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ALLUVIAL CHRONOLOGY OF THE THOMPSON CREEK WATERSHED, HARRISON COUNTY, IOWA*

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ABSTRACT. The Tazewell to Recent alluvium in the Thompson Creek Watershed, Harrison County, Iowa, is named the De Forest formation. Buried organic zones and unconformities within the formation permit division into the Soetmelk, Watkins, Hatcher, Mullenix, and Turton members.

Radiocarbon dates indicate that from about 14,000 years to sometime before 2000 years ago the Soetmelk and Watkins members were deposited, with only an apparent temporary pause about 11,000 years ago. Since about 2000 years ago, three cycles of erosion and sedimentation have taken place. The last cycle started prior to 250 years ago and probably ended about the time the streams in the area started their present cycle of entrenchment.

INTRODUCTION

The alluvial fill in the Willow River Valley and two tributary valleys has been studied in detail to depths of 30 feet or more. In the Thompson Creek and Magnolia Creek Watersheds (fig. 1) over 8 miles of exposures were mapped in detail. A reconnaissance was conducted along the deeply entrenched Willow Drainage Ditch (Daniels, 1960). The alluvium exposed in the stream banks is dominantly a silt-loam[1] sediment, although silty-clay-clay-loam sediments and sand and gravel lenses are present.

The Thompson Creek and Magnolia Watersheds are located in the thick loess area of Western Iowa (Kay and Graham, 1943, p. 197). Wisconsin loess is the dominant nonalluvial surficial deposit.

DE FOREST FORMATION

The De Forest formation is proposed as the formational name for the silty alluvium in the Willow River Valley and its tributary valleys. The formation was first identified and studied in detail in the Thompson Creek Watershed (fig. 1), and the name of the formation is taken from a tributary of Thompson Creek.

The De Forest formation has been mapped throughout the Willow River Valley and two of its major tributaries. Its distribution outside the Willow River Valley has not been studied.

In the Thompson Creek and Magnolia Creek Valleys the formation overlies Kansan till. Its base is seldom exposed in the Willow Drainage Ditch, but in two exposures near loess-mantled terraces it disconformably overlies calcareous sands and gravels. The contact may be sharp, or gradational over a distance of 1 to 2 feet. The formation may be exposed at the surface or overlain by 1 to 5 feet of alluvium deposited since the watershed has been cultivated.

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[1] All textures are based upon the textural classification used by the Soil Survey Staff (1951, p. 209).

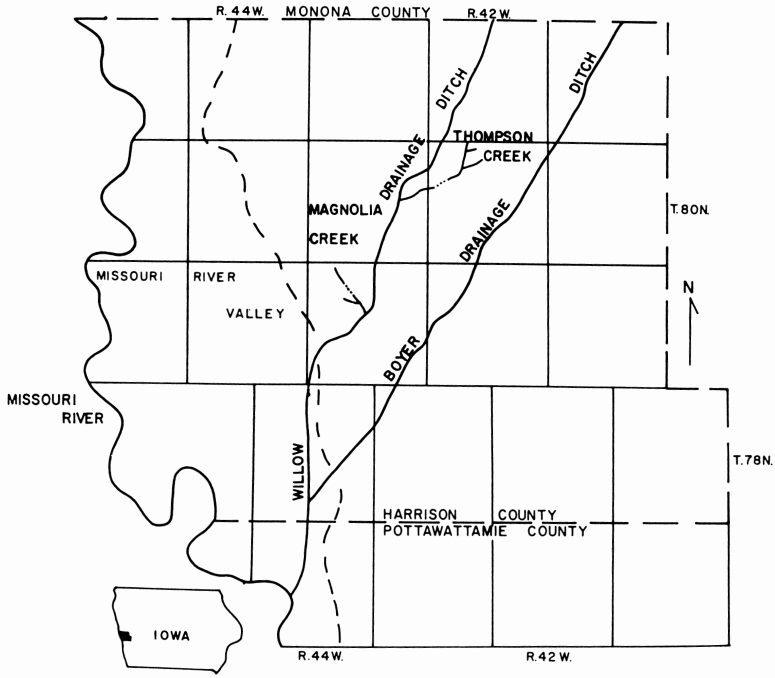

Fig. 1. Location of the Willow River, Thompson Creek, and Magnolia Creek Valleys, Harrison County, Iowa.

Buried erosion surfaces and/or organic horizons within the formation have been traced continuously throughout the Willow River Valley and the two tributary valleys studied in detail. The erosion surfaces and organic horizons are used to subdivide the formation into five members. The members from the base upward are the Soetmelk, Watkins, Hatcher, Mullenix, and Turton. Names for the members of the formation are from tributaries of Thompson Creek.

All members are not exposed in one vertical section, so two type sections are designated for the formation. The type section for the Soetmelk, Watkins, Hatcher, and Mullenix members is located on Thompson Creek 100 yards east of the country road between sections 13 and 14, in the SW 1/4 sec. 13, T. 80 N., R. 43 W., Harrison County, Iowa (fig. 2). The type section for the Turton member is 200 feet west from the confluence of Watkins Branch and Thompson Creek in the NE 1/4, sec. 18, T. 80 N., R. 42 W., Harrison County, Iowa.

The characteristics, distribution, and age of the members are described in detail in the following paragraphs.

