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Distribution and habitats of the orchids of Iowa

by

David Arthur Niemann

A Dissertation Submitted to the
Graduate Faculty in Partial Fulfillment of
The Requirements for the Degree of
DOCTOR OF PHILOSOPHY

Department: Botany and Plant Pathology
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For the Graduate College

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Ames, Iowa
1975
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INTRODUCTION

General

The state of Iowa is located near the middle of the North American continent in the upper Mississippi valley. It lies approximately between latitude 40°20' and 43°30' north, and between the longitude 90° and 96°30' west. The state is bounded by the Mississippi River on the east, and by the Missouri River on the west. The northern and southern boundaries follow parallels of latitude rather than natural geographical features. The area of the state is 143,967 square kilometers (55,586 square miles). The greatest length of the state east and west is about 539 km (335 miles), its width 335 km (208 miles).

Although not very varied in latitude or altitude, Iowa serves as a home for 25 species and 2 natural hybrids of orchids. These species and hybrids are Aplectrum hyemale, Calopogon tuberosus, Corallorhiza maculata, Corallorhiza odontorhiza, Cypripedium calceolus var. pubescens, Cypripedium candidum, Cypripedium reginae, Goodyera pubescens, Habenaria clavellata, Habenaria flava var. herbiola, Habenaria hookeri, Habenaria hyperborea, Habenaria leucophaea, Habenaria psycodes, Habenaria viridis var. bracteata, Liparis lilifolia, Liparis loeselii, Malaxis unifolia, Orchis spectabilis, Pogonia ophioglossoides, Spiranthes cernua, Spiranthes lacera, Spiranthes romanzoffiana, Spiranthes vernalis, Triphora trianthophora, Cypripedium x andrewsii, and Spiranthes cernua x lacera.

A number of these species reach the limits of their range in Iowa. Spiranthes vernalis reaches the northern limit of its range in the Missouri valley in Iowa. Spiranthes romanzoffiana and Habenaria hyperborea reach
the southern limits of their ranges in northern Iowa. Many of the remaining species reach the western limits of their ranges in Iowa. The characteristics of the habitats in which our native orchids grow and the factors limiting their distribution in Iowa are discussed in this dissertation.

The Iowa Environment

The climate of Iowa

The climate of most of Iowa is characterized as humid continental, warm summer (Espenshade, 1964). A small portion of northern and northeastern Iowa falls into the cool summer subtype. This climatic type is characterized by warm or occasionally hot summers with rainfall in the form of showers and thunder storms. The spring and autumn seasons are brief, unpredictable, and usually consist of alternating warm and cold periods rather than a uniform warming or cooling (Trewartha, 1968). Winters are long and cold with most precipitation coming as snow. Long periods of subfreezing temperatures occur annually. Wide departures from the mean temperatures are often experienced, especially during the winter.

Precipitation is one of the most important factors governing the distribution of plants in Iowa. It is a main limiting factor in the westward expansion of orchid species beyond their present range limits in Iowa. Precipitation is greatest in the southeastern part of the state, and decreases toward the northwest. Precipitation ranges from more than 86 cm (34 in) in the southeastern part of the state to less than 66 cm (26 in) in the northwestern part of the state (Figure 1). Under our temperature regime, the 86 cm of precipitation in eastern Iowa is adequate to support dense upland deciduous forests, but the 66 cm in the northwestern corner of the state
Figure 1. Iowa mean annual precipitation (cm)
supports tall grass prairie and scrubby upland forest.

There is a precipitation maximum in late spring or early summer, and a precipitation minimum in winter, giving the area a monsoon character. In Ames, for example, the maximum precipitation comes in June with 13.2 cm (5.21 in). The minimum is in February with 2.5 cm (.98 in) falling mostly as snow. Thus, most precipitation comes during the growing season. However, the summer rains are often heavy, resulting in much runoff and less effective moisture than if it came in gentle showers. The winter precipitation is even less effective because most of it falls on frozen ground which remains frozen until after the snow melts, resulting in much runoff.

Periodic droughts are also of importance in determining the distribution of species. If nearly equal precipitation occurred each year, doubtless more orchid species would be present in Iowa, and the ones already present would have their ranges extended farther west. Droughts are more severe to the west. In 1910, Rock Rapids in Lyon County had only 29.2 cm (11.5 in) of precipitation. There are apparently no native orchids in the arid northwestern corner of the state where the droughts are most severe. On the other hand, extremes of excess precipitation probably have no value in changing ranges of long-lived plants, although it may alter their abundance. The highest precipitation recorded in Iowa was 189.2 cm (74.5 in) at Muscatine in 1851.

Temperature is of secondary importance in determining the ranges of species in Iowa because the temperature regime is relatively uniform. The mean July temperature ranges from 25° C (77° F) in the southeastern part of the state to 21.7° C (71° F) in the northeastern part of the state (Figure 2). Although this range is not great, it is probably at least partly
Figure 2. Iowa mean July temperature in °C (after Soth, 1936)
responsible for limiting certain northeastern species, such as *Habenaria hookeri*, to the northeastern corner of the state. The southeastern corner of the state is evidently not warm enough to allow more southern species, such as *Isotria verticillata*, to enter the state. The southeastern part of the state has not been well collected, however, and there may be some surprises in store for collectors in that area.

The January range in temperature is greater across the state. In the southeastern part of the state, the January mean is -4.4° C (24° F). In the northwestern part of the state, the January mean temperature is -10.6° C (13° F) (Figure 3). The steeper January gradient in temperature is probably not very important for orchid species distribution, as nearly all Iowa species can tolerate the entire range in temperature. One exception may be *Spiranthes vernalis*, which has migrated into Iowa up the Missouri valley from the south. Its northward range is probably limited by the sharp northward gradient in January temperatures.

In a typical year, the lowest winter temperatures can be expected in the northern part of the state. There, minimum winter temperatures are usually -29° to -32° C (-20° to -25° F). In the southern part of the state, the lowest annual temperatures usually are -23° to -26° C (-10° to -15° F) (Figure 4). Doubtless temperatures well below -40° C (-40° F) occur in northern Iowa occasionally, but these extremes are probably not very important in herbaceous plant distribution, as the overwintering parts are insulated from such low temperatures by the soil and snow.

The growing season in Iowa ranges from 135 days in the northwestern part of the state to 170 days in the southeastern part (Figure 5). The northeastern part of the state has a 140-day growing season. The 140-day
Figure 3. Iowa mean January temperature in °C (after Soth, 1936)
Figure 4. Iowa mean annual minimum temperature in °C (from U.S.D.A. Plant Hardiness Zone Map)
Figure 5. Growing season in Iowa in days (after Shaw, Thorn, and Barger, 1954).
line there combines with the other climatic factors to establish a unique region where many species are found which are limited to the northeastern counties. If the precipitation were heavier in western Iowa, doubtless more northern species would also be found there in the 135-140 day zone. Due to the arid nature of the climate, however, northern species such as Habenaria hyperborea and Spiranthes romanzoffiana are limited to fens where moisture is available.

The geology of Iowa

The indurated rocks of Iowa are chiefly sandstones, shales, limestones, and dolomites. In most places, the rocks are covered with glacial till; but, where exposed, they provide important habitats for orchids. Figure 6 shows the bedrock geology of Iowa.

The oldest rock in Iowa is the Sioux Quartzite which is exposed only in the arid northwest corner of the state where there are apparently no native orchids. It is Precambrian (Algonkian) in age.

Cambrian rocks are exposed only in the northeast corner of the state. These are soft rocks, sandstones, shales, and dolomites. The rocks occur mainly in the "Driftless Area" where the climate of Iowa is most favorable to orchids. The rocks have been cut into deeply by streams giving the most rugged topography in the state. These rocks provide a protected habitat for several orchid species which thrive in the soils derived from these rocks and loess.

Ordovician sandstones, shales, limestones, and dolomites also occur in the "Driftless Area" and provide conditions similar to the Cambrian rocks in the same area. The remarkable Bluffton balsam fir stand occurs on Ordovician
Figure 6. Bedrock of Iowa (after Kay and Apfel, 1929)

1. Precambrian
2. Cambrian
3. Ordovician
4. Silurian
5. Devonian
6. Mississippian
7. Pennsylvanian
8. Permian
9. Cretaceous
limestone.

The Silurian system consists mainly of the Niagaran dolomite, a resistant rock which is exposed in the eastern part of the state. This rock has also been deeply dissected and the deep valleys afford protection from the drying effects of the general climate which allows numerous northern and eastern plants to persist there.

Devonian rocks outcrop in a band from northwest to southeast across the eastern part of the state. These are mostly limestones and dolomites. These outcrop along the Cedar River near Cedar Rapids, and allow Palisades-Kepler State Park to act as a refugium for certain northern and eastern species.

Mississippian rocks occur in a belt to the west of the Devonian rocks. The oldest formation, the Kinderhook, is mainly shale, but the later Osage and St. Genevieve are mainly limestones. These limestones outcrop at Geode State Park in Henry County, but are probably not of much importance in orchid distribution. These rocks are mainly covered with deep drift deposits.

Pennsylvanian rocks are divided into two series, the Des Moines or Lower Coal Measures, and the Missouri or Upper Coal Measures. The Des Moines series consists of shales and sandstones. The sandstones are exposed, especially along the Des Moines River in Webster, Boone, and Marion Counties where the outcrops provide a favorable habitat for orchids and other eastern and northern species. These rocks also provide the habitat for the westernmost stand of Pinus strobus in Iowa, and a western outlier of Aplectrum hyemale in Hardin County.

Permian rocks occupy only a small portion of Webster County, and are of no consequence in orchid species distribution.
Cretaceous rocks occur in the northwestern part of Iowa, but they are covered with a thick mantle of drift and are thus of no consequence in orchid distribution.

Tertiary rocks consisting of the "High Level Gravels" of the Windrow formation are limited in extent and are not of importance in orchid distribution.

Erosion during the Tertiary led to peneplanation of Iowa. Remnants of the Dodgeville peneplain are still visible in northeastern Iowa.

The entire state of Iowa has been glaciated one or more times during the Pleistocene. Portions of the state have been glaciated by four major continental glaciers. The drift of these glaciers and the loess derived from the meltwater served as the parent material for most Iowa soils.

The Nebraskan ice sheet was the first to cross Iowa. This glacial stage was named by Shimel (1909) because the till appeared to have come from Nebraska. The center of dispersion of this ice sheet was the Keewatin field (Kay and Graham, 1943). The Nebraskan glaciation began about a million years ago, and lasted for 100,000 years (glacial dates are from Eardley, 1965). Nebraskan ice and its accompanying deposits probably covered all of Iowa; but in most places, the Nebraskan drift is covered with more recent deposits. The Nebraskan drift was thick, perhaps over 30 m on the average, and thus greatly smoothed the bedrock landscape of Iowa. The Nebraskan till has little significance in orchid distribution in Iowa.

Following the Nebraskan glacier was a warm interglacial period, the Aftonian, which lasted perhaps 200,000 years. The Aftonian was named by Chamberlin (1895) for deposits near Afton, Union County, Iowa. During the Aftonian, the Nebraskan till was highly weathered. In many places this
material is impervious to water and causes seepy areas or fens on hillsides where it is truncated. These seepy areas and fens are sometimes good habitats for orchids.

About 680,000 years ago, another ice sheet, the Kansan, moved across the entire state of Iowa, leaving a new drift surface. Kansan deposits probably covered most of the state except for the "Driftless Area". The Kansan drift was thinner than the Nebraskan, perhaps only 10-20 m thick, but it served to further smooth the landscape. The Kansan glacial stage lasted for about 100,000 years. Kansan till has not been covered by later drift sheets in southern and western Iowa; and in southern Iowa especially, this has allowed erosion to work for over half a million years, yielding a rather mature, dissected landscape.

Following Kansan glaciation, there was another long, warm interglacial period called the Yarmouth interglacial. This interglacial was named by Leverett (1898) for deposits near Davenport, Iowa. Intense weathering of the Kansan till on nearly level surfaces during and since this long interglacial stage yielded the Kansan gumbotill. Where this outcrops on hillsides, there are often seepy areas or fens which provide moist habitats for orchids.

The third major glacial stage to enter Iowa was the Illinoian. This ice sheet entered only the southeastern portion of the state. This glacial stage lasted perhaps 100,000 years. Its major significance was the construction of glacial Lake Calvin when the ice sheet blocked the Iowa River. The sand deposits of the former lake shores form special plant habitats.

Another long interglacial stage, the Sangamon, lasted from about 180,000 years ago until about 30,000 years ago. During this stage, further weathering and dissection of the landscape occurred.
The most recent glacial stage, the Wisconsin, began about 30,000 years ago. The first ice advance into Iowa was the Tazwell substage (Ruhe, 1969) which entered Iowa about 20,000 years ago. The second ice advance entering Iowa was the Cary substage. This last advance occurred about 14,000 years ago.

The major significance of the Wisconsin glacial stage is that it mantled the entire state with calcareous deposits. The Tazwell and Cary tills are calcareous, and the Wisconsin loess, which was deposited over older tills from 24,000 to 14,000 years ago is also calcareous. Thus, only in special habitats will acidic soils develop which are essential to many orchid species. Figure 7 shows the distribution of surface deposits in Iowa.

The vegetational history of Iowa

Iowa has been continuously available for terrestrial vegetation since the close of the Cretaceous, about 70 million years ago. At that time, the climate was warm and subtropical, and so was the vegetation. Such exotic types as tigs and cinnamon grew in what is now Iowa (Bartsch, 1856). The climate since Cretaceous times has cooled progressively, driving the subtropical vegetation southward and leaving a vegetative assemblage known as the Arctotertiary Forest, which doubtless covered all of Iowa. Our present vegetation was derived from the Arctotertiary Forest flora. Cooling continued until it resulted in the great Pleistocene glacial epoch. Our present vegetational patterns have been largely influenced by the glacial advances and retreats. Since most Pleistocene studies concern the region of the Cary Lobe, most statements regarding the vegetational history of Iowa are derived from studies in north-central Iowa.
Figure 7. Surficial materials of Iowa (after Ruhe, 1969)

1. Valley alluvium
2. Cary Lobe, Wisconsin
3. Loam sediments on Iowan erosion surface on Kansan and older drift
4. Wisconsin loess on Iowan erosion surface on Tazwell drift
5. Wisconsin loess on Iowan erosion surface on Kansan and older drift
6. Wisconsin loess on Sangamon paleosol
7. Wisconsin loess on Vermouth-Sangamon paleosol
8. Wisconsin loess on patchy drift on bedrock
9. Glacial Lake Calvin
Parts of Iowa were glaciated by the four major glacial advances—Nebraskan, Kansan, Illinoian, and Wisconsin, but the most recent Wisconsin has left the most evidence regarding former vegetational types. There is some evidence to indicate that at least parts of Iowa were forested during the interglacial periods. Buried logs and occasional interglacial peat deposits yield some evidence regarding vegetative cover, but often these deposits were buried by glacial deposits, indicating only the type of vegetation which grew near the ice front, not the general vegetation of the interglacial. Paleosols suggest the type of vegetation which grew on them (Scholtes, et al., 1951). However, up to the present time, little can be said of interglacial vegetation in Iowa. It would be particularly interesting to know whether the Wisconsin glacier affected the vegetation over the rest of the state which was unglaciated, and how far from the ice front into unglaciated areas the boreal forest extended. In some parts of the world, distinctly nonglacial and even subtropical vegetation extends almost to the ice, but these are areas of mountain glaciers and doubtless conditions in front of a continental glacier would have been different.

As the Wisconsin glacier retreated from north-central Iowa, it left a barren glacial plain of terminal and ground moraines. Considerable erosion of the surface took place before vegetation stabilized it. The boreal forest of spruce and fir (*Picea mariana* and *Abies balsamea*) retreated northward along with the glacier, following the barren zone. Gleason (1922) felt that the boreal forest belt was probably rather narrow, with deciduous forest relatively close to the ice sheet. He was limited mostly to speculation regarding vegetational changes following glaciation. More evidence is available now, and it suggests that the boreal forest belt was rather wide.
Bog sediment studies in central Iowa indicate that the boreal forest remained dominant from the close of glaciation (13,000 ybp) to about 10,500 ybp (Walker, 1966). If the forest remained dominant over that length of time, it seems probable that the forest was a rather wide belt, several hundred km, at least on the newly glaciated landscape. There seems to be no evidence regarding how far into the unglaciated areas the boreal forest extended. During this early period of boreal forest dominance, there were doubtless numerous boreal orchids abundant in Iowa, such as Calypso bulbosa, Cypripedium passerinum, Habenaria orbiculata, and Habenaria obtusata. There is, however, no direct evidence of their presence. Since orchids are mainly entomophilous and none are anaemophilous, it is unlikely that pollen evidence for their presence will come to light, but plant communities tend to migrate as units, and thus with the boreal forest one would expect boreal orchids.

Warming of the general climate continued until about 10,500 ybp, when the climate apparently stabilized. The deposition of inorganic sediments from the uplands decreased markedly, indicating a stabilized vegetation over the landscape. A hardwood forest dominated the uplands, with representatives of the genus Quercus as the dominants. This forest probably moved in from the south and east. Other genera present included Acer, Ulmus, Betula, Tilia, Jugias, Corylus, and perhaps Fagus (Lane, 1931, Brush, 1967). In the bogs, boreal relicts remained, with Abies, Picea, and Pinus. The Pinus may have been on either the uplands or in the bogs or in both places. At that time, the postglacial orchid flora was probably at its peak. The bogs would have provided a habitat for the boreal orchids, and the upland deciduous forests would have provided the habitat for many
forest species of orchids. The climate during this period was probably very similar to that of the present time, perhaps slightly cooler and moister. This climatic and vegetative condition persisted until about 8,000 ybp. At that time, the climate again changed markedly.

At 8,000 ybp, the boreal relicts disappeared from the bogs, and prairies replaced the upland forests (Walker, 1966). Some forests probably remained in protected locations, especially in northeastern Iowa where pine forests and even balsam fir stands have persisted through the xerothermic to the present. Eilers (1965) feels that such outliers as the pine forests of Hardin County represent recent invasions since such communities would appear to be incapable of surviving the xerothermic. I feel that it is more likely that the communities did persist, and are true glacial relicts. Migration of tree species, even like the pine which has winged seeds, over long distances with no favorable habitats seems even less likely. A case in point is the Ledges in Boone County, about 100 km to the west of the nearest native pine stands. There are similar sandstone bluffs where one would expect to find pine, but there is none there. The distance of migration is too great. However, the habitat is unquestionably favorable to pine. Several pines have been planted in the park and are now producing seed. At least two pine seedlings are well established on the bluffs, and doubtless will reach maturity unless vandals destroy them. It has taken perhaps 10 to 20 years for these seedlings to get established from seed trees a few hundred to about 1000 m away. Since migration becomes increasingly unlikely the farther one is from a seed source, it is highly unlikely that pine seeds would have gotten from Hardin County to Boone County with no favorable habitats in the 100 km gap. It is equally unlikely that the
pine stands at Eldora originated from recent migration from almost equally distant stands to the east. Their relict nature is almost certain. Another example is the sphagnum mat in Deadman's Lake in Hancock County. There are no tamaracks, but a similar habitat near a seed source would doubtless develop a tamarack forest. Tamaracks are not there because they were eliminated during the xerothermic and the migration distance is too great for reestablishment.

The change in vegetation about 8,000 ybp indicates a warming and drying of the climate. The vegetative cover on the upland became sparse and erosion accelerated the rate of sediment deposition in the bogs. Abundant pollen of Chenopodiaceae and Amaranthaceae indicate an open, weedy, and xeric environment on the upland. This period has been called the xerothermic by Sears (1942) and the hypsithermal by Deevey and Flint (1957). The climate was doubtless drier and probably warmer than at the present time. Xerophytic vegetation migrated much farther eastward than it now is in general. The disjunct xeric vegetation on the loess bluffs of western Iowa was trapped there following the xerothermic when more mesic vegetation returned to all but the most edaphically xeric locations. Eastern outliers of prairie in Ohio are probably also relicts of this warm, dry period. Great Plains species, such as *Ratibida columnifera* are found as far east in Iowa as the Iowan erosion surface in eastern Iowa, indicating a climate perhaps similar to present central Nebraska. At that time, the climate in Iowa was so arid that except for some refuges in the northeastern part of the state, few orchids were probably present in Iowa. This arid climate continued until 3,000 ybp.

Around 3,000 years ago, the climate became more humid and perhaps
cooler. Deciduous forests returned from the east and perhaps the south. The forest migration was almost exclusively along the major river valleys which afforded protection from the drying effects of the wind, as well as broken, erosive topography which enabled forest to invade. Moisture supplies are also more uniform along the river valleys. The soil is rarely saturated, but it is also rarely very dry because of seepage.

One important factor came into play at least by this time. This was the American Indian. Studies in Illinois indicate the presence of Indians at least 10,000 years ago, and Iowa studies indicate their presence by the time this cooling and increasingly humid period began. The Indians set fire to the prairies, thereby restricting the forests of fire-sensitive trees to the river valleys. Even where forests existed, they must have been more open than they are now, due to the fires.

Along rivers and streams, which afforded fire breaks, forest began to migrate eastward from the valleys onto upland locations. Without the prairie fires set annually by the Indians, Iowa would doubtless have been dominated by forests at the time of settlement (White, 1870). In a study area in central Iowa, 80% of forest soils occur on the east side of the rivers, indicating the clear fire break effect of the rivers in this region of prevailing westerly winds (McComb and Loomis, 1944).

Despite the prairie fires, trees began to invade the prairie. By the time of the original land surveys in Iowa, around 1850, surveyors noted this recent expansion of the forest. Prairie fires were still frequent at that time. In one county in Iowa, soil surveys indicate forest soils on 1.9% of the land, but the original land surveys indicate forest on 8.1% of the surface, indicating recent invasion of forest (Loomis and McComb, 1943).
This is partly because the surveyors often classed as forest what we would now consider savanna. Thus the soils would be influenced as much or more by the continuous grass cover as by the scattered trees and would be prairie soils, but still the fact that rapid forest invasion was taking place prior to settlement is significant. Other members of the forest community invaded along with the trees. Orchids were probably among the quickest to occupy new favorable areas because of their light, airborne seeds.

Soils evidence (McComb and Loomis, 1944) indicates that there may have been an early expansion of the forests at the close of the xerothermic. This was followed by a period when the forest shrank, probably in response to fire, leaving only prairie and burr oak savanna on the upland. This was followed by a rapid expansion of the forests even beyond the original line of expansion.

Following settlement and the cessation of prairie fires, forests continued their expansion. In western Iowa, the advances have been most dramatic. Rainfall is relatively low, but burr oak (Quercus macrocarpa) forests have completely covered areas of former prairie. A comparison of photos taken around 1900 with current photos reveals the magnitude of the change.

In addition to the increase in extent of the forests, there has been a rapid change in structure and composition. In Iowa, upland forests usually consist of widely spaced open grown specimens of Quercus alba and Quercus macrocarpa. These are remnants of the fire induced savannas bordering the river and stream forests. Younger trees of other species, such as Tilia americana, Fraxinus pennsylvanica var. subintegerrima, Carya ovata, Quercus rubra, and even Acer nigrum have come in under the oaks and
are forming a dense forest which is taller than the original oaks. Eventually the old oaks will be replaced in the upland forests by these more mesic species, at least over the eastern half of the state.

In eastern Iowa, there are numerous rocky bluffs where one can find *Juniperus virginiana* dead and dying probably due to lack of sunlight. Evidently the bluffs were much less densely forested in relatively recent times, for it is doubtful that the junipers could have established there and reached ages over 200 years under the shade which is now present. This increase in forest density has doubtless altered orchid abundance. *Orchis spectabilis* and *Liparis lilifolia* thrive in relatively open forests, but are less abundant and vigorous in dense forests. These species benefit from disturbances such as light logging which opens the canopy.

*Corallorhiza odontorhiza* is one species which may be greatly increasing its distribution due to the recent forest colonization. This species often grows on uplands just where the slope breaks to a river or stream valley. This is the location where the large, low-branching oaks occur. Formerly prairie grasses grew at the bases of these trees, but now there is often little or no herbaceous cover under the trees. In places nearly devoid of other herbs, *Corallorhiza odontorhiza* thrives. This habitat did not exist until the 20th century, and this may be a partial explanation for the apparent rarity of this species in Iowa according to early collectors, and the apparent abundance and wide distribution of this species now.

Other species doubtless also have suffered from the increased shade. *Cypripedium calceolus* var. *pubescens* and *C. reginae* thrive in bright light, so increased shading has probably contributed to their decrease in abundance. The same may be true of *Habenaria viridio* var. *brecteate*, although
this species is capable of invading disturbed habitats where it may be increasing in abundance.

The vegetation of Iowa

The natural vegetation of Iowa has been highly modified by the activities of man, and probably nowhere in the state can one find vegetation completely free from our disturbance.

Prairie originally occupied about 85% of the land surface of Iowa, with deciduous forest covering most of the remaining 15%. The forests of the state were occupied first in preference to the prairies by early settlers who cut trees for construction purposes, fuel, and to clear the land for agriculture. The rapidly expanding railroads also cut the forests for ties and fuel. When the richness of the prairie soils was discovered, the upland prairies were quickly occupied and plowed. Later, as drain tiles were laid under the lower prairie areas, most of these areas were also plowed, leaving prairie remnants only along some railroad rights of way and in a few hay fields.

Forested areas are presently preserved in somewhat natural conditions in numerous state parks. Unfortunately, only a few relatively large tracts of prairie were set aside as parks and preserves.

The destruction of the natural vegetation took place so early in the history of the state of Iowa that few trained observers were able to see significant portions of the state in a natural condition. One early observer, Bohimul Shimek, made observations as early as the 1880's, but even at that time, much of the prairie had been plowed and most of the forests had had some cutting taken place. Early workers in the state, including
Bessey, Arthur, and Hitchcock, were apparently more concerned with the flora of the state and did not pursue vegetational studies. Thus, Shimek was the earliest observer to study the vegetation of the state. He had planned to write the plant geography of Iowa, but by the time of his death, he had only completed the first part of this work, and had not begun the portion concerned with the actual vegetation.

The earliest records of the vegetation of Iowa are contained in the survey records of the original land survey teams which subdivided the state into townships and sections during the 1840's and 1850's. The surveyors were to note the type of vegetation they passed through on their transects. Although the surveyors were not extensively trained in plant identification, they did make lists of species and descriptions of the undisturbed vegetation through which they passed. Doubtless some identifications were incorrect, but the survey records are good enough to allow a general reconstruction of the main features of the vegetation of Iowa. These records were used by Shimek (1900) to reconstruct the natural forested areas of Iowa prior to settlement.

One difficulty arises in this use of the original surveyors' notes. The surveyors were to select and mark large and healthy witness trees at the section corners for future reference. Often these witness trees were Quercus macrocarpa specimens about 20 cm (8 in) in diameter, and often they were 10 m (30 ft) or more from the section corner. This would indicate savanna vegetation of relatively young trees, presenting two problems. First, the areas mapped as forest included areas which we would now classify as savanna. Second, the young age of the trees, indicated by their small size, indicates that prior to settlement, some drastic changes in the native
vegetation, previously discussed, were taking place.

Despite these shortcomings, the original survey records are the only detailed records of the original vegetation of Iowa, and they must be used in any attempt to reconstruct the native vegetation prior to settlement.

Up to the present time, there has been no map of the vegetation of Iowa, other than the part of Küchler's map of the vegetation of the United States showing Iowa (Küchler, 1964). In my extensive travels in Iowa for the orchid study, I have observed the vegetation of much of the state, and I have noticed that certain orchids are limited geographically. This has led me to produce a preliminary map of the vegetation of Iowa.

The vegetation of small areas of the state has been mapped. Brumfiel (1919) mapped the vegetation of Johnson County. Hewes (1950) mapped Story County forests. Shimek (1900) mapped forest cover of the state, and this map has been of great value in preparing a map of all the vegetation types in Iowa.

Küchler (1964, 1974) concluded that the best method of mapping vegetation is to map the potential natural vegetation. For much of the United States this would be a meaningful goal, but some problems arise when one tries to apply this standard in Iowa. Shimek (1925) felt that tall grass prairie was the climax vegetation over most of Iowa. He cited as evidence that prairie vegetation returned to abandoned farmland and railroad rights of way. This was at a time when there were still abundant local seed sources for prairie plants. Now seed sources are rare, preventing prairie plants from getting to land that is abandoned. Thus, prairie would have limited capacity to occupy such areas under present conditions.

