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AN ECOLOGICAL COMPARISON OF TWO TYPES
OF WOODLAND

(*A Preliminary Report*)

O. R. CLARK

During parts of the growing seasons of 1924 and 1925 a preliminary study has been made of two types of woodland in the vicinity of Cedar Falls, Iowa. In later studies, now under way, an attempt will be made to determine more accurately the structure of these woodlands and to correlate the differences in structure with the ecological factors.

The first of these two regions will hereafter be designated as the Red Oak-Linden type since it has been determined, by means of quadrats, that these species are the most abundant and most important members. This woodland is found occupying the bluffs which rise abruptly from the Cedar River approximately three miles east of Cedar Falls. The bluffs, composed of glacial till, are overlain with a deposit of loess averaging about six inches in thickness, though in some places it may reach a depth of one foot. This very fine material gives to the soil a relatively high water-holding capacity. There is a considerable leaf litter covering the surface and the first six inches or so below the surface show a rather high humus content, which still further aids in the retention of moisture. The region is deeply cut by ravines which run in a north or northeasterly direction toward the river and is covered by a fairly dense stand of typical deciduous forest.

This forest is clearly an extension of the deciduous, climax forest which centers in the Ohio Valley, the less mesophytic character of this extension being indicated by the fact that the Red Oak (*Quercus rubra*) and the Linden (*Tilia americana*) have assumed a dominance not possible to them in the main climax forest farther eastward. Besides the two species mentioned the Shagbark Hickory (*Hicoria ovata*) is also dominant and other prominent species are *Quercus alba*, *Fraxinus americana* and *F. lanceolata*, and *Ulmus americana*. The hard maple (*Acer saccharum*) is frequent on the moist slopes of the ravines though it does not reach a large size. At the bottom of the bluffs near the river the Black Walnut (*Juglans nigra*) and the Butternut (*Juglans cinerea*) are abundant and assume a large size. In the more open situations the intolerant Large-toothed Aspen (*Populus grandidentata*) and the American Aspen (*Populus tremuloides*) are

found though they are unable to compete with the dominants, as indicated by the standing dead trunks. The trees stand fairly close together with tall, straight trunks and small crowns. The crowns usually touch each other producing practically continuous shade beneath. Beneath the larger trees the Hop Hornbeam (*Ostrya virginiana*) is very abundant but never reaches large size and is able to survive only because of its tolerance. Aside from this species the layer of small trees and shrubs is not well developed though *Xanthoxylum americanum* and species of *Cornus*, *Crataegus* and *Ribes* are frequently found. The mesophytism of this forest and the approach to the parent climax type is indicated by the presence in the herbaceous layer of such species as *Sanguinaria canadensis*, *Podophyllum peltatum*, *Arisaema triphyllum*, *Trillium grandiflorum*, *Claytonia virginica*, *Impatiens biflora* and *Isopyrum biternatum*.¹ The more important woody and herbaceous species are listed below.

WOODY SPECIES

Quercus rubra	v.a. ²	Xanthoxylum americanum	f.
Tilia americana	v.a.	Celtis occidentalis	i.
Hicoria ovata	v.a.	Gleditsia triacanthos	i.
Quercus alba	a.	Populus grandidentata	f.
Acer saccharum	a.	Populus tremuloides	i.
Ostrya virginiana	v.a.	Prunus serotina	r.
Fraxinus lanceolata	f.	Prunus virginiana	r.
Fraxinus americana	f.	Cornus sp	i.
Juglans nigra	f.	Ribes sp	f.
Juglans cinerea	f.	Crataegus sp	f.

HERBACEOUS SPECIES

Sanguinaria canadensis	v.a.	Hydrophyllum appendiculatum	f.
Erythronium albidum	a.	Hydrophyllum virginicum	v.a.
Asarum canadense	a.	Viola papilionacea	v.a.
Arisaema triphyllum	a.	Viola pubescens	a.
Podophyllum peltatum	a.	Trillium declinatum	f.
Bicuculla canadensis	f.	Impatiens biflora	v.a.
Bicuculla cucullaria	a.	Phlox maculata	a.
Isopyrum biternatum	v.a.	Polygonatum commutatum	f.
Syndesmon thalictroides	f.	Aquilegia canadensis	f.
Uvularia sessilifolia	a.	Smilax herbacca	f.
Uvularia grandiflora	a.	Anemone quinquefolia	f.
Polemonium reptans	v.a.	Washingtonia claytoni	a.
Caulophyllum thalictroides	f.	Washingtonia longistylis	a.
Claytonia virginica	v.a.	Ranunculus septentrionalis	v.a.
Hepatica acutiloba	v.a.	Vagnera stellata	a.
Geranium carolinianum	v.a.	Vagnera racemosa	a.
Sanicula marylandica	f.	Erigeron philadelphicus	f.

The Bur Oak-Black Oak woodland is found on a portion of an old flood plain, approximately one mile north of Cedar Falls, along Snag Creek, a tributary of the Cedar River. The soil in

¹ Pool, Weaver and Jean — Further Studies in the Ecotone Between Prairie and Woodland. Botanical Survey of Nebraska N. S. No. II. 1918.