Characteristics of Members of the De Forest Formation

At the type section of the Soetmelk, Watkins, Hatcher, and Mullenix members (A on fig. 2), the sequence and characteristics of the members from the surface downward are:

	Member	Description	Depth below surface (ft)
Post-settlement[2] alluvium		Dark brown (10YR 4/3)[3] silt loam; calcareous; sharp contact to the Mullenix member.	0-3.0
De Forest formation	Mullenix	Very dark gray (10YR 3/1) silt loam; granular; noncalcareous;	3.0-4.5
		Very dark grayish brown (10YR 3/2) silt loam; massive; calcareous; unconformity in base; sharp contact to the Hatcher member.	4.5-10.5
	Hatcher	Yellowish brown (10YR 5/4) silt loam with abundant grayish brown mottles; massive; calcareous; sharp contact to the Watkins member.	10.5-24.3
	Watkins	Black (10YR 2/1) silt loam massive; calcareous; sharp contact below.	24.3-24.7
		Gray (5Y 5/1) silt loam; massive; calcareous; gradational contact below.	24.7-32.2
		Greenish gray (5GY 5/1) silt loam; massive; calcareous; sharp contact to the Soetmelk member.	32.2-34.0
	Soetmelk	Dark gray (10YR 4/1) silt loam with abundant black (10YR 2/1) streaks and strains; calcareous; abundantly fossiliferous; abundant twigs and logs; base of section; flow line of Thompson Creek.	34.0-35.0

Soetmelk member

The Soetmelk is the basal member of the formation and is named after Soetmelk Branch, a tributary of Thompson Creek.

In the Thompson Creek Valley the Soetmelk has a basal calcareous sand and gravel layer 6 to 24 inches thick overlain by massive calcareous silt-loam sediments with discontinuous intercalated sand lenses. Maximum thickness is about 10 feet. Colors range from grayish green to dark grayish green (5GY 5/1 to 5GY 4/1) or greener.

In the trench of Thompson Creek the Soetmelk is exposed only near the mouth of the creek (fig. 3) but has been identified in borings as far upstream

[2] Alluvium deposited since cultivation of the watershed.
[3] Munsell color of moist soil.

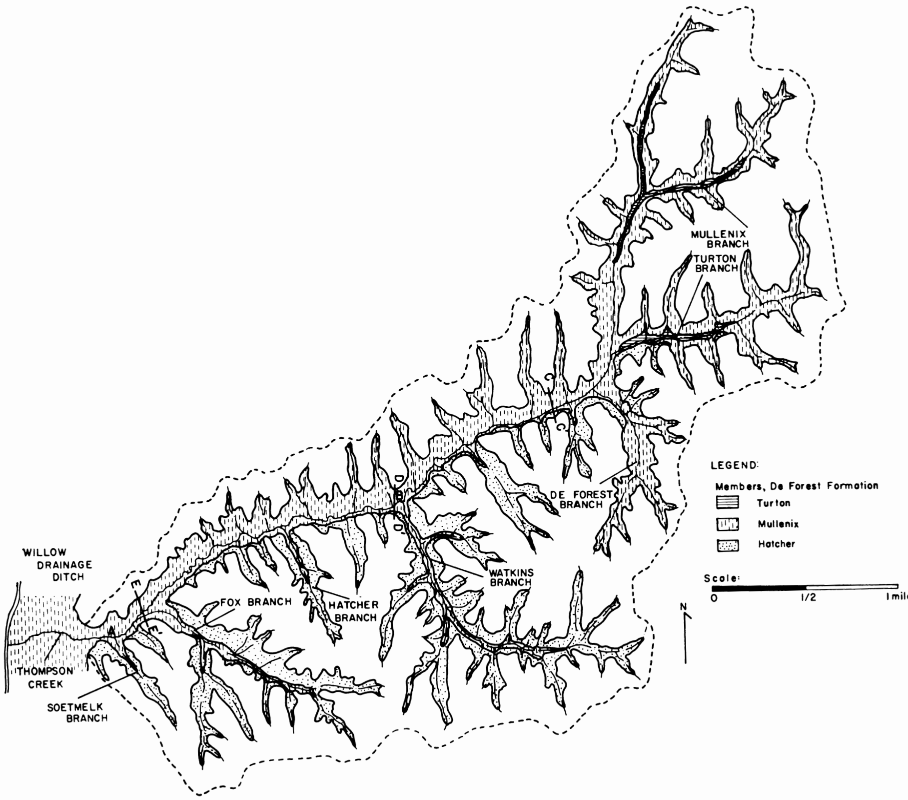

Fig. 2. Outcrop areas of the Hatcher, Mullenix, and Turton members in the Thompson Creek Watershed. Note: A; the type section for the Soetmelk, Watkins, Hatcher, and Mullenix member. C-C′, D-D′, and E-E′ are sites of cross sections of the alluvial fill.

as the mouth of Turton branch (fig. 2). In the Willow River Valley the member has been discontinuously along the Willow Drainage Ditch from near the mouth of Thompson Creek upstream to about 1½ miles north of the Monona-Harrison County line (fig. 1).

Cross sectional profiles of the Thompson Creek Valley show that the Soetmelk has very little relief transverse to the axis of the valley and is everywhere overlain by the Watkins member (fig. 4). The Soetmelk member does not crop out on the modern surface.