There is ample observational evidence that deciduous forest is the
climatic climax over most if not all of Iowa. Whenever cropland is aban­
doned, forest trees move in quickly. A seed source is present in all parts
of Iowa, and seedlings have no difficulty getting started. Probably nowhere
could one now find an area of abandoned land now in the process of returning
to prairie, except perhaps immediately adjacent to a prairie preserve or
railroad prairie. Furthermore, there are numerous examples of forest in­
vading into prairie relicts. The Ames High School Prairie and the Hayden
Prairie are but two examples. McComb and Loomis (1944) and Loomis and
McComb (1943) present evidence for presettlement advances of the forest into
the prairie which I have already discussed. This can only lead one to the
conclusion that prairie vegetation in Iowa was a relict vegetation type per­
sisting from earlier times when conditions favored prairie as opposed to
forest.

Insufficient time has passed since settlement to allow us to determine
what the structure of upland vegetation over most of Iowa would eventually
be like after the prairie is displaced. In all probability, it would be a
rather open forest type dominated by oaks and hickories over most of the
state, but there is some evidence in the eastern half of the state for a
somewhat more mesic forest type such as discussed by McIntosh (1957) in
Wisconsin. Because of this problem of not knowing what the potential nat­
ural vegetation would be like in Iowa, it may be best to map the vegetation
as it occurred at the time of settlement. This appears to be essentially
what Kuchler (1964) has done for Iowa on the United States map. There is
evidence enough remaining from early studies and present studies on relicts
of natural vegetation to allow this. Such a method of mapping would also
allow us to trace ranges of species more precisely than a map of potential
vegetation with vegetation types characterized by species which have not actually assumed dominance in the area.

The vegetation of Iowa was primarily tall grass prairie. Fires set by lightning and by Indians burned from west to east periodically, if not annually, maintaining the prairie in this relatively humid region by killing trees which became established in the prairie. In most places, the prairie-forest border was sharp, often with a shrub zone of *Rhus glabra* or *Corylus americana* between the two major types.

Forests flourished over most of the state along river valleys where protection from strong winds lowered evapotranspiration stress and modified the effects of prairie fires. A more uniform water supply throughout the year, plus protection from prairie fires on the steep, erosive slopes where prairie could not maintain itself also favored river valley forests. The forests were best developed in the northeast, becoming less tall and rich in species southward and westward. In the northwestern part of the state, where rainfall is lowest and summer droughts are most severe, the forests are often composed of only a few drought resistant species which assume a low, almost shrubby growth form.

A few special edaphic habitats form special vegetational regions. The wide foodplain of the Missouri River has a distinctive vegetation consisting of a mosaic of tall grass prairie and forests of *Salix* and *Populus*. Adjacent to the Missouri valley is an area of deep loess deposits. These dry, west-facing bluffs support a vegetation type more similar to that found a few hundred km farther west, with *Yucca glauca* a conspicuous element. A small area in northwest Iowa has outcrops of the Sioux Quartzite, making the habitat intensely xeric, and this area supports *Opuntia fragilis* as
well as other species more characteristic much farther west. The Missis­sippi River valley also forms a distinctive vegetation area in the southeastern part of the state where a sand prairie flora is found. The northeastern part of the state is included in the "Driftless Area" because it was thought never to have been glaciated, and appeared to be free of glacial drift. Recent studies show that most if not all of the "Driftless Area" in Iowa has actually been glaciated, but this area plus adjacent topographically similar areas of the state do support a distinctive type of vegetation because of steep topography and cool moist conditions. A forest similar to the Great Lakes forest occurs there with a few patches of boreal forest relicts.

The species lists for the vegetation types are in no way comprehensive. In many cases, several hundred species could be listed. An attempt was made to list those characteristic species which are obvious and give the landscape its particular appearance. In some cases, the choice of species was difficult because only small remnants of the vegetation type remain. Early species lists completed while larger units of natural vegetation still existed rarely give any idea of dominance. When such lists were used, I attempted to choose those species from the list which I have seen on remnant areas and which I considered dominant. A second factor to consider regarding the lists is that the vegetation varies across the state, even in one vegetation type. Another consideration is slope aspect. In central Iowa, for example, maple dominates north-facing slopes, while oak-hickory dominates all other slopes. Even on the prairie, slope aspect and elevation above valleys makes a difference in species composition. On north-facing slopes, big bluestem is more dominant than on south-facing slopes.
References useful in compiling the species lists included:

1a & 1b - Tall grass prairie: Shimek (1911a, 1925), Weaver (1958), Weaver and Fitzpatrick (1934), Carter (1962)

2 - Loess bluff prairie: Pammel (1896)

3 - Sand prairie: Burk (1931), Brown and Brown (1939)

4 - Sioux Quartzite prairie: Shimek (1896), Carter (1961)

5a - Maple-basswood forest: Cooperrider (1962a), Hartley (1966)

5b - Great Lakes forest: Pammel (1923), Thorne (1964), Cawley (1965)

5c - Northern hardwoods: Conard (1938)

6 - Oak-hickory forest: Lindley (1905), Boot (1916), Shimek (1919a), Aikman and Smelser (1938), Larson and Dillworth (1939), Augustine (1940), Aikman and Gilly (1948), Van Bruggen (1959)

7a - Mississippi valley: Davidson (1960)

7b - Missouri valley: Weaver (1960)

8 - Reservoirs: Wilson (1973) (unpublished manuscript)

9 - Natural lakes: Conard (1952)

10 - Marsh: Conard (1952)

11 - Fens: Cratty (1904), Wolden (1932), Holte and Thorne (1962)

The vegetation map is Figure 8.

1a. Bluestem Prairie (Andropogon-Panicum-Sorghastrum)

Physiognomy and structure:

Dense stands of medium to tall grasses, depending on slope aspect and drainage, often with scattered prairie potholes and marshes, especially in the north-central part of the state. Forbs vary in height from very low to 3 m. Varying flowering times make the forbs appear prominent on the prairie
Figure 8. The vegetation of Iowa

1a Tall grass prairie
1b Tall grass prairie, arid phase
2 Loess bluff prairie
3 Sand Prairie (S)
4 Sioux Quartzite region
5a Maple-basswood forest
5b Great Lakes forest (G)
5c Northern hardwoods - fir forest (N)
6 Oak-hickory forest
7a Mississippi valley
7b Missouri valley
8 Reservoir flats (R)
9 Natural lakes (L)
10 Marshes (not shown) (prevalent in north-central region)
11 Fens (F)
during the first half of the growing season, grasses during the latter half.

Dominant species:

- Big bluestem (*Andropogon gerardii* Vitman)
- Little bluestem (*Andropogon scoparius* Michx.)
- Switchgrass (*Panicum virgatum* L.)
- Indian grass (*Sorghastrum nutans* (L.) Nash)

Other characteristic components:


Location and site:

Mainly on uplands or gently rolling topography over most of the state, occurring as prairie openings even in the most heavily forested northeastern part of the state.

Orchids of the tall grass prairie include *Cypripedium candidum*, *Habenaria leucophaea*, *Spiranthes cernua*, and *Spiranthes lacera*. 
lb. Bluestem Prairie, Arid Phase (*Andropogon-Panicum-Sorghastrum*)

Physiognomy and structure:

Tall grasses and forbs in low areas, grading into short grasses and forbs on exposed, often gravelly upland sites.

Dominant species:

- Big bluestem (*Andropogon gerardii* Vitman)
- Little bluestem (*Andropogon scoparius* Michx.)
- Switchgrass (*Panicum virgatum* L.)
- Indian grass (*Sorghastrum nutans* (L.) Nash)

Other characteristic components:


Location and site:

Northwestern Iowa, rolling upland.

*Habenaria leucophaea* is the only native orchid which approaches this vegetation type. It occurs in potholes near the eastern margin of this arid phase of the tall grass prairie.
2. Loess Bluff Prairie (Andropogon-Bouteloua)

Physiognomy and structure:

Dense to relatively open community of short and medium to tall grasses and forbs.

Dominant species:

Big bluestem (Andropogon gerardii Vitman)

Little bluestem (Andropogon scoparius Michx.)

Sideoats grama (Bouteloua curtipendula Michx.)

Muhlenbergia cuspidata (Torr.) Rydb.

Other characteristic components:


Location and site:

High, exposed loess bluffs adjacent to the Missouri and Big Sioux Rivers. Forest is rapidly invading this region of the state at the present time, and surprisingly rich pockets of forest vegetation occupy deep ravines.

Native orchids of this region are restricted to the rich, forested
parts of the loess bluffs in southwestern Iowa. _Orchis spectabilis_ and _Corallorhiza odontorhiza_ may be found in such sites.

3. Sand Prairie (Andropogon-Calamovilfa)

**Physiognomy:**

Sparse to dense vegetative cover on shifting to stabilized sand dunes. Prairie dominates less stable areas, forests occupy stabilized sand.

**Dominants:**

- Big bluestem (*Andropogon gerardii* Vitman)
- Little bluestem (*Andropogon scoparius* Michx.)
- Sandreed (*Calamovilfa longifolia* (Hook.) Scrib.)

**Other characteristic components:**


**Location and site:**

Sandy areas, mainly in river valleys. Most areas are small, but the area around Muscatine was large and showed affinities with the coastal plain vegetation of the Lake Michigan region.

Orchids of the sand prairie include *Spiranthes cernua*, *S. lacera*, and *S. vernalis*. 
4. Sioux Quartzite Region (Opuntia-Selaginella-Talinum)

Physiognomy and structure:

Low, scattered groups of plants on outcrops of Sioux Quartzite, becoming more dense with more species where the soil over the quartzite becomes thicker.

Dominants (limited mainly to rock outcrops):

- Fragile Prickly Pear (*Opuntia fragilis* (Nutt.) Haw.)
- Spikemoss (*Selaginella rupestris* (L.) Spring)
- Flameflower (*Talinum teretifolium* Pursh)

Other characteristic components (extending east and south on dry soils):


Location and site:

Extreme northwestern Iowa on outcrops of Sioux Quartzite.

No native orchids have been found in this area.

5a. Maple-basswood forest (Acer-Tilia)

Physiognomy and structure:

Dense forests of tall deciduous trees, with rich shrub and herb layers.
Dominant species:

Sugar Maple (*Acer saccharum* Marsh. and *Acer nigrum* Michx. f.)

Basswood (*Tilia americana* L.)

White oak (*Quercus alba* L.)

Red oak (*Quercus rubra* L.)

Bitternut hickory (*Carya cordiformis* (Wang.) K. Koch)

Ironwood (*Ostrya virginiana* (Mill.) K. Koch)

Other characteristic components:


*Erythronium americanum* Ker., *Geranium maculatum* L., *Hepatica acutiloba* DC.,


Location and site:

Uplands and slopes of the deeply dissected topography of the north-eastern counties. Most of the area is included in the "Driftless Area". This forest type continues westward into the oak-hickory forest and even into the prairie on north-facing slopes. Orchids of the maple-basswood
forest include *Aplectrum hyemale*, *Cypripedium calceolus* var. *pubescens*, *C. reginae*, *Corallorhiza maculata*, *C. odontorhiza*, *Habenaria psycodes*, *H. viridis* var. *bracteata*, and *Triphora trianthophora*.

5b. Great Lakes forest (Acer-Betula-Pinus)

Physiognomy and structure:

Dense forests dominated by needleleaf evergreen trees, often with a variety of deciduous trees and shrubs. The understory often not very dense.

Dominants:

- Sugar maple (*Acer saccharum* Marsh.)
- Paper birch (*Betula papyrifera* Marsh.)
- Quaking aspen (*Populus tremuloides* Michx.)
- White pine (*Pinus strobus* L.)

Other characteristic components:


Location and site:

Scattered relict groves of *Pinus strobus* occur mainly in the area of the maple-basswood forest, but outliers occur as far west as central Iowa.
(Hardin County) and as far south as Muscatine County. The pines are usually found on areas of steep topography with exposed bedrock. Similar island communities of this vegetation type extend even farther west, but the pine is lacking, so these areas are not included.

Orchids found in this vegetation type include Aplectrum hyemale, Coral-lorhiza maculata, C. odontorhiza, Cypripedium calceolus var. pubescens, C. reginae, Goodyera pubescens, Habenaria psycodes, H. viridis var. bracteata, H. hookeri, Orchis spectabilis, and Triphora trianthophora.

5c. Northern hardwoods-fir forest (Abies-Betula-Tilia)

Physiognomy and structure:

Forests dominated by Abies balsamea, with scattered individuals of Betula papyrifera and Tilia americana.

Dominants:

- Balsam fir (Abies balsamea (L.) Mill.)
- Sugar maple (Acer saccharum Marsh.)
- Paper birch (Betula papyrifera Marsh.)
- White pine (Pinus strobus L.)
- Basswood (Tilia americana L.)

Other characteristic components:

- Campanula rotundifolia L., Cryptogramma stelleri (Gmel.) Prantl.
Location and site:

Scattered relict groves of Abies balsamea occur or once occurred in Allamakee, Howard, and Winneshiek Counties. The groves are located on steep, north-facing slopes of limestone.

6. Oak-hickory forest (Quercus-Carya)

Physiognomy and structure:

Dense forests of tall trees in the eastern part of the state to low, scrubby forests in the western part of the state. There is often a strong middle story of shorter trees, a strong shrub layer, and an herb layer.

Dominants:

- Bitternut hickory (Carya cordiformis (Mill.) K. Koch)
- Shagbark hickory (Carya ovata (Wang.) K. Koch)
- White oak (Quercus alba L.)
- Burr oak (Quercus macrocarpa Michx.)
- Red oak (Quercus rubra L.)
- Black oak (Quercus velutina Lam.)

Other characteristic components:

serotina Ehrh., Prunus virginiana L., Rhus radicans L., Ribes cynosbati L.,
Sanguinaria canadensis L., Smilax herbacea L., Smilax tamoides L., Tilia
americana L., Uvularia grandiflora Sm., Viburnum rafinesquianum Schultes,
and Xanthoxylum americanum Mill.

Location and site:

Oak-hickory forests are located on sloping land mainly along rivers
and streams across most of the state. The number of species decreases to
the northwest where few forests occur.

Orchids characteristic of the oak-hickory forest include Corallorhiza
odontorhiza, Habenaria viridis var. bracteata, Liparis lilifolia, and Orchis
spectabilis.

7a. Mississippi valley (Acer-Celtis-Ulmus)

Physiognomy and structure:

Tall trees laden with vines, some shrubs, and a dense herb layer are
present.

Dominants:

Silver maple (Acer saccharinum L.)

Hackberry (Celtis occidentalis L.)

American Elm (Ulmus americana L.)

Other characteristic components:

Acer negundo L., Amorpha fruticosa L., Arisaema dracontium (L.) Schott,
Betula nigra L., Bidens cernua L., Bidens frondosa L., Carya illinoense
(Wang.) K. Koch, Carya laciniosa (Michx.) Loud., Cornus drummondii Meyer,
Fraxinus pennsylvanica Marsh., Galium aparine L., Gleditsia triacanthos L.,
Gymnocladus dioica (L.) K. Koch, Impatiens capensis Meerb., Impatiens

Location and site:

Mississippi valley floodplain on alluvial soil. Similar vegetation may be found in the floodplains of the larger rivers and streams to the north and west, but the farther away, the fewer the number of species.

Orchids characteristic of the Mississippi valley forests include Calopogon tuberosus and Habenaria clavellata.

7b. Missouri valley (Andropogon-Salix-Populus)

Physiognomy and structure:

Mosaic of graminoids and forbs, occasional marshes, and scattered groves of trees, with a fringe of low trees along the river bank.

Dominants:

Big bluestem (Andropogon gerardii Vitman)

Peach-leaved willow (Salix amygdaloides Anders.)

Black willow (Salix nigra Marsh.)

Eastern cottonwood (Populus deltoides Marsh.)

Other characteristic components:

Location and site:

Missouri River valley in western Iowa. The topography is nearly level, but old oxbows and other depressions are marshy. This vegetation type has been almost completely destroyed by agriculture. Often only the fringe of willow along the river remains.

The only characteristic orchid of the Missouri valley is *Spiranthes vernalis*.

8. Reservoir flats (*Acer-Salix*)

Physiognomy and structure:

River valleys formerly forested but now permanently or periodically flooded by fluctuating level reservoirs.

Dominants:

- Silver maple (*Acer saccharinum* L.)
- Sandbar willow (*Salix interior* Rowlee)
- Black willow (*Salix nigra* Marsh.)

Other characteristic components:


Location and site:

Reservoirs are scattered throughout the state, but the main ones are in the eastern two thirds of the state, including Coralville, Red Rock,
Saylorville, and Rathbun. This vegetation occupies the flat, often inundated land influenced by silt and clay deposition by flood waters.

No orchids are known to persist or invade fluctuating level reservoirs.

9. Natural lakes (Potamogeton-Myriophyllum)

Physiognomy and structure:

Natural shallow areas of open, standing water with aquatic vascular plants.

Dominants:

Pondweed (Potamogeton natans L.)

Water milfoil (Myriophyllum spp.)

Other characteristic components:


Location and site:

The "Great Lakes" region of Iowa centered in Dickinson County possesses the largest area of lakes. Smaller lakes are scattered throughout the Cary Lobe.

There are no aquatic orchids in Iowa.

10. Marsh (Carex-Scirpus-Typha)

Physiognomy and structure:

Dense stands of graminoids with lower forbs occupying poorly drained fresh water areas.
Dominants:

Sedge (Carex aquatilis Wahlenb.)

Bullrush (Scirpus atrovirens Willd.)

River bullrush (Scirpus fluviatilis (Torr.) Gray)

Cat tail (Typha latifolia L.)

Other characteristic components:


Location and site:

Poorly drained areas, mostly in north central Iowa. Marshes are too small and numerous to show on a vegetation map at the scale I have used.

Orchids growing in marshes are Calopogon tuberosus, Habenaria clavelata, H. flava var. herbiola, H. hyperborea, H. psycodes, and Liparis loeselii.

11. Fens (Eleocharis-Parnassia-Triglochin)

Physiognomy and structure:

In Iowa, fens occur on hillsides and consist of low growths of graminoids.

Dominants:

Spike rush (Eleocharis tenuis (Willd.) Schultes)

Grass of paryassus (Parnassia glauca Raf.)
Arrow grass (*Triglochin maritima* L.)

Other characteristic components:


Location and site:

Fens are most abundant in Dickinson County and formerly in Emmet County where they occur on hillsides. Fens found elsewhere in Iowa do not have this characteristic fen vegetation, but may have other species not common in Iowa.

Orchids found in fens in Iowa include *Cypripedium candidum*, *Habenaria hyperborea*, *Liparis loeselii*, *Spiranthes romanzoffiana*, and, in one fen in southern Iowa, *Cypripedium x andrewsii*.

Phylogeny in the Orchidaceae

Classification in the Orchidaceae above the level of genus has not received adequate attention. Arrangements of tribes, subtribes, and genera in a phylogenetic sequence have been attempted from the earliest days of orchid taxonomy (Schweinfurth, 1959), but a completely acceptable arrangement has not yet been developed.

Garay (1960), van der Pijl and Dodson (1966), and Luer (1972) propose five subfamilies in the Orchidaceae. These subfamilies are delimited on the basis of anther and pollen characteristics. I have followed Luer (1972)
in adopting the five following subfamilies of the Orchidaceae: Apostasioideae, Cypripedioideae, Neottioideae, Orchidoideae, and Epidendroideae. Dressler and Dodson (1960) have developed the same groups, but treat some of them at the tribal level. They recognize two subfamilies, the Cypripedioideae and the Orchidoideae. The Apostaseae and the Cypripedeae are treated as tribes in the Cypripedioideae; and the Neotteae, Orchideae, and Epidendreae are treated as tribes in the Orchidoideae. These five tribes correspond to the five subfamilies of Luer (1972) and Garay (1960), although there are some genera which are placed in different groups in the different schemes. Dressler and Dodson (1960) also present a key to the subfamilies, tribes, and subtribes, and place these in a proposed phylogenetic order.

I have placed the Iowa Orchidaceae in this paper in the subfamilies, tribes, and subtribes in the order proposed by Luer (1972). This is much the same as the order proposed by Dressler and Dodson (1960), but some features of Schlechter's key are restored. The genera are arranged as in Schweinfurth's translation of Schlechter's key in Withner (1959).

Family Orchidaceae

Subfamily Apostasioideae (no Iowa representatives)

Subfamily Cypripedioideae

Tribe Cypripedeae

Genus Cypripedium

Subfamily Neottioideae

Tribe Neottiæae

Subtribe Pogoniinae

Genus Triphora
Genus *Pogonia*
Subtribe *Arethusinae*
Genus *Calopogon*

Tribe *Goodyereae*
Subtribe *Spiranthinae*
Genus *Spiranthes*
Genus *Goodyera*

Subfamily *Orchidoideae*

Tribe *Orchideae*
Subtribe *Orchidinae*
Genus *Orchis*
Genus *Habenaria*

Subfamily *Epidendroideae*

Tribe *Epidendreae*
Subtribe *Liparidinae*
Genus *Malaxis*
Genus *Liparis*
Subtribe *Corallorrhizinae*
Genus *Aplectrum*
Genus *Corallorhiza*
REVIEW OF LITERATURE

Literature regarding orchids in Iowa is extremely limited. Most papers merely mention the location of a species and give no further information regarding the habitat or associated species. In many cases, the species appear in a species list with no further comment. Because of the limited usefulness of such papers, they will not be reviewed here, but will be listed in each species discussion. Any important details in the paper will also be mentioned in each species discussion.

There is only one paper devoted exclusively to the orchids of Iowa, and, although it is quite out of date, it still has some value. Fitzpatrick and Fitzpatrick (1900) listed 22 native Iowa orchids. These species were Cypripedium calceolus var. pubescens (as C. hirsutum), Cypripedium calceolus var. parviflorum (as C. parviflorum), Cypripedium candidum, Cypripedium reginae, Orchis spectabilis, Habenaria hookeri (as H. hookeriana), Habenaria viridis var. bracteata (as H. bracteata), Habenaria clavellata, Habenaria flava, Habenaria leucophaea, Habenaria psycudes, Habenaria hyperborea, Triphora trianthophora (as Pogonia trianthophora), Spiranthes cernua (as Cyrostachys cernua), Spiranthes lacera (as Cyrostachys gracilis), Goodyera pubescens (as Peramium pubescens), Malaxis unifolia (as Achroanthes unifolia), Liparis lilifolia (as Leptorchis liliifolia), Liparis loeselii (as Leptorchis loeselii), Corallorhiza odontorhiza, Calopogon tuberosus (as Limodorum tuberosum), and Aplectrum hyemale.

The most valuable information in this paper is the author's comments regarding abundance of these species in Iowa: that the cypripediums were formerly quite common, but by 1900 they were becoming rather rare due to...
destruction of habitats and collection; that *Spiranthes cernua* was appar-
tently more common in the early settlement period than it was in 1900; and 
that *Corallorhiza odontorhiza* was mentioned as being rare and known only 
from Johnson County, whereas it is now abundant and common.
METHODS AND MATERIALS

The first phase of this study involved searching a number of herbaria for Iowa orchid specimens. Over 800 specimens were located. All information on the herbarium sheets was recorded. Habitat information was not detailed in most cases, but often the collection site was described in sufficient detail to allow it to be located.

Many collection sites were examined to determine whether the species still occurred at the site. Over 26,000 miles were traveled in visiting herbaria and collection sites.

When an orchid plant was found, the vegetation was sampled around the plant or colony. I felt that a sample centered on the orchid plant or colony would give the best description of associated vegetation. Sample sizes were those suggested by Oosting (1956) for forest: 1 x 1 m for the herb layer, 4 x 4 m for the shrub layer, and 10 x 10 m for the tree layer. The percentage canopy coverage was estimated for the herb layer and shrub layer plots. The diameter of trees over 2.5 cm in diameter at breast height (DBH) was recorded in the tree layer plots. In the herb layer plots, all herbs plus any woody plants less than 25 cm tall were recorded. Although low shrubs and tree seedlings are not herbs, they are considered here to have the same ecological role as herbs and are recorded as such. Listing seedlings of trees and shrubs in the herb layer plots also gives some idea of the reproduction of the shrub and tree synusia. Only woody plants were recorded in shrub layer plots. These plants were over 25 cm tall, but less than 2.5 cm in diameter. Trees over 2.5 cm in diameter were recorded as to diameter in the tree layer plots. In the results section, the species
within a group (herb layer, shrub layer, tree layer) are arranged in the order of importance based on percent cover or dbh.

A soil sample was collected as near the orchid colony as possible without disturbing the root system. The soil was taken from the top 2 to 4 cm of the A horizon. The soil was analyzed for nitrate nitrogen within one or two days of collection by a method described by Frederick and Murphy (1965). Soil moisture was determined by the gravimetric method. Soil organic matter was approximated by combustion in a muffle furnace at 500° C. Soil pH was determined with a Beckman pH meter using a 2:1 mixture of soil:water, stirred at intervals over a half hour period. The remaining soil was refrigerated until the sampling was nearly completed, then it was sent to International Minerals and Chemical Corporation of Libertyville, Illinois where determinations of P, K, Ca, Mg, Mn, Fe, Cu, and Zn as well as cation exchange capacity were carried out using the five extraction method. The results for nutrients were reported as pounds per acre. I converted these figures to ppm by multiplying by .5 (Thompson, 1957).

In the results section, there is a key to the genera of Iowa orchids. Each genus is discussed. The genus name and author are given, followed by the derivation of the generic name according to Schultes and Pease (1963). A general description of the genus follows. A key is used to separate species in genera in which there is more than one species native to Iowa. In the species discussion, the species name and author are given. Following this is the derivation of the specific epithet, mostly from Correll (1950). The type location for the species, according to Correll (1950), is given next. Next is the flowering season of the species in Iowa. A list of references which mention the species in Iowa is presented in chronological and
alphabetical order. Next is a list of Iowa counties in which the species has been found. The herbarium abbreviations follow Lanjouw and Stafleu (1964) except where none exist. Then I have used lower case letters to indicate unlisted herbaria. The herbaria are:

AMES - Oakes Ames Orchid Herbarium of Harvard University
Barnes - Barnes Herbarium in the Putnam Museum, Davenport
Clinton - Clinton Herbarium in the Putnam Museum, Davenport
Grinnell - Grinnell College, Grinnell
IA - Herbarium of the University of Iowa, Iowa City
ISC - Herbarium of Iowa State University, Ames
ISTC - Herbarium of the University of Northern Iowa, Cedar Falls
Kovarik - Kovarik collection, Luther College, Decorah
Lake - Herbarium of Lakeside Laboratory, Dickinson County
Luther - Herbarium of Luther College, Decorah
MO - Missouri Botanical Garden Herbarium
Niem - Personal herbarium of D. A. Niemann - to be deposited at ISC
NY - Herbarium of the New York Botanical Garden
Parry - Parry collection, Iowa State University, Ames
Plouffe - Personal herbarium of M. Plouffe
US - National Herbarium, Smithsonian Institution
WIS - University of Wisconsin Herbarium

The year of the most recent collection is listed in parentheses. At the end of the list, I have placed collections in parentheses when no county of collection could be determined. The range of the species, mostly from Correll (1950) is given. Next is a general discussion of the habitat of the species in Iowa. The main part of the discussion is a detailed description of the habitat, if it is known, including associated species found in the sample plots. Swink (1969) has used associated species to characterize habitats in which certain species are found, and this aids in developing a mental picture of the site.