² v.a. = very abundant; a = abundant; f = frequent; i = infrequent; r = rare.

this region is a coarse sandy loam with a comparatively low humus content and low water-holding capacity. The soil is also quite probably slightly acid due to the ease with which leaching may occur. This woodland is much more open than the one previously described, open spaces are common in which prairie species are found. Because of the more intense light and the accompanying drying effect few of the herbaceous species abundant in the more mesophytic habitat grow well here. The two dominant species, *Quercus macrocarpa* and *Q. velutina*, make up the bulk of the woody species, the number of individuals of other species not being large. The list of shrubs found is practically limited to the Prickly Ash (*Xanthoxylum americanum*) and species of *Ribes*, while the herbaceous ground cover is much less luxuriant than in the first type described. Following is a list of the principal woody and herbaceous species.

WOODY SPECIES

<i>Quercus macrocarpa</i>	v.a.	<i>Tilia americana</i>	r.
<i>Quercus velutina</i>	v.a.	<i>Prunus serotina</i>	r.
<i>Quercus rubra</i>	i.	<i>Juniperus virginiana</i>	a.
<i>Ulmus fulva</i>	f.	<i>Prunus virginiana</i>	r.
<i>Ulmus americana</i>	f.	<i>Populus tremuloides</i>	f.
<i>Hicoria minima</i>	r.	<i>Xanthoxylum americanum</i>	f.
<i>Juglans nigra</i>	f.	<i>Ribes</i> sp.	a.
<i>Gymnocladus dioica</i>	i.	<i>Corylus americana</i>	a.
<i>Acer saccharum</i>	r.		

HERBACEOUS SPECIES

<i>Mertensia virginica</i>	v.a.	<i>Ranunculus abortivus</i>	i.
<i>Polemonium reptans</i>	a.	<i>Oxalis violacea</i>	a.
<i>Circaea lutetiana</i>	f.	<i>Lithospermum linearifolium</i>	f.
<i>Phlox bifida</i>	f.	<i>Monarda fistulosa</i>	a.
<i>Pedicularis canadensis</i>	f.	<i>Anemone cylindrica</i>	f.
<i>Scrophularia marylandica</i>	f.	<i>Brauneria pallida</i>	f.
<i>Viola pedatifida</i>	a.	<i>Rudbeckia hirta</i>	f.

Some preliminary work has been done towards a comparison of the important ecological factors in the two habitats. Because of the fragmentary nature of the data secured no definite conclusions can be stated now though the results indicate a considerable difference in the environmental conditions. Water content of the soil and evaporating power of the air have been directly compared for short periods, the results showing a higher water content of the soil and a lower evaporating power of the air for the Red Oak-Linden region. A comparison of these two conditions for a two weeks period in the fall of 1925 is shown in the following table.

It has been shown by Livingston,² and verified by Fuller³ and

² Livingston, B. E., Evaporation and Plant Habitats. Plant World 11:1-10, 1908.

³ Fuller, George Damon, Evaporation and Soil Moisture in Relation to the Succession of Plant Associations. Bot. Gaz. 58: No. 3, Sept., 1914.

TABLE I
COMPARISON OF DAILY EVAPORATION AND TOTAL WATER CONTENT OF THE SOIL

WEEK END-ING	STATION	EVAP-ORATION IN C.C. PER DA.	TOTAL WATER CONTENT			
			0-6"	6-12"	12-18"	18-24"
Sept. 28	Red Oak-Linden 1*	4.5	37.4	25.1	13.9	11.6
	Red Oak-Linden 2*		23.5	13.3	7.4	9.5
	Bur Oak-Black Oak		13.3	11.5	10.2	10.1
Oct. 5	Red Oak-Linden 1	2.1	35.0	19.9	18.2	
	Red Oak-Linden 2	3.2	40.2	22.8	22.1	24.0
	Bur Oak-Black Oak	3.9	13.6	9.5	8.2	10.9
Oct. 12	Red Oak-Linden 1	3.3	35.8	17.3	18.2	19.3
	Red Oak-Linden 2	4.5	31.5	20.7	20.8	15.8
	Bur Oak-Black Oak	5.6	12.5	9.2	9.9	9.5

others, that the evaporating power of the air furnishes a reliable means of comparing all the atmospheric factors in different habitats since it integrates the effect of air temperature, air moisture and air movement, which are chiefly concerned in water loss from plants and varies with their rates of transpiration. The evaporating power of the air and the available water content of the soil without doubt are the factors which affect most markedly the development and distribution of plants.

Other factors have not been compared directly because of a lack of instruments but some isolated readings have been made. Readings for relative humidity of the air, air temperature and soil temperatures at depths of 2 inches, 1 foot and 2 feet were taken in typical situations. The results show a higher relative humidity of the air, lower air and soil temperatures for the Red Oak-Linden habitat. No comparison of light values has been made but in this respect the Red Oak-Linden woodland is more favorable for mesophytic species.

In comparing the ecological factors in the two woodland habitats with those in the prairie it is noted that the Bur Oak-Black Oak habitat approaches more nearly the prairie condition. This less favorable type of environment is reflected in the smaller number of species and less luxuriant growth of the herbaceous species. This is in accord with the results of investigations of Pool, Weaver and Jean in eastern Nebraska, in that the woodland communities nearest the climax are the most mesophytic especially with respect to evaporating power of the air and water content of the soil.

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* Station 1, in Red Oak-Linden at foot of north slope.

* Station 2, on ridge above ravine.