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A REGIONAL STUDY OF THE LEGUMES OF BERRIEN COUNTY,
MICHIGAN, THEIR ASSOCIATES, AND THE SOILS
IN WHICH THEY GROW

THESIS FOR DEGREE OF M. S.

BY

LEWIS NATHAN HOLM



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A REGIONAL STUDY OF THE LEGUMES OF BERRIEN COUNTY,
MICHIGAN, THEIR ASSOCIATES, AND THE SOILS
IN WHICH THEY GROW

BY

LEWIS NATHAN HOLM

Submitted in partial fulfillment of the requirements
for the degree of Master of Science in the
Graduate School, Michigan State College,
Department of Botany
September, 1936

THESIS

DEDICATION

To my dear parents who taught me to recognize a divine Power and Intelligence in babbling brook, in singing bird, and in the intricacy and beauty of the flowers, this book is affectionately dedicated.

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INTRODUCTION

In 1932 the writer came to Emmanuel Missionary College to take charge of the farm and teach agriculture. Having spent practically all of his life either in Minnesota or in Eastern Canada one of his first interests was in the new plants of this lake region of southern Michigan. Many tests were made of the soils, and plants of all kinds were collected and studied. It was not, however, until the spring of 1934 that an intensive study was begun of a region about twelve miles square comprising the townships of Royalton, Sodus, Pipestone, Oronoko, and Berrien. The purpose of the study was an attempt to discover the distribution of legumes over the area, the types of soil in which they grow, particularly with reference to their pH, and the other plants found growing on the same soil types. This region presents a great variety of soil types and shows considerable adaptability of certain plants to a wide variety of soils and conditions.

PART ONE

METHODS AND MATERIALS

The intensive study of this region was begun about the middle of July, 1934, and was carried on every day for a period of eight weeks. Plants of all kinds were gathered, pressed, and identified using Gray's New Manual of Botany by Robinson and Fernald, and Illustrated Flora of the Northern States and Canada by Britton and Brown. In cases where the writer was uncertain of identification he was assisted in the work by Doctors E. A. Bessey and H. T. Darlington of Michigan State College, a number of the specimens being studied during the fall and winter term. Abundant use was also made of the State and Federal herbariums housed in the Botany building of Michigan State College. Since this study was not begun until the middle of July, the following spring it was resumed with the opening of the first wild flowers and continued periodically throughout the summer and again in the spring of 1936.

Throughout the study, wherever legumes were found growing, notes were taken of the thriftiness of the plants under observation, the plants found associated with them, the pH of the soil, whether the soil had been limed or not, the surface drainage, the under-drainage both natural and artificial, the height of the water table, the soil and subsoil, and whether the plants were growing in surface soil formed in cuts or in other unusual manner.

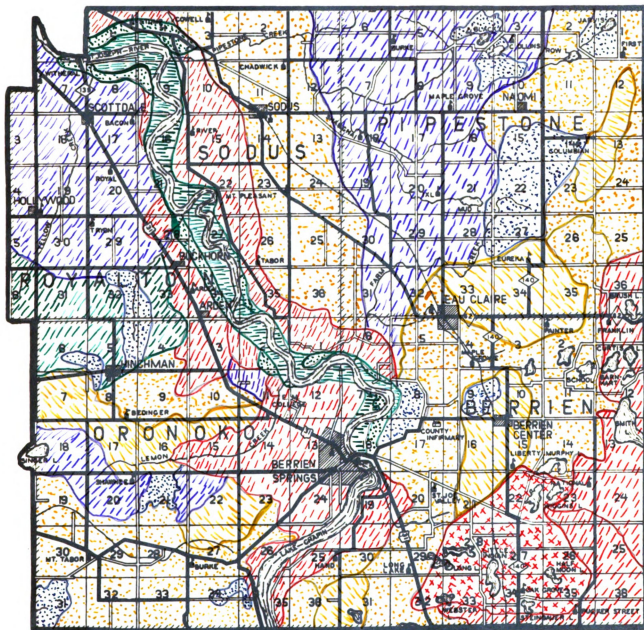
The materials and equipment used were a soil auger, a piece of oilcloth on which to place soil samples, pint mason jars for carrying soil samples to the laboratory, a shovel and pick for digging plant

specimens, a press with blotters and plenty of newspapers for preserving specimens, a vasculum for preserving fresh specimens, litmus paper and a tube of soil-text for making field tests, soil maps, and charts for soil identification. A car was used to drive to various regions and studies were made of the various soil areas as indicated by soil survey maps. Wherever possible, sections of country still containing the native growth of lumber were studied and regions that contained volunteer growths. Other sections were observed but not so extensively.

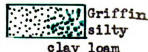
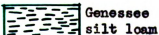
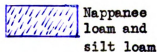
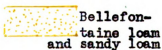
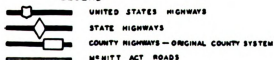
Many portions along the St. Joseph River cannot be reached by car. On this land there is growing much in the way of native vegetation. Several trips were made on foot into this region and produced many interesting opportunities to observe plants in their natural habitat. In general the study proceeded from the immediate banks of the St. Joseph River backward to the higher portions of the valley and the pictures were taken with that in mind and in an attempt to give somewhat of an idea of the region studied. In good weather many of the identifications were made in the field as were also the soil tests. In bad weather soil samples were taken to the laboratory and plants difficult of identification were pressed and preserved and later studied with the use of a dissecting microscope.

Soil Map of Area Studied

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LEGEND



PART TWO
THE AREA STUDIED

The study constitutes a survey of an area about twelve miles square at the center of which is Emmanuel Missionary College and from which point the study was carried on.

The River Flats

Beginning at the bank of the St. Joseph River adjacent to the Emmanuel Missionary College campus the lower flats of the river were first studied. These flats are about a mile wide lying sometimes on one side of the river only or portions may be on either side. They are essentially an alluvial plain, the height above the river being greater next to the river and lower at the points from which the first terrace rises with frequent swampy and poorly drained areas. The soil upon which these alluvial deposits were superimposed becomes the subsoil and is frequently sand or gravel and, being on a level with the river, the water table rises and falls with the increase and decrease in height of the river. For several hours or at times for several days these flats may be completely covered with water which generally lowers in time to prevent destruction of vegetation. Certain low-lying portions at the outer extremities are always wet, being on an approximate level with the river, and are characterized by plants of a semi-aquatic nature such as the meadow grasses, sedges, mints, willows, button-bush, American elm, soft maple, and swamp white oak.

Very frequently muck soils constitute considerable portions of these more swampy areas. Some of them are difficult to drain because

the height of the water table follows the rise and fall of the river and is frequently very close to the surface. These soils vary in depth from three to twenty feet. The native growth on this muck land consists of such plants as cat-tails, reeds, marsh grasses, sedges, mints, huckleberry, tamarack, willows, and red osier dogwood. These muck areas, when they can be properly drained, are used mostly to grow corn, although some are used to grow onions and celery while a few are used, where the soil is sufficiently acid, as blueberry plantations. Farther west much muck land is planted in peppermint.

The muck lands vary greatly in the pH range of their soil. Quite frequently beds of marl ranging from one to five feet are found. These deposits have apparently dissolved out of the soil in the terraces above and subsequently precipitated upon reaching a lower level. Where the deposits are large enough they are dug out and sold to sweeten up soils to be planted in clover or alfalfa. In what are known as the huckleberry swamps the soils are distinctly acid.

By far the larger portion of the river flats is flooded for only a few hours at a time after a heavy rain or during a freshet. The soil is mostly Genessee silt loam with some Griffin silty clay loam lying along the outer portions. The position of the latter at the outside of the river flat and next to the terrace causes the land to be rather wet due partly to the failure of the flood water to get away and also to numerous seeps and springs in the bluffs forming parts of the adjacent terrace. Most of this Griffin soil is still in woods and is pastured. There is a heavy growth of such trees as elm, red maple, ash, sycamore, cottonwood, etc. Volunteer legumes are rare, probably

due to the poorly drained condition of the soil, but alfalfa, sweet clover, and black medick grow well after the soil is drained. The soil is neutral or alkaline. There are liberal deposits of small shells, and blue grass grows luxuriantly.

The Genessee silt loam presents a somewhat different picture from the Griffin silt loam. The land lies higher and being closer to the river has considerable sand mixed with the silt deposits. The wooded areas consist of trees similar to those on the Griffin silt loam but added to these are two trees of the legume family, the honey locust (*Gleditsia triacanthos*) and the redbud (*Cercis canadensis*). The former does not seem particularly selective as to habitat, but the latter is found only on the higher and more sandy locations. On one sandy, well-drained knoll a grove about one-fourth acre in extent of almost exclusive redbud was found. Trees found associated with redbud in other places were honey locust, hackberry, red elm, and post oak.