Nomenclature for orchids follows Correll (1950) except for Calopogon tuberosus, Cypripedium x andrewsii, and Spiranthes lacera where I followed
RESULTS

Key to Genera of Iowa Orchidaceae

1. Lip large, 2-5 cm long, showy, slipper-shaped; leaves pleated; fertile anthers 2 ........................................ 1. Cypripedium

1. Lip flat or concave, not large and inflated; fertile anthers 1

2. Plants with ordinary green leaves at flowering time

3. Flowers distinctly spurred, the spur over 2 mm long

4. Flowers usually bicolored, the lip white, sepals and petals purple (occasional plants produce flowers with white sepals and petals as well); leaves 2, basal, oval ..... 2. Orchis

4. Flowers of one color ...................... 3. Habenaria

3. Flowers not spurred

5. Flowers large, more than 1 cm across, solitary or several

6. Leaves elongated and grass-like; flowers several in a spike, nonresupinate .................. 4. Calopogon

6. Leaves not elongated and grass-like; flowers resupinate

7. Leaf solitary ......................... 5. Pogonia

7. Leaves several, alternate ........... 6. Triphora

5. Flowers smaller, several to many in a spike

8. Flowers white, greenish-white, or yellowish-white

9. Leaves basal, variegated with whitish veins, evergreen, inflorescence not a spiral .... 7. Goodyera

9. Leaves basal or alternate, not variegated, often withering before anthesis; inflorescence often more or less spirally twisted ........... 8. Spiranthes

8. Flowers greenish or purplish

10. Leaf solitary, near the middle of the stem, ovate or oval, clasping; flowers greenish, many in a dense spike ...................... 9. Malaxis

10. Leaves two, basal ................. 10. Liparis
2. Plants without ordinary green leaves at flowering time

11. Inflorescence spirally twisted; flowers white, greenish-white, or yellowish-white

8. Spiranthes

11. Inflorescence not spirally twisted

12. Underground rhizomes not coral-like; one basal green leaf produced in late summer or early autumn, persisting until early spring

11. Aplectrum

12. Underground rhizomes coral-like; leaves all reduced to scales

12. Corallorhiza

Cyripedium L.

This genus name is from the Greek Κυρίπις, Kypris (Venus) and πεδίλον, pedilon (slipper), in recognition of the slipper-shaped lip.

Our species of Cyripedium have the two ventral sepals fused. The petals are spreading, linear or oblong. The lip is inflated and slipper-like. Two anthers are functional, and the third is modified into a petaloid staminode. The leaves are pleated, sheathing the stem at the base, and glandular pubescent. Some people are sensitive to the leaves and stems, developing a skin reaction similar to Rhus radicans (Poison Ivy) reaction (Correll, 1950). Cyripedium reginae seems to be the one causing the most serious problems. The roots are coarsely fibrous.

The genus Cyripedium is more or less restricted to the north temperate zone of the Old and the New World. Eleven species are native to North America (Correll, 1950). Worldwide there are about 28 species (Rolfe, 1896).

The cyripediums are the most primitive orchids found in Iowa. Instead of a single anther, which is the general rule for orchids, this genus has two fertile anthers. The pollen is loose and granular, unlike that of most orchids which have waxy pollen aggregated into discrete bundles called
pollinia.

Key to the species and hybrid of *Cypripedium* in Iowa

1. Sepals oval, not twisted, white; lip 3-4 cm long, pinkish .. *C. reginae*

1. Sepals lanceolate, attenuate, twisted, not white

2. Lip yellow, 2-5 cm long; wooded hillsides and ravines ..............
   ............................................ *C. calceolus* var. *pubescens*

2. Lip white or cream, 2-2.5 cm long

3. Sepals and petals greenish-yellow, lip white; in fens and prairies .......................... *C. candidum*

3. Sepals and petals darker; lip cream, fading to nearly white;
   exceedingly rare in Iowa ......................... *C. x andrewsii*

*Cypripedium calceolus* L. var. *pubescens* (Willd.) Correll

Basionym: *Cypripedium pubescens* Willd.

The specific epithet and the varietal name are from Latin words meaning little shoe and pubescent.

Type locality: North America

Flowering season in Iowa: mid-May to mid-June, with extremes of May 10 and June 28

Literature: Parry (1852) 619; Arthur (1876) 31; Nagel and Haupt (1876) 164; Hitchcock (1892) 519; Pammel (1896) 133; Shimek (1896) 212; Fink (1897) 103; Fitzpatrick (1898) 128; Fitzpatrick and Fitzpatrick (1898) 165; Fitzpatrick and Fitzpatrick (1899) 197; Barnes, Reppert, and Miller (1900) 260; Fitzpatrick and Fitzpatrick (1900) 188-191; Craity (1904) 217; King (1904) 127; Mueller (1904) 277; Peck (1905) 204; Oleson and Somes (1906) 34; Greene (1907) 152; Pammel (1907) 65, 69, 91; Pammel and Fogel (1907) 154; Shimek (1907) 173; Pammel (1909) 754; Lindley (1911) 22; Shimek (1911a) 220; Shimek (1911b) 41; Somes (1913) 46; Verink (1914) 92; Findlay (1919) 90; Henning (1919) 117; Kellog (1919) 238; Lazell (1919) 96; Pammel (1919a) 146; Pammel (1919b) 163; Shimek (1919a) 60; Tuttle (1919a) 278; Tuttle (1919b) 144; Lohman (1926) 44, 45; Conard (1928) 94; Wolden (1932) 103; Cretty (1933) 197; Fuller (1933) 54; Fults (1934) 262; Tolsteed (1938) 399; Hayden (1943) 373; Gilly and McDonald (1947) 115; Grant (1950) 106; Easterly (1951) 78; Fay (1951) 114; Thorne (1955) 192; Russell (1956) 172; Thorne (1956) 219; Wolden
(1956) 130; Davidson (1959) 39; Cooperrider (1960) 152; Guldner (1960) 37, 84, 212; Cooperrider (1962b) 31; Thorne (1964) 29; Hartley (1966) 59; Eilers (1971) 79, 131

Benton: IA (1910)
Black Hawk: ISC (nd)
Cedar: IA (1950)
Cerro Gordo: ISC (1917)
Clay: IA, ISTC (1954)
Clayton: IA, ISC, Niem, NY (1974)
Crawford: ISC (1922)
Dallas: ISC (1897)
Delaware: IA, ISC (1963)
Dubuque: IA, ISC, ISTC (1958)
Emmet: ISC (1917)
Fayette: AMES, ISC, US (1894)
Guthrie: IA (1952)
Hancock: ISC (1962)
Hardin: ISC (1905)
Howard: ISC, Niem (1974)
Iowa: IA, ISC, Niem (1973)
Jackson: IA (1957)
Johnson: Grinnell, IA, ISC, ISTC (1954)
Jones: IA, ISC, MO, US (1956)
Keokuk: IA (1897)
Linn: Grinnell, IA, ISC, ISTC (1937)
Lucas: IA (1956)
Marion: ISC (1871)
Mitchell: ISC (nd)
Muscatine: IA, ISC (1878)
Poweshiek: Grinnell, IA, NY (1906)
Scott: Barnes (1952)
Story: ISC (1907)
Tama: IA (1895)
Taylor: ISC (1911)
Union: ISC (nd)
Van Buren: ISC (1934)
Webster: IA, ISC (1894)
Winneshiek: IA, ISC, ISTC, Kovarik, Luther, Niem (1974) (ISC)

The Appanoose County report is based on Fitzpatrick and Fitzpatrick (1898) and Fitzpatrick and Fitzpatrick (1900). The Cherokee County report is based on Pammel (1896). The Jefferson County report is based on Gilly
and McDonald (1947). The Lee County report is based on Fults (1934). The Madison County report is based on Mueller (1904). The Ringgold County report is based on Fitzpatrick and Fitzpatrick (1899), and Fitzpatrick and Fitzpatrick (1900). The Woodbury County report is based on Fitzpatrick and Fitzpatrick (1900).

The general distribution of this species is from Quebec and Newfoundland south to South Carolina, Georgia, Alabama; west to Louisiana, Texas, Arkansas, Iowa, Colorado, New Mexico, Utah; northwest to Oregon, Washington, British Columbia, and Yukon.

Much confusion has surrounded *Cypripedium calceolus* in North America because of its great variability. Fitzpatrick and Fitzpatrick (1900) concluded that all the yellow lady's-slippers of the Middle West should go by one name. Correll (1950) felt that all variation in the North American representatives of *C. calceolus* should be referred to var. *pubescens*. Fernald (1950) recognized three varieties of *C. calceolus*, *parviflorum*, *pubescens*, and *planipetalum*. The variety *planipetalum* is a far northern taxon and does not enter into Iowa, but the other two varieties have been reported from Iowa. Case (1964) recognized both variety *parviflorum* and variety *pubescens* in the western Great Lakes region. He pointed out that the difference between the two varieties is not based on size alone. The variety *parviflorum* has small flowers, the lip is less than 4 cm long, the sepals and petals are a dark mahogany color, and the plant grows in cool, wet soils. The variety *pubescens* may have large flowers or small flowers in the size range of variety *parviflorum*, but the sepals and petals tend to be greenish-brown rather than darker mahogany, and the plants tend to grow in well-drained upland woods and ravines rather than in wet soil.
My experience with *Cypripedium calceolus* in the Great Lakes region leads me to the same conclusion arrived at by Case. There are valid reasons for separating these two varieties. Both varieties have been reported for Iowa in the literature, but Hitchcock (1892) and most later writers only recognize the presence of variety *pubescens*. I have seen no Iowa specimens referable to variety *parviflorum*.

*Cypripedium calceolus* var. *pubescens* was one of the most widespread orchids in Iowa at the time of settlement. It probably grew in nearly every county of the state, except for the arid northwestern counties. The plants were nowhere abundant, as I have seen them in northwest Indiana, but plants were well distributed in woods across the state. Wildflower collectors, and unfortunately also botanists, have collected this species ruthlessly, and now it is rarely seen in Iowa.

This species grows in a number of different habitats in Iowa. One of the most striking habitats is the boreal relict balsam fir stand in Winnebago County. On a steep north-facing slope of Ordovician limestone riddled with solution holes, cold water seeps out, cooling the soil surface, and allows the fir to persist (Conard, 1938). *Cypripedium calceolus* var. *pubescens* grows in a ravine near the upper part of the fir forest, near its margin. In this habitat, its associates are (herb layer) *Cystopteris bulbifera*, *Sanguinaria canadensis*, *Impatiens pallida*, *Rudbeckia laciniata*, *Carex* sp., *Mitella diphylla*, (shrub layer) *Taxus canadensis*, *Prunus serotina*, (tree layer) *Abies balsamea*, and *Tilia americana*.

According to early collectors, the most widespread habitat of *Cypripedium calceolus* var. *pubescens* was upland deciduous forest. In this habitat, its associates are (herb layer) *Osmunda claytoniana* (north-facing
slopes), Pedicularis canadensis, Desmodium glutinosum, Parthenocissus quinquefolia, Amphicarpa bracteata, Cystopteris bulbifera, Asarum canadense, Cornus sp., Geranium maculatum, Impatiens pallida, Mitella diphylla, Rhus radicans, Panicum latifolium, (shrub layer) Celtis occidentalis, Hamamelis virginiana, Corylus americana, Carya cordiformis, Ostrya virginiana, Carpinus caroliniana, Acer saccharum, Rubus sp., Tilia americana, Quercus alba, (tree layer) Quercus rubra, Tilia americana, Quercus alba, and Acer saccharum.

Cypripedium calceolus var. pubescens apparently reaches its northwestern limits in Iowa in Dickinson County. The forests of that part of the state are distinctly lower, more open, and poorer in species than forests elsewhere in the state because of the lower rainfall and periodic severe droughts in that part of the state. In 1974, a prolonged summer drought occurred which imparted an October-like aspect in July, with leaf fall of the trees and shrubs due to lack of moisture. The cypripediums were wilted, but still green. In deciduous forest near Milford, the associates of this species are (herb layer) Smilacina racemosa, Osmorhiza claytoni, Amphicarpa bracteata, Aster cordifolius, Caulophyllum thalictroides, Galium triflorum, Phryma leptostachya, Sanicula marilandica, Smilacina stellata, (shrub layer) Fraxinus pennsylvanica, Apocynum sibiricum, Rubus occidentalis, Cornus racemosa, (tree layer) Quercus alba, and Fraxinus pennsylvanica.

Another habitat in which Cypripedium calceolus var. pubescens is found is aspen bogs in the northern part of the state. These bogs are situated in kettle holes that have filled up with peat and sediments so that they are now scarcely lower than the surrounding upland. The soils are not saturated during the summer, but the high organic matter content retains moisture.
well. In the bogs, the aspen (*Populus tremuloides*) is very dense, up to 35 stems per 10 x 10 m plot, but the stem diameters are small, mainly about 5 cm (dbh). In this habitat, *Cypripedium calceolus* var. *pubescens* is associated with (herb layer) *Solidago altissima*, *Sanicula marilandica*, *Carex* sp., *Thalictrum dasycarpum*, *Zizia aurea*, *Calamagrostis canadensis*, *Comandra richardsiana*, *Equisetum arvense*, *Fragaria virginiana*, *Geum canadense*, *Pycnanthemum virginianum*, (shrub layer) *Populus tremuloides*, *Crataegus mollis*, *Betula pumila*, and (tree layer) *Populus tremuloides*.

In at least one site in Iowa, *Cypripedium calceolus* var. *pubescens* grows with prairie species on the margin of a hanging fen. In this locality, it has hybridized with plants of *C. candidum* to produce the hybrid, *Cypripedium x andrewsii* which grows between its two parents in the fen. In this habitat, var. *pubescens* is associated with (herb layer) *Equisetum arvense*, *Cypripedium candidum*, *Geranium maculatum*, *Pedicularis canadensis*, *Phlox maculata*, *Poa pratensis*, *Zizia aurea*, *Aquilegia canadensis*, *Equisetum hyemale*, *Fragaria virginiana*, and (shrub layer) *Ostrya virginiana*.

The soil nutrient levels vary considerably from site to site. *Cypripedium calceolus* var. *pubescens* was found on soils ranging from low to high levels of nearly all the measured nutrients. It is found in all temperature zones in Iowa, from the coldest to the warmest, and from the area of the longest growing season to the area of the shortest growing season in the state. Of all the factors known in this study, only rainfall seems to be a limiting factor for this species, preventing its establishment in the arid northwest corner of the state.
Cypripedium candidum Muhl. ex Willd.

The specific epithet is from a Latin word meaning dazzling white, referring to the white colored lip

Type locality: Pennsylvania

Flowering season in Iowa: mid- to late May, with extremes of April 30 and June 17

Literature: Parry (1852) 619; Arthur (1876) 31; Nagel and Haupt (1876) 164; Hitchcock (1892) 519; Shimek (1896) 212; Fink (1897) 103; Fitzpatrick and Fitzpatrick (1898) 165; Pammel (1898) 45; Barnes, Reppert, and Miller (1900) 260; Fitzpatrick and Fitzpatrick (1900) 191; Gow (1901) 159; Cratty (1904) 216; Anderson (1905) 135; Peck (1905) 204; Oleson and Somes (1906) 84; Greene (1907) 152; Pammel (1907) 103, 113; Pammel and Fogel (1907) 154; Shimek (1907) 173; Pammel (1909) 743, 745; Lindley (1911) 22; Verink (1914) 92; Diehl (1915) 89; Gow and Tilton (1916) 344; Spurrell (1919) 236; Tuttle (1919a) 278; Conard (1928) 94; Burk (1931) 138; Wolden (1932) 103; Cratty (1933) 197; Fuller (1933) 54; Tolstead (1938) 339; Hayden (1943) 373; Correll (1950) 31; Conard (1952) 112; Russell (1956) 172; Wolden (1956) 130; Davidson (1959) 40; Guldner (1960) 84, 212; Cooperrider (1962b) 31; Hartley (1966) 152; Eilers (1971) 79, 131

Counties: Adair: IA (nd)
Allamakee: ISC (1900)
Benton: IA, US (1885)
Black Hawk: ISC, ISTC (1897)
Cerro Gordo: ISC, IA (1944)
Chickasaw: Nicm (1974)
Clay: ISC (1941)
Crawford: ISC (1922)
Decatur: ISC, Niem (1974)
Emmet: IA, ISC, US (1917)
Fayette: AMES, ISC, US (1893)
Grundy: ISC (1901)
Hamilton: AMES, ISC (1945)
Hardin: ISTC (1926)
Howard: IA, Niem (1974)
Linn: IA (1909)
Muscatine: IA, ISC (1878)
Poweshiek: Grinnell, NY (1883)
Sac: IA, ISC (1921)
Scott: Barnes, NY (1887)
Story: AMES, Clinton, ISC, NY (1924)
Webster: ISC (1904)
Winnebago: ISC (1934)
(ISC, NY, US)
The Boone County report is based on Diehl (1915). The Johnson County report is based on Shimek (1896). The Page County report is based on Fitzpatrick and Fitzpatrick (1898) and Fitzpatrick and Fitzpatrick (1900).

The general distribution is from Ontario; south through New England to New Jersey and Pennsylvania; west through the Lake States to Minnesota, Iowa, Nebraska, and South Dakota; and south to Missouri and Kentucky.

*Cypripedium candidum* was once a widespread and abundant species in Iowa. The primary habitat in Iowa was moist, tall grass prairie. This habitat was most abundant in the north-central part of the state which was most recently glaciated, and had not developed a mature drainage system. Although most often collected in north-central Iowa, *Cypripedium candidum* also occurred elsewhere in the state, but was probably not as abundant. Fens provide the constant supply of moisture which is needed by this species, and since most of the tall grass prairie has now been plowed, fens provide the last habitat in Iowa where this species may be found in abundance.

I was only able to locate *Cypripedium candidum* in one habitat which would qualify as tall grass prairie. This site, in Howard County, was being invaded by aspen (*Populus tremuloides*). The associated species were: (herb layer) *Andropogon gerardii*, *Carex* sp., *Silphium laciniatum*, *Sorghastrum nutans*, *Aster ericoides*, *Fragaria virginiana*, *Helianthus grosseserratus*, *Pycnanthemum virginianum*, and (shrub layer) *Populus tremuloides*.

In nearby Chickasaw County, *Cypripedium candidum* was found in a similar, but moister area which would not be classified as a prairie. Aspen (*Populus tremuloides*) was nearby (about 20 m away) but did not occur in the plot. The site is characterized by hummocks raised about 20 cm above the ground. The hummocks are formed by a species of *Carex*. *Thelypteris palustris* also
forms hummocks, or perhaps takes over those produced by Carex after the sedge dies. *Cypripedium candidum* also occupies the hummocks. In this site, its associated species are: (herb layer) *Helianthus grosseserratus*, *Carex* sp., *Solidago altissima*, *Thelypteris palustris*, *Kuhnia eupatorioides*, and *Viola* sp.

The largest concentration of *Cypripedium candidum* I know about in Iowa is at the Silver Lake Fen in Dickinson County. It was much more abundant in the late 1960's until a large quantity of gravel was placed over a part of the colony to produce a parking lot. The cypripediums continued to come up through the gravel until 1973, but I saw no plants in the parking lot in 1974. Fortunately, the species is still abundant elsewhere in the fen. The associates of *Cypripedium candidum* in the Silver Lake Fen are: (herb layer) *Helianthus grosseserratus*, *Parnassia palustris*, *Viola* sp., *Carex* sp., *Eupatorium maculatum*, and *Phalaris arundinacea*. In some places in the fen, *Cypripedium candidum* grows with numerous specimens of *Habenaria hyperborea*.

A fen in the southern part of the state, in Decatur County, possesses a flora more closely related to moist prairies than to the fens of the northern part of the state. It is here that *Cypripedium candidum* grows with *C. calceolus* var. *pubescens* and has hybridized with it to produce the exceedingly rare (in Iowa) *Cypripedium x andrewsi*. The associates of *Cypripedium candidum* in this fen are: (herb layer) *Andropogon scoparius*, *Aster laevis*, *Calium* sp., *Sorghastrum nutans*, *Equisetum hyemale*, *Spiranthes cernua*, and (shrub layer) *Ostrya virginiana*.

The soil measurements indicate that *Cypripedium candidum* prefers constantly moist to saturated soils in the alkaline pH range, and high levels of alkaline metals such as calcium, magnesium, and manganese. The very low
copper levels probably have no significance. Habitats supplying these re-
requirements are most abundant in the area of Wisconsin glaciation in Iowa,
and C. candidum is most abundant in this area. It was probably rare else-
where in the state, most likely restricted to alkaline seep areas or fens
such as the Decatur County fen. Edaphic rather than climatic factors pre-
dominate in limiting this species in Iowa.

*Cypripedium reginae* Walt.

The specific epithet is from a Latin word meaning "of the queen" in recogni-
tion of the queenly nature of the flowers of this species.

Type locality: Carolina

Flowering season in Iowa: mid- to late June, with extremes of June 7 and
July 1

Literature: Parry (1852) 619; Arthur (1876) 31; Hitchcock (1892) 519;
Shimek (1896) 212; Fink (1897) 103; Fitzpatrick and Fitzpatrick (1898) 165;
Fitzpatrick and Fitzpatrick (1899) 197; Barnes, Reppert, and Miller (1900)
260; Fitzpatrick and Fitzpatrick (1900) 191, 192; Pammel (1900) 308; Greene
(1907) 152; Pammel (1907) 99; Shimek (1907) 173; Stookey (1910) 197; Shimek
(1911b) 41; Verink (1914) 92; Diehl (1915) 89; Findlay (1919) 90; Henning
(1919) 117; Lazell (1919) 96; Pammel (1919c) 114; Conard (1928) 94; Wolden
(1932) 103; Cratty (1933) 197; Fuller (1933) 54; Correll (1950) 41; Easterly
(1951) 78; Thorne (1955) 192; Russell (1956) 172; Wolden (1956) 136;
Davidson (1959) 40; Guldner (1960) 84; Hartley (1966) 59; Eilers (1971) 79,
131

Counties: Allamakee: IA, ISC (1959)
Boone: ISC (1927)
Chickasaw: ISC (1926)
Clayton: IA, ISC (1960)
Emmet: ISC (1922)
Fayette: AMES, ISC, US (1893)
Guthrie: ISC (1930)
Hardin: MO (1899)
Iowa: Clinton, IA, ISC (1904)
Jasper: Grinnell (1885)
Johnson: IA, ISC (1902)
Jones: IA (1957)
Linn: IA, ISTC (1907)
Muscatine: IA, ISC (1879)
Story: ISC (1883)
Tama: IA (1895)
Webster: ISC (1905)
Winnebago: IA (1895)
Winneshiek: ISC, Kovarik (1903)

The Jefferson County report is based on Fitzpatrick and Fitzpatrick (1899). The Poweshiek County report is based on Russell (1956). The Scott County report is based on Parry (1852), Fuller (1933), and Guldner (1960); and there is a specimen in the Parry Collection at Iowa State University which has no collection data, but may represent a Scott County collection.

The general distribution is from Newfoundland and Nova Scotia south through the Atlantic States to North Carolina and Tennessee; west through the Lake States to Missouri, Iowa, North Dakota, and Saskatchewan.

Cypripedium reginae was once a widespread orchid species in Iowa, occurring in all but the western and southern counties. The plants were apparently never abundant in any one location, but they were well distributed in moist woods. The showy flowers of this species led to its rapid extinction in many places. It is no longer present in Boone or Story Counties. Searches in Allamakee and Clayton County stations also revealed no plants. There is one station in Chickasaw County where the species still grows.

This species is essentially northern in distribution. It occurs in Illinois at latitudes equivalent to southern Iowa, indicating the possibility of its presence there. However, no specimens exist for these counties, a fact which may be attributed to the extinction of plants by early settlers before many collectors visited this still poorly known part of the state. On the other hand, plants may yet be found in some of the many rich ravines in the southeastern counties.
**Cypripedium x andrewsii** Fuller

This hybrid is named for its discoverer, Dr. E. P. Andrews, of Portage, Wisconsin

Type locality: adjacent to Swan Lake, Columbia County, Wisconsin

Flowering season in Iowa: mid-May


The general distribution of this species includes Wisconsin, Michigan, Illinois, and Iowa.

In the transition zone between an open fen and a forest in Decatur County, *C. calceolus* var. *pubescens* and *C. candidum* grow nearly side by side. A few plants of *C. x andrewsii* also occur in the transition zone.

In addition to being intermediate between the two parents in habitat preference, *C. x andrewsii* was also intermediate in phenology. On the day of collection, *C. calceolus* var. *pubescens* had almost fully expanded leaves, and the flowers were just beginning to open. Most plants of *C. candidum* were in full flower, and the leaves in many cases were still unfurling. *C. x andrewsii* had its leaves unfurled to an intermediate degree, and the flower was only partially open. The lip of *C. x andrewsii* displayed the cream color which easily distinguishes it from its parents.

The associates of *C. x andrewsii* in Decatur County are (herb layer) *Cypripedium candidum*, *Equisetum arvense*, *Helianthus strumosus*, *Zizia aurea*, *Pediculurus canadensis*, *Ratibida pinnata*, *Senecio plattensis*, (shrub layer) *Ostrya virginiana*, *Cornus sp.*, *Acer nigrum*, *Quercus rubra*, *Tilia americana*, (tree layer) *Ostrya virginiana*, *Tilia americana*, and *Quercus rubra*.

The nutrient levels of the site where this species grows indicate a preference for alkaline soils high in calcium and magnesium, as is the case
for \textit{C. candidum}. However, soil conditions are probably not responsible for the rarity of this species in Iowa. More likely, its rarity is due to the infrequency of sympatric stands of \textit{C. calceolus} var. \textit{pubescens} and \textit{C. candidum}. Climatic conditions are probably favorable for this hybrid throughout the state, except perhaps for the arid northwest corner of the state.

One other characteristic of the Decatur County fen may have some ecological importance. The saturated clay tends to slump, giving rise to a natural disturbance which is rather severe. This disturbance may also contribute to the suitability of this habitat for \textit{C. x andrewsii}, as hybrids are often most abundant in sites of disturbance (Anderson, 1954). Another factor which may prove to be important in the future is the apparent invasion of the fen margin where \textit{C. x andrewsii} grows by woody species. If this invasion should continue, it might cause too much shade for \textit{C. x andrewsii}. This seems unlikely, but the area should be observed in the future to determine whether the present saplings will mature or whether they will be toppled due to the slumping of the substrate.

There has been some unnecessary confusion regarding the name of this hybrid. Fuller (1932) described the hybrid between \textit{C. calceolus} var. \textit{parviflorum} and \textit{C. candidum} calling it \textit{C. x andrewsii}. Later the same year, Curtis (1932) described the hybrid between \textit{C. calceolus} var. \textit{pubescens} and \textit{C. candidum}, calling it \textit{C. x favillianum}. Voss (1966) stated that the International Code of Botanical Nomenclature advised the use of only one name for a hybrid between the same two species, regardless of the number of different varieties involved in the hybrids. Thus, according to Voss (1966), all hybrids between \textit{C. calceolus} and \textit{C. candidum} should be called \textit{C. x andrewsii}. I have followed Voss in this regard. It should be clear,
however, that Iowa C. x andrewsii is a hybrid between C. calceolus var. pubescens and C. candidum.

**Triphora Nutt.**

This genus name is derived from the Greek τρι-, *tri-* (threefold), φορός, *phoros* (bearing), probably in reference to the tendency to bear three flowers.

This is a small genus of perhaps a dozen small or very small terrestrial orchids native to forests of temperate and tropical regions of the New World. The plants are stoloniferous and produce fleshy tubers. The stem is slender and bears several clasping, alternate leaves. The lip has three crests. The capsules are erect or pendent. In Iowa, there is only one species of *Triphora*.

**Triphora trianthophora (Sw.) Rydb.**

Basionym: *Arethusa trianthophoros* Sw.

The specific epithet is from the Greek τρι-, *tri-* (threefold), ἄνθος-, *anthos-* (flower), and φορός-, *phoros* (bearing) referring to the common occurrence of three flowers per plant.

Type locality: North America

Flowering season in Iowa: mid- to late August, with extremes of July 2 and September 8

Literature: Arthur (1876) 31; Shimek (1896) 212; Fink (1897) 102; Fitzpatrick and Fitzpatrick (1898) 165; Fitzpatrick and Fitzpatrick (1900) 194; Niles (1904) 260; Greene (1907) 153; Verink (1914) 92; Lazell (1919) 96; Cratty (1933) 198; Correll (1950) 139; Fernald (1950) 476; Grant (1953b) 144; Thorne (1955) 192; Guldner (1960) 85; Thorne (1964) 29; Hartley (1966) 60; Eilers (1971) 80, 132

Benton: IA (1963)
Bremer: ISTC (1927)
Clayton: AMES, IA, ISC, MO (1940)
Delaware: IA, MO (1963)
Dubuque: IA, Niem (1973)
Fayette: AMES, ISC (1895)
Johnson: IA (1889?)
Linn: IA, ISC (1947?)

