know of no recent record and I am inclined to doubt its occurrence. Its root is similar to that of Apictetum, but the root-stock is so shortened that it is not visible and the several corms lie side by side. The leaf is shorter and broader than that of Apictetum-- scarcely longer than broad, whereas the leaves of Apictetum are nearly twice as long as the breadth. The leaves of both species are strongly ribbed and those of Tipularia are purple beneath, tending to become more purple with age. Apictetum is green on both sides. (Pl. 6)

The numbers in parentheses refer to the illustrations. The names are those of Gray's Manual, seventh edition (1908), unless otherwise stated.

Written April, 1932.

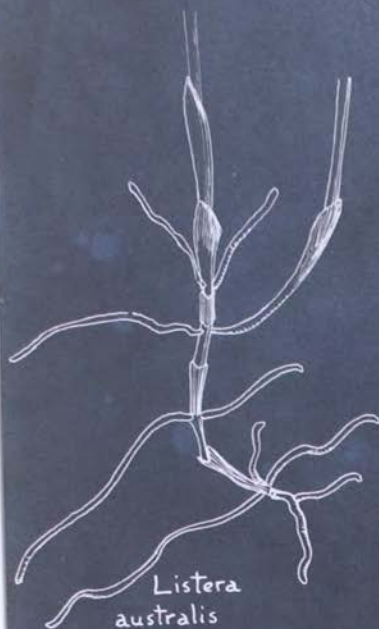
Cypripedium acaule





HABENARIA

Hunt Institute for Botanical Documentation



*Listera
australis*



*Listera
cordata*



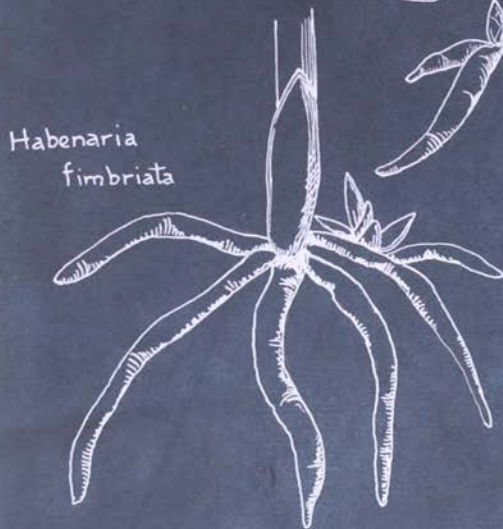
Corallorrhiza maculata



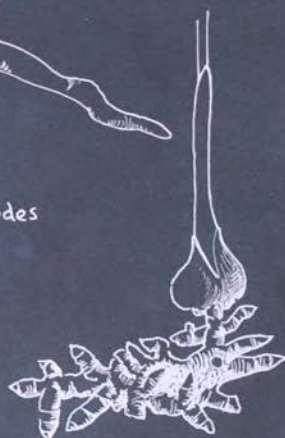
*Arethusa
bulbosa*



Hab. psycodes



*Habenaria
fimbriata*



*Corallorrhiza
odontorhiza*

Spiranthes Beckii



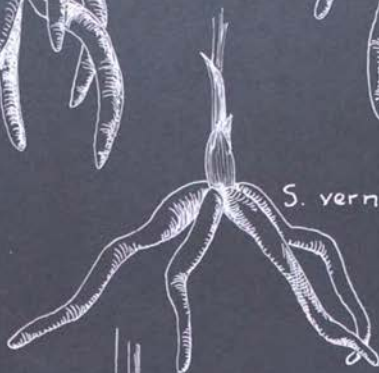
S. gracilis