On the well drained portions of these lower flats many species of the legume family thrive, and in growing the clovers and alfalfa no application of lime is required and probably will not be for several years to come because of the liberal deposits of shells. Probably 75 per cent of this land is in cultivation, the chief crops being corn, wheat, oats, and legume hay.

The River Terraces

A terrace thirty to sixty feet high rises quite abruptly from the river flats, the banks of which are too abrupt for farming, and are

still covered with the native timber including beeches, elms, oaks, hickory, basswood, sycamore, etc. Many of these trees are large and of considerable value but are cut out only when mature as they are necessary to hold the bank from erosion. Where the timber has been cut the bank presents a sorry sight with gullies twenty to thirty feet deep. Legumes are frequently found on these banks and include the clovers, black locust, and showy tick trefoil. Once upon the terrace the land is generally level to gently rolling.

Fox sandy loam is the predominant type of soil with Fox loam following next. It contains varying quantities of small gravel. In places the gravel is so abundant as to make up a considerable part of the soil. There is little run-off as the water sinks quickly into the sandy soil, passes into the substrata and gives rise to numerous springs in the river bluffs. Where the virgin timber remains, these are beautiful forests made up mostly of maples, beech, oak, elm, and walnut although there are many other species. Legumes do well on these well drained lands. The black locust is very abundant and is found in groves excluding most other kinds of trees particularly along the terrace borders. The redbud tree (*Cercis canadensis*) is of frequent occurrence and there is also a grove of Kentucky coffee trees. In open spaces as along railroads and highways yellow and white sweet clover (*Melilotus*), showy tick trefoil (*Desmodium canadense*), and black medick (*Medicago lupulina*) are abundant. The sweet clover and trefoil often reach a height of six feet while the black medick frequently forms a mat completely carpeting the roadside and excluding practically all other vegetation. Volunteer plants in abundance of the clover (*Trifolium*), alfalfa, and vetch show

this land well adapted to these crops and in the wooded areas are found several species of *Desmodium*. Where the land has not been farmed the soil is neutral to slightly alkaline but since the subsoil is rather porous the lime quickly disappears into the deeper soils. It is therefore necessary for farmers to supply calcium in some form for the successful growing of clover and alfalfa.

The soil retains sufficient moisture to carry field crops through ordinary droughts in good condition, and has very good moisture conditions for the growth of fruit trees and berries. Corn, wheat, oats, and rye are the principal grain crops raised and considerable emphasis is now being placed on growing tomatoes, peppers, and melons.

St. Joseph Valley Slopes

Above the terraces, the slopes of the St. Joseph valley are made up chiefly of five soil types, viz: Bellefontaine loam and sandy loam, Coloma loamy sand, Miami silt loam, Nappanee silt loam, and Maumee silty clay loam. Each of these soils have well defined characteristics, and the plant life on them varies quite noticeably.

In general these soil areas are quite well defined but there is some mixing and interspersing of one with the other.

Bellefontaine Sandy Loam

The surface layer of the Bellefontaine sandy loam in a forest is a brown sandy loam mixed with leaf mold, to a depth of one or two inches, with a slight but noticeable layer of light gray sand at its

base. Beneath this the soil is a brown to slightly yellowish brown sandy loam, grading at about eight to sixteen inches into reddish brown sandy loam or sandy clay. At about thirty-six to forty-eight inches this passes into unweathered or slightly weathered, unassorted, stony, gravelly material. There are some gravel and small rock fragments through the soil and subsoil and occasional boulders. Very few piles of rock, however, are seen in the fields. The stony, unassorted parent material is typically calcareous, but the soil proper has no free carbonates in it.

The land is generally rolling and sometimes quite rough and hilly, and the portion remaining in forest consists of oak, maple, hickory, ash, and other hardwoods. Volunteer white clover is quite abundant in cuts and this soil is generally found to be neutral or only slightly acid. Red clover and alfalfa cannot be grown successfully without liming, but sweet clover pastures appear to be tolerant of the soil acidity, although it produces a much heavier growth on limed soils. This is generally a productive soil and is being used both for fruit and general farming.

Coloma Loamy Sand

Upon entering this soil area one notices a definite change in vegetation. In the wooded areas there is a predominance of oaks with a few beech, hard maple, black ash, and other hard woods. Most wooded areas also contain an undergrowth of flowering dogwood and sassafras along the roadside, and in the vacant and unworked fields sour dock, sorrel, various mosses, bindweed, yarrow, vetch, St. John's-wort, wild carrot, lupines, rabbit's-foot clover, and Lespedeza frutescens and Lespedeza hirta grow in abundance. The surface of this

soil is a grayish brown or light yellowish brown loamy sand, grading into a brownish yellow sand with enough clay to act somewhat as a binder. It does not constitute a good general farming soil and was not brought under cultivation until the fruit industry was developed. Now it is used extensively for grape vineyards, bramble fruits, peach, apple, pear, and cherry orchards with a limited amount of general farming and responds well to good farming methods. Limed soils produce crops of alfalfa profitably. Four legumes particularly seem to thrive on this acid soil--*Trifolium arvense*, *Lespedeza frutescens*, *Lespedeza hirta*, and *Lupinus perennis* of which there was a great abundance. Two *Desmodiums*, *nudiflorum* and *rotundifolium*, and a wild bean, *Apios tuberosa*, were found in the wooded area. One is struck in this instance by the selectivity of the plants as pertained to soil which is almost as marked as between semi-aquatic and land plants.

Miami Silt Loam

Very little of this soil can be found covered with the native vegetation as it is practically all under plow except for the occasional small wood lot. It is a productive farm land used more for general farming than for fruit growing. The surface soil is a grayish brown to brown silt loam about twelve inches deep underlain by a yellowish brown silty clay to a depth of three feet. The unweathered till is yellowish or bluish gray and is moderately to strongly calcareous even sometimes effervescing in acid. This was the only region observed where many of the farmers said that up to the present time liming of the soil for alfalfa had been unnecessary. Volunteer red clover (*Trifolium repens*) and sweet clover (*Melilotus*) grows abundantly along the roads and in railroad rights of way.

Nappanee Silt Loam

Like Miami silt loam the Nappanee silt loam is a good soil for general farming. The only lumber remaining is in small wood lots. The growth is various species of hardwoods including oak, elm, ash, hickory, beech, hard maple, and basswood. The only legumes found in the woods were the Desmodiums, but along the roadsides and in open spaces sweet, red, and white clover and the showy tick trefoil grow luxuriantly. The top soil is a brownish gray clayey soil and the subsoil is a rust brown containing a preponderance of clay. The heavy clays are neutral or alkaline in reaction, but the lighter clays and sandy soils are acid. There is insufficient drainage in considerable of this area; tiling improves the soil generally. Where the drainage is adequate clovers and alfalfa can be grown without liming, but the crop is improved by moderate applications.

Maumee Silty Clay Loam

This type occupies what was at one time known as the Big Meadows and occupied a poorly drained portion of the St. Joseph valley and was in an intermittently swampy condition. The natural growth was probably wild grasses and sedges some of which can still be found in undrained spots. The surface soil is a black silty clay loam with a high content of organic matter five to ten inches thick. Below this for about twelve inches is a layer of bluish gray to mottled brown clay which is underlain to a depth of three feet with a medium to coarse sand. The water table has been lowered by large dredge ditches and most of the land is under cultivation, mint, corn, and hay being the principal crops. Bramble fruits and strawberries also do well on this land. The absence, or nearly so, of all legumes is very noticeable. The soil is

acid. Some fields of alfalfa were observed. In general the alfalfa was doing poorly on unlimed soils but very well when limestone or marl had been applied.



A Dredge Ditch in the Big Meadows Section

The level contour of the land is characteristic of this entire region





A Close-up Showing a Terrace
60 Feet High

Looking at the Terraces Across
a Flat $\frac{3}{4}$ Mile Wide



Corn Planted Lengthwise of
One of the Lower Terraces

PART THREE

GENERAL OBSERVATIONS WITH REGARD TO LEGUMES

The leguminous plants have come into great agricultural prominence because of the power that some, perhaps all, of them have of fixing the free atmospheric nitrogen contained in the soil, and thereby enriching the land in this valuable element when they decay, to the great advantage of plants that do not possess this power. These are plants of the great natural family, Leguminosae, which contains several thousand species in all parts of the world, some of them being great trees, as mahogany, locust, and Kentucky coffee trees; some of them bear very gaudy flowers, placing them among the most showy of plants; and many are cultivated as field crops being used as food for man and as grain and forage for livestock. Many species are also grown in greenhouses and open gardens for ornament.