The Washington County report is based on Correll (1950).

The general distribution of this species is Canada through New England and the Atlantic States south to Florida, Texas, Mexico, Guatemala, and Panama; west through the Lake States to Iowa, Missouri, Kansas, and Arkansas.

This species has only seldom been collected in Iowa. This is probably due to three factors. First, this species is apparently not widespread nor abundant in Iowa. Second, the plants are rather inconspicuous when not in flower, and may have escaped the view of the casual collector. The flowers last only a few days. Third, according to Correll (1950), this species may be common one year in one location, but may be exceedingly rare the next. I suspect that this last factor is the most important one. In one location one year, I found hundreds of plants in an area of perhaps half a hectare; but the following year, I could see no plants in the same area, although I did find a few scattered plants in a different part of the same forest.

*Triphora trianthophora* tends to grow in old forested areas as opposed to areas of recent invasion in Iowa, and it also appears to grow where there are high levels of organic matter, often rooting mainly in decaying leaves, needies of conifers, and the leaf mold immediately underneath. Such conditions are found mainly in the eastern quarter of the state, but some outliers in Hardin County and Fremont County are likely places to look for *Triphora trianthophora* farther west.

In a pine forest (*Pinus strobus*) in Dubuque County, where *T. triantho-
phora* was very abundant one year, its associates in thick pine needle litter
were: (herb layer) *Osmunda claytoniana*, *Osmorhiza claytoni*, *Parthenocissus quinquefolia*, *Monotropa uniflora*, (shrub layer) *Acer saccharum*, *Tilia americana*, (tree layer) *Quercus rubra*, *Pinus strobus*, and *Acer saccharum*. The ground cover was very sparse in this location. In addition to the normal purple colored forms, there were very light pink forms, and some which appeared at first to be pure white, but which on closer examination had a slight tinge of color at the base of the lip.

*Triphora trianthophora* may have some tolerance of local disturbance. In Allamakee County, I found it along a path edge, a situation typical of several disturbance orchid species such as *Orchis spectabilis* and *Liparis lilifolia*. It was not abundant, but it was vigorous in this location. Its associates were: (herb layer) *Parthenocissus quinquefolia*, *Amphicarpa bracteata*, *Circaea quadrisulcata*, (shrub layer) *Fraxinus pennsylvanica*, *Xanthoxylum americanum*, (tree layer) *Populus grandidentata*, *Fraxinus americana*, *Carya ovata*, and *Quercus alba*.

The soil nutrient levels are not unlike those of other orchid species, so nutrient levels are unlikely to be a limiting factor in Iowa. The requirement for an acidic soil may limit its distribution in Iowa, however. This species most likely requires a moist climate, free from extremes of heat and drought, and these requirements have limited this species to the eastern quarter of Iowa. There is a possibility that this species will eventually be found in Hardin County, where these conditions also prevail. *Triphora trianthophora* may also be found eventually in southwestern Iowa in some of the sheltered valleys in the loess bluff region. In these valleys, a thick leaf mold layer develops, and the surface soil is acidic. *Triphora trianthophora* approaches southwestern Iowa from the south, being
present in northeastern Kansas. The rainfall and temperature pattern is nearly identical in southwestern Iowa and northeastern Kansas, so all conditions appear to be suitable for it there. It is unlikely, however, that *Triphora trianthophora* will be found in Iowa between a potential southwestern station and the eastern Iowa stations, except for the possible discovery of an outlier colony in Hardin County in central Iowa.

**Pogonia Juss.**

The name is derived from the Greek πογόνιος, pogonias, meaning a "beard", referring to the fringed crest of the lip.

This is a small genus of less than 10 species which are widely dispersed in the Old and New World. The plants are often found in rather strongly acid soils, in meadows, pine and oak barrens, and sphagnum bogs, habitats not found in Iowa. The plants are terrestrial herbs with slender roots and a system of slender stolons. The stem is erect, possesses a solitary leaf, and 1-3 flowers at the apex. There is only one species of *Pogonia* found in the United States.

**Pogonia ophioglossoides** (L.) Ker-Gawl.

Basionym: *Arethusa ophioglossoides* L.

The specific epithet is from the Greek, meaning "like the Adder's-tongue fern", referring to the remarkable similarity of nonflowering specimens to the Adder's-tongue fern, *Ophioglossum*.

Type locality: Virginia and Canada

Flowering season in Iowa: late June

Literature: Pammel (1907) 121; Pammel (1909) 769; Verink (1914) 92; Eilers (1971) 80, 132

Counties: Linn: IA (1913)
The general distribution of this species is from Newfoundland south through New England and the Atlantic States to Florida; west along the Gulf Coast to Texas; and west through the Lake States to Minnesota, Iowa, Missouri, and Tennessee.

*Pogonia ophioglossoides* is a species of rather strongly acid soils. I have seen it in great abundance in a tamarack bog in northeastern Illinois, and in abundance in moist sand prairie, also in northeastern Illinois. There are no tamarack bogs in Iowa so this habitat is eliminated. There are a few areas where *Sphagnum* grows, and these are possible sites for it. Some moist, acidic sand prairies occur in Iowa, especially along the Cedar River in Linn, Cedar, and Muscatine Counties; and it was in one of these prairies that the only Iowa specimen of *Pogonia ophioglossoides* was collected. The collecting site is briefly described on the herbarium sheet by the collector, G. H. Berry, "In low boggy swamps near river. Shaded by aspens." I attempted to relocate the collection site, but was not able to do so. This particular site may no longer exist, but others do, and this species should be sought in any such sites.

I have no list of associates for *Pogonia ophioglossoides*, but Sheviak (1974) lists some associates for similar Illinois sites.

I have no soil samples for *Pogonia ophioglossoides* in Iowa, but the relatively small number of moist, sandy areas with a low pH seems to be the limiting factor for this species in Iowa. Edaphic factors rather than climatic factors have limited the abundance of *Pogonia* in Iowa.

Apparently suitable sites in the Cedar River valley should be investigated by collectors in the event that this species is still present. The plant is rather inconspicuous when not in flower, and could have escaped...
earlier collectors. A slight hope for additional colonies in Linn County is given by Pammel (1909) who states that Lazell told him of its presence in Linn County.

**Calopogon** R. Br.

This genus name is from the Greek words ἀργός, kalos (beautiful), and πογόν, pogon (beard), in reference to the brightly colored fringed crest on the lip of members of this genus.

This is a small New World genus with 4-6 species, depending on different authorities. The species are warm-temperate to tropical except for one species which extends into our range. The plants are terrestrial herbs with usually a solitary leaf arising from a corm. The inflorescence is a terminal spike with few to several showy flowers. The lip is nonresupinate, and possesses brightly colored hairs which apparently attract pollinators because they look similar to the anthers of other plants. In Iowa, there is only one species of **Calopogon**.

**Calopogon tuberosus** (L.) BSP.

Basionym: *Limodorum tuberosum* L.

Type locality: none given

Flowering season in Iowa: late June to early July, with extremes of June 9 and July 14

Literature: Parry (1852) 619; Arthur (1876) 31; Shimek (1896) 212; Fink (1897) 102; Fitzpatrick and Fitzpatrick (1898) 165; Barnes, Reppert, and Miller (1900) 259; Fitzpatrick and Fitzpatrick (1900) 196; Greene (1907) 153; Pammel (1907) 116, 121; Pammel (1909) 769; Somes (1911) 5; Somes (1913) 47; Tuttle (1919a) 279; Cratty (1933) 198; Fuller (1933) 54; Tolstead (1938) 339; Rowe (1945) 102; Correll (1950) 176; Thorne (1955) 192; Davidson (1959) 39; Guldner (1960) 85, 213; Case (1964) 79; Hartley (1966) 58; Eilers (1971) 79, 131
Counties: Appanoose: ISC (1883)
Fayette: AMES, ISC, US (1894)
Floyd: ISC (1874)
Howard: IA (nd)
Johnson: ISC, MO (1889)
Linn: ISC (1928)
Muscatine: Barnes, IA, ISC, ISTC (1899)
 Winneshiek: ISC (1880)

The Mitchell County report is based on Tuttle (1919a).

The general distribution of this species is from Newfoundland south through New England and the Atlantic States to Florida, the Bahamas, and Cuba; west to Texas and through the Lake States to Minnesota, Iowa, Missouri, and Arkansas.

This species, like Pogonia ophioglossoides, is usually found in moist, acidic soils. Because of the rarity of proper edaphic conditions in Iowa, this species is rare in Iowa. The last Iowa collection was in Linn County in 1928. I visited the last site of collection several times, as well as other collection sites, but saw no evidence of Calopogon tuberosus.

The habitat for Calopogon tuberosus in Iowa is generally listed on herbarium sheets simply as "prairies", "boggy, low prairies" or "hillyside bogs", implying an open, moist habitat. No herbarium sheets I have seen for Iowa specimens list any associates. Barnes, Reppert, and Miller (1900) list the associates of this species in a rather unusual dry habitat in Muscatine County, "With Lechea tenuifolia, Helianthemum canadense, Coreopsis palmata, and Viola pedata on a dry gravelly hillside at Wildcat Den". Sheviak (1974) also mentions a bluff crown habitat in Illinois.

In most cases, however, Calopogon grew in moist, open areas in Iowa. Swink (1969) lists some associates for this species in the Chicago area.

I have no soil samples for Calopogon tuberosus in Iowa, but it is
probably safe to state that it usually requires moist, acidic soil conditions as noted by Wherry in Correll (1950) and Sheviak (1974). Such habitats are mainly restricted to the eastern part of the state.

**Spiranthes L. C. Rich.**

This generic name is derived from the Greek σπείρα, speira (coil), and ανθός, anthos (flower), in reference to the spiral arrangement of the flowers of many species.

This is a large and complex genus of perhaps 300 species which are found from boreal areas, equatorward through the temperate zones and the tropics of the Old and New Worlds. Plants are found in saturated fens, on dry hillsides, in open prairies, and in forests. Many species make up closely related groups, and often these plants are difficult to separate at the species level. Hybridization also is frequent, adding to the bewildering problems found in this genus. The plants may be coarse, or quite delicate, arising from somewhat tuberous roots. The flowers are often whitish (always so in our species), although other colors are found. The column is terete or clavate. The anther is erect on the back of the column, 2-celled. The pollinia have granular pollen. In Iowa, there are at least four species and one natural hybrid.

**Key to the Iowa species of Spiranthes**

1. Inflorescence slender, appearing to possess 1 tight or loose spiral rank of flowers

   2. Leaves ovate, forming a rosette on the soil surface, often absent at anthesis .............................................. *S. lacera*

2. Leaves linear-lanceolate, erect, often present at anthesis
3. Inflorescence pubescent with pointed hairs only ... \textit{S. vernalis}

3. Inflorescence pubescent with at least some capitate hairs ..... \textit{S. lacera} x \textit{S. cernua}

1. Inflorescence dense, appearing to have several spiral ranks of flowers

4. Lip pandurate, plants of fens in Iowa, rare ..... \textit{S. romanzzoffiana}

4. Lip not pandurate, plants rarely found in fens, usually in moist to dry prairie \textit{S. cernua}

\textit{Spiranthes cernua} (L.) L. C. Rich.

Basionym: \textit{Ophrys cernua} L.

The specific epithet is a Latin adjective meaning "nodding" referring to the nodding habit of the flowers

Type locality: Virginia and Canada

Flowering season in Iowa: September, with extremes of August 2 and October 11

Literature: Arthur (1876) 31; Hitchcock (1892) 519; Pammel (1896) 133; Fink (1897) 102; Pammel (1898) 44; Fitzpatrick and Fitzpatrick (1899) 197; Pammel (1899a) 181; Barnes, Reppert, and Miller (1900) 259; Fitzpatrick and Fitzpatrick (1900) 194; Cratty (1904) 217; Peck (1905) 205; Oleson and Somes (1906) 84; Greene (1907) 153; Pammel (1907) 113; Pammel (1909) 754; Somes (1913) 47; Verink (1914) 92; Kellogg (1919) 238; Burk (1920) 143; Conard (1928) 95; Wolden (1932) 104; Cratty (1933) 198; Tolstead (1938) 340; Hayden (1943) 373; Grant (1950) 106; Conard (1952) 111; Grant (1953b) 144; Thorne (1955) 192; Morrissey (1956) 205; Russell (1956) 172; Wolden (1956) 130; Davidson (1959) 40; Guldner (1960) 85; Cooperrider (1962b) 31; Hartley (1966) 60; Eilers (1971) 80, 132

Counties: Allamakee: AMES, IA, ISC, WIS, US (1958)
Appanoose: ISC (1921)
Benton: WIS (nd)
Black Hawk: ISTC (1960)
Bremer: IA, ISC (1963)
Buchanan: IA, ISC (1963)
Cerro Gordo: IA, ISC (1921)
Chickasaw: ISC (1924)
Clinton: IA, WIS (1956)
Decatur: ISC (1902)
Delaware: IA (1963)
Emmet: IA, ISC (1937)
The Hardin County report is based on Peck (1905). The Winnebago County report is based on Pammel (1909) and Grant (1953b). The Woodbury County report is based on Grant (1953). The Grant (1953b) report for Dickinson County is based on *Spiranthes romanzoffiana*, as are earlier reports of *S. cernua* for Dickinson County.

The general distribution of *Spiranthes cernua* is from Nova Scotia, Quebec, and Ontario south through New England and the Atlantic States to Florida; along the Gulf Coast to Texas; and west through the Lake States to Minnesota, Iowa, North and South Dakota, Nebraska, Kansas, Oklahoma, and New Mexico.

This is a highly variable species, and I am following Correll (1950) who treats it as a single polymorphic species. Several workers have attempted to isolate additional species or varieties from *S. cernua* (Rydberg in Britton, 1901; Ames, 1905; Ames, 1921; Sheviak, 1973). These species and varieties have not been universally accepted.
Spiranthes cernua is most abundant in somewhat disturbed, moist prairie habitats, although it is also found in nearly undisturbed prairie, sand prairie, and even in a fen.

In Boone and Story Counties, S. cernua grows in prairie remnants along railroad rights-of-way. In these locations, soil was removed during railroad construction in the 1860's in order to raise the roadbed above the surrounding low prairie to avoid floods and snow drifts. Thus the present soil has developed from cinders from the locomotives and soil which has blown and washed in from surrounding fields. Although supporting prairie vegetation, these areas probably should not be called prairie relicts, since the areas were heavily modified at the time of railroad construction, and were later invaded by prairie vegetation. In these habitats, the associates of S. cernua include (herb layer) Andropogon gerardii, Muhlenbergia frondosa, Sorghastrum nutans, Aster pilosus, Panicum virgatum, Petalostemnum purpureum, Poa compressa, Agrostis alba, Solidago graminifolia, Aster ericoides, Ratribida imnata, Cirsium sp., Equisetum hyemale, Fragaria virginiana, Juncus effusus, Juncus torreyi, Spartina pectinata, and Viola sp. In such habitats, S. cernua may be quite abundant, reaching densities of 5 or 6 plants per square meter. According to Sy Angstrom (ISU experimental farm, Kanawha, personal communication), S. cernua invades similar excavated sites along roads, where it may become abundant after about 20 years.

Spiranthes cernua is also relatively abundant in part of the Williams Prairie in Johnson County. It occupies a highly disturbed part of the prairie, which appears to have been heavily grazed. In this location, the associates are (herb layer) Poa pratensis, Solidago graminifolia, Agrostis alba, Andropogon gerardii, Lespedeza capitata, Oenothera biennis,
Pycnanthemum virginianum, Ratibida pinnata, Cassia fasciculata, Polygala viridescens, and Juncus tenuis.

Spiranthes cernua also occurs in nearly undisturbed prairies (Hayden Prairie, Kalsow Prairie) but it is quite rare in such habitats, and I have never seen it under such conditions.

Spiranthes cernua grows in a hanging fen in Decatur County. It is apparently absent from the fens in northwestern Iowa, so the Decatur County site is the only fen station I know about. This is not a typical fen, and is quite unlike the fens of northwestern Iowa. It possesses a sparse, depauperate assemblage of moist prairie species, and a few invading trees and shrubs. In this fen, the associates of S. cernua include (herb layer) Andropogon scoparius, Aster laevis, Sorghastrum nutans, Equisetum hyemale, Gentiana andrewsii, Cypripedium candidum, and (shrub layer) Ostrya virginiana.

I have also found Spiranthes cernua in a moist, sandy lawn in Greene County. In this location, it grows among Poa pratensis, Taraxacum officinale, and Trifolium repens.

The soil characteristics for Spiranthes cernua are quite variable, indicating that soils are of secondary importance. I have found this species growing in fine sands, in heavy clays, and in soils intermediate in texture.

Spiranthes cernua probably was, and perhaps still is, more widespread than the distribution map indicates. Although fairly conspicuous when in flower, it may have been overlooked in many places because of the relatively late period of anthesis, after the conclusion of most collecting. It probably also occurs or occurred in all the north central counties. The western range limits are probably set by increasing aridity, although it may even-
tually be found in areas of moist soils to the west. The limited number of stations in the southern part of the state is probably due in part to the dominance of forest, and in part due to the older, often acidic soils. Future collectors should look for this species in railroad prairies throughout the state, and in other suitable prairie habitats. It has also been collected in lightly forested habitats, and might also be sought in such places.

Spiranthes lacera (Raf.) Raf.

Basionym: Neottia lacera Raf.

The specific epithet lacera is a Latin adjective meaning "torn", apparently referring to the ragged appearance of the apical part of the lip.

Type locality: Massachusetts, vicinity of Boston, in dry hilly woods.

Flowering season in Iowa: late August (August 22 - September 1)

Literature: Arthur (1886) 67; Shimek (1896) 211; Fitzpatrick and Fitzpatrick (1898) 164; Fitzpatrick and Fitzpatrick (1899) 197; Barnes, Reppert, and Miller (1900) 259; Fitzpatrick and Fitzpatrick (1900) 194; Gow (1901) 159; Greene (1907) 153; Shimek (1907) 174; Gow and Tilton (1916) 344; Shimek (1925) 27; Cratty (1933) 198; Fuller (1933) 113; Gilly and McDonald (1947) 115; Correll (1950) 197; Fay (1951) 115; Grant (1953b) 144; Thorne (1955) 192; Morrissey (1956) 205; Davidson (1959) 40; Guldner (1960) 85; Case (1964) 83; Hawkes (1965) 447

Counties: Cedar: IA, Niem (1974)
Decatur: ISC (1900)
Johnson: IA, ISC (1889)
Muscatine: ISC (1889)
Scott: Barnes (1954)
Winneshiek: ISC (1882)

The Adair County report is based on Gow (1901) and Gow and Tilton (1916). The Jefferson County report is based on Gilly and McDonald (1947) and Grant (1953b). Shimek (1925) reports this species from Cerro Gordo County, but this report is based upon a misidentified specimen of S. cernua.
The general distribution of *Spiranthes lacera* is from Nova Scotia to Quebec and Ontario; south through New England and the Atlantic States to Florida, along the Gulf Coast to Texas; and west through the Lake States to Minnesota, Iowa, Missouri, and Oklahoma.

*Spiranthes lacera* has never been very common in Iowa, and it is apparently quite rare at the present time. It is restricted to rather dry prairie habitats, often on sandy soil. Where it is found, it may be quite abundant, but the number of known sites where it still grows is only three.

*Spiranthes lacera* is quite abundant in a prairie cemetery in Cedar County. There are probably several hundred plants in an area of a few hectares. The associates of *S. lacera* on this site are (herb layer) *Andropogon gerardii*, *Apocynum androsaemifolium*, *Antennaria plantaginifolia*, *Trifolium pratense*, *Euphorbia corallata*, *Sorghastrum nutans*, and *Setaria viridis*. The weedy components were present on the sampling site, which appeared to have been disturbed in some way, but these species were not evident in other places where *S. lacera* grew.

The plants on this site exhibited a great variation in the degree of spiraling of the inflorescence. Some inflorescences had a very tight spiral, with the flowers of one rank just above those of the rank below, while other plants were so loosely spiraled that the flowers made only one revolution on the spike.

*Spiranthes lacera* is a relatively inconspicuous species with a rather short period of anthesis in Iowa, and thus may have escaped the notice of casual collectors. Although probably not very common, it may be found in additional eastern counties, especially in sandy sites, during the last week of August.
Spiranthes romanzoffiana Cham.

The specific epithet commemorates Nikolai Rumiantzov (Count Romanzoff), a Russian statesman and patron of science (1754-1826)

Type locality: lowermost valleys of Unalaska

Flowering season in Iowa: mid-July (July 6-25)

Literature: Cratty (1926) 127; Wolden (1932) 104; Cratty (1933) 198; Correll (1950) 222; Fernald (1950) 480; Grant (1950) 106; Grant (1953b) 144; Wolden (1956) 130; Case (1964) 85; Rickett (1966) 80

Counties: Dickinson: IA, ISC, ISTC, Lake, Niem (1973)
Emmet: AMES, IA, ISC, US (1953)

There is a Worth County report (Grant, 1953b), but this is based upon an incorrectly determined specimen of Spiranthes cernua collected by Pammel in 1908 (ISC 46687). Fernald (1950) incorrectly attributes this species to "ne. Ia."; this should read "nw. Ia."

The general distribution of this species is from Newfoundland and Labrador south through northern and western New England; west through Illinois, Iowa, South Dakota, Nebraska, Colorado, Nevada, Arizona, New Mexico, California, Oregon, Washington, British Columbia, Yukon, Alaska, and the Aleutian Islands; and also in Ireland.

Spiranthes romanzoffiana is essentially a boreal species. It apparently reached its southermost (nonmountainous) distribution in central Illinois in historical times, but it has not been collected there since 1947 (Sheviak, 1974). I have not seen the Illinois specimens, but the flowering time stated on the herbarium sheet was "October" according to Sheviak (1974) which raises some doubt as to the collection site or time, since S. romanzoffiana only flowers in mid-July in Iowa. In any case, the remaining Iowa station appears to be the most southerly nonmountainous station for this
species now.

I have seen *S. romanzoffiana* in only one fen, in northern Iowa (Dickinson County). In 1974, I found only one plant of *S. romanzoffiana* there. In view of its former relative abundance in the general area, the species appears to be on the brink of extinction in Iowa. This may be due, in part, to botanical collecting, although there are only 7 collections that I know about from this particular fen. Other fen sites, in Emmet County, apparently no longer exist according to information on an herbarium specimen collected by Thorne in 1953. I was able to find remnants of a fen in Emmet County along the Des Moines River, and although the habitat seemed suitable, I found no plants of *S. romanzoffiana*.

In Dickinson County, the immediate associates of *S. romanzoffiana* are (herb layer) *Juncus* sp., *Parnassia palustris*, and *Triglochin maritima*. Nearby, in the same community is *Liparis loeselii*. In the same fen, but not closely associated with *S. romanzoffiana* is another boreal orchid, *Habenaria hyperborea*. The fen is characterized by a constant flow of water. It became much drier than normal in the severe drought in the summer of 1974, but the particular spot where *S. romanzoffiana* grew remained wet.

The soil characteristics for *S. romanzoffiana* in Iowa are based on the one site where I found it in Dickinson County. The fen is constantly bathed in cool, alkaline water from a subsurface source. This has led to marl formation in some of the pools in the fen where *Chara* grows. The soil sample, however, was taken near *S. romanzoffiana*, which grows just on the upper margin of where the water wells up out of the ground.

The extreme nature of the nutrient levels is due to the water supply to the fen. It is very high in calcium and magnesium because of the quantity
of these materials in the glacial till through which the water flows. The level of other nutrients is extremely low because they are continually leached away by the flowing water. While these extreme nutrient levels may not be directly necessary for the *S. romanzoffiana*, they are probably of indirect importance in that few other Iowa plants can grow under these edaphic conditions with constantly saturated soil. Thus, a very low, almost lawn-like zone of herbs which can tolerate these conditions has developed, and *S. romanzoffiana* is a member of this community. In other moist habitats in Iowa, a rank growth of coarse herbs develops which would doubtless exclude *S. romanzoffiana* even if it could tolerate the edaphic conditions. Thus, in Iowa, this species is restricted to fens.

It is likely that *S. romanzoffiana* was much more abundant in Iowa following the glacial retreat. It was probably eventually restricted to the northwestern fens during the xerothermic, and failed to expand its range following the xerothermic due to the lack of suitable habitats. The disappearance of this species from the northwestern fens in the past few years may be due to the tile drainage of agricultural land which has upset the water table and cut down the supply of water to the fens. Thorne comments on an herbarium sheet of *S. romanzoffiana* from Emmet County that the collection site had just been drained and was drying up. Drainage of the surrounding land may also have influenced the quantity of water flowing in the fen where I found *S. romanzoffiana*, although the station remained wet even through the severe 1974 drought in northwest Iowa. In any case, *S. romanzoffiana* appears to be in the last stages of extinction in Iowa.
Spiranthes vernalis Engelm. & Gray

The specific epithet, *veralis*, is a Latin adjective meaning "spring" because in the south, this species blooms in Spring.

Type locality: Galveston and Houston, Texas.

Flowering season in Iowa: August (August 7-27)

Literature: Verink (1914) 92; Correll (1950) 227

Counties: Fremont: ISC (1915)
          Harrison: ISC, MO, WIS (1918)

A Linn County report for this species (Verink, 1914) is based on a misidentified specimen of *S. cernua*.

The general distribution of this species is from Quebec south through New England and the Atlantic States to Florida; west through the Central and Lake States to Missouri, Iowa, Nebraska, Kansas, Oklahoma, and New Mexico; also in Mexico and Guatemala.

*Spiranthes vernalis* is essentially an austral species, extending from Guatemala northward to reach its northern limit (in the west) in Iowa. It was evidently never very abundant in Iowa. I have seen only four herbarium sheets of this species from Iowa, the last collected in 1918. The species is apparently abundant slightly farther south according to Magrath (1971). I have searched for it in Fremont and Harrison Counties in Iowa several times, but with no success. It may no longer be present in Iowa; however, collectors should watch for it in the Missouri valley.

The habitat of *S. vernalis* in Iowa is not well known. Specimens collected in Harrison County list the habitat as "sand dunes", or "pools" or "low ground". The Fremont County specimen lists the habitat as "roadside". Correll (1950) states that this species is found in "low swampy pastures and
meadows, bogs, fresh and coastal salt marshes, low wet pine barrens and flatwoods, swamps, floodplain areas, low prairies and savannahs, sandy beaches and dune areas, in open woods and hammocks, and occasionally in calcareous soils".

The associates of *S. vernalis* in Iowa are unknown, but a few possible associates which I found in sand dunes at the Blair Bridge collection site in Harrison County include *Cannabis sativa*, *Celastrus scandens*, *Cenchrus longispinus*, *Cycloloma atriplicifolium*, *Euphorbia missurica*, *Helianthus annuus*, *Panicum virgatum*, *Populus deltoides*, and *Vitis riparia*.

The soil characteristics of *S. vernalis* are also unknown in Iowa except that at the Blair Bridge site the substrate was glacio-fluvial-aeolian fine sand.

The hybrid between *S. lacera* and *S. cernua* appears very similar to *S. vernalis*, which led me to believe that these specimens from Fremont and Harrison Counties might be referable to the hybrid rather than *S. vernalis*. All of the specimens I have examined from western Iowa had pointed trichomes on the inflorescence, while hybrid specimens should have some capitate trichomes. Furthermore, I have not seen specimens of either *S. cernua* or *S. lacera* which indicate that either species grows within 100 km of these sites in Iowa, making the possibility of hybrid plants at these sites quite remote. The hybrid is quite rare in Iowa even where the two species are growing near each other.

*Spiranthes lacera x Spiranthes cernua*

Ames (1921) speculated that the hybrid between *S. lacera* and *S. cernua* yielded the plant known as *S. vernalis*. Indeed, the two entities are nearly
identical in appearance. The best method of determining the true identity of a specimen is to observe the pubescence on the inflorescence. If the pubescence is of pointed trichomes, the plant is *S. vernalis*. If the plant has some capitate trichomes, it is *S. lacera* × *S. cernua*. I have not found much information about this hybrid in the literature. This may be the *Spiranthes casei* described by Catling and Cruise (1974). It occurs in New England (Ames, 1921), Michigan (Case, 1964), and in Illinois (Sheviak, 1974).

