KANSAS GEOLOGICAL SURVEY OPEN-FILE REPORT 2000-12

Upper Pennsylvanian (Virgilian) Fusulinid Biozonation Preliminary Report

Amoco Production Company, Research Department Report No. M81-G-11

by

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KANSAS GEOLOGICAL SURVEY

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Amoco Production Company

Research Department

UPPER PENNSYLVANIAN (VIRGILIAN) FUSULINID BIOZONATION - PRELIMINARY REPORT

Ву

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and

G. J. Verville

Report No.: M81-G-11
Date: September 21, 1981
Research Proposal No.: 80-3

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SUMMARY

Fusulinids from the Kansas Virgilian are being studied to provide a more diverse faunal component to that portion of the "U" Composite Standard which now contains only a more restricted fauna from Arrow Canyon. The result will be a reference standard of greater applicability in the Late Pennsylvanian.

Our Kansas reference sequence comprises 35 measured sections in Elk and Chautauqua counties which have been stacked to produce a continuous rock succession through the Virgilian. We have recognized and sampled 50 fusulinid-bearing beds from the sedimentary cycles which make up the Midcontinent Virgilian.

Essentially all sample processing has been completed, and interpretive study of the fusulinids has begun. A number of stratigraphically significant fusulinids already can be recognized. However, the close sample control, the short geologic time span, and the pronounced morphologic variability of the fusulinids will require quantitative analysis for adequate definition of phyletic lineages as well as recognition of paleoecologic influences.

STATEMENT OF PROBLEM

The Virgilian portion of Amoco's reference section in Arrow Canyon, Nevada, contains an abundant microfauna of relatively low diversity, which is characteristic of a somewhat restricted environment. In order to create a Pennsylvanian composite standard of widespread applicability, it is necessary to integrate the Arrow Canyon succession with other sections containing more diversified faunas. In the case of the Virgilian, this is being approached through the study of a cratonic sequence in Kansas, where sediments representing very different environmental conditions may be found in close juxtaposition. This investigation has been initiated as Research Proposal 80-3.

OBJECTIVES OF STUDY

The primary objective of Research Proposal 80-3 is to establish a detailed fusulinid biozonation in a continuous rock succession of Virgilian age in Kansas. A secondary, albeit important, goal is to provide paleoecologic insights into the spatial distribution of fusulinid faunas and their paleogeographic significance. The project is a joint effort involving Tulsa Research and Denver Region personnel.

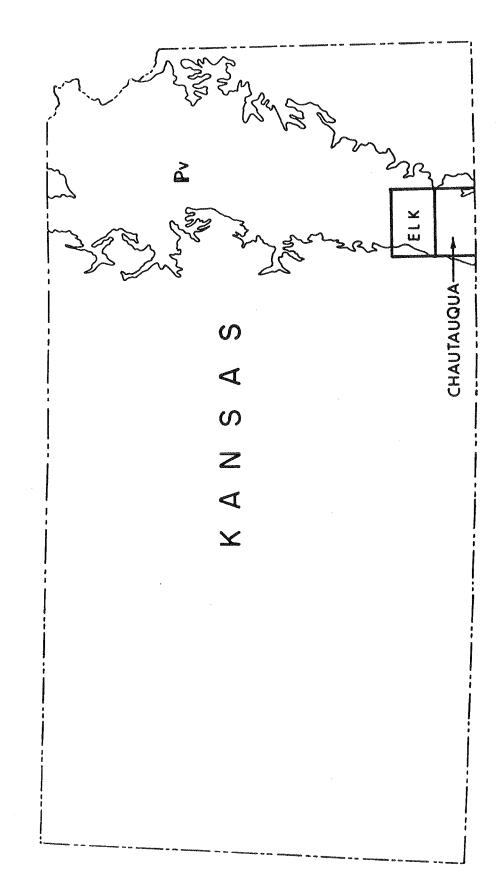


FIG. 1 MAP OF STUDY AREA

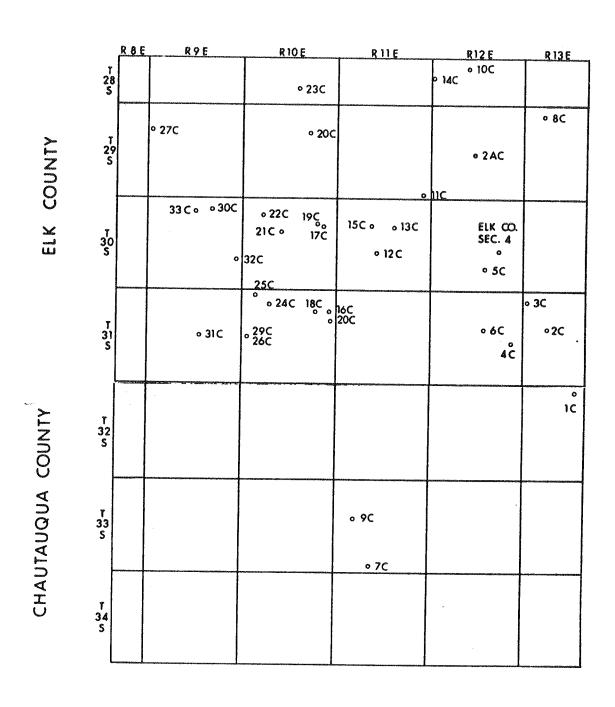


FIG. 2 LOCATION OF MEASURED SECTIONS

STUDY AREA

The primary reference succession for this study is located in south-eastern Kansas (Figure 1), and comprises a series of contiguous, or overlapping, measured sections. All but two of the thirty-four sections are located in Elk County; the remaining two are in Chautauqua County (Figure 2). A listing of all collecting localities may be found in Appendix I. Most of the sections were measured and collected by G. J. Verville some years ago, although a number of supplementary collections were made recently to fill in gaps in stratigraphic control.

In addition to our in-house material, we have been given an extensive collection of Kansas Virgilian fusulinid thin sections, which were acquired over the years by Dr. M. L. Thompson, formerly with the Illinois Geological Survey. Dr. Thompson's plans to publish the Virgilian fusulinids were thwarted by failing health, and custody of the material was given to us. For purposes of our composite standard work, the Elk County succession must form our basic control, but the Thompson collections will provide us with insight into the geographic and paleoecologic variability of the Virgilian fusulinids throughout Kansas. Such additional control is very important, because we know that considerable lateral variability is exhibited by fusulinids in the Toronto and Leavenworth limestones and, presumably, in other units as well.

STRATIGRAPHY

The Virgilian Stage of the Upper Pennsylvanian Series consists of three groups; in ascending order they are Douglas, Shawnee, and Wabaunsee (Figure 3). Each of these groups comprises a number of sedimentary cycles lumped as formations by their dominant lithology. These, in turn, are subdivided into members which generally have been named. For example, the Oread Formation, or megacyclothem, consists of a number of members, again in ascending order, the Toronto Limestone, the Snyder-ville Shale, the Leavenworth Limestone, the Heebner Shale, the Plattsmouth Limestone, the Heumader Shale, and the Kereford Limestone. Many of these members are fossilferous, and the distribution of fusulinids is shown by the + symbol in Figure 3. All the fossiliferous horizons indicated are represented in our collections.

CYCLIC SEDIMENTATION

The cyclical nature of sedimentation in the Midcontinent during Pennsylvanian time has been recognized and studied for many years. The cyclicity is highly complex with many variations in the development of individual cyclothems as well as in the successions of the cyclothems which make up the megacyclothems. Nevertheless, it is possible to recognize a basic sequence of events comprising the transgressive and regressive

Brownville Ls Mbr Pomy Creek Shale Mbr Grayhorse Ls Mbr Plumb Shale Member Nebraske City Ls Mbr French Creek Sh. Mbr Jim Creek Ls. Mbr Grandhaven Ls. Mbr Grandhaven Ls Mbr Dry Shale Member Dover Limestone Mbr	Wood Siding Formation Root Shale Stotler Limestone	Richardson Subgroup				
Maple Hill Le Mbr Wemego Shale Member Farkus Limestone Min	Pillsbury Shale Zeandale Limestone	Rich				
Elmont Limestone Mbr.	Willard Shale	de	g g			
Harveyville Shale Mbr. Reading Limestone Mbr.	Emporia Limestone	Nemaha Subgroup	Wabaunsee Group			
	Auburn Shale	134	1 2	11	İ	
Wakarusa Ls Mbr Soldier Creek Sh Mbr Burlingame Ls Mbr	Bern Limestone	Nema	Waba			
Silver Lake Shale Mbr. Rulo Limestone Member Ceder Vale Shale Mbr. Happy Hollow Ls. Mbr. White Cloud Shale Mbr.	Scranton Shale	Sactox Subgroup				
Utopis Limestone Mbr Winzeler Shale Member Church Limestone Mbr Aarde Shale Member Bechelor Cr. Ls Mbr	Howard Limestone	Sactox S				
	Severy Shale		i			
Coal Creek Ls Mbr Holf Shale Member De Bos Limestone Mbr Turner Creek Sh. Mbr Sheldon Limestone Mbr Jones Point Shale Mbr Curzon Limestone Mbr Lows Point Shale Mbr	Topeka Limestoi	16		VIRGILIAN STAGE		
Hartford Ls. Mbr.	Calhoun Shale		- 1		S	1
Ervine Creek Ls Mbr Larsh & Burroas Sh Mors Rock Blurf La Mbr Oskaloosa Shale Mbr Ozawkie Limestone Mbr	Deer Creek Limest	one	0	VIRG	AN SERIE	SYSTEM
	Tecumseh Shale	1	nous a		VAN	Z
Aroca Limestone Mbr King Hill Shale Mbr Beil Limestone Member Queen Hill Shale Mbr Big Springs Lis Mbr Doinjshan Shale Member Spring Branch Lis Mbr	Lecompton Limesto	ne	Shawnee Group		UPPER PENNSYLVANIAN SERIES	ENNSYLVANIAN SYSTEM
Stuff Shale Member Clay Creek Ls. Mbr. Jackson Park Sh. Mbr.	Kanwaka Shale				품	۵
Kereford Ls Mbr Heumader Shale Member Le Le Plattamouth Ls Mbr Heebner Shale Member Leavenworth Ls Mbr Snyderville Shale Mbr Toronto Limeatone Mbr	Oread Limestone					
Ameronie La Mbr. Ireland Sandstone Mbr.	Lawrence Formation	- 1				
Robbina Shele Member Haskell Limestone Mbr.		9	Douglas Group			!
Vinland Shale Member Westohalia Ls. Mbr Tonganoxie Sa. Mbr. Jalan Limestone Mbr.	Stranger Formation		non			
Weston Shale Member						!

+ = FUSULINID

aspects of the depositional cycle. As shown in Figure 4, a representative cyclical succession embraces a transition from nonmarine sediments to marine sediments and back to nonmarine units. The completeness of expression of transgressive and regressive phases is variable, and marine and nonmarine units often are in close juxtaposition, which provides an excellent opportunity for observing ecologic controls. Fusulinids are, of course, confined to the marine phases of the cyclothems, but within them they occur in different lithologies representing differing habitats, which offer the potential of improved understanding of paleoecology.

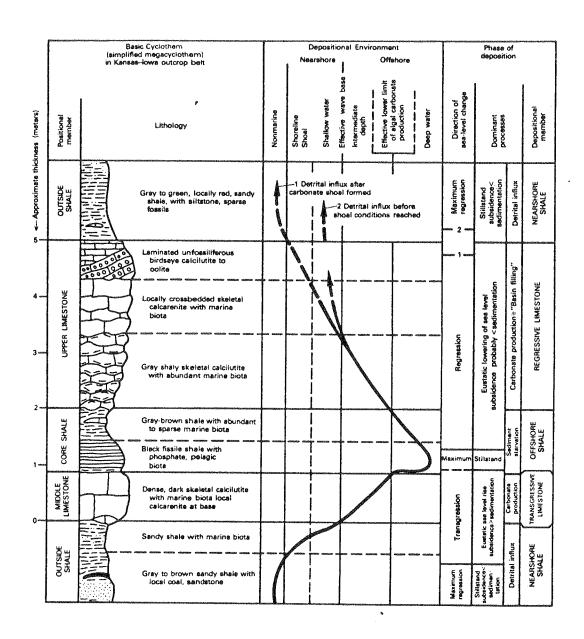
SAMPLE CONTROL

Numerous collections have been made from fifty stratigraphic horizons within the Virgilian of Kansas (Figure 3). For purposes of our composite standard construction, we have established a continuous reference sequence through the Virgilian in Elk and Chautauqua counties. In all, thirty-five measured sections, representing nearly twelve hundred feet of rock, were stacked to provide the reference standard (Figure 5). Our datum is the top of the Tonganoxie Sandstone near the base of the Douglas Group, and all sections stacked above have either overlapping or contiguous relationships (Figure 5). The total range of each measured section is represented by the solid and dashed lines. The solid bar is the portion of a given section used in the stacked sequence, whereas the dashed lines represent overlap. Appendix III summarizes the salient features of the composite sequence, including thicknesses of all the lithic units, portions of the individual sections included in the stacked sequence and cumulative footages of all units above the datum.

Fusulinids generally are abundant if they occur at all, and preservation is good for the most part, although surface weathering has had a degrading effect upon some samples. As previously noted (Figure 3), the fusulinid-bearing horizons are rather well distributed throughout the Virgilian sequence.

PROJECT STATUS

Essentially all sample processing, such as thin-sectioning, has been completed, and specimens representative of all levels have been photographed, not only to characterize faunas but also to delineate phyletic lineages. Visual interpretation has begun, but the closeness of sample control and the abundance of specimens require quantitative study for precise differentiation of intra-specific variability from evolutionary or environmental effects. This involves making numerous measurements of morphologic parameters and their subsequent statistical analysis. Recent acquisition of new measuring equipment, which not only has improved accuracy but also computer interfacing capability, should greatly expedite this aspect of the project.



(AFTER EBANKS ET AL, 1979)

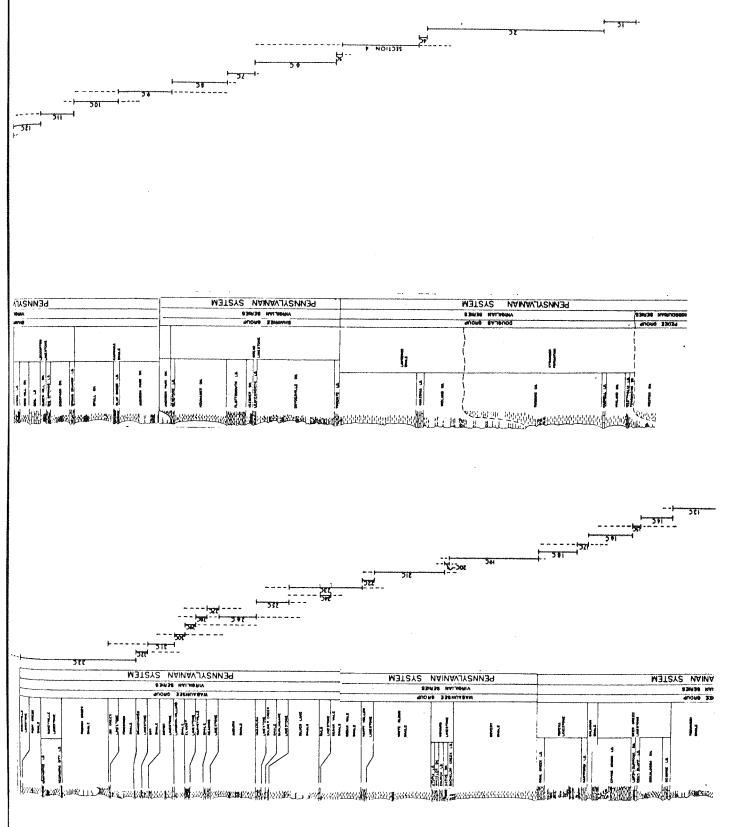
FIG. 4. REPRESENTATIVE KANSAS CYCLOTHEM

Even without the quantitative data, it is already possible to recognize a number of stratigraphically significant fusulinids as well as several instances of ecologic effect. Fusulinids of obvious stratigraphic value include Waeringella spiveyi, Dunbarinella ervinensis, Triticites plummeri, Triticites beedi, Triticites ex. gr. T. secalicus, Kansanella spp., Schubertella kingi, Triticites ex. gr. T. ventricosus, and unnamed precursors of the genus Leptotriticites. From a paleoecological standpoint, it is apparent that lateral differentiation of the fusulinid fauna occurs; this can be demonstrated in the Toronto Limestone, for example, by the differing distribution patterns of Triticites plummeri, Kansanella osagensis, and Triticites secalicus. There seems little doubt that this study will provide us with an excellent, regional, stratigraphic reference standard as well as with a vehicle for paleoecologic investigation.