In the Thompson Creek Watershed the Soetmelk normally overlies calcareous oxidized or unoxidized Kansan till (fig. 4). At the type section of the member, however, noncalcareous, weakly bedded silt loam to silty clay loam alluvium overlain by calcareous Tazewell loess is truncated by the contact at the base of the Soetmelk (fig. 5). In the Willow River, the Soetmelk unconformably overlies sands and gravels of undetermined age.

Sparse to abundant logs and twigs are present throughout the member, but the greatest concentration of carbonaceous material is at the top. The

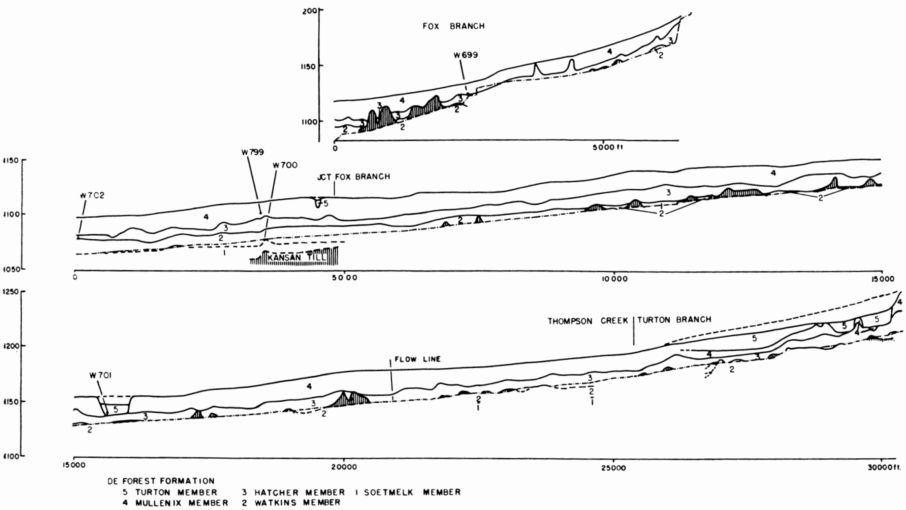

Fig. 3. Members of the De Forest formation exposed in the trenches of Thompson Creek, Turton Branch, and Fox Branch. Solid lines represent contacts; dashed lines represent inferred contacts; dash and dot indicate the flow line of the streams.

Soetmelk is terminated upward by a black (10YR 2/1 to N 2/0) organic horizon ranging in thickness from 3 to 6 inches. If the organic horizon at the top is absent the member cannot be differentiated visually from the overlying Watkins.

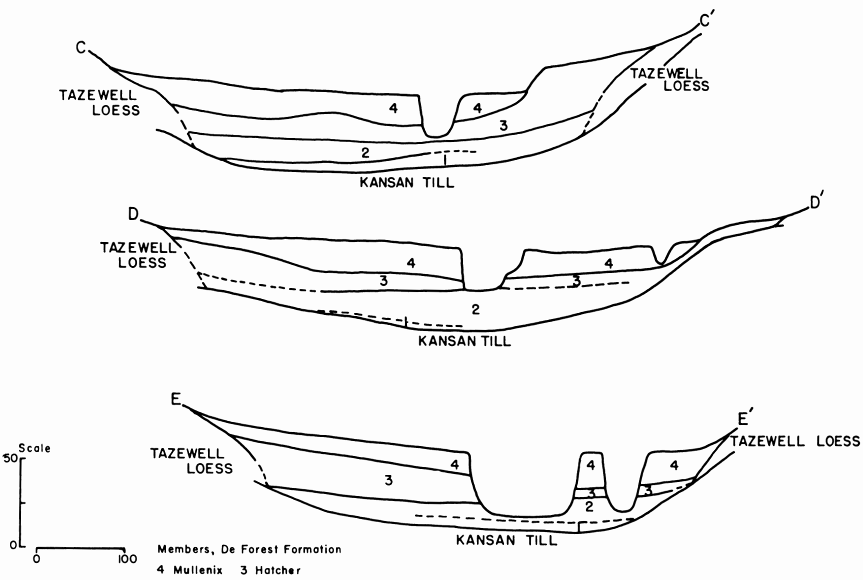

Fig. 4. Distribution of members of the De Forest formation transverse to the longitudinal axis of the Thompson Creek Valley.