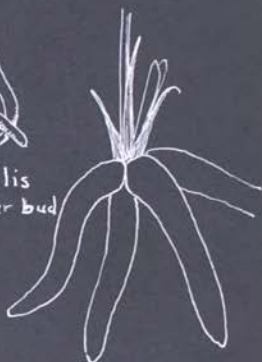
S. lucida



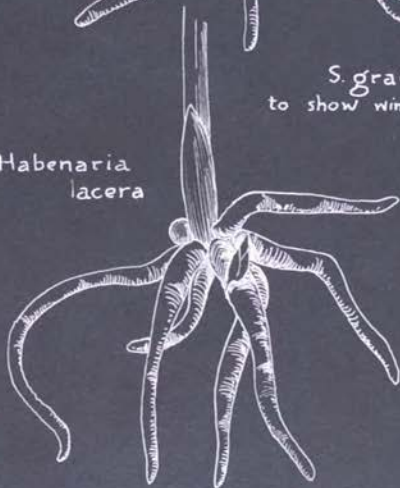
S. vernalis



S. gracilis
to show winter bud



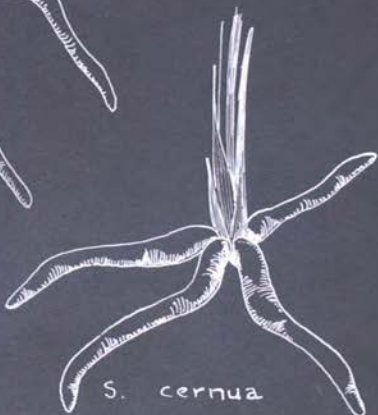
Habenaria lacera

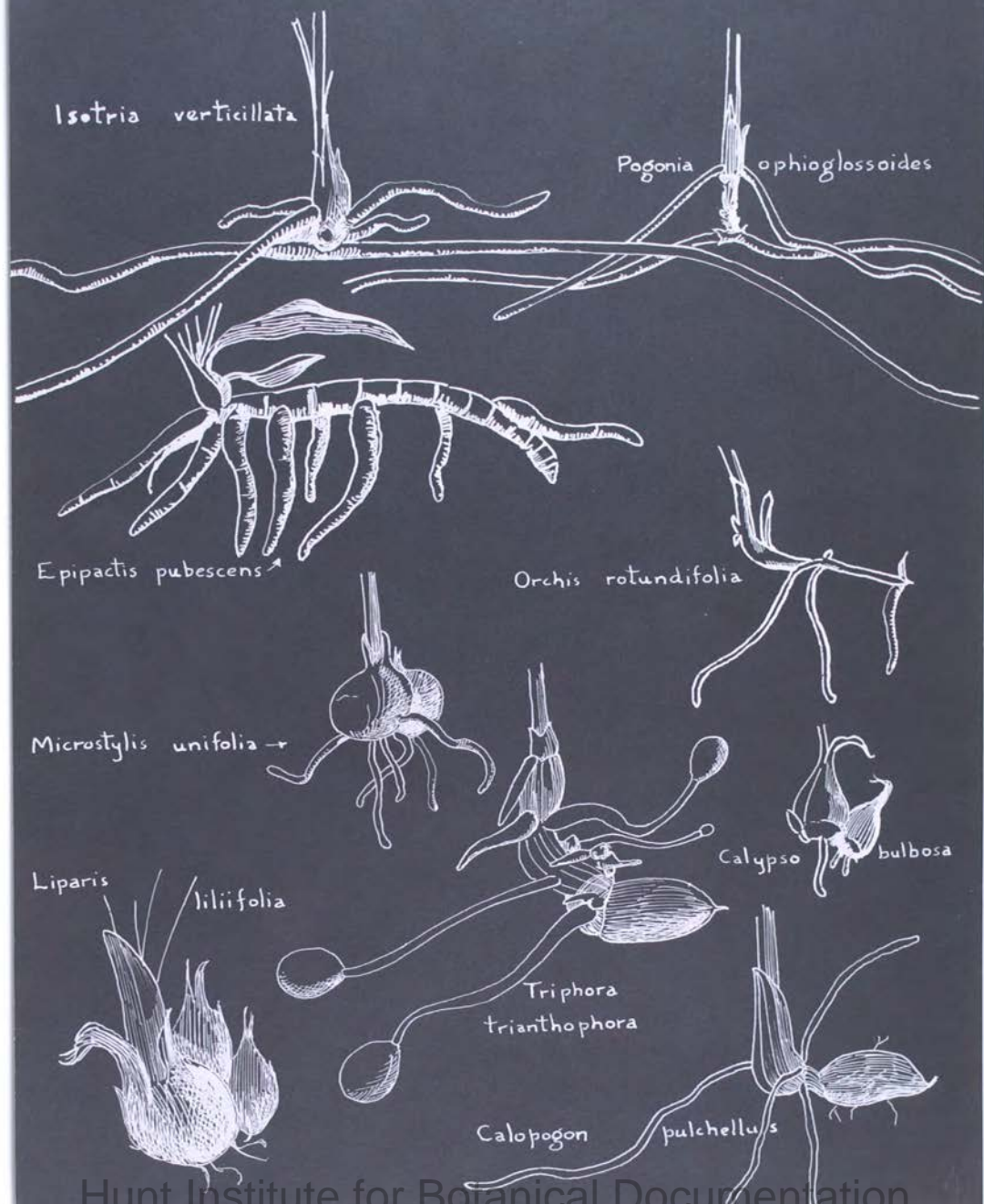


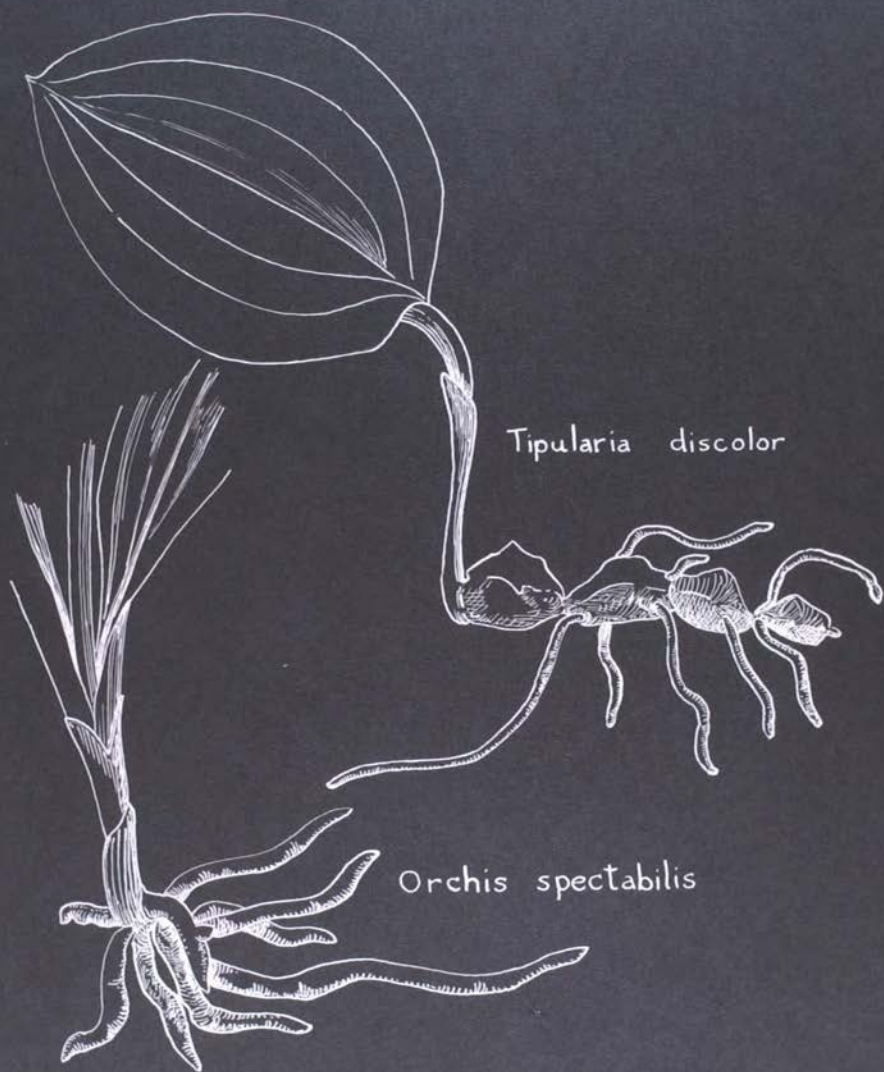
Aplectrum hyemale

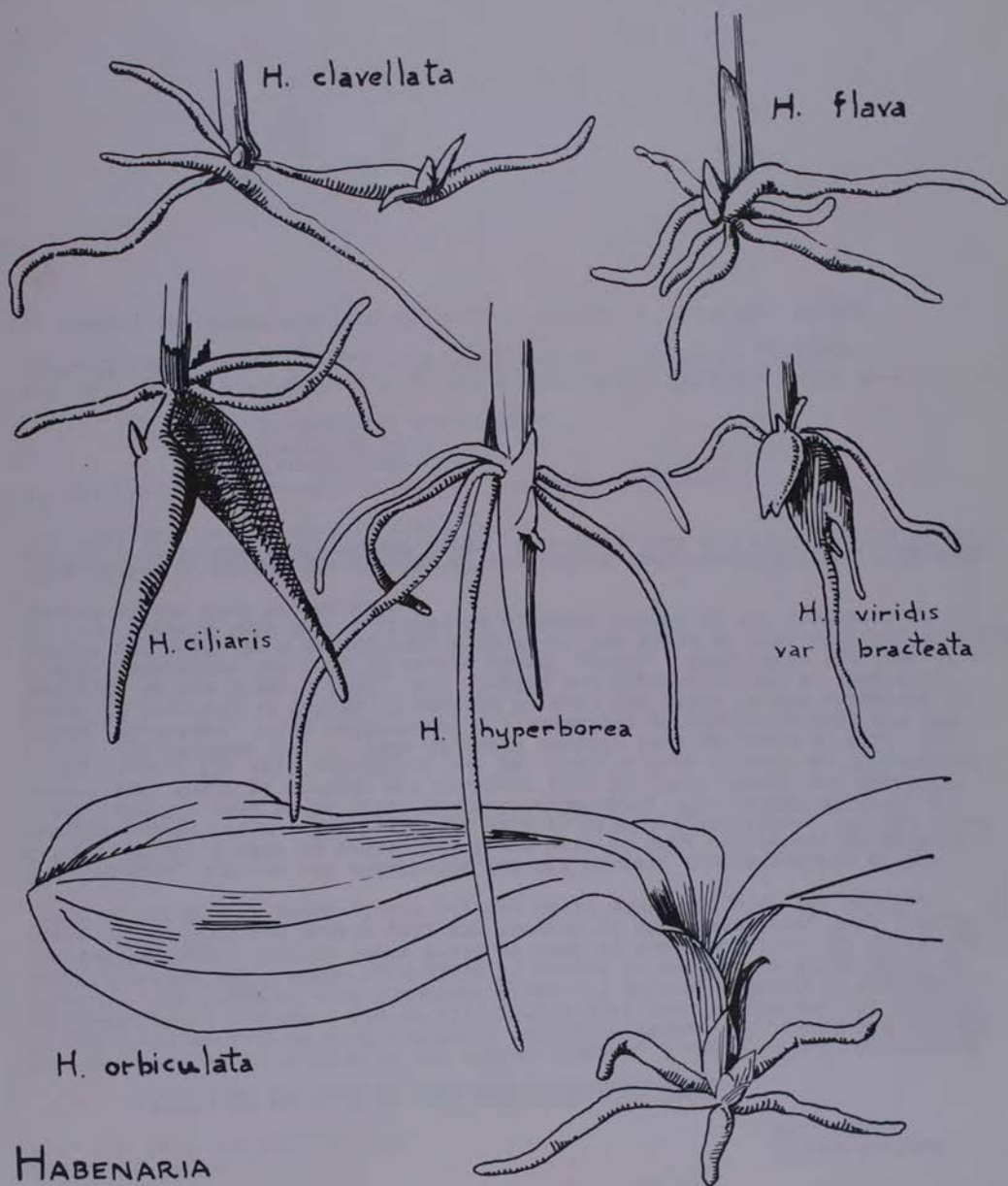


S. cernua









HABENARIA

Hunt Institute for Botanical Documentation

Albert E. Lowmes
P.O. Box 1531, Providence, R.I.

Orchid Special
April 1932

NOTES ON THE ROOTS OF SOME NEW ENGLAND ORCHIDS.

In the course of my studies of our native orchids, I became deeply interested in the great variety of root structure that they show. Each genus has its own characteristics and these are so distinctive that even a tyro can classify an orchid on the basis of root structure alone. I am very anxious to continue my investigations and I would appreciate it deeply if members in other parts of the country would send me fresh roots of some of their orchids. If these are packed in some of the native soil and wrapped in damp newspaper, they should reach me safely. I shall gladly pay any costs connected with the sending.