CONCLUSIONS

- 1. Preliminary examination of the fusulinids from Kansas indicates that the objectives of the study can be achieved using the continuous succession through the Virgilian in Elk County.
- 2. Both biostratigraphic and environmental data will be derived from study of the material on hand.
- 3. Evaluation of the fusulinids by qualitative means has already demonstrated a significant stratigraphic subdivision of the Kansas Virgilian.
- 4. In view of the levels of precision in sampling, quantitative analysis will be necessary to differentiate among details of intraspecific variation, evolution, and paleoenvironmental effects.
- G. A. Sanderson

GAS:ksb 81264ART0152



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APPENDIX I

AMOCO MEASURED SECTIONS

MEASURED SECTIONS - VIRGILIAN REFERENCE STANDARD ELK & CHAUTAUQUA COUNTIES, KANSAS

Section No.	Field No.	Location	Locality No.
33-C	Meas. Sec. 9	Sec. 4/9, T30S, R9E	11004
32-C	Meas. Sec. 18	Sec. 24, T30S, R9E	11377
31-C	Meas. Sec. 19	Sec. 15, T31S, R9E	11002
30-C	Meas. Sec. 15	Sec. 2, T30S, R9E	11010
29-C	Meas. Sec. 14	Sec. 19/18, T31S, R10E	11011
28-C	Meas. Sec. 24	Sec. 13/18, T31S, R10E	11014
27-C	Meas. Sec. 36	Sec. 7, T29S, R10E	11033
26 C	Meas. Sec. 24	Sec. 13/18, T31S, R10E	11014
25-C	Meas. Sec. 34	Sec. 6, T31S, R10E	11013
24-C	Meas. Sec. 35	Sec. 5, T31S, R10E	11012
23-C	Meas. Sec. 27	Sec. 27, T28S, R10E	11015
22-C	Meas. Sec. 77	Sec. 8, T30S, R10E	11286
21-C	Meas. Sec. 28	Sec. 16, T30S, R10E	11017
20-C	Meas. Sec. 30	Sec. 11, T29S, R10E	11309
19-C	Meas. Sec. 31	Sec. 11, T30S, R10E	11376
18-C	Meas. Sec. 52	Sec. 11, T31S, R10E	11020
17-C	Meas. Sec. 33	Sec. 12, T30S, R10E	11021
16-C	Meas. Sec. 38	Sec. 12, T31S, R10E	11023
15-C	Meas. Sec. 42	Sec. 9, T30S, R11E	11024
14-C	Meas. Sec. 68	Sec. 29, T28S, R12E	10999
13-C	Meas. Sec. 41	Sec. 10, T30S, R11E	11026
12-C	Meas. Sec. 39	Sec. 21, T30S, R11E	11027
11-C	Meas. Sec. 40	Sec. 36, T29S, R11E	11029
10-C	Meas. Sec. 80	Sec. 21, T28S, R12E	10997
9 - C	Meas. Sec. 59	Sec. 17, T33S, R11E	11375
8-C	Meas. Sec. 49	Sec. 5, T29S, R13E	10998
7 - C	Meas. Sec. 54	Sec. 33, T33S, R11E	10994
6_C	Meas. Sec. 44	Sec. 15, T31S, R12E	11031
5-C	Meas. Sec. 45	Sec. 27, T30S, R12E	11028
4-C	Meas. Sec. 67	Sec. 24, T31S, R12E	11032
3-C	Meas. Sec. 69	Sec. 6, T31S, R13E	11374
2-C	Meas. Sec. 63	Sec. 17, T31S, R13E	11373
2A-C	USGS Sect. 3	Sec. 21, T29S, R13E	11371
1-C	Meas. Sec. 64	Sec. 3, T32S, R13E	10993
4	Elk Co. Sec. 4	Sec. 23, T30S, R12E	11372

APPENDIX II

M. L. THOMPSON COLLECTIONS

VIRGILIAN OF KANSAS - M. L. Thompson Collection

COLLECTION NO.	HORIZON AND LOCATION
K-1	Beil limestone, ½ mile NE of Virgil.
K-2	Elmont limestone, $NW_{\frac{1}{4}}$ Sec. 9, T. 34 S., R. 8 E.
K-4	Topeka limestone, Hartford ls. mbr., $NW_4^{\frac{1}{4}}$ Sec. 16, T. 11 S. R. 16 E.
K-5	Reading limestone, $SE_{4}^{\frac{1}{4}}$ NW $_{4}^{\frac{1}{4}}$ Sec. 35, T. 11 S., R. 14 E.
K-7	Tarkio limestone, $NW_{4}^{\frac{1}{4}}$ SW $_{4}^{\frac{1}{4}}$ Sec. 25, 11 S., R. 15 E.
K-8	Maple Hill limestone, NE cor. Sec. 19, T. 11 S., R. 13 E.
K-9	Rulo limestone, $NE_{\frac{1}{4}}$ Sec. 12, T. 34 S., R. 8 E.
K-11	Wakarusa limestone, NW SE $\frac{1}{4}$ Sec. 35, T. 11 S., R. 14 E.
K-12	Grandhaven 1s., Hwy cut, Creek exp., S. cent. Sec. 13, T. 16 S., R. 12 E.
K-13	Tarkio ls., Hwy cut, SW_4^1 NW_4^1 Sec. 20, T. 12 S., R. 14 E.
K-14	Brownville ls., Hwy cut, c. W line Sec. 33, T. 12 S., R. 13 E.
K-15	Happy Hollow 1s., SE_4^1 SW_4^1 Sec. 4, T. 26 S., R. 10 E.
K-16	Jim Creek ls., Creek exp., c. w line, Sec. 33, T. 12 S., R. 13 E.
K-17	Big Springs ls., 1.5 miles north of Big Springs. Syntypes: Triticites cullomensis Dunbar and Condra.
K-19	Dover ls., Hwy cut, and creek exp., S cent. Sec. 13, T. 16 S., R. 12 E.
K-21	Oread ls., top of ls., near Tourist Inn, Lawrence, Douglas County.
K-22	Beil ls., center of east line $SE^{\frac{1}{4}}$ Sec. 15, T. 12 S., R. 18 E.

COLLECTION NO.	HORIZON AND LOCATION
K-23	Westphalia ls., 0.5 mile north of Westphalia, <u>T. secalicus</u> oryziformis Newell (=K-141).
K-24	Big Spring ls., center east line SE $\frac{1}{4}$ Sec. 15, T. 12 S., R. 18 E.
K-25	Ozawkie ls? "Haynies ls." = "Middle Deer Creek ls.", $SE\frac{1}{4}$ $SW\frac{1}{4}$ Sec. 32, T. 11 S., R. 18 E.
K-26	Ervine Creek sh., Deer Creek, SW_{4}^{1} Sec. 32, T. 11 S., R. 18 E.
K-27	Deer Creek ls., base of Rock Bluff ls., Hwy cut, $NW_{4}^{\frac{1}{4}}$ NW $_{4}^{\frac{1}{4}}$ Sec. 13, T. 5 S., R. 20 E., Atchison County, Stp. 14, KGS 1936, 2nd day.
K-29	Deer Creek ls., 8 ft above base of Ervine Creek ls., Hwy cut, $NW_{\frac{1}{4}}$ $NW_{\frac{1}{4}}$ Sec. 13, T. 5 S., R. 20 E., Atchison County, Stp. 14, KGS 1936.
K-30	Lecompton 1s., base of Big Springs 1s. mbr., Hwy 7, abt. 2.0 miles N of Atchison. South part, $SW_4^{\frac{1}{4}}$ $NW_4^{\frac{1}{4}}$ Sec. 18, T. 5 S., R. 20 E., Atchison County.
K-31	Beil 1s., Lecompton 1s., Hwy cuts Hwy 40, NW_{4}^{1} NE_{4}^{1} Sec. 24, T. 12 S., R. 18 E., Douglas County, east side valley wall, Stp. 18, KGS 1936.
K-32	Kanwaka sh., base of Clay Creek 1s., Creek exp., $NE_4^{\frac{1}{4}}$ SE $_4^{\frac{1}{4}}$ Sec. 11, T. 5 S., R 20 E., Atchison County, Stp. 13, KGS 1936.
K-36	Clay Creek 1s., basal part, Kereford Bros. Quarry on left. NW_{4}^{1} Sec. 18, T. 6 S., R. 21 E., Atchison County, Stp. 15, KGS, 1936.
K-37	Oread ls., top of Kereford ls., Kereford Bros. Quarry on left, $NW^{\frac{1}{4}}$ Sec. 18, T. 6 S., R. 21 E., Atchison County, Stp. 15, KGS 1936.
K-39	Spring Branch mbr., Lecompton Fm., 2.0 miles north of north edge, Atchison, Ks., SW_4^1 NW_4^1 Sec. 18, T. 5 S., R. 20 E. Mileage 34.0, 2nd day, KGS 1936.

COLLECTION NO.	HORIZON AND LOCATION
K-41	Shale at top of Heumader shale, Kereford Bros. Quarry, NW ¹ / ₄ Sec. 18, T. 6 S., R. 21 E., Atchison County, Stp. 15, KGS 1936.
K-42	Oread 1s., basal Plattsmouth 1s., Hwy cut in NW4 Sec. 22, T. 8 S, R. 22 E., Leavenworth County, Stp. 16, KGS 1936.
K-43	Hartford ls., about 3.0 ft above base of lower ls. mbr., Hwy cut NW_4^1 Sec. 16, T. 11 S., R. 16 E., Shawnee County, KGS 1936, Stp. 21.
K-44	Clay Creek ls., basal part, road cut on each side of valley along Hwy 40, NE $\frac{1}{4}$ NE $\frac{1}{4}$ Sec. 34, T. 12 S., R. 18 E., Douglas County.
K-45	Grandhaven, basal part, road cut, SE_{4}^{1} Sec. 35, T. 17 S., R. 12 E., Lyon County, Stp. 36, KGS 1936.
K-46	Deer Creek ls., Ervine Creek ls., 3 ft below top and 8 ft above base, Hwy cut $NW_{\frac{1}{4}}$ $NW_{\frac{1}{4}}$ Sec. 13, T. 5 S., R. 20 E., Atchison County, Stp. 14, KGS 1936.
K-47	Brownville ls., mileage 5.0, 4th day, KGS 1936, Stp. 37, W side Neosho, NW of Emporia, NE $\frac{1}{4}$ Sec. 31, T. 18 S., R. 11 E., Lyon County.
K-48	Dover ls., Creek exposure in S cen. part Sec. 13, T. 16 S., R. 12 E., Lyon County, Stp. 32, KGS 1936.
K-50	Deer Creek ls., top Ervine Creek ls., Hwy cut $NW_{\frac{1}{4}}$ $NW_{\frac{1}{4}}$ Sec. 13, T. 5 S., R. 20 E., Atchison County, Stp. 14, KGS 1936.
K-51	Reading 1s., Hwy cut $NE\frac{1}{4}$ $NE\frac{1}{4}$ Sec. 20, T. 17 S., R. 13 E., Lyon County, Stp. 34, KGS 1936.
K-52	Lecompton ls., base of Big Spring ls., Hwy cuts in NW_4^1 NE_4^1 Sec. 34, T. 12 S., R. 18 E., Douglas County, Hwy 40, Stp. 18, KGS 1936.
K-53	Brownville ls., creek exposure, NW_{4}^{1} NW_{4}^{1} Sec. 21, T. 16 S., R. 12 E., Lyon County, Stp. 31, KGS 1936.
K-55	Lecompton 1s., Spring Branch 1s., Hwy cuts, $NW_{4}^{\frac{1}{4}}$ NE $_{4}^{\frac{1}{4}}$ Sec. 34, T. 12 S., R. 18 E., Douglas County, Stp. 18, KGS 1936.

COLLECTION NO.	HORIZON AND LOCATION
K-56	Burlingame ls., quarry in SE_4^1 NE $_4^1$ Sec. 33, T. 17 S., R. 13 E., Lyon County, KGS 1936.
K-57	Avoca 1s., $SE_{\frac{1}{4}}^{\frac{1}{4}}$ SW $_{\frac{1}{4}}^{\frac{1}{4}}$ Sec. 36, T. 11 S., R. 17 E.
K-58	Doniphan sh., Hwy cut, NW_4^1 NE_4^1 Sec. 34, T. 12 S., R. 18 E.
K-59	Ozawkie ls., Hwy cut NE corner Sec. 6, T. 12 S., R. 17 E.
K-62	Top Topeka ls., small creek on J. E. Kirkham's farm, $NE^{\frac{1}{4}}$ $SE^{\frac{1}{4}}$ Sec. 5., T. 11 S., R. 16 E.
K-64	Middle of Reading 1s., Hwy cut, $SE^{\frac{1}{4}}$ NW $^{\frac{1}{4}}$ Sec. 35, T. 11 S., R. 14 E., Shawnee County, Stp. 24, KGS 1936.
K-63	Glenrock 1s., 2.5 ft below top, $NW_{\frac{1}{4}}^{\frac{1}{4}} NW_{\frac{1}{4}}^{\frac{1}{4}}$ Sec. 3, T. 20 S., R. 7 E., (=K-85).
K-65	Top Clay Creek ls., cut bank on east wall of valley along Hwy near $NW_4^{\frac{1}{4}}$ NE $\frac{1}{4}$ Sec. 34, T. 12 S., R. 18 E., Douglas County, Stp. 18, KGS 1936.
K-66	Base Burlingame ls., Hwy cuts near center E. line Sec. 36, T. 11 S., R. 14 E., Shawnee County, Stp. 23, KGS 1936.
K-67	Jim Creek ls., creek exposure south of highway near center of W line, Sec. 33, T. 12 S., R. 13 E., Wabaunsee County, Stp. 29, KGS 1936.
K-68	Base Wakarusa 1s., road cut Hwy 10, NW_4^1 Sec. 34, T. 11 S., R. 14 E., Shawnee County, Stp. 25, KGS 1936.
K-69	Tarkio ls., Hwy cut SW $\frac{1}{4}$ NW $\frac{1}{4}$ Sec. 20, T. 12 S., R. 14 E., Shawnee County, Stp. 26, KGS 1936.
K-70	Upper Reading and sh. just below Elmont, road cut $SW_4^{\frac{1}{4}}$ $NW_4^{\frac{1}{4}}$ Sec. 20, T. 12 S., R. 14 E., Shawnee County, Stp. 26, KGS 1936.
K-71	Ozawkie ls., top bed 1, Hwy cut at NE corner Sec. 6, T. 12 S., R. 17 E., Shawnee County, Stp. 19, KGS 1936.
K-72	Maple Hill ls., creek bank NE $\frac{1}{4}$ NW $\frac{1}{4}$ Sec. 19, T. 16 S., R. 13 E., Lyon County, Stp. 33, KGS 1936.

COLLECTION NO.	HORIZON AND LOCATION
K-56	Burlingame ls., quarry in $SE_{\frac{1}{4}}^{\frac{1}{4}}$ Sec. 33, T. 17 S., R. 13 E., Lyon County, KGS 1936.
K-57	Avoca 1s., $SE_{\frac{1}{4}}^{\frac{1}{4}}$ SW $_{\frac{1}{4}}^{\frac{1}{4}}$ Sec. 36, T. 11 S., R. 17 E.
K-58	Doniphan sh., Hwy cut, NW_{4}^{1} NE_{4}^{1} Sec. 34, T. 12 S., R. 18 E.
K-59	Ozawkie ls., Hwy cut NE corner Sec. 6, T. 12 S., R. 17 E.
K-62	Top Topeka ls., small creek on J. E. Kirkham's farm, NE $\frac{1}{4}$ SE $\frac{1}{4}$ Sec. 5., T. 11 S., R. 16 E.
K-64	Middle of Reading 1s., Hwy cut, $SE\frac{1}{4}$ $NW\frac{1}{4}$ Sec. 35, T. 11 S., R. 14 E., Shawnee County, Stp. 24, KGS 1936.
K-63	Glenrock 1s., 2.5 ft below top, $NW_{4}^{\frac{1}{4}} NW_{4}^{\frac{1}{4}}$ Sec. 3, T. 20 S., R. 7 E., (=K-85).
K-65	Top Clay Creek ls., cut bank on east wall of valley along Hwy near $NW_4^{\frac{1}{4}}$ NE $_4^{\frac{1}{4}}$ Sec. 34, T. 12 S., R. 18 E., Douglas County, Stp. 18, KGS 1936.
K-66	Base Burlingame 1s., Hwy cuts near center E. line Sec. 36, T. 11 S., R. 14 E., Shawnee County, Stp. 23, KGS 1936.
K-67	Jim Creek ls., creek exposure south of highway near center of W line, Sec. 33, T. 12 S., R. 13 E., Wabaunsee County, Stp. 29, KGS 1936.
K-68	Base Wakarusa 1s., road cut Hwy 10, NW_{4}^{1} Sec. 34, T. 11 S., R. 14 E., Shawnee County, Stp. 25, KGS 1936.
K-69	Tarkio ls., Hwy cut SW_4^1 NW_4^1 Sec. 20, T. 12 S., R. 14 E., Shawnee County, Stp. 26, KGS 1936.
K-70	Upper Reading and sh. just below Elmont, road cut $SW_{4}^{1} NW_{4}^{1}$ Sec. 20, T. 12 S., R. 14 E., Shawnee County, Stp. 26, KGS 1936.
K-71	Ozawkie ls., top bed 1, Hwy cut at NE corner Sec. 6, T. 12 S., R. 17 E., Shawnee County, Stp. 19, KGS 1936.
K-72	Maple Hill ls., creek bank NE_4^1 NW_4^1 Sec. 19, T. 16 S., R. 13 E., Lyon County, Stp. 33, KGS 1936.

COLLECTION NO.	HORIZON AND LOCATION
K-78	Plattsmouth 1s., Kereford Bros. Quarry, NW ¹ / ₄ Sec. 18, T. 6 S., R. 21 E., Atchison County, Stp. 15, KGS 1936.
K-79	Wakarusa 1s., Hwy cut SW_{4}^{1} NW_{4}^{1} Sec. 20, T. 12 S., R. 14 E., Shawnee County, Hwy 10, Stp. 25, KGS 1936.
K-85	Glenrock 1s., $2\frac{1}{2}$ ft below top, $NW_{\frac{1}{4}}$ $NW_{\frac{1}{4}}$ Sec. 3, T. 20 S., R. 7 E., Chase County (=K-63).
K-115	Big Spring ls., basal 1 ft, Hwy cut NW_4^1 NE_4^1 Sec. 34, T. 12 S., R. 18 E., Douglas County.
K-118	Lecompton ls., upper, Sedan, Kansas.
K-119	Kereford ls., quarry just south of RR, NE of Lecompton, Kansas.
K-122	Snyderville sh., top, Hwy 40 road cut W edge of Lawrence, Kansas.
K-129	Stull sh., lower 1 ft, sh. on top blue 1s. of Deer Creek, NW_4^1 Sec. 34, T. 12 S., R. 18 E., Douglas County, 0.3 mile E Stp. 18, KGS 1936.
K-130	Toronto ls., top, at spillway of Lone Star Lake, 15± miles Woof Lawrence, Kansas.
K-132	Stull sh., top, Hwy cut NW_{4}^{1} NE_{4}^{1} Sec. 34, T. 12 S., R. 18 E., Douglas County.
K-133	Clay Creek 1s., 0.9-1.7 ft above lower 1s. of Clay Creek, 0.3 mile E Stp. 18, KGS 1936, NE_4^1 Sec. 35, T. 12 S., R. 18 E., Douglas County road cut.
K-134	Ervine Creek 1s., very top of cut, Hwy cut $NW_{\frac{1}{4}}$ $NW_{\frac{1}{4}}$ Sec. 13, T. 5 S., R. 20 E., Atchison County, Stp. 14, KGS 1936.
K-135	Clay Creek 1s., Grey sh., 0.3 mile E of Stp. 18, KGS 1936, NW_{4}^{1} NE_{4}^{1} NE_{4}^{1} Sec. 34, T. 12 S., R. 18 E.
K-136	Spring Branch 1s., NW_{4}^{1} NE_{4}^{1} Sec. 34, T. 12 S., R. 18 E., Douglas County, Stp. 18, KGS 1936.