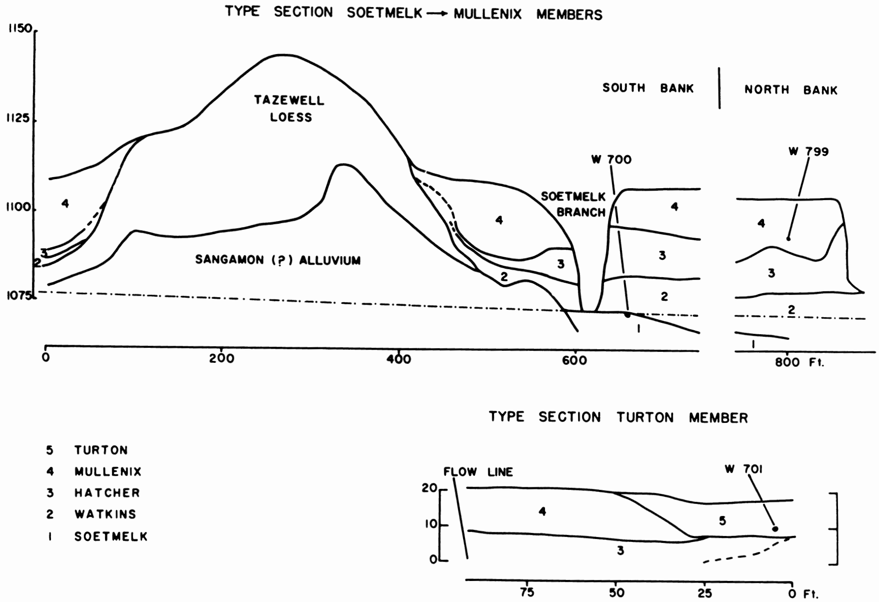

Fig. 5. Relationship of members of the De Forest formation to older sediments.

The Soetmelk contains terrestrial and aquatic gastropods (table 1). The terrestrial species are the same as those found in the Wisconsin loess of the area (Daniels and Handy, 1959, p. 118; Ruhe and Cady, 1962).

The Soetmelk overlies Kansan till and Sangamon (?) alluvium and is inset below, but not overlain by, Tazewell loess (figs. 4, 5). Thus the base of the member may be Tazewell or younger. Age of the top of the member has been determined by the radiocarbon method (table 2).

In the Willow River Valley detrital spruce[4] logs from a carbonaceous horizon 2 feet below the top of the member (fig. 6) were dated at 14,300 ± 250 years B.P. (table 2, W-881). The top of the member was marked by a weakly expressed, discontinuous organic horizon that in places contained abundant wood. The wood at the top was not dated. At the type section (fig. 5), detrital spruce twigs sampled from the top foot of the Soetmelk were dated at 11,120 ± 400 years B.P. (table 2, W-700). Deposition of the Soetmelk therefore took place from Tazewell to postglacial time in Iowa (Ruhe and Scholtes, 1959, p. 592). The end of deposition is roughly synchronous with the advance of the Valders in Wisconsin (Thwaites and Bertrand, 1957, p. 859).

Watkins member.—The Watkins member overlies the Soetmelk (fig. 5), and was named after a major tributary of Thompson Creek (fig. 2). The Watkins is dominantly a massive, calcareous silt loam with little indication of

[4] All wood was identified by Professor D. W. Bensend, Dept. of Forestry, Iowa State University.

TABLE 1

Invertebrate fossils from the De Forest formation†

	Soetmelk member organic horizon	Watkins member organic horizon	Mullenix member 120-140 inches	Turton member 98-110 inches	Terres-trial‡	Aquatic
Anguispira sp.	X		X		*	
Anguispira alternata		X			*	
Discus cronkhetei	X			X	*	
Discus shimeki		X			*	
Gastracopta armifera				X	*	
Gastracopta contracta	X	X			*	
Gyraulus labiatus	X					*
Gyraulus similaris				X		*
Helicodiscus parallelus	X	X	X	X	*	
Helisoma antrosa				X		*
Hendersonia sp.	X				*	
Hendersonia occulta				X	*	
Lymnaea sp.	X			X		
Lymnaea parva	X			X		*
Pelecypods		X				*
Physa anatina		X		X		*
Physa elliptica				X		*
Pupilla muscorum	X				*	
Retinella electrina	X	X			*	
Sphaerium solidum				X		*
Stenotrema leai aliciae		X			*	
Strobilops sparsicosta	X	X			*	
Succinea sp.	X				*	
Succinea grosvenori		X	X	X	*	
Triodopsis sp.	X				*	
Vallonia gracilicosta	X			X	*	
Vertigo modesta	X	X			*	
Zonitoides sp.		X		X	*	
Zonitoides arboreus	X			X	*	

† Fossils identified by Professor L. A. Thomas, Dept. of Geology, Iowa State University.
‡ Authority: Leonard, 1950, 1952; Pilsbry, 1948.

TABLE 2

Radiocarbon dates from the De Forest formation in Thompson Creek and Willow River Valleys, Harrison County, Iowa

Sample No.*	Date**	Member	Vegetation†
W-701	< 250	Turton	Box elder
W-799	1100±170	Mullenix	Walnut
W-699	1800±200	Mullenix	Willow
W-702	2020±200	Hatcher	Red elm
W-882	11,600±200	Watkins	Spruce
W-700	11,120±400	Soetmelk	Spruce
W-881	14,300±250	Soetmelk	Spruce

* U. S. Geological Survey, Washington, D. C., Rubin and Alexander, 1960.
** Radiocarbon years before present.
† All wood was identified by Professor D. W. Bensend, Dept. of Forestry, Iowa State University.

