Proceedings of the Iowa Academy of Science

Volume 9 | Annual Issue Article 26

1901

Preliminary Notes on the Flora of Western Iowa, Especialy from the Physiographical Ecological Standpoint

L. H. Pammel

PRELIMINARY NOTES ON THE FLORA OF WESTERN IOWA, ESPECIALLY FROM THE PHYSIOGRAPHICAL ECOLOGICAL STANDPOINT.

BY L. H. PAMMEL.

In this preliminary paper I shall consider briefly only the ecological conditions of the flora, chiefly in the counties of Harrison and Pottawattamie, with brief references also to the flora of the adjoining counties. The writer has spent some time in a study of the flora of western Iowa, but much more work needs to be done before the subject is entirely completed. The region is of great interest from the botanical standpoint because this flora has many plants which are common to the western flora.

Much work has been done along ecological lines, especially that portion dealing with the different plant formations, but we are only at the beginning of this important line of work. This work was started by Warming, whose general treatise is classical. His work has given greater impetus to this study than any other investigator, but we are also indebted to numerous other writers especially American. On this side of the Atlantic we are especially indebted to Prof. Conway MacMillan,* who, in several admirable papers and his paper on the "Distribution of Plants" along the shore at Lake of the Woods has shown what may be done.†

A contribution to the knowledge of the flora of southeastern Minnesota.

Likewise the paper by Wheeler on a small district of southeastern Minnesota.‡

*Minnesota Plant Life. Rept. of the Survey. Botanical Series. 3: 568. *pl. 4. 240 f.*

†Minn. Bot. Studies. 1: 949–1023. pl. 1897.

‡ Minn. Bot. Studies. 4: 353. *Pl. 21-27.* 1901. separate.

The work of Clements and Pounds views the subject from a broad standpoint, giving also minute details of the plant formations.* In a more recent paper they have extended their work to more local conditions.† The chief center of this line of work in this country has been at the University of Chicago, where Cowles‡ and students of Prof. Coulter have devoted themselves assiduously to a study of the many intricate problems, problems by no means easy as shown by Cowles.

During the summer and fall two important papers on this subject have appeared, one by Dr. Bray‖ on the ecological relations of the vegetation of western Texas, a region well worked by botanists and a choice field for botanical investigation. The richness of the flora became known through Wright, Lindheimer, Fendler, culminating in the large Flora of Western Texas by Coulter.§

While these men discussed the general floristic features of so interesting a region but little was known of the biological relations of these plants. The paper takes up (1) the climatic and edaphic factors, (2) physiography and geology, (3) plant formations.

The main divisions of plant formations are grouped under

a. Grass formations.
b. Woody formations.
c. Succulent formations.
d. Halophytic formations.

It is unnecessary in this connection to enter into details of the subdivisions of each, though important in interpreting the character of the plants and their relation to the general features of the flora.

Dr. Charles Mohr,** the well known botanist of Alabama, left us a monument to his many years of labor in Alabama

* Clements and Pounds. The Phytogeography of Nebraska. Gen. Sur. Nebr. 442. *pl.* 4, (2 ed.)

† Bessey, Pound and Clements. Report on the Recent Collections, Studies in the Vegetation of the State. 1: Univ. of Nebr. Bot. Surv. 5.

‡ Cowles. The Ecological Relation of the Vegetation in the Sand-dunes of Lake Michigan. Bot. Gaz. **27**: 95, 167, 281, 361. 1899.

‖ The ecological relations of the vegetation of western Texas. Bot. Gazette **32**: 99, 195, 262, 24 f. 1901. Contr. Hull. Bot. Lab. 80.

§ Botany of Western Texas. Contr. U. S. Nat. Herb. **2**: 1891–4.

** Plant Life of Alabama. An account of the distribution, modes of association and adaptations of the flora of Alabama, together with a systematic catalogue of the plants growing in the state. Contr. U. S. Nat. Herb. U. S. Dept. of Agrl. **6**: 921, *13 Pl.* 1901.

the most important contribution on local botany of our country. The author has discussed the ecological relations of this interesting flora. Each of the regions contains a discussion of the ecologic features. This great work may be compared with Willkonnu's der Iberischen Halbinsel.* Nor should I omit in this connection the interesting studies made by Kearney† on the plant covering of ocracoke island and Pieters‡ of Lake Erie in which interesting local conditions are described, as well as one by Lloyd F. Tracy on the Insular Flora of Mississippi and Louisiana.‖

We should not however fail to recognize the fact that a number of investigators, especially those who concern themselves with the distribution of plants, discuss in a general way some of the physiographic conditions. In fact it was known to many of these investigators that physiographic conditions played an important part in the distribution of plants; these floristic studies therefore contain notes of some importance on this subject. Some of these papers contain a true conception of this subject only lacking a classification. Warming's chief contribution was therefore an orderly arrangement and classification of these different formations. But Warming's classification was unsatisfactory in many respects, and we certainly are indebted to Dr. Cowles for having presented at least a classification which, though it may need some modifications, will prove satisfactory along broad lines. The complicated classifications presented by many writers rendered a study and proper conception of the subject nearly impossible. Classifications of this character should always be reduced to their simplest form, but even then in order to classify it may be necessary to study a large number of separate regions in order to bring the subject-matter together.

PHYSIOGRAPHY AND GEOLOGY.

The region which we are about to discuss is one that represents many interesting peculiarities. The soil con-

*Engler and Drude. Die Vegetation der Erde. I. Pflanzenverbreitung auf der Iberischen Halbinsel. 1896.

†Contr. U. S. Nat. Herb. **5**: 261. *f. 33-50.*

‡The plants of western Lake Erie with observations on their distribution. Bull. U S. Fish Com. **1901**: 57-59 *pl. 11-20.* 1901.

‖Bull Torrey Bot. Club **28**: 61. *pl. 8-11.*

ditions are so peculiar that they are well worth considering somewhat more in detail. Mr. W J McGee in a paper on the loess material of northeastern Iowa briefly discusses the question as follows:*

The macroscopic characters of the deposit are moderately constant:

"(1) It is commonly fine, homogeneous, free from pebbles or other adventitious matter, and either massive or so obscurely stratified that the bedding plains are inconspicuous; (2) it commonly contains unoxidized carbonate of lime in such quantity as to effervesce freely under acids; (3) it frequently contains nodules and minute ramifying tubules of carbonate of lime; (4) in many regions it contains abundant shells of land and fresh water mollusca; (5) is commonly so friable that it may be removed with a spade or impressed with the fingers, yet it resists weathering and erosion in a remarkable manner, standing for years in vertical faces and developing steeper erosion slopes than any other formation except the more obdurate clastic or crystalline rocks."

McGee states that it is a fallacy to regard the loess as identical in composition or that it is identical in genesis even in age.

As to its origin Chamberlain and Salisbury† find that in western Wisconsin and contiguous parts of Illinois and Iowa its composition varies in different localities with that of the associated drift and that composition and distribution point to glacial silt as the parent formation of the loess in the upper Mississippi valley. Prof. McGee in speaking of the plants of northeastern Iowa lays great stress upon the occurrence of forest trees upon this area. Now while it is true that the loess of the northeastern and eastern Iowa is abundantly covered with trees except in certain limited sections the loess of the Missouri deposits is more frequently devoid of trees, it is true that a part of this area is covered with good forest growth. In a paper

*The Pleistocene history of northeastern Iowa. Ann. Rept. U. S. Geological Survey 11: 291.

†Ann. Rep. U. S. Geol. Survey 6: 286 1885.

on the loess by Prof. B. Shimek,* "Is the Loess of Aqueous Origin?", he discusses the question of the loess, in which he comes to the conclusion.

"It seems evident that the loess materials originated largely or wholly in drift, and as the comparatively recent investigations by members of the Iowa geological survey have demonstrated the presence of several drift sheets in this state, and as Nebraska has at least two such sheets, an interesting problem is suggested to geologists, namely: the determination of the relation which the various deposits of loess bear to those drift sheets which during the deposition of the loess were found at the surface of adjacent regions. This would involve a careful comparison of the finer materials in the drift with loess, and the consideration of the probable or possible direction and means of transportation to the present location of the loess."

In another paper on the same subject Prof. B. Shimek† says:

"The loess-fauna, of Council Bluffs, is thus not wholly terrestrial, but with the exceptions noted, is almost identical with the modern upland fauna of the same regions. Surely no conditions of excessive moisture prevail in that region today.

"The amount of material carried by the winds need not have been so great as is sometimes assumed. The estimate made by the writer for the rate of deposition for eastern loess (1 mm. per year), and that made by Keyes for western loess (one-tenth to one-fourth of an inch) would be sufficient to form most of these deposits respectively in the 8,000 years, usually computed, since the recession of the glaziers.

"The objection made by Dr. Chamberlain that 'the eolian deposits are measured, not by the quantity of silt borne by the winds and lodged on the surface, but by the difference between such lodgment and the erosion of the surface,' is met, at least in part, by the theory offered, for it is a well-known fact that timbered areas, even when very rough and

* Proc. Io. Acad. Sci. 5: 32.

† The distribution of loess fossils. Proc. Io. Acad. Sci. 6: 98.

Figure 7. *Astragalus lotiflorus* on loess bluffs, Missouri Valley. Photographed by Miss C. M. King.

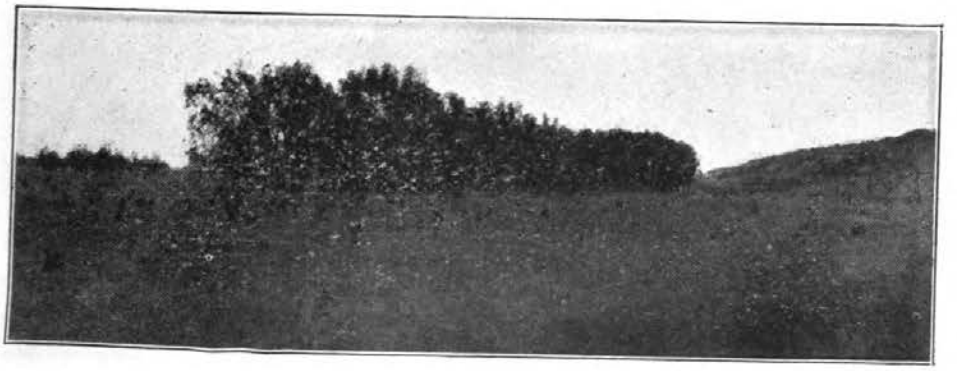

Figure 8 The loess bluffs in the distance; the Missouri River flood plain is a great prairie except here and there small willow groves consisting of the small *Salix interior* and *S. amygdaloides*, the latter a tree from a foot to ten feet in diameter; on the borders *Vernonia fasciculata*, *Boltonia asteroidea;* in the shallow water *Scirpus lacustris*, *Ranunculus multifidus; Helianthus Maximiliani* on high grounds. Photographed by L. H. Pammel.

with abundant slopes, are scarcely eroded by even the most violent precipitations of moisture."

