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Surficial Geology, Soils, and Plant Zonation Ross Biological Area[1]

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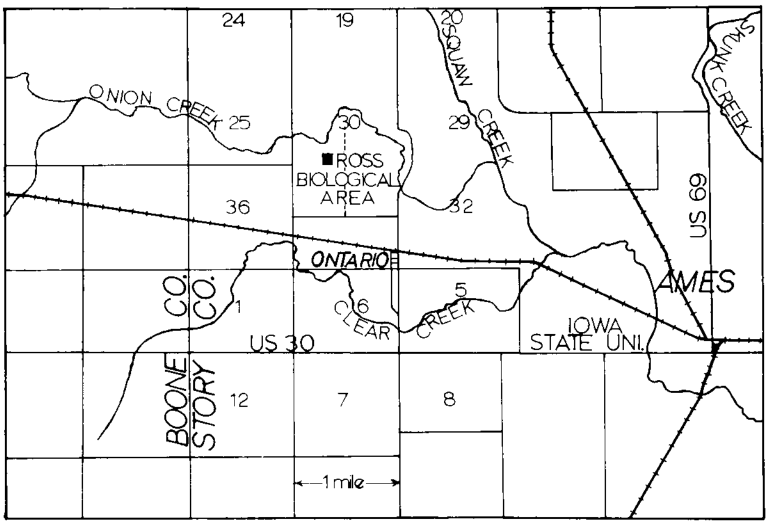
Abstract. Plant distribution is investigated with regard to geologic, geomorphic, and pedologic influences. Little is know about the soil-plant relationship of native species. This study attempts to develop a basic concept that the native plant zonation can be described in terms of the above three factors simply on the basis of routine field investigations. Further studies may then be designed to bring about a more quantitative understanding of the actual nutrient and moisture regimes under which certain native species will be most commony found.

The tract of land investigated in this study lies to the south of Onion Creek in the SE¼ SW¼ sec. 30, T. 83 N., R. 24 W. (42° 03′ N, 93° 41′ W). It is one mile northwest of the Ames city limits (see Fig. 1).



INDEX MAP

(modified from 1912 U.S.G.S. Topographic Map - Ames Quadrangle)

Fig. 1 Index Map

[1] Appreciation is expressed to Doctors R. Q. Landers, F. F. Riecken, and T. E. Fenton for review of and suggested improvements in the manuscript. C. S. Fisher and J. D. Hghland freely discussed the soil interpretations with the authors, and Highland also spent time at the study site verifying the particular soils described in the report. Their suggestions were quite helpful and worthwhile.

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One continuous landform, from the top of the hill down the sideslope and out onto the relic floodplain, was chosen for an extensive plant distribution study. More limited soils and geomorphic investigations were also conducted. The topographic map (Fig. 2) was drawn to a relative datum level of 100 feet. The highest elevation was found at the bend in the fence line; therefore, it was taken as the 100-foot point for the topographic datum. Seven down-hill traverses were made for the soil and topographic surveys. In the plant distribution study, 21 parallel traverses were made, and sample sites were located at four meter intervals. The total area of the study site is 69,684 square feet.

Geologic Setting

The Cary glacial drift in Iowa extends southward from the Minnesota state line to the City of Des Moines (see Fig. 3). It is called the Des Moines drift lobe, and the major subdivisions (from