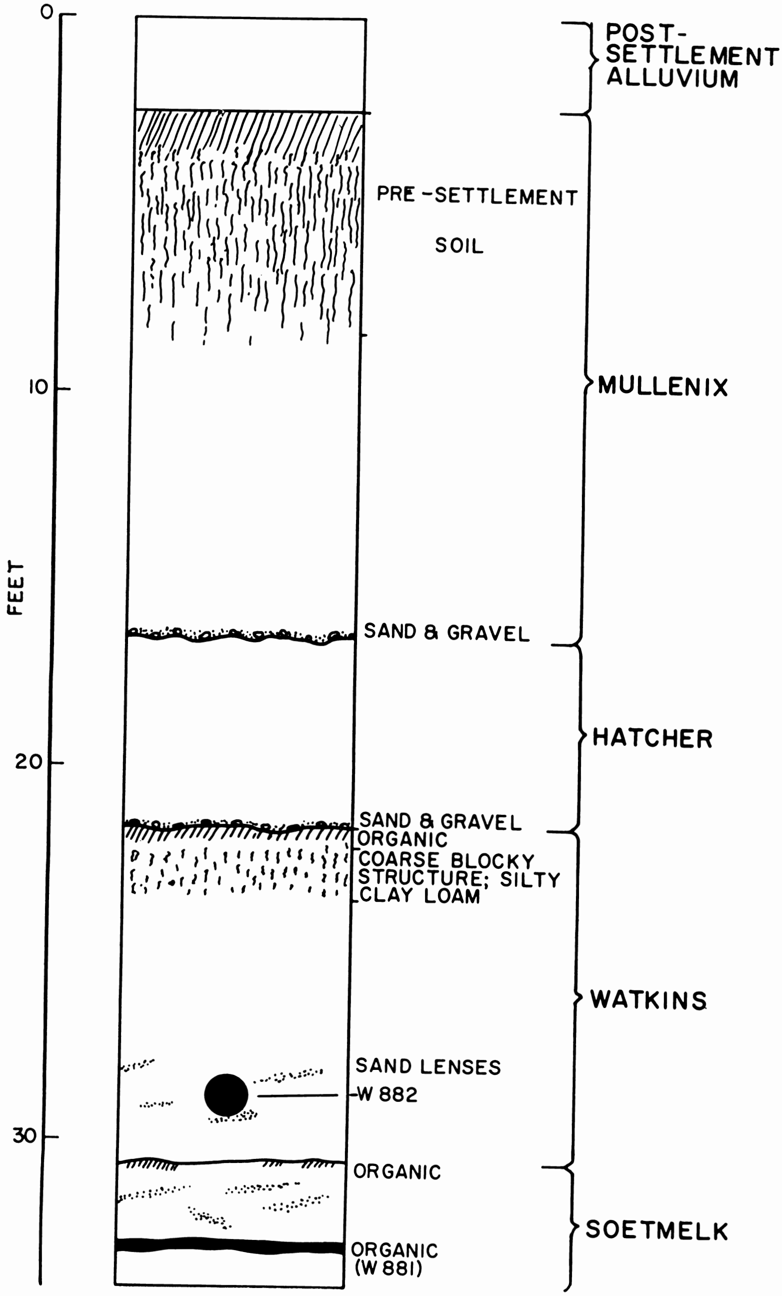

Fig. 6. Members of the De Forest formation exposed in the west bank of the Willow Drainage Ditch in the SW ¼ sec. 11, T. 80N., R. 43W., Harrison County, Iowa. The section is 100 feet north of an unnamed tributary that enters from the west.

bedding. In the lower part of the Thompson Creek Valley a thin, 6- to 24-inch, discontinuous sand lens has been found in the member. The color of the lowermost part is similar to that of the subjacent Soetmelk, but the upper part may range in color from black (10YR 2/1 to N 20) to grayish brown (2.5Y 5/2). The thickness of the member ranges from 8 to 13 feet.

The Watkins has been identified and mapped in the trenches of Thompson Creek, Turton Branch, and Fox Branch (fig. 3) and in borings across the Thompson Creek Valley (fig. 4). The member is exposed in the Willow Drainage Ditch, Harrison County (fig. 1). Reconnaissance work shows the member to be present throughout the Willow River Valley.

The Watkins always disconformably overlies the Soetmelk. In the Thompson Creek Watershed the top of the Watkins is marked by a distinct black (10YR 2/1 to N 2/0) organic horizon ranging in thickness from 2 to 8 inches. In the Willow River Valley the top of the member may be marked by an organic horizon, an erosion surface marked by thin 1- to 3-inch sands and gravels, or by an abrupt textural change.

Fossils from the organic horizon of the member are mixed terrestrial and aquatic species (table 1).

A detrital spruce log from the Willow River Valley section, 15 inches above the base of the Watkins, was dated at 11,600 $\pm$ 250 years B.P. table 2, W-882). This sample predates the top of the Soetmelk in Thompson Creek but is within the statistical error of the method. Also, the log may have been eroded from the Soetmelk and redeposited in the base of the Watkins.

At the confluence of Thompson Creek and the Willow Drainage Ditch, a detrital red elm log resting on, but not incorporated within, the organic horizon marking the top of the Watkins member was dated at 2020 $\pm$ 200 years B.P. (table 2, W-702; fig. 3, sta. 0). The age of the Watkins member therefore, ranges from about 11,000 to greater than 2020 years B.P. It seems unlikely that in the Thompson Creek Watershed the approximate 9000 years encompassed by the Watkins member is represented only by a period of slow sedimentation. Except for the thin, discontinuous sand lens near the mouth of Thompson Creek, unconformities, organic horizons, or paleosols are not incorporated within the Watkins. In the Thompson Creek Watershed a weak organic horizon marks the top of the Watkins, but in the Willow River Valley the top of the bed is often marked by an unconformity (fig. 6). The presence of the unconformity in the Willow River Valley suggests that the organic horizon in Thompson Creek may represent only a temporary period of stability, and the major period of deposition of the Watkins may considerably pre-date 2020 years B.P.