Professor Udden's recent admirable report also bears on this question, and should not be overlooked by the student of loess-problems.

"No distinction can be made between the origin of eastern and western loess. The finer quality and lesser thickness of the former rather suggest that there had been more moisture (*i. e.*, a shorter dry period during each year) and, hence, less dust; that the winds were less violent, and that there were greater areas completely covered with vegetation, this resulting in the necessity of transporting dust much greater distances, which would therefore be finer."

CLIMATIC AND EDAPHIC FACTORS.

While the physiographic and geological formations have an important bearing on the distribution of plants there are certain other factors such as climate and the edaphic that must be taken into account when considering the distribution of plants. Mr. Nicholas Whitford* in a paper on "The Genetic Development of the forests of northern Michigan" considers the ecological factors into edaphic, atmospheric, hydrodynamic, and biotic. The hydrodynamic may play some part in the distribution of seeds, and the biotic determine the tension lines between forest and prairie, the atmospheric influence the soil so as to make it receptive for tree growth.

ALTITUDE. The altitude of the Missouri river basin is not far from 1,000 feet. It is somewhat less on the immediate shore lines of the Missouri and more than this towards the interior and northward. The region here considered lies between 39.5° and 43.5° north latitude.

The following altitudes are taken from reports of the Iowa Geological Survey† and Gannett's table of altitudes.

*Bot Gazette **31**: 291.

†Bain, H. F. Geology of Plymouth county. Io. Geol. Surv. **8**: 320.
Bain, H. F. Geology of Woodbury county. Io. Geol. Surv. **5**.
Bain, H. F. Geology of Carroll county. Io. Geol. Surv. **9**: 59.

TABLE OF ALTITUDES.

STATION.	ALTITUDE.	AUTHORITY.
Chatsworth, Big Sioux Valley	1,152	C. M. & St. P. Ry.
Westfield, Big Sioux Valley	1,131	C. M. & St. P. Ry.
Struble, Floyd Valley	1,271	S. C. & N. Ry.
Dalton, Floyd Valley	1,212	S. C. & N. Ry.
Merrill, Floyd Valley	1,167	I. C. Ry.
Sioux City, (low water) Missouri River	1,076	Mo. River Comm.
Sioux City, (reservoir) Missouri River	1,342	City Engineer.
Salix, Missouri River	1,092	S. C. & P. Ry.
Sargent's Bluff, Missouri River	1,103	S. C. & P. Ry.
Carroll, Tops of Hills	1,400	
Council Bluffs, Federal Building	989	
Hamburg, Missouri Valley		
Clarinda		
Cresco, Missouri Valley		
Missouri Valley, Missouri Valley		
Woodbine, Boyer Valley		

Temperature—The region here considered naturally would not show very much variation in temperature except such coming within the limits of difference due to latitude. The northern portion, owing to its higher altitude and open prairie, is somewhat cooler than the more thickly wooded southwestern Iowa. It is a noticeable fact, however, that the thermal belts extend along the Missouri and that they can successfully grow certain varieties of apples and cherries that will not succeed further eastward on the same parallels of latitude. This is brought out quite strikingly in a paper by Mr. Greene.*

The following temperature records show these differences for Page county in southeastern Iowa, Sioux City in Woodbury county, and Council Bluffs in Pottawattamie county:

CLARINDA.

YEAR.	TEMPERATURE—DEGREES.						
1893	47.4	57.9	70.5	75.3	69.6	65.9	41.1
1894	53.3	62.1	73.5	76.3	77.6	66.4	51.0
1895	53.9	62.2	68.6	70.2	73.2	68.4	47.8
1896	54.3	63.8	68.4	73.7	73.8	61.5	49.8
1897	50.8	61.6	72.9	78.8	71.6	73.2	51.3
1898	51.8	62.2	75.0	80.2	80.6	72.6	52.4
Averages	51.9	61.6	71.5	75.8	74.4	68.0	49.9

*Rep. Iowa Hort. Soc. 1900: 55.

SIOUX CITY.

YEAR.	TEMPERATURE—DEGREES.						
1893	44.6	57.0	72.0	75.0	70.7	66.0	45.0
1894	51.6	62.4	72.0	76.0	75.2	65.7	49.2
1895	57.0	62.0	68.0	72.4	72.6	67.7	47.8
1896	52.0	64.4	70.0	72.4	71 8	58.4	41.2
1897	47.6	59.1	68.4	76.2	68.2	71.7	46.8
1898	49.6	59.5	70.9	73.3	72.5	65.2	47.8
Averages	50.4	60.7	70.2	74.2	71.8	65.8	46.4

COUNCIL BLUFFS FOR 1900.

	Date.	Maximum degrees.	Minimum degrees.	Date.
January	22	63	-8	25
February	11	47	-11	8
March	12	77	-4	16
April	26	81	26	10
May	11	91	32	2
June	6	98	50	1
July	6	101	55	16
August	17	96	60	25
September	5	96	38	16
October	4	89	29	16
November	3	77	10	20
December	17	60	0	31

Annual mean, 51.9 degrees.

SUNSHINE AND WIND.

Temperature is influenced to a considerable extent by the condition of the atmosphere. The following table kindly prepared by Mr. J. R. Sage of the Iowa State Weather and Crop Service shows the number of cloudy, partly cloudy, and clear days for year 1898, also recording the totals for the year 1900 for the same places.

MONTH.	CHARACTER OF THE DAYS.	Keokuk.	Sioux City.	Council Bluffs.	Clarinda.
January....	Clear days	13	15	13	15
January....	Partly cloudy	4	4	3	4
January....	Cloudy	14	12	15	12
February...	Clear days	12	10	8	15
February...	Partly cloudy	4	11	11	8
February...	Cloudy	12	7	9	5
March	Clear days	11	11	10	15
March.....	Partly cloudy	5	10	12	6
March.....	Cloudy	15	10	9	10
April.....	Clear days	11	12	3	16
April.....	Partly cloudy	10	8	18	7
April.....	Cloudy	9	10	9	7
May.....	Clear days	7	6	4	12
May.....	Partly cloudy	14	8	21	7
May.....	Cloudy	10	17	6	12
June.....	Clear days	15	13	0	17
June.....	Partly cloudy	7	7	24	4
June.....	Cloudy	8	10	6	9
July.....	Clear days	20	16	*	18
July.....	Partly cloudy	6	8	*	10
July.....	Cloudy	5	7	*	3
August.....	Clear days	17	16	16	21
August.....	Partly cloudy	4	12	12	7
August.....	Cloudy	10	3	3	3
September..	Clear days	10	18	17	19
September..	Partly cloudy	13	2	6	6
September..	Cloudy	7	10	7	5
October...	Clear days	8	12	15	8
October....	Partly cloudy	8	5	3	12
October....	Cloudy	15	14	13	11
November..	Clear days	12	14	15	15
November..	Partly cloudy	12	6	6	8
November..	Cloudy	6	10	9	7
December..	Clear days	16	13	19	18
December..	Partly cloudy	6	10	3	8
December..	Cloudy	9	8	9	5
	Total clear days	152	156	120	189
	Total partly cloudy days	93	91	129	87
	Total cloudy days	120	118	95	89
	PREVAILING WINDS—	N.W.	N.W.	S.	N.W.
	Total clear days	242	169	200	164
	Partly cloudy days	31	86	74	111
	Cloudy days	92	110	91	90

Heat is an important factor in the development of plants. The plant zones of Humboldt were established by connecting the points having the same mean annual temperature. He called these isothermal lines. On this basis there were established the *Boreal*, *Austral* and the *Tropical*

* Not reported.

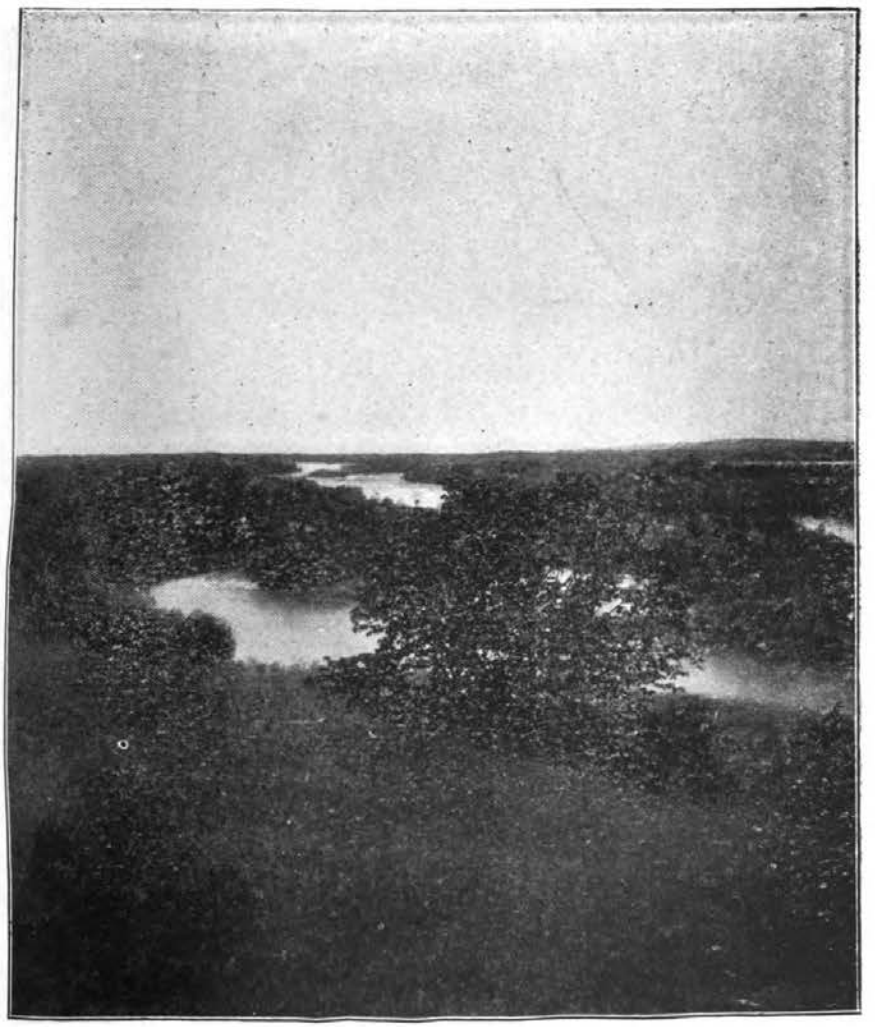

Figure 9. Mississippi River bottom above Clinton showing the heavily timbered woods and the wide flood plain. The timber consists mostly of *Acer saccharinum*, *Ulmus Americana*, *Fraxinus viridis*, *Betula nigra*, *Salix fluviatilis*; *Vernonia fasciculata* and *Boltonia asteroides* also here. Photographed by L. H. Pammel.