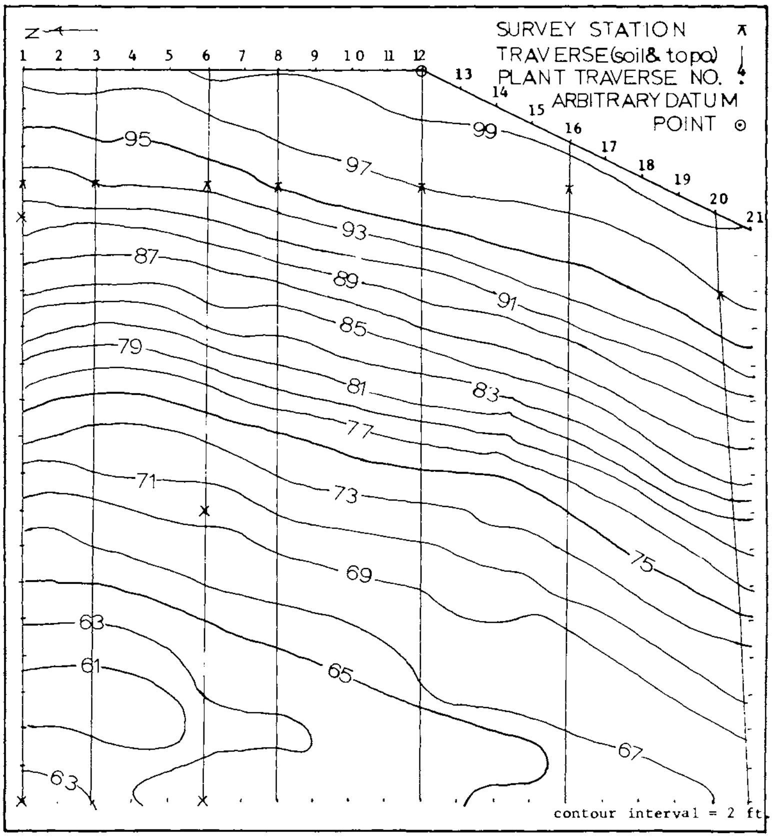


Fig. 2 Topographic Map

the oldest to the youngest) are successively: 1) Bemis end moraine, 2) Altamont end moraine, 3) Humboldt end moraine, and 4) Algona end moraine. The Ross biological area lies on the Bemis moraine.

Carbon-14 dating of wood in stratigraphic horizons immediately beneath the till in the vicinity of Ames places the date of burial at approximately 14,000 years B.P. (Ruhe, 1969, p 61). These dates range from 13,280 ± 400 (W-513) at the Scranton No. 1 site, Greene County, to 14,700 ± 400 (W-153) at the Clear Creek site in Story County. The former sample was spruce wood and the latter was hemlock (Ruhe, Op. Cit.). The Clear Creek site is only 2 miles south and ½ mile east of the Onion Creek location (see Fig. 1).

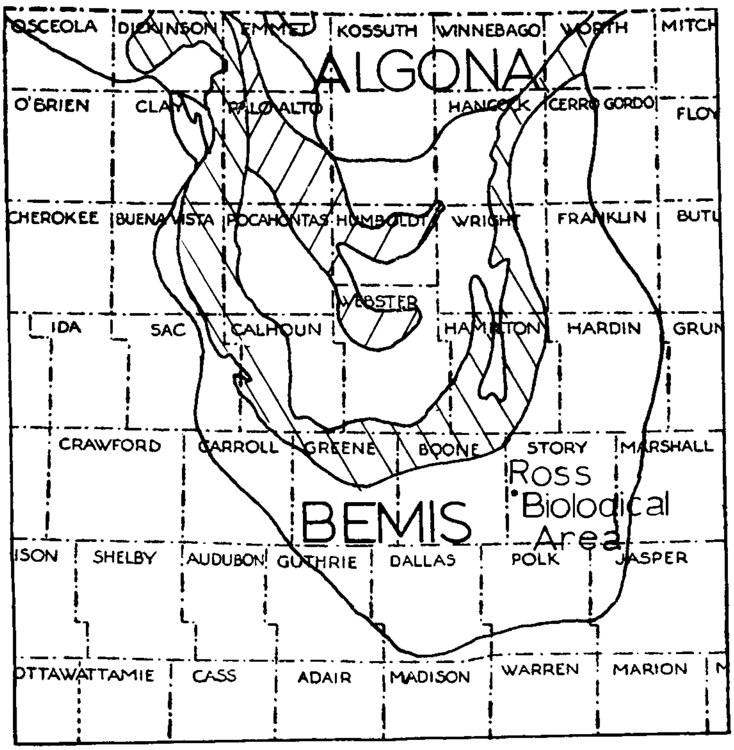
In 5 of the 7 soil traverses, loess was identified beneath the till on the lower portion of the backslope. Due to the effect of overriding of the glacial ice sheet, it is very contorted and discontinuous. Sand lenses and many discontinuities occur between the overlying Cary Drift and the underlying tills.

The thickness of the Cary Age glacial till is approximately 30 feet under the summit. It most likely represents a minimum thickness as the study site descends from a secondary or tertiary summit. A large knoll to the southeast of the study area stands 20 to 30 feet higher in elevation and probably also represents a thicker till deposit at that point.

Alluvium covers the base of the slope. It forms a bench terrace which appears as a broadening of the contour lines on the topographic map (Fig. 2). In the northwest corner of the study area a small point bar deposit exists that has the same relative texture as the bench terrace. Between the point bar and the terrace a swale is found that ecologically is classified as a wet meadow. From the shallow boring, the sediments present in this area appear to be similar to the upper part of those described by Walker (1966, p. 845) in the bogs of the Des Moines lobe. Free water is found standing at or just below the ground surface in this area in spite of efforts to drain it by shallow ditches to the west of the study area and a tile line into the wet meadow.

