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Plant Communities of the Apple River Canyon, Wisconsin

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One of the most attractive scenic features to be found in the vicinity of Minneapolis, Minnesota, is the steep, narrow gorge of Apple River. This gorge or "canyon" extends for a mile in an almost exact east-west direction and is located about one mile east of the junction of Apple River with the St. Croix River. The two rivers join about eight miles north of Stillwater, Minnesota, in St. Croix Co., Wisconsin.

Apple River, though at present a small shallow stream, must have been much larger in the past, for it occupies, in its lower reaches, a canyon perhaps two hundred yards wide and about 200 feet deep, with high cliffs on either side. Figure 1 is a rough sketch of the canyon in cross-section. The upper cliffs are not always as vertical as indicated in the drawing, being occasionally interrupted by smaller erosion gullies, talus slides, and small ledges.

The vegetation here is of paramount interest due to its diversity. Its zonation may be briefly sketched as follows. On the upland to the north stands an oak forest (Figure 2); on the south-facing bevel a strip of prairie grasses, these sometimes extending down the cliffs on upper talus slopes (Figures 3 and 6); on the south facing cliffs (Figure 5) there are only a few mosses, lichens, liverworts, and rock ferns; on the lowest talus and floodplain are young floodplain forest; on the talus slopes on the north-facing side a mesic forest is found, composed of an admixture of northern evergreens and deciduous trees (Figure 4); on the north-facing cliffs mostly cryptogams; on the north-facing bevel a very narrow, interrupted strip of prairie; and on the upland to the south, cultivated fields. The more important communities will be discussed in detail later.

The research here reported upon was done during the growing seasons of 1947, 1948, and 1949, while the author was at the University of Minnesota. Many thanks are due Dr. William S. Cooper of Denver, Colorado, Dr. Donald B. Lawrence of the University of Minnesota, and Dr. Rolla M. Tryon Jr. of the Missouri Botanical Garden for assistance and advice given during the course of the investigations. Specimens of all plants referred to in the text are deposited in the Herbarium of the University of Minnesota.

The Environment

The canyon of Apple River lies in the area between the southeastern limit of the "gray" drift of the St. Croix sublobe of the Mankato ice sheet and the southeastern limit of the Cary ("red drift") glaciation (Cooper, 1935). It is a few miles south of the limits of the glacial Lake Grantsburg, and in its lower parts runs more or less parallel to the postulated southeastern border of the lake. Presumably the gorge was formed during the period of drainage of Lake Grantsburg. The till on the Ordovician caprock of the upland, through which the gorge is cut, is mainly "red" or Cary in nature, though there is evidence of some admixture of calcareous Mankato outwash. The soils of the upland are very sandy (sandy loams and fine sands), well drained and relatively poor in humus content. Those of the canyon are mostly immature and also very sandy, and the alluvial soils of the floodplain are for the most part shallow but with greater humus content.

General climatic data for this region are given in Table 1. The four stations used are those closest to the canyon. Both New Richmond, Wisconsin, and Stillwater, Minnesota, are within ten miles of Apple River, while Minneapolis and St. Paul are about 40 miles to the southwest. The contrast between the readings from these