There are a few sheets in the Barnes Herbarium of the Putnam Museum in Davenport which appear to be hybrids between *S. lacera* and *S. cernua*. Both species grow in Scott County, where the hybrid plants were collected. L. F. Guldner collected three of the four sheets, and apparently regarded the plants as *S. lacera* (Guldner, 1960).

The plants collected by Guldner were growing in sandy soil on the edge of a marsh. Guldner (1960) lists other species found in the same marsh.

*Goodyera* R. Br.

This generic name commemorates the English botanist, John Goodyer, Esq. (1592-1664).

This is a genus of about 25 species found in boreal, temperate, and tropical regions of the world. The variegated leaves typical of this genus are also found in the closely related genera *Anoectochilus, Ludisia*, and *Macodes*. The leaves are alternate, but are so close together that they appear to be in a rosette. The flower spike arises from the center of the rosette. In Iowa, there is only one species of this genus represented, *Goodyera pubescens*. The other North American species are more boreal in
distribution, and it is unlikely that any other species will be found in Iowa.

**Goodyera pubescens** (Willd.) R. Br.

**Basionym:** *Neottia pubescens* Willd.

The specific epithet is a Latin adjective meaning "downy", in reference to the hairs on the inflorescence.

**Type locality:** Canada to Florida

**Flowering season in Iowa:** mid- to late July and early August

**Literature:** Shimek (1896) 198; Fitzpatrick (1898) 128; Fitzpatrick and Fitzpatrick (1898) 164; Pammel (1899) 186; Barnes, Reppert, and Miller (1900) 259; Fitzpatrick and Fitzpatrick (1900) 195; Greene (1907) 153; Pammel (1907) 116; Shimek (1907) 174; Somes (1913) 47; Pammel (1919d) 75, 76; Cratty (1933) 198; Gilly and McDonald (1936) 146; Tolstead (1938) 339; Gilly and McDonald (1947) 115; Correll (1950) 236; Easterly (1951) 78; Thorne (1955) 192; Thorne (1956) 219; Davidson (1959) 40; Guldner (1960) 85; Cooperrider (1962b) 31; Thorne (1964) 29; Hartley (1966) 59; Eilers (1971) 79, 131

**Counties:**
- Allamakee: ISC, ISTC (1934)
- Clayton: AMES, ISTC (1958)
- Delaware: ISTC (nd)
- Dubuque: ISTC, Niem (1973)
- Iowa: AMES, MO, Niem (1973)
- Johnson: Clinton, ISTC, MO (1895)
- Linn: ISC (1931)
- Winneshiek: ISC, Kovarik (1898)

The Jones County report is based on Shimek (1896) and Cooperrider (1962b). The Muscatine County report is based on Barnes, Reppert, and Miller (1900). The Van Buren County report is based on Gilly and McDonald (1947).

The general distribution of this species is from Quebec and Ontario south through New England and the Atlantic States to South Carolina and Georgia and west through the Central and Lake States to Minnesota, Iowa, Kentucky, and Tennessee.
In Iowa, *Goodyera pubescens* is a rather uncommon plant. It is found mainly in rich forests along the major rivers in the eastern part of the state. This species probably migrated northward along these valleys following glaciation. It was probably more widespread in Iowa before the xerothermic period, but it appears to be nearly restricted to valleys and moist forests of northeastern Iowa now. Intolerance to drought is probably the main factor responsible for its restriction to the eastern part of the state.

*Goodyera pubescens* reaches its greatest abundance in Iowa in pine forests (*Pinus strobus*). In parts of a pine forest in Dubuque County, *G. pubescens* carpets the ground with dozens of plants per square meter. In other places, it occurs as single plants or small clumps. In a location of the second type, its associates are (herb layer) *Hepatica acutiloba*, *Osmunda claytoniana*, *Parthenocissus quinquefolia*, *Adiantum pedatum*, *Aralia nudicaulis*, *Geranium maculatum*, *Mitella diphylla*, *Osmorhiza claytoni*, *Panax quinquefolia*, (shrub layer) *Carpinus caroliniana*, *Ostrya virginiana*, *Cornus sp.*, *Pinus strobus*, (tree layer) *Quercus rubra*, and *Acer nigrum*.

*Goodyera pubescens* is also found sparingly in deciduous forests in eastern Iowa. In such places, it often occurs as a single plant or a few scattered plants, and rarely as small clusters. In one deciduous forest site in Iowa County, the associates of *Goodyera pubescens* were (herb layer) *Aralia nudicaulis*, *Adiantum pedatum*, *Vitis riparia*, *Hepatica acutiloba*, *Ulmus americana*, (shrub layer) *Ulmus americana*, *Celtis occidentalis*, *Tilia americana*, *Fraxinus pennsylvanica*, (tree layer) *Quercus rubra*, *Carya ovata*, and *Fraxinus pennsylvanica*.

From an edaphic standpoint, there are probably many suitable sites for
this species in Iowa. High pH values in parts of western Iowa may, however, limit westward extensions. The main limiting factor appears to be periodic drought conditions in central and western Iowa which are more severe than those in eastern Iowa. It is possible that the range of this species may be extended westward to Hardin County, where many northern relict species have survived. It has not yet been found there, but collectors in that county should look for it.

**Orchis L.**

The generic name is from the Greek ὀρχής, orchis (testicle), in reference to the shape of the tubers of some species.

This is the type genus for the Orchidaceae. It contains about 100 species in the temperate zones of Europe, Asia, northern Africa, and North America (Correll, 1950). The European and African species hybridize naturally, leading to introgression and a confusing array of variations which make their classification difficult. The plants are fleshy, leafy terrestrial herbs, often with tuberous roots. In North America, there are only three species of *Orchis*, only one of which occurs in Iowa, the other two being boreal in distribution.

**Orchis spectabilis L.**

The specific epithet is from a Latin word meaning "showy", in reference to the attractive flowers.

Type locality: Virginia

Flowering season in Iowa: mid-May with extremes of April 29 and June 10

Literature: Arthur (1876) 31; Hitchcock (1892) 519; Pammel (1896) 133; Shimek (1896) 212; Fink (1897) 102; Fitzpatrick and Fitzpatrick (1898) 165; Barnes, Reppert, and Miller (1900) 259; Fitzpatrick and Fitzpatrick (1900)
192; King (1904) 128; Peck (1905) 205; Oleson and Somes (1906) 84; Greene (1907) 152; Shimek (1907) 173; Stookey (1910) 197; Lindley (1911) 22; Shimek (1911a) 220; Shimek (1911b) 41; Somes (1913) 46; Verink (1914) 92; Diehl (1915) 89; Lazell (1919) 96; Tuttle (1919a) 278; Tuttle (1919b) 144; Lohman (1926) 42, 48; Conard (1928) 95; Burk (1931) 138; Wolden (1932) 103; Cratty (1933) 197; Tolstead (1938) 340; Gilly and McDonald (1947) 115; Correll (1950) 48; Easterly (1951) 78; Fay (1951) 115; Conard (1952) 66; Wagenknecht (1954) 190; Thorne (1955) 192; Russell (1956) 172; Wolden (1956) 130; Davidson (1959) 40; Cooperrider (1960) 152; Davidson (1960) 165, 173; Guldner (1960) 37, 84, 212; Cooperrider (1962b) 31; Case (1964) 49; Thorne (1964) 29; Hawkes (1965) 343; DeLisle (1966) 23; Hartley (1966) 60; Eilers (1971) 80, 131

Counties: Allamakee: ISC, Niem (1973)  
Boone: ISC, Niem (1973)  
Black Hawk: ISC (nd)  
Buchanan: IA (1963)  
Cass: ISC (1967)  
Cedar: IA (1950)  
Cerro Gordo: IA (1900)  
Clayton: IA, Niem (1973)  
Delaware: IA, ISC (1963)  
Dubuque: IA, ISC, ISTC, MO, Niem (1974)  
Emmet: ISC (1917)  
Fremont: IA, ISC, Niem (1974)  
Hancock: Niem (1973)  
Hardin: IA, Niem (1974)  
Henry: IA, Niem (1973)  
Howard: IA (1963)  
Iowa: IA, ISC, Niem (1973)  
Jackson: IA (1957)  
Jefferson: IA, ISC (1930)  
Jones: IA (1957)  
Kossuth: ISC (1956)  
Linn: Cornell, IA, ISC, ISTC, Niem (1973)  
Marion: IA, Niem (1974)  
Marshall: ISC (1925)  
Mitchell: IA (1921)  
Muscatine: Barnes, IA, ISC, (1952)  
Polk: ISC (1922)  
Pottawattamie: IA, Niem (1973)  
Poweshiek: Grinnell (1966)  
Scott: Barnes (1947)  
Tama: ISC (1924)  
Van Buren: Niem (1973)  
Warren: IA (1957)
The Woodbury County report is based on Pammel (1896).

The general distribution of *Orchis spectabilis* is from New Brunswick and Quebec south through New England and the Atlantic States to Georgia and Alabama and west through the Lake States to Minnesota, Iowa, Nebraska, Missouri, and Arkansas.

*Orchis spectabilis* is probably the most widespread and most abundant orchid in Iowa at the present time. It may be found in almost any deciduous forest without much difficulty. Although collections exist for less than half of the Iowa counties, it would not be surprising if it is eventually collected in nearly all of the counties.

There are often plants which commonly associate with a particular orchid species frequently enough to be of value as indicator plants. An ideal indicator species is one which always associates with the orchid species in question. It should not be present where the orchid is not present. It should be more abundant than the orchid, but not so abundant as to be present all over in the habitat. There is probably no ideal indicator species, but the closest approach to it for Iowa orchids is the relationship between *Orchis spectabilis* and *Botrychium virginianum*. In all but one station for *Orchis spectabilis* which I have found in Iowa, Illinois, and Indiana, *Botrychium virginianum* was associated closely enough with *Orchis spectabilis* to be visible with the orchid in one field of view. As a general rule, I have found that if there are three or more plants of *Botrychium virginianum*...
in one's field of view, there is probably also an Orchis spectabilis in
the field of view. Botrychium virginianum is infrequent enough to be a
valuable indicator plant, and its unique appearance makes it stand out among
the other herbs in Iowa forests, whereas Orchis spectabilis leaves blend in
with their surroundings so well that they are often difficult to spot. The
almost constant association of these two plants, both of which are very de-
pendent upon a mycorrhizal association, suggests that they may have the same
or a very similar mycorrhizal association. An investigation of this rela-
tionship is beyond the scope of this dissertation, but it is an interesting
topic which merits further attention.

Orchis spectabilis grows under a wide range of habitats in Iowa,
ranging from mature forests with a closed canopy, to very open sites which
are in the early stages of forest recovery. The habitats in which this
species is found can be roughly arranged along a disturbance gradient. Case
(1964) and Auclair (1972) state that this species is found in mature forests
and resents disturbance. Bullington (1973) and Sheviak (1974), however,
state that this species is an invading species, invading old pastures and
similar habitats. My experience with this species in Indiana, Illinois,
and especially Iowa indicates that it is unquestionably favored by disturb-
ance to the habitat. In forests which have been free from browsing by
domestic animals and free from cutting for 50-100 years, Orchis spectabilis
is uncommon. The few plants present are likely to remain in a vegetative
state, only rarely flowering. As one progresses toward more and more open
canopy conditions, the Orchis spectabilis plants become larger and flower
regularly. In very open habitats, Orchis spectabilis acts as an invader,
reaches its peak abundance, and flowers vigorously. I will discuss the
habitats of *Orchis spectabilis* starting with the ones with the most open canopies progressing toward the ones with the most closed conditions. Habitats of intermediate canopy coverage are arranged subjectively, rather than on actual measurements of the canopy coverage.

The most open habitats examined were of several types. One type of open habitat found in two places in Story County was apparently pasture which is now undergoing the early stages of forest invasion. In these locations, the associates of *Orchis spectabilis* are (herb layer) *Agrimonia* sp., *Geum canadense*, *Parthenocissus quinquefolia*, *Phlox divaricata*, *Rhus radicans*, *Sanguinaria canadensis*, *Sanicula marilandica*, *Taraxacum officinale*, *Viola pubescens*, *Dicentra cucullaria*, *Polygonatum biflorum*, *Smilacina racemosa*, *Viola sororia*, *Galium concinnum*, *Galium triflorum*, (shrub layer) *Quercus alba*, *Carya ovata*, *Quercus rubra*, *Ribes cynosbati*, *Celtis occidentalis*, *Prunus serotina*, *Rubus* sp., *Ulmus americana*, *Tilia americana*, (tree layer) *Gleditsia triacanthos*, *Prunus serotina*, *Ulmus americana*, *Carya cordiformis*, *Celtis occidentalis*, *Carya ovata*, *Tilia americana*, *Acer negundo*, *Crataegus mollis*, and *Crataegus* sp.

At Waubonsie State Park in Fremont County, *Orchis spectabilis* has invaded an old pasture which has progressed to a somewhat more advanced stage of secondary succession. At Waubonsie, the associates are (herb layer) *Parthenocissus quinquefolia*, *Bromus inermis*, *Vitis riparia*, *Anemone cylindrica*, *Botrychium virginianum*, *Phryma leptostachya*, *Stellaria* sp., (shrub layer) *Rhus glabra*, *Cornus* sp., (tree layer) *Acer saccharinum*, *Juglans nigra*, and *Ulmus americana*.

Near Lower Pine Lake in Hardin County, *O. spectabilis* grows in a scrubby, open forest associating with (herb layer) *Parthenocissus*
quinquefolia, Cryptotaenia canadensis, Anemone canadense, Botrychium virginianum, Phryma leptostachya, Geum canadense, Osmorhiza claytoni, (shrub layer) Quercus alba, Rubus sp., Rhamnus cathartica, (tree layer) Fraxinus americana, Gymnocladus dioica, Quercus velutina, Prunus serotina, Robinia pseudoacacia, Quercus alba, and Carya ovata.

In Marion County, on the slopes above the Des Moines River (Red Rock Reservoir), in regenerating forest, Orchis spectabilis is found with the following associates: (herb layer) Carex pensylvanica, Amphicarpa bracteata, Carex sp., Cryptotaenia canadensis, Galium triflorum, Geranium maculatum, Symphoricarpos albus, Viola sororia, (shrub layer) Tilia americana, Fraxinus pennsylvanica, Ribes cynosbati, (tree layer) Tilia americana, Fraxinus americana, Acer nigrum, Ulmus americana, and Fraxinus pennsylvanica. The Marion County site is somewhat unusual in that the Orchis spectabilis is abundant, but the coverage of the other herbs is low and there is much bare ground.

In Pilot Knob State Park in Hancock County, there is another anomalous disturbance habitat where Orchis spectabilis grows. This site has apparently been recently invaded by woody species, which were only 3-5 m high at sampling time, and the canopy was still quite open. Orchis spectabilis was vigorous, but not nearly as abundant as it usually is in disturbance habitats. This may be due to a recent time of invasion of Orchis spectabilis, or it may be due to abnormally high soil moisture of the site, which is only about \( \frac{1}{2} \) m above the water level of a pond. At this site, the associates of Orchis spectabilis are (herb layer) Plantago rugelii, Sanicula marilandica, Amphicarpa bracteata, Galium concinnum, Galium sp., Geranium maculatum, Osmorhiza claytoni, Phryma leptostachya, Helianthus strumosus,
Anemone quinquefolia, Polygonatum biflorum, Solidago sp., Uvularia perfoliata, Viola sororia, (shrub layer) Xanthoxylum americanum, Cornus racemosa, Prunus serotina, (tree layer) Populus tremuloides, Prunus serotina, and Quercus rubra.

North of Hesper in Winneshiek County, Orchis spectabilis occupies a forest which is currently pastured. The grazing has led to a rather open habitat without a closed canopy. In this habitat, the associates of Orchis spectabilis are (herb layer) Hydrophyllum virginianum, Aquilegia canadensis, Carex pensylvanica, Osmorhiza claytoni, Apocynum sp., Galium concinnum, Geranium maculatum, Phryma leptostachya, Sanicula marilandica, Smilacina racemosa, Viola sororia, Ostrya virginiana, Viola pubescens, (shrub layer) Ribes cynosbatii, Lonicera tatarica, Tilia americana, (tree layer) Populus grandidentata, Carya cordiformis, Quercus velutina, and Amelanchier arborea.

The western counties offer open forest communities where Orchis spectabilis reaches its western limits in Iowa. Although not due to disturbance, the rather open canopies of these forests which have only recently invaded prairie, offer conditions similar to those in disturbed habitats. Orchis spectabilis is abundant in Fremont County sites, but it is apparently rather rare in Pottawattamie County in western Iowa. Sites in these counties have the following associates of Orchis spectabilis: (herb layer) Galium concinnum, Carex sp., Cystopteris fragilis, Cercis canadensis, Circaea quadriradiata, Dicentra cucullaria, Lactuca sp., Smilax tamnoides var. hispide, Geum canadense, Arisaema triphyllum, Botrychium virginianum, Galium sp., Parthenocissus quinquefolia, Polygonatum biflorum, Ranunculus abortivus, Viola pennsylvanica, (shrub layer) Ostrya virginiana, Asimina triloba, Corylus americana, Tilia americana, Ulmus americana, Lonicera tatarica,
Amelanchier arborea, (tree layer) Carya cordiformis, Quercus muhlenbergii, Ulmus rubra, Ostrya virginiana, Celtis occidentalis, Quercus rubra, Fraxinus pennsylvanica, and Juglans nigra.

Devon Woods in Chickasaw County is an open woods and has numerous aspen and blackberries. It is likely that it has experienced some type of disturbance. *Orchis spectabilis* is abundant, and its associates in Devon Woods are (herb layer) Geranium maculatum, Cryptotaenia canadensis, Geum canadense, Parthenocissus quinquefolia, Amphicarpa bracteata, Carex sp., Circaea quadriruscata, Galium triflorum, Osmorhiza claytoni, Uvularia sessilifolia, (shrub layer) Corylus americana, Sambucus canadensis, (tree layer) Populus tremuloides, Prunus serotina, and Quercus alba.

Forests on steep topography often tend to have a rather open canopy, but in Iowa the canopy coverage of these sites is increasing. The associates of *Orchis spectabilis*, which is fairly abundant and vigorous in these sites, are (herb layer) Carex sp., Mitella diphylla, Leersia virginica, Athyrium filix-femina, Amphicarpa bracteata, Anemonella thalictroides, Aster cordifolius, Circaea quadriruscata, Osmorhiza claytoni, Parthenocissus quinquefolia, Polygonatum biflorum, Acer saccharum (eastward), Arisaema triphyllum, Pilea pumila, (shrub layer) Ostrya virginiana, Acer saccharum (eastward), Prunus serotina, Tilia americana, Taxus canadensis (eastward), Quercus rubra, (tree layer) Acer saccharum (eastward), Tilia americana, Carya cordiformis, Populus grandidentata, Quercus alba, Pinus strobus (eastward), Ostrya virginiana, Fraxinus americana, and Carpinus caroliniana.

*Orchis spectabilis* is least often found in dense forests which have not experienced recent disturbance and have developed closed canopies. When *Orchis spectabilis* is present in such habitats, it is frequently represented
by weak plants with a single leaf, and it often remains in the vegetative
state, probably for long periods of time. Occasional, scattered flowering
plants may be found, but these are not frequent. The associates of *Orchis
spectabilis* in these habitats are (herb layer) *Asarum canadense*, *Parthenocissus
quinquefolia*, *Adiantum pedatum*, *Geranium maculatum*, *Impatiens
pallida*, *Amphicarpa bracteata*, *Botrychium virginianum*, *Circaea quadrisulcata*,
*Osmorhiza claytoni*, *Ostrya virginiana*, *Podophyllum peltatum*, *Pyrola elliptica*,
*Sanicula marilandica*, *Solidago ulmifolia*, *Ulmus americana*, *Actaea alba*,
*Arisaema triphyllum*, *Carex pensylvanica*, *Corylus americana*, *Fraxinus pennsylvania*,
*Mitella diphylla*, *Oryzopsis racemosa*, *Polemonium reptans*,
*Staphylea trifoliata*, *Carex sp.*, *Cornus sp.*, *Carpinus caroliniana*, *Dioscorea
villosa*, *Phlox divaricata*, *Pilea pumila*, *Sanguinaria canadensis*, (shrub layer) *Ribes
cynosbati*, *Acer saccharum* (eastward), *Carpinus caroliniana*,
*Staphylea trifoliata*, *Ulmus americana*, *Corylus americana*, *Ostrya
virginiana*, *Tilia americana*, *Carpinus caroliniana*, *Carya cordiformis*, *Carya
ovata*, *Cornus sp.*, *Prunus virginiana*, *Fraxinus pennsylvania*, (tree layer)
*Quercus alba*, *Acer saccharum* (eastward), *Carya ovata*, *Quercus rubra*, *Ostrya
virginiana*, *Quercus muehlenbergii*, *Celtis occidentalis*, *Carya cordiformis*,
*Ulmus americana*, *Ulmus rubra*, *Tilia americana*, *Juglans cinerea*, *Carpinus
caroliniana*, *Aesculus glabra* (south), and *Cercis canadensis* (south).

I found *Orchis spectabilis* in one site which does not fit into the up-
land forest successional gradient I discussed. This was a site on the flood-
plain of the Cedar River in Iowa County. In this site, the associates of
*Orchis spectabilis* are (herb layer) *Cryptotaenia canadensis*, *Arisaema tri-
phyllum*, *Galium aparine*, *Carex sp.*, *Hydrophyllum virginianum*, *Impatiens
pallida*, *Osmorhiza claytoni*, *Viola sororia*, (shrub layer) *Corylus americana*,
Crataegus sp., Smilax tamnoides var. hispida, (tree layer) Juglans nigra, Prunus serotina, and Tilia americana.

The distribution of Orchis spectabilis in Iowa does not appear to be dependent on climatic factors. It grows in all temperature zones, from the coldest to the warmest, and from the region of the shortest growing season to the region of the longest growing season. It grows in all rainfall regions, from the wettest to the driest (if we accept the Sioux City report). The absence of this species from the northwest corner of the state may be due to periodic extreme droughts which occur there. On the other hand, it may be that it simply has not yet been found in that poorly collected part of the state. Some wooded hillsides along the Big Sioux River in Lyon County appear suitable and may support Orchis spectabilis.

Orchis spectabilis appears to grow best in mineral soils and to be absent from highly organic soils. It may have a requirement for high levels of potassium, calcium, magnesium, manganese, and zinc; in short, it may grow best in rather fertile soils. The most important ecological factor for Orchis spectabilis is the availability of relatively open, or young forests, which allow the high light intensity required by this colonizing species.

Habenaria Willd.

This genus name is from the Latin habena (reins), referring to the long strap-like or rein-like petals of some species.

The genus Habenaria is a very large one, representing perhaps 750 species (Hawkes, 1965). Representatives are present in both the Old World and the New World. Species are present from the Arctic Circle southward into the tropics.
Much confusion has surrounded the habenaria group because of its size and complexity. Correll (1950) treats all species under the genus *Habenaria*. Luer (1972) splits the group into the northern species under the genus *Platanthera*, and the more tropical species under the genus *Habenaria* based on absence or presence of a pair of fleshy stigmatic processes. Other authors have split the group into more than half a dozen genera such as *Habenaria, Platanthera, Peristylis, Satyrium, Blephariglottis, Gymnadenia, Gymnadeniopsis*, and so on. Many species were originally placed in the closely related genus *Orchis*. I have chosen to follow Correll in placing all species of this group into the genus *Habenaria*.

Plants are mostly leafy terrestrial herbs ranging from only a few centimeters to a meter tall. The roots are fleshy or tuber-like. The inflorescence is a spike. The flowers are small to medium in size, and they may be inconspicuous or rather showy. The sepals are free, the dorsal sepal is sometimes curved to form a hood over the column, the lateral sepals are spreading or reflexed. The lip in our species is the lowermost floral segment. It may be simple or lobed and possesses a prominent spur.

**Key to Iowa species of Habenaria**

1. Lip deeply 3-parted and fringed on the margin .......................... 2

2. Flowers white, fringe cut about 2/3 the length of the lip segments. A plant of moist prairies ................................. *H. leucophaea*

2. Flowers purple (white-flowered forms are also possible, but have not yet been collected in Iowa), lip fringe only cut 1/2 the length of the lip segments ................................. *H. psycodes*

1. Lip simple, not fringed .................................................. 3

3. Lip entire, not lobed or notched ........................................ 4
4. Leaves 2, basal .............................. H. hookeri

4. Leaves several, on the stem ............... H. hyperborea

3. Lip angled or lobed at the base or tridentate at the apex ...... 5

5. Lip lobed or with teeth at the base .... H. flava var. herbiola

5. Lip not lobed or with teeth at the base; lip tridentate at the apex ............................. 6

6. Plants with leafy stems, spur short, much shorter than the ovary; lip unequally 3-lobed at the apex; a fairly common woodland orchid in Iowa ........... H. viridis var. bracteata

6. Plant with one main leaf, others bract-like; a very rare plant in Iowa ......................... H. clavellata

Habenaria clavellata (Michx.) Spreng.

Basionym: Orchis clavellata Michx.

The specific epithet clavellata is a Latin adjective meaning "like a small club" which refers to the club-shaped spur

Type locality: Carolina

Flowering season in Iowa: July

Literature: Fink (1894) 103; Fink (1897) 102; Barnes, Reppert, and Miller (1900) 259; Fitzpatrick and Fitzpatrick (1900) 193; Greene (1907) 153; Cratty (1933) 197; Fuller (1933) 89; Correll (1950) 67; Davidson (1959) 40; Guldner (1960) 84; Eilers (1971) 79, 131; Sheviak (1974) 36

Counties: Fayette: AMES, ISC, US (1894)

Muscatine: IA, ISC (1894)

(Barnes)

The general distribution of this species is from Newfoundland, Nova Scotia, Quebec, and Ontario south through New England and the Atlantic States to Florida; west along the Gulf Coast to Texas; and west through the Central and Lake States to Illinois, Minnesota, Iowa, Missouri, and Arkansas.

This wide-ranging species reaches its western limits in Iowa. It is essentially an eastern species which has apparently been limited in its
westward expansion by the increasing aridity of the climate. It is limited
to moist areas according to Wherry in Correll (1950), Case (1964), and
Sheviak (1974). Wherry also states that this species appears to prefer sub­
acid to mediacid soil reactions, pH 6-4. Such conditions are not common in
Iowa, thus partly accounting for the scarcity of this species in Iowa.

Detailed collection information is not available for this species in
Iowa. I have searched for it in Fayette County (Wadena) and in Muscatine
County, but I was not able to locate any plants. The exact collection sites
are not known, but numerous areas along the Cedar River in Cedar and Musca­
tine Counties probably still provide an adequate habitat for this species.

The habitat in Fayette County is described on an herbarium sheet
simply as "prairies". In Muscatine County, the collection site is described
on an herbarium sheet as "along damp or moist little banks of the sandy
woody hills along the Cedar River".

The associates with which H. clavellata grew in Iowa are not known.
Swink (1969) and Sheviak (1974) list some associates for the Chicago area
and Illinois which may also be found in suitable habitats in Iowa.

The soil conditions where H. clavellata grew can only be surmised from
information in literature. Most likely all of the soils were sandy, con­
stantly moist, and with a pH between 4-6.

Habenaria flava (L.) R. Br. ex Spreng. var. herbiola (R. Br.) Ames & Correll

Basionym: Habenaria herbiola R. Br.

The specific epithet flava is a Latin word meaning yellow, referring to the
yellowish flowers of this species, the varietal name, herbiola, is a Latin
word meaning "little plant", perhaps referring to the smaller stature of
this plant compared to some other habenarias
Type locality: North America

Flowering season in Iowa: (May?) late June - early July

Literature: Barnes, Reppert, and Miller (1900) 259; Fitzpatrick and Fitzpatrick (1900) 193; Fay and Thorne (1953) 123; Davidson (1959) 40; Guldner (1960) 85; Eilers (1971) 79, 132

Counties: Bremer: IA (1963)  
Cedar: IA (1951)  
Mitchell: MO (1947)  
Muscatine: IA (1894)  
Van Buren: ISC, MO, US (1925)

The general distribution of Habenaria flava var. herbiola is from Nova Scotia, Quebec, and Ontario south through New England to North Carolina and west through the Central and Lake States to Minnesota, Iowa, and Missouri.