The Watkins encompasses a large part of the postglacial history of Iowa (Ruhe and Scholtes, 1959, p. 593) and includes the major vegetational and inferred climatic changes from coniferous forest to grassland (table 1; Ruhe, Rubin, and Scholtes, 1957, p. 687-688). The Watkins also encompasses the gulley fill cycle in Pottawattamie County, Iowa (ibid., p. 688).

Hatcher member.—The Hatcher was named after Hatcher Branch, where excellent exposures of the member in the trench of the branch as well as surficial outcrops are available for study.

The Hatcher member overlies the Watkins and is a massive, calcareous silt-loam sediment. Carbonate nodules similar to those in the Wisconsin loess are found incorporated within the member in several tributary valleys of Thompson Creek.

In the Thompson Creek Watershed the thickness of the Hatcher ranges from a maximum of 28 feet to a minimum of about 3 feet. The dominant color is yellowish brown (10YR 5/4 to 4/4) but may range in hue from 10YR to 5Y.

The Hatcher has been mapped continuously from the mouth to within one-half mile of the headwaters of Thompson Creek, and throughout Fox and Turton Branches (fig. 3). In the Willow River Valley from about the south line of T. 80N., upstream to about 2½ miles north of the Monona-Harrison County line (fig. 1), the member is present in the drainage ditch. In other areas of the valley it cannot be identified. From the sequence of sediments and characteristics of the contacts the Hatcher apparently pinches out.

In most parts of the Thompson Creek, Fox Branch, and Turton Branch trenches the Hatcher is overlain by the Mullenix member (fig. 3). However, the Hatcher crops out at the surface as a terrace 10 to 15 feet above the younger alluvium in the south side of the Thompson Creek Valley and in tributary stream valleys that flow from south to north (figs. 2, 4). In, and upstream from De Forest Branch Valley, only small remnants of the Hatcher are present at the surface (fig. 2).

The base of the Hatcher rests disconformably upon the Watkins. The Hatcher is terminated upward in all but the extreme headwaters by a scour-and-fill disconformity marked by gravels dominated by detrital carbonate. The disconformity has a relief of 20 to 25 feet where the Hatcher rises to the modern surface (fig. 4). In the headwaters, and near the mouth of Thompson Creek, the disconformity grades to a surface unmarked by erosion but by a weakly expressed organic horizon.

Although invertebrate fossils were not collected from exposures of the Hatcher, pelecypods were found in the member in the Willow River Valley. Vertebrate fossils are represented by elements of a right metarsus,[5] right scapula (incomplete), left astragolus, two proximal phalanges, a distal phalanx, four partial dorsal vertebrae, five partial lumbar vertebrae, and several rib fragments recovered from the Hatcher 200 feet west of the confluence of Thompson Creek and Watkins Branch (figs. 2, 2, sta. 75). Measurements of the metarsus indicate a fairly large bison within the range of extinct species. However, because the skull is lacking, the individual may represent a large animal of recent species.

The detrital red elm log resting on the top of, but not incorporated within, the Watkins member (fig. 3, W-702) places a maximum age of 2020 radiocarbon years on the base of the Hatcher member. A willow stump rooted in place at the erosional contact between the Hatcher and Mullenix members (fig. 3, Fox Branch, W-699) was dated at 1800 ± 200 years B.P. (table 2, W-699). Statistically the samples have the same age, but sample W-699 was

[5] Identification and interpretation by Mr. W. D. Frankforter, Director, Sanford Museum, Cherokee, Iowa.

rooted in place and is stratigraphically above sample W-702 (fig. 3). Thus, deposition of the Hatcher member took place from 2020 B.P. to slightly greater than 1800 B.P. Except for deposition of minor amounts of slope wash, the top of the Hatcher exposed at the surface must date from about 1800 B.P.

Mullenix member.—The Mullenix member is named for a tributary of Thompson Creek where excellent exposures of the member in the trench of the tributary, as well as surficial outcrops, are available for study.

The Mullenix is composed of silt-loam and silty clay-loam sediments. Discontinuous erosion surfaces marked by sand and gravel lenses that can be traced for a few feet, or at most a few hundred feet, are present within the member. Maximum thickness is about 25 feet near the stream channel in Turton Branch (fig. 2). The color varies but, in general, is darker than the underlying Hatcher. The upper part, influenced by modern soil development, is noncalcareous, whereas the lower part is calcareous. The depth to carbonate from the top of the member ranges from about 5 to 15 feet.

The Mullenix is exposed throughout most of Thompson Creek, Fox, and Turton Branch trenches (fig. 3). In the Willow River Valley the member is exposed in the trench of the drainage ditch and river.

Throughout most of Thompson Creek a scour-and-fill disconformity separate the Mullenix and Hatcher members. The contact is marked by sand and gravel and has a local relief approaching 20 to 25 feet where the Hatcher crops out at the surface (fig. 4). Where the Hatcher is at the surface the Mullenix is inset below the top of the Hatcher, and a scarp 3 to 10 feet high separates the members (fig. 4). The height of the scarp usually increases in an upstream direction, and in the upper part of the larger tributaries the top of the Hatcher may be 15 feet above the top of the Mullenix.