In the beginning of this study the writer held to the belief that legumes of all kinds required a limestone or at least a neutral soil and that the reason for this was that the various forms of nitrogen-gathering bacteria lived only in an alkaline medium. The study seems to indicate, however, that certain bacteria thrive even in acid soils and that the calcium is probably mostly used by the plant itself rather than by the soil bacteria and that its influence aside from that of supplying nourishment is one of physiological effect and that its beneficial effects to bacteria are, in part at least, in the form of improved physical condition of the soil by providing better ventilation and a more suitable medium in which to develop.

This conclusion was reached because practically all the legumes

studied bore bacterial galls called nodules on their roots and that some of the largest and most thrifty colonies were found on plants growing in soils with a pH of 5 or lower. It was also noticed that sometimes nodules would be found on plants growing on a certain kind of soil in one locality while in another locality there would be an absolute absence of them on the same plant growing on the same soil type. Experience in the growing of cultivated legumes bears this out in that it is necessary to inoculate the soil if the plants are to have the benefit of the nitrogen gathering bacteria.

The writer also was of the opinion that legumes were very selective in the matter of the soils on which they grow. Many appear, however, to be quite adaptable to a wide range of conditions, and, like alfalfa, some species or variety will thrive on almost any soil, and because of the tap rooting habit of many of them they can hold their own in times of drought and adversity.

PART FOUR
THE NATIVE LEGUMES

Twelve native legumes were identified and studied. Usually one thinks of the cultivated clovers, alfalfa, beans, and peas when legumes are mentioned. None of the legumes native to this area are cultivated species. The Lespedezas are a cultivated crop on the sandy acid soils of the South, but those found here are not useful either for forage or soil improvement.

In Europe and North Africa there are species of cultivated Lupines. None of the North American species are cultivated to any extent.

Cercis canadensis Redbud. Judas-tree.

These trees are found growing quite abundantly along the river, particularly in sandy, well-drained locations, and on the banks of the terraces of the river. Sometimes they are found growing alone. Other times they will be found forming a thicket. Just east of Emmanuel Missionary College on the lower flats the land rises forming a sort of knoll about one-half acre in extent. This entire knoll is covered with a dense thicket of redbud trees. This tree appears to do best in a rich, well-drained, sandy loam or silty loam soil. It is generally found in river valleys as it is in this case, but can be transplanted to higher locations. In most cases the soil, particularly the subsoil, was found to have a neutral or alkaline reaction. The roots of trees would naturally have the advantage in reaching down into the subsoil to the less acid soils.

Some representative associated plants were red and white elm, red and white oak, honey locust, flowering dogwood, soft maple, black walnut, basswood, and sycamore. The ground vegetation varied greatly since there was considerable variation in the quality of the top soil in different locations.

Gleditsia triacanthos Three-thorned Acacia. Honey Locust.

This tree is also found along the river flats, but has a somewhat wider distribution than the redbud tree but is more thinly scattered. It is found several miles back from the river associating with other forest trees and is no doubt indigenous to this section. Some of these trees grow to a considerable size. One was found measuring nearly two feet in diameter. It grows in a variety of soils with

a probable optimum pH of 7 and with varying plant associates.

Some associated trees and shrubs were white and black ash, redbud, hard and soft maple, red and white elm, beech, spice bush, hackberry, flowering dogwood, and prickly ash. There is still greater variation in the surface vegetation and it probably has little bearing on the soil environment of this plant since its roots penetrate deeply into the subsoil.

Gymnocladus dioica Kentucky Coffee-tree.

Only one small grove of this plant was found consisting of about twenty-five trees and ranging in age from two to sixty or seventy years. This grove was located upon the first terrace growing in Fox sandy loam soil. The top soil tested 5.0 - 5.6 and the subsoil, 7.4

One would believe from observing this tree that it does not stand shade well. All the lower limbs on the tree die early, and a number of trees were observed to have died when less than two inches in diameter. The largest tree observed was nearly one foot in diameter and about seventy-five feet high. The drainage was good. Associated with this tree were beech, hard maple, ironwood, American elm, black ash, hickory, basswood, and paw paw.

Lupinus perennis Wild Lupine.

It grows well in sandy soil testing quite strongly acid. The probable optimum is 5.6 or less. This plant was found growing abundantly in Coloma loamy sand and occasionally in very sandy areas in other sections. Evidence that these plants thrive in sand is their frequency in the dunes area. Rather sharp lines are evident in the

type of plant growth where lupines grow. The trees consist mostly of black and bur oaks with occasional cherry or sycamore trees. There is an abundant growth of staghorn sumac and sassafras and near the ground, brambles, catbrier, grapevines, asters, plantains, Lespedeza, and wild carrot.

In Europe large tracts of sandy soils have been brought into condition for profitable cultivation by green-manuring with lupines and fertilizing with phosphates and potash salts. As a forage crop, the cultivated lupines are of no great importance and are but little used for that purpose. The native lupines of North America have been tested at experiment stations and so far have been found to be of little value for soil building. It is quite possible that if it ever becomes profitable to build up some of the sandy soils of the West one or more of the lupines, probably of a European species, may prove valuable.

Trifolium repens White Clover.

This is a small perennial plant with creeping stems rooting at the joints. It is well distributed throughout the area studied being most prolific in soils that are neutral or alkaline. In the very sandy acid soil regions it can readily be found but is not abundant. It comes naturally in pastures and along roadsides and in lawns. Well kept lawns that are limed frequently have it in abundance. It grows best in the early part of the season as it delights in a cool climate and in soils retentative of moisture. It makes good bee pasture, and is liked by all animals. When in seed it sometimes salivates horses causing them to "slobber." It is exceedingly nutritious. It does well with most grasses, enriching the soil, giving place to them

when they are vigorous, but reappearing when they are subdued.

Some frequent associates are: black medick, red clover, sweet clover, bluegrass, timothy, buckhorn, wild carrot, dandelion, wood sorrel, etc.

Robinia Pseudacacia Common Locust. False Acacia.

The native habitat of this tree is thought to be the slopes of the Allegheny Mountains, but because of its beauty, rapid growth, and value as a timber tree it was early transported westward. It was formerly used extensively in shipbuilding and turnery, in construction, and for posts and treenails. It was also planted much as an ornamental tree. If it were not for the borers which riddle the trunks and branches this would become one of the most valuable trees of the United States. It appears to adapt itself well to different soils and reproduces itself readily from seed, from stump shoots, and roots. A single locust given a free hand and a good soil will soon produce a thicket, for the roots creeping along the upper layers of the soil send up numerous shoots which quickly set up in life for themselves. The habit accounts for the numerous groves of locusts growing in the loam soils of the St. Joseph valley. They apparently have a very wide pH range as they are found growing and appear thrifty in soils ranging from pH 4.9 down to pH 7 up. Their plant associates vary with the soil in which they are found growing.

Desmodium canadense Showy Tick trefoil.

This plant is found growing in a limited way throughout the area

studied but in many sections is quite sparsely scattered. It grows in open woods, along river banks, and in a more limited way along highways and railroad tracks. It seeks locations that are well drained and seems to thrive on the dryer soils containing a moderate amount of clay. Very few plants were found in the Big Meadows section on the Maumee silty clay loam, on muck land, or on Coloma loamy sand. The average pH range is high and the probable optimum neutral or slightly alkaline. Some associated plants: white oak, black oak, American elm, red elm, red cherry, tulip tree, sumac, wild carrot, goldenrod, sweet clover, evening primrose, bluegrass, wild lettuce, red clover, English plantain, dandelion, milkweed, quack-grass.

Desmodium nudiflorum Naked-flowered Tick Trefoil.

This plant is quite generally distributed about the area studied. Wherever there is unpastured woods one is almost certain to find some of these plants growing. They appear, however, to prefer dry, sandy soils and were found growing most abundantly in the Coloma loamy sand region, the average pH of the soil being 5.5. One is led to believe that cattle eat this legume where the woods are in pasture, because the plants can seldom be found in the pasture while outside the fence they may readily be found. Plants associated with nudiflorum in regions where distribution is the greatest are: black oak, post oak, sassafras, sumac, brambles, grapevines, Lespedeza, wild carrot, asters.

Desmodium rotundifolium Prostrate Tick Trefoil.