COLLECTION NO.	HORIZON AND LOCATION
	HORIZON IND DOMITON
K-137	Queen Hill sh., upper, $NW_{\frac{1}{4}}$ NE $\frac{1}{4}$ Sec. 34, T. 12 S., R. 18 E., Douglas County, Stp. 18, KGS 1936.
K-138	Beil 1s., top, NW_{4}^{1} NE_{4}^{1} Sec. 34, T. 12 S., R 18 E., Douglas County, Stp. 18, KGS 1936.
K-139	Kereford ls., Quarry NE edge of Lecompton, just S of RR.
K-141	Westphalia ls., $\underline{\text{type locality}}$, Westphalia, Anderson County (=K-23).
K-142	Ozawkie ls., Hwy cut NE cor. Sec. 6, T. 12 S., R. 17 E., Shawnee County, Stp. 19, KGS 1936.
K-143	Kereford ls., middle, SE corner of Kereford Quarry, Sec. 18, T. 6 S., R. 21 E., Atchison County, Stp. 15, KGS 1936.
K-144	Hartford ls., Hwy cut NW_4^1 Sec. 16, T. 11 S., R. 16 E., Shawnee County, Stp. 1, KGS 1936 (called Dashner ls.).
K-145	Ervine Creek 1s., Hwy cut NW_{4}^{1} NW_{4}^{1} Sec. 13, T. 5 S., R. 20 E., Atchison County, Stp. 14, KGS 1936.
K-146	Clay Creek 1s., creek exposure $NE\frac{1}{4}$ $SE\frac{1}{4}$ Sec. 11, T. 5 S., R. 20 E., Atchison County, Stp. 13, KGS 1936.
K-147	Snyderville sh., upper, Hwy cut $NW_{4}^{\frac{1}{4}}$ Sec. 22, T. 8 S., R. 22 E., Leavenworth County, Stp. 16, KGS 1936.
K-148	Coal Creek, Hwy cut $NW_{4}^{\frac{1}{4}}$ Sec. 16, T. 11 S., R. 16 E., Shawnee County, Stp. 21, KGS 1936.
K-149	Wakarusa 1s., Hwy cut and creek exp., $SE\frac{1}{4}$ $NW\frac{1}{4}$ Sec. 35, T. 11 S., R. 14 E., Shawnee County, Stp. 24, KGS 1936.
K-150	Rock Bluff ls., Hwy cut NW_{4}^{1} NW_{4}^{1} Sec. 13, T. 5 S., R. 20 E., Atchison County, Stp. 14, KGS 1936.
K-152	Reading ls., lower, Hwy cut $SW_{\frac{1}{4}}$ $NW_{\frac{1}{4}}$ Sec. 20, T. 12 S., R. 14 E., Shawnee County, Stp. 26, KGS 1936.
K-153	Sheldon ls., sh. above and below, Hwy cut on S facing bluff, NW_{4}^{1} Sec. 16, T. 11 S., R. 16 E., Shawnee County, Stp. 21, KGS 1936, Bed 8.

COLLECTION NO.	HORIZON AND LOCATION
K-154	Reading ls., Hwy cut, SW_4^1 NW_4^1 Sec. 20, T. 12 S., R. 14 E., Shawnee County, Stp. 26, KGS 1936.
K-156	Curzon 1s., Hwy cut on S facing bluff, NW_{4}^{1} Sec. 16, T. 11 S., R. 16 E., Shawnee County, Stp. 21, KGS 1936.
K-157	Turner Creek sh., road cut on S facing bluff, NW ¹ / ₄ Sec. 16, T. 11 S., R. 16 E., Shawnee County, Stp. 21, KGS 1936, Bed 13.
K-158	Larsh-Mission Creek sh., road cut NW_{4}^{1} NW_{4}^{1} Sec. 13, T. 5 S., R. 20 E., Atchison County, Stp. 14, KGS 1936.
K-160	Wakarusa 1s., Hwy cut $NW_{\frac{1}{4}}$ Sec. 34, T. 11 S., R. 14 E., Shawnee County, Stp. 25, KGS 1936.
K-161	Reading 1s., Hwy cut SE_4^1 NW_4^1 Sec. 35, T. 11 S., R. 14 E., Shawnee County, Stp. 24, KGS 1936.
K-162	Plattsmouth 1s., SE cor. Kereford Quarry, Sec. 18, T. 6 S., R. 21 E., Atchison County, Stp. 15, KGS 1936.
K-163	Tarkio ls., sh. below, road cut SW_{4}^{1} NW_{4}^{1} Sec. 20, T. 12 S. R. 14 E., Shawnee County, Stp. 26, KGS 1936.
K-164	Topeka 1s. (1), upper of 3 thin ledges of 1s. in shale, just SW of fork of Hwys 99 and 160, $6\pm$ ft above (2), Elk County, E of Moline.
K-165	Topeka 1s. (2), middle of 3 thin 1s. in sh., just SW of forks of Hwys 99 and 160, $6\pm$ ft below (1), E of Moline, Elk County.
K-166	Heumader sh., Kereford Quarry, S of Leavenworth, SE cor. quarry, Sec. 18, T. 6 S., R. 21 E., Atchison County, Stp. 15, KGS 1936.
K-167	Hartford ls., sh. below Sheldon ls., road cut on S facing hill, NW_{4}^{1} Sec. 16, T. 11 S., R. 16 E., Shawnee County, KGS 1936, Stp. 21.
K-168	Long Creek ls., lower, road cut $SE_4^{\frac{1}{4}}$ NE $_4^{\frac{1}{4}}$ Sec. 4, T. 13 S., R. 12 E., Wabaunsee County, Stp. 30, KGS 1936.

COLLECTION NO.	HORIZON AND LOCATION Elmont 1s., Hwy cut SW 1/4 NW 1/4 Sec. 20, T. 12 S., R. 14 E., Shawnee County, Stp. 26, KGS 1936.				
K-169					
K-170	Clay Creek ls., SE cor. Kereford Quarry, Stp. 15, KGS 1936.				
K-171	Leavenworth 1s., Hwy cut NW_4^1 Sec. 22, T. 8 S., R. 22 E., Leavenworth County, Stp. 16, KGS 1936, type section.				
K-172	Big Spring ls., Hwy cut NE_4^1 Sec. 11, T. 5 S., R. 20 E., Atchison County, Stp. 13, KGS 1936.				
K-173	Toronto 1s., basal, Hwy cut NW_4^1 Sec. 22, T. 8 S., R. 22 E., Leavenworth County, Stp. 16, KGS 1936.				
K-174	Big Spring ls., NW_4^1 NE_4^1 Sec. 34, T. 12 S., R. 18 E., Douglas County, Stp. 18, KGS 1936.				
K-175	Jim Creek ls., creek exposure near center of W line, Sec. 33, T. 12 S., R. 13 E., Wabaunsee County, just S of Hwy, Stp. 29, KGS 1936.				
K-176	Topeka ls., $NE\frac{1}{4}$ Sec. 20, T. 28 S., R. 11 E., just S of Greenwood-Elk County line.				
K-177	"Jim Creek" ls., SE_4^1 Sec. 11, T. 10 S., R. 9 E., Pottawatomie County.				
K-178	Happy Hollow ls., 12 ft below, $NW_{4}^{1} NW_{4}^{1}$ Sec. 7, T. 34 S., R. 9 E., 7 miles E of Cedarvale, Kansas.				
K-180	Dover ls., 1 ft zone, 5 ft above base, 3 miles S Maple Hill, Kansas.				
K-181	Tarkio ls., $6\frac{1}{2}$ miles W of Burlingame, Kansas, center Sec. 15, T. 15 S., R. 13 E.				
K-183	Topeka ls., between "Curzon ls." and Wolf River ls., SE_4^1 Sec. 31, T. 29 S., R. 11 E., near golf course.				
K-184	Oread 1s., lower, 1-2 ft below top, SW_4^1 NW_4^1 Sec. 27, T. 14 S., R. 20 E., 1 mile N of Baldwin, Kansas.				
K-185	Topeka 1s, 12 ft above base; center of $N\frac{1}{2}$, Sec. 16, T. 11 S., R. 10 E.				

COLLECTION NO.	HORIZON AND LOCATION				
K-186	Oread ls., lower, W end of KU campus, Lawrence, Kansas.				
K-187	Clay Creek ls., 5 miles W of Quenemo, Osage County, Waymire Farm.				
K-189	Topeka ls., basal, E of junction Hwys 116 and 11, Moline, Elk County.				
K-190	Lecompton ls., just below lower, 1 mile west of intersection of Hwys 50 S and 75, west of Waverly, Kansas.				
K-193	Topeka ls., thin limestones between Coal Creek and Curzon. NW_4^1 SW $_4^1$ Sec. 11, T. 31 S., R. 10 E.				
K-194	Dover ls., upper, 10 ft above Dover ls., Sec. 13, T. 16 S., R. 12 E., on Hwy 50 N., in road ditch.				
K-196	Clay Creek ls., just west of Kanwaka, Kansas.				
K-198	Ervine Creek ls., west edge of Calhoun Bluffs at Ervine Creek Quarry.				
K - 199	Topeka ls., lower, "Dashner ls.", center Sec. 12, T. 18 S., R. 14 E., Osage County.				
K-200	Topeka 1s., between "Curzon" and "Wolf River", $SE\frac{1}{4}$ Sec. 31, T. 29 S., R. 11 E., near golf course.				
K-201	Toronto 1s., $SW_{\frac{1}{4}}$ $NW_{\frac{1}{4}}$ Sec. 27, T. 14 S., R. 20 E., 2.4 miles south of Vinland, Kansas.				
K-202	Coal Creek mbr., Topeka fm., SW_4^1 SW_4^1 Sec. 9, T. 10 S., R. 17 E., 3 \pm miles E of Meriden, Kansas.				
K-203	Topeka ls., type section of Jones Point, $NE_{\frac{1}{4}}$ $NW_{\frac{1}{4}}$ Sec. 16, T. 11 S., R. 16 E.				
K-204	Oread ls., lower, West Campus Quarry at KU, Lawrence, lower ledge of ls.				
K-205	Spring Branch, upper, $NE\frac{1}{4}$ Sec. 33, T. 13 S., R. 17 E.				
K-206	Topeka ls., calc. sh. just above Hartford, part of Curzon(?), NW cent. Sec. 9, T. 17 S., R. 15 E.				

COLLECTION NO.	N HORIZON AND LOCATION				
K-207	Topeka ls., between "Curzon" and "Wolf River", SE Sec. 31, T. 29 S., R. 11 E., near golf course.				
K-208	Topeka 1s., "Curzon" mbr., W cent. Sec. 7, T. 2 S., R. 20 E.				
K-209	Tecumseh sh., sh. below fusulinid ls., 57 ft above Beil ls., 2 miles S of Lynden, Kansas.				
K-210	Westphalia 1s., NE ¹ / ₄ Sec. 12, T. 29 S., R. 12 E.				
K-211	Ozawkie ls., Deer Creek ls., 1/8 mile S on US Hwy 75 from cent. Sec. 7, T. 15 S., R. 16 E.				
K-212	Topeka ls., sh. just below "Curzon", Atchison County, center Sec. 12, T. 5 S., R. 19 E.				
K-213	Upper Oread ls., near base, Willard cut, Lawrence, Kansas.				
K-227	Toronto ls., sh. just below, cont. E side Sec. 15, T. 31 S., R. 12 E., Elk County, on road cut at bottom of hill.				
K-228	Happy Hollow 1s., sh. breaks within, near SW cor. $SE\frac{1}{4}$ $SE\frac{1}{4}$ Sec. 27, T. 28 S., R. 10 E., Elk County, road cuts at top of creek bank.				
K-230	Soldier Creek sh., just below Wakarusa ls., cont. E side NE_4^1 Sec. 6, T. 31 S., R. 10 E., Elk County, road cut on N-S road.				
K-231	Howard ls., Aarde sh. mbr., sh. 1 ft above road cut just below Church ls., center of N line Sec. 5, T. 29 S., R. 11 E., on E-W road, Elk County.				
K-232	Happy Hollow 1s., lower part, $SE^{\frac{1}{4}}$ NW $^{\frac{1}{4}}$ Sec. 18, T. 19 S., R. 13 E., Lyon County.				
K-233	Ervine Creek ls., 3-5 ft below top, Moline Quarry, Sec. 11, T. 31 S., R. 10 E., Elk County.				
K-234	Heumader sh., 2.1 miles S of Longton in road cut on N-S road, west side of $NE^{\frac{1}{4}}$ NE $^{\frac{1}{4}}$ Sec. 21, T. 31 S., R. 12 E., Elk County.				

COLLECTION NO.	HORIZON AND LOCATION Beil 1s., sh. break 5 ft from top, center Sec. 21, T. 30 S., R. 11 E., Elk County, road cut on N-S road.				
K-236					
K-237	Burlingame 1s., lower 2-3 ft, E center NE_{4}^{1} Sec. 6, T. 31 S., R. 10 E., Elk County (Burlingame 4.5 ft thick).				
K-229	Avoca 1s., 3.5 from bottom, E side of N-S road at center of Sec. 21, T. 30 S., R. 11 E., Elk County, road cut.				
K-238	Avoca ls., sh. breaks 5 ft above base, cont. Sec. 21, T. 30 S., R. 11 E., Elk County, road cut on N-S road and on E side of road.				
K-239	Brownville 1s., SW_{4}^{1} SW_{4}^{1} Sec. 3, T. 30 S., R. 9 E., on north-facing hill and on N-S road.				
K-240	Topeka ls., 2-3 ft below top, $NW_{\frac{1}{4}}$ SW $_{\frac{1}{4}}$ Sec. 12, T. 30 S., R. 10 E., Elk County, road cut on N-S road just south of low-water bridge.				
K-241	Ervine Creek sh., 7 ft below top, Moline Quarry, Sec. 11, T. 31 S., R. 10 E., Elk County.				
K-242	Church ls., limestones and shales in lower part, at contact with Aarde sh., SW_4^1 Sec. 25, T. 29 S., R. 10 E., Elk County, road cut at high creek banks and at top of bank on N-S road.				
K-243	Big Spring 1s., middle, S line of SW_4^1 SE_4^1 Sec. 36, T. 29 S., R. 11 E., Elk County, road cut on E-W road.				
K-244	Topeka ls., lower part, north rim of Moline Quarry, Sec. 11, T. 31 S., R. 10 E., Elk County.				
K-249	Haskell ls., near cen. E line NE $\frac{1}{4}$ Sec. 21, T. 11 S., R. 21 E., Leavenworth County.				
K-250	Spring Hill ls., quarry at NW corner of junction old US Hwy 59 and Santa Fe RR 5 miles SW of Garnett, Kansas, 5 miles from 7th St. and new US 59 in City of Garnett.				
K-260	Haskell ls., sh. just below, S side of E-W road, $NW_4^{\frac{1}{4}}$ $NW_4^{\frac{1}{4}}$ $NE_4^{\frac{1}{4}}$ Sec. 13, T. 29 S., R. 13 E., Wilson County.				

COLLECTION NO.	HORIZON AND LOCATION
K-91	Ozawkie ls.
K-124	Deer Creek ls.
K-125	Elmont 1s. mbr.
K-20	Jim Creek ls. mbr.

APPENDIX III

COMPOSITED OUTCROP SECTIONS

VIRGILIAN REFERENCE SEQUENCE COMPOSITED OUTCROP SECTIONS

	LITHIC UNITS	THICKNESS IN FEET	MEASURED SECTIONS	CUMULATIVE FOOTAGE ABOVE DATUM
Manage and an analysis and an			CALADO LA CALIFORNIA DE LA CALADA CAL	1189.2
(B	BROWNVILLE 1s.	1.7	•	1187.5
WOOD SIDING FM	PONY CREEK sh	17.5		1170.0
S OC SI	GRAYHORSE 1s	1.5		1168.5
Ŏ	PLUMB sh	22.0	33 C	1146.5
game digital september and the analysis and the september and the	NEBRASKA CITY ls	1.0		1145.5
	FRENCH CREEK sh	47.0		1098.5
ROOT	JIM CREEK 1s	0.9		1097.6
9A59AA84555584774	FRIEDRICH sh	36.1		1061.5
ш Ж	GRANDHAVEN 1s	10.5	32 C	1051.0
STOTLER FM	DRY sh	6.6	31 C	1044.4
<i>S</i>	DOVER 1s	28.6		1015.8
ΑI	WILLARD-PILLSBURY INTERVAL TARKIO-WAMEGO-MAPLE HILL NOT RECOGNIZED	10.7	30 C	1005.1
EMPORIA	ELMONT 1s	5.1	29 C	1000.0
	HARVEYVILLE sh	10.3	28 C	989.7
	_ READING ls	8.8	27 C	980.9
AUBURN	AUBURN sh	34.2	26 C	946.7
	WAKARUSA 1s	4.9	1	941.8
BERN FM	SOLDIER CREEK sh	3.4	25 C	938.4
(1)	BURLINGAME 1s	5.5		932.9

		BURLINGAME 1s			932.9
especialists for more and the set of the set	SILVER LAKE sh	42.0	23 C	890.9	
	SCRANTON	RULO 1s	0.6	24 C	890.3
		E CEDARVALE sh	28.0	23 C	862.3
		HAPPY HOLLOW 1s	10.8	22 C	851.5
***************************************		WHITE CLOUD sh	51.4		800.1
		UTOPIA ls	4.8		795.3
		WINZELER sh	1.6	21 C	793.7
	HOWARD	CHURCH 1s	2.5		791.2
	HOW I	AARDE sh	4.8	20 C	786.4
emerikaansk		BACHELOR CREEK 1s	3.7	1	782.7
	SEVERY	E ∸ SFVFDV sh	70.0	19 C	
. milyaniyalinda da	SE	SEVERY sh	70.8	***************************************	711.9
2 W Marco 10 to 100 and		COAL CREEK 1-	6 1	1	705.8
		COAL CREEK 1s	6.1		683.5
		HOLT sh	22.3	10.6	-
	\$	DUBOIS 1s	0.7	18 C	682.8
- Indiana	TOPEKA	₹ TURNER CREEK sh	1.0		681.8
	•	SHELDON 1s	2.9		678.9
4		JONES POINT sh	5.0	 17 C	673.9
Mecan	ana mandiikko ee boolooboo	CURZON 1s HARTFORD	1.0 4.7		668.2
	<u>z</u>				
İ	CALHOUN	Œ CALHOUN sh	4.6	16 C	
	3	**************************************			663.6
\ \ \ \	ERVINE CREEK 1s	31.5	Ī	631.6	
	LARSH-BURROAK sh	2.8	15 C	629.3	
	DEER CREEK FM	E ROCK BLUFF 1s	2.0		627.3
		OSKALOOSA sh	34.5	↑ 14 C	592.8
-		OZAWKIE ls	3.1		589.7
1					