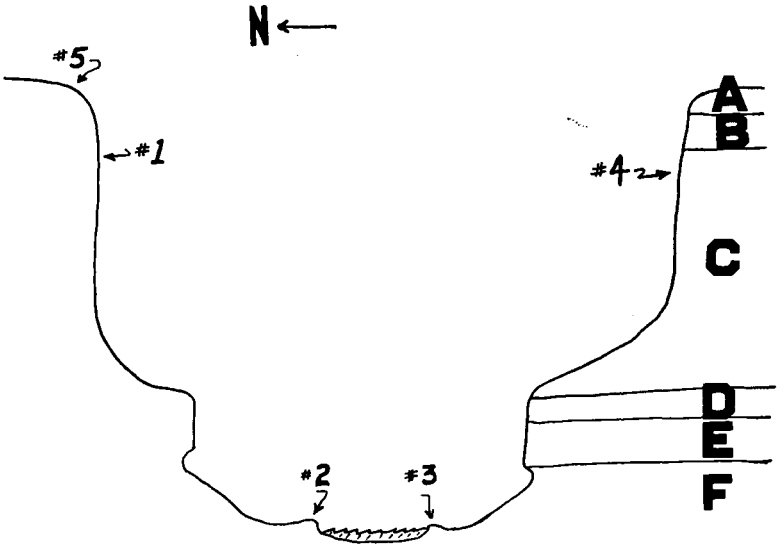

Figure 1. A cross-sectional view of the Apple River Canyon. Modified from a figure by D. B. Lawrence. Stations for collection of microclimatic data are numbered from 1 through 5. Geological formations indicated by the large letters to the right are as follows: A—Glacial outwash; B—Oneota Dolomite (Ordovician); C—Jordan Sandstone (Cambrian); D—Lodi Shale (Cambrian); E—Nicollet Creek Dolomite (Cambrian); and F—Franconia Sandstone (Cambrian). Total depth of the canyon is about 200'. The vertical scale is [illegible] somewhat exaggerated.

two regions is striking. In the Apple River region the temperatures are usually lower, the growing season much shorter, and the rainfall about 2 inches greater than that in the Twin Cities, only 40 miles away.

In a deep, east-west gorge such as this very striking differences in microclimates were anticipated, and some preliminary observations were made. Maximum-minimum thermometers were set up at four stations, the positions of which are indicated in Figure 1 by the numbers 1, 2, 3 and 4. Taylor U-type thermometers were used and were attached to wooden holders that kept them about two feet above the soil and protected from the direct rays of the

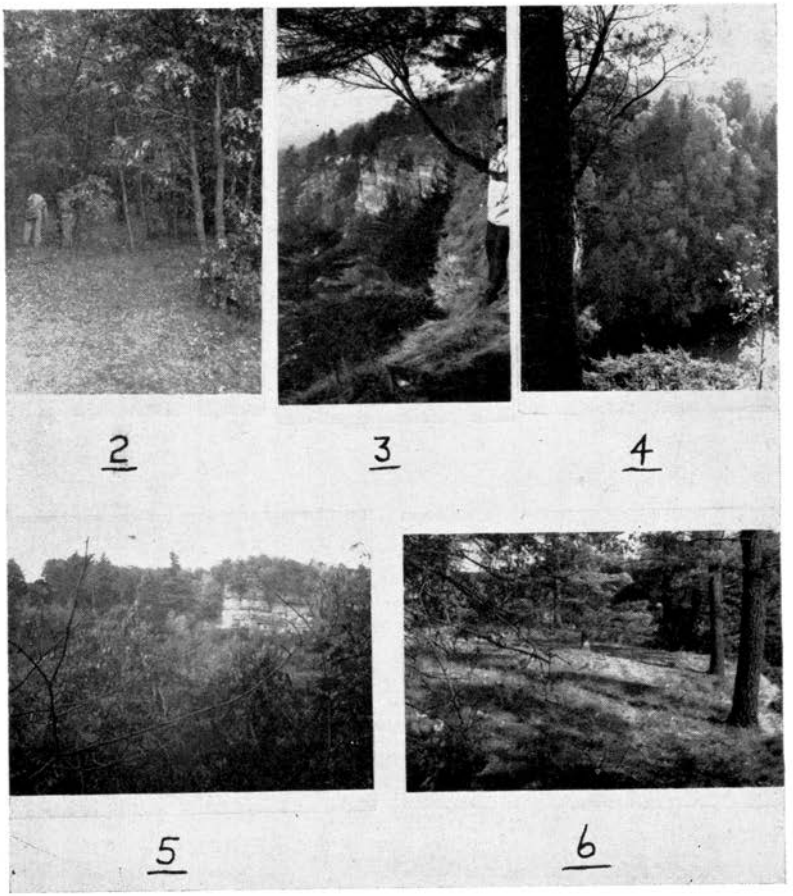

Figure 2. Interior view of the upland oak forest at Apple River Canyon. Figure 3. View of the edge of the bevel of the south-facing cliffs showing both prairie grasses and evergreens. *Juniperus communis* var. *depressa* in foreground. Figure 4. View of the rich pine-fir-hardwood forest on the north-facing slope. Figure 5. The south-facing cliffs at Apple River. Figure 6. Another view, looking eastward, of the vegetation of the south-facing cliffs.

sun. Readings were taken for five consecutive weeks in early spring and are presented in Table 2. They show that lowest minima were reached in the two valley stations, indicating that air drainage may be a climatic factor of significance in spring. The smallest range

Table 1

General climatic data for stations located in the general region of Apple River. Data obtained from Climate and Man (U.S.D.A., 1941).