Wherever *Desmodium nudiflorum* grows one might expect to also find *Desmodium rotundifolium*. It is, however, much more sparsely distributed.

In the Coloma loamy sand region about ninety per cent of the Desmodiums found in the woods were *Desmodium nudiflorum* and ten per cent *Desmodium rotundifolium*. The soils adapted to one are probably also adapted to the other. This was also true of the associated plants.

Apios tuberosa Groundnut.

This plant is fairly well distributed throughout this area wherever the land lies along a creek, river or lake. It appears to thrive in moist soils and tolerates a wide pH range. It was found growing on soil testing 5.6 and again right in a marl bed. It is found mostly in the woods but also in open land along creek bottoms, climbing many times to the top of other vegetation distributed along the water course. It is not thickly distributed any place and seems not to stand much pasturing as it is seldom found in pastures. Its wide range occasions a large list of plant associates.

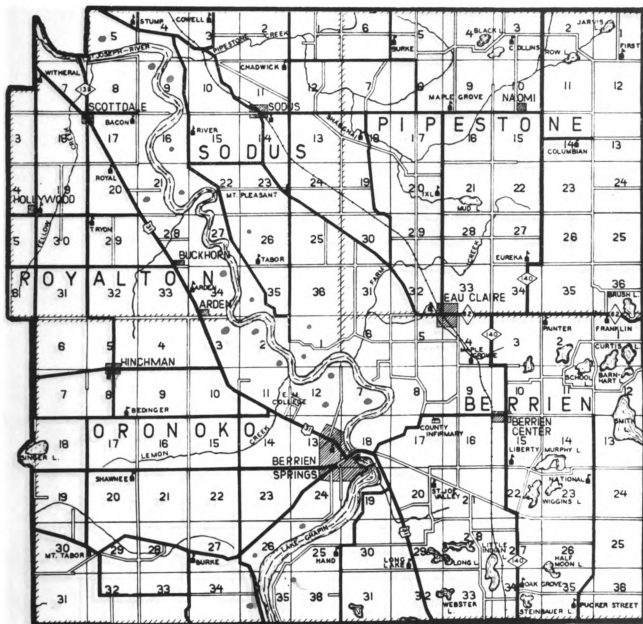
Lespedeza frutescens Wand-like Bush Clover.

This plant loves a dry, sour soil and was found growing abundantly in the Coloma loamy sand region. Its absence from other regions indicates that it is very selective in regard to this point. This is more evident when one discovers that a very small tract of land having sandy soil and a pH range of about 5.6 will soon be growing some of these plants. It grows in open places in the woods, along fields, and highways, and in deserted fields. Certain species of *Lespedeza* are valuable as forage for livestock and for soil building. They are grown in many of the southern states on land where the soil is impoverished

and acid in reaction. Plants associated with and enjoying a similar soil are: oaks, sassafras, sumac brambles, grapevines, lupines, asters, wild carrot, *Lespedeza hirta*.

Lespedeza hirta Hairy Bush Clover.

In most instances where *Lespedeza frutescens* was found, *Lespedeza hirta* was also found. The plants evidently enjoy similar soils and their plant associates would also be the same.

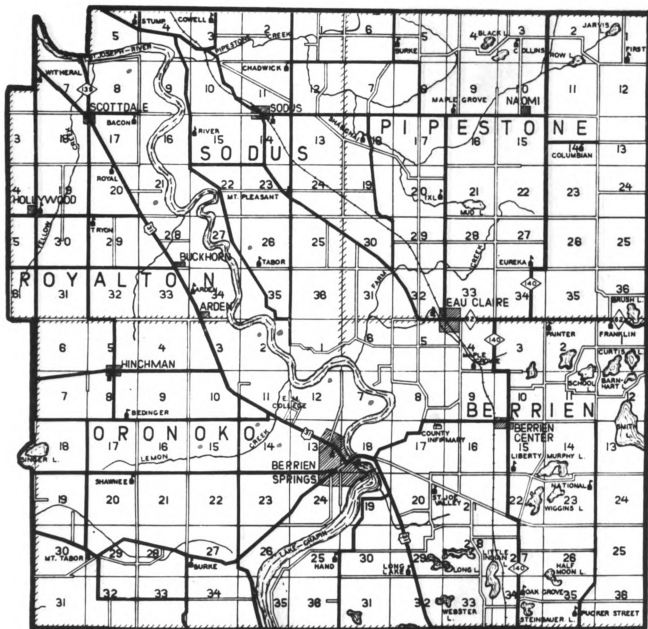


LEGEND

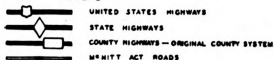
- UNITED STATES HIGHWAYS
- STATE HIGHWAYS
- COUNTY HIGHWAYS — ORIGINAL COUNTY SYSTEM
- MCHITT ACT ROADS

- Light distribution
- Medium distribution
- Heavy distribution

Upper pH range of top soil 7.4
 Lower pH range of top soil 6.1
 Average pH range of top soil 6.6
 Probable optimum 7.4

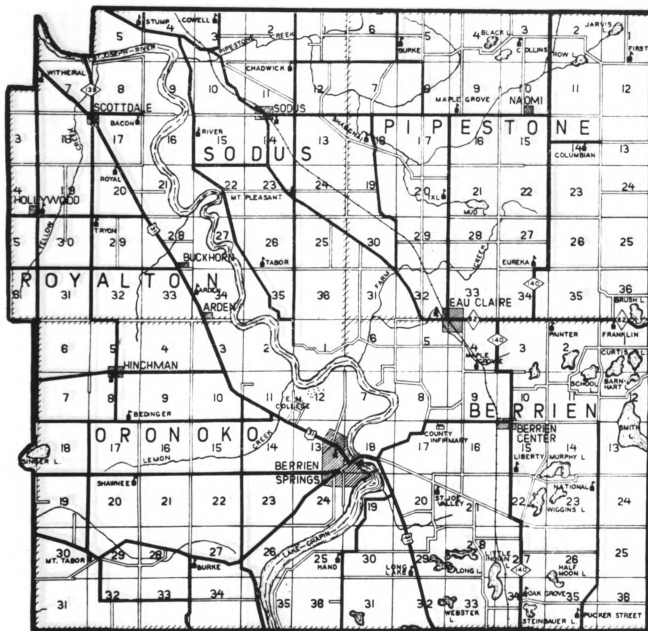


LEGEND



- Light distribution
- Medium distribution
- Heavy distribution

Upper pH range of top soil 7.4
 Lower pH range of top soil 6.1
 Average pH range of top soil 6.5
 Probable optimum 7.

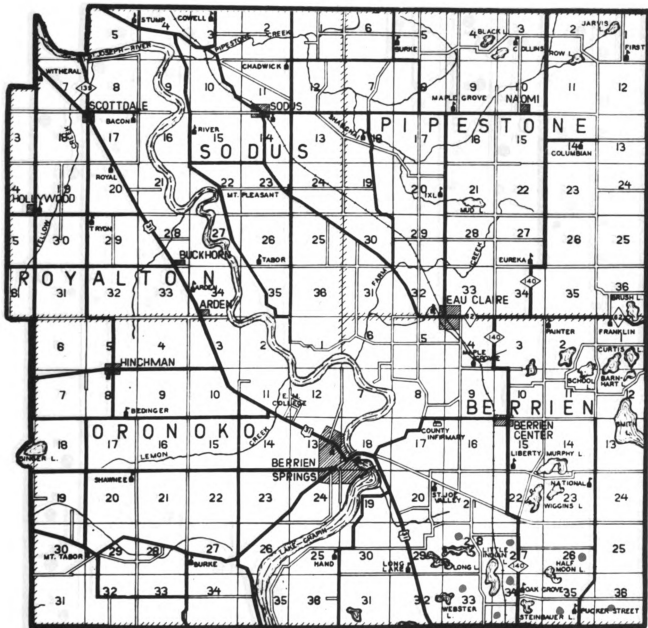


LEGEND

- UNITED STATES HIGHWAYS
- STATE HIGHWAYS
- COUNTY HIGHWAYS - ORIGINAL COUNTY SYSTEM
- MCHITT ACT ROADS

- Light distribution
- Medium distribution
- Heavy distribution

Only one group of these trees we found.
 Here the top soil test was 5.0 - 5.6
 but the subsoil was 7 1/2