Habenaria flava is essentially an eastern species. It is represented by two varieties, H. flava var. flava—a southern variety characterized by often fewer, narrower leaves and a suborbicular to ovate lip and H. flava var. herbiola—a more northern variety with a more elongated lip. The closest approach of H. flava var. flava to Iowa is southern Illinois, so it is unlikely that it will be found in Iowa. H. flava var. herbiola has been collected a few times in eastern Iowa where it reaches the western limits of its range. Iowa plants differ somewhat from H. flava var. herbiola as figured in Correll (1950) in that they have a less dense inflorescence and shorter floral bracts. The lip, however, is characteristic of var. herbiola.

Habenaria flava var. herbiola is a denizen of low, marshy places (Morris and Eames, 1929; Correll, 1950; Case, 1964; Sheviak, 1974). Iowa collections were made in areas characterized by moist, sandy soil. I have searched for H. flava var. herbiola in Bremer County, the most recent collection site, but I have been unable to locate it. The habitat is listed
on the herbarium sheet as "moist remnant prairie". Another fairly recent collection from Cedar County is from a "sandy swale". In Muscatine County, it grew in "wet grassy grounds, Cedar River bottom". The Van Buren County collection site was "swampy ground".

The associates of *H. flava* var. *herbiola* in Iowa are unknown. Swink (1969) and Sheviak (1974) list some associates of this species in Illinois, and some of these may also be present in favorable sites in Iowa.

I have not seen *H. flava* var. *herbiola* in Iowa, but I have seen it in Illinois in a wet sand prairie. This and numerous literature references to this type of habitat plus the habitat descriptions on herbarium sheets of Iowa collections lead me to believe that in Iowa this species also grows in low, constantly moist sites possessing sandy soil with an acidic reaction.

This species has probably been limited in its westward migration in Iowa by the increasing aridity in the west, and increasingly severe periodic droughts. These same conditions limit the development of the proper edaphic conditions to the eastern part of the state.

This species almost certainly still exists in Iowa and should be sought by collectors in sandy, moist, acidic habitats in eastern Iowa, especially along the Cedar River in Linn, Cedar, and Muscatine Counties.

**Habenaria hookeri** Torr. ex Gray

The specific epithet commemorates William Jackson Hooker (1785-1865), a famous English botanist

Type locality: New York

Flowering season in Iowa: June, with extremes of May 24 and July 12
Literature: Arthur (1883) 170; MacMillan (1892) 167; Fink (1894) 103; Fink (1897) 102; Fitzpatrick and Fitzpatrick (1900) 192; Niles (1904) 250; Gibson (1905) 31; Greene (1907) 153; Shimek (1907) 173; Britton and Brown (1913) vol. 1, p. 556; Cratty (1921) 250; Cratty (1933) 197; Fuller (1933) 92; Tolstead (1938) 340; Correll (1950) 78; Fernald (1950) 472; Thorne (1953) 262; Thorne (1956) 219; Case (1964) 58; Thorne (1964) 29; Hartley (1966) 59; Rickett (1966) vol. 1, p. 78; Eilers (1971) 79, 132; Sheviak (1974) 39

Counties: Allamkee: IA (1959)
Clayton: ISC (1905)
Delaware: IA (1963)
Dubuque: IA, ISC, ISTC, Niem (1974)
Winnebago: IA, ISC, MO, NY (1958)

Sheviak (1974) reports this species from Story County based on a specimen in the Herbarium of Iowa State University. This specimen has no collection information, indicating that it was probably collected by A. S. Hitchcock. "Habenaria" is written in ink on the herbarium sheet in Hitchcock's handwriting. There is no date on the specimen, but the herbarium label is a type used at ISC during the end of the 19th century. H. hookeri does not appear in Hitchcock (1892), which is a list of Story County plants. Furthermore, the collection label lists "Ames, Iowa" in printed form, and someone subsequently penciled in "Story Co."

Also, it is extremely unlikely that H. hookeri could have been growing in Story County as there are no suitable habitats, the summers are too hot, and Story County is disjunct by about 120 km from the nearest known Iowa station for the species. Thus, I have excluded the Story County specimen from the distribution of this species and attribute it to an error in labeling.

The general distribution of this species is from Nova Scotia, Quebec, and Ontario south through New England to Pennsylvania and west through the Lake States to Wisconsin, Illinois, Minnesota, and Iowa.

Habenaria hookeri is essentially a boreal species which reaches its
southwestern limits in Iowa. It is restricted to the northeastern corner of Iowa, the area characterized by a Great Lakes forest type. The cooler summer temperatures along with rather reliable rainfall have allowed *H. hookeri* to persist there.

In Iowa, *H. hookeri* grows in hardwood or mixed pine-hardwood forests on steeply sloping topography. In some places, it was apparently rather abundant. I have only located one station for the species in Iowa, a colony of perhaps a dozen plants. In this station, it is growing in a mixed pine-hardwood forest in thin soil over limestone bedrock in Dubuque County. In this location, its associates are (herb layer) *Galium concinnum*, *Goodyera pubescens*, *Rhus radicans*, *Viburnum rafinesquianum*, *Acer saccharum*, *Carex* sp., *Erigeron* sp., *Ribes* sp., *Ulmus americana*, *Viola sororia*, (shrub layer) *Carpinus caroliniana*, *Ulmus americana*, (tree layer) *Acer saccharum*, *Pinus strobus*, and *Carpinus caroliniana*. The ground cover of the herbs was rather low, totaling only about 30%.

**Habenaria hyperborea** (L.) R. Br.

Basionym: *Orchis hyperborea* L.

The specific epithet is from the Greek words for above or beyond, and north, meaning beyond the north, in reference to the boreal latitudes in which this species grows.

Type locality: Iceland

Flowering season in Iowa: late June - early July, with extremes on June 16 and July 21

Literature: Arthur (1883) 170; Macmillan (1892) 167; Fitzpatrick and Fitzpatrick (1900) 194; Greene (1907) 153; Shimek (1907) 173; Wolden (1932) 104; Cratty (1933) 197; Grant (1950) 106; Grant (1953b) 143; Wolden (1956) 130
Emmet: ISC (1925)
Story (?): ISC (1890)
Winneshiek: ISC (nd)

I am including the improbable Story County collection of *H. hyperborea*, Burgess s. n. (ISC 3728), because the collection data appear to be accurate.

The general distribution of *Habenaria hyperborea* is Greenland, Newfoundland, and Labrador west to British Columbia, Alaska, and the Aleutian Islands and south through New England to Pennsylvania, and the Lake States to Illinois, Minnesota, Iowa, South Dakota, Colorado, New Mexico, Arizona, California, Oregon, and Washington; also Iceland and Asia.

*Habenaria hyperborea* is a boreal species. It reaches the southern limits of its range (at this longitude) in Iowa. This species is limited mainly to the fens of northwestern Iowa, where the roots are bathed in cool, flowing water, a situation which evidently compensates for the aridity of the general climate. It was also collected once in deep woods in Winneshiek County, near Hesper, but nothing is known of this habitat. The Story County collection, if actually from Story County, is probably also from a forested area.

*Habenaria hyperborea* is most abundant in the fens of Dickinson County. It was formerly abundant in fens in Emmet County, but most of these no longer exist. In one fen in Dickinson County, the associates of *H. hyperborea* were (herb layer) *Parnassia palustris*, *Viola* sp., *Helianthus grosseserratus*, *Smilacina stellata*, *Aster novae-angliae*, *Eupatorium perfoliatum*, *Liatris spicata*, *Solidago graminifolia*, and *Spartina pectinata*. In this location *H. hyperborea* was not in the highly saturated, low herb zone, but grew among taller herbs, up to a meter high. The plants were mainly robust, but a few
weaker specimens were also present.

I have a soil sample from only one fen site, but the floras of the fens of northwestern Iowa are similar, so it seems likely that these soil parameters could serve as a general guide to the preferences of this species in fen habitats.

The source of the fen water is responsible for the very high levels of calcium and magnesium, and the leaching action of the flowing water removes most of the other nutrients, keeping them at low or very low levels. These unusual nutrient levels are doubtless responsible for the peculiar fen flora, probably because most other elements of the flora of the state are unable to tolerate these nutrient levels.

The associates and soil characteristics of the forest site for *H. hyperborea* in Winneshiek County are unknown. I tried several times to locate plants of this species north of Hesper, but I was not successful. Doubtless, the associates and soil conditions are very different from those in the fens.

*Habenaria hyperborea* is a boreal species which was probably much more abundant in Iowa immediately following the glacial retreat, but with subsequent increasing temperatures and aridity, it was limited to the extreme northern parts of the state where the lowest summer temperatures prevail. It is doubtful that this species will be found elsewhere in the state. It should be sought in seepy areas in northeast Iowa, however, where additional stations may be found.
Habenaria leucophaea (Nutt.) Gray

Basionym: Orchis leucophaea Nutt.

The specific epithet, leucophaea, is derived from Greek, meaning "whitish", referring to the flower color.

Type locality: in moist prairies near Kiamesha, Red River

Flowering season in Iowa: July, with extremes of May 23 (?) and August 19

Literature: Arthur (1876) 31; Hitchcock (1892) 519; Pammel (1896) 133; Shimek (1896) 212; Fink (1897) 103; Fitzpatrick and Fitzpatrick (1898) 165; Pammel (1899b) 245; Barnes, Reppert, and Miller (1900) 259; Fitzpatrick and Fitzpatrick (1900) 193; Gow (1901) 159; Cratty (1904) 217; Mueller (1904) 277; Peck (1905) 205; Oleson and Somes (1906) 34; Greene (1907) 153; Shimek (1907) 173; Pammel (1909) 754; Stookey (1910) 197; Shimek (1911a) 184, 185, 220; Somes (1913) 46; Gow and Tilton (1916) 344; Shimek (1919a) 45; Shimek (1919b) 3; Spurrell (1919) 236; Conard (1928) 95; Burk (1931) 138; Wolden (1932) 104; Cratty (1933) 197; Fuller (1933) 96; Tolstead (1938) 340; Correll (1950) 85; Grant (1950) 106; Easterly (1951) 78; Fay (1951) 115; Conard (1952) 64, 66; Thorne (1955) 192; Aikman and Thorne (1956) 193; Russell (1956) 172; Wolden (1956) 130; Davidson (1959) 40; Guldner (1960) 85; Sorenson (1962) 51; Eilers (1971) 79, 132

Counties: Adair: IA, ISC (1892)
Black Hawk: ISC (1894)
Buena Vista: ISC (1880?)
Cedar: MO (1917)
Chickasaw: ISC (1925)
Clayton: ISC (1923)
Decatur: AMES, ISC, MO (1905)
Dickinson: IA, ISC, ISTC, Lake (1953)
Fayette: ISC (nd)
Grundy: IA (1903)
Guthrie: IA (1952)
Hamilton: ISC (1940)
Hancock: IA (1896)
Henry: MO (1897)
Ida: ISC (1945)
Iowa: IA, ISC, US (1950)
Johnson: IA, ISC, Niem, US (1973)
Linn: IA, ISC, ISTC (1928)
Muscatine: ISC (1908)
Palo Alto: ISC (1943)
Pocahontas: ISTC (1954)
Pottawattamie: MO (1905)
Poweshiek: Grinnell (1884)
Scott (?): Perry (1847)
The Cerro Gordo County report is based on Pammel (1909). The Cherokee County report is based on Pammel (1896). The Hardin County report is based on Peck (1905). The Jasper County report is based on Fitzpatrick and Fitzpatrick (1900). The Madison County report is based on Mueller (1904). The Wayne County report is based on Fitzpatrick and Fitzpatrick (1900). The Worth County report is based on Pammel (1909). The Scott County report is tentative, as it is based on the Parry 1847 collection of the Davenport vicinity, so it is not certain that that specimen is from Scott County.

The general distribution of *Habenaria leucophaea* is from Nova Scotia and Ontario southward through New England to New York and west through the Lake States to Iowa, South Dakota, North Dakota, Nebraska, Kansas, Missouri, Arkansas, and Louisiana.

Correll (1950) and Case (1964) report that this species thrives in woods in the eastern and Lake States, but it reached its greatest abundance and widest distribution in the tall grass prairies of Illinois and Iowa. This species is one of the few orchid species truly at home in the tall grass prairie. Its tendency to grow in rich, deep prairie soils has led to its near disappearance in Iowa. Pammel and other early collectors commented many times that this species was once very abundant in Iowa, but by 1900 it was very scarce due to utilization of the prairie lands for agricultural purposes. *H. leucophaea* has persisted in several of the prairie preserves in Iowa, including Cayler, Kalsow, Sheeder, and the Williams prairies, as
well as in some prairie remnants along railroads.

_Habenaria leucophaea_ inhabits the moister spots in Iowa prairies, and is often obscured by other vegetation, making it difficult to see unless it is in flower. Furthermore, this species appears to exhibit a periodicity in blooming, being very abundant one year, and vary rare or not evident in later years (Barnes, Reppert, and Miller, 1900; Sheviak, 1974; R. Hulbary, University of Iowa, personal communication). Early collectors in Iowa attributed the sudden appearance of numerous flowering specimens, where formerly there had been none, to abnormally high rainfall. Fire on the prairie may also stimulate flowering in this species as it does in other prairie species, but prairie fires ceased in Iowa before botanical observations could reveal whether flowering is affected in this species by fire.

In the Williams Prairie in Johnson County, _Habenaria leucophaea_ grows in a low area dominated by _Spartina pectinata_ and little else. Other associates include _Solidago_ sp. and _Thalictrum dasycarpum_. In the same general area were _Lilium michiganense_ and _Melanthium virginicum_. Only three flowering plants were found in 1973, but according to Dr. R. Hulbary of the University of Iowa, it is occasionally much more floriferous. Case (1964) discusses the life span of plants of this species, indicating that they are longer-lived than some other species of _Habenaria_, so it is probably that a percentage of the plants remain in a vegetative or perhaps even in a subterranean condition until the proper environmental stimulus triggers the gregarious flowering.

The high level of the nutrients in the low prairie soil is probably a necessity for the survival of this species in Iowa, as is the bright sunlight of the prairie, for this is its only habitat in Iowa. Climatic factors
do not seem to be limiting except perhaps in the northwest corner of the state which may be too arid to permit the prairie potholes to remain moist enough for this species.

Habenaria psycodes (L.) Spreng.

Basionym: Orchis psycodes L.

The specific epithet, psycodes, is the Greek term meaning "butterfly-like", referring to the shape of the flowers.

Type locality: Canada

Flowering season in Iowa: late July - early August, with extremes of July 13 and August 26

Literature: Fink (1894) 103; Fink (1897) 103; Fitzpatrick and Fitzpatrick (1900) 194; Pammel (1907) 64; Pammel (1909) 769; Verink (1914) 92; Cratty (1933) 197; Fuller (1933) 96; Bowne (1945) 102; Correll (1950) 98; Fernald (1950) 474; Case (1964) 64; Hartley (1966) 59; Eilers (1971) 80, 132

Counties: Allamakee: IA (1959)
Chickasaw: ISC (1926)
Fayette: ISC, US (1893)
Floyd: ISC (1953)
Linn: IA (1913)
Winneshiek: ISC (1896)

The general distribution of Habenaria psycodes is from Newfoundland, Nova Scotia, Quebec, and Ontario southward through New England to North Carolina, Georgia, Tennessee, Kentucky, and Arkansas through the Lake States to Minnesota and Iowa.

Habenaria psycodes is a northeastern species which reaches the western limits of its range in Iowa. Some authors have separated this species into two varieties, the typical var. psycodes and the var. grandiflora. Variety grandiflora is supposed to have more elongate petals and a more deeply fringed lip than the typical variety. Also var. grandiflora is supposed to be larger flowered than the typical variety. Iowa material fits the
description of var. grandiflora, except that the flowers are too small. Case (1964) states that he has not seen material referable to var. grandiflora from west of central Ontario, so I am including Iowa material under H. psycodes. Case (1964) also points out that there are apparently more than two races, and the material should be studied more carefully to sort out the true number of varieties and the habitats in which they grow.

Habenaria psycodes is not very abundant in Iowa. I have searched for it at stations in Allamakee, Chickasaw, Floyd, and Linn Counties without success, although the relatively recent collection dates and continued existence of apparently suitable habitats suggest that it is still present in Iowa.

In Iowa, all habitats of H. psycodes appear to be quite moist. Two general habitats exist: moist, open meadows and moist, low forests, often occurring near streams. There is one collection from a roadside in an upland location originally occupied by prairie. The roadside ditch is quite moist, with a rank growth of typical species such as Typha latifolia.

The associates of H. psycodes in Iowa are unknown, but some of the species listed by Swink (1969) for the Chicago area and Sheviak (1974) for Illinois would probably also be found in suitable Iowa sites.

Soil conditions for H. psycodes in Iowa are not known. In at least some localities, it grew in sandy soil, indicating a probable acidic reaction.
**Habenaria viridis (L.) R. Br. var. bracteata (Muhl. ex Willd.) A. Gray**

**Basionym:** *Orchis bracteata* Muhl. ex Willd.

The specific epithet is a Latin word meaning "green" in reference to the greenish flower color of this species; the varietal name is a Latin word meaning "bracted", in reference to the long floral bracts of this species.

**Type locality:** Pennsylvania

**Flowering season in Iowa:** late May through June, with extremes of May 8 and August 3.

**Literature:** Arthur (1876) 31; Hitchcock (1892) 519; Macmillan (1892) 168; Shimek (1896) 212; Fink (1897) 102; Fitzpatrick (1898) 128; Fitzpatrick and Fitzpatrick (1898) 165; Barnes, Reppert, and Miller (1900) 259; Fitzpatrick and Fitzpatrick (1900) 192, 193; Peck (1905) 205; Oleson and Sones (1906) 84; Greene (1907) 153; Shimek (1907) 173; Verink (1914) 92; Diehl (1915) 89; Conard (1928) 95; Burk (1931) 138; Wolden (1932) 103; Cratty (1933) 197; Tolstead (1938) 339; Correll (1950) 116; Fernald (1950) 471; Grant (1950) 106; Fay and Thorne (1953) 123; Grant (1953a) 134; Grant (1953b) 143; Thorne (1955) 192; Russell (1956) 172; Thorne (1956) 219; Wolden (1956) 130; Davidson (1959) 40; Davidson (1960) 172; Guldner (1960) 84; Cooperrider (1962b) 31; Case (1964) 66; Thorne (1964) 29; Hartley (1966) 60; Rickett (1966) 78; Eilers (1971) 80, 132

**Counties:**
- Allamakee: AMES, IA, ISTC, US (1959)
- Cedar: IA (1952)
- Cerro Gordo: ISC (1924)
- Clay: IA, ISTC, Lake (1957)
- Clayton: ISC (1901)
- Clinton: ISC (1933)
- Delaware: IA (1963)
- Dickinson: IA, ISC (1954)
- Dubuque: IA, ISC, ISTC, US (1958)
- Emmet: IA, ISC (1953)
- Fayette: AMES, ISC, US (1894)
- Floyd: IA (1963)
- Iowa: ISC (1915)
- Jackson: IA (1954)
- Jasper: Grinnell (1896)
- Johnson: IA (1892)
- Jones: IA (1957)
- Keokuk: IA (1962)
- Linn: IA, ISTC (1910)
- Muscatine: IA, ISC (1892)
- Poweshiek: Grinnell (1907)
- Scott: Barnes (1892)
The Black Hawk County report is based on Burk (1931). The Decatur County report is based on Fitzpatrick and Fitzpatrick (1898), Fitzpatrick and Fitzpatrick (1900), and Grant (1953b). The Hardin County report is based on Peck (1905). There is also a specimen in the National Herbarium at the Smithsonian Institution collected by C. A. Geyer on April 18, 1839, during Nicollet’s North-Western Expedition which lists the collection site as near Council Bluffs. If this referred to a collection near the present city of Council Bluffs, Iowa, this would add a Pottawattamie County station. This is probably not the case, however. Shimek (1912) points out that the term "Council Bluff" originally applied to a locality at which Lewis and Clark held council with the Otoe and Missouri Indians, August 3, 1804. It is now thought, based on descriptions of the site, that this name applies to Fort Calhoun, which is on the opposite side of the river from the present day Council Bluffs and upstream, in what is now Washington County, Nebraska. Shimek (1912) states that this is the Council Bluff mentioned by Nicollet. Thus, I am excluding this specimen from Iowa. *H. viridis* var. *bracteata* has been collected elsewhere in eastern Nebraska (Correll, 1950) which means that stations in western Iowa are possible, since the climate is essentially the same on both sides of the river, but edaphic limitations on the eastern side of the river may be unfavorable, and no western Iowa collections have come to my attention. *Orchis spectabilis*, typically found in the same habitats as *H. viridis* var. *bracteata* has been collected in western Iowa, and is abundant in sheltered canyons surrounded by the loess hills, further indicating the possibility of a western Iowa station.
The general distribution of Habenaria viridis var. bracteata is from Newfoundland, Nova Scotia, Quebec, and Ontario west to British Columbia, Alaska, and the Aleutian Islands; south from Canada through New England and the Atlantic States to North Carolina; and west through the Lake States to Minnesota, Iowa, and Nebraska and in mountains west through Colorado, New Mexico, Utah, Wyoming, and Montana to Washington; also in Iceland, China, and Japan.

In view of the fact that this species is boreal in distribution, one might expect to find it in cool, moist locations along with other boreal relicts. In some cases this is true, but the plants are often few and rather small in such habitats. This species reaches its greatest abundance in somewhat disturbed habitats such as old pastures, or even in prairie where it is being invaded by forest.

In nearly undisturbed forest in Boone County, this species is rare, and often represented by only small and spindly plants. In such locations, the canopy is rather closed and the herbs are in quite deep shade. Under these conditions, the associates of H. viridis var. bracteata include (herb layer) Carex pensylvanica, Helianthus strumosus, Comandra richardsiana, Galium concinnum, Solidago ulmifolia, (shrub layer) Ostrya virginiana, Staphylea trifoliata, Praxinus pennsylvanica var. subintegerrima, Ulmus americana, Crataegus mollis, Tilia americana, Viburnum rafinesquianum, (tree layer) Quercus alba, Quercus rubra, and Ostrya virginiana.

Under relatively undisturbed forest conditions in Webster County, H. viridis var. bracteata often occurs on steep slopes, or at the shoulder position of such slopes. On thin soil over sandstone bedrock at the shoulder position, this species is more abundant and vigorous, and here the
associates are (herb layer) *Carex pensylvanica*, *Viburnum rafinesquianum*, *Pedicularis canadensis*, *Thalictrum dioicum*, *Antennaria plantaginifolia*, *Ribes cynosbatl*, (shrub layer) *Ostrya virginiana*, *Amelanchier arborea*, (tree layer) *Quercus rubra*, *Ostrya virginiana*, and *Tilia americana*. In such sites, the herbaceous cover is scant, allowing this *Habenaria* to stand out conspicuously above a mat of mosses and lichens, which characterize these habitats.

This species is present in the margins of prairie openings where they are being invaded by forest. Under such conditions, the dominant associate is *Andropogon gerardii*. *H. viridis* var. *bracteata* is very robust and stout under such conditions, where the light is bright.

*H. viridis* var. *bracteata* appears to reach its greatest abundance under somewhat disturbed conditions, such as formerly pastured woods. Under such conditions, its associates are (herb layer) *Carex pensylvanica*, *Carex sp.*, *Aster cordifolius*, *Geum canadense*, *Parthenocissus quinquefolia*, *Phryma leptostachya*, *Solidago sp.*, *Achillea lanulosa*, *Cirsium sp.*, *Viola sororia*, (shrub layer) *Lonicera tatarica*, *Carya ovata*, *Crataegus mollis*, *Quercus macrocarpa*, (tree layer) *Quercus macrocarpa*, and *Carya ovata*.

This species is probably more widespread than the distribution map indicates. The plant is relatively inconspicuous even when in flower and may have been overlooked in many places. It should be sought near the slope break of major and minor drainage systems throughout the eastern two thirds of the state and also in the loess canyons in the western tier of counties where it may be found.
Malaxis Sw.

This generic name is derived from the Greek μαλαξίας, malaxis (softening), referring to the soft and tender texture of the leaves.

The genus Malaxis is a relatively large and complex one, with perhaps 300 species (Hawkes, 1965). The species are distributed in temperate and tropical regions of the Old and New Worlds, but the greatest numbers are found in Asia and the Pacific islands. The plants are terrestrial, lithophytic or epiphytic, mostly small and inconspicuous. The inflorescence is terminal, with few to many minute flowers. The anther has four waxy pollinia. One species of Malaxis occurs in Iowa.

Malaxis unifolia Michx.

The specific epithet is from a Latin word meaning "one-leaved", in reference to the solitary leaf produced by this species.

Type locality: in dense woods, Pennsylvania, Carolina, and Florida

Flowering season in Iowa: July, with extremes of June 30 and August 6

Literature: Arthur (1883) 170; Shimek (1896) 211; Fitzpatrick and Fitzpatrick (1898) 164; Barnes, Reppert, and Miller (1900) 258; Fitzpatrick and Fitzpatrick (1900) 195; Greene (1907) 153; Cratty (1933) 198; Thorne (1955) 192; Davidson (1959) 40; Guldner (1960) 85; Eilers (1971) 80, 132

Counties: Iowa: ISC, MO (1928)  
Johnson: IA, ISC (1907)  
Muscatine: IA (1893)  
Story: ISC (1879)  
Tama: ISC (nd)  
Winnebago: ISC (1879)

The general distribution of this wide-ranging species is from Newfoundland, Nova Scotia, Quebec, and Ontario south through New England and the Atlantic States to Florida; west along the Gulf Coast to Texas; southward to Mexico, Guatemala, Cuba, and Jamaica; and west from New England through
the Central and Lake States to Minnesota, Iowa, Missouri, and Arkansas.

*Maiaxis unifolia* is a very rare plant in Iowa, and may now be extinct in the state. It is known only from a few collections in six counties. The last collection was in 1928. I have attempted to locate this species at the collection sites in Iowa, Johnson, Story, and Winneshiek Counties, but I have not been successful. Collection data for the Muscatine and Tama County collections was insufficient to relocate the stations.

The reasons for this species rarity are not known. The forest habitats have remained essentially undisturbed since the collections were made, at least in the sites I have visited, so the species should still be there. The tile drainage of fields, which probably helped eliminate *Calopogon tuberosus* and *Pogonia ophioglossoides* from Iowa is probably not a factor, as these forests are far from cultivated fields. The disappearance may be due to a closing of the canopies of the forests, but there are still plenty of open forests which it could occupy if light were the major factor. Edaphic factors may have prevented this, however.

Since I have not been able to locate this species in Iowa, I know nothing about its habitat or associated species. The notations on herbarium sheets mention only that it grows in "woods" or "upland woods". One clue to its habitat may lie in Case (1964): "Occasionally found growing in moist, acid sandy humus of hillsides and pastures, often about rotting pine stumps or under Brake Ferns. Southward, this type of habitat seems to be preferred."

*Pteridium aquilinum* is sufficiently rare in Iowa to act as a possible indicator of the proper habitat. It occurs in all but the Story County collection sites I visited. *Maiaxis unifolia* should be sought in all such locations, as it may still be present in Iowa.
The associates of this species in Iowa are unknown. Neither Swink (1969) in the Chicago area nor Sheviak (1974) in Illinois list any associates.

The soil characteristics in Iowa are, of course also unknown. The soils are probably acidic, and in some cases sandy according to Correll (1950) and Case (1964).


This genus name is derived from the Greek word λιπαρός, liparos (fat; greasy; shining), which refers to the smooth, shining surface of the leaves of some species.

This is a relatively large genus of about 350 species or more, distributed through the temperate and tropical regions of the earth. The greatest concentration of species of this cosmopolitan genus occurs in tropical Asia. The Iowa species are terrestrial herbs with a pair of leaves arising from a pseudobulb. The pseudobulb of the previous year is usually present along with that of the current year. The spike of small flowers arises between the two leaves. There are two species of Liparis in Iowa.

Key to the Iowa species of Liparis

1. Ovary 3-6 mm long; flowers yellowish; plants of fens, marshes, or rarely moist forests .................................................. L. loeselii
1. Ovary about 1 cm long; flower predominantly purplish; plants mainly of upland forests ................................................. L. lilifolia
Liparis lilifolia (L.) L. C. Rich.

Basionym: Ophrys lilifolia L.