Locality	Length Record (yrs.)	Temperature (°F.) Jan. Ave.	July Ave.	Max.	Min.	Killing Frosts Last in Spring	First in Autumn	Growing Season (days)
New Richmond, Wis.	15	10.0	70.2	100	—42	May 10	Oct. 3	146
Minneapolis, Minn.	40	13.1	73.2	108	—34	Apr. 25	Oct. 13	171
St. Paul, Minn.	36	13.1	72.2	104	—41	Apr. 23	Oct. 10	170

Locality	Length Record (yrs.)	Average Precipitation in Inches Jan.	Feb.	Mar.	Apr.	May	June	July
New Richmond	13	1.44	1.11	1.42	1.65	3.91	5.36	3.42
Minneapolis	38	.88	.85	1.35	1.95	3.40	4.27	3.44
St. Paul	38	.89	.91	1.43	2.10	3.46	4.09	3.23
Stillwater, Minn.	13	.93	1.08	1.23	2.08	4.06	4.99	3.86

Locality	Precipitation (cont.) Aug.	Sep.	Oct.	Nov.	Dec.	Annual
New Richmond	2.96	3.21	2.30	1.56	1.04	29.38
Minneapolis	3.26	3.40	2.19	1.40	.92	27.31
St. Paul	3.19	3.15	2.16	1.32	.91	26.84
Stillwater	3.60	3.22	2.37	1.33	.98	29.73

Table 2

Temperature data from maximum-minimum thermometers, Apple River Canyon, St. Croix Co., Wisconsin. The locations of the four stations are shown in Figure 1. (Set up)

Station		4-18-48	4-25-48	5-2-48	5-9-48	5-16-48	5-23-48	Mean
#1	Min.	75	38	39	34	42.5	44.5	39.6
	Max.	75	84	79	73	75.5	93	80.9
#2	Min.	71	33	33	29	38	43	35.2
	Max.	71	86	86	80	79	90	84.2
#3	Min.	73.5	30.5	33	28	36	41	33.7
	Max.	73.5	78	71.5	77	79	87	78.5
#4	Min.	73	34	36	30.5	40	41	36.3
	Max.	73	76	69.5	67	72.5	84	73.8

Means of weekly ranges.....Station #1—41.3
Station #2—49.0
Station #3—44.8
Station #4—37.5

Table 3

Precipitation collected in one-quart fruit juice cans at Apple River Canyon, St. Croix Co., Wisconsin, in May, 1948. Cans set up first on April 25, 1948 and read and emptied weekly. Approximately 20 ccs. of kerosene were added to the cans each week.

Station	Date of Reading 5-2-48	5-9-48	5-16-48	5-23-48
#1	22 cc.	10 cc.	11 cc.	6 cc.
#2		81	74	35
#3	97	87	64	27
#4	63	51	24	
#5	95	76	62	

in temperature was found in every instance at Station 4, on the north-facing cliff, where both insolation and radiation were lower than elsewhere. Soil temperatures were taken at one inch and six inch depths at the four stations on April 25, 1948 and May 2, 1948 and were found to be from 2 to 6 degrees (F.) colder at the surface and up to 10°F. colder at the six inch level on the north-facing cliff.

Several one-quart fruit juice cans were set up at the four stations and, in addition, at a fifth station on the south-facing bevel, to measure precipitation reaching ground level. A layer of kerosene sufficient to cover the water in the cans to a depth of several millimeters was added to prevent evaporation of the precipitation. The data, though extremely fragmentary, are presented in Table 3 as an indication of the importance of site in relation to total rainfall. Station 1, on the windswept face of the south-facing cliff received only a fraction of the precipitation to reach the other cans in more protected places. Station 4, on a small ledge on the north-facing cliff, also had low readings. The other three stations were on level or nearly level sites.