	OZAWKIE ls			589.7
TECUMSEH	TECUMSEH sh	62.7	13 C	527.0
жардуу олд жайн өскөр оруун алам фоносон ойн өсө об 44 жил бөгүүлөгү	AVOCA ls	9.4	12 C	517.6
	KING HILL sh	10.3	Algorithmic contribution before the authors of the	507.3
Z.	BEIL 1s	9.3	1	498.0
LECOMPTON FM	QUEEN HILL sh	5.3		492.7
E03	BIG SPRING 1s	4.1	11 C	488.6
	DONIPHAN sh	30.2	elissialis kralatinojo rojos onema <mark>punktinojojik sa kirisk</mark> alis	458.4
	_ SPRING BRANCH 1s	6.4	1	452.0
IKA	STULL sh	34.4	10. C	417.6
KANWAKA FM	CLAY CREEK 1s	5.9		411.7
⊻	JACKSON PARK sh	54.0	9 °C	357.7
appropries primaries de participante de participante de la constitución de la constitució	KEREFORD 1s	0.8	∳ 8 C	356.9
	HEUMADER sh	16.5		340.4
	PLATTSMOUTH ls	13.1	T 7 C	327.3
OREAD FM	HEEBNER sh	4.7		322.6
0	LEAVENWORTH 1s	1.8	T 6.C	320.8
	SNYDERVILLE sh	74.8		246.0
	TORONTO ls	6.4	5 C	239.6
	UNNAMED sh	50.0	2 AC	189.6
LAWRENCE	AMAZONIA ls	3.5	4 C	186.1
	UNNAMED sh	15.0	2 AC	171.1
	IRELAND ss	14.3	2 C	156.8
GER	ROBBINS sh	111.9	distribution of the property of the second o	44.9
	HASKELL 1s	1.0	Ţ	43.9
	VINELAND sh	35.4		6.4
STRANGER		2.1	1 C	
ST	UNNAMED sh TONGANOXIE ss	6.4		DATUM

KANSAS GEOLOGICAL SURVEY OPEN-FILE REPORT 2000-12

Upper Pennsylvanian (Virgilian) Fusulinid Biozonation Final Report

Amoco Production Company, Research Department Report No. F83-G-18

by

G.A. Sanderson G.J. Verville

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KANSAS GEOLOGICAL SURVEY

1930 Constant Avenue University of Kansas Lawrence, KS 66047 TO:

Division Geologists

Managers, Geology, APC (USA and INTL), Chicago

Regional Geologists Regional Paleontologists

SUBJECT:

Transmittal of Geological Research Department Report F83-G-18, "Upper Pennsylvanian (Virgilian) Fusulinid Biozonation - Final

Report"

The attached report marks the completion of a study undertaken to strengthen our Upper Pennsylvanian biostratigraphic control which previously had been based upon a low diversity, provincial fauna. The primary result of this project is the establishment of a tightly controlled reference standard which will significantly improve the precision and applicability of our fusulinid zonation in the subsurface. Although the study was fundamentally stratigraphic in nature, some very useful insights into fusulinid response to environmental factors also emerged.

The results achieved in this investigation were due in part to the application of our new, computer-based, FUSDATA system to the discrimination of fusulinid populations and their distribution. We anticipate further enhancements in quantitative methods in the future.

R. Michaelis

Eric R. Michaelis

GAS: 1mw Attachment

cc: Exploration Systems Manager, TDC Regional Exploration Libraries

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ABSTRACT

A Virgilian reference standard has been established in the Midcontinent (Kansas) using fusulinids from 50 stratigraphic levels within a stacked sequence of 35 measured outcrop sections. Quantitative data generated and processed by a newly developed computer system have been employed to help discriminate fusulinid populations and their stratigraphic ranges.

INTRODUCTION

This project was undertaken (see Research Department Report M81-G-11) to strengthen our control in the Upper Pennsylvanian portion of the U. Composite Standard which was represented only by the Arrow Canyon succession. The latter is characterized by abundant fusulinid faunas of low diversity which provide a reference of restricted applicability. Not only does the Kansas Virgilian contain a much greater faunal diversity, but it may be a more complete section as well. Thus, the fortified standard will provide better control in the subsurface, and it will be of wider applicability because it will contain fossil elements from different provinces.

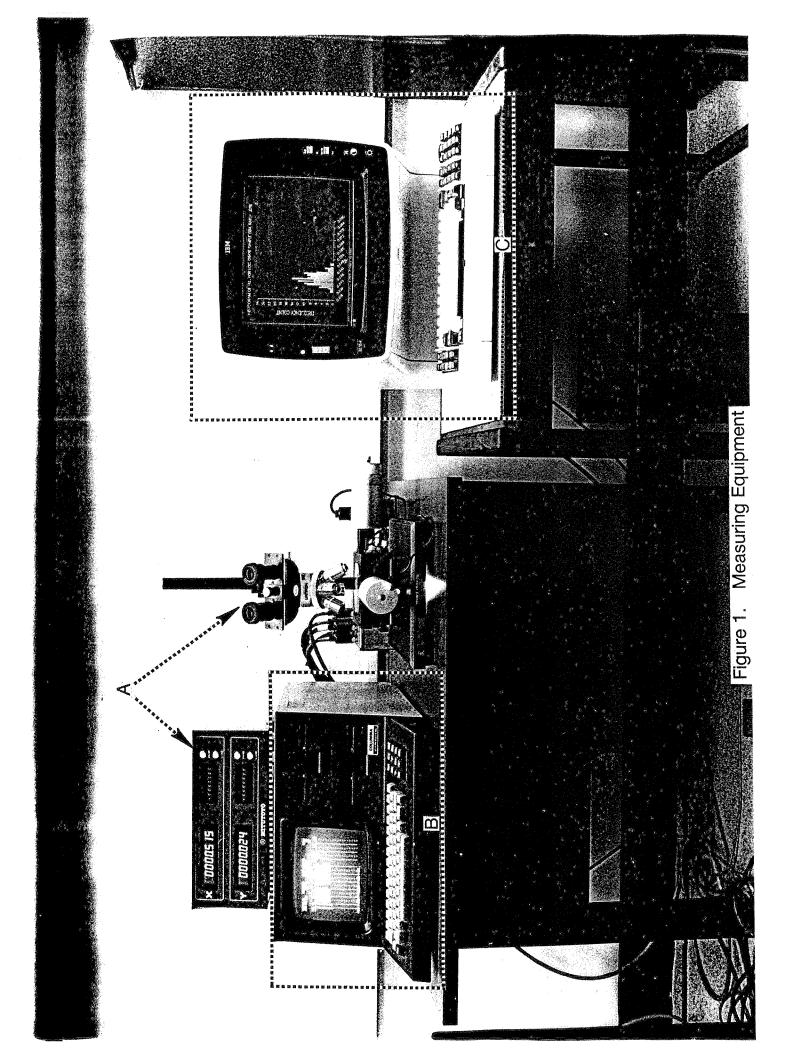
Although the bulk of this report is devoted to documentation of the fauna (mainly in the Appendices) for use by paleontologists, the exploration geologist will benefit from the enhanced control which now can be provided in the subsurface.

SUMMARY

The main objective of this study has been accomplished in the creation of an excellent fusulinid reference section for the Midcontinent Virgilian. This control can be expanded with little additional effort to include the Wolfcampian, since much of that information is already in hand, and we recommend that as the next logical step in our Composite Standard development.

This study also marks the first use of our new, computer-based FUSDATA system to generate and display quantitative data used in the discrimination of fusulinid populations and their distribution, both vertical and lateral. This technology is being disseminated, and two Regions have already taken steps to acquire at least part of appropriate hardware needed to use FUSDATA. Further development of this modular system is planned.

Since this study employed in-house material which was not collected with environmental studies in mind, our paleoecologic results are not definitive. However, we have been able to demonstrate empirically that the fusulinids exhibit considerable ecologic sensitivity within their relatively short stratigraphic ranges, and the effects of environmental controls can be seen in both their vertical and lateral distribution. A repetitive pattern of occurrence can be linked to functional morphology, but this pattern does not correlate well with the lithologic sequences seen in typical Pennsylvanian cyclothems, suggesting a different set of controls. A better understanding of those controlling factors would provide a powerful predictive capability, and additional research in that direction is strongly recommended.



CONCLUSIONS

- 1. The Midcontinent Virgilian contains a diversified fusulinid fauna with well-defined taxonomic ranges, and excellent biostratigraphic control has been established in the Virgilian utilizing 56 fusulinid taxa.
- 2. Several evolutionary lineages have been recognized, and subtle morphologic changes have been identified with the aid of our new FUSDATA computer system of quantitative data analysis.
- 3. Fusulinid occurrences are episodic, reflecting ecologic pressures within the cyclothems. They are not simply related to lithology per se, but are apparently influenced by factors such as depth, agitation, turbidity, and salinity which can vary within the sedimentary cycle.
- 4. There is evidence of a fusulinid succession within the depositional cycle, but the relationship to bathymetry is still unclear, since it is not known in our material whether minor fluctuations have interrupted the main transgressive-regressive depositional cycle.
- 5. Lateral distribution of fusulinid species also varies within a given cycle, apparently reflecting the same ecologic controls observed in stratigraphic distribution. These are potentially mappable parameters.
- 6. The Midcontinent data will greatly strengthen our U Composite Standard in its Late Pennsylvanian portion.

RECOMMENDATIONS

- 1. The stratigraphic data generated in the course of this study which are now in the Paleofile should be integrated with part of the Arrow Canyon section as soon as possible so that the improved control is available for operational use as needed.
- We already have in house detailed fusulinid range data from a Wolfcampian surface section, which is actually a continuation of the Virgilian succession just completed, as well as from an Amoco core. These can be combined readily to extend our stratigraphic control through most of the Wolfcampian without mounting a major project. The potential benefits of doing so far outweigh the limited time expenditure required, and the resultant control will have operational application.
- 3. The samples used in the Virgil study had been collected previously for purely stratigraphic purposes and, as such, were limited in their

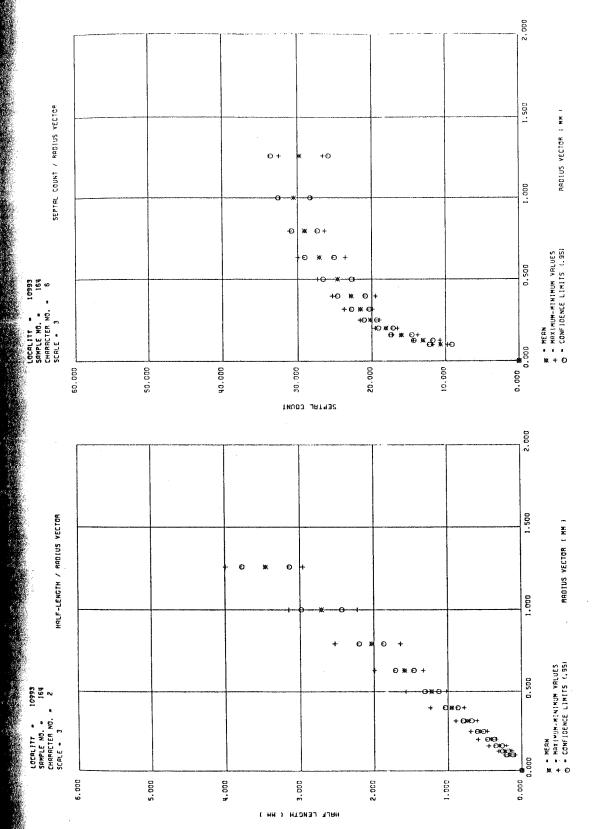


Figure 2. Ontogenetic Plots

applicability to detailed paleoecologic analysis. Inasmuch as we have established significant ecologic sensitivity on the part of the fusulinids, we should attempt to improve our understanding of the environmental controls over their distribution.

4. A newly implemented computer system (FUSDATA) for processing morphologic measurements was used in this study to evaluate quantitative data and to help define fusulinid species. FUSDATA has proved to be a valuable tool for discriminating fossil populations and evolutionary change. It is particularly flexible because of its modular nature. Development of this system should be continued, and, where possible, adapted to other fossil groups.

DISCUSSION

Methodology

Designed for compatibility with our Composite Standards, our approach involved the use of stacked or overlapping, measured successions to provide a continuous physical section representing the entire Virgilian time interval. A detailed discussion of the physical stratigraphy and sampling procedures may be found in Research Department Report M81-G-11.

This study differs from previous fusulinid projects in the substantial use of quantitative data, statistical treatment, and graphic displays to aid in the discrimination of species. The biometric approach is supplementary to purely visual examination, not a replacement for it, since many structural features are not quantified at present and will not be until image analysis is integrated into our system. Nevertheless, the FUSDATA/CUTLASS system provided calculations and graphic displays which rendered subtle differences more obvious and eliminated purported distinctions which, in fact, were more apparent than real. It is clear that biometrics will play a significant role in paleontology in the future.

Instrumentation

The FUSDATA/CUTLASS system will be described in detail in a separate report; in simplest terms it consists of a semi-automated measuring system with digital display and direct input to a microprocessor, plus a modular, interactive software system in VM which is used for statistical analysis and the generation of graphic displays, such as ontogenetic growth curves, frequency distribution diagrams, etc. (Fig. 1).

The measuring equipment (Fig. 1-a) can be used in almost any thin section application, but it is particularly convenient for study of planispirally-coiled foraminifers such as the fusulinids. Similar units are being acquired by two Regions at the present time.

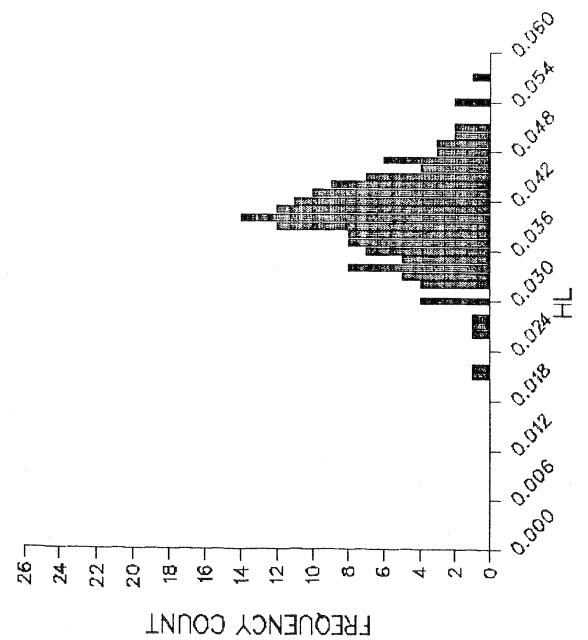


Figure 3. Frequency Distribution Of Half Length

Measured data are formatted, edited and stored on floppy disk by the microprocessor (Fig. 1-b) which is menu driven and self-prompting. The software is, of course, specifically designed for fusulinid measurements, but the method can be applied to a variety of data acquisition situations—vitrinite reflectance, for example. The potential uses are limited only by need and imagination.

Raw data stored on floppy disk can be transferred to VM at will and manipulated interactively (Fig. 1-c) by accessing a series of modules to generate data lists, statistics, and graphic displays. Numerous options are available, and more will be added to the system in the future. For example, ontogenetic plots may be made of various parameters in a population (Fig. 2). Histograms illustrating the frequency distribution of measured or calculated data are easily produced, both on the CRT and in hard copy (Fig. 3). These and other options are currently operational and, there doubtless will be additions, improvements, and refinements as the system evolves. The emphasis is on usefulness and ease of operation.

Biostratigraphy

The fusulinid zonation established in our Kansas reference succession consists of 89 fusulinid collections from 50 named stratigraphic units in a stacked sequence of 35 measured sections. In all some 56 taxonomic entities were recongized, of which the 45 most significant ranges are plotted on the composite stratigraphic chart (Fig. 4). Computer plots of all occurrences arranged by Tops and by Bases are in Appendix I (Figs. 5 & 6).

The fusulinids characteristic of each of the stratigraphic horizons are illustrated on Plates 1-50 in Appendix II. An effort has been made to show the spectrum of morphologic variability wherever possible, and the facing pages have plate descriptions as well as stratigraphic keys, so the plates should be useful for preliminary identifications. More detailed information will be available in the individual taxon folders, including various graphic displays of biometric data.

It is readily apparent from Figure 4 that the Virgil Stage and its 3 Groups, Douglas, Shawnee and Wabaunsee are clearly defined by the fusulinid forams. Some taxa are, in fact, confined to specific formations or even members. All have relatively restricted ranges, which is due in part to ecologic factors inherent in cyclical deposition, but the net result of compositing these ranges will be an excellent reference standard. Even without the Composite Standard it is possible to make some significant observations.

The Douglas Group, for example, is devoid of inflated, highly fluted fusulinids, such as <u>Triticites beedei</u>, <u>T. plummeri</u>, etc. The units below the Toronto are characterized by <u>T. secalicus</u>, <u>T. oryziformis</u> and a form of

Kansanella which is distinct from succeeding species of that genus. The type level of T. oryziformis is, in fact, the Westphalia Limestone.

A much greater diversity of forms is evident in the Shawnee Group, including the afore-mentioned, inflated forms such as T. beedei, several new species of Kansanella and Triticites, and, in its upper part, the first occurrence of the genus Dunbarinella. Nevertheless, Triticites secalicus, T. oryziformis and their descendents are very prominent in the Shawnee, recurring in a number of beds, but they did not survive into Wabaunsee time. The lower part of the Shawnee contains a species of Waeringella, which is closely related to W. spiveyi found in the lower Cisco in Texas. The genus appears to be very restricted stratigraphically in both the northern and southern Midcontinent, but a very similar form, generally referred to Pseudofusulinella, has a longer range in the Cordilleran region.