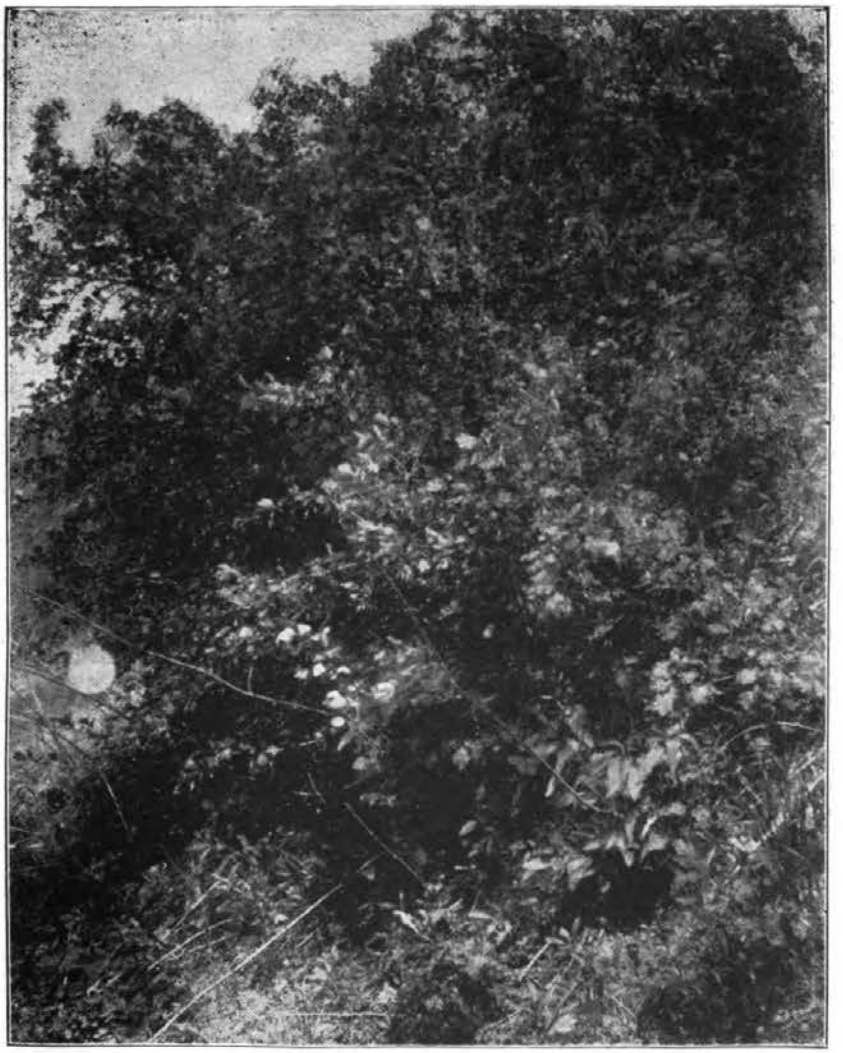

Figure 10. A densely wooded bank in one of the canyons along the Missouri River near Missouri Valley, Iowa. *Ribes gracile* in the foreground, *Prunus Virginiana* and other shrubs farther back; underneath these bushes *Dicentra cucullaria* and *Viola cucullata* grow in abundance. Photographed by L. H. Pammel.

zones. It was found, however, that zones established on isothermal lines did not express the true conditions, since two points of the same mean annual temperature may show wide differences in the extremes of annual, monthly or daily temperatures. It was found that life processes depend on these more than on the mean, hence some other basis must be established for the life zones.

Merriam established his life zones on another principle, namely, that it requires a definite amount of heat to accomplish the life* cycle of the plant from the time of germination to maturity. That for a given species this is the same, being the sum of the mean daily temperatures during the cycle of vegetation. This is the physiological constant.

Dr. Merriam recognizes the following classification:

(1)	Boreal Region		Arctic or arctic alpine.
			Hudsonian zone.
			Canadian zone.
		Transition zone	Alleghanian.
			Arid transition.
			Pacific coast transition.
(2)	Austral Region.	Upper austral zone	Carolinian area.
			Upper Sonoran.
		Lower austral zone	Austroriparian.
			Lower Sonoran.
(3)	Tropical Region.		

Alleghanian area. This area reaches its greatest development in this state along the Mississippi and reaches over to the Missouri river extending further eastward in southwestern Iowa, thence further north along the river. The the representative plants are:

Juniperus Virginiana (northward).	*Tilia Americana.*
Quercus macrocarpa.	*Sanguinaria Canadensis.*
Corylus Americana.	*Negundo aceroides.*
Rhus glabra.	*Ulmus Americana.*
Prunus Americana.	*Acer saccharinum.*
Dicenta cucullaria.	*Acer nigrum* (Des Moines basin.)
Solidago serotina (northward).	*Aster Novæ Angliæ* (northward).

Carolinian. This area reaches its greatest extension in southeastern Iowa, spreading northward to Dakota, with a few representatives. The representative plants are:

* Life Zones and Crop Zones of the United States. Div. Biol. Surv. U. S. Dept. Agrl. 10. Yearbook U. S. Dept. of Agrl. 1897: 115. 1894: 208-214.

Gymnocladus Canadensis.
Morus rubra.
Nelumbo lutea.
Polygonum Pennsylvanicum.
Martynia proboscidea.
Juglans nigra.
Rhamnus lanceolata.
Vernonia Noveboracensis.
Polygonum dumetorum var. *scandens.*
Eupatorium serotinum.

Arid transition. This area reaches its greatest development along the immediate border of the Missouri river on the loess bluffs but extends eastward to the divide between the Mississippi and Missouri rivers in Carroll and Dickinson counties. Representative plants are as follows:

Cnicus canescens.
Symphoricarpos occidentalis.
Yucca augustifolia.
Petalostemon multiflorus.
Aplopappus spinulosus.
Grindelia squarrosa.
Euphorbia marginata.
Hosackia Purshiana.
Erysimum asperum.
Psoralea esculenta.
Lygodesmia juncea.
Bouteloua oligostachya.
Schedonnardus Texanus (N W.).
Astragalus lotiflorus var. *brachypus.*
Shepherdia argentea (N).
Helianthus annuus.
Helianthus Maximiliani.
Gaura coccinea.
Gaura parviflora.
Liatris punctata.
Euphorbia heterophylla.
Lactuca pulchella.
Dalea laxiflora.
Mentzelia ornata.
Sporobolus cuspidatus.
Buchloe dactyloides (N. W.).
Oxytropis Lambertii.

It should be observed that the zonal boundaries of plants are not sharply marked, but that the different areas contain marked types of each of the areas. The main features of the flora is essentially prairie. The intermingling of western and eastern prairie types is most marked on the loess bluffs.

RAINFALL.

That moisture is an important factor in the development of plants cannot be questioned. The occurrence of strictly western plants within the border of Iowa must in part be attributed to the smaller amount of precipitation. The precipitation is given for the same points as the temperature.

SIOUX CITY.

Precipitation in Inches.

YEAR.	April.	May.	June.	July.	August.	September.	Annual.
1893	3.56	3.17	1.63	2.29	5.85	1.11	23.83
1894	2.79	1.91	2.74	1.81	1.68	0.73	18.79
1895	3.20	2.15	4.95	2.63	1.54	3.91	20.29
1896	6.16	6.39	2.94	5.54	0.86	2.09	30.77
1897	4.03	1.24	2.13	2.26	2.51	0.51	20.38
1898	1.37	4.69	6 61	2.78	3.10	0.95	22.91
Average	3.52	3.26	3.50	2.88	2.59	1.55	22.83

CLARINDA.

1893	3.11	3.17	4.12	8.84	6.22	2.38	33.27
1894	2.06	1.37	4.02	0.41	0.23	2.53	17.96
1895	2.82	2.99	8.33	6.44	4.64	0.95	30.79
1896	3.72	7.48	2.12	6.63	2.86	2.56	33.73
1897	6.00	2.01	4.04	2.63	2.53	1.55	26.32
1898	3.70	5.15	2.99	4.49	1.16	5.74	33.49
Average	3.57	3.70	4.27	4.91	2.94	2.62	29.26

KEOKUK.

1893	5.41	4.36	2.37	2.60	1.16	3.18	27.94
1894	2.75	3 06	2.95	0.37	0.51	4.86	25 20
1895	3.38	3.45	2.61	5.46	2.28	2.67	29.42
1896	2.35	4.40	2.18	8.01	3.90	9.44	36.77
1897	3.34	1.86	5.43	6.75	0.65	0.64	33.14
1898	4.80	6.70	4 77	3.06	6.92	8.07	52.48
Average	3.67	3.97	3.38	4.38	2.57	4.81	34.16

COUNCIL BLUFFS.

The precipitation for Council Bluffs for 1900 was 31.87 inches.

It will be seen from the above tables that the average rainfall for a period of six years in the northern section along the Missouri river at Sioux City was 22.8 inches, at Clarinda in Page county, 29.26 inches. Compare this with the precipitation in Keokuk in the southeastern part of the state the precipitation for the same period was 34.16 inches. Now compare this with the mean annual temperature for the same regions: Keokuk, 52.2°F., Sioux City, 46.4°F., Clarinda, 49.9°F. The greater number

of clear days or partly cloudy days in western Iowa is shown in the table prepared for the year 1898 by Mr. J. R. Sage and which has been given under the heading sunshine and wind. It is not as marked as one would expect.

PHENOLOGICAL DATA FOR WESTERN IOWA.