Data were obtained on five weekends in early spring, 1948, on the species of plants blooming on the south- and north-facing sides of the stream. These data illustrated two phenomena: first, that there were considerably more Angiosperms flowering in early spring on the south-facing slope, and secondly, that those plants found on both sides of the stream flowered about two weeks earlier in the spring on the south-facing side of the stream. This is, in all probability, a direct consequence of the greater insolation received by the south-facing cliffs.

The Plant Communities

The Upland Oak Forest

This, the typical forest of the sandy "red drift" of Minnesota and western Wisconsin, was found well represented here only on the upland to the north of Apple River, where it encroached in places to the cliff edge, though more often it came only within about 20 feet of the bevel.

In the autumn of 1948 the author and a class in Ecology from the University of Minnesota ran a total of 50 sample plots, 10 meters on a side, in this oak forest. The data gathered from these plots are presented in Table 4. The dominance of the two oaks, *Quercus ellipsoidalis* and *Q. alba* is apparent. The shrub layer was sampled by the author on May 24, 1948, and these data are presented in Table 5.

This was a dry forest of small, stunted trees. There were three layers of vegetation: the tree layer, about 40-50 feet high; the shrub layer, 1-3 feet high; and a sparse herbaceous layer (seldom with a coverage of more than 30%), about 8-10 inches high. There was no appreciable moss synusia. The forest had superficially the appearance of youth, though the composition of the arborescent layer was much the same as that of most red drift oak forest of the Anoka sandplain in Minnesota and adjacent regions in Wisconsin. The woods were difficult to traverse due to the close spacing of the trees and the abundance of dead lower branches which had not

Table 4

Sampling data for the arborescent stratum of the upland oak forest at Apple River Canyon, St. Croix Co., Wisconsin. Data obtained from 50 sample plots, 10 meters on a side, run in autumn, 1948.

Species	Total Density	Percent Density	Basal Area	B.A. Percent	Frequency Percent
*Quercus ellipsoidalis**	357	65.5	79.8359	72.3	98%
Q. alba	124	22.8	19.7167	17.9	100
Populus tremuloides	38	7.0	7.3001	6.6	68
Prunus serotina	15	2.8	2.1696	2.0	76
Betula papyrifera	3	0.55	0.2290	0.2	6
Populus grandidentata	3	0.55	0.8831	0.8	10
Pinus resinosa	1	0.18	0.0490	0.04	2
P. Strobus	(seedlings only)				4
Quercus macrocarpa	3	0.55	0.0696	0.06	4
Q. rubra	1	0.18	0.1363	0.1	2
Ulmus americana	(seedlings only)				6
Totals	545	100	110.3893	100	

Total Basal Area per acre—89.1283 sq. ft.

*In nomenclature of all plants cited, Fernald (1950) has been followed.

Table 5

Sampling data for ten 4 m. × 4 m. quadrats, run in the frutescent layer of the upland oak forest, Apple River Canyon, Wisconsin, on May 24, 1948. Only woody plants with stems below 1" DBH were considered.

Species	Total Density	Ave. Height	Coverage Class[1]	Sociability[2]	Frequency
Corylus americana	170	2½′	2	2	90%
Prunus serotina	118	1′	1	1	100
Diervilla Lonicera	70	3′	1	2	90
Populus tremuloides	16	3′	x	1	50
Quercus sp.	10	15″	x	1	40
Amelanchier sp.	6	15″	x	1	30
Rosa blanda	6	11″	x	1	40
Salix humilis	1	1′	x	1	10
Ulmus americana	1	7″	x	1	10
Totals	398		2	1-2	

[1]Coverage classes used were: x—less than 1%; 1—1-5%; 2—6-25%; 3—26-50%; 4—51-75%; 5—76-100%.

[2]Sociability classes are defined as: 1—growing one in a place, singly; 2—grouped or tufted; 3—in troops, small patches, or cushions; 4—in small colonies, in extensive patches, or forming carpets; 5—in great crowds (pure populations) (Braun-Blanquet, 1932).

fallen from the trees. There was much evidence of fire; almost every oak bore a deep fire scar extending sometimes several feet up the trunk, and there was much charred wood found beneath the rather thick leaf litter. Decomposition of plant remains and their incorporation into the soil apparently took place slowly here. Several pits were dug and revealed the presence of glacial pebbles about a foot below the soil surface. Soil samples were taken in each of the arborescent quadrats. The median pH of these was 5.35, and the mean percentage of available moisture in the subsoil was 3.62% at the time of sampling.