Among plants, orchids are remarkable for the extreme specialization of the floral parts. I have no doubt that there will be many references to this in the present bulletin. The roots are no less highly specialized. In the first place, orchids seem to be quite without root hairs. They depend entirely on mycorrhizal fungi to perform the functions that in other plants are performed by the roots. (In this connection see Dr. Clark's fine article on "Mycorrhiza" in "A" for October 1929.) Some tropical orchids have no roots at all! The roots, therefore, being relieved of all necessity of obtaining food are reduced in function to acting as anchors to hold the plant in the earth and to carrying on the plant's life. All orchids are perennials and so they have within themselves the germ of future years' growth. This takes the form of a winter bud which is a conspicuous feature of the roots of many orchids, although in some species this bud is hidden in a sheath formed by the leaf-base or by bracts at the foot of the stem.

In addition to having the promise of the future, many orchids bring with them in their roots the story of the past. In others, the old root is lost by decay, and only this year's root is visible.

In studying root systems, three things should be noticed:

- a. Form of roots
- b. Number of roots
- c. Location of winter-buds.

The form of the root shows the greatest variation. This may range from a long cord-like shot as in Pogonia to a small compact corm as in Arethusa.

In number, the roots run from the single tuber of Spiranthes Beckii

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In number the roots run from the single tubercoid of Spiranthes Beckii to the very numerous fl shy fibrous roots of Cypripedium.

The location of the winter-bud varies considerably, as has been suggested above. In some species it is very close to this year's stem, so that the plant remains almost stationary, while in others it is several inches away, so that the plant "marches" slowly but steadily along at quite an appreciable rate.

On latest available information, there are (including hybrids and color forms) 50 species of orchids in New England. These are grouped in 17 genera. I have studied 45 species in the field, representing 16 genera. I have never found Amesia (Serapias of Gray's Manual), nor Habenaria cristata (reported but once from N.E.), H. leucophaea, Listera auriculata nor L. convallarioides.

New England Orchids.

		Color	B-W	Remarks.
	<i>Cypripedium arietinum</i>			
	<i>pariiflorum</i>	✓	✓	
	<i>reginae</i>	✓	✓	
	<i>acaulis</i>	✓	✓	
5	<i>Onchis rotundifolia</i>		✓	
	<i>spectabilis</i>	✓		Root
	<i>Habenaria flava</i>		✓	
	<i>viridis</i> var. <i>bracteata</i>		✓	
	<i>clavellata</i>		✓	
10	<i>hyperborea</i>		✓	
	<i>dilatata</i>			
	<i>obtusata</i>			
	<i>Hookeri</i>			
	<i>obovata</i>	✓	✓	
15	<i>cristata</i>	?		
	<i>ciliaris</i>	✓	✓	
	<i>blephariglottis</i>		✓	
	<i>lacera</i>		✓	
	<i>leucophaea</i>	?		
20	<i>psychea</i>		✓	
	<i>fimbriata</i>	✓	✓	
	<i>Histera cordata</i>		✓	
	<i>australis</i>		1/2	
	<i>auriculata</i>			
25	<i>convallarioides</i>			
	<i>Pogonia ophioglossoides</i>	✓	✓	
	<i>Isotria verticillata</i>	✓	✓	
	<i>affinis</i>			

	<i>Triphora trianthophora</i>		✓	
30	<i>Arethusa bulbosa</i>		✓	
	<i>Calopogon pulchellus</i>	✓	✓	
	<i>Spiranthes Beckii</i>		✓	
	<i>gracilis</i>		✓	
	<i>vernalis</i>	✓	✓	
35	<i>lucida</i>		✓	
	<i>cemua</i>	✓	✓	
	<i>Romanzoffiana</i>		1/2	
	<i>Epipactis decipiens</i>			
	<i>trassolata</i>			
40	<i>repens</i> var. <i>ophioides</i>		✓	
	<i>pubescens</i>		✓	
	<i>Malaxis monophyllos</i> var. <i>trachypoda</i>			
	<i>unifolia</i>		✓	
	<i>Hiparis liliifolia</i>		✓	
45	<i>Loeselii</i>			
	<i>Calypso bulbosa</i>		✓	
	<i>Aplectrum hyemale</i>			Root
	<i>Corallorhiza trifida</i>			Root
	<i>maculata</i>	✓	✓	
50	<i>odontorhiza</i>	✓	✓	

Need- (Colored)

Cypripedium arietinum

Orchis rotundifolia

Habenaria flava

viridis var. *bracteata*

clavellata

hypobryea

dilatata

obtusata

Hookeri

cristata.

blephariglottis

lacina

leucophaea

psycodes

Listra cordata

austalis

auriculata

convallarioides

Partia affinis

Triphora trianthophora

Arethusa bulbosa

Spiranthes Beckii

gracilis

lucida

Romanzoffiana

Epipactis deiciens

fuscescens

repens var. *ophioides*

pubescens

Malaxis monophylla

Need (Colored)

M. unifolia

Liparis liliifolia

hosselii

Calypso bulbosa

Aplectrum hyemale

Corallorhiza trifida.