Crescent. May 3, 1901.
Sisyrinchium angustifolia.
Ellisia nyctelea.
Staphylea trifolia.
April 27.
Prunus Americana.
Viola palmata var. *cucullata.*
Viola pedatifida.
April 28
Lithospermum canescens.
Lithospermum angustifolium.
Cratægus mollis.
Fragaria Virginiana.
Sisymbrium canescens.
May 4.
Castillea sessifolia.
Astragalus caryocarpus.
Pyrus malus.
May 5.
Prunus Virginiana.

Missouri Valley, May 19, 1901.
Ceanothus ovatus.
Anemone Pennsylvanica.
Senecio aureus
May 20.
Erigeron annuus.
Phlox pilosa.
Utricularia vulgaris.
June 18.
Echinacea angustifolia.
Asclepias tuberosa.
Asclepias syriaca.
June 20.
Cacalia tuberosa.
Lilium Philadelphicum.
Convolvulus sepium.

Mr. John J. Thornber* prepared a phenological record of some plants found in Nebraska City, Nebraska, which is south of Council Bluffs, but typical of the loess region.

April 27, 1900.
Viola pedatifida
Lithospermum canescens
May 4, 1900.
Carex festucaceæ
May 7, 1899.
Comandra umbellata
May 10, 1900.
Ceanothus ovatus
May 20, 1900.
Eleocharis palustris
Juncus tenuis
May 28, 1900.
Chenopodium album
Eatonia obtusata
June 7, 1901.
Coreopsis palmata
Cornus asperifolia
June 21, 1900.
Helianthus annuus
June 22, 1900.
Lilium Canadense
Desmodium Illinoense
July 15, 1900.
Scutellaria lateriflora
August 4, 1900.
Solidago Canadensis
August 30, 1900.
Gentiana puberula
September 17, 1900.
Aster azureum

* The prairie grass formation in Region I. Bot. Survey Nebraska. 5: 137.

These records may be compared with the phenological notes for Ames and Armstrong. The former in central Iowa and the latter in north central Iowa.

AMES.	ARMSTRONG.
May .	June 18.
Crataegus mollis	*Salsola Kali* var. *Tragus*
May 7.	*Acerates viridiflora*
Aquilegia Canadensis	*Asclepias tuberosa*
Prunus Virginiana	*Linum usitatissimum*
Fragaria Virginiana	*Symphoricarpos occidentalis*
	Lathyrus venosus
	Ruabeckia hirta

Unfortunately there are but few representatives of the same species from these different localities. The *Cratægus mollis*, *Aquilegia Canadensis*, *Prunus Virginiana* and *Fragaria Virginiana* are nearly a week later in Ames than in Missouri Valley and Crescent. These points are slightly south of Ames, but not enough to materially influence the period of flowering. The loess region along the Missouri river is distinctly warmer than central Iowa, which is distinctly influenced by the cold and impervious soil. The impervious nature of the soil is shown by the many small lakes and ponds in central Iowa, but nearly wanting in western Iowa.

While plants are called into activity sooner in Keokuk than in Sioux City, they mature in a relatively shorter period of time in the latter place owing to clearness of the sky, and the drier weather.

WIND.

The wind is another most important factor in the development of the plant life in that region. The tendency of the wind is to increase transpiration so that plants with tender foliage are wanting or occur in the canons or wooded ravines. The wind has such an erosive action that stones may become polished as in the boulder here shown resting on the drift. The writer has seen clouds of dust, carried high in the air, last for several days. Such dust settling on plants cannot but be injurious in checking the

life processes of the plant. A smooth leaf soon has its stomata filled with dust. On the other hand the hairs on leaves serve to hold this dust.

Protected plants. Such plants as *Applopappus spinulosus, Oxytropis Lambertii, Lithospermum canescens, L. angustifolium, Psoralea argophylla, Gaura coccinea, Dalea alopecuroides* are well protected from the driving winds of summer and fall.

Of the plants needing much moisture and commonly growing in open woods of the eastern section of the state but rare or wanting in western Iowa, mention may be made of the following:

Podophyullum peltatum.
Heracleum lanatum (rare).
Caulophyllum thalictroides (rare).
Solidago latifolia.
Dodecatheon media.
Fragaria vesca.
Mertensia Virginica.
Lobelia cardinalis.
Lobelia inflata.
Hydrophyllum appendiculatum.

Deep rooted plants. An equally instructive list of plants may be added to show how some plants have protected themselves from the injurious influences of wind and drouth by producing deep roots. These roots are sometimes several feet long.

Dalea laxiflora.
Psoralea esculenta.
Lygodesmia juncea.
Lactuca pulchella.
Aplopappus spinulosus.
Yucca angustifolia.
Oxytropis Lambertii.
Astragalus lotiflorus var. *brachypus.*
Cnicus canescens.
Gaura coccinea.
Sporobolus cuspidatus.
Asclepias tuberosa.

Transpiration reduced. As a protection against transpiration the leaves of many plants are hairy or reduced in size. Of the hairy leaved plants we may mention the following:

Convolvulus sepium.
Asclepias verticillata.
Cnicus canescens.
Cnicus Iowensis.
Aplopappus spinulosus.
Euphorbia marginata.
Achillea millefolium.
Oxytropis Lambertii.
Castilleia sessiflora.
Gaura parviflora.
Salvia lanceolata.
Plantago Patagonia var. *gnapalioides*
Asclepias speciosa.

Xerophytic grasses. The Xerophytic grasses of the loess mounds are especially characterized by their reduction of

leaf surface or the leaves roll in when the transpiration is too great. Of these we may enumerate:

Sporobolus cuspidatus.	*Stipa spartea.*
Calamovilfa longifolia.	*Poa compressa.*
Andropogon scoparius.	*Poa pratensis.*
Bouteloua racemosa.	*Agropyron occidentale.*
Bouteloua oligostachya.	*Elymus Canadensis.*

It must not be assumed that hydrophytic and mesophytic plants are wanting, they are numerous as the writer's list* indicates. Such species as *Leersia oryzoides*, and *Leersia Virginica*, *Ultricularia vulgaris*, *Potamogeton*, *Sagittaria*, *Ranunculus multifidus* are well known representatives of stagnant pools and slow running streams. *Cystopteris fragilis*, *Festuca nutans*, *Bromus purgans*, *Eupatorium ageratoides* are well known mesophytic representatives of woods.

PLANT FORMATIONS.

In this paper I have adopted the excellent classification of Cowles† as well as some valuable suggestions from the paper by Pound and Clements.‡

In the paper by Cowles two general groups are made.

I. *Inland group:*
   1. River.
   2. Swamp.
   3. Upland.

II. *Coastal:*
   1. Lake bluff.
   2. Dune.

The Pounds and Clements Classification for Nebraska is as follows:

I. Wooded—bluff and meadow land region.
II. Prairie region.
III. Sandhill region.
IV. Foothill region.

The region considered in this paper would be embraced in the wooded bluff and meadow land region.

* L. H. Pammel. Notes on the Flora of Western Iowa. Proc. Io. Acad. of Sci. 8: 106-135. Contr. Bot. Dept. Io. Coll. Agri. and Mech. Arts. 1.
† Bot. Gazette 31: 73, 145.
‡ The Phytogeography of Nebraska. General Survey. Univ. Neb. Bot. Survey of Neb. 1.

INLAND GROUP.

1. RIVER SERIES.

1. *The Missouri Floodplain.*—It is not necessary in this connection to discuss the early history of the formation of this flood plain* as this follows the same general laws so well set forth by Cowles.

This is the youngest of the series, and near the shore of the river is subject to frequent changes. The broad level plain is from eight to twelve miles wide, varying but little in the consistency of the soil or the vegetation from Council Bluffs to Sioux City. Sparsely timbered except near the shore lines of older streams, the bayous of more recent formation or near the basis of the bluffs. In the earlier stages of the development of this flood plain as it exists today. The plants are mainly hydrophytic. Among the lower plants, *Spirogyra and Zygnema.* Of the flowering plants:

Potamogeton natans.
Ranunculus multifidus.
Scirpus lacustris.
Rumex verticillatus.
Lemna major.
Utricularia vulgaris.
Scirpus palustris.

SWAMPS.

Owing to the wide flood plain the waters of the Missouri have never had a very rapid current. It has frequently shifted its course. When sufficient age has been obtained mesophytic plants appear. One of the most conspicuous of these is the *Phalaris arundinacea*, one of the vernal grasses, which blooms and produces ripe fruit before the dry season. During its early growth it is of hydrophytic habit. It is thus semi-mesophytic. *Ranunculus multifidus* is also a frequent inhabitant of these slow running streams, and during its early existence only produces finely dissected leaves freely floating in the water, but as the stream dries up the plants at once develop smaller round, reniform, coarsely dissected leaves. These plants root in the mud.

* l. c. 98.

Other plants of like character also appear under such conditions.

Sagittaria variabilis.
Iris versicolor.
Typha latifolia.
Alismago Plantago var. *Americana.*
Carex Sps.

At least the *Iris*, *Typha*, and *Scirpus lacustris* may occur in places that during later summer are entirely dry. These plants on the one hand are deep rooted as in Scirpus or have thick root-stocks as in Iris. When not covered by plants the ground often becomes very hard. On the disappearance of the early vernal plants, the ground soon becomes covered with a thick growth of late summer and autumn plants. The ground is thickly covered towards the center and margins of the bayous. Of spring and early summer plants under the shade of *Salix amygdaloides*, *Polygonum acre* is a dominant plant. The *Boltonia asteroides* is one of the most conspicuous of later plants, and along with it *Vernonia fasciculata* which, however, is more mesophytic than *Baldwinia*. Conspicuous later vernal plants here are *Veronica peregrina*, and *Erigeron annuus*. The bayous with the continual deposit of alluvium sand and dirt and the decay of the hydrophytic and mesophytic plants or other material washed in gradually becomes filled up, so that a change in the character of plants occurs. The *Salix amygdaloides* is the only tree found in these situations. When these slow-running streams are filled up with vegetable detritus and inorganic material they die and the *alluvial prairie* appears. In this alluvial flood plain many plants are common to those of the upland prairies. The alluvial prairie is rich in grasses although there are but few species. Fresh water cord grass, *Spartina cynosuroides* is conspicuous. The rhizomes of the grass are often two feet long. This is essential for the plant as it prevents washing the plant away. There are times when a good part of this flood plain has been under water for several days at a time. Here, too, *Rumex altissimus* is a dominant type.

Vernonia fasciculata.
Helianthus maximiliani.

Of the annuals.