The herbaceous vegetation was not sampled. In the spring it was represented principally by *Anemonella thalictroides, Anemone quinquefolia* var. *interior,* and *Geranium maculatum,* with occasional patches of woodland Carices in more open spots. The summer aspect showed principally a loose society of *Geranium maculatum* in vegetative condition, with occasional plants of fruiting *Viola sororia* and flowering *Monarda fistulosa* var. *mollis.*

The Bevel

On either side of the gorge there exists a short, rounded slope between the relatively horizontal upland and the vertical cliff face; this is known as the "bevel" (Fig. 1). On the south-facing slope this varies in width from 5 to 30 feet and is partially discontinuous.

On the north-facing side of the river the bevel is much narrower. The south-facing bevel bore a mixture of prairie plants and various trees and shrubs. Two kinds of sampling were done here. A belt transect, 5 meters wide and 100 meters long, was run along the south-facing bevel and only woody vegetation sampled. The data from this transect appear in Table 6. In addition ten one-meter plots were run in the herbaceous stratum in early spring, and the data from these are given in Table 7. At the time of sampling the author was unable to identify the grasses and several of the forbs which were then in vegetative condition.

From the data in Table 6 we see that the dominant trees were the two pines, *Pinus strobus* and *P. resinosa,* and that the basal area per acre was actually greater than that found in the contiguous oak forest. However, the data may be deceiving. The pines, *Juniper, Amelanchier, Viburnum, Populus, Betula, Tilia,* and *Rhus* are virtually confined to the very edge of the cliff, and the other woody plants were mainly at the edge of the oak forest, exposing most of the prairie strip between them.

The large pines here showed evidence of ground fires. *Pinus resinosa* trunks had scars in every instance, these sometimes ten feet high and extending deeply into the heartwood, whereas the white pines seldom had more than the lower foot or two of bark singed. The largest of the trees sampled was a white pine, 18 inches in diameter.

It was observed that the appearance of the prairie changed al-

Table 6

Sampling data from belt transect along south-facing bevel, Apple River Canyon, Wisconsin, May 24, 1948. Strip 100 meters long and 5 meters wide.

Species	Density	% Dens.	Basal area*	B.A. per acre*	% B.A.	Ave. DBH	DBH Range
Pinus Strobus	8	10.8%	6.7073	53.7255	49.9%	11.0"	4-18"
Pinus resinosa	6	7.2	4.1905	33.5659	31.1	11.2	9-13
Quercus ellipsoidalis	22	26.5	1.2870	10.3089	9.6	2.6	1-6½
Populus tremuloides	21	25.3	.1644	1.3168	1.2	1.1	1-2
Juniperus virginiana	8	9.8	.8259	6.6153	6.1	4.0	1-6
Quercus macrocarpa	6	7.2	.1202	.9628	0.9	1.7	1-3
Betula papyrifera	4	4.8	.1037	.8306	0.8	1.7	1-4
Tilia americana	4	4.8	.0383	.3065	0.3	1.2	1-2
Amelanchier canadensis	1	1.2	.0055	.0441	.....	1.0	1
Viburnum Lentago	1	1.2	.0055	.0441	.....	1.0	1
Rhus glabra	1	1.2	.0055	.0441	.....	1.0	1
Totals	83	100.0	13.4538	107.7646	99.9		1-18"

*square feet.

Table 7

Sampling data from ten 1 m. × 1 m. quadrats run in a belt transect in the richest part of the prairie strip on the south-facing bevel of Apple River Canyon, Wisconsin, May 2, 1948.