The following approximate geologic ages of the surficial deposits which are encountered in the study area are constructed from data provided by Walker (1966, p. 871) on the depositional sequences in the bogs.

Upper swale deposits $\approx <$ 3,000 years B.P.
Bench terrace and point bar ? to $<$ 13,000 years B.P.
Cary drift $\approx$ 13,000 to 14,000 years B.P.
Wisconsin loess $>$ 14,000 years B.P.



MORAINAL SYSTEMS of DES MOINES LOBE

☐ BEMIS ▧ ALTAMONT

▨ HUMBOLDT ☐ ALGONA

FIGURE 3

After Ruhe, 1952

GEOMORPHOLOGY AND SOILS

The topographic form of the study area is schematically illustrated in Figure 4. The main trend of the crest line is roughly north-south, with the slope exhibiting a westerly aspect. The summit is not on a primary divide. It is either a secondary or a tertiary divide, and as such, can be expected to be in a rather unstable position on the landscape. Such topography is typical in morainal areas. Both Onion Creek and the smaller tributaries on Onion Creek have, by headward and/or lateral movement, considerably modified the original topography. As the summit width here is less than 200 feet, the surface characteristics of the soil tend to be

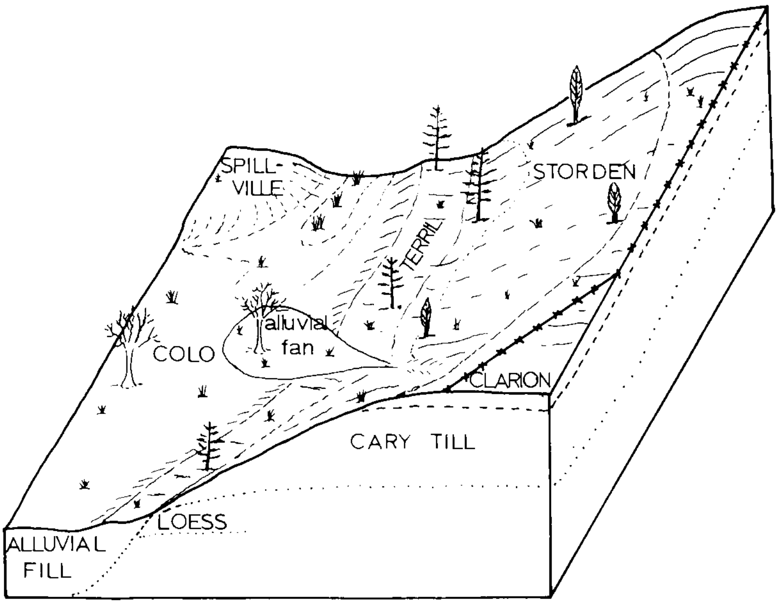


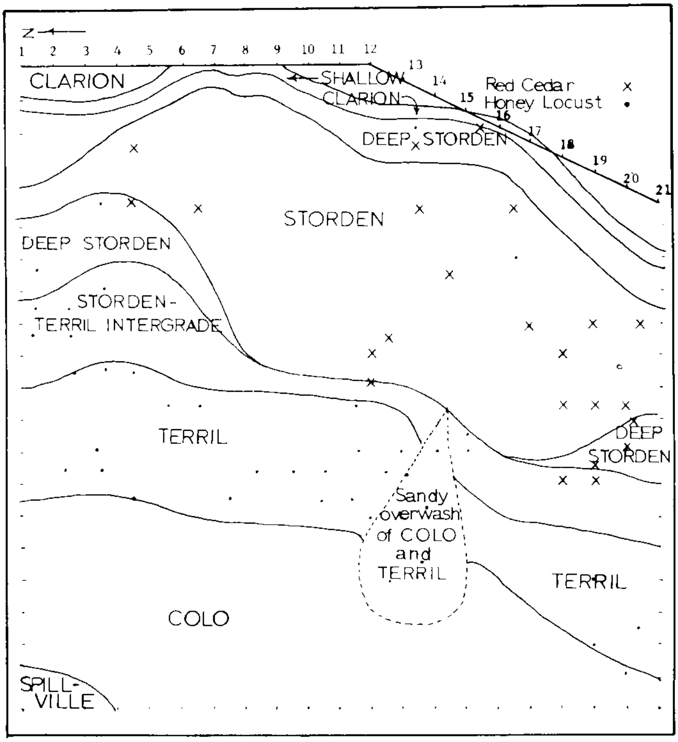
Fig. 4 Schematic Diagram Ross Biological Area

quite variable.