Evolutionary trends are also in evidence. The occurrences of the genus Kansanella, which arose in the mid-Missourian, come to an end in the lower part of the Deer Creek Formation and is replaced in the middle of the Deer Creek by Dunbarinella, which appears to be an offshoot of the Kansanella stock. Within the latter genus are changes as well--subtle, but demonstrable. In particular, there is a trend toward looser coiling and reduction of septal count, which is discernable in the more advanced forms only in the outer volution. Such changes, which are invaluable for phylogenetic interpretations, require quantitative methods that are now available.

The faunal aspect of the Wabaunsee Group is quite different. Inflated forms such as T. beedei, T. plummeri, and T. happyhollowensis are prominent in the lower portion with species of Dunbarinella and several rather undistinguished species of Triticites whose significance is not understood. The upper part of the Wabaunsee, on the other hand, has different faunal elements which are truly harbingers of the overlying Wolfcampian. There are several primitive species of Leptotriticites, a genus characteristic of the Early Wolfcampian. Similarly, Schubertella ex. gr. S. kingi become very abundant in the Nebraska City and Brownsville limestones. Schubertella kingi is a long-recognized "marker" of the Wolfcampian, and the Virgilian forerunners are very closely related indeed. It has been proposed that the Pennsylvanian--Permian boundary be lowered to accommodate these forms, but we disagree because it is a transitional sequence and more than one position for the boundary could be selected with equal justification. Here is a case where graphic correlation provides the only reasonable solution.

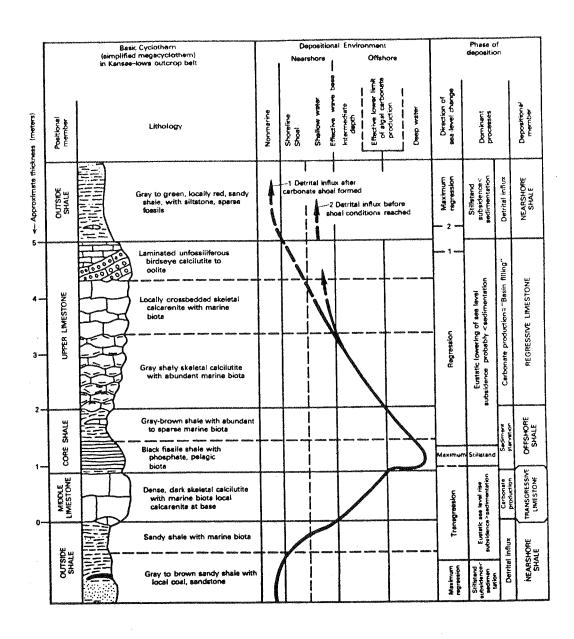
All in all, this is an excellent reference section for strengthening the Upper Pennsylvanian part of our Composite Standard. Control is continuous from pre-Virgilian into the Wolfcampian, fusulinid occurrences are frequent, ranges are restricted, and evolutionary changes can be discerned

PENNSYLVANIAN

Figure 4. Stratigraphic Chart

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(After Ebanks et al, 1979)
Figure 7. Representative Kansas Cyclothem

within fossil lineages. These data will be integrated with those from Arrow Canyon to provide a diversified standard of wide applicability.

Paleoecology

The question of Virgilian fusulinid paleoecology engenders both optimism and frustration—the former because we can readily demonstrate that environmental controls exist and the latter because we do not understand them as well as we would like to. Much of the difficulty lies in the fact that our material, collected many years ago, was not sampled with the study of ecology in mind. Further, many samples were processed to destruction in the past, and what has served admirably for stratigraphic study is found wanting for the broader objectives of today. Nevertheless, a number of facts have become apparent, and some relationships are hinted at in a tantalizing manner. They certainly will provide direction for more definitive efforts in the future.

First of all there are gross environmental constraints which are quite familiar. In an intracratonic setting in which sea level fluctuates and depositional environments shift in cyclical fashion, there are obvious parts of the regimen which are totally unsuited to the fusulinids--the coals and nonmarine sediments, for example. Even within the marine portions of the cyclothem there are differences in lithology, bathymetry, turbidity, etc. which affect fusulinid distribution. In the so-called "Representative Kansas Cyclothem" (Fig. 7), fusulinids are generally attributed to the Middle Limestone or the offshore limestone at (or near, depending upon one's interpretation of the black, fissile shales) maximum transgression. The regressive or Upper Limestone is usually characterized as algal and perhaps oolitic at the top. Actually, fusulinids can be found in both transgressive and regressive shales and limestones, although the open marine conditions are most attractive. The salient questions are first, whether the same fusulinids inhabit all the marine portions of a given cycle, and second, whether they are laterally consistent in their distribution. The answer to both appears to be negative.

The most conclusive evidence comes from study of lateral distribution, and there are several examples of faunal variability within the same stratigraphic unit. On a fairly large scale, it can be seen that the Plattsmouth Limestone in southern Kansas contains large, inflated Triticites of beedei - plummeri - cullomensis type, whereas in Nebraska the same unit is the type level for T. secalicus, a very different species. This suggests either a miscorrelation or a change in biofacies. Fortunately, we have similar, well-documented data from other horizons, including an earlier detailed investigation in which the Toronto Limestone was traced through Kansas and found to exhibit clear cut distribution patterns for species of Triticites and Kansanella (Fig. 8). Unfortunately, there seems at present to be no simple relationship to lithology or to some quantifiable parameter. Nevertheless, lateral changes are a fact and will have to be dealt with in the future.

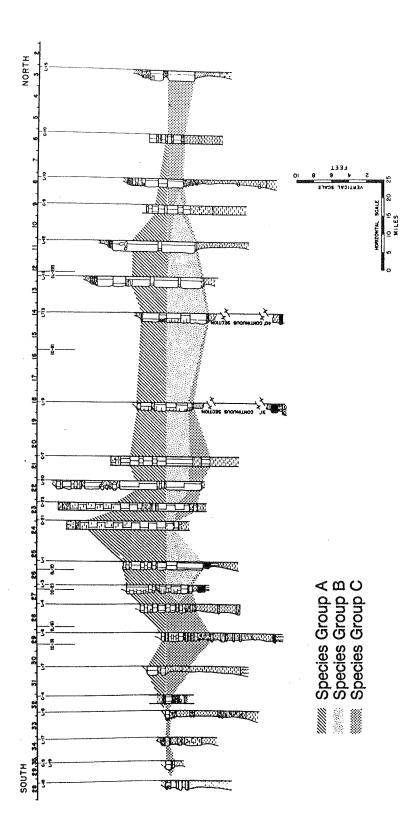


Figure 8. Toronto Fusulinid Distribution

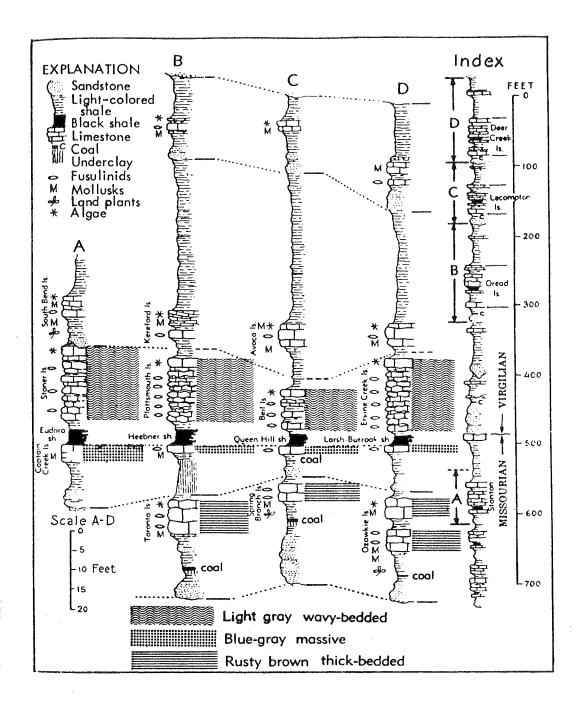
In the vertical or stratigraphic sense we also have evidence of fusulinid succession within the sedimentary cycle, but its significance is not clear because we do not know if the physical sequence in our examples represents a smooth continuum or whether it embraces minor fluctuations. Thus, it is not certain if the <u>Kansanella</u> which overlie the inflated <u>Triticites</u> in a Middle Limestone such as the Toronto represent deeper water or a slight regression before maximum transgression is achieved. As indicated above, corroborative information is lacking in our material.

Several of our distinctive morphotypes are recurrent in the Virgil, just as are the physical units comprising the cyclothems. Bearing in mind the concept of functional morphology, we plotted the stratigraphic distribution of these morphotypes regardless of taxonomic identification. The three morphologic groups recognized are first; the fusiform to cyclindrical, lightly fluted species of Triticites including T. secalicus, T. oryziformis, T. postoryziformis, and T. pseudoryziformis; second, the inflated, robust, moderately fluted species of Triticites including T. beedei, T. plummeri, T. bungerensis, T. postcallosus, T. happyhollowensis, and T. subventricosus; and, finally, the thin-walled, highly fluted forms with axial filling referable to various species of Kansanella, Dunbarinella, Leptotriticites, and possibly Triticites sp. D. These are, of course, different taxa, but they exhibit basic similarities in gross morphology and presumably they may have lived in similar environments.

Comparison of the distribution patterns reveals a strong, although not perfect, tendency toward mutual exclusion, suggesting a significant ecological bias. Also, since we did not differentiate samples within members of formations, the exceptions may prove to be more apparent than real. In any case, ecologic patterns appear to be emerging, however poorly they may be understood.

There has been much discussion of megocyclothems and the apparent correspondence of individual cycles in successive units. Placing the Oread, Lecompton and Deer Creek megacyclothems side by side (Fig. 9) illustrates the comparable nature of the various units, such as the correspondence of the Plattsmouth, Beil and Ervine Creek limestones. Since our fusulinid morphotypes also exhibit well-defined recurrent patterns, we attempted to correlate their distribution with that of the corresponding lithic units. In short, if the Plattsmouth, Beil and Ervine Creek are ecologically comparable units, they should contain similar morphotypes, if not the same species. Unfortunately, no definitive correlation is evident, suggesting either that the units are not truly comparable in our samples, or that the fusulinids do not respond to the same controls.

The fact that the fusulinids are so widespread and evolve so rapidly tends to obscure their ecologic sensitivity, which can become a significant predictive tool once understood. The factors controlling fusulinid



(After Moore, 1964)

Figure 9. Comparison of Megacyclothems

distribution are evidently complex, and sophisticated techniques may be required to unravel them. That remains the challenge to permit maximum utilization of the fusulinids.

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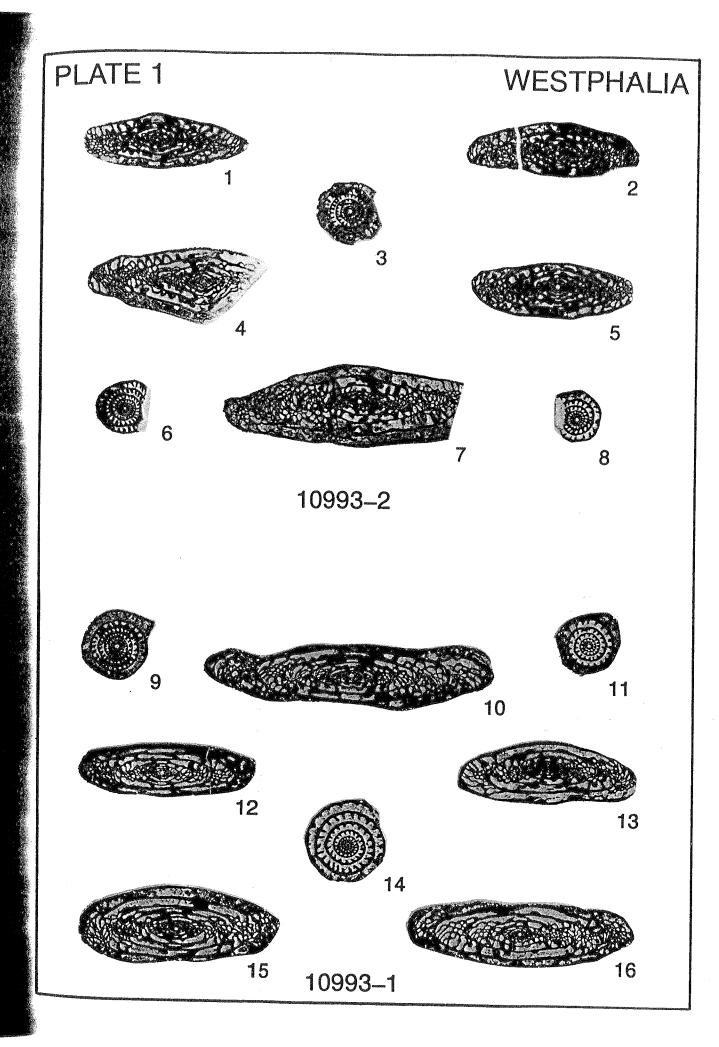
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APPENDIX

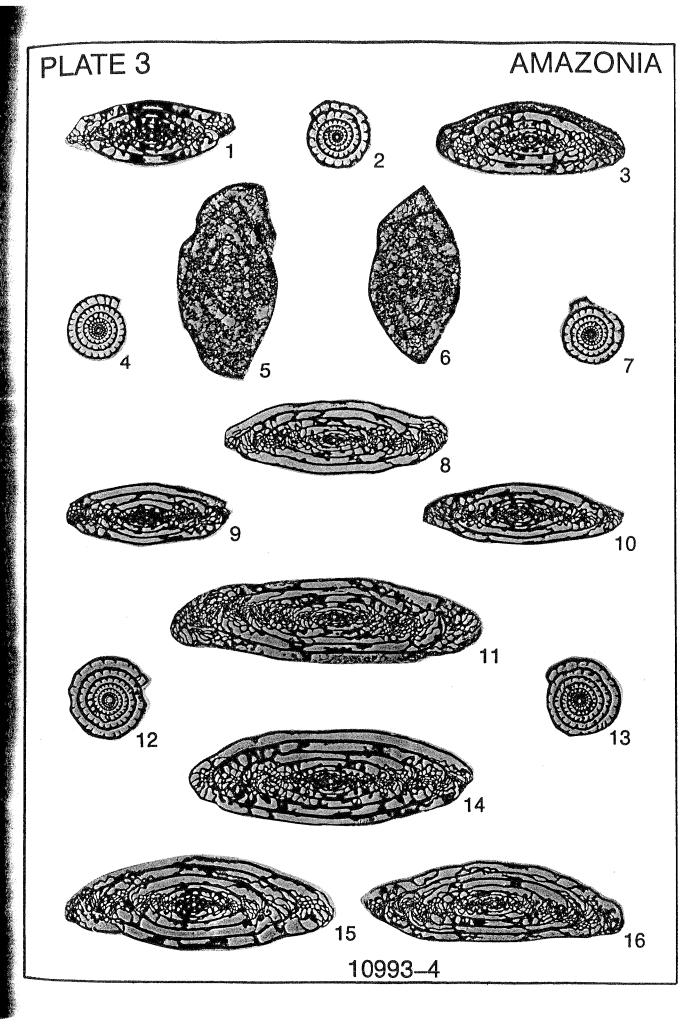
PLATES



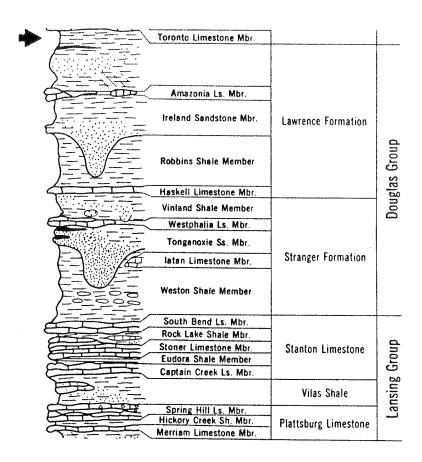
1	ר	•	the state of the s
*	-	Toronto Limestone Mbr.	
Formation	Lawrence Forn	Amazonia Ls. Mbr.	
Douglas Group		Robbins Shale Member Haskell Limestone Mbr.	
=======================================			
		Vinland Shale Member	
_]	Westphalia Ls. Mbr.	
		Tonganoxie Ss. Mbr.	
Formation	Stranger Form	latan Limestone Mbr.	$E \rightarrow \mathcal{F}$
		Weston Shale Member	
	***************************************	South Bend Ls. Mbr.	
		Rock Lake Shale Mbr.	
Limestone	Stanton Lime	Stoner Limestone Mbr.	
	Jeanton Linte	Eudora Shale Member	
5		Captain Creek Ls. Mbr.	
Limestone Cuon Shale	Vilas Sha		
	Plattsburg Lim	Spring Hill Ls. Mbr. Hickory Creek Sh. Mbr. Merriam Limestone Mbr.	