Species	Density	% Dens.	Freq.	Cov.*	Sociability*	Periodicity
Viola pedata var. *lineariloba*	295	54.0%	100%	1	1	bud
Carex sp.	92	16.8	100	1	2	flowering
Panicum sp.	55	10.1	100	1	2	foliage
Solidago sp.	32	5.9	90	x	1-2	fol.
Anemone cylindrica	16	2.9	30	x	1	fol.
Besseya Bullii	14	2.5	60	x	1	fl.
Anemone patens var. *Wolfgangiana*	12	2.2	50	x	1	fruiting
Lithospermum croceum	8	1.5	70	x	1	bud
Antennaria neodioica	8	1.5	30	x	2	fl.
Artemisia ludoviciana	5	0.9	40	x	1(2)	fol.
Aster sp.	5	0.9	30	x	1	fol.
Potentilla arguta	2	0.4	20	x	1	fol.
Taraxacum sp.	1	0.2	10	x	1	fol.
Comandra Richardsiana	1	0.2	10	x	2	fol.
Misc. grasses	.....	.....	100	4	2-3	fol.

*Scales for Coverage and Sociability are given in the footnotes to Table 5.

most weekly, due principally to the flowering of different forbs. *Anemone patens* var. *Wolfgangiana,* the pasque flower, was the first to bloom, followed by *Besseya Bullii* with its 6-8″ racemes of yellow flowers, and *Viola pedata* var. *lineari-loba* later in the spring. In early summer an entirely different aspect of this prairie strip was seen with *Anemone cylindrica, Petalostemon candidum, P. purpureum, Amorpha canescens, Rudbeckia triloba,* and *Bouteloua curtipendula.* Some of the prairie grasses blooming in late spring and summer were *Koeleria cristata, Bouteloua hirsuta, Muhlenbergia* spp., *Andropogon Gerardi, A. Scoparius,* and *Stipa spartea.*

The Cliff Vegetation

The south-facing cliffs were almost barren. Along their upper fringe *Juniperus communis* var. *depressa* and *Potentilla fruticosa* clung and below them was a large expanse of bare sandstone (Figures 3 and 5). Ledges were few and narrow and supported at most a few plants of *Pellaea glabella* and *Aquilegia canadensis.* Toward the west end of the canyon where the cliff was lower and not steep a few stunted trees of *Ulmus americana* and *Tilia americana* were found, and at the base of the cliff *Juniperus communis* var. *depressa* and a small fern, *Cryptogramma Stelleri,* grew.

Table 8

Sampling data for floodplain forest, south-facing side of gorge, Apple River Canyon, Wisconsin. Five 10 m. × 10 m. quadrats were run in a belt transect directly east-west about 10 meters from the river bank on May 24, 1948.

Species	Density	% Density	Coverage Class	Basal Area	% Basal Area	% Frequency
Ulmus americana	45	56.2%	3	4.2811	58.6%	100%
Fraxinus pennsylvanica var. *subintegerrima*	13	16.2	2	1.9994	27.3	60
Acer Negundo	6	7.5	1	.6460	8.8	40
Alnus incana	6	7.5	x	.1488	2.0	40
Rhus glabra	5	6.2	x	.0275	0.3	40
Cornus alternifolia	3	3.7	x	.0165	0.2	40
Betula papyrifera	1	1.2	x	.1649	2.2	20
Tilia americana	1	1.2	x	.0218	0.3	20
Totals	80	99.7	3	7.3060	99.7	
Basal Area per acre—58.5231 sq. ft.						

The north-facing cliffs were equally precipitous though not so high due to the greater talus accumulation at their bases. The upper cliffs were often eroded inward and great shallow grottoes were formed. The cliffs were marked in places by shallow rain channels and in spots had a luxurious ledge vegetation. Bryophytes, especially mosses, were dominant over much of the rock surface. *Prunus pensylvanica, Ribes* spp., *Aquilegia canadensis,* and *Arabis lyrata* were found frequently on ledges.

The Floodplain Forest

The Apple River Canyon possessed only remnants of the extensive floodplain forest beyond its western exist and fringing the St. Croix River. A small island near the center of the river and a stretch of level land on the north side of the river near the western end of the canyon were the only stands in the gorge. Five sample plots were run in the latter stand, and the data are assembled in Table 8. The basal area per acre was the lowest of any woodland sampled (58.52 sq. ft.) and the trees were rather uniformly small, the largest sampled being a Green Ash 8″ in diameter. American Elm and Green Ash were the most important trees, the canopy averaging about 70′ in height.