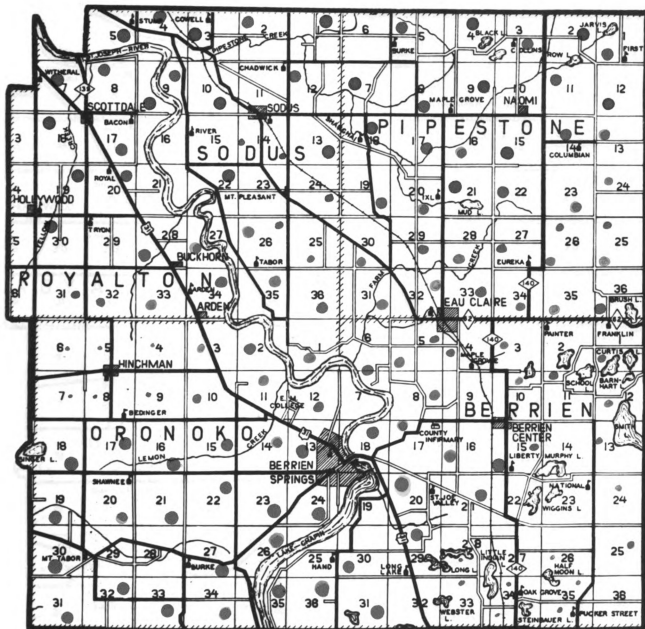


LEGEND

- UNITED STATES HIGHWAYS
- STATE HIGHWAYS
- COUNTY HIGHWAYS — ORIGINAL COUNTY SYSTEM
- M^o HITT ACT ROADS

- Light distribution
- Medium distribution
- Heavy distribution

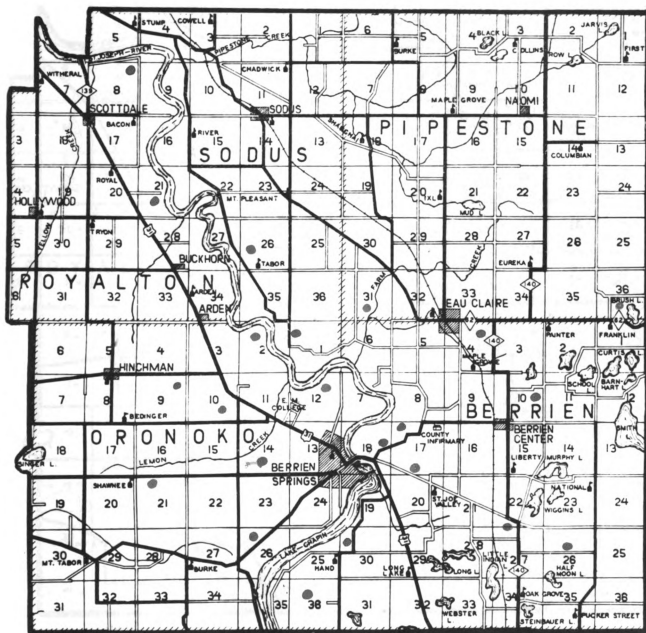
Upper pH range of top soil 6.1
 Lower pH range of top soil 4.9
 Average pH range of top soil 5.5
 Probable optimum 5.6



LEGEND

- UNITED STATES HIGHWAYS
- STATE HIGHWAYS
- COUNTY HIGHWAYS - ORIGINAL COUNTY SYSTEM
- M⁰ HITT ACT ROADS

- Light distribution
- Medium distribution
- Heavy distribution
- Upper pH range of top soil 7.4
- Lower pH range of top soil 4.9
- Average pH range of top soil 6.2
- Probable optimum 7.4



LEGEND

- UNITED STATES HIGHWAYS
- ◇— STATE HIGHWAYS
- COUNTY HIGHWAYS — ORIGINAL COUNTY SYSTEM
- M-HITT ACT ROADS

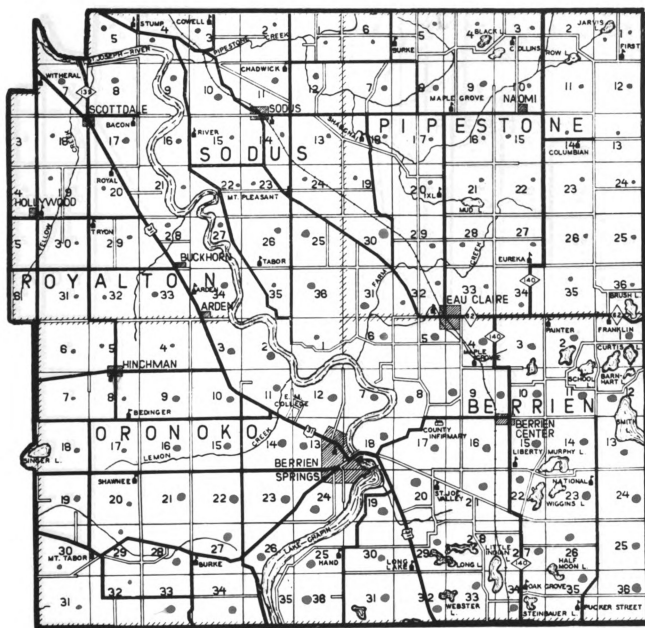
- Light distribution
- Medium distribution
- Heavy distribution

Upper pH range of top soil 7.4

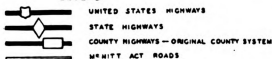
Lower pH range of top soil 5.

Average pH range of top soil 5.6

Probable optimum - Apparently not selective. At least they are acid tolerant.

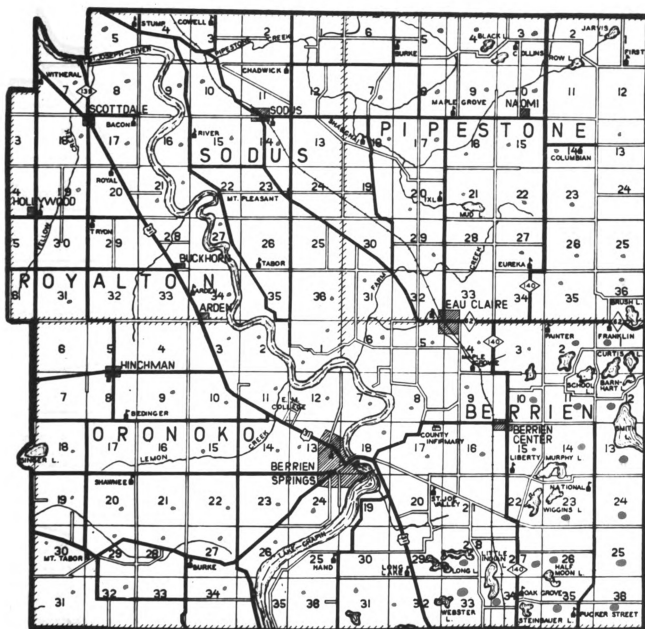


LEGEND







- Light distribution
- Medium distribution
- Heavy distribution

Upper pH range of top soil 7.4
 Lower pH range of top soil 6.1
 Average pH range of top soil 6.4
 Probable optimum 7.



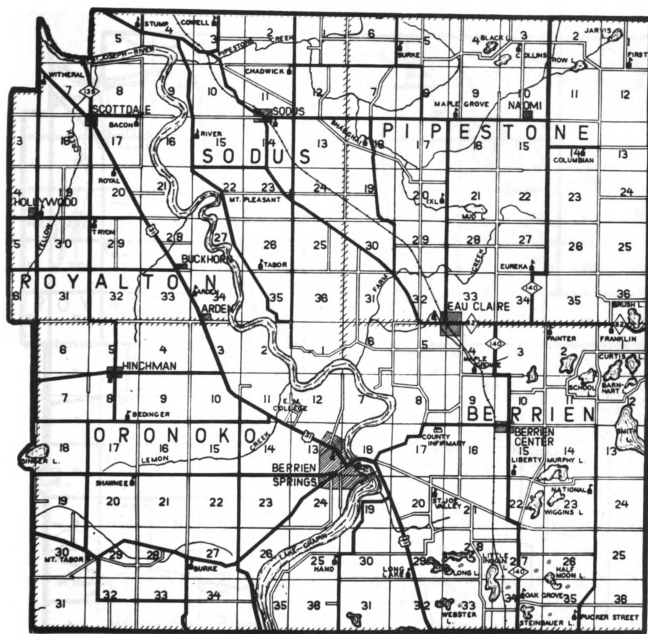
LEGEND

-  UNITED STATES HIGHWAYS
-  STATE HIGHWAYS
-  COUNTY HIGHWAYS - ORIGINAL COUNTY SYSTEM
-  M⁴ NITTY ACT ROADS

- Light distribution
- Medium distribution
- Heavy distribution

Upper pH range of top soil 6.1
 Lower pH range of top soil 4.9
 Average pH range of top soil 5.5
 Probable optimum 5.6