The specific epithet refers to the leaves which resemble those of some liliaceous plants

Type locality: swamps, Virginia

Flowering season in Iowa: May - June, with extremes of May 3 and June 29

Literature: Arthur (1876) 31; Nagel and Haupt (1876) 164; Shimek (1896) 211; Fitzpatrick (1898) 128; Fitzpatrick and Fitzpatrick (1898) 164; Barnes, Reppert, and Miller (1900) 258; Fitzpatrick and Fitzpatrick (1900) 195, 196; Niles (1904) 274; Anderson (1905) 135; Greene (1907) 154; Shimek (1907) 174; Shimek (1911b) 41; Somes (1913) 47; Conard (1928) 95; Cratty (1933) 198; Fuller (1933) 128; Tolstead (1938) 340; Correll (1950) 274; Fay (1951) 115; Conard (1952) 66; Grant (1953b) 143; Thorne (1955) 192; Russell (1956) 172; Davidson (1959) 40; Cooperrider (1960) 152; Guldner (1960) 85; Cooperrider (1962b) 31; Case (1964) 97, 98; Thorne (1964) 29; Hawkes (1965) 267; Hartley (1966) 60; Eilers (1971) 80, 132

        Appanoose: Niem (1974)
        Boone: ISC (1960)
        Cedar: IA (1957)
        Clayton: IA, ISC, MO (1959)
        Dallas: IA (1917)
        Davis: ISC, Niem (1974)
        Decatur: ISC, Niem (1973)
        Delaware: IA (1963)
        Dubuque: IA, Lake (1958)
        Iowa: ISC, Niem (1973)
        Jackson: IA (1957)
        Jasper: IA (1894)
        Johnson: AMES, IA, ISC (1952)
        Jones: IA (1956)
        Lucas: IA (1956)
        Muscatine: IA, ISC, ISTC (1933)
        Poweshiek: Grinnell (1930)
        Van Buren: ISC (1930)
        Wapello: ISC (1902)
        Webster: ISC, Niem (1970)
        Winneshiek: IA, ISC, Kovarik, Niem (1974)

The Scott County report is based on Nagel and Haupt (1876) and Grant (1953b). I am excluding the Story County collection by Hitchcock s. n.
The general distribution of *Liparis lilifolia* is from New England south through the Atlantic States to South Carolina, Georgia, Alabama and west through the Lake States to Minnesota, Iowa, Missouri, Kentucky, Arkansas, and Tennessee; also in China (Kwangsi, Kwangtung).

In Iowa, *Liparis lilifolia* tends to be an upland forest plant, but it is most abundant in regenerating forests and even in prairie margins near forest invasion. This type of behavior, similar to that of *Orchis spectabilis*, indicates that *Liparis lilifolia* is an invading species. It is at its best where the trees are young and where the canopy is still rather open. It also seems to thrive on impoverished soils, another characteristic of a successional species. Bullington (1973) describes *Liparis lilifolia* as an invader of an old pasture in Illinois. This species is rather uncommon in relatively undisturbed forests in Iowa, only an occasional plant or two is found. In areas where windthrow has knocked over the trees, opening the canopy, it can become very abundant. It sometimes grows on old animal mounds in forests rather than undisturbed soil. It grows especially well along and in old logging roads. Disturbance evidently is an important factor in the occurrence of this species. Case (1964) and Sheviak (1974) also discuss the reaction of this species to disturbance.

In central and eastern Iowa, in relatively undisturbed forest, the associates of *Liparis lilifolia* are (herb layer) *Parthenocissus quinquefolia*, *Desmodium glutinosum*, *Carva cordiformis*, *Smilacina racemosa*, *Solidago ulmifolia*, *Vitis riparia*, *Amphicarpa bracteata*, *Aster cordifolius*, *Carex pensylvanica*, *Circaea quadrirrculata*, *Cryptotaenia canadensis*, *Galium concinnum*, *Helianthus strumosus*, *Osmorhiza claytoni*, *Phryme leptostachya*, *Rhus radicans*,
Xanthoxylum americanum, (shrub layer) Carya cordiformis, Xanthoxylum americanum, Amelanchier arborea, Cornus sp., Tilia americana, Ulmus americana, (tree layer) Quercus alba, Quercus palustris (east), Carya ovata, Carya cordiformis, Fraxinus pennsylvanica, Quercus rubra. In such habitats, Liparis lilifolia is not abundant.

In eastern Iowa, in cut-over forests, Liparis lilifolia is more abundant, often most abundant along paths or abandoned roads. In these locations, the associated species are (herb layer) Geranium maculatum, Adiantum pedatum, Circaea quadrisulcata, Parthenocissus quinquefolia, Ampicarpa bracteata, Helianthus strumosus, Vitis riparia, Arisaema triphyllum, Osmorhiza claytoni, Taraxacum officinale, (shrub layer) Cornus sp., Ulmus americana, (tree layer) Quercus alba, Tilia americana, Populus tremuloides, Ulmus americana, Fraxinus americana, Quercus rubra, and Ostrya virginiana.

The site of a severe windthrow in Webster County, which knocked over all of the trees, possesses at least 50 plants in an area of perhaps 20 x 20 m. The site has thin soil bedrock, and no large trees were present at the time of windthrow, so this may be a cyclic phenomenon on this site. The recent windthrow (within a year or so of the time of observation) would have been too recent to account for the establishment of Liparis lilifolia. On this site, the associates were (herb layer) Carex pensylvanica, Pedicularis canadensis, Aster cordifolius, Quercus rubra, (shrub layer) Quercus rubra, Carya ovata, Corylus americana, Quercus alba, Ribes cynosbati, and Viburnum rafinesquianum. The presence of abundant Pedicularis is often an indicator of orchids in general.

In the southern tier of counties, Liparis lilifolia grows in impoverished forests. The forests consist of young trees, which may indicate a
relatively recent time of invasion. In these forests, the associates are
(herb layer) *Poa compressa*, *Antennaria plantaginifolia*, *Parthenocissus quinquefolia*, *Solidago* sp., *Carex pensylvanica*, *Aster cordifolius*, *Desmodium glutinosum*, *Prunus serotina*, *Solidago ulmifolia*, *Veronicastrum virginicum*, *Amphicarpa bracteata*, *Panicum* sp., *Prunella vulgaris*, (shrub layer) *Morus alba*, *Prunus virginiana*, *Quercus alba*, *Carya ovata*, *Hypericum prolificum*, *Rhus aromatica*, *Fraxinus pennsylvanica*, *Ulmus americana*, (tree layer) *Quercus alba*, *Quercus macrocarpa*, *Ostrya virginiana*, *Quercus imbricaria*, *Fraxinus pennsylvanica*, *Ulmus americana*, and *Carya ovata*. In such habitats, *Liparis lilifolia* is frequently encountered, but there are only scattered plants, rather than large aggregations of plants such as characterize logged areas.

One striking habitat in Decatur County is the open prairie occurrence of *Liparis lilifolia*. I do not know the history of the site, but I suspect that it might have been utilized for grazing or for crops at one time, then underwent secondary succession to prairie. The adjacent forest appears to be encroaching slowly into the prairie, and is now perhaps 10 m away from where *Liparis lilifolia* is growing. Its associates in this site are (herb layer) *Sorghastrum nutans*, *Andropogon gerardii*, *Fragaria virginiana*, *Plantago rugelii*, *Hystrix patula*, *Symphoricarpos orbiculatus*, *Agrimonia gryposepala*, *Panicum dichotomiflorum*, *Solidago rigida*, and *Cassia fasciculata*. In this site, there were only a few plants, but they were large and vigorous, and evidently competing well with the prairie species.

In Iowa, *Liparis lilifolia* grows in soils ranging from subacid to minimalkaline (pH 5.4 in Appanoose County to pH 7.8 in Clayton County). Soil reaction may be significant in the distribution of this species. Only
the Appanoose County site had a pH value significantly above 7. Also, the species distribution map shows an almost complete avoidance of the most recent and least leached glacial deposit, the Cary Lobe, and also areas where alkaline loess is present. The only stations in the Cary Lobe are along the Des Moines River Valley in Boone and Webster Counties where the most recent (Wisconsin) glacial till has been severely eroded, exposing lower, older, and more leached materials.

In general, *Liparis lilifolia* was most abundant in areas where the general vegetation seemed to be impoverished, but in most cases soil nutrients, except for nitrate, seemed adequate. The high levels of alkaline metal ions (calcium, magnesium, manganese) may be significant in the distribution of this species. The most important factor appears to be soil reaction, namely a requirement for a pH in the vicinity of 5.5-6.5. Rainfall may be a factor limiting westward expansion of the range, but in many places, this is confounded with pH of the calcareous loess deposits in western Iowa. Invading forests where the surface material has been leached sufficiently, such as in Waubonsie State Park in Fremont County, would be a likely place to seek western outliers of this species.


Basionym: *Ophrys loeselii* L.

The specific epithet may honor Johann Loesel (1607-1655), a German botanist, or Loiseleur-Deslongchamps, a French botanist

Type locality: in swamps, Sweden and Prussia

Flowering season in Iowa: late June, with extremes of June 12 and July 13
The general distribution of *Liparis loeselii* is from Nova Scotia south through New England; south in the mountains to North Carolina and Alabama; and west through the Lake States to Illinois, Minnesota, Iowa, Kansas, North Dakota, and Saskatchewan to Washington. It is also found in Europe, in Scandanavia and south to France, Italy, and the Balkans, and in northwestern Siberia.

*Liparis loeselii* is found in a surprising array of different habitats in Iowa. It reaches its greatest abundance in highly calcareous fens in northwest Iowa. It is also present in sandy, acidic habitats, in prairies, on seepy hillsides in forests, and on sphagnum mats. In view of the diversity of habitats in which this species grows, it is likely that it has segregated into several ecotypes, each capable of growing best under the conditions of one of these habitats. Lack of sufficient plants to allow for experimentation precluded investigations into this possibility.

The calcareous fens of northwestern Iowa provide a suitable habitat for several orchids, and *Liparis loeselii* reaches its greatest abundance there. In the Silver Lake fen, *Liparis loeselii* grows on the margin of the higher
ground, just about where the water seeps out of the ground. The associates of this orchid in the fen are (herb layer) *Parnassia palustris*, *Triglochin maritima*, *Calamagrostis canadensis*, *Carex* sp., and *Juncus* sp. In other places in the fen, it is closely associated with *Habenaria hyperborea*.

One of the most unusual natural areas I have found in Iowa is a sandy, acidic area a few miles north of Cedar Rapids in Linn County. It possesses a number of plants not frequently seen in Iowa. *Liparis loeselii* also thrives here, producing the largest plants I have seen in Iowa. Its associates are (herb layer) *Thelypteris palustris*, *Carex* sp., *Potentilla* sp., *Equisetum arvense*, *Fragaria virginiana*, (shrub layer) *Gaylussacia baccata*, *Betula nigra*, *Acer saccharinum*, *Prunus serotina*, and *Quercus velutina*.

*Liparis loeselii* also inhabits wet prairie swales, or perhaps these areas would better be termed marsh-like habitats. In one sand prairie in Black Hawk County, *Liparis loeselii* grows on the side of *Carex* hummocks in a swale. The plants are not very vigorous, probably due to heavy shading by the other vegetation growing on the hummocks. In this habitat, the associates are (herb layer) *Carex* sp., *Onoclea sensibilis*, *Thelypteris palustris*, *Calamagrostis canadensis*, *Eupatorium purpureum*, *Aster umbellata*, *Campanula aparinoides*, and *Triadenum fraseri*.

The remaining habitats for *Liparis loeselii* in Iowa were not studied. The species was once collected by Thorne on the *Sphagnum* mat of Dead Man's Lake in Hancock County. Since it was the only plant he saw there, it may no longer be present in Hancock County. However, it is very abundant in the *Sphagnum* of tamarack bogs in Illinois, so it may still be present in Dead Man's Lake. If so, it may associate with *Typha latifolia* as it does in Illinois bogs.
The forest habitats of Liparis loeselii were not located. Collection data on herbarium sheets is often of a scanty nature, and does not indicate much about the habitat. A relatively recent (1959) collection in Allamakee County by Hartley describes the habitat as "rather moist, north-facing wooded slope on bluff bordering Bear Creek". Presumably the habitat is a wooded, seepy hillside, but the soil reaction cannot be guessed.

The environmental factors studied indicate that Liparis loeselii has two basic requirements. It is only found in wet sites, and it is only found in the northern part of the state, typically with other species of northern affinities, indicating a need for cool summers, or perhaps a rather short growing season to succeed. Rainfall is not of direct importance because this species depends (in Iowa) on seepage or otherwise constantly wet habitats.

**Aplectrum Nutt.**

This genus name comes from the Greek α-α (without), πλέκτρον, -plectron (spur), because of the absence of a spur in this genus.

This is a monotypic genus whose only member is native to North America. The plants are scapose terrestrial herbs with a solitary basal leaf which persists through the winter.

**Aplectrum hyemale** (Muhl. ex Willd.) Torr.

Basionym: *Cymbidium hyemale* Muhl. ex Willd.

The specific epithet, *hyemale*, is a Latin term meaning "of the winter", referring to the habit of this species which produces a leaf in late summer which withers the following spring, the leaf thus being present all winter.

Type locality: Pennsylvania
Flowering season in Iowa: late May, with extremes of May 25 and June 17

Literature: Arthur (1876) 31; Shimek (1896) 211; Fink (1897) 102; Fitzpatrick and Fitzpatrick (1898) 164; Fitzpatrick and Fitzpatrick (1900) 196; Greene (1907) 154; Shimek (1907) 174; Sones (1913) 47; Verink (1914) 92; Tuttle (1919a) 279; Burk (1931) 138; Cratty (1933) 198; Fuller (1933) 132; Correll (1950) 317; Fay (1951) 114; Conard (1952) 66; Thorne (1955) 192; Guldner (1960) 86; Thorne (1964) 29; Hartley (1966) 58; Eilers (1971) 78, 131

Cedar: IA (1950)
Clayton: AMES, IA, Niem (1974)
Delaware: IA (1963)
Dubuque: IA (1954)
Fayette: AMES, IA, ISC (1897)
Hardin: Plouffe (1974)
Howard: ISC (1940)
Johnson: AMES, IA, ISC, MO, NY (1898)
Linn: IA, ISTC, Niem (1974)
Winnebago: IA, ISC, Kovarik (1903)
(ISTC)

The Black Hawk County report is based on Burk (1931). The Mitchell County report is based on Tuttle (1919a). A specimen in the Herbarium of the University of Northern Iowa is labeled as having been collected in Linn Grove. Someone added "Buena Vista County" to the label. This would be an extremely improbably western disjunct station for this species, so I am excluding it from Buena Vista County. The specimen may be from Linn County, but it could also be from another of the eastern counties.

The general distribution of Aplectrum hyemale is from Quebec and Ontario south through New England and the Atlantic States to South Carolina, Georgia, Alabama, and Tennessee; west through the Central and Lake States to Minnesota, Iowa, Kansas, Missouri, and Arkansas; and also in the mountains of Arizona.

Aplectrum hyemale behaves as a distinctly eastern species in Iowa, reaching its westernmost distribution at our latitude in central Iowa. It
is found farther west in Kansas and in the mountains of Arizona, however. In Iowa, *A. hyemale* typically inhabits moist forested upland or shoulder slope positions above major or minor drainageways. This is in contrast to my experience with this species in Illinois, where it often tends to occupy quite low land near rivers and streams. The dominant tree species tends to be *Acer saccharum*. The associates of *Aplectrum hyemale* in eastern Iowa include (herb layer) *Cryptotaenia canadensis*, *Polemonium reptans*, *Aster cordifolius*, *Circaea quadrirugata*, *Desmodium glutinosum*, *Dryopteris spinulosa*, *Osmorhiza claytoni*, *Parthenocissus quinquefolia*, *Carex albursina*, *Adiantum pedatum*, *Athyrium filix-femina*, *Carex pensylvanica*, *Hepatica acutiloba*, *Rhus radicans*, *Solidago sp.*, (shrub layer) *Acer saccharum*, *Xanthoxylum americanum*, *Ulmus americana*, *Carya ovata*, *Fraxinus pennsylvanica* var. *subintegerrima*, *Tilia americana*, (tree layer) *Acer saccharum*, *Quercus alba*, *Celtis occidentalis*, *Tilia americana*, and *Ostrya virginiana*.

According to Wherry in Correll (1950) only two or three percent of *Aplectrum hyemale* plants flower in any one year. In dense forests this may be true, but at one Iowa site, about 40% of the plants flowered near a roadside which allowed more light to enter the forest. The percentage flowering farther in the forest was much lower and closer to Wherry's figures.

Although only two soil samples were available for study, they were similar in their values. The levels of all of the macronutrients were in the medium to very high range, suggesting that this species may require rather fertile soil conditions. The greatest abundance of this species I have ever observed is on prairie soils invaded by forest in Illinois mentioned by Sheviak (1974), again suggesting the necessity of a rich soil. The Iowa sites, however, do not appear to have been occupied by prairie in
historic times.

Its distribution suggests an eastern species migrating northward into Iowa along the major drainageways following the glacial retreat. Although it migrated northward along the Mississippi valley all the way to the northernmost counties of Iowa, it does not appear to have migrated up the Des Moines River valley. It also migrated northward along the Missouri River valley into northern Kansas (Magrath, 1971), but it does not appear to have reached as far north as Iowa, perhaps due to the lack of forested land because of prairie fires. With the cessation of fires, it may migrate farther northward along the Missouri valley and may reach the southwestern Iowa loess bluff forests. Collectors should seek it in Fremont County forests.

_Corallorhiza_ R. Br.

This genus name is derived from the Greek _κοράλλιον_, korrallion (coral), and _ριζα_, riza (root). This is in reference to the coral-like shape of the underground rhizomes of these species.

This is a small genus of about 12 species mainly restricted to North and Central America. There is one Eurasian species. All species are saprophytes, probably deriving most of their nourishment from dead organic matter in the soil with the aid of mycorrhizal fungi.

Most species are rather inconspicuous, although the reduction in the amount of chlorophyll allows other pigments to dominate, giving the plant a brownish, yellowish, or reddish color. The inflorescence is a spike of flowers. The waxy pollen is in four pollinia. There are two species of _Corallorhiza_ known from Iowa: _C. maculata_ and _C. odontorhiza_. According to Hartley (1966), _C. trifida_ was collected in Minnesota just across the Iowa
state line north of Allamakee County, so this species should also be sought in northeastern Iowa.

Key to the Iowa species of Corallorhiza

1. Lip 3-lobed or with a curved tooth on each side; capsules greater than 1.5 cm long ..................................................... C. maculata

1. Lip not 3-lobed or toothed; capsule less than 1.5 cm long .............. .......................................................... C. odontorhiza

Corallorhiza maculata Raf.

The specific epithet is a Latin adjective meaning "spotted", and refers to the purplish spots on the lip

Type locality: shady woods of Long Island, near Flatbush, Flushing, Oyster Bay, etc., New York

Flowering season in Iowa: August, with extremes of July 17 and September 6

Literature: MacMillan (1892) 174; Greene (1907) 154; Shimek (1907) 174; Verink (1914) 92; Grant (1953b) 143; Thorne (1953) 262; Thorne (1964) 29; Hartley (1966) 58

Counties: Allamakee: Niem (1973)
Clayton: IA, ISC (1924)
Dubuque: IA, Niem (1973)

The Linn County report is based on Verink (1914).

The general distribution of this species is from Newfoundland, Nova Scotia, and Ontario west to Alberta and British Columbia; south through New England and the Atlantic States to North Carolina; west through the Central and Lake States to the west coast; and south through Texas, Mexico, and Guatemala.

In Iowa this species is limited to the northeastern counties. It grows in cool, moist deciduous or mixed pine-hardwood forests in level upland
locations. Although it has not been collected often in Iowa, this species is relatively abundant in places.

In northeastern Iowa, typical associates include (herb layer) Osmorrhiza claytoni, Sanicula marilandica, Carex pensylvanica, Desmodium glutinosum, Acer saccharum, Aralia nudicaulis, Geranium maculatum, Parthenocissus quinquefolia, AmphiCARPA BRACtEATA, Astercordifolius, PhryMA leptostachya, (shrub layer) Acer saccharum, Ostrya virginiana, Cornus rugosa, Prunus serotina, Rubus sp., Ribes cynosbatI, (tree layer) Quercus alba, Quercus rubra, Acer saccharum, Ostrya virginiana, and Tilia americana. In these locations, the largest trees are Quercus alba and Quercus rubra, but a successional trend appears to be in progress which involves the replacement of the oaks with Acer saccharum. It would be interesting to follow the changes in abundance of Corallorhiza maculata in these forests as the composition of tree species changes. I suspect that there will be a decrease in abundance of C. maculata.

The relatively high levels of most of the nutrients suggest that Corallorhiza maculata must have relatively rich soil to grow well.

Corallorhiza maculata grows in the cool, moist forests of northeastern Iowa. Future collectors should look in Fayette and Delaware Counties, as this species may grow in these counties also. Additional eastern Iowa counties may also have colonies.

Corallorhiza odontorhiza (Willd.) Nutt.

Basionym: Cymbidium odontorhizon Willd.

The specific epithet, odontorhiza, is from the Greek and means "toothed root", in reference to the shape of the coralloid rhizome system
Type locality: Canada, New England, Pennsylvania, and Virginia

Flowering season in Iowa: August - October, with extremes of August 8 and October 7; occasional fresh specimens can be found in flower even in early November.

Literature: Shimek (1896) 215; Fitzpatrick (1897) 108; Fitzpatrick and Fitzpatrick (1898) 164; Barnes, Repert, and Miller (1900) 259; Fitzpatrick and Fitzpatrick (1900) 196; Greene (1907) 154; Lohman (1926) 42, 48, 55, 56; Cratty (1933) 198; Fuller (1933) 139; Correll (1950) 331; Grant (1953) 143; Thorne (1955) 192; Cooperrider (1960) 162; Guldner (1960) 85; Cooperrider (1962b) 31; Case (1964) 105; Thorne (1964) 29; Hartley (1966) 59; Eilers (1971) 79, 131

Clayton: IA, Niem (1973)
Decatur: Niem (1973)
Dubuque: IA (1961)
Fremont: IA, Niem (1973)
Johnson: IA, ISC, ISTC, NY, US (1932)
Jones: IA (1959)
Linn: ISC (1948)
Monona: Niem (1974)
Muscatine: Niem (1974)
Scott: Barnes (1892)
Story: Niem (1974)
Webster: Niem (1972)
Winneshiek: IA, Niem (1974)

The general distribution of this species is from Maine south through New England and the Atlantic States to South Carolina, Georgia, Alabama, and Mississippi; west through the Central and Lake States to Wisconsin, Iowa, Nebraska, Arkansas; and south through Mexico and Guatemala to Honduras.

This plant was formerly regarded as quite rare and restricted in range in Iowa (Fitzpatrick and Fitzpatrick, 1900). Several factors may account for this apparent rarity. First, the plant is probably the least conspicuous of our native orchids, and can be easily overlooked by someone not specifically searching for it. Second, the flowering season commences rather late, when academic personnel would no longer be likely to be out collecting. These explanations are at least partially true even today, for
few collections have been made recently, despite intensive collecting by Thorne's students. On the other hand, I have added six new county records for the species without any special effort directed toward locating new sites. Doubtless the list of counties could be doubled in a single collecting season without much difficulty.

A further explanation of the lack of collections probably does concern actual rarity of this species. At the present time, it reaches its greatest abundance in young, open oak forests which were savanna or perhaps even prairie during the time when early collectors were active. Thus, the habitats did not exist, accounting for the actual rarity of the species. I feel that all of these explanations have played some role in keeping the number of collections rather low.

In Iowa, *Corallorhiza odontorhiza* occupies upland locations, often just at the slope break. These habitats are usually characterized by rather large, open-grown oaks.

Under disturbed forest conditions in central Iowa, *Corallorhiza odontorhiza* associates with (herb layer) *Galium concinnum*, *Solidago nemoralis*, (shrub layer) *Acer nigrum*, *Cornus* sp., *Corylus americana*, *Xanthoxylum americanum*, (tree layer) *Quercus alba*, *Carya ovata*, *Gleditsia triacanthos*, and *Ostrya virginiana*. In this and many other places, the herb layer is scant to nonexistent.

In relatively undisturbed deciduous woods in northeastern Iowa, *Corallorhiza odontorhiza* associates with (herb layer) *Sanicula marilandica*, *Osmorhiza claytoni*, *Phryma leptostachya*, *Smilacina racemosa*, *Phlox divaricata*, *Parthenocissus quinquefolia*, *Viola pubescens*, (shrub layer) *Acer saccharum*, *Carya cordiformis*, (tree layer) *Ulmus americana*, *Tilia americana*. 
Quercus alba, Carya cordiformis, and Ostrya virginiana.

In northeastern Iowa, in pine forest changing to deciduous forest, Corallorhiza odontorhiza associates with (herb layer) Carex sp., Cryptotaenia canadensis, Amphicarpa bracteata, Galium aparine, Phryma leptostachya, (shrub layer) Acer saccharum, Fraxinus pennsylvanica var. subintegerrima, Pinus strobus, (tree layer) Quercus alba, Ostrya virginiana, Juniperus virginiana, and Quercus rubra.

In southeastern Iowa, in mixed pine-hardwood forest, Corallorhiza odontorhiza grows near the slope break and the associates are (herb layer) Aster cordifolius, Carex sp., Parthenocissus quinquefolia, Amphicarpa bracteata, Solidago ulmifolia, Festuca obtusa, (shrub layer) Rhus radicans, Acer saccharum, Ostrya virginiana, and Quercus alba.

In south-central Iowa, in scrubby oak forest, the associates of Corallorhiza odontorhiza are (herb layer) Carex pensylvanica, Desmodium glutinosum, Phryma leptostachya, Galium sp., (shrub layer) Rubus sp., (tree layer) Quercus alba, and Carya ovata.

In western Iowa, in the loess bluff forests, the associates of Corallorhiza odontorhiza are (herb layer) Symphoricarpos orbiculatus, Fragaria virginiana, Carex sp., Circaea quadriradulata, Festuca obtusa, Geum canadense, Ulmus americana, Viola sororia, (shrub layer) Cornus sp., Ulmus americana, Ostrya virginiana, Ulmus rubra, Morus rubra, Prunus virginiana, Carya cordiformis, Fraxinus pennsylvanica var. subintegerrima, Tilia americana, (tree layer) Quercus macrocarpa, Quercus muhlenbergii, Ulmus rubra, Ostrya virginiana, Morus rubra, and Cercis canadensis (south).

Species of oak always seem to be associated with Corallorhiza odontorhiza suggesting that the oaks may serve as a source of nutrition for this
Corallorhiza odontorhiza seems somewhat favored by local disturbance. It is often found in paths, along old roadways and in disturbed woods. The reason for this is unknown. Light intensity is unlikely to be a factor, as this species surely derives only a small part of its nutrition from photosynthesis.

The soil nutrient levels indicate the wide range of soil conditions in which this species grows in Iowa. The values tend to be rather high, indicating a possible preference for rich soils.

This species is probably much more abundant than the distribution map indicates, for the reasons that I discussed earlier. My Monona County station for this species makes it the westernmost orchid whose distribution in Iowa I have been able to confirm. I suspect that it might be found in other counties in western Iowa in forested loess canyons.


Fink, B. 1894. Additions to Iowa flora. Iowa Academy of Science Proceedings 1:103-104.


Gilly, C., and M. McDonald. 1936. Rare and unusual plants from southeastern Iowa. Iowa Academy of Science Proceedings 43:143-149.


Gow, J. E. 1901. Preliminary list of the flowering plants of Adair County. Iowa Academy of Science Proceedings 8:152-159.


Greene, W. 1907. Plants of Iowa. Des Moines, Iowa, Bishard Brothers, Printers.


Shimek, B. 1919b. The plant geography of the Lake Okoboji region: additional notes. Bulletin from the Laboratories of Natural History of the State University of Iowa 7(4):3-5.


Soth, L. K. 1936. Agricultural economic facts basebook of Iowa. Iowa State College of Agriculture and Mechanic Arts Agricultural Experiment Station Special Report 1.