Along either side of the river a narrow fringe of floodplain species extended. Along the south shore *Betula lutea* and *Tilia americana* were of considerable importance also, and a single large tree of Cottonwood (*Populus deltoides*) was noted near the east end of the gorge.

The herbaceous vegetation along the edge of the creek was relatively rich in species, including not only numerous emergent hydrophytes and waifs but also meadow and marsh plants. Almost every step along the bank of the river took one into a different society. Where the forest was sampled (on May 24, 1948) *Galium concinnum* and *Viola conspersa* were locally dominant, though elsewhere they were absent or rare. The following list of plants collected along the north shore of the stream gives some idea of the diversity. Along the north-facing side species were much the same.

Angelica atropurpurea
Apios americana
Arenaria lateriflora
Arisaema atrorubens
Asclepias incarnata
Blephilia hirsuta
Caltha palustris
Cyperus sp.
Galium asprellum
Galium concinnum
Helianthus tuberosus
Hydrocotyle americana
Hypericum pyramidatum
Impatiens capensis
Juncus sp.
Lycopus virginicus
Pedicularis lanceolata
Polygonum spp.
Pteretis pensylvanica
Ranunculus abortivus
R. septentrionalis
Rudbeckia laciniata
Scutellaria epilobiifolia
Spartina pectinata
Symplocarpus foetidus
Urtica gracilis
Verbena hastata
Viola conspersa
V. pallens
V. sororia

The River Vegetation

Due to two conditions the flora of the river was sparse. Some algae were found on the glacial boulders and pebbles over which the river flowed, but due to its swift current these were few in number. The second disturbing factor was the daily fluctuation in the depth of the river of from two to about four feet. This occurred throughout the spring and summer due to the daily release of water from a government dam about 2 miles upstream from the canyon. As a result there were no proper hydrophytic zones along the river's edge—rather an abrupt change from open water to floodplain forest with a barren 'intertidal" zone. At no time was the river too deep to wade, though this was hazardous in the spring due to the swiftness of the current.

The White Pine-Paper Birch-Balsam Fir-Linden Forest

This forest occurs on the long upper talus slope on the north-facing side of the canyon and was the least disturbed of the communities here. It was sampled on August 14, 1948, and the sampling data are presented in Tables 9, 10 and 11. This forest was of particular interest because of the presence of a number of northern elements in it, particularly *Abies balsamea*. As is indicated in Table

9, *Abies* was well established here though not very important in the canopy. Of 25 trees sampled only two were as large as 4″ DBH, and 16 were only 1″ DBH. However it was found in the forest in all stages of growth and actually seemed to be reproducing more successfully than most other trees present.

Other northern elements in this forest were the two pines, *Pinus Strobus* and *P. resinosa, Taxus canadensis, Equisetum scirpoides,* and *Cryptogramma Stelleri.* Basal area per acre was relatively low (79.05 sq. ft.), but this was not unduly low, in view of the steep, rocky slope upon which the forest grew. The trees varied considerably in height, and the canopy, though complete, was ragged. The pines rose above the deciduous trees, and *Ostrya* and *Abies* formed an indistinct lower tree layer.

On the lower talus slopes on the north-facing side of the river other species entered and dominance changed. *Tilia americana, Betula lutea,* and *Juglans cinerea* were of more importance here. *Taxus canadensis,* important on the upper talus, continued in thick mats down almost to the stream edge. It seemed very vigorous here, though no evidence of flowering or fruiting was noted in 1948.

The herbaceous growth was very scanty in the summer (Table 11). One reason for this was the local abundance of *Taxus* and the dense shade it cast. The spring aspect of the herb layer was more varied, though still exhibiting little overall coverage of the

Table 9

Sampling data for arborescent layer, white pine-paper birch-balsam fir-linden forest, north-facing talus, Apple River Canyon, Wisconsin. Ten 10 m. × 10 m. quadrats run on August 14, 1948.