In the Thompson Creek Valley upstream from the Turton Branch (fig. 2), the contact between the Mullenix and Hatcher is marked by a weakly expressed organic horizon that can be traced to and merges with the scour-and-fill disconformity farther downstream. Discontinuously along the trench of Thompson Creek and throughout most of Turton Branch the member is terminated upward by scour-and-fill disconformity marked by sands and gravels and is overlain by the Turton member (figs. 2, 3).

The areal distribution of the Hatcher contrasts to the Mullenix. Only small remnants of the Hatcher are present on the south side of the Thompson Creek Valley, but in tributary valleys on the south side of Thompson Creek it extends from near the stream to the valley sides (fig. 2). The Mullenix, however, is present from the mouth to the headwaters on the north side of the Thompson Creek Valley, and upstream from Turton Branch it extends from near the stream to the valley sides (fig. 2).

In the Thompson Creek Valley the contact between the Mullenix and Hatcher slopes from north to south (fig. 4). The tributaries on the north side of Thompson Creek have built fans that in places extend almost to the south side of the valley. Thus, the outcrop pattern in the Thompson Creek Valley downstream from Turton Branch apparently is controlled primarily by sediment deposition from tributaries forcing the creek toward the south valley side.

In tributary valleys on the south side of Thompson Creek the erosion cycle preceding deposition of the Mullenix was essentially channel trenching because the member is inset into the Hatcher and confined to an area adjacent to the present drainage system that narrows in width upstream (fig. 2, Soetmelk Branch). Why the Hatcher member was not eroded and subsequently buried by Mullenix alluvium in these valleys as it was upstream from Turton Branch is not clearly understood.

Fossils collected from the Mullenix are terrestrial species (table 1), but in the Willow River Valley pelecypods are incorporated within the member. Near the confluence of Thompson Creek and Watkins Branch (fig. 5) 15 feet above the flow line of Thompson Creek, the left pelvis, right radius, and two rib fragments of bison were recovered. The bones are not diagnostic but their small size suggest they represent the *Bison* (*Bison*) *bison*, a recent form.[6]

The base of the Mullenix is dated by a willow stump rooted in place at the contact between the Mullenix and Hatcher (fig. 3, W-699). The age of the wood is 1800 ± 200 years B.P. (table 2, W-699); thus the base of the Mullenix must be 1800 years or less. At the type section of the Mullenix member, a walnut log 3 feet above the base of the Mullenix was dated at 1100 ± 170 years B.P. (fig. 5, W-799; table 1). About three-fourths of the Mullenix overlies the walnut log, and the major part of the member therefore was deposited after 1100 B.P.

The Mullenix is overlain locally by the Turton (figs. 2, 5), and deposition of the Mullenix must have ended prior to 250 years B.P. (table 2).

Turton member.—The Turton is the youngest member of the De Forest formation and was named after Turton Branch, where the relationships of the member to older sediments are best expressed.

The type section for the Turton member is located on the east bank of Thompson Creek 200 feet west from the confluence of Watkins Branch and Thompson Creek (figs. 2, 5). The sequence and characteristics of the sediments from the surface downward are:

	Member	Description	Depth below surface (ft)
De Forest formation	Turton	Very dark grayish brown (10YR 3/2) silt loam with abundant gray horizontal bedding planes less than 1 mm thick in lower 66 inches; noncalcareous; sharp contact below.	0-7.1
		Very dark grayish brown (2.5Y 3/2) silt loam with abundant dark reddish brown (5YR 3/4) mottles; massive; noncalcareous; sharp contact below.	7.1-8.1

[6] Written communication, 1960, W. D. Frankforter, Director, Sanford Museum, Cherokee, Iowa.

	Very dark gray (10YR 3/1) loam to silt loam; calcareous fossiliferous; buried tree rooted at 110 inches; sharp contact below.	8.1-9.1
	Very dark grayish brown (10 YR 3/2) loam with abundant fine yellowish red and strong brown mottles; massive; calcareous; fossiliferous; disconformity in base; base of Turton member; sharp contact to Hatcher member.	9.1-11.1
Hatcher	Dark olive-gray (5Y 3/2) silt loam; massive; calcareous; base of section; flow line of Thompson Creek.	11.1-18.5

The Turton member varies texturally from silt loam to loam. It may be calcareous to the surface, or the upper 5 to 6 feet may be noncalcareous. Colors range from dark grayish brown to grayish brown (10YR 3/2 to 2. 5Y 5/2). Maximum thickness is 12 feet in the upper part of Turton Branch (fig. 3).

The member has been mapped discontinuously from near the mouth of Thompson Creek upstream to near the mouth of Turton Branch (fig. 3). In Fox Branch it has been recognized but is present in areas too small and discontinuous to be mapped. By contrast, in the trench of Turton Branch the member is present almost continuously from the mouth to near the headwaters. The Turton is present as a narrow strip adjacent to the stream in the upper part of Thompson Creek, Mullenix, and Turton Branches (fig. 2) but was identified in only two small areas in the Willow River Valley.