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 • The fifth part of the paper discusses the importance of the



LEGEND



UNITED STATES HIGHWAYS

 **STATE HIGHWAYS**

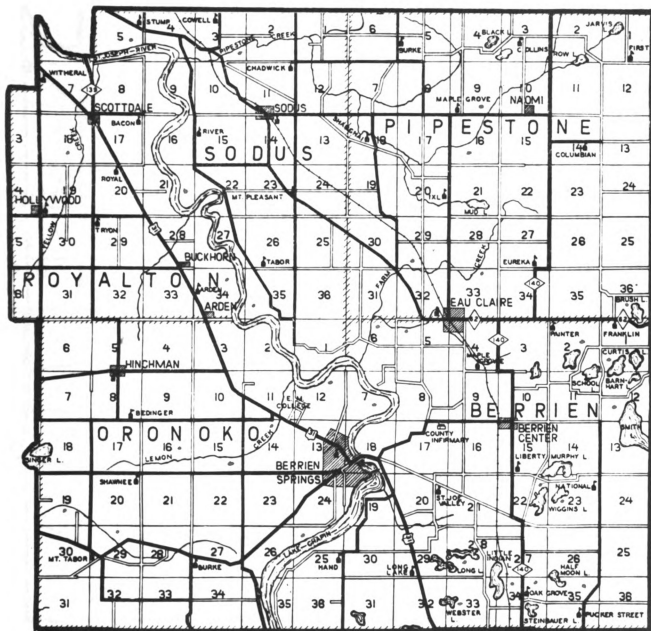
 COUNTY HIGHWAYS — ORIGINAL COUNTY SYSTEM



MCNITT ACT ROADS

- Light distribution
- Medium distribution
- Heavy distribution

Upper pH range of top soil	-	
Lower pH range of top soil	-	only a few
Average pH range of top soil	-	plants found
Probable optimum	-	

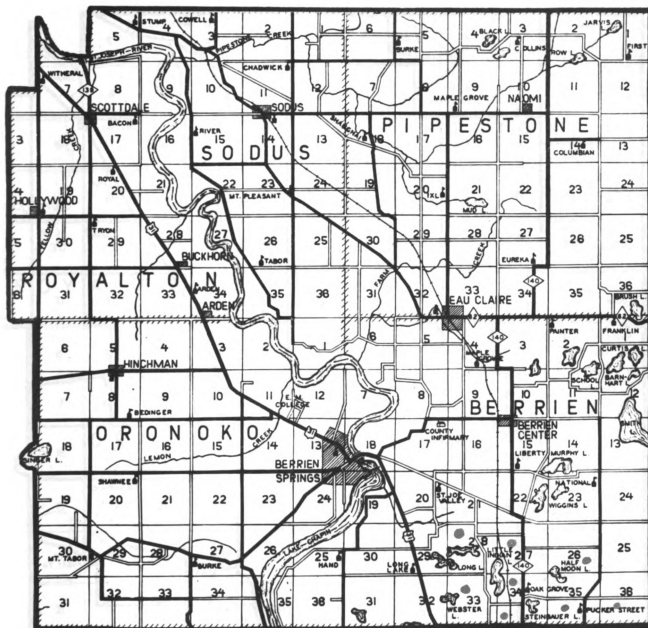


LEGEND

- UNITED STATES HIGHWAYS
- STATE HIGHWAYS
- COUNTY HIGHWAYS - ORIGINAL COUNTY SYSTEM
- MCHITT ACT ROADS

- Light distribution
- Medium distribution
- Heavy distribution

Upper pH range of top soil 7.4
 Lower pH range of top soil 5.5
 Average pH range of top soil 5.6
 Probable optimum 6.1

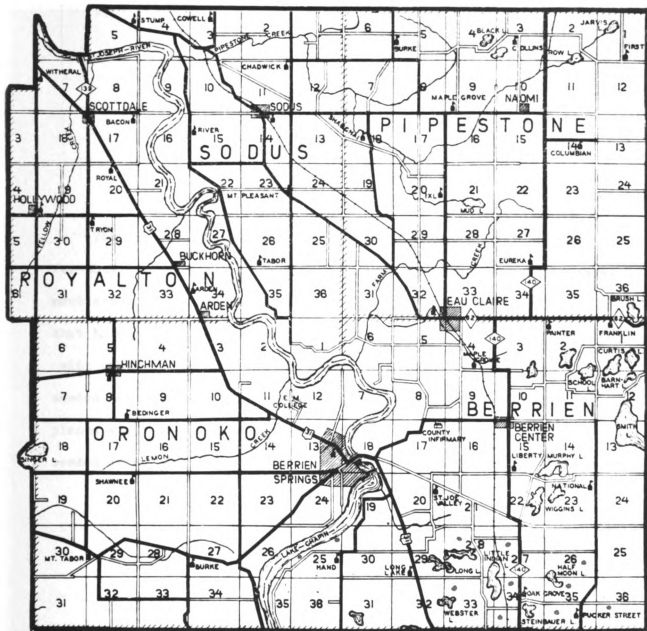


LEGEND

- +— UNITED STATES HIGHWAYS
- ◇— STATE HIGHWAYS
- COUNTY HIGHWAYS — ORIGINAL COUNTY SYSTEM
- M-HITTY ACT ROADS

- Light distribution
- Medium distribution
- Heavy distribution

Upper pH range of top soil 6.1
 Lower pH range of top soil 4.9
 Average pH range of top soil 5.5
 Probable optimum 5.6



LEGEND

- UNITED STATES HIGHWAYS
- STATE HIGHWAYS
- COUNTY HIGHWAYS — ORIGINAL COUNTY SYSTEM
- WENNETT ACT ROADS

• Light distribution

● Medium distribution

● Heavy distribution

Upper pH range of top soil 6.1

Lower pH range of top soil 4.9

Average pH range of top soil 5.5

Probable optimum 5.6

PART FIVE

THE INTRODUCED LEGUMES

The introduced legumes are of great importance to farmers for they include the most important forage, pasture, and soil improvement crops. In making this study, account was taken only of those that have escaped from cultivation and are growing in competition with other wild plants. It is a little difficult to know which are seeded naturally and which artificially, but cognizance was taken of plants where it was evident that they were not a part of a field seeded crop.

Medicago sativa Lucerne. Alfalfa.

This plant is rather sparsely distributed in most areas. Some variety of this species can be found that is adaptable to a very wide range of soil and climate, but it does not do very well as a volunteer plant. Once established, however, its roots penetrate the soil to a considerable depth and it maintains its place fairly well provided the soil is either neutral or alkaline. It cannot tolerate a sour soil, not that it will not grow but it soon becomes unthrifty and dies. However, the aforeheld theory that alfalfa would not thrive without irrigation unless planted in soils that were proved to be adapted to the growth of corn or cottonwood has been found to be entirely fallacious and instead alfalfa is growing with more or less prosperity on much of the wide diversity of soils of the United States. A student of this crop has said, "However unpromising their appearance whether river bottom land or high plateaus sixty to one hundred feet above available water, gravel, desert sand, or richest mold, in fact in many places supposed to be least encouraging, and even on rough lands far removed from any accessible water supply, it grows with a persistence that almost tempts one to class it as a weed." Considerable alfalfa is grown in this area, and in most cases the soil must be limed in order to produce a good crop. In inoculation of the soil with nitrogen-gathering bacteria is very essential in the field culture of this crop.

Medicago lupulina Black Medick.

On the flats adjacent to the river where the soil is sweet from the abundant deposits of shells, black medick covers the ground in July

and August in a mat, particularly in fields from which a crop of winter wheat has been cut and the field left unplowed. It is also found quite abundantly in waste places all over this area where the soil is sweet but appears not to tolerate soil acidity. Some plants found neighboring with black medick are: red clover, strawberry, buckhorn, ragweed, white clover, goldenrod, alsike clover, bluegrass.

Melilotus alba White Melilot. White Sweet Clover.

This plant is very abundant in most of the area studied, being found along roadsides, rights of way, open spaces in the woods, discarded fields, etc. The plant produces an abundance of seed and seeds itself. In earlier years no doubt it was seeded for bee pasture. It is one of the most prolific of the legumes and its adaptability to a variety of soils causes it to be used as pasture and hay where alfalfa, clover, and timothy will not do well. Soils that are almost pure sand and gravel bear prolific crops of this plant. It loves a sweet soil and one of the best ways to improve poor soil is to lime it, inoculate with nitrogen-gathering bacteria, and plant with sweet clover. It gathers nitrogen abundantly, and when plowed under supplies a large amount of humus because of its rank and rapid growth. Acid and poorly drained soils are suited to the growth of sweet clover.