All Magnifications x10 Unless Otherwise Indicated Figs. 1-11 26482 Kansanella n.sp. [Haskell form]

PLATE 2 HASKELL 10 11 10993-3



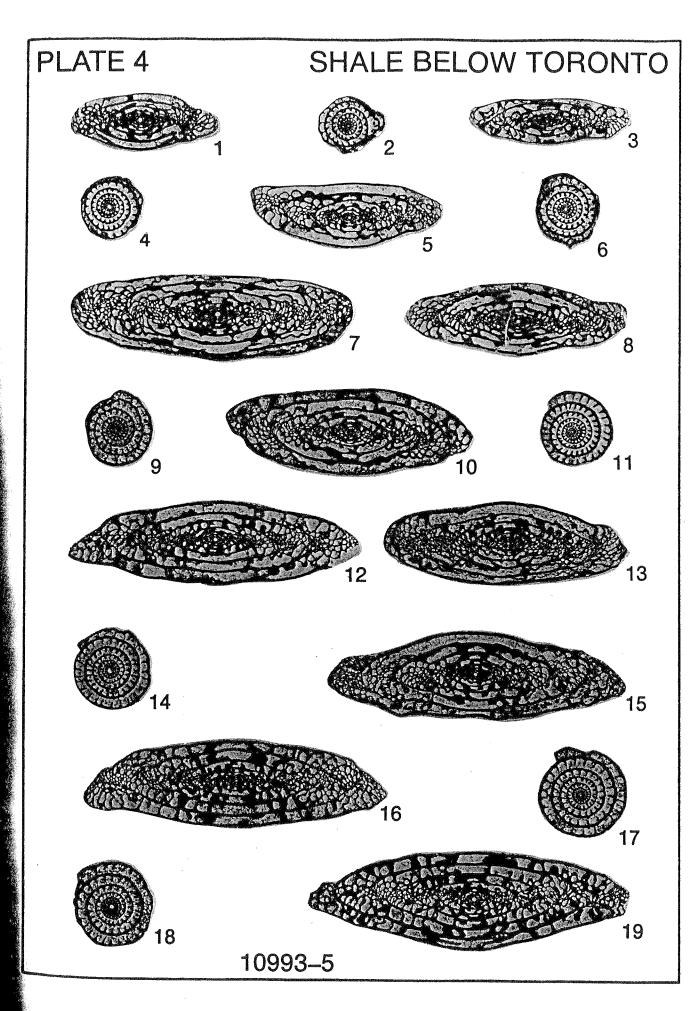
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Figs. 1-11 26496 <u>Triticites</u> <u>oryziformis</u> Newell, 1934

Figs. 12-19 26498 Triticites secalicus (Say, 1823) sensu Douglass, 196

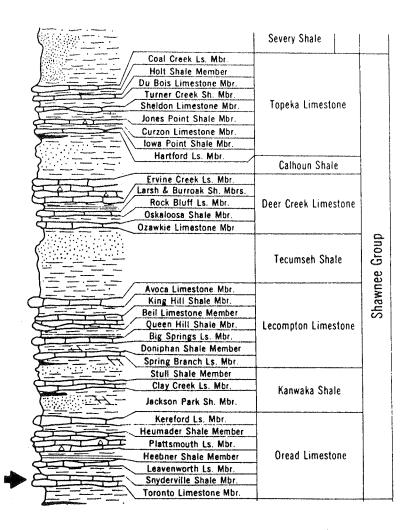


	Severy Shale	
Coal Creek Ls. Mbr.		
Holt Shale Member	1	-
Du Bois Limestone Mbr.	1	l
Turner Creek Sh. Mbr.	1	1
Sheldon Limestone Mbr.	Topeka Limestone	Į
Jones Point Shale Mbr.	1	
Curzon Limestone Mbr.	1 !	
Iowa Point Shale Mbr.	-	
Hartford Ls. Mbr.		
The second secon	Calhoun Shale	
Ervine Creek Ls. Mbr.		
Larsh & Burroak Sh. Mbrs.	1	
Rock Bluff Ls. Mbr.	Deer Creek Limestone	
Oskaloosa Shale Mbr.	7	
Ozawkie Limestone Mbr.	1	
		요
		5
Management comments	Tecumseh Shale	5
Security Sec		Shawnee Group
Avoca Limestone Mbr.		1 8
King Hill Shale Mbr.		*
Beil Limestone Member	-(-
Queen Hill Shale Mbr.	Lecompton Limestone	0,
Big Springs Ls. Mbr.	- Lecompton Ennestone	
Doniphan Shale Member	1	1
Spring Branch Ls. Mbr.		
Stull Shale Member		1
Clay Creek Ls. Mbr.		
Jackson Park Sh. Mbr.	- Kanwaka Shale	
Kereford Ls. Mbr.		-
Heumader Shale Member		
Plattsmouth Ls. Mbr.	-	
Heebner Shale Member	Oread Limestone	
Leavenworth Ls. Mbr.		
Snyderville Shale Mbr.	-	
Toronto Limestone Mbr.	7	
TOTOTIO ENTRESTON MOT.		

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Figs. 1-21 26502 Triticites precullomensis n.sp.

Figs. 22,23 26498 Triticites secalicus (Say, 1823) sensu Douglass, 1966

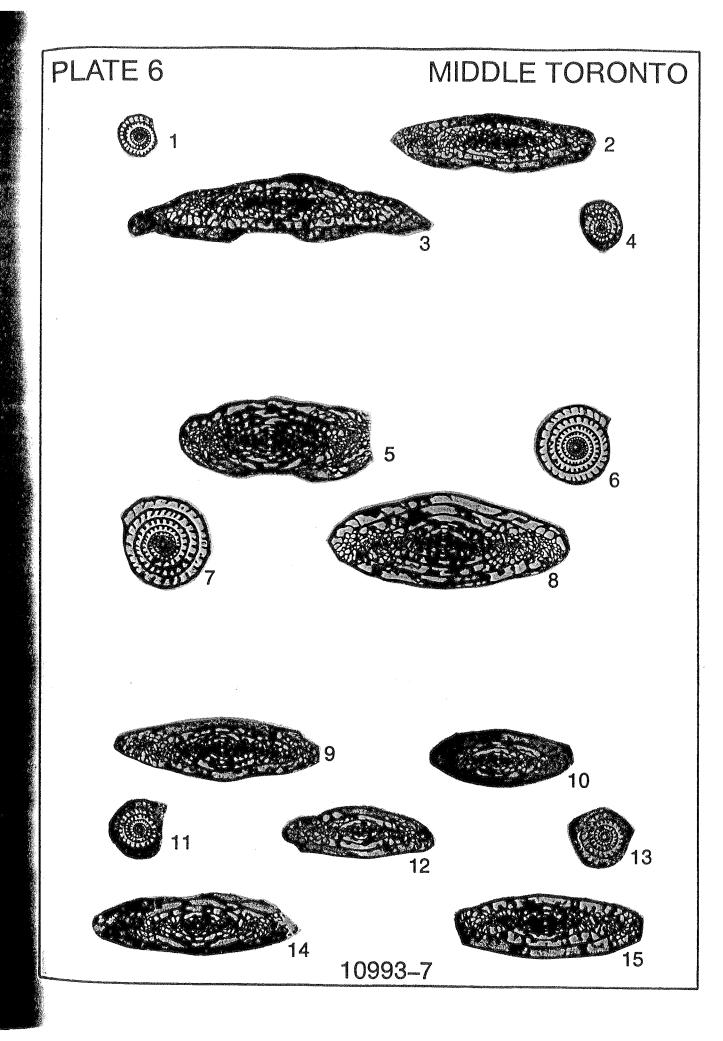


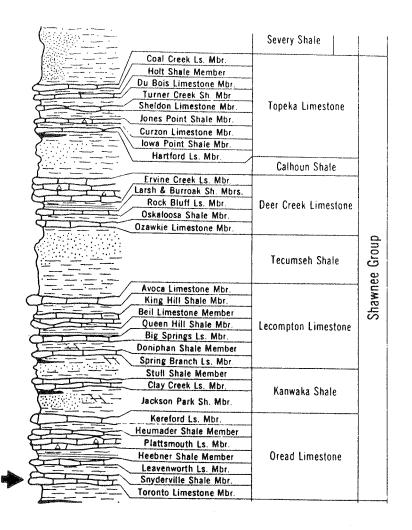
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Figs. 1-4 26615 Kansanella n.sp. [SP. 1]

Figs. 5-8 26501 Triticites ex. gr. T. cullomensis Dunbar & Condra, 197

Figs. 9-15 26502 Triticites precullomensis n.sp.





All Magnifications x10 Unless Otherwise Indicated Figs. 1-10 26615 Kansanella n.sp. [SP. 1]

PLATE 7

UPPER TORONTO





















UPPER SNYDERVILLE

	Severy Shale	1
Coal Creek Ls. Mbr.		
Holt Shale Member]	
Du Bois Limestone Mbr.		
Turner Creek Sh. Mbr.		İ
Sheldon Limestone Mbr.	Topeka Limestone	
Jones Point Shale Mbr.		
Curzon Limestone Mbr.		
lowa Point Shale Mbr.		
Hartford Ls. Mbr.		
	Cathoun Shale	
Ervine Creek Ls. Mbr.		
Larsh & Burroak Sh. Mbrs.	1	
Rock Bluff Ls. Mbr.	Deer Creek Limestone	1
Oskaloosa Shale Mbr.		ļ
Ozawkie Limestone Mbr.		
		2
	1	5
) in the same of t	Tecumseh Shale	ලි
4 4 1 Parameter Inspection Control of the Control o		ره
Avoca Limestone Mbr.		Shawnee Group
King Hill Shale Mbr.		₹
Beil Limestone Member	d	0
Queen Hill Shale Mbr.	Lecompton Limestone	
Big Springs Ls. Mbr.	-{	
Doniphan Shale Member	_	1
Spring Branch Ls. Mbr.		4
Stull Shale Member		1
Clay Creek Ls. Mbr.	Kanwaka Shale	1
Jackson Park Sh. Mbr.		
Kereford Ls. Mbr.		
Heumader Shale Member		1
Plattsmouth Ls. Mbr.		-
Heebner Shale Member	Oread Limestone	1
Leavenworth Ls. Mbr.		-
Snyderville Shale Mbr.	7	
Toronto Limestone Mbr.		1
TOTOTTO ETITESTOTE MOT.		+

All Magnifications x10 Unless Otherwise Indicated

Fig. 1 26502 <u>Triticites precullomensis n.sp.</u>

PLATE 8

UPPER SNYDERVILLE



10993-10

	()	Severy Shale	
	Coal Creek Ls. Mbr.		
	Holt Shale Member		
•	Du Bois Limestone Mbr.		
	Turner Creek Sh. Mbr Sheldon Limestone Mbr.	Topeka Limestone	
		Topeka Limestone	
	Jones Point Shale Mbr.		}
	Curzon Limestone Mbr.		
	lowa Point Shale Mbr.		İ
	Hartford Ls. Mbr.	Calhoun Shale	
		Calnoun Share	
	Ervine Creek Ls. Mbr.		
(Larsh & Burroak Sh. Mbrs.		
	Rock Bluff Ls. Mbr.	Deer Creek Limestone	
	Oskaloosa Shale Mbr.		
	Ozawkie Limestone Mbr.		
		Tecumseh Shale	Shawnee Group
	A		<u> </u>
	Avoca Limestone Mbr.		₹
(King Hill Shale Mbr.		rg P
	Beil Limestone Member		S
•	Queen Hill Shale Mbr.	Lecompton Limestone	ì
(Big Springs Ls. Mbr.		
	Doniphan Shale Member		
	Spring Branch Ls. Mbr.		
	Stull Shale Member		
	Clay Creek Ls. Mbr.	Kanwaka Shale	
	Jackson Park Sh. Mbr.		
	Kereford Ls. Mbr.		1
	Heumader Shale Member]	
Ş	Plattsmouth Ls. Mbr.]	
	Heebner Shale Member	Oread Limestone	
	Leavenworth Ls. Mbr.		
1	Snyderville Shale Mbr.	· ·	
•	Toronto Limestone Mbr.		

Figs. 1-7 26481 Kansanella ex. gr. K. pauper (Dunbar & Henbest, 1942)

Fig. 8 26489 <u>Millerella</u> Gen. [x100]

Figs. 9-11 26493 <u>Schubertella</u> Gen. [9-10=x100; 11=x40]

Figs. 12-14 26523 Waeringella n.sp. [x25]

Figs. 15-27 26502 <u>Triticites precullomensis</u> n.sp.

PLATE 9 LEAVENWORTH 13 20 25 10993_11

		Severy Shale	1
	Coal Creek Ls. Mbr.		
	Holt Shale Member		
	Du Bois Limestone Mbr.		
	Turner Creek Sh. Mbr.		
	Sheldon Limestone Mbr.	Topeka Limestone	
	Jones Point Shale Mbr.		
	Curzon Limestone Mbr.		ì
	lowa Point Shale Mbr.		i
	Hartford Ls. Mbr.	0.11	- [
		Calhoun Shale	l
	Ervine Creek Ls. Mbr.		Į
	Larsh & Burroak Sh. Mbrs.		
	Rock Bluff Ls. Mbr.	Deer Creek Limestone	
	Oskaloosa Shale Mbr.		
	Ozawkie Limestone Mbr.		
		Tecumseh Shale	Shawnee Group
	Avoca Limestone Mbr.		9
,	King Hill Shale Mbr.		1 €
'	Beil Limestone Member		-5
	Queen Hill Shale Mbr.	Lecompton Limestone	0,
	Big Springs Ls. Mbr.	Lecompton Emicatone	
	Doniphan Shale Member	1	
	Spring Branch Ls. Mbr.		
	Stull Shale Member		1
	Clay Creek Ls. Mbr.	1	
	Jackson Park Sh. Mbr.	Kanwaka Shale	
	Kereford Ls. Mbr.		1
	Heumader Shale Member		
A. Carrier	Plattsmouth Ls. Mbr.		
	Heebner Shale Member	Oread Limestone	
	Leavenworth Ls. Mbr.	1	
	Snyderville Shale Mbr.		
			4

All Magnifications x10 Unless Otherwise Indicated

Figs. 1-16 26504 <u>Triticites beedei</u> Dunbar & Condra, 1927

	Severy Shale	
Coal Creek Ls. Mbr.		İ
Holt Shale Member	1	1
Du Bois Limestone Mbr.		ļ
Turner Creek Sh. Mbr	3	
Sheldon Limestone Mbr	Topeka Limestone	
Jones Point Shale Mbr.		İ
Curzon Limestone Mbr.		
lowa Point Shale Mbr.		
Hartford Ls. Mbr.		1
American Street, and the stree	Calhoun Shale	
Ervine Creek Ls. Mbr.]
Larsh & Burroak Sh. Mbrs.	_	ĺ
Rock Bluff Ls. Mbr.	Deer Creek Limestone	ļ
Oskaloosa Shale Mbr.	· ·	
Ozawkie Limestone Mbr.		
	Tecumseh Shale	Shawnee Group
Avoca Limestone Mbr.		<u> </u>
King Hill Shale Mbr.	†	**
Beil Limestone Member		
Queen Hill Shale Mbr.	Lecompton Limestone	0)
Big Springs Ls. Mbr.	Lecompton Emicstone	ļ
Doniphan Shale Member	1	İ
Spring Branch Ls. Mbr.	1	İ
Stuli Shale Member		1
Clay Creek Ls. Mbr.	1	1
Jackson Park Sh. Mbr.	Kanwaka Shale	
Kereford Ls. Mbr.		1
Heumader Shale Member	1	
Plattsmouth Ls. Mbr.]	
Heebner Shale Member	Oread Limestone	
Leavenworth Ls. Mbr.	1	
Snyderville Shale Mbr.	1	
Toronto Limestone Mbr.	1	
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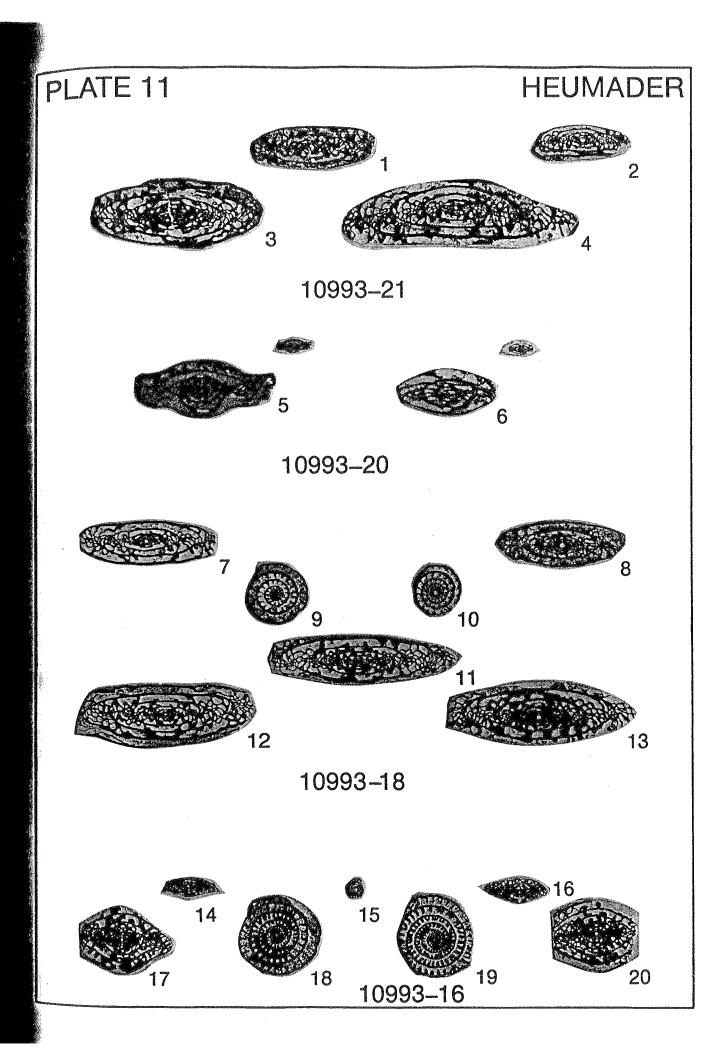
PLATE 11 All Magnifications x10 Unless Otherwise Indicated

Figs. 1-4, 7-13 26496 Triticites oryziformis Newell, 1934

Figs. 5,6 26494 Schubertella n.sp. [Heumader form] [x10 & x40]

Figs. 14-16 ?26481 Kansanella ex.gr. K. pauper (Dunbar & Henbest, 194)

Figs. 17-20 26504 Triticites beedei Dunbar & Condra, 1927



	Severy Shale	
Coal Creek Ls. Mbr.		
Holt Shale Member		
Du Bois Limestone Mbr.		
Turner Creek Sh. Mbr		
Sheldon Limestone Mbr.	Topeka Limestone	
Jones Point Shale Mbr.		
Curzon Limestone Mbr.		
lowa Point Shale Mbr.		
Hartford Ls. Mbr.		
State of the state	Calhoun Shale	
Ervine Creek Ls. Mbr.		
Larsh & Burroak Sh. Mbrs.		
Rock Bluff Ls. Mbr.	Deer Creek Limestone	
Oskaloosa Shale Mbr.		
Ozawkie Limestone Mbr.		
		므
		5
	Tecumseh Shale	5
The state of the s		بو
Avoca Limestone Mbr.		Shawnee Group
King Hill Shale Mbr.	1	*
Beil Limestone Member		==
Queen Hill Shale Mbr.	Lecompton Limestone	0,
Big Springs Ls. Mbr.	Lecompton Limestone	
Doniphan Shale Member	1	
Spring Branch Ls. Mbr.	1	}
Stull Shale Member		-
Clay Creek Ls. Mbr.		
Jackson Park Sh. Mbr.	Kanwaka Shale	
Kereford Ls. Mbr.		
Heumader Shale Member]	ļ
Plattsmouth Ls. Mbr.	1	
Heebner Shale Member	Oread Limestone	
Leavenworth Ls. Mbr.	1	1
Snyderville Shale Mbr.	1	
Toronto Limestone Mbr.	1	
·		