No representation at all.

Cypripedium arietinum

Habenaria dilatata

obtusata (Single flowers)

Hookeri (Single flowers)

5 *cristata*

leucophaea

?

histria auriculata

convallarioides

Isotria affinis

10 *Epipactis decipiens*

tessellata

Malaxis monophyllos

Liparis hoeselii (Single flower)

In the course of my studies of our native orchids, I have been deeply impressed by the great variety of root structure that they show. Each genus has its own characteristics and these are so distinctive that even a tyro can easily bring an orchid to its proper genus by its root structure alone. Moreover, it is possible, simply on the basis of ^{the} roots to divide the numerous sub-genera of the polymorphic *Habenaria* group. Whether my ~~remarks~~ thesis would hold good for a larger area or not, I do not know. It would be valuable to have comments from other parts of the country where different species may be found, and I should greatly appreciate it if our members outside of New England will send me roots of their orchids. If these are packed in some of the native soil, wrapped in damp newspaper and sent by mail, they should reach me in good condition. I shall gladly pay any costs ~~of packing & postage~~. Does *Hab. leucophaca*, for instance, follow the typical structure of the *fimbriata-lacera* group?

Has H. cristata the two spindle-shaped main roots of ciliaris + blephariglottis? These and many other questions need to be answered.

~~The next~~ In study of root systems, ^{three} ~~many~~ points are important.

- a.) Form -
- b.) Number
- c.) Location of Winter bud.

The form shows most variation and is most characteristic. This varies from the small compact corm of Arethusa bulbosa to the long cord-like stolons of Pogonia ophioglossoides.

In number the roots run from the single tuber of S. Beckii to the very numerous fleshy fibrous roots of Cypripedium.

The location of the winter bud, while of less value than the other two, as a diagnostic character, is a matter of considerable interest. All orchids are perennials, and consequently have in them the germs of future years' growth. This takes the form of a winter bud, which is usually well developed by blossoming-time. The bud is usually in two parts, -

one providing for the stem, leaves, and flowers; the other containing the embryo root. In most cases it is possible also to find the roots of previous years, also, — sometimes of several years growth. In some species, the bud is produced very close to the stem, so that the plant remains almost stationary. In others, it is produced several inches from the stem so that the plant "marches slowly but steadily along."

I have made careful drawings of dozens of orchid root systems, and on the back ~~leaf~~ of this article are reproduced the typical roots of many New England orchids, representing all but ~~two~~ of the genera growing in our region. ~~Practically~~ All of them were made from living plants, ~~the exceptions being:~~ except that of *Aplectrum*, which was made from a photograph. All are full size.

Critical notes on ^{the} various genera involved follow:

Get dope on root structure.

Anusia

~~*Anusia*~~

C. trifida - ?

C. acaulis

C. arictinum

C. hispidum

C. parviflorum

C. p. var. pubescens

E. decipiens

E. ophioides

E. tessellata

H. cristata

H. dilatata

H. Hookeri

H. leucophaea

H. obtusata

~~*H. obtusata*~~

Liparis locellii

Liparis auriculata

L. convallarioides

Malaxis palmata

M. monophyllos

O. spectabilis

49
21
28
2
28
28

H. viridis var. *bracteata*

H. flava

H. hypnoides

H. dilatata

var. *media*

H. clavellata

H. obtusata

H. Hookeri

H. orbiculata

H. macrophylla

H. cuneata - ?

H. ciliaris

H. blephariglossis

H. laevis

H. leucophaca

A. psychodes

X *H. Andrewsii*

H. fimbriata

forma *albiflora*

Cypripedium - "Roots coarsely fibrous," G.M.

C. arietinum

C. parviflorum

C. p. var. pubescens

C. reginae

✓ C. acaule

Orchis

✓ *O. rotundifolia*

✓ *O. spectabilis*

Halimaria - "Tubercles elongated, fusiform, or somewhat palmate" G.M.