As one descends the hillside, the thickness of the Cary till decreases to the point where it has been completely eliminated from the stratigraphic section by erosion. The thalweg of the ancestral Onion Creek formerly occupied a position at the base of the hill. It now is located ⅛ of a mile due north. The former meander channel has undergone some of the later sedimentation cycles that characterize the filling of bogs on the upland surface of the Des Moines lobe.

Between the lower wet meadow (swale) and the backslope of the hillside a transitional zone occurs. This is represented by a small bench terrace. The sediment that composes the terrace is both colluvial and alluvial in origin. That is, it has been derived from sheet wash on the backslope and from the ancestral Onion Creek. It is at this precise location that the Wisconsin loess would appear at the ground surface, were it not cut out and incorporated into both the colluvial and alluvial deposits of the bench terrace.

From analysis of pollen data on the Colo bog, approximately 20 miles east of the study site. Walker (Op. Cit.) concluded that the environment was favorable to conifers from 13,000 to 10,500 years B.P. Between 10,500 and 8.000 years ago there was a gradual transition from conifers to hardwoods. A herbaceous maximum occurred between 8.000 and 3.000 B.P.. after which the oak began



SOIL and TREE DISTRIBUTION
FIGURE 5

to invade the prairie subclimax. The soils that began forming after recession of the glacial ice have been subjected to the various plant successions; however, they show evidence of only the prairie vegetation since it has been the latter and stronger influence. This is also true on the lower portions of the backslope, as well as in the slough and on the point bar.

The soil toposequence is represented by the Clarion, Storden, Terril, Colo, and Spillville series (see Figs. 4 and 5). These soils are respectively located on the summit, shoulder and backslope, footslope and terrace, slough and swale, and point bar. Typical profile descriptions of these soils appear in the Polk County, Iowa, soil survey bulletin (1960). The distribution of these soils is illustrated in Figure 5. Locations where complete profile descriptions were made are indicated by an X on the topographic map.

The Clarion series occupies the most stable portion of the landscape. It typically is naturally well drained. The surface runoff is medium, and there is a moderate permeability. It has been generally assumed that the original native vegetation was tall prairie grasses. It was formerly considered to be in the Brunizem group, but it is now classified as a member of the fine-loamy, mixed, mesic family of Typic Hapludolls. The profile description is as follows:

A1	0-8"	Black (10YR 2/1) medium loam; few faint fine 10YR 3/2 mottles; weak fine subangular blocky structure; friable; slightly acid; clear boundary.
A12	8-11"	Dark brown (10YR 3/3) medium loam; common distinct medium 10YR 7/8 mottles; weak fine angular blocky structure; friable; slightly acid; gradual boundary.
A3	11-15"	Dark brown to brown (10YR 4/3) medium loam; common distinct medium 10 YR 5/8 mottles; weak fine granular structure; friable; slightly acid; gradual boundary.
B21	15-20"	Yellowish brown (10YR 5/6) medium loam; few faint medium 10YD 3/2 coatings on ped faces; weak fine subangular blocky structure; friable; neutral; gradual boundary.
B22	20-31"	Light olive brown (2.5Y 5/4) medium loam; weak fine subangular blocky structure; friable; calcareous at 24 inches; clear boundary.
C1	31-42"	Light olive brown (2.5Y 5/6) medium loam; few fine faint light olive brown (2.5Y 5/4) coatings; massive; friable; small white lime spots; calcareous; gradual boundary.
C2	42-120"+	Brownish yellow (10YR 6/6) medium loam; many distinct coarse strong brown (7.5YR 5/8) and light brownish gray (10YR 6/2) mottles; massive; friable; many gravel-size particles; some disintegrated granite cobbles; large white lime concretions; calcareous.

The type location is traverse no. 1 (0 + 00 meters).

The Storden series occupies portions of the summit, shoulder, and backslope. It is dominantly found on the backslope. It is typically somewhat excessively drained. Surface runoff is rapid, and permeability is moderate. Native vegetation was tall prairie grasses. It was formerly classified as a Regosol. It is now considered to be a member of the fine-loamy, mixed, mesic family of Entic Hapludolls.

The profile described below is from traverse no. 1 (0 + 16 meters).

A1	0-6"	Very dark brown (10YR 2/2) loam; weak fine granular structure; friable; mildly alkaline in the upper 2 inches; strongly calcareous below 2 inches; clear boundary.
C1	6-16"	Yellowish brown (10YR 5/4) loam; massive breaking to weak fine subangular blocky structure; friable; strongly calcareous; clear boundary.
C2	16-27"	Yellowish brown (10YR 5/4) loam; massive breaking to weak fine subangular blocky structure; few distinct medium yellowish brown (10 YR 5/6) mottles; friable; strongly calcareous; gradual boundary.
C3	27-37"	Brown to yellowish brown (10YR 5/3-5/4) loam; massive; common prominent large strong brown (7.5 YR 5/8) mottles; friable; strongly calcareous; gradual boundary.