The Turton disconformably overlies the Mullenix and Hatcher (figs. 3 and 5). The disconformity is marked by sands and gravels and locally has a relief of 12 feet or more. In all cases the member is inset below the top of the Mullenix (fig. 3), and the top may be as much as 16 feet below the top of the Mullenix. The vegetated scarp separating the Mullenix and Turton has a slope ranging upward to 45 percent.

Invertebrate fossils of the member include terrestrial and aquatic species (table 1). Vertebrates were not found.

At the type section of the Turton a box elder stump rooted 2 feet above the base of the member (fig. 5) was dated at less than 250 years (table 2, W-701). Tree ring counts show that trees growing on the member have a maximum age of 76 years. The Turton therefore may range in age from greater than 250 years B.P. to greater than 76 years B.P.

DISCUSSION

The age and characteristics of the various members of the De Forest formation indicate that from sometime before 14,300 years ago to sometime before 2000 years B.P. apparently continuous alluviation was in progress in the Thompson Creek and Willow River Valleys. Major periods of erosion of the alluvial fill during this period cannot be demonstrated.

Since about 2020 years or more ago, three cycles of erosion and deposition have taken place. The first, the Hatcher cycle, eroded the fill in parts of the Willow River Valley, and possibly in the Thompson Creek Valley before 2020 years ago. Alluviation followed erosion and a maximum of 28 feet of sediment was deposited in parts of Soetmelk Branch. Sometime prior to 1800 years ago the Hatcher member was eroded (figs. 3, 5). In tributary valleys on the south side of the Thompson Creek Valley, erosion of the Hatcher was largely confined to the areas adjacent to the stream system but elsewhere apparently was from the valley slope to the stream (figs. 2, 4). During the sedimentation phase that followed, from 15 to 25 feet of the Mullenix member was deposited, but in tributaries entering Thompson Creek from the south the cycle of alluviation failed to fill to the level of the Hatcher. Consequently the top of the Hatcher was left suspended 3 to 15 feet above the top of the adjacent Mullenix in several valleys (fig. 4). The Mullenix was being deposited 1100 years B.P. and may have continued until the Turton cycle started greater than 250 years B.P.

Sometime prior to 250 years ago erosion of the Mullenix started, and up to 25 feet of the Mullenix and Hatcher members were removed (fig. 3, sta. 30,000). The erosion, unlike the cycle started sometime before 1800 years ago, was confined to a narrow strip adjacent to the present stream system (fig. 2) and apparently did not extend to the headwaters of the drainage system. Sedimentation subsequent to the erosion cycle again failed to fill to the level of the preceding Mullenix cycle (fig. 3). Sedimentation of the Turton member ended sometime prior to 76 years ago.

Cause.—The members of the De Forest Formation do not contain macroflora or fauna that can be used as direct evidence of climatic change during a single cycle of erosion or deposition. Thus, climatic control of the alternate deposition and erosion of the fill can only be inferred.

Deposition of the Soetmelk member may date from Tazewell but extends into postglacial time in Iowa. Deposition of the upper part of the bed may be related to climatic changes associated with retreat of the Cary ice. Deposition of the Watkins member encompasses the major post-Cary climatic change in Iowa (Ruhe, Rubin, and Scholtes, 1957, p. 687-688), but little evidence of cyclic erosion and deposition can be found.

Except for the pollen sequence in the McCullock Peat Bog (Lane, 1931), there is little direct evidence of climatic fluctuation in Iowa during the last 2000 years. Lane (1931, p. 167) found a strong semiarid element, indicated by major amounts of amaranths, after grass became dominant about 6500 years B.P. (Ruhe, Rubin, and Scholtes, 1957, p. 688). The semiarid elements were not dated (ibid. p. 687-688), and direct correlation of the later cycles of erosion or deposition in Thompson Creek with the semiarid elements of Lane cannot be made.

Age of valley slopes.—Ruhe and Cady (1962), in a detailed landscape study in southwestern Iowa, were able to show that the valley slopes were eroded subsequent to 6800 years ago. The alluvial chronology of the Thompson Creek watershed shows that the valley slopes in the watershed were eroded much later than 6800 years ago.

The valley sides pass down and under the alluvial fill, and the top of the fill merges with the slopes in a smooth concave upward profile (fig. 4). The valley sides, therefore, are the source of sediment for the fill, and erosion on the slopes and deposition in the valley must have been contemporaneous.

In areas where the Hatcher member extends to the valley slopes (fig. 2) the major erosion of the slopes must have taken place between 2020 and 1800 years ago. However, ephemeral streams rising on the valley sides have trenched into the Hatcher alluvium and are graded to the top of the Mullenix. Thus, slight erosion near the ephemeral valley-side streams may have taken place since 1800 years ago.

Where the Mullenix member can be traced to the upland (fig. 2), the major erosional period of the valley sides was between 1800 and 250 years ago.

The Turton member is confined to a narrow strip adjacent to the present stream system, and sediment for the member may have been derived largely from erosion of the Mullenix and/or Hatcher members. Erosion of the valley slopes during deposition of the Turton cannot be demonstrated.

Two Recent degradational surfaces on the valley slopes can therefore be recognized. The oldest surface, the Hatcher, dates from 1800 years ago to present and is geographically associated with exposures of the Hatcher member. The youngest surface, the Mullenix, is associated with the Mullenix member and has a maximum age of somewhat less than 1100 years.

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