✓ H. viridis var. bracteata - Tubercles somewhat palmate, the divisions elongated, tapering" G.M.

Cicloglossum

✓ H. flava

Perularia

✓ H. hyperborea

Limnorchis

H. dilatata

H. d. var. media

✓ H. clavellata

Gymnadeniopsis

H. obtusata

Lysichla

(OVER)

H. Hookeri

Lysiae

✓ H. orbiculata

H. macrophylla

H. cristata

Blephariglottis

✓ H. ciliaris

✓ H. blephariglottis

✓ H. lacera

H. leucophaea

✓ *H. psycodes*

✗ *H. Andrewsii*

✓ *H. fimbriata*

H. f. forma albiflora

✓ *H. repens.*

Pogonia

✓ P. ophioglossoides

Triphora

✓ T. trianthophora

Isotria

✓ *I. verticillata*

I. affinis

Calopogon "*Solid helle*" G.M.

✓ *C. pulchellus*

Arcthusa - "Solid white or greenish bulb" GM.

✓ A. bulbosa

Amesia

A. latifolia

Ponthieva

✓ P. racemosa

Spiranthes "Roots clustered", G.M.

✓ S. Beckii - "Solitary subcylindrical or spindle-shaped root", G.M.

✓ S. gracilis "Cluster of thickened roots", G.M.

✓ S. vernalis "Roots elongated, fusiform", G.M.

X S. intermedia

✓ S. lucida

✓ S. cernua "Slender, fleshy roots", G.M.

S. c. var. ochroleuca

S. Romanzoffiana "Roots 5-8 mm thick," G.M.

Epipactis "Root of thick fibres from a somewhat fleshy creeping rootstock," G. M.

○ E. repens var. ophioides

E. tessellata

E. decipiens

✓ E. pubescens

Listera "Reticulata" G.M.

✓ L. cordata

✓ L. australis

L. auriculata

L. convallarioides

Coralorrhiza "Much branched and toothed coral-like underground rootless stems."

✓ *C. trifida*

✓ *C. maculata*

✓ *C. odontorrhiza* - "Bulbous thickened at base", G.M.

Microstylis "Solid bulbs"

M. monophyllos

✓ M. unifolia

Liparis "Solid bulbs"

✓ L. liliifolia

L. Loeselii

Calypto "Rounded or elongated corn"

✓ C. bulbosa

Aplectum "Slender naked rootstock produces each year a globular solid bulb or corn, often 2.5 cm. in diameter (filled with exceedingly glutinous matter) G.M."

✓ A. hyemale

Tipularia

✓ T. discolor

Amesia

✓ *Aplecturnum hyemale* - EHL (phd)

✓ *Arethusa bulbosa*

✓ *Calopogon pulchellus*

✓ *Calypso bulbosa*

✓ *Corallorhiza maculata*

✓ *C. odontorhiza*

C. trifida

Cypripedium acaule

• *C. arietinum*

C. hirsutum

C. parviflorum

Cyp. par. var. pubescens

E. pipactis decipiens

✓ E. pubescens

E. repens var. ophioides

E. tasselata

Habenaria Andrewsii

H. blephariglottis

✓ A. ciliaris

✓ A. clavellata

H. cristata

H. dilatata

H. d. var. media

H. fimbriata (cf. albiflora)

✓ H. flava

H. Hookeri

✓ H. hyperborea

✓ H. laevis

H. leucophaea

H. macrophylla

H. obtusata

✓ H. orbiculata

✓ H. psycodes

✓ H. ~~viridissima~~ bracteata

~~H. ~~viridissima~~ macrophylla~~

Isotria (at end) -

✓ *Liparis liliifolia*

Liparis hoeselii

Listra auriculata

✓ *L. australis*

L. convallarioides

✓ *L. cordata*

Malaxis paludosa

Microstylis monophyllos

✓ *M. unifolia*

✓ *Orchis rotundifolia*

O. spectabilis

✓ *Pogonia ophioglossoides*

✓ *Spiranthes Beckii*

✓ *S. cernua*

S. c. var. ochroleuca

✓ *S. gracilis*

S. x intermedia

✓ *S. lucida*

✓ *S. vernalis*

~~*Tipularia discolor*~~

✓ *Triphora trianthophora*

Isoetes affinis

✓ *I. verticillata*

49

56
59 sp. + rare (in collection)