C4 -- 37-48" --Same as above with following exception in mottling: common prominent large reddish brown (5YR 4/3) mottles.

C5 -- 48-84" —Brown to yellowish brown (10YR 5/3-5/4) sandy loam; massive; common prominent large yellowish brown (10YR 5/8) and strong brown (7.5YR 5/8) mottles often in bands 4 to 6 inches apart; friable; moderately calcareous; gradual boundary.

C6 -- 84-90" --Similar to above with strong Fe and Mn staining.

C7 — 90-108"+—Brown to yellowish brown (10YR 5/3-5/4) sandy loam; massive; common distinct medium to coarse yellowish brown (10YR 5/6) to strong brown (7.5YR 5/6-5/8) mottles; friable; moderately calcareous; more gravel-size particles than above.

The Terril series occupies portions of the footslope and bench terrace. It is moderately well drained. Surface runoff is medium and permeability is moderate. Terril soils were formerly classified as Brunizems; however, they are now considered to be a member of the fine-loamy, mixed, mesic family of Cumulic Hapludolls.

The profile described below is from traverse no. 6 (0 + 48 meters).

A11 -- 0-6" Very dark brown (10YR 2/)(loam; weak fine subangular blocky structure; friable; slightly acid; clear boundary.

A12 -- 6-18" ---Black (10YR 2/1) loam; few medium yellowish brown mottles and iron concretions between 6 and 10 inches; weak fine subangular blocky structure breaks to weak fine granular structure; friable; slightly acid; gradual smooth boundary.

A13 -- 18-24" --Black (10YR 2/1) heavy loam; weak coarse blocky structure breaking to weak fine and medium subangular blocky structure; friable; slightly acid; gradual smooth boundary.

A3 -- 24-31" —Very dark brown (10YR 2/2) light clay loam; ped interiors very dark grayish brown (10YR 3/2); weak fine and medium subangular blocky structure; friable; slightly acid; gradual smooth boundary.

B1 — 31-38" --Very dark grayish brown (10YR 3/2) light clay loam; weak fine and medium subangular blocky structure; friable; neutral; gradual smooth boundary.

B2 — 38-44" --Dark brown (10PR 3/3) heavy loam; weak fine and medium subangular blocky structure; friable; neutral; gradual smooth boundary.

B3 -- 44-60" --Brown (10YR 4/3) heavy loam; some strong brown (7.5YR 5/8) mottles; very weak fine subangular blocky structure; friable; neutral.

The Colo series is found in the swales and sloughs. It is poorly drained and permeability is moderately slow. Surface runoff is slow. This soil was formerly classified as a Huic Gley intergrading to Alluvial soils. It is now considered to be a member of the fine-silty, mixed, noncalcareous, mesic family of Cumulic Haplaquolls.

The profile described below is from traverse no. 6 (0 + 80 meters).

A11 — 0-12"	—Black (10YR 2/1) light silty clay loam; weak medium subangular blocky structure; friable; medium acid; diffuse smooth boundary.
A12 — 12-24"	—Black (10YR 2/1) light silty clay loam; weak and medium subangular blocky structure; friable; slightly acid; diffuse smooth boundary.
A13 — 24-38"	—Black (10YR 2/1) medium silty clay loam; few to common dark brown oxide concretions; slightly acid; diffuse smooth boundary.
AC — 38-52"	—Very dark gray (10YR 3/1) medium silty clay loam; few to common dark brown oxide concretions; common distinct medium dark gray (5YR 4/1) mottles; very weak granular structure; firm; diffuse smooth boundary.

The Spillville series is found on an elevated portion of the relic floodplain that resembles a point bar deposit. It is moderately well drained; permeability is moderate and runoff is slow. This soil was formerly called a Brunizem intergrading to Alluvial soil. It is now considered as a member of the fine-loamy, mixed, mesic family of Cumulic Hapludolls.

The profile described below is from traverse no. 1 (0 + 80 meters).

A11 — 0-26"	—Black (10YR 2/1) loam; weak fine granular structure; very friable; neutral; gradual smooth boundary.
A12 — 26-36"	Black (10YR 2/1) loam; weak fine granular structure; neutral; gradual smooth boundary.
A13 — 36-54"	—Black (10YR 2/1) and very dark brown (10YR 2/2) silt loam; weak fine granular structure; slightly acid; gradual smooth boundary.
C — 54-60"	—Very dark grayish brown (10YR 3/2) loam; common medium faint dark gray (10YR 4/1) mottles; massive; friable; slightly acid.