Melilotus officinalis Yellow Melilot. Yellow Sweet Clover.

Yellow sweet clover has nearly as great a distribution but is far more sparsely scattered than white sweet clover. It needs a heavy soil and does not grow nearly so rank. It is not used much as a soil improvement crop for this reason and no doubt accounts for it being more

sparsely distributed. It also loves a limestone soil and is found associated with the white sweet clover on the heavier soils.

Trifolium arvense Rabbit's-foot Clover.

This plant is not widely distributed in this area. It was found only in the Coloma loamy sand region and then not in great quantity. The soil in which it was growing was very light and tested 6.1. Some associated plants were: lupines, mildweed, bluegrass, vetch, and wild strawberry. Nearby in the woods were oaks, sassafras, sumac, brambles.

Trifolium hybridum Alsike Clover.

Along the creek and river valleys and in meadows and depressions providing abundance of moisture, alsike clover thrives. It does best on a fairly heavy loam soil that is neutral or slightly alkaline. Its average pH range was 6.4 and associated with it in various locations were such plants as white and pink boneset, mints, sedges, dandelion, wild carrot, bluegrass, red clover, Medicago lupulina.

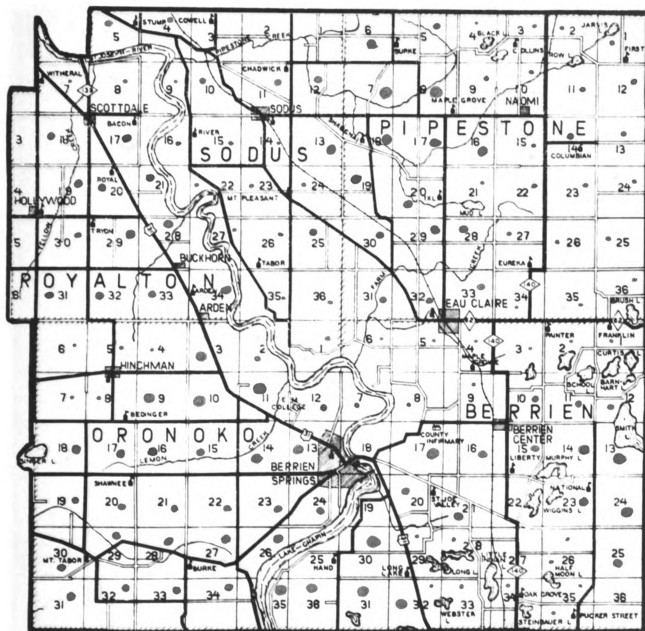
Trifolium pratense Red Clover.

For many years farmers planted red clover as the chief legume hay and soil improvement crop, and it is well distributed throughout the area. Volunteer plants are quite abundant in soils with a pH of 6.1 and up. It loves an alkaline soil and its response to soil conditions is easily discovered. In soils with a pH range of 5.5 and downward the absence of volunteer red clover is very noticeable. Eighteen soil tests were made for red clover. The average pH was about 6.2.

Some plant associates were alsike clover, Canada thistle, dandelion, timothy, bluegrass, wild carrot, milkweed, mint, goldenrod, and alfalfa.

Vicia Cracca Cow Vetch.

In many orchards vetch has been planted for a green manure and cover crop. This plant has escaped from cultivation and is found growing as a volunteer, particularly in the more dry and sandy soils. The occasional plant may be found almost any place. In the Coloma loamy sand and in Fox sandy loam it can be seen most frequently. It appears to grow well on either limed or unlimed soils, but prefers a loose loamy soil and good drainage.

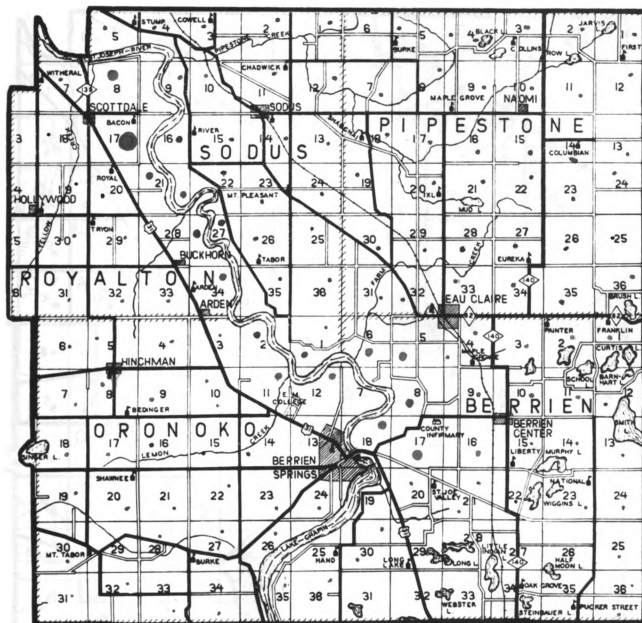


LEGEND

- UNITED STATES HIGHWAYS
- STATE HIGHWAYS
- COUNTY HIGHWAYS — ORIGINAL COUNTY SYSTEM
- HIGHWAY ACT ROADS

- Light distribution
- Medium distribution
- Heavy distribution

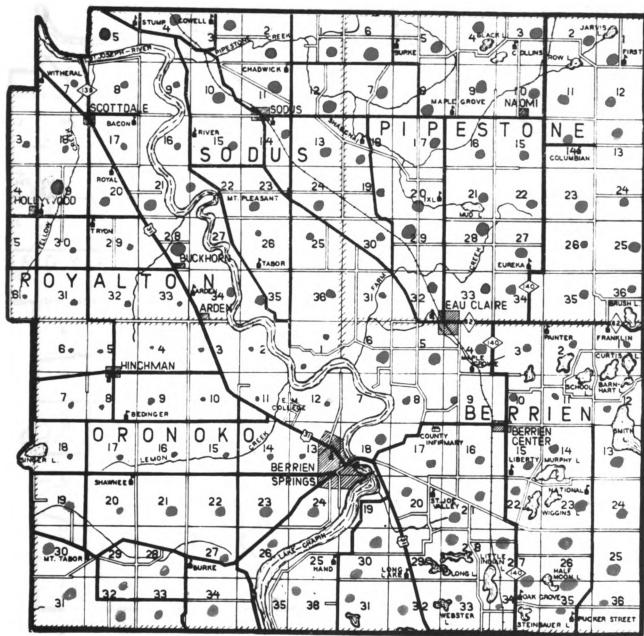
Upper pH range of top soil 7.4
 Lower pH range of top soil 4.9
 Average pH range of top soil 6.5
 Probable optimum 7.4







LEGEND

- UNITED STATES HIGHWAYS
- STATE HIGHWAYS
- COUNTY HIGHWAYS - ORIGINAL COUNTY SYSTEM
- M-HITT ACT ROADS

- Light distribution
 - Medium distribution
 - Heavy distribution
- Upper pH range of top soil 7.4
 Lower pH range of top soil 6.7
 Average pH range of top soil 6.8
 Probable optimum 7.4