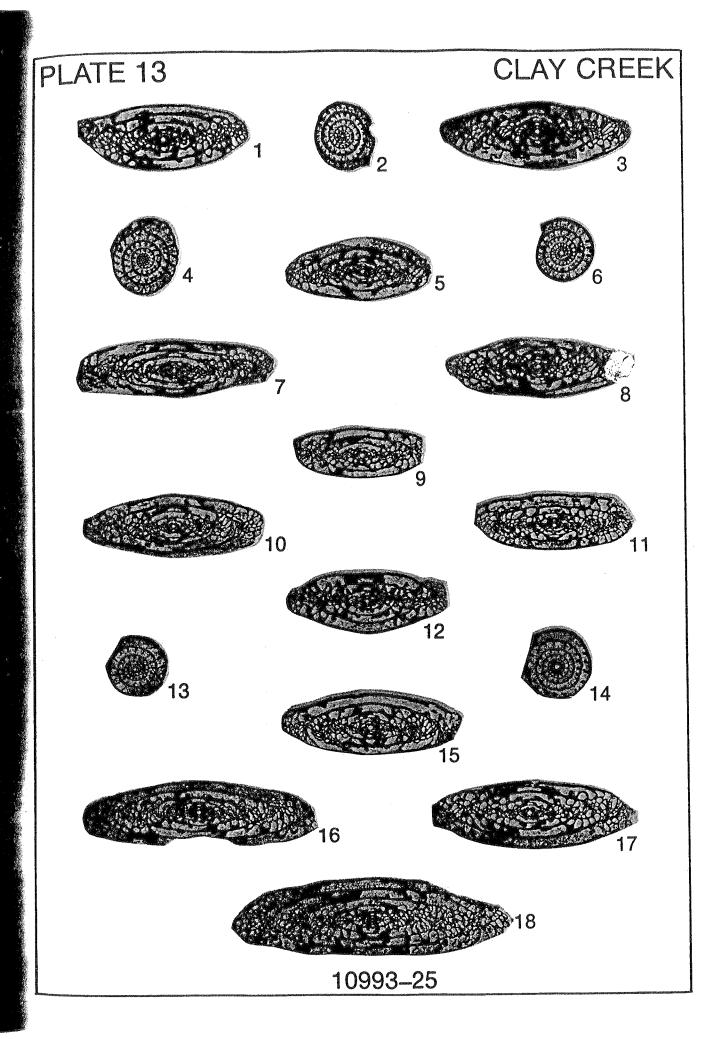
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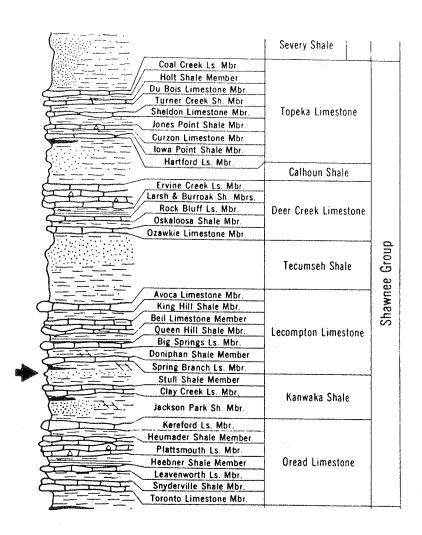
Figs. 1-19 26497 <u>Triticites</u> ex.gr. <u>T</u>. <u>oryziformis</u> Newell, 1934

	Severy Shale	
Coal Creek Ls. Mbr.		
Holt Shale Member		
Du Bois Limestone Mbr.	1	
Turner Creek Sh. Mbr.	1	
Sheldon Limestone Mbr.	Topeka Limestone	
Jones Point Shale Mbr.		
Curzon Limestone Mbr.		
lowa Point Shale Mbr.		
Hartford Ls. Mbr.]	
Notice to the second se	Calhoun Shale	
Ervine Creek Ls. Mbr.		
Larsh & Burroak Sh. Mbrs.		
Rock Bluff Ls. Mbr.	Deer Creek Limestone	
Oskaloosa Shale Mbr.		
Ozawkie Limestone Mbr.	1	
		9
	~	ē
Separation security security specializes specialized s	Tecumseh Shale	Ü
### ##################################		0,
Avoca Limestone Mbr.	-	Shawnee Group
King Hill Shale Mbr.	1	25
Beil Limestone Member	1	5
Queen Hill Shale Mbr.	Lecompton Limestone	٠.
Big Springs Ls. Mbr.	1	
Doniphan Shale Member	1	
Spring Branch Ls. Mbr.	1	
Stull Shale Member		İ
Clay Creek Ls. Mbr.	Namuela Chala	
Jackson Park Sh. Mbr.	- Kanwaka Shale	
Kereford Ls. Mbr.		1
Heumader Shale Member	_	
Plattsmouth Ls. Mbr.		
Heebner Shale Member	Oread Limestone	-
Leavenworth Ls. Mbr.]	
Snyderville Shale Mbr.		
Toronto Limestone Mbr.		1

All Magnifications xl0 Unless Otherwise Indicated

Figs. 1-18 26497 <u>Triticites</u> ex.gr. <u>T</u>. <u>oryziformis</u> Newell, 1934





All Magnifications x10 Unless Otherwise Indicated Figs. 1-16 26502 <u>Triticites precullomensis</u> n.sp.



























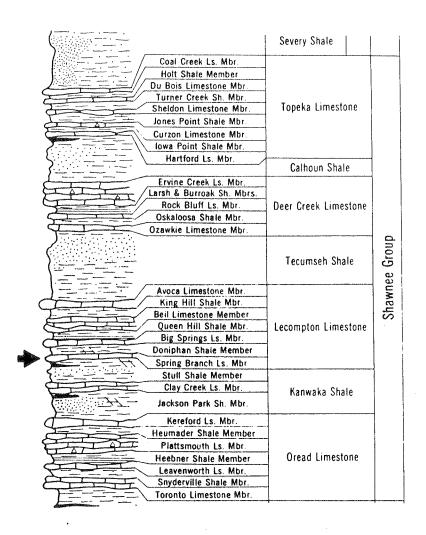




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PLATE 15

SPRING BRANCH

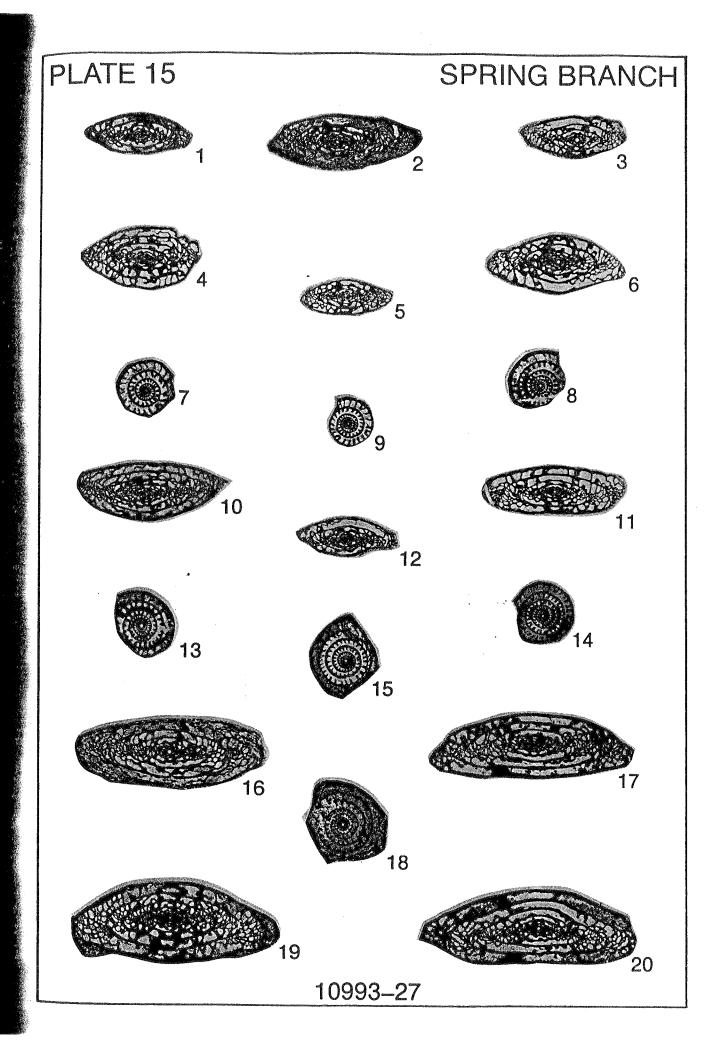


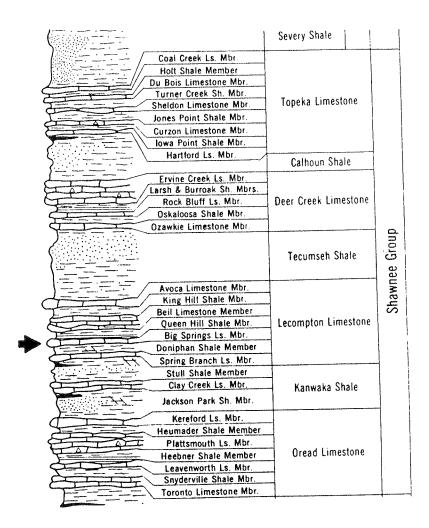
All Magnifications x10 Unless Otherwise Indicated

Figs. 1-11 26502 Triticites precullomensis n.sp.

Figs. 13-18,20 26497 Triticites ex.gr. T. oryziformis Newell, 1934

Fig. 19 26501 <u>Triticites</u> ex.gr. <u>T. cullomensis</u> Dunbar & Condra, 1927



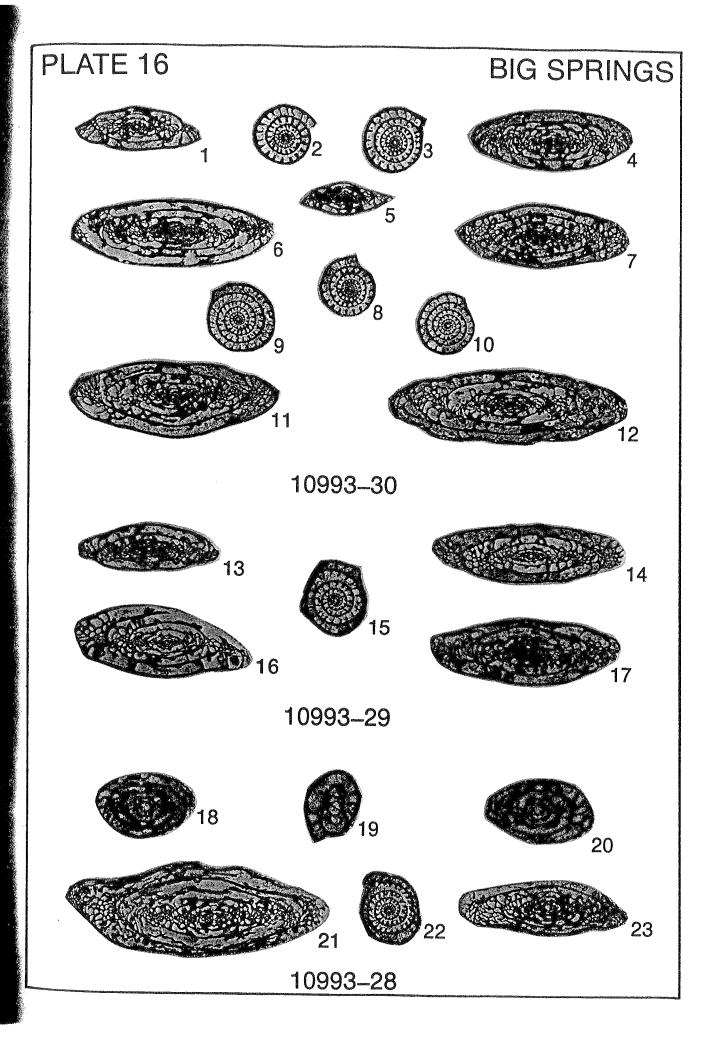


Figs. 1-17 26497 Triticites ex.gr. T. oryziformis Newell, 1934

Figs. 18,20 26492 Oketaella n.sp. [SP. A] [x40]

Fig. 19 26493 Schubertella Gen. [x100]

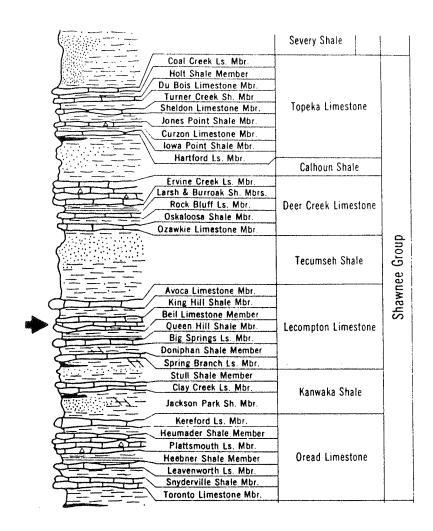
Figs. 21-23 26501 Triticites ex.gr. T. cullomensis Dunbar & Condra, 1927



		Severy Shale	1		
	Coal Creek Ls. Mbr.				
图》———王二/	Holt Shale Member				
	Du Bois Limestone Mbr.				
	Turner Creek Sh. Mbr	[
	Sheldon Limestone Mbr.	Topeka Limestone			
	Jones Point Shale Mbr.				
	Curzon Limestone Mbr.				
	lows Point Shale Mbr.	1			
	Hartford Ls. Mbr.				
}		Calhoun Shale			
	Ervine Creek Ls. Mbr.				
TATE OF THE PARTY	Larsh & Burroak Sh. Mbrs.				
	Rock Bluff Ls. Mbr.	Deer Creek Limestone			
	Oskaloosa Shale Mbr.				
QIII	Ozawkie Limestone Mbr.				
			ds		
		V	2		
1	Tecumseh Shale	Shawnee Group			
			ee		
\ <u></u>	Avoca Limestone Mbr.		Ş		
	King Hill Shale Mbr.		eg.		
	Beil Limestone Member	1	동		
	Queen Hill Shale Mbr.	Lecompton Limestone			
	Big Springs Ls. Mbr.				
Y=====================================	Doniphan Shale Member	7			
	Spring Branch Ls. Mbr.				
	Stull Shale Member		1		
	Clay Creek Ls. Mbr.	Kanwaka Shale			
	Jackson Park Sh. Mbr.	Natiwaka Stidle			
	Kereford Ls. Mbr.]		
	Heumader Shale Member	1			
	Plattsmouth Ls. Mbr.	7			
TA	Heebner Shale Member	Oread Limestone			
	Leavenworth Ls. Mbr.				
	Snyderville Shale Mbr.				
	Toronto Limestone Mbr.	7			

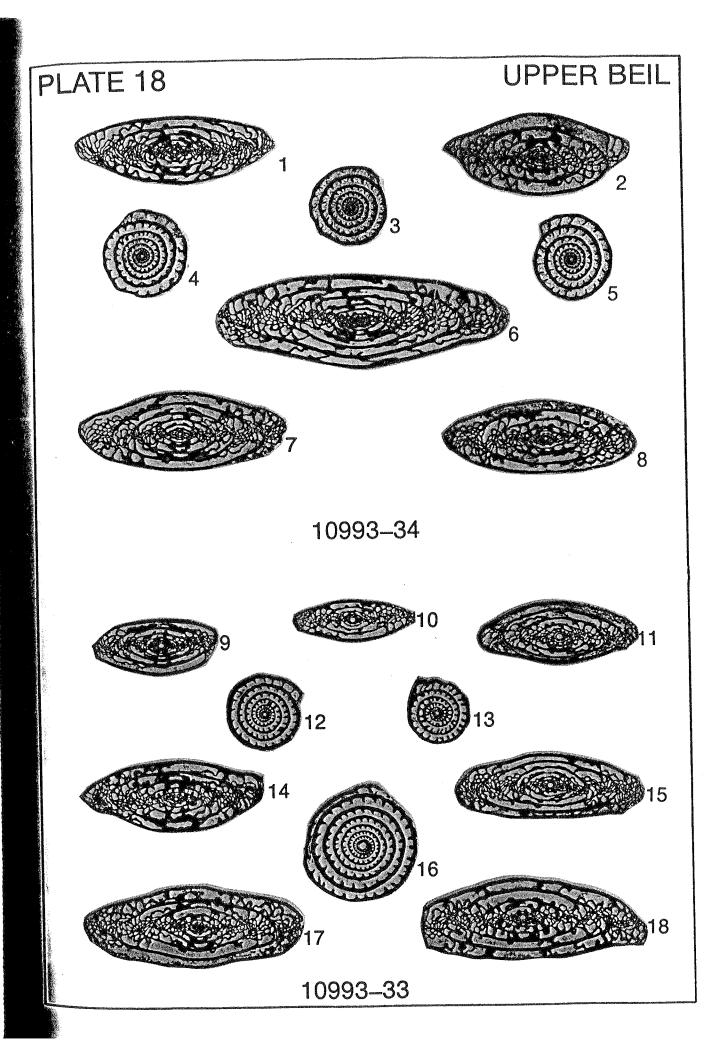
Figs. 1-9 26500 <u>Triticites cullomensis</u> Dunbar & Condra, 1927

Figs. 10-18 26616 Kansanella n.sp. [SP. 2]



Figs. 1-15,17,18 26499 <u>Triticites</u> ex.gr. <u>T. sealicus</u> (Say) sensu Douglass,

Fig. 16 26501 <u>Triticites</u> ex.gr. <u>T. cullomensis</u> Dunbar & Condra, 1997