In drawing the soil map it was recognized that the soils do not represent the described units except in their modal positions. As a consequence of their continuous nature, the following subdivisions of the major units have been adopted:

1. Clarion — a) Clarion—fits recognized series description.
   b) Shallow Clarion—profile is shallower with carbonates occurring between 8 and 18 inches.
2. Storden — a) Storden—fits recognized series description.
   b) Deep Storden—profile deeper than normally described. Carbonates occur between 1 and 8 inches below surface.
3. Terril — a) Terril-Storden intergrade—occurs in colluvial position on slope. Carbonates may be found in deeper parts of porfile where overwash material is not too thick.
   b) Terril—fits recognized series description.
4. Colo — a) Sandy overwash of Colo—alluvial fan material 3 to 20 inches thick over typical Colo soils.
   b) Colo—fits recognized series description.

No segregation was made of the Spillville series because it occupies only a small portion of the study area.

The distribution of the above soils is illustrated in figure 5 and specifically located according to transects in table 1. Depth to carbonates and several selected plant species are also listed in the table; the significance of their particular locations will be discussed in a latter section. The location of the listed traverses may be found on figure 2.

Land Use History

The plant species found on the Ross biological area indicate that it has been heavily grazed in the past, but that it has never been cultivated. The soils information shows no evidence of a plow layer except near the fence line at the top of the summit. The soils are dominantly Brunizems; therefore, it is assumed that they have developed under a tall grass prairie.

The Ames topographic Quadrangle, surveyed in 1912, indicates that the area was not forested at that time. The USDA Soil Survey of Story County (field investigations conducted in 1934-36) indicates no forest soils occur at this site; however, a more recent aerial photo (no. CAB-2-13, May 29, 1939) shows sparse forest cover all along Onion Creek up to the Boone County line. No large trees can be recognized on the study site in this photo; however, they are found just north of traverse no. 1. When the site was surveyed for seedlings in the fall of 1969, large numbers were counted. The indications are that the forest species are invading the prairie sites along the drainageways.

The lack of trees in the 1939 photo and the sparseness of grasses indicates heavy grazing. Some bare areas appear to have been heavily eroded already in 1939, and some of the small discontinuous gullies have persisted up to the present on the backslope. The area is typical of unimproved pasture land in much of central Iowa.

Plant Distribution

Twenty-one parallel traverses were laid out to run from the fence line, at the summit, 80 meters down the hillside and into the wet meadow at the base of the slope. Sample sites were located at four-meter intervals along each traverse. The distance between lines was four meters; therefore, sample sites were located at each corner of a 4-meter square. A list quadrat method, described by Oosting (1956, p. 35), was employed. This consists of laying a 20 cm x 50 cm quadrat on the ground and recording all of the species found within the rectangular area of the frame. The cover class of each species was also estimated according to the method outlined by Daubenmire (1959). Cover classes are coded in numbers from 1 to 6; the respective percentages which the numbers refer to are given at the base of table 1.

Table 1
Ross Biological Area
Data Summary Sheet

Distance from summit (meters)	Depth to $CaCO_3$ (inches)							Soil Type +						
Traverse #	1	3	6	8	12	16	20	1	3	6	8	12	16	20
0	24	38	16	15	36	....	....	1	1	2	2	1		
4	17	22	0	0	21	....	....	2	1	3	3	1		
8	3	1	0	0	6	15	....	3	3	4	4	3	2	
12	1	0	0	0	0	0	....	3	4	4	4	3	3	
16	0	0	0	0	0	0	40	4	4	4	4	4	4	1
20	1	3	0	2	0	0	23	3	3	4	4	4	4	1
24	1	7	6	0	0	0	9	3	3	3	4	4	4	3
28	4	12	>54	0	0	0	0	3	5	5	4	4	4	3
32	18	43		0	0	0	0	5	5	5	4	4	4	4
36	22	>54		0	0	0	0	5	5	5	3	4	4	4
40	>54			0	0	0	0	5	6	5	5	5	4	4
44				>54		0	0	6	6	6	6	6	4	4
48						0	5	6	6	6	6	6	4	3
52						>54	>54	6	6	6	6	6	5	5
56								7	7	7	7	6	5	5
60								7	7	7	7	7	6	6
64								7	7	7	7	7	6	6
68								7	7	7	7	7	7	6
72								7	7	7	7	7	7	6
76								8	8	7	7	7	7	7
80								8	8	7	7	7	7	7