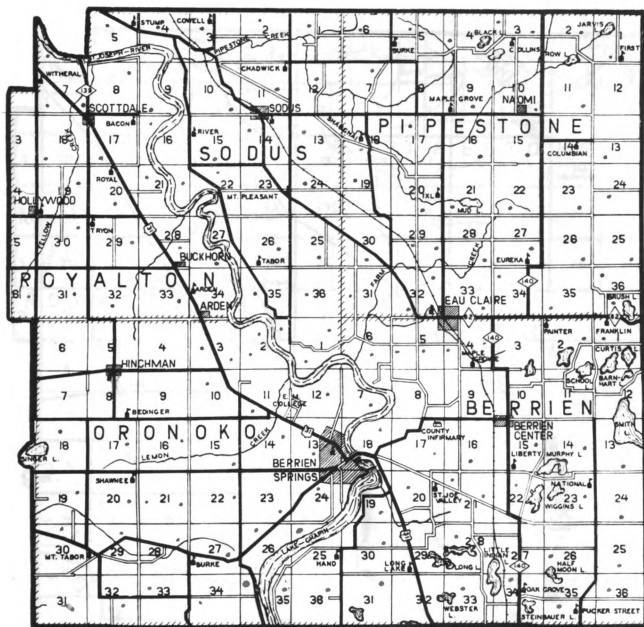


LEGEND

-  UNITED STATES HIGHWAYS
-  STATE HIGHWAYS
-  COUNTY HIGHWAYS — ORIGINAL COUNTY SYSTEM
-  MICHITT ACT ROADS

- Light distribution
- Medium distribution
- Heavy distribution

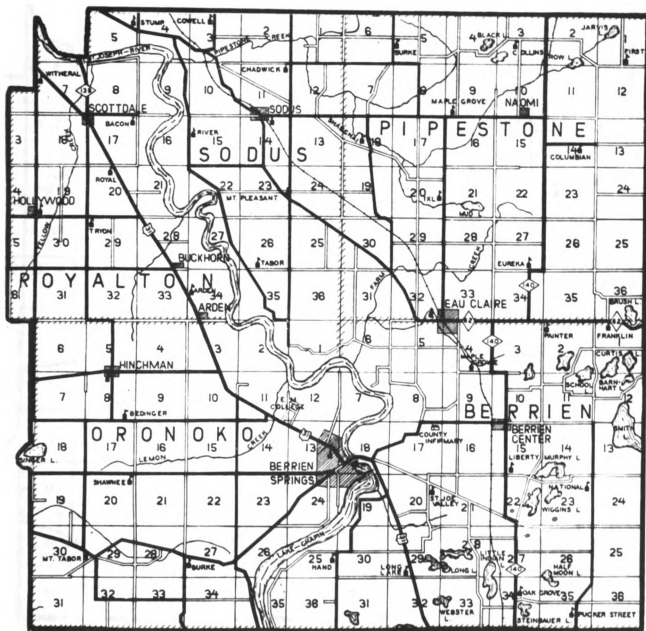
Upper pH range of top soil 7.4
 Lower pH range of top soil 4.9
 Average pH range of top soil 6.5
 Probable optimum 7.4







LEGEND

- UNITED STATES HIGHWAYS
- STATE HIGHWAYS
- COUNTY HIGHWAYS — ORIGINAL COUNTY SYSTEM
- MC HITT ACT ROADS

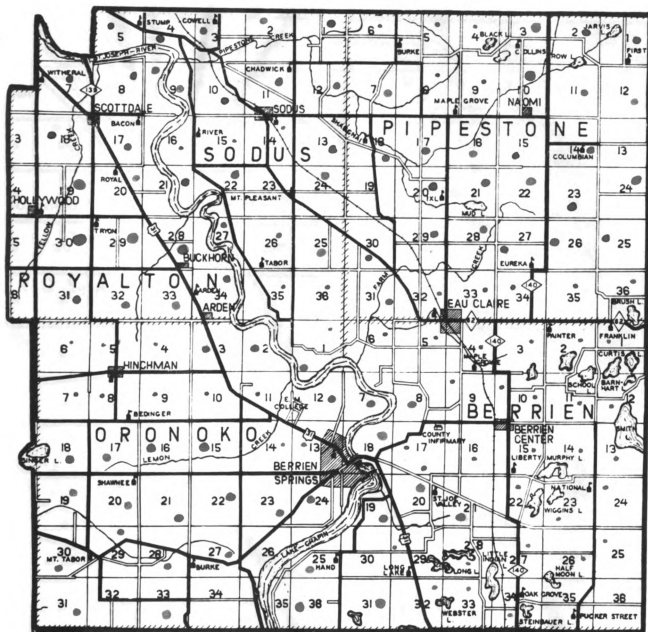
- Light distribution
 - Medium distribution
 - Heavy distribution
- Upper pH range of top soil 7.7
 Lower pH range of top soil 4.9
 Average pH range of top soil 6.3
 Probable optimum 7.7



LEGEND

-  UNITED STATES HIGHWAYS
-  STATE HIGHWAYS
-  COUNTY HIGHWAYS - ORIGINAL COUNTY SYSTEM
-  M'NITT ACT ROADS
- Light distribution
- Medium distribution
- Heavy distribution

Only found in a very few locations
and the soil test in each case
was about 6.1



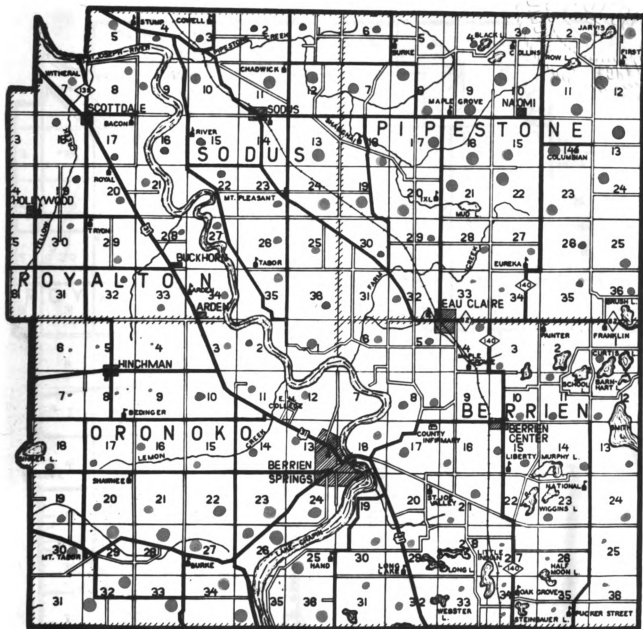
LEGEND

- UNITED STATES HIGHWAYS
- STATE HIGHWAYS
- COUNTY HIGHWAYS — ORIGINAL COUNTY SYSTEM
- MC HITT ACT ROADS





- Light distribution
- Medium distribution
- Heavy distribution

Upper pH range of top soil 7.4
 Lower pH range of top soil 4.9
 Average pH range of top soil 6.4
 Probable optimum 7.4

11

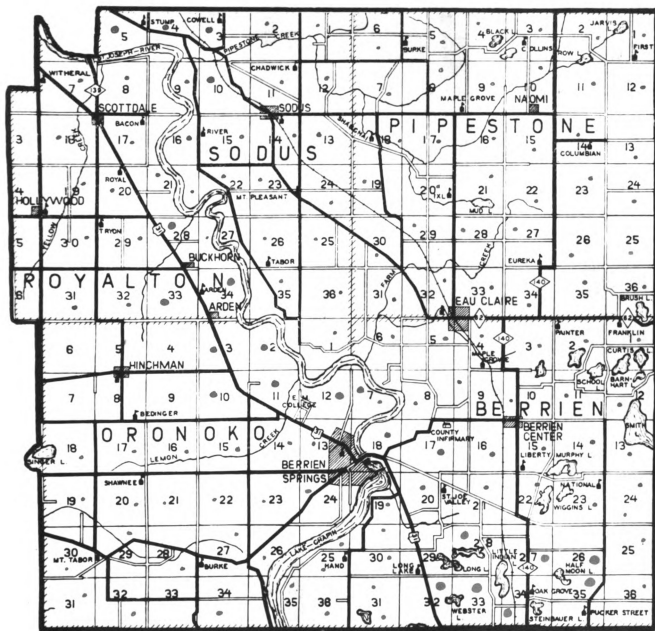


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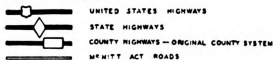
-  UNITED STATES HIGHWAYS
-  STATE HIGHWAYS
-  COUNTY HIGHWAYS - ORIGINAL COUNTY SYSTEM
-  MICHIGAN ACT ROADS

- Light distribution
- Medium distribution
- Heavy distribution

Upper pH range of top soil 7.4
 Lower pH range of top soil 4.9
 Average pH range of top soil 6.2
 Probable optimum 7.4



LEGEND



- Light distribution
- Medium distribution
- Heavy distribution

Upper pH range of top soil 7.4
 Lower pH range of top soil 4.9
 Average pH range of top soil 5.5
 Probable optimum 6.5 - 7.

Plants Found Growing on Coloma Loamy Sand



Desmodium nudiflorum



Lespedeza frutescens



Lespedeza hirta



An Oak Grove in the Coloma
Loamy Sand Region

An Oak and Sassafras Grove
in the Same Region



General View of Coloma Loamy
Sand Area



Sweet Clover Growing by the Roadside Interspersed by Young Sassafras Trees. The soil is almost pure sand and gravel.



Sweet Clover Pasture in Coloma Loamy Sand Region



Lupines Growing in Coloma Loamy Sand



A Grove of Twenty-five Kentucky
Coffee Trees



A Close-up of a Young Kentucky
Coffee Tree



View Showing Bark Characteristics of
Kentucky Coffee Tree



One-half Acre Grove of Redbud Trees



Redbud Tree in Fruit

Honey Locust Showing the
Large Thorns



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DATE OF BIRTH August 14, 1892

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