()	g Milliande g Milliande Garages Mandriff C	Severy Shale	
	Coal Creek Ls. Mbr. Holt Shale Member Du Bois Limestone Mbr. Turner Creek Sh. Mbr Sheldon Limestone Mbr. Jones Point Shale Mbr. Curzon Limestone Mbr. lowa Point Shale Mbr. Hartford Ls. Mbr.	Topeka Limestone	
}	and a service of	Calhoun Shale	
	Ervine Creek Ls. Mbr. Larsh & Burroak Sh. Mbrs. Rock Bluff Ls. Mbr. Oskaloosa Shale Mbr. Ozawkie Limestone Mbr.	Deer Creek Limestone	
		Tecumseh Shale	Shawnee Group
•	Avoca Limestone Mbr. King Hill Shale Mbr. Beil Limestone Member Queen Hill Shale Mbr. Big Springs Ls. Mbr. Doniphan Shale Member Spring Branch Ls. Mbr.	Lecompton Limestone	Shawn
	Stull Shale Member Clay Creek Ls. Mbr. Jackson Park Sh. Mbr.	Kanwaka Shale	
	Kereford Ls. Mbr. Heumader Shale Member Plattsmouth Ls. Mbr. Heebner Shale Member Leavenworth Ls. Mbr. Snyderville Shale Mbr. Toronto Limestone Mbr.	Oread Limestone	

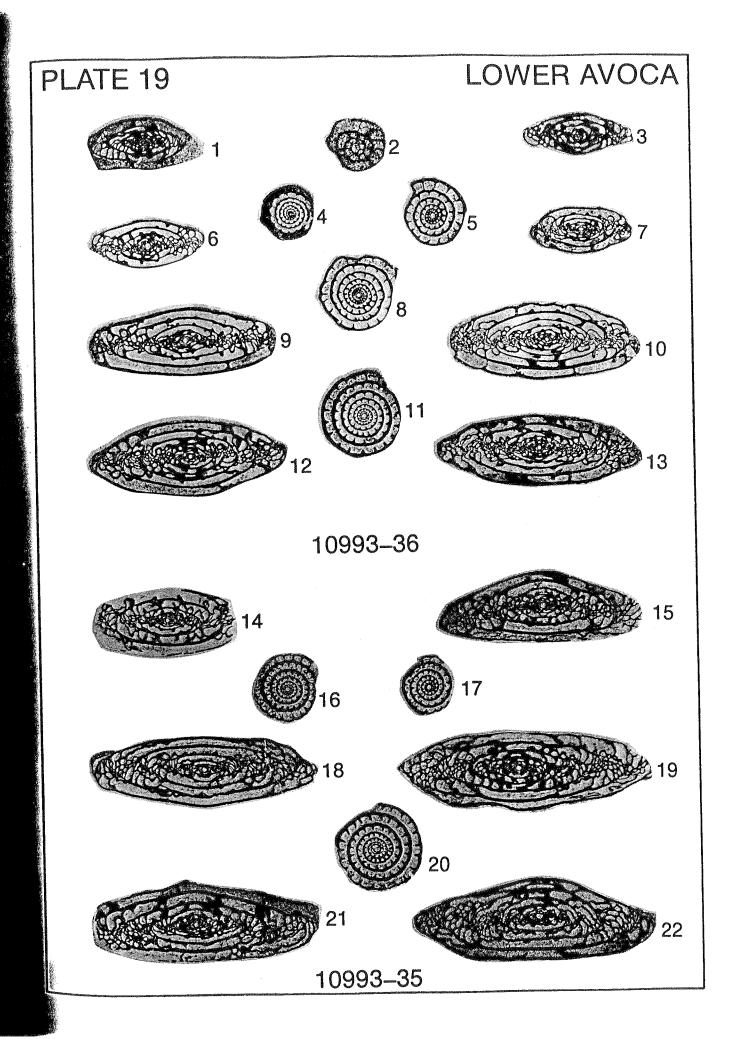
Figs. 1,3

Microspheric forms. Triticites sp.

Fig. 2 26493 Schubertella Gen. [x100]

Figs. 4-13 26497 <u>Triticites</u> ex.gr. <u>T</u>. <u>oryziformis</u> Newell, 1934

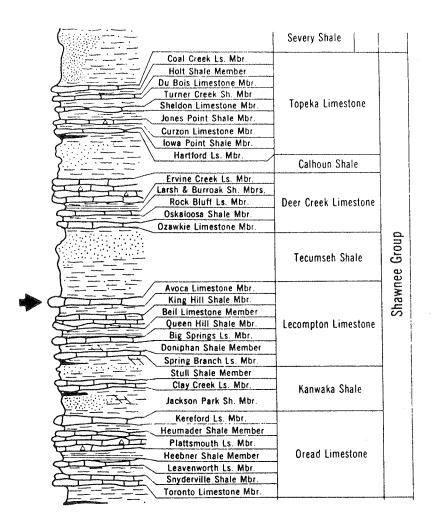
Figs. 14-22 26499 <u>Triticites</u> ex.gr. <u>T</u>. <u>secalicus</u> (Say) sensu Douglass, 1966



	Severy Shale	
Coal Creek Ls. Mbr.		
Holt Shale Member	\	
Du Bois Limestone Mbr.	i i	ļ
Turner Creek Sh. Mbr.		
Sheldon Limestone Mbr.	Topeka Limestone	
Jones Point Shale Mbr.		ļ
Curzon Limestone Mbr.		
lowa Point Shale Mbr.		1
Hartford Ls. Mbr.		1
Hartiord LS, Midt	Calhoun Shale	1
Ervine Creek Ls. Mbr.		[
Larsh & Burroak Sh. Mbrs.		
Rock Bluff Ls. Mbr.	Deer Creek Limestone	1
Oskaloosa Shale Mbr.	1	ļ
Ozawkie Limestone Mbr.	1	
		Shawnee Group
		2
	Tecumseh Shale	ပ
A manager samples and mana		ရွာ
Avoca Limestone Mbr.		Ş
King Hill Shale Mbr.	1	es es
Beil Limestone Member	1	5
Queen Hill Shale Mbr.	Lecompton Limestone	
Big Springs Ls. Mbr.	- Eccompton Emissions	Ì
Doniphan Shale Member	1	1
Spring Branch Ls. Mbr.	-	ļ
Stull Shale Member		1
		}
Clay Creek Ls. Mbr.	Kanwaka Shale	
Jackson Park Sh. Mbr.		1
Kereford Ls. Mbr.		
Heumader Shale Member		1
Plattsmouth Ls. Mbr.		
Heebner Shale Member	Oread Limestone	
Leavenworth Ls. Mbr.		
Snyderville Shale Mbr.		
Toronto Limestone Mbr.		
		•

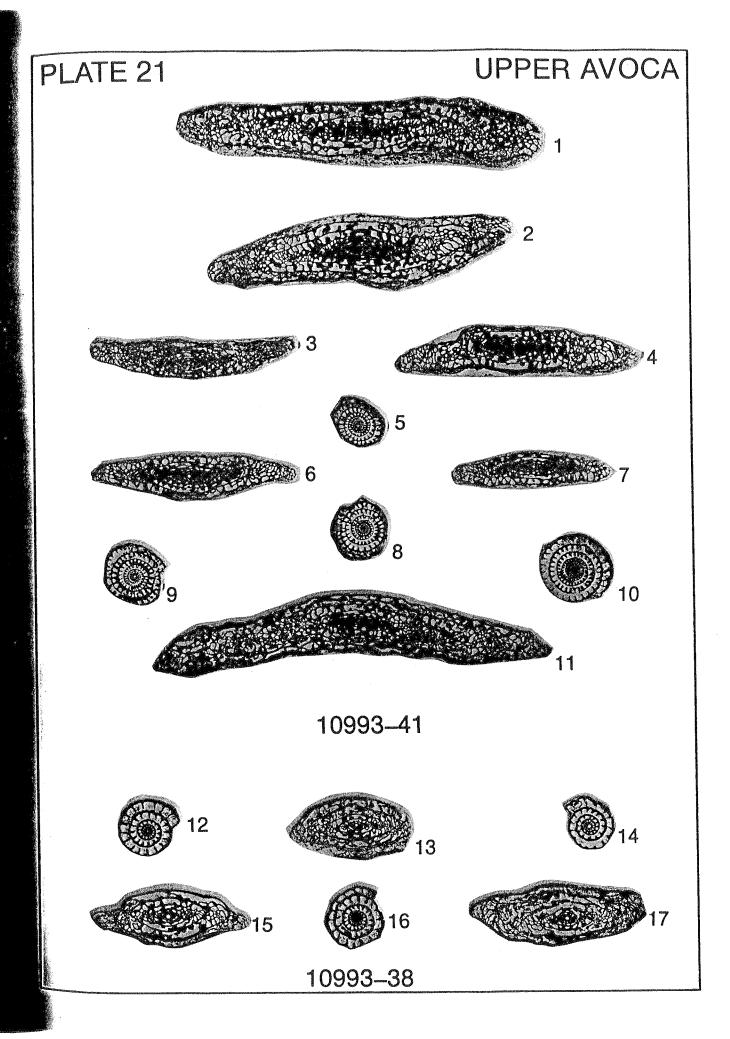
All Magnifications x10 Unless Otherwise Indicated

Figs. 1-18 26497 <u>Tricites</u> ex.gr. <u>T</u>. <u>oryziformis</u> Newell, 1934.



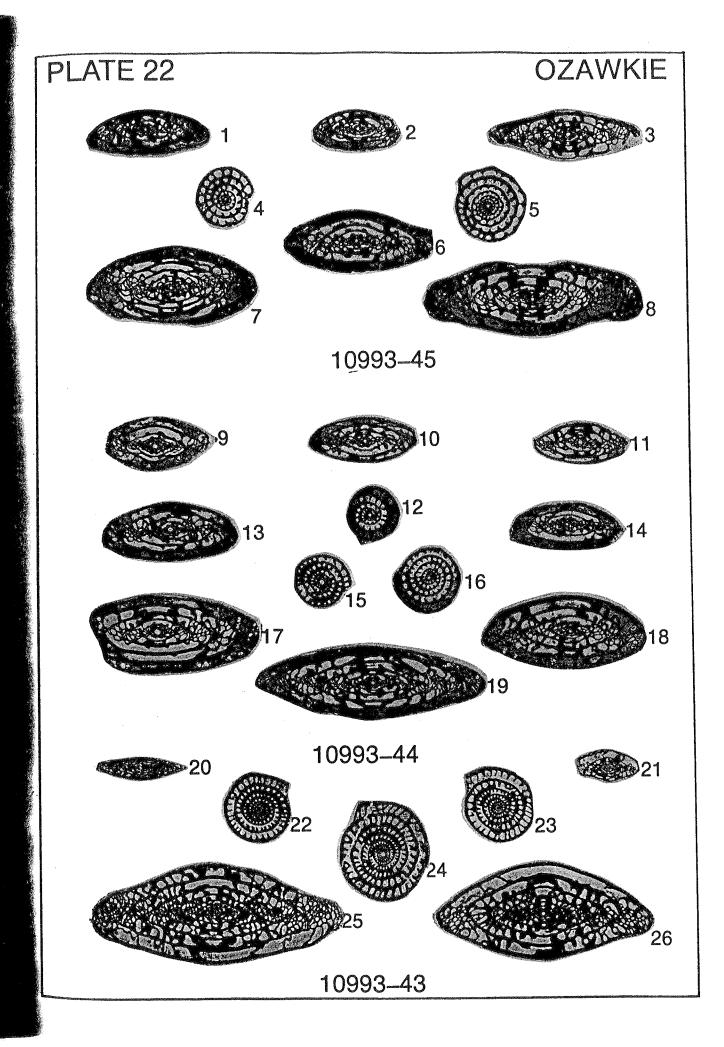
Figs. 1-11 26616 <u>Kansanella</u> n.sp. [SP. 2]

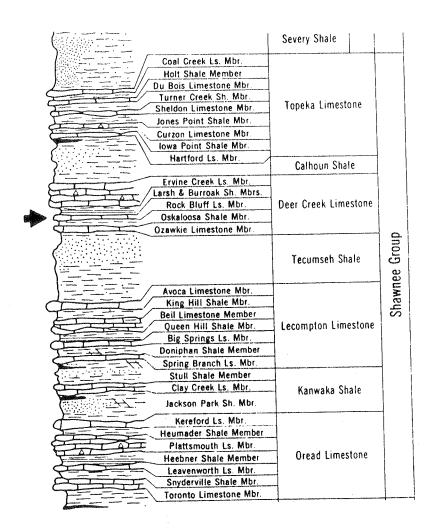
Figs. 12-17 26497 Triticites ex. gr. T. oryziformis Newell, 1934



	Severy Shale	
Coal Creek Ls. Mbr.		
// Holt Shale Member		
Du Bois Limestone Mbr.		
Turner Creek Sh. Mbr.	Tanalia Limostona	
Sheldon Limestone Mbr.	Topeka Limestone	
Jones Point Shale Mbr.		
Curzon Limestone Mbr.		
lowa Point Shale Mbr.		
Hartford Ls. Mbr.	Cathoun Shale	1
	Camoun Shale	
Ervine Creek Ls. Mbr.		
Larsh & Burroak Sh. Mbrs.		
Rock Bluff Ls. Mbr.	Deer Creek Limestone	
Oskaloosa Shale Mbr.		
Ozawkie Limestone Mbr.		1
	Tecumseh Shale	Shawnee Group
Avoca Limestone Mbr.		d le
King Hill Shale Mbr.	1	Š
Beil Limestone Member		l S
Queen Hill Shale Mbr.	Lecompton Limestone	
Big Springs Ls. Mbr.		
Doniphan Shale Member	1	
Spring Branch Ls. Mbr.		
Stull Shale Member		7
Clay Creek Ls. Mbr.	1 , , , , ,	1
Jackson Park Sh. Mbr.	Kanwaka Shale	
Kereford Ls. Mbr.		
Heumader Shale Member	_]	1
Plattsmouth Ls. Mbr.		
Heebner Shale Member	Oread Limestone	1
Leavenworth Ls. Mbr.	7	
Snyderville Shale Mbr.		
Toronto Limestone Mbr.	7	1

Figs. 1-19	26505	Triticites pierceae Kauffman & Roth, 1	966
Fig. 20	26480	Kansanella pauper (Dunbar & Henbest, 1	942)
Fig. 21	26495	Triticites Gen.	
E: 00 22m26	26504	Triticitas bandai (Dunhar & Condra 19	27)





Figs. 1-4 26478 Kansanella Gen. [primitive and/or juvenile]

Fig. 5 26495 <u>Triticites</u> Gen. [juvenile form]

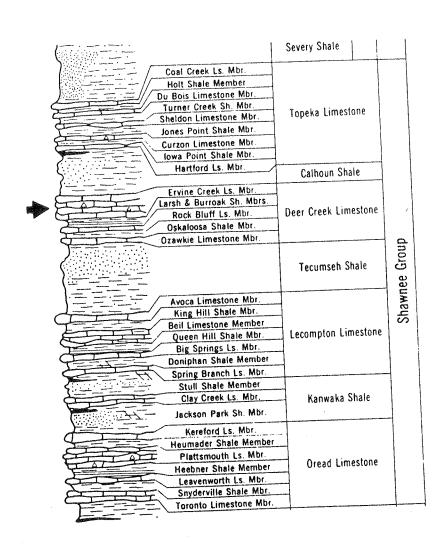
Figs. 6-11,17 26504 Triticites beedei Dunbar & Condra, 1927

Figs. 12-14 26499 <u>Triticites</u> ex. gr. <u>T. secalicus</u> (Say) sensu Douglass,

Figs. 15-16 26506 Triticites bungerensis Kauffman & Roth, 1966

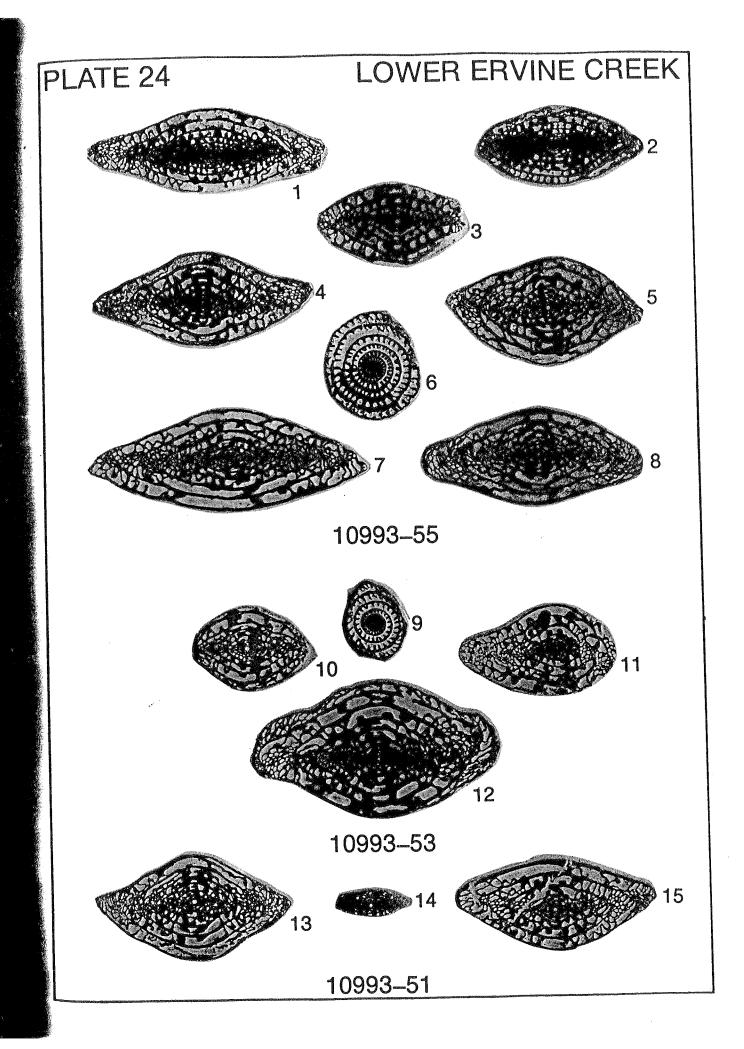
ROCK BLUFF PLATE 23 10993-47 10993-46

LOWER ERVINE CREEK



All Magnifications x10 Unless Otherwise Indicated

Figs. 1-2	22321	Dunbarinella ervinensis Thompson, 1942
Figs. 3-13,15	26504	Triticites <u>beedei</u> Dunbar & Condra, 1927
Fig. 14	26478	Kansanella Gen.