Selected Species Listing*

Distance from summit (meters)	#26 Equisetum hiemale							#49 Poa compressa						
Traverse #	1	3	6	8	12	16	20	1	3	6	8	12	16	20
0														
4									3	3	5			
8									3	5	3			
12								4	5	3	4			
16								5	5	2	4	5		
20								5	4	5	4	6		2
24								5	5	3	3	4	5	2
28	1							5	3	5	4	3	5	2
32	1	2						5				4	4	1
36		2						3				2	4	4
40		2						3					4	1
44	2	2						3						2
48	1							2						
52	2					2		4						
56	1		2			2	2							
60			2				2							
64							2							
68		2					3							
72							2							
76							2							
80														

Distance from summit (meters)	#50 Pao pratensis				
Traverse #	1	3	6	8	12
0					4
4	3		2		5
8	2				5
12	3				
16	2			2	
20					
24				2	
28					3
32		5	2	3	2
36		5	3	5	3
40		4		5	5
44		5	2	6	5
48	2	5	4	6	6
52	1	5	5	5	
56	1	5	5	5	5
60		5	2		5
64	4	2	3	4	5
68			2	5	3
72		2	3	3	3
76	2	4	4	5	3
80			5	3	

+Number indicate Soil Type
1 Clarion
2 Shallow Clarion
3 Deep Storden
4 Storden
5 Storden-Terril Intergrade
6 Terril
7 Colo
8 Spillville

*Numbers indicate cover class
1 0-5%
2 5-25%
3 25-50%
4 50-75%
5 75-95%
6 95-100%

Tree species were individually identified and located on field sheets in the specific 4-meter square corresponding to their actual location.

A total of 104 plant species were identified within the study area. Of these, 59 occur or are identified in only a small number of quadrats; therefore, the remaining 45 have been accepted as indicator species for zonation purposes. Of the 45, only 3 species appear to be randomly distributed. The remaining 42 show a distinct preference for certain slope positions, soil types, and/or moisture regimes.

If slope position, i.e., summit, shoulder, backslope, etc. is considered as the sole basis for plant zonation, a fairly reasonable fit of plants to topography can be obtained. Table 2 summarizes these zones and the characteristic plants found on them.

Table 2. Slope Position and Characteristic Plants

1. Summit	*Poa pratensis* (Kentucky bluegrass); *Trifolium pratense* (Red clover)
2. Shoulder	*Poa compressa* (Canadian bluegrass); *Ratibida pinnata* (Yellow cone flower);
3. Backslope	*Ratibida pinnata* (Yellow cone flower); *Juniperus virginiana* (Red cedar); *Poa pratensis* (Kentucky bluegrass)
4. Terrace and footslope	*Poa pratensis* (Kentucky bluegrass); *Medicago lupulina* (Black medic); *Equisetum hiemale* (scouring rush)
5. Terrace-slough transition	*Lobelia siphilitica* (blue lobelia); *Phleum pratense* (timothy); *Eleocharis obtusa* (Spike rush); *Leersia oryzoides* (cut grass)
6. Slough (toeslope)	*Scirpus atrovirens* (Bulrush); *Carex normalis* (Carex)
7. Point bar	*Carex gravida* (Carex); *Medicago lupulina* (Black medic); *Solidago sp.* (Golden rod)

Oosting (1956, p. 329) has used a similar topographic scheme in dealing with the native components of the tall grass prairie. In the Ross Biological Area this approach gives a broad picture of the relationships. Refinement of the plant zonation may be obtained by a consideration of the soils and their subdivisions. An investigation of the soil (figure 5) reveals that unequal erosion and sedimentation has occurred. Therefore, the soils do not completely conform to landscape positions such as shoulder, backslope, etc. Use of soil data permits not only a more precise criterion for soil plant relationships but also affords a means of interpreting erosional and depositional patterns.

Table 3. Plant Distribution According to Soil Type

Species	Common name	Clarion	Storden	Terril	Colo	Spillville
Agrostis alba	red top				3*	2
Ambrosia artemisiifolia	ragweed	2	0-1	4		4
Aclepias incarnata	marsh milkweed				0-2	
Asclepias verticillata	whorled milkweed	0-2	0-2	0-2		1
Aster sp.	aster		0-5			
Carex gravida	carex (sedge)				[2] 0-2	
Carex normalis	carex (sedge)				0-3	
Carex volpinoidea	carex (sedge)				[2] 0-2	
Cirsium altissimum	tall thistle			0-3	0-2	
Crataegus sp.	hawthorn			0-6		
Eleocharis obtusa	spike rush				0-5	
Equisetum arvense	horsetail				0-3	
Equisetum hiemale	scouring rush			0-3		
Fragaria virginiana	wild strawberry		0-2			
Glyceria striata	mannagrass				0-4	
Hordeum jubatum	foxtail barley				0-3	
Juncus balticus	jucus				0-2	
Leersia oryzoides	cut grass					
Medicago lupulina	black medic		0-4	0-5		2-5
Melilotus alba	white sweetclover	0-5	0-3	0-4		
Monarda fistulosa	horse mint		0-4	0-5		0-1
Melilous officinale	yellow sweetclover		0-2			
Panicum implicatum	rosette panic grass			[0-3]		
Panicum scribnerianum	scribner's panic grass	0-2	0-2			
Phleum pratense	timothy				[0-4] 0-3	