Helianthus annuus.
Panicum crus-galli.
Euphorbia maculata.
Euphorbia serpens.

The Missouri carries large amounts of finely suspended matter and the throwing up of this along the shore lines causes the formation of the higher places in the flood plain.

The most prominent of the grasses here is *Andropogon provincialis. Panicum virgatum* is also common. *Helianthus maximiliani* also occurs on the borders of the meadows.

Species of the alluvial region of the Missouri and their origin.

Ranunculus septentrionalis (E.).
Ranunculus abortivus (E.).
Nasturtium terrestre (E.).
Viola palmata var. *cucullata* (E.).
Crotalaria sagittalis (E.).
Clycyrrhiza lepidota (W.).
Strophostyles angulosa (E. & S.).
Potentilla Norvegica var. *millegrana* (W.).
Crypototænia Canadensis (E.).
Cicuta maculata (E. & N.).
Vernonia fasciculata (E. & S.).
Solidago serotina (E.)
Boltonia asteroides (E. & S.).
Aster ericoides (E. & S.).
Erigeron Philadelphicus (E.)
Iva xanthiifolia (W.).
Ambrosia trifida (E).
Xanthium Canadense (E. & S.).
Helianthus annuus (W.).
Helianthus grosse-serratus (W.).
Helianthus maximiliani (W.).
Bidens chrysanthemoides (E.)
Scirpus lacustris (Cos.).
Panicum virgatum (W. & E.).
Mimulus ringens (E. & S.).
Verbena hastatata (E. & S.).
Teucrium canadense (E.).
Acnida tuberculata (S.).
Amarantus alba (W.).
Rumex verticillatus (E.).
Polygonum ramosissimum (S.).
Polygonum Virginianum (E.).
Polygonum lapathifolium var. *incarnatum* (S.).
Polygonum Muhlenbergii (E. & S.).
Polygonum Pennsylvanicum (E. & S).
Shepherdia argentea (W.).
Euphorbia marginata (W.).
Euphorbia serpens (W. & S.).
Euphorbia glyptosperma (S. & W.).
Euphorbia Geyeri (W.)
Juncus tenuis (Cos.).
Typha latifolia (Cos.).
Sparganium eurycarpum (E & W.).
Alisma Plantago var. *Americana* (E)
Echinodorus rostratus (S. & W.).
Cyperus diandrus (E. & W.).
Andropogon furcatus (E. & W.).
Spartina cynosuroides E. & W.).

OLDER FLOOD PLAINS.

During glacial times the Missouri carried large volumes of water and much of the present flood plain was a huge stream of water, being augmented by several streams of considerale size like the Boyer, Floyd, and Big Sioux, with inland lakes some of which like Lake Manawah near Council Bluffs still exist, these lakes being formed by the washing of sediment at the mouth of the streams, by the deposition of fine silt. The water of the streams flowing through these flood plains is so slow that the backwater

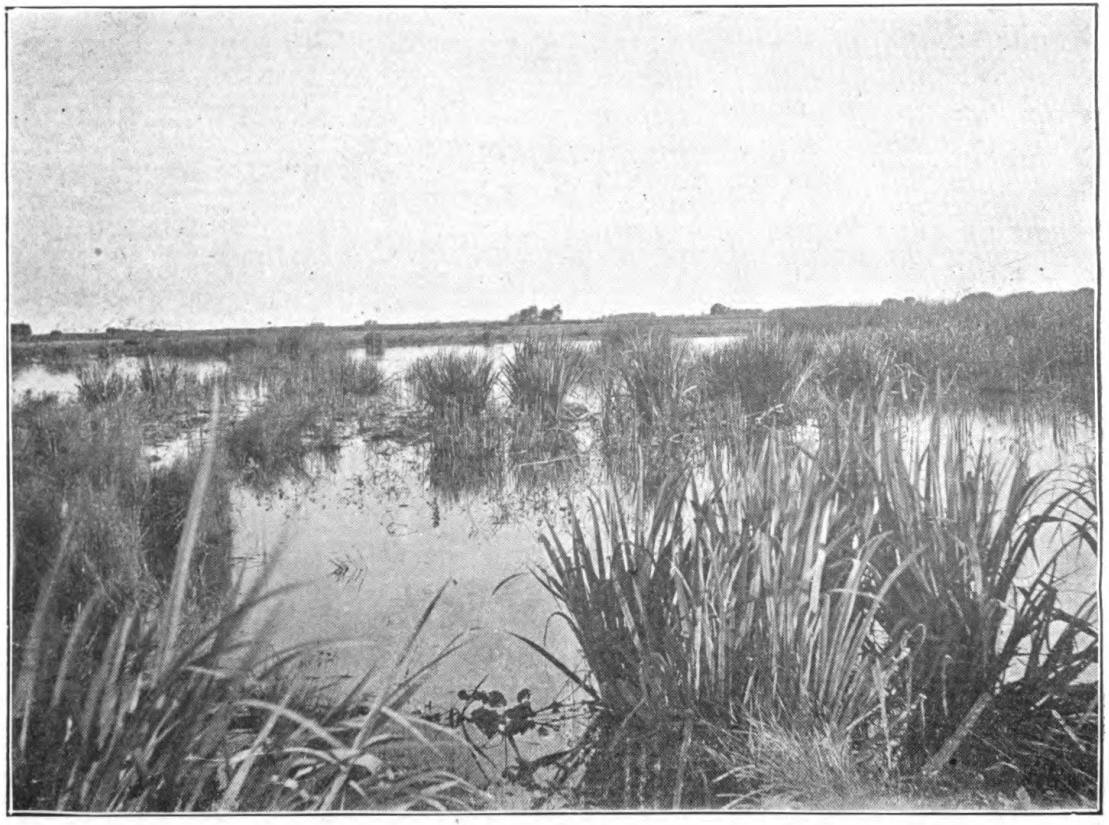

Figure 16. Hydrophytic vegetation in the flood plain of the Missouri river near Honey creek. *Phragmites communis* and *Phalaris crundinacea*.

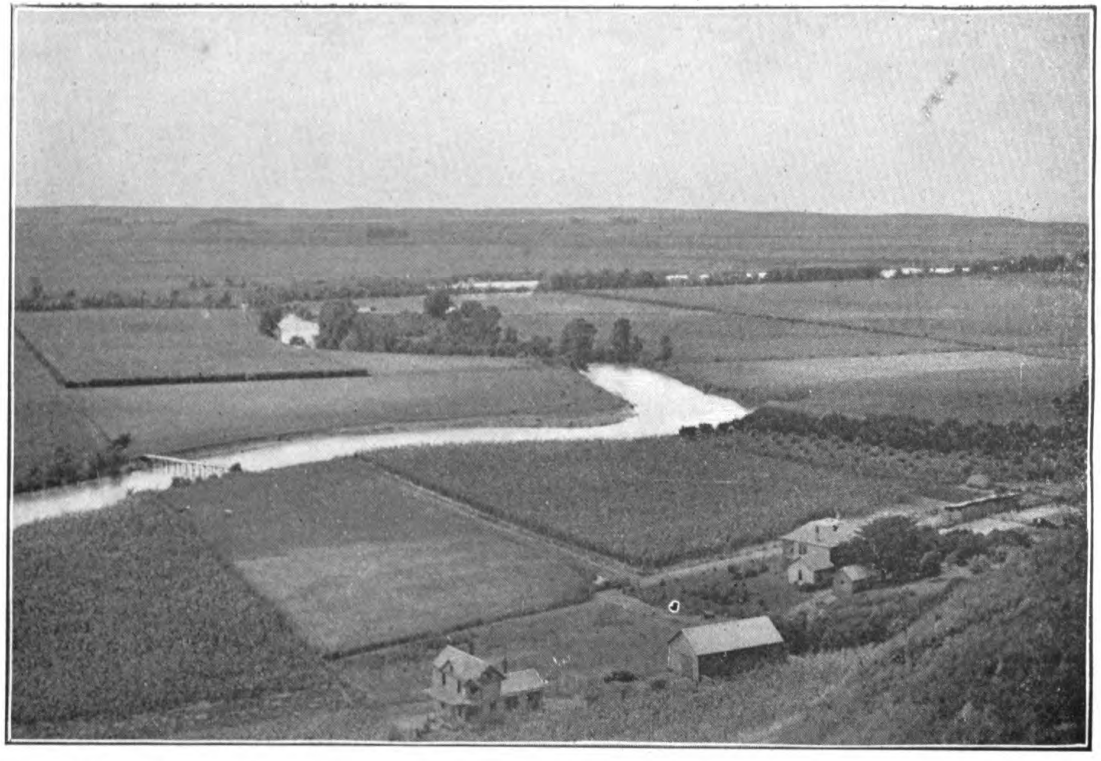

Figure 17. Alluvial bottoms of the Missouri. The sluggish streams with hydrophytic vegetation and the higher shore lines with such mesophytic plants as *Spartina cynosuroides*, *Helianthus Maximiliani*.

from the Missouri fills up the nearly level plain forming the lakes in which an abundant hydrophytic vegetation occurs. As these ancient lakes became gradually filled with organic matter, herbaceous plants similar to those of the Missouri flood plain appeared. The continued increase of organic matter made a soil more suitable for prairie plants of a different character. Of the vernal plants we may note the *Ranunculus septentrionalis*, *Senecio aureus* var. *Balsamite*, the latter forming distinctive features of these meadows, frequently producing masses of yellow flowers. The *Anemone Pennsylvanica* also forms solid masses. *Thalictrum purpurascens*, *Heuchera villosa*, *Asclepias syriaca*, *Silphium laciniatum*. These form great masses in the moister places. *Phlox pilosa* grows abundantly in the prairie meadows and is distinctively a prairie mesophytic plant, like *Poa pratensis*, *Helianthus grosse-serratus*. Of the younger formation distinctly hydrophytic we may mention

Rumex verticillatus.	*Glyceria fluitans*.
Phalaris arundinacea.	*Typha latifolia*.

The Boyer valley is marked by its prairie-like meadows intersected by very small ravines. The deposition of humus and considerable moisture in the soil prevents the rapid desintegration of organic matter, hence unsuited for the growth of trees and shrubs, but well adapted for species of *Carex*, *Elymus robustus*, *Phlox pilosa*, *Anemone Pennsylvanica* and *Senecio aureus*.

Towards the approach of the bluff formation on either side of the valley the drainage is more perfect, and tree and shrub life begins. Unlike the younger flood plain of the Missouri a narrow zone of forest growth skirts the Boyer. This forest area is not making much encroachment upon the prairie flood plain.