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The author wishes to express appreciation and gratitude to Dr. R. Q. Landers for his guidance throughout the course of this investigation and for his constructive criticism of the manuscript. Appreciation is also expressed to the other members of the graduate committee for their aid and suggestions. Special thanks go to the curators of the herbaria visited during this study, including Dr. Richard W. Pohl, Dr. Leslie Garay, Dr. Roger Knutson, Dr. Lawrence Eilers, Dr. Robert Hulbary. Thanks also to the many people who suggested collecting sites. Appreciation is also expressed to Dr. Frederick Smith for finding funds to partially offset travel expenses. Thanks also to my parents for their financial aid which allowed additional travel.
APPENDIX I: EXCLUDED TAXA

The following taxa are reported from Iowa in the literature, but are excluded from the orchid flora of Iowa in this paper. In most cases, the exclusion is based on improperly identified herbarium material.

**Arethusa bulbosa** L. is reported from Linn County by Verink (1914). As Thorne (1953) pointed out, this report is based on a specimen of *Polygala paucifolia* in the University of Iowa Herbarium.

**Cypripedium acaule** Ait. is reported from Mitchell County by Tuttle (1919a). She states that it was reported by old settlers from the area. The report is probably based on *Cypripedium reginae* because this species is often called the "Pink Ladyslipper" in the Middle West. Although there are no Iowa specimens, there is at least a remote possibility that this species may eventually be located in northeast Iowa.

**Cypripedium calceolus** L. var. *parviflorum* (Salisb.) Fern. has been reported numerous times in the literature, but these reports appear to be based on small specimens of *C. calceolus* var. *pubescens*. I have seen no specimens referable to var. *parviflorum* from Iowa.

**Epipactis helleborine** (L.) Crantz. There is a specimen in the Herbarium of Iowa State University with the collection site listed as Mortlake Swamps, Dubuque County, August, 1873. This species is native to Europe, and was first collected in North America in August 1879 near Syracuse, New York. It was accidentally introduced into New York about that time, and soon radiated outward in all directions from that point. Thus, the supposed Iowa specimen
was collected before the plant was discovered near the point of introduction. Also, there is no Mortlake in Dubuque County, but there is such a location in England, and all of the writing on the label, except "Dubuque County" is in a script more characteristic of Europeans than Americans, so I am attributing this collection to Europe.

Habenaria blephariglottis (Willd.) Torr. is reported from Iowa prairies by Shimek (1911a), but as Conard (1952) pointed out, Shimek meant H. leucophaea.

Habenaria dilatata (Pursh) Hook is reported from Linn County by Verink (1914). This report is based on a specimen of Habenaria viridis var. bracteata in the Herbarium of the University of Iowa.

Habenaria lacera (Michx.) Lodd. is reported from Linn County by Verink (1914). This report is based on a specimen of Habenaria psycodes in the Herbarium of the University of Iowa. H. lacera may, however, occur in eastern Iowa, and it should be sought there.

Habenaria peramoena A. Gray is reported from Linn County by Verink (1914). This report is based on a specimen of Habenaria psycodes in the Herbarium of the University of Iowa.
## APPENDIX II: SOIL INFORMATION

**Cypripedium calceolus var. pubescens** (9 sites)

<table>
<thead>
<tr>
<th>Soil Type</th>
<th>pH</th>
<th>Soil Moisture</th>
<th>Loss on Ignition</th>
<th>Cation Exch. Cap.</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>8.0</td>
<td>158%</td>
<td>52%</td>
<td>29 me/100 g</td>
</tr>
<tr>
<td>Mean</td>
<td>57%</td>
<td>25%</td>
<td>6%</td>
<td>21 me/100 g</td>
</tr>
<tr>
<td>Low</td>
<td>17%</td>
<td>6%</td>
<td></td>
<td>3 me/100 g</td>
</tr>
</tbody>
</table>

### Nutrients in ppm

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>High</th>
<th>Mean</th>
<th>Low</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>34</td>
<td>8</td>
<td>2</td>
</tr>
<tr>
<td>P</td>
<td>38</td>
<td>19</td>
<td>2</td>
</tr>
<tr>
<td>K</td>
<td>359</td>
<td>156</td>
<td>62</td>
</tr>
<tr>
<td>Ca</td>
<td>5000+</td>
<td>3488+</td>
<td>68</td>
</tr>
<tr>
<td>Mg</td>
<td>500+</td>
<td>371+</td>
<td>40</td>
</tr>
<tr>
<td>Mn</td>
<td>50+</td>
<td>26+</td>
<td>8</td>
</tr>
<tr>
<td>Fe</td>
<td>30+</td>
<td>6.8</td>
<td>1.5</td>
</tr>
<tr>
<td>Cu</td>
<td>.5</td>
<td>.32</td>
<td>.2</td>
</tr>
<tr>
<td>Zn</td>
<td>39</td>
<td>16</td>
<td>6</td>
</tr>
</tbody>
</table>

**Cypripedium candidum** (4 sites)

<table>
<thead>
<tr>
<th>Soil Type</th>
<th>pH</th>
<th>Soil Moisture</th>
<th>Loss on Ignition</th>
<th>Cation Exch. Cap.</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>7.9</td>
<td>304%</td>
<td>61%</td>
<td>30 me/100 g</td>
</tr>
<tr>
<td>Mean</td>
<td>7.2</td>
<td>116%</td>
<td>34%</td>
<td>24 me/100 g</td>
</tr>
<tr>
<td>Low</td>
<td>22%</td>
<td>7%</td>
<td></td>
<td>17 me/100 g</td>
</tr>
</tbody>
</table>

### Nutrients in ppm

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>High</th>
<th>Mean</th>
<th>Low</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>6</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>P</td>
<td>22</td>
<td>10</td>
<td>1</td>
</tr>
<tr>
<td>K</td>
<td>223</td>
<td>130</td>
<td>57</td>
</tr>
<tr>
<td>Ca</td>
<td>5000+</td>
<td>4041+</td>
<td>2865</td>
</tr>
<tr>
<td>Mg</td>
<td>500+</td>
<td>391+</td>
<td>223</td>
</tr>
<tr>
<td>Mn</td>
<td>50+</td>
<td>22+</td>
<td>11</td>
</tr>
<tr>
<td>Fe</td>
<td>30+</td>
<td>6</td>
<td>.55</td>
</tr>
<tr>
<td>Cu</td>
<td>.25</td>
<td>.24</td>
<td>.2</td>
</tr>
<tr>
<td>Zn</td>
<td>18</td>
<td>8</td>
<td>4</td>
</tr>
</tbody>
</table>

**Cypripedium x andrewsi** (1 site)

<table>
<thead>
<tr>
<th>Soil Type</th>
<th>pH</th>
<th>Soil Moisture</th>
<th>Loss on Ignition</th>
<th>Cation Exch. Cap.</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>8.1</td>
<td>40%</td>
<td>9%</td>
<td>24 me/100 g</td>
</tr>
</tbody>
</table>

### Nutrients in ppm

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>High</th>
<th>Mean</th>
<th>Low</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>6</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>P</td>
<td>3</td>
<td>130</td>
<td>140</td>
</tr>
<tr>
<td>K</td>
<td>130</td>
<td>130</td>
<td>130</td>
</tr>
<tr>
<td>Ca</td>
<td>4140</td>
<td>309</td>
<td>14</td>
</tr>
<tr>
<td>Mg</td>
<td>309</td>
<td>14</td>
<td>.6</td>
</tr>
<tr>
<td>Mn</td>
<td>14</td>
<td>.6</td>
<td>.3</td>
</tr>
<tr>
<td>Fe</td>
<td>.6</td>
<td>.3</td>
<td>12</td>
</tr>
<tr>
<td>Cu</td>
<td>12</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>Zn</td>
<td>12</td>
<td>12</td>
<td>12</td>
</tr>
</tbody>
</table>
### Triphora trianthophora (1 site)

<table>
<thead>
<tr>
<th>pH</th>
<th>Soil moisture</th>
<th>Loss on ignition</th>
<th>Cation exch. cap.</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.3</td>
<td>28%</td>
<td>21%</td>
<td>10 me/100 g</td>
</tr>
</tbody>
</table>

**Nutrients in ppm**

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>P</th>
<th>K</th>
<th>Ca</th>
<th>Mg</th>
<th>Mn</th>
<th>Fe</th>
<th>Cu</th>
<th>Zn</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>10</td>
<td>22</td>
<td>109</td>
<td>1610</td>
<td>208</td>
<td>50+</td>
<td>14</td>
<td>.4</td>
<td>28</td>
</tr>
</tbody>
</table>

### Spiranes cernua (5 sites)

**High**

<table>
<thead>
<tr>
<th>pH</th>
<th>Soil moisture</th>
<th>Loss on ignition</th>
<th>Cation exch. cap.</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.2</td>
<td>86%</td>
<td>38%</td>
<td>27 me/100 g</td>
</tr>
</tbody>
</table>

**Mean**

<table>
<thead>
<tr>
<th>pH</th>
<th>Soil moisture</th>
<th>Loss on Ignition</th>
<th>Cation exch. cap.</th>
</tr>
</thead>
<tbody>
<tr>
<td>46%</td>
<td>21%</td>
<td>18 me/100 g</td>
<td></td>
</tr>
</tbody>
</table>

**Low**

<table>
<thead>
<tr>
<th>pH</th>
<th>Soil moisture</th>
<th>Loss on ignition</th>
<th>Cation exch. cap.</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.9</td>
<td>22%</td>
<td>5%</td>
<td>10 me/100 g</td>
</tr>
</tbody>
</table>

**Nutrients in ppm**

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>P</th>
<th>K</th>
<th>Ca</th>
<th>Mg</th>
<th>Mn</th>
<th>Fe</th>
<th>Cu</th>
<th>Zn</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>3</td>
<td>22</td>
<td>175</td>
<td>4355</td>
<td>500+</td>
<td>50+</td>
<td>34</td>
<td>1.</td>
<td>24</td>
</tr>
<tr>
<td>Mean</td>
<td>2</td>
<td>7</td>
<td>132</td>
<td>3067</td>
<td>367+</td>
<td>24+</td>
<td>8</td>
<td>.5</td>
<td>13</td>
</tr>
<tr>
<td>Low</td>
<td>2</td>
<td>1</td>
<td>92</td>
<td>1655</td>
<td>208</td>
<td>8</td>
<td>.4</td>
<td>.2</td>
<td>4</td>
</tr>
</tbody>
</table>

### Spiranes lacera (1 site)

<table>
<thead>
<tr>
<th>pH</th>
<th>Soil moisture</th>
<th>Loss on Ignition</th>
<th>Cation exch. cap.</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.2</td>
<td>39%</td>
<td>10%</td>
<td>10 me/100 g</td>
</tr>
</tbody>
</table>

**Nutrients in ppm**

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>P</th>
<th>K</th>
<th>Ca</th>
<th>Mg</th>
<th>Mn</th>
<th>Fe</th>
<th>Cu</th>
<th>Zn</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>8</td>
<td>121</td>
<td>1535</td>
<td>192</td>
<td>50+</td>
<td>10</td>
<td>.5</td>
<td>10</td>
<td></td>
</tr>
</tbody>
</table>

### Spiranes romanoffiana (1 site)

<table>
<thead>
<tr>
<th>pH</th>
<th>Soil moisture</th>
<th>Loss on Ignition</th>
<th>Cation exch. cap.</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.6</td>
<td>145%</td>
<td>10%</td>
<td>19 me/100 g</td>
</tr>
</tbody>
</table>

**Nutrients in ppm**

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>P</th>
<th>K</th>
<th>Ca</th>
<th>Mg</th>
<th>Mn</th>
<th>Fe</th>
<th>Cu</th>
<th>Zn</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>1</td>
<td>254</td>
<td>3315</td>
<td>208</td>
<td>3</td>
<td>.6</td>
<td>.2</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>
### Goodyera pubescens (2 sites)

<table>
<thead>
<tr>
<th></th>
<th>pH</th>
<th>Soil moisture</th>
<th>Loss on Ignition</th>
<th>Cation Exch. Cap.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>High</strong></td>
<td>7.1</td>
<td>35%</td>
<td>Not Available</td>
<td>16 me/100 g</td>
</tr>
<tr>
<td><strong>Mean</strong></td>
<td>5.7</td>
<td>26%</td>
<td></td>
<td>12 me/100 g</td>
</tr>
<tr>
<td><strong>Low</strong></td>
<td>5.7</td>
<td>16%</td>
<td></td>
<td>7 me/100 g</td>
</tr>
</tbody>
</table>

#### Nutrients in ppm

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>P</th>
<th>K</th>
<th>Ca</th>
<th>Mg</th>
<th>Mn</th>
<th>Fe</th>
<th>Cu</th>
<th>Zn</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>High</strong></td>
<td>50</td>
<td>54</td>
<td>117</td>
<td>2375</td>
<td>500+</td>
<td>50+</td>
<td>18</td>
<td>.5</td>
<td>17</td>
</tr>
<tr>
<td><strong>Mean</strong></td>
<td>26</td>
<td>34</td>
<td>92</td>
<td>1700</td>
<td>326+</td>
<td>50+</td>
<td>12</td>
<td>.42</td>
<td>16</td>
</tr>
<tr>
<td><strong>Low</strong></td>
<td>2</td>
<td>14</td>
<td>68</td>
<td>1125</td>
<td>152</td>
<td>50+</td>
<td>6</td>
<td>.35</td>
<td>16</td>
</tr>
</tbody>
</table>

### Orchis spectabilis (16 sites)

<table>
<thead>
<tr>
<th></th>
<th>pH</th>
<th>Soil moisture</th>
<th>Loss on Ignition</th>
<th>Cation Exch. Cap.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>High</strong></td>
<td>8.0</td>
<td>48%</td>
<td>13%</td>
<td>23 me/100 g</td>
</tr>
<tr>
<td><strong>Mean</strong></td>
<td>6.2</td>
<td>36%</td>
<td>10%</td>
<td>15 me/100 g</td>
</tr>
<tr>
<td><strong>Low</strong></td>
<td>6.2</td>
<td>16%</td>
<td>7%</td>
<td>11 me/100 g</td>
</tr>
</tbody>
</table>

#### Nutrients in ppm

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>P</th>
<th>K</th>
<th>Ca</th>
<th>Mg</th>
<th>Mn</th>
<th>Fe</th>
<th>Cu</th>
<th>Zn</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>High</strong></td>
<td>30</td>
<td>53</td>
<td>268</td>
<td>3895</td>
<td>500+</td>
<td>50+</td>
<td>34</td>
<td>.45</td>
<td>32</td>
</tr>
<tr>
<td><strong>Mean</strong></td>
<td>10</td>
<td>27</td>
<td>146</td>
<td>2363</td>
<td>294+</td>
<td>37+</td>
<td>7</td>
<td>.36</td>
<td>16</td>
</tr>
<tr>
<td><strong>Low</strong></td>
<td>2</td>
<td>8</td>
<td>72</td>
<td>1365</td>
<td>169</td>
<td>24</td>
<td>2</td>
<td>.25</td>
<td>8</td>
</tr>
</tbody>
</table>

### Habenaria hookeri (1 site)

<table>
<thead>
<tr>
<th></th>
<th>pH</th>
<th>Soil moisture</th>
<th>Loss on Ignition</th>
<th>Cation Exch. Cap.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>High</strong></td>
<td>7.1</td>
<td>55%</td>
<td>20%</td>
<td>17 me/100 g</td>
</tr>
</tbody>
</table>

#### Nutrients in ppm

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>P</th>
<th>K</th>
<th>Ca</th>
<th>Mg</th>
<th>Mn</th>
<th>Fe</th>
<th>Cu</th>
<th>Zn</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>High</strong></td>
<td>5</td>
<td>5</td>
<td>82</td>
<td>2450</td>
<td>500+</td>
<td>22</td>
<td>4</td>
<td>.35</td>
<td>14</td>
</tr>
</tbody>
</table>
**Habenaria hyperborea** (1 site)

<table>
<thead>
<tr>
<th></th>
<th>pH</th>
<th>soil moisture</th>
<th>loss on ignition</th>
<th>cation exch. cap.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>7.7</td>
<td>174%</td>
<td>22%</td>
<td>26 me/100 g</td>
</tr>
</tbody>
</table>

**Nutrients in ppm**

<table>
<thead>
<tr>
<th>N</th>
<th>P</th>
<th>K</th>
<th>Ca</th>
<th>Mg</th>
<th>Mn</th>
<th>Fe</th>
<th>Cu</th>
<th>Zn</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>0</td>
<td>126</td>
<td>4355</td>
<td>500+</td>
<td>26</td>
<td>.6</td>
<td>.25</td>
<td>3</td>
</tr>
</tbody>
</table>

**Habenaria leucophaea** (1 site)

<table>
<thead>
<tr>
<th></th>
<th>pH</th>
<th>soil moisture</th>
<th>loss on ignition</th>
<th>cation exch. cap.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>6.3</td>
<td>90%</td>
<td>26%</td>
<td>25 me/100 g</td>
</tr>
</tbody>
</table>

**Nutrients in ppm**

<table>
<thead>
<tr>
<th>N</th>
<th>P</th>
<th>K</th>
<th>Ca</th>
<th>Mg</th>
<th>Mn</th>
<th>Fe</th>
<th>Cu</th>
<th>Zn</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>16</td>
<td>140</td>
<td>4040</td>
<td>500+</td>
<td>19</td>
<td>17</td>
<td>.3</td>
<td>24</td>
</tr>
</tbody>
</table>

**Habenaria viridis var. bracteata** (3 sites)

<table>
<thead>
<tr>
<th></th>
<th>pH</th>
<th>soil moisture</th>
<th>loss on ignition</th>
<th>cation exch. cap.</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>7.8</td>
<td>36%</td>
<td>11%</td>
<td>29 me/100 g</td>
</tr>
<tr>
<td>Mean</td>
<td></td>
<td>23%</td>
<td>7%</td>
<td>15 me/100 g</td>
</tr>
<tr>
<td>Low</td>
<td>5.2</td>
<td>11%</td>
<td>3%</td>
<td>5 me/100 g</td>
</tr>
</tbody>
</table>

**Nutrients in ppm**

<table>
<thead>
<tr>
<th>N</th>
<th>P</th>
<th>K</th>
<th>Ca</th>
<th>Mg</th>
<th>Mn</th>
<th>Fe</th>
<th>Cu</th>
<th>Zn</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>11</td>
<td>166</td>
<td>5000+</td>
<td>400</td>
<td>38</td>
<td>16</td>
<td>.5</td>
<td>6</td>
</tr>
<tr>
<td>3</td>
<td>9</td>
<td>146</td>
<td>2543+</td>
<td>271</td>
<td>25</td>
<td>11</td>
<td>.4</td>
<td>4</td>
</tr>
<tr>
<td>2</td>
<td>6</td>
<td>126</td>
<td>745</td>
<td>128</td>
<td>8</td>
<td>6</td>
<td>.3</td>
<td>2</td>
</tr>
</tbody>
</table>
### Liparis lilifolia (7 sites)

<table>
<thead>
<tr>
<th></th>
<th>pH</th>
<th>soil moisture</th>
<th>loss on ignition</th>
<th>cation exch. cap.</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>7.8</td>
<td>56%</td>
<td>14%</td>
<td>18 me/100 g</td>
</tr>
<tr>
<td>Mean</td>
<td>5.3</td>
<td>32%</td>
<td>9%</td>
<td>11 me/100 g</td>
</tr>
<tr>
<td>Low</td>
<td>5.3</td>
<td>14%</td>
<td>6%</td>
<td>6 me/100 g</td>
</tr>
</tbody>
</table>

#### Nutrients in ppm

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>P</th>
<th>K</th>
<th>Ca</th>
<th>Mg</th>
<th>Mn</th>
<th>Fe</th>
<th>Cu</th>
<th>Zn</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>7</td>
<td>39</td>
<td>189</td>
<td>2580</td>
<td>360</td>
<td>50+</td>
<td>.5</td>
<td>22</td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>3</td>
<td>19</td>
<td>118</td>
<td>1734</td>
<td>228</td>
<td>44+</td>
<td>12</td>
<td>.41</td>
<td>12</td>
</tr>
<tr>
<td>Low</td>
<td>2</td>
<td>8</td>
<td>70</td>
<td>875</td>
<td>118</td>
<td>34</td>
<td>3</td>
<td>.25</td>
<td>7</td>
</tr>
</tbody>
</table>

### Liparis loeselii (3 sites)

<table>
<thead>
<tr>
<th></th>
<th>pH</th>
<th>soil moisture</th>
<th>loss on ignition</th>
<th>cation exch. cap.</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>7.5</td>
<td>368%</td>
<td>48%</td>
<td>20 me/100 g</td>
</tr>
<tr>
<td>Mean</td>
<td>4.2</td>
<td>245%</td>
<td>28%</td>
<td>14 me/100 g</td>
</tr>
<tr>
<td>Low</td>
<td>4.2</td>
<td>81%</td>
<td>16%</td>
<td>6 me/100 g</td>
</tr>
</tbody>
</table>

#### Nutrients in ppm

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>P</th>
<th>K</th>
<th>Ca</th>
<th>Mg</th>
<th>Mn</th>
<th>Fe</th>
<th>Cu</th>
<th>Zn</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>4</td>
<td>34</td>
<td>156</td>
<td>3555</td>
<td>229</td>
<td>41</td>
<td>50+</td>
<td>.5</td>
<td>20</td>
</tr>
<tr>
<td>Mean</td>
<td>3</td>
<td>20</td>
<td>127</td>
<td>2435</td>
<td>187</td>
<td>27</td>
<td>34+</td>
<td>.4</td>
<td>13</td>
</tr>
<tr>
<td>Low</td>
<td>3</td>
<td>1</td>
<td>111</td>
<td>835</td>
<td>131</td>
<td>12</td>
<td>1</td>
<td>.35</td>
<td>2</td>
</tr>
</tbody>
</table>

### Aplectrum hyemale (2 sites)

<table>
<thead>
<tr>
<th></th>
<th>pH</th>
<th>soil moisture</th>
<th>loss on ignition</th>
<th>cation exch. cap.</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>7.0</td>
<td>44%</td>
<td>12%</td>
<td>15 me/100 g</td>
</tr>
<tr>
<td>Mean</td>
<td>6.4</td>
<td>41%</td>
<td>11%</td>
<td>14 me/100 g</td>
</tr>
<tr>
<td>Low</td>
<td>6.4</td>
<td>38%</td>
<td>10%</td>
<td>13 me/100 g</td>
</tr>
</tbody>
</table>

#### Nutrients in ppm

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>P</th>
<th>K</th>
<th>Ca</th>
<th>Mg</th>
<th>Mn</th>
<th>Fe</th>
<th>Cu</th>
<th>Zn</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>19</td>
<td>38</td>
<td>122</td>
<td>2505</td>
<td>266</td>
<td>50+</td>
<td>4</td>
<td>.4</td>
<td>22</td>
</tr>
<tr>
<td>Mean</td>
<td>15</td>
<td>34</td>
<td>118</td>
<td>2168</td>
<td>265</td>
<td>38+</td>
<td>3.5</td>
<td>.35</td>
<td>16</td>
</tr>
<tr>
<td>Low</td>
<td>11</td>
<td>30</td>
<td>114</td>
<td>1830</td>
<td>264</td>
<td>26</td>
<td>3</td>
<td>.3</td>
<td>10</td>
</tr>
</tbody>
</table>
Corallorhiza maculata (3 sites)

<table>
<thead>
<tr>
<th></th>
<th>pH</th>
<th>Soil moisture</th>
<th>Loss on ignition</th>
<th>Cation exch. cap.</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>7.1</td>
<td>23%</td>
<td>12%</td>
<td>16 me/100 g</td>
</tr>
<tr>
<td>Mean</td>
<td></td>
<td>18%</td>
<td>10%</td>
<td>11 me/100 g</td>
</tr>
<tr>
<td>Low</td>
<td>5.2</td>
<td>12%</td>
<td>9%</td>
<td>6 me/100 g</td>
</tr>
</tbody>
</table>

**Nutrients in ppm**

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>P</th>
<th>K</th>
<th>Ca</th>
<th>Mg</th>
<th>Mn</th>
<th>Fe</th>
<th>Cu</th>
<th>Zn</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>12</td>
<td>41</td>
<td>102</td>
<td>2960</td>
<td>225</td>
<td>50+</td>
<td>22</td>
<td>.5</td>
<td>20</td>
</tr>
<tr>
<td>Mean</td>
<td>5</td>
<td>32</td>
<td>79</td>
<td>1857</td>
<td>163</td>
<td>50+</td>
<td>16</td>
<td>.4</td>
<td>17</td>
</tr>
<tr>
<td>Low</td>
<td>2</td>
<td>16</td>
<td>66</td>
<td>920</td>
<td>76</td>
<td>50+</td>
<td>5</td>
<td>.3</td>
<td>14</td>
</tr>
</tbody>
</table>

Corallorhiza odontorhiza (7 sites)

<table>
<thead>
<tr>
<th></th>
<th>pH</th>
<th>Soil moisture</th>
<th>Loss on ignition</th>
<th>Cation exch. cap.</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>7.6</td>
<td>34%</td>
<td>21%</td>
<td>28 me/100 g</td>
</tr>
<tr>
<td>Mean</td>
<td></td>
<td>23%</td>
<td>10%</td>
<td>17 me/100 g</td>
</tr>
<tr>
<td>Low</td>
<td>5.9</td>
<td>9%</td>
<td>6%</td>
<td>8 me/100 g</td>
</tr>
</tbody>
</table>

**Nutrients in ppm**

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>P</th>
<th>K</th>
<th>Ca</th>
<th>Mg</th>
<th>Mn</th>
<th>Fe</th>
<th>Cu</th>
<th>Zn</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>4</td>
<td>44</td>
<td>341</td>
<td>5000+</td>
<td>500+</td>
<td>50+</td>
<td>22</td>
<td>.5</td>
<td>50+</td>
</tr>
<tr>
<td>Mean</td>
<td>3</td>
<td>20</td>
<td>182</td>
<td>2642+</td>
<td>320+</td>
<td>44+</td>
<td>11</td>
<td>.4</td>
<td>16+</td>
</tr>
<tr>
<td>Low</td>
<td>2</td>
<td>7</td>
<td>64</td>
<td>880</td>
<td>149</td>
<td>26</td>
<td>2</td>
<td>.3</td>
<td>8</td>
</tr>
</tbody>
</table>
APPENDIX III: SPECIES DISTRIBUTION MAPS

A closed circle indicates that I have seen an herbarium specimen from the location indicated on the map. An open circle indicates a report in the literature which I have been unable to verify with herbarium material. The circles indicate the actual collection site.
Figure 9. Distribution of *Cypripedium calceolus* var. *pubescens* in Iowa
Figure 10. Distribution of *Cypripedium candidum* in Iowa
Figure 11. Distribution of *Cypr pedium reginae* in Iowa
Figure 12. Distribution of *Cypripedium x andrewsii* in Iowa.
Figure 13. Distribution of *Triphora trianthophora* in Iowa
Figure 14. Distribution of *Pteronia ophioglossoides* in Iowa
Figure 15. Distribution of *Calopogon tuberosus* in Iowa
Figure 16. Distribution of *Spiranthes cernua* in Iowa
Figure 17. Distribution of *Spiranthes lacera* in Iowa
Figure 13. Distribution of *Spiranthes romanzoffiana* in Iowa
Figure 19. Distribution of *Spiranthes vernalis* in Iowa
Figure 20. Distribution of *Goodyera pubescens* in Iowa
Figure 21. Distribution of *Orchis spectabilis* in Iowa
Figure 22. Distribution of *Habenaria clavellata* in Iowa
Figure 23. Distribution of *Habenaria flava* var. *herbiola* in Iowa
Figure 24. Distribution of *Habenaria hookeri* in Iowa
Figure 25. Distribution of *Habenaria hyperborea* in Iowa
Figure 26. Distribution of Habenaria leucophaea in Iowa
Figure 27. Distribution of *Habenaria psycodes* in Iowa
Figure 28. Distribution of *Habenaria viridis* var. *bracteata* in Iowa
Figure 29. Distribution of Malaxis unifolia in Iowa
Figure 30. Distribution of *Liparis lilifolia* in Iowa
Figure 31. Distribution of *Liparis loeselli* in Iowa
Figure 32. Distribution of *Aplectrum hyemale* in Iowa
Figure 33. Distribution of *Corallorhiza maculata* in Iowa
Figure 34. Distribution of Corallorhiza odontorhiza in Iowa