Table 3.—Continued

Species	Common name	Clarion	Storden	Terril	Colo	Spillville
Plantago aristata	braeted plantain		0-3			
Plantago rugelii	rugels plantain		0-3			
Poa compressa	Canadian bluegrass		0-6			
Poa pratensis	Kentucky bluegrass	2-5	0-5	3-6	0-5	0-3
Prunella vulgaris	selfheal		0-3			
Ratibida pinnata	yellow coneflower		0-4			
Rosa sp.	prairie rose		0-3			
Scirpus atrovirens	bullrush				0-5	
Silphium laciniatum	compass plant		0-3			
Solidago sp.	goldenrod		0-4			
Sporobolus asper	tall dropseed				0-4	
Taraxacum officinale	dandelion	2-4	0-2		0-3	
Teucrium sp.	germander		0-2			
Triolium pratense	redclover	0-4	[0-3]	[0-3]	[0-3]	
Vitis riparia	grape			[0-6]		

[ ] indicates transition.

*numbers indicate cover class.

The most obvious zonation present in the Ross biological area is demonstrated by *juniperus virginiana* (Red cedar) and *Gleditsia triacanthos* (Honey locust). These two species occur in distinctly different bands with practically no overlap. Superposition of these two species' locations on the soil map (Fig. 5) revealed that the Red cedar is restricted to the Storden area, and that the Honey locust occurs only on the Terril and the Terri-Stoden intergrade soils. Subsequent comparison of the presence of the remaining 40 indicator species with the soil distribution, revealed that these species all fall into specific soil zones. These data are summarized in Table 3. Six of the species (*Carex gravida, Carex volpinoidea, Panicum implicatum, Phleum pratense, Trifolium pratense,* and *Vitis riparia*) occur predominantly in transition zones between the well defined (modal) soil types. Of the 34 species remaining, 28 are found on one or two soil types and the other 6 occur on three or more soils. Four of the six (*Ambrosia artemisiifolia, Asclepias verticillata, Medicago lupulina,* and *Monarda fistulosa*) do not occur on the Colo sites. The high water table is thought to be the controlling factor here, and not the soil type. Of the other two, *Popa pratensis* does not occur on the Storden, and *Taraxacum officinale* does not appear on either of the elevated alluvial soils (Terril or Spillville).

The moisture regime may be considered a restriction to plant growth as in the foregoing paragraph, or it may be considered as a necessary requisite as below.

Lobelia siphlitica demonstrates one of the most restricted and continuous zones in the study area. It occurs as a band running north and south approximately 25 cm wide, on the eastern and western edges of the slough. It seems to illustrate the moisture restrictions and needs of a plant species which cannot grow where the water table lies above the ground surface, or where the free water surface is more than several inches below the surface.

Equisetum hiemale is also a very good indicator of the influence of the moisture regime on plant zonation. It is found in the foot-slope position where the volumetric moisture content is relatively high. Its location is give in Table 1 for the traverses which were used to characterize the soil types.

Conclusions

1. After recession of the Cary ice, stream channel dissection by the ancestral Onion Creek was responsible for the development of the major topographic features found in the Ross biological area. This includes development of the backslope, bench terrace, and meander scrolls which appear as point bar deposits in the study area.

2. Soils formed on the various landscape components reflect both the environmental and erosional influences, as well as the geologic parent material in which they are developed.

3. The composition of the herbaceous and woody plants is characteristic of lightly grazed unimproved pastureland. Species common to the tall grass prairie are abundant; however, they do not exceed the pasture types. Trees, which are invading the study site, occur most frequently on the lower portions of the backslope and bench terrace.

4. Both herbaceous and woody plants are closely correlated with soil type. A more diffuse relationship exists between plant distribution and geomorphic landscape position.

5. Soil moisture regimes are quite important as illustrated by observation of the restricted distribution of Lobelia siphlitica (blue lobelia).

6. The relationship between plant distribution and geology, or more specifically geomorphology, lies in the common ground of pedology. The soil, therefore, serves as the link between ecological and geomorphic studies where both are concerned with developmental history.

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