Species	Density	% Dens.	Coverage Class	Basal Area	% B.A.	% Frequency
Pinus Strobus	18	13.8%	2	7.4545	38.2%	60%
Betula papyrifera	13	10.0	1	1.6683	8.5	60
Abies balsamea	25	19.2	1	.4949	2.5	100
Tilia americana	22	16.9	2	2.7151	13.9	100
Populus grandidentata	5	3.8	1	1.8752	9.6	20
Ulmus americana	7	5.4	1	1.6682	8.5	40
Pinus resinosa	11	8.5	1	1.2556	6.4	50
Juglans cinerea	3	2.2	x	1.0520	5.6	20
Ostrya virginiana	19	14.6	1	.6837	3.5	80
Betula lutea	2	1.5	x	.2889	1.5	10
Acer rubrum	2	1.5	x	.1854	0.8	10
Acer Negundo	2	1.5	x	.1418	0.7	20
Prunus pensylvanica	1	1.0	x	.0218	0.1	30
Quercus alba (?)	(Seedling only)					10

Basal Area per acre—79.0504 sq. ft.

Table 10

Results of sampling frutescent layer, north-facing talus slope forest, Apple River Canyon, Wisconsin. Ten 10 m. × 10 m. quadrats run on August 14, 1948.

Species	Frequency %	Coverage Class
Taxus canadensis	100%	4
Cornus alternifolia	50	1
Diervilla Lonicera	80	x
Vitis riparia	50	x
Ribes sp.	50	x
Sambucus pubens	50	x
Rhus radicans	70	x
Cornus Amomum	30	x
Celastrus scandens	20	x
Parthenocissus inserta	20	x
Corylus cornuta	10	x

Table 11

Results of sampling herbaceous layer, north-facing talus, slope forest, Apple River Canyon, Wisconsin. Ten 4 m. × 4 m. quadrats run August 14, 1948.

Species	Frequency Report
Polygonatum pubescens	80%
Athyrium Filix-femina var. *Michauxii*	80
Aralia nudicaulis	70
Actaea rubra	60
Maianthemum canadense	60
Arisaema atrorubens	60
Adiantum pedatum	50
Trillium cernuum	40
Aquilegia canadensis	40
Rubus sp.	30
Solidago flexicaulis	20
Aster macrophyllus	20
Prenanthes sp.	20
Galium triflorum	20
Smilacina racemosa	20
Oryzopsis sp.	10
Ambrosia artemisiifolia var. *elatior*	10
Phryma Leptostachya	10
Botrychium virginianum	10
Woodsia sp.	10
Dioscorea villosa	10

ground. Important spring herbs were *Asarum canadense, Trillium cernuum, Actaea rubra,* and *Arisaema atrorubens.*

Discussion

The picture that emerges from this study is that of an isolated little river canyon with a peculiar admixture of northern, southern, eastern, and western plants. On the north-facing slope there occurred a "relict conifer" forest, on the south-facing bevel relict prairie, on the river floodplain, such as it was, a fragment of the floodplain elm-ash-maple forest, and on the upland the oak forest of the region. Phytogeographic studies (Russell, ms.) indicate the extreme diversity of the floral elements contributing to the flora of the canyon. Ninety-four percent of the species here were found to be "extraneous" (Cain, 1930), therefore nearer the peripheries of their ranges than the centers.

Though relatively inaccessible, the canyon is apparently rapidly becoming known to fishermen, hikers, and picnickers. In the three years when the gorge was studied by the author, increased disturbance of the natural habitats was noted. Paths became broader and more numerous, and various kinds of debris were seen.

However, the area has several features which should protect it from excessive disturbance. It is approached only by dirt roads which are seldom in good shape. The cliffs and steep talus slopes are obviously unsuited either to grazing or lumbering, and the small areas of floodplain at the west end stop abruptly a short distance into the canyon.

The question of what is climax here would seem superfluous. So long as the particular habitats here remain, I believe they will continue to be vegetated approximately as at present. Each vegetation type was reproducing itself and had apparently been doing so for a long time.

Summary

A phytosociological study was made of the vegetation of the canyon of Apple River in St. Croix Co., Wisconsin. The following plant communities were recognized and discussed: oak forest, prairie, floodplain forest, and the white pine-paper birch-balsam fir-linden forest. Sampling data were presented for each of these. In addition the vegetation of cliffs and the river were briefly described. Data from short microclimate studies indicated markedly different local climates in each of the plant communities. It was concluded that the four recognized vegetation types may all be classified as "climax", even if only climax for their sites.

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