The soil along the stream is of much more recent formation than the prairie flood plains. To the gradual sloping banks there is added from year to year more black alluvial deposit. At first such plants as *Eragrostis reptans*, *Mimulus ringens*, *Polygonum acre*. Of the later autumn plants to appear here are *Helianthus grosse-serratus* and

Ambrosia trifida. The *Ambrosia trifida* being the immediate foreunner of small shrubs and trees.

The drainage along the stream is naturally more perfect than the soil away from the flood plain, the soil is better areated, hence trees can grow here. One of the first woody plants to appear is *Salix nigra* which overhangs the streams, *Salix amygdaloides* is also an early tree replaced later by *Negundo aceroides*, *Ulmus americanas*, *Populus monilifera* and *Fraxinus viridis.* Of the woody climbers the following may be mentioned.

Vitis riparia.
Menispermum canadense.
Ampelopsis quinquefolia.
Rhus toxicodendron.

of the herbaceous climbers the following appear in these young forests

Echinocystis lobata.
Humulus lupulus.

and shade loving plants like

Impatiens pallida.
Bidens frondosa.
Coreopsis connatus.
Urtica gracilis.

UPLAND.

THE RAVINE.

Owing to the peculiar loess formation in the Missouri valley region very few ravines in their younger stages can be seen, at least not in the west slope of the hills. It is only through the removal of loess material for manufacturing or grading that these embryonic ravines occur. Where such are found very little vegetation occurs. The vertical faces of the bluffs are in many cases one hundred feet high. On the bare faces one sometimes finds *Rosa blanda* var. *Arkansana and Lygodesmia juncea* deeply rooted in the soil. Very few land slides occur except where there is a considerable growth of herbaceous plants and the formation is underlaid by a sheet of water. At the base of these hills plants like *Gaura coccinea*, *Sporobolus cuspidatus*, *Lactuca pulchella* occur. The characteristic plants of the ravine beginning at the base are as follows:

Populus monilifera,
Salix humulis,
Tilia Americana,
Ulmus Americana,
Fraxinus pubescens,
Celtis occidentalis,
Prunus Virginiana,
Ribes gracile,
Celastrus scandens,
Rhus glabra,
Rosa blanda var. *Arkansana*,
Ulmus fulva,
Quercus macrocarpa,
Crataegus mollis,
Populus monilifera,
Ostrya Virginica,
Vitis riparia,
Ampelopsis quinquefolia.

Near the edges towards the top of the ravine,

Salix humilis,
Amorpha canescens,
Salix amygdaloides,
Symphoricarpos occidentalis.

The *Symphoricarpos occidentalis* is the most abundant shrub in clearings, and on the hills is one of the most important plants in preparing the soil for a mesophytic forest. It remains as an undergrowth in the forest till the trees have attained an age of ten to fifteen years. It is abundant in all open clearings in the woods. This plant takes the place of *Corylus Americana* to a large extent in preparing the soil for a forest growth. *Corylus Americana* is rather a rare shrub. The *Rhus glabra* is nearly as important as *Symphoricarpos*. From the ravine the mesophytic flora extends to the slopes of hills, especially on the east and north slopes. The more important mesophytic herbaceous plants in the ravines are—

Dicentra cucullaria,
Eupatorium ageratoides,
Lophanthus scrophulariæfolias
Viola palmata var. *cucullata*.
Parietaria Pennsylvanica,
Teucrium Canadense,
Viola pubescens,

As the ravines become older with a good covered humus and sufficient shade, the following plants are abundant:

Smilacina stellata,
Viola palmata var. *cucullata*,
Aquilegia Canadensis,
Mosses like *Hypnum* and *Bryum*.
Sanicula Marylandica
Hydrophyllum Virginicum,
Cystopteris fragilis,
Bromus purgans,
Aster sagittifolius.
Viola pubescens,
Vicia Americana,
Arabis hirsuta
Eupatorium ageratoides.
Ranunculus abortivus,
Phlox divaricata,
Smilax herbacea,
Laportea Canadensis,

The older ravines with a truly mesophytic flora contains a curious assemblage of southern plants that in the Missis-

sippi basin occur in the second or older alluvial flood plain, namely,

Morus rubra,
Juglans nigra,
Ulmus Americana.
Gymnocladus Canadensis,
Celtis occidentalis,

These plants occur at an altitude of nearly one hundred feet above the flood plain of the Missouri. The same species also occur on the western slope of the hills where sufficient age has been attained. Their occurrence under these conditions is due to lines of least tension. In the Mississippi basin and its tributaries such places would be occupied by—

Acer nigrum.
Juglans cinerea.
Quercus alba.
Quercus rubra.
Quercus tinctoria.
Cratægus species.

When we compare the trees we find but few prominent species of western Iowa that occupy the uplands of eastern Iowa, namely, *Crataegus mollis Quercus macrocarpa Q. rubra*, *Ulmus fulva* and a few others It seems to be a general law that closely related species generally have different habitats. *Juglans cinerea* along the Mississippi occupies the higher stony hills and this is more and more evident as the region of its greatest prominence is reached. It is easy therefore for *Juglans nigra* and its other southern types to become important ravine and bluff plants along the Missouri.

Towards the east the xerophytic area becomes increasingly less, the ravines being filled to a considerable extent. These older ravines contain larger amounts of humus. These soils being well aerated permit decomposition and nitrification much more readily than in older soils, hence the appearance here of such mesophytic plants as

Cystopieris fragilis.
Dicentra cucullaria.
Smilacina racemosa.
Viola pubescens.
Uvularia grandiflora.
Amphicarpæa monoica.

These basins filled with humus also are more subject to washing owing to changes brought about by cultivation at the base of a ravine or the making of roads. These banks contain no plants though there is enough moisture present.

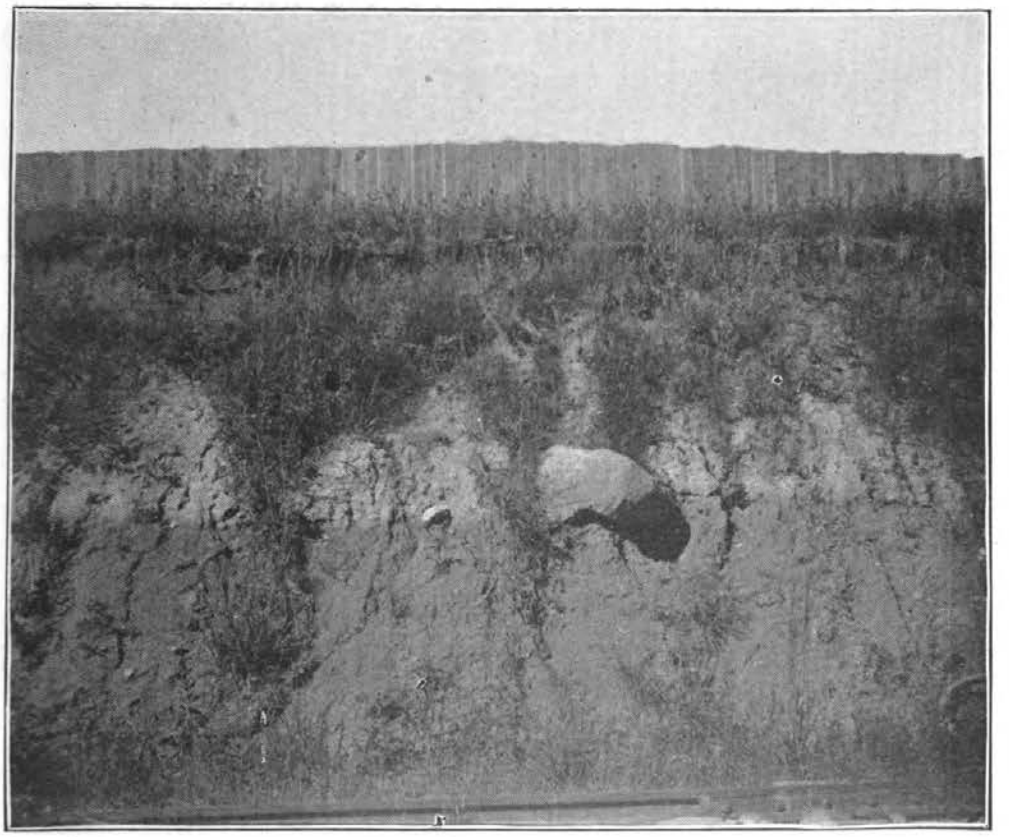

Figure 11. Loess resting on drift; northwestern Iowa. Herbaceous plants, like *Andropogon scoparius*, *Lygodesuria juncea*, &c. (From Vol. X, Iowa Geol. Surv.)

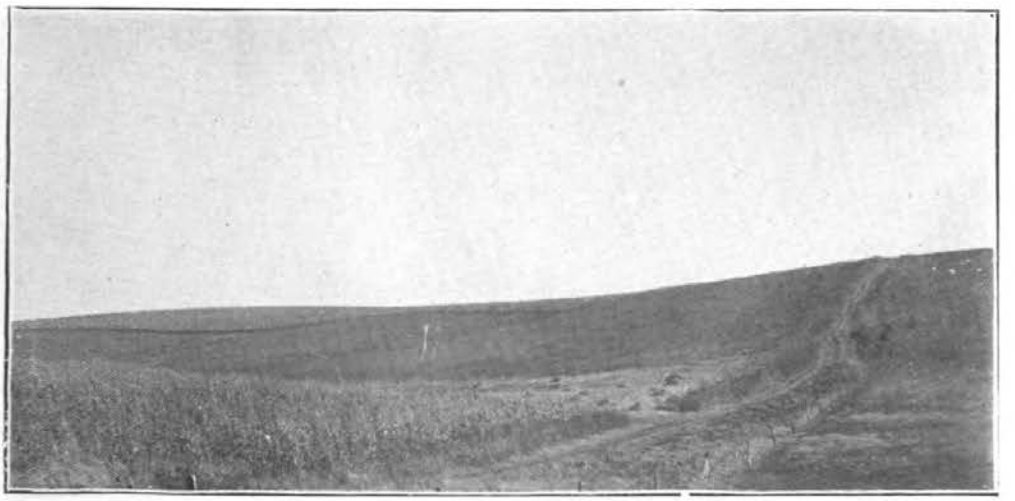

Figure 12. Loess slopes of the upland region, Plymouth county. The borders of the slopes are covered with *Andropogon provincialis*, *Helianthus maximiliani* (From Vol. VIII, Iowa Geol. Surv.)

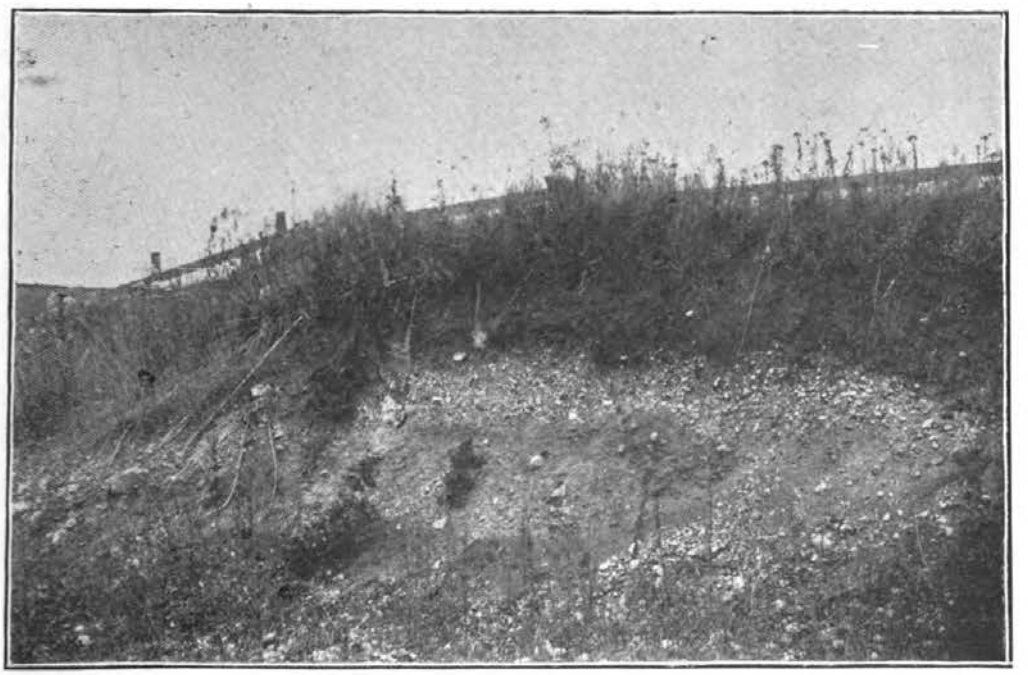

Figure 13. Loess over drift in Plymouth county. *Cleone integrifolia*, *Grendelia squamosa* and other composite with grasses like *Sporobolus cuspidata* cover the loess soil. (From Vol. VIII, Iowa Geol. Surv.)

Plants cannot anchor themselves because the soil is subject to washing. It is only when the washing has proceeded far enough to cause a considerable fill and a young alluvium forms that plants like the following appear:

Salix nigra. *Salix amygdaloides*.
Coreopsis palmata. *Bidens frondosa*.

We have in this region an excellent illustration of a mesophytic flora well established on the crest of hills. Nearly all of the eastern slopes of the hills and the very tops, east of the main line of bluffs, or those facing the principal streams are covered with a mesophytic vegetation which does not differ essentially from those of the older ravines.

GRASSY HILLS.

The loess mounds though made of a tenacious clay show no springs or running water anywhere except in the wooded canons at the base of the hills. The vegetation from early spring to fall is a succession of bloom, beginning with such plants as

Anemone patens var. *Nuttalliana*, *Oxytropis Lambertii*,
Castilleia sessiliflora, *Lithospermum canescens*.
Lithospermum angustifolium.

Another common plant over the hillside is *Comandra umbellata*. Three weeks later the most conspicuous plant over the loess mound is *Symphoricarpos occidentalis*, which is most abundant near the timber line, encroaching upon the mounds. The *Symphoricarpos* is a forerunner of shrubs and trees at the edge of the loess mounds. Along with it, frequently in great abundance, is the *Verbena stricta* and the *Psoralea argophylla*, the latter with long roots. The *Lygodesmia juncea*, a typical xerophytic plant, is extremely common, occurring not only in the vertical clay banks but over the entire mound.

Near the tops of the mounds *Aplopappus spinulosus* forms broad masses. Quite widely distributed over these loess mounds we have the *Dalea laxiflora* and the *D. alopecuroides*, the former, with roots several feet long,

is particularly well adapted to xerophytic conditions, the small teretish leaves make it admirably fitted for the conditions existing upon the mounds. Along with it we find the *Petalostemon multiflorus*, both belonging to the typical plants of the plains of Nebraska and Colorado.

Of the early composite flowering plants upon the loess mounds the *Echinacea angustifolia* and *Rudbeckia hirta* are more or less common over the entire loess mounds. The *Heliopsis scabra* is common on the borders along with the *Symphoricarpos, Ceanothus* and *Verbena.*

Solidago Missouriensis,
Achillea millefolium,
Solidago rupestris,
Aster sericeus,
Antennaria plantaginifolia,
Silene antirrhina,
Asclepias verticillata,
Oxybaphus angustifolius,
Gerardia aspera,
Dysoides chrysanthemoides,
Helianthus Maximiliani,
Grindelia squarrosa,
Aster multiflorus,
Ambrosia psilostachya,
Helianthus rigidus,
Oxybaphus hirsutus,
Salvia lanceolata,
Gerardia tenuiflora,

are some of the common types found over the entire loess mounds. The *Liatris punctata* with its deep, straight roots enables the plant to be adapted to the drouthy conditions which frequently prevail in that region. The *Yucca angustifolia*, common in sections of Nebraska, the Dakotas and Kansas, is a rare plant in this region, although becoming more common northward in the vicinity of Sioux City. It is confined to the steep banks, well up near the summits of the mounds.

The mesophytic flora is gradually encroaching upon the xerophytic, and as important forerunners for the mesophytic vegetation several of the shrubs like *Symphoricarpos* play a conspicuous part. Eastward in northeastern and central Iowa the *Corylus Americana* is the chief forerunner for the mesophytic flora. In the Missouri valley the *Symphoricarpos* is the chief factor in changing the character of the vegetation.

The amount of precipitation collected for a series of years indicates that this region is much drier than in the drainage area east of the Missouri river basin.

PARTIAL LIST OF THE PLANTS OF THE LOESS BLUFFS AND THEIR ORIGIN.

Aplopappus spinulosus (W).
Lygodesmia juncea (W).
Vernonia Noveboracensis (S).
Eupatorium serotinum (S).
Kuhnia eupatoroides (E).
Liatris punctata (W).
Liatris scariosa (E).
Grindelia squarrosa (W).
Solidago speciosa (E).
Solidago rupestris (W).
Solidago rigida (E).
Aster oblongifolius (S).
Aster sericeus (E).
Aster multiflorus (E).
Antennaria plantaginifolia (E).
Silphium laciniatum (E & S).
Iva xanthiifolia (W).
Ambrosia psilostachya.
Echinacea angustifolia (E & S).
Rudbeckia hirta (W).
Lepachys pinnata (W).
Helianthus petiolaris (W).
Helianthus Maximiliani (W).
Coreopsis palmata.
Dysodia chrysanthemoides (W).
Cnicus canescens (W)
Cleome integrifolia (W).
Callirhoe involucrata (W).
Linum rigidum (W).
Trifolium stoloniferum (W).
Dalea laxiflora (W).
Solidago Missouriensis (W).
Asclepias tuberosa.
Monarda fistulosa.
Psoralea argophylla (W).
Sisymbrium canescens.
Oxalis corniculata (E).
Petalostemon violaceus (W).
Oxytropis Lambertii (W).
Cassia Chamæcrista (W & S).
Symphoricarpos occidentalis (W).
Erigeron strigosus (E & W).
Helianthus rigidus (W).
Troximon cuspidatum (W).
Taraxicum officinale (Cos).
Oxybaphus hirsutus (W).
Euphorbia maculata.
Lactuca pulchella (W).
Lobelia spicata (E).
Asclepias verticillata (western form).
Acerates viridiflora.
Phlox pilosa (E).
Lithospermum canescens (E).
Lithospermum angustifolium (E).
Pentstemon grandiflorus (E).
Castilleia sessiliflora.
Verbena stricta (W).
Hedeoma hispida (W).
Salvia lanceolata (W).
Scutellaria parvula (W).
Oxybaphus angustifolius (W).
Polygonum ramosissimum (S).
Euphorbia marginata (W).
Euphorbia corollata (E).
Salix humilis (E).
Yucca angustifolia (W).
Zygadenus elegans (W).
Sporobolus cuspidatus (W).
Elymus robustus (W).
Delphinium azureum (W).
Corydalis aurea var. *occidentalis* (W).
Erysimum asperum (W).
Viola pedata (W).
Linum sulcatum (W).
Ceanothus ovatus (W).
Hosackia Purshiana (W).
Petalosteum multiflorus (W).
Stipa spartea (W).
Amorpha canescens (W).
Anemone cylindrica (W & E).
Oxalis violacea (E).
Rhus glabra (E).
Astragalus carycocarpos (W).
Glycyrrhiza lepidota (W).
Potentilla arguta (E & W).
Houstonia angustifolia (E).
Helianthus annuus (W).
Achillea millefolium (Cos).
Convolvulus sepium, hairy form (W).
Rumex acetosella (Cos).
Euphorbia dictyosperma.
Euphorbia Geyeri (W).
Poa pratensis (Cos).

Euphorbia hexagona.
Euphorbia heterophylla.
Poa compressa (Eu).
Panicum Wilcoxianum (W).
Andropogon scoparius (W).
Calamovilfu longifolia.
Panicum capillare (E & W).
Bouteloua racemosa (E & W).
Panicum virgatum (W).
Sporobolus cryptandrous (E & W).

WOODBINE BLUFF FLORA.

It is interesting in this connection to compare the flora of the loess bluffs with that occurring at Woodbine. The region here is essentially the same as that at Woodbine excepting that the loess is somewhat diminished and the bluffs immediately encroaching upon the broad valley of the Boyer are more or less wocded. It is a noticeable fact here that of the strictly western species comparatively few of them are represented at Woodbine. On the grass covered bluffs the following are some of the more important of the plants. Of the early grasses we may mention —

Stipa spartea,
Poa pratensis,
Poa compressa,
Panicum Scribnerianum.

Of the early vernal plants—

Sisyrinchium angustifolium,
Viola palmata var. *cucullata,*
Oxalis violacea,
Sisymbrium canescens,
Achillea millefolium,
Lithospermum angustifolium,
Astragalus carycocarpus.
Hypoxis erecta,
Viola pedatifida,
Corydalis aurea var. *occidentalis,*
Antennaria plantaginifolia,
Lithospermum canescens,
Castillea sessiliflora.

Of the later blooming plants we may mention as especially prominent

Delphinium azureum,
Polytænia Nuttallii,
Silene antirrhina,
Lobelia spicata.
Echinacea angustifolia,
Phlox pilosa,
Erigeron annuus,
Rumex acetosella,
Erigeron strigosus.

especially the latter, which is extremely common.

Of the late June and July plants we may mention especially

Monarda fistulosa,
Psoralea argophylla,
Asclepias verticillata,
Heliopsis scabra,
Anemone cylindrica,
Lepachys pinnata,

Figure 14. A heavily wooded ravine in the loess region. The chief types are *Prunus Virginiana*, *Ribes gracile*, *Ulmus fulva*, *U. Americana*, *Quercus macrocarpa* and occasionally *Morus rubra*. (From Vol. V, Iowa Geol. Surv.)

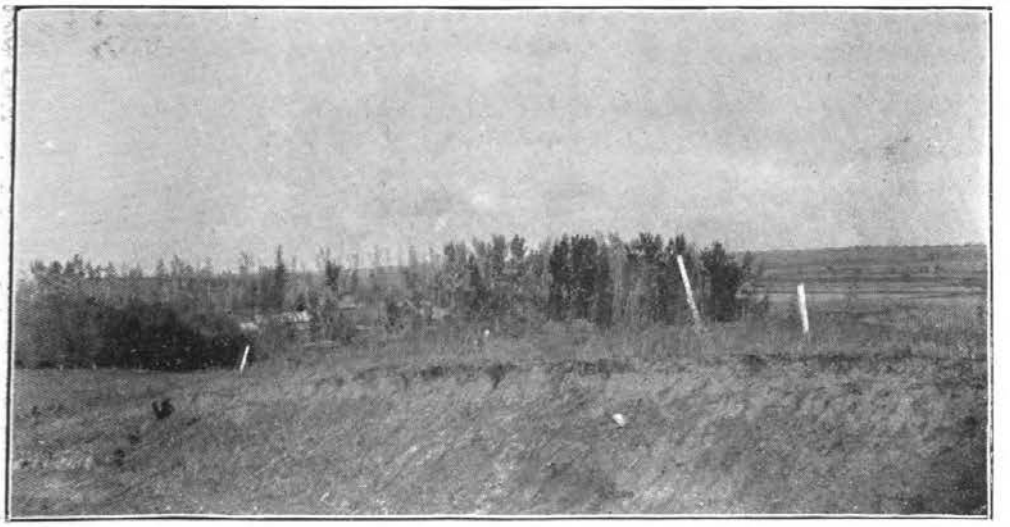

Figure 15. One of the smaller valleys, the Floyd, in Plymouth county. The stream is bordered with *Salix amygdaloides*, *Ulmus Americana*, and herbaceous plants like *Anemone Pennsylvanica*, *Phlox pilosa*, *Elynus robustus*. These soils are often very moist in the spring. (From Vol. VIII, Iowa Geol. Surv.)

Petalostemon candidus,
Potentilla arguta,
Lactuca pulchella,
Verbena stricta,
Euphorbia corollata.
Petalostemon violaceus,
Cassia chamæcrista,
Coreopsis palmata,
Convolvulus sepium,
Verbena bracteosa.

August and September list—

Solidago Missouriensis,
Aster sericeus,
Ambrosia psilostachya,
Cnicus discolor,
Euphorbia maculata.
Solidago rigida,
Aster multiflorus,
Helianthus Maximiliani,
Euphorbia marginata,
Euphorbia dictyosperma.

Loess grasses—

Bouteloua racemosa,
Panicum virgatum,
Andropogon nutans.
Andropogon scoparius,
Andropogon provincialis,
Panicum virgatum,
Sporobolus cuspidatus.

Sporobulus cuspidatus forms thick interlacing rootstocks that firmly bind the soil. Where it grows it forms a most conspicuous feature of the vegetation. It usually grows in newer made soil being much younger than the formation occupied by *Andropogon provincialis* and *A. scoparius*.

Few shrubs occur upon the open grassy meadows. A few however should be listed here.

Ceanothus ovatus,
Rosa blanda var. *Arkansana*.
Symphoricarpos occidentalis.
Rhus glabra,
Amorpha canescens.

It should be stated here that the other shrubs like *Corylus Americana* and *Prunus Virginiana* are found in close proximity to the woods. The *Rhus glabra* also spreads from the borders of woods reaching out into the meadows and is a forerunner of a forest growth.

AMES.

Early flowering plants of Ames during April and May are as follows:

Anemone patens var. *Nuttalliana* (rare),
Viola pedata,
Oxalis violacea,
Astragalus carycocarpus,
Sisymbrium canescens,
Viola palmata var. *cucullata*,
Oxalis corniculata,
Taraxacum officinale,

Lithospermum canescens, *Lithospermum angustifolium*.
Castilleia sessiliflora.

Of the later blooming plants—

Anemone cylindrica, *Delphinium azureum*,
Lepidium apetalum, *Phlox pilosa*,
Verbena bracteosa, *Hedeoma hispida*,
Rumex acetosella, *Poa pratensis*,
Poa compressa, *Echinacea angustifolia*,
Achillea millefolium, *Troximon cuspidatum* (rare).
Lobelia spicata, *Erigeron strigosus*.
Antennaria plantaginifolia.

Of the June and July plants—

Asclepias verticillata, *Psoralea argophylla*,
Petalostemon violaceus, *Petalostemon candidus*,
Erigeron divaricatus, *Cassia Chamæcrista*,
Potentilla arguta, *Liatris cylindrica*,
Solidago Missouriensis, *Coreopsis palmata*,
Verbena stricta, *Euphorbia corollata*.
Panicum pubescens.

Of the shrubs we may mention—

Ceanothus ovatus, *Rhus glabra*,
Rosa blanda var. *Arkansana*. *Amorpha canescens*.

The shrubs in the drift hills are not much more conspicuous than near Woodbine and Missouri Valley.

August and September list.

Solidago rigida, *Solidago nemoralis*,
Aster sericeus, *Aster multiflorus*,
Ambrosia psilostachya, *Heliopsis scabra*,
Cnicus discolor, *Artemisia caudata*,
Panicum capillare, *Euphorbia maculata*,
Andropogon scoparius, *Bouteloua hirsuta*,
Sporobolus asper. *B. racemosa*,
Panicum virgatum,
Aristida basiramea.

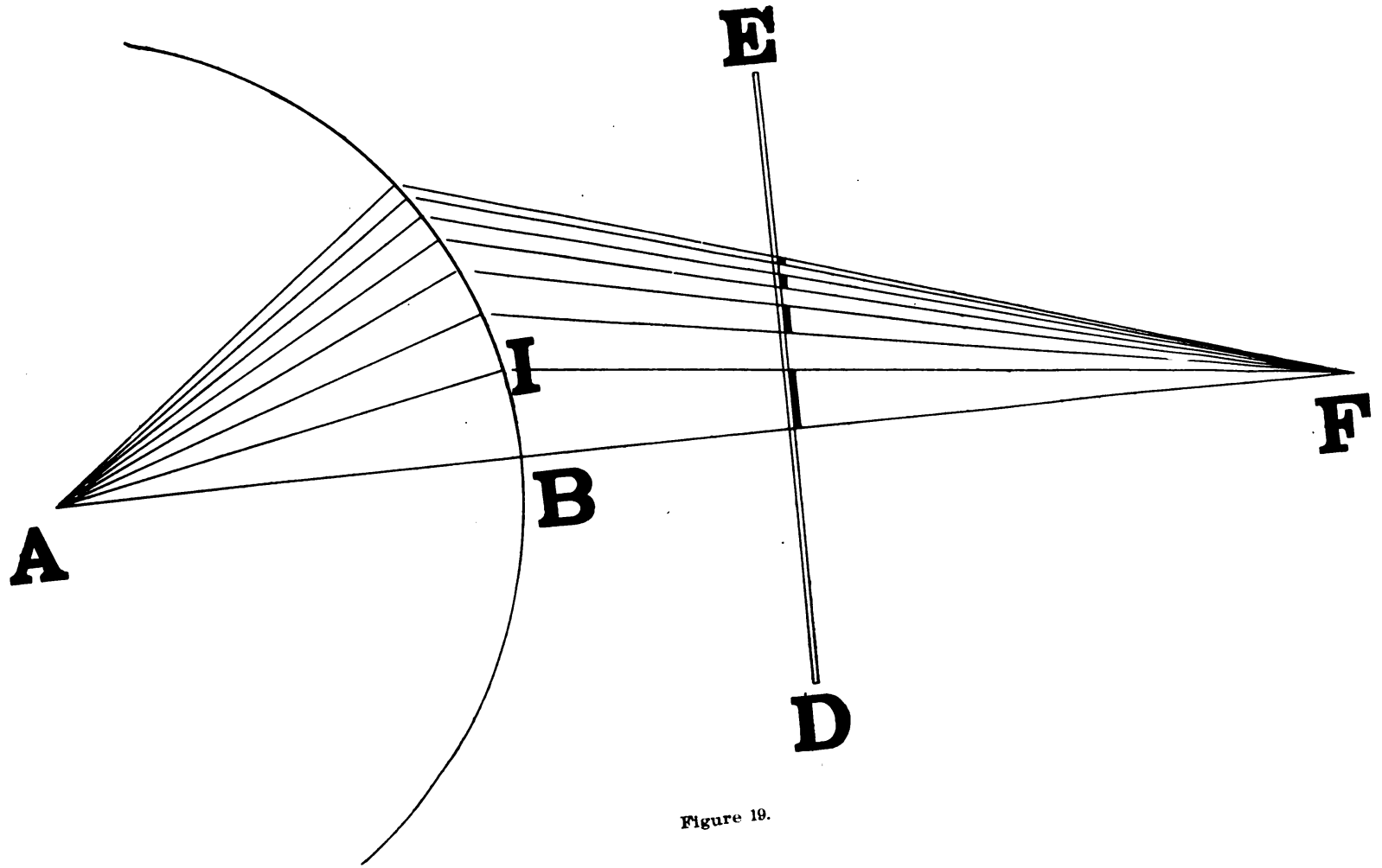

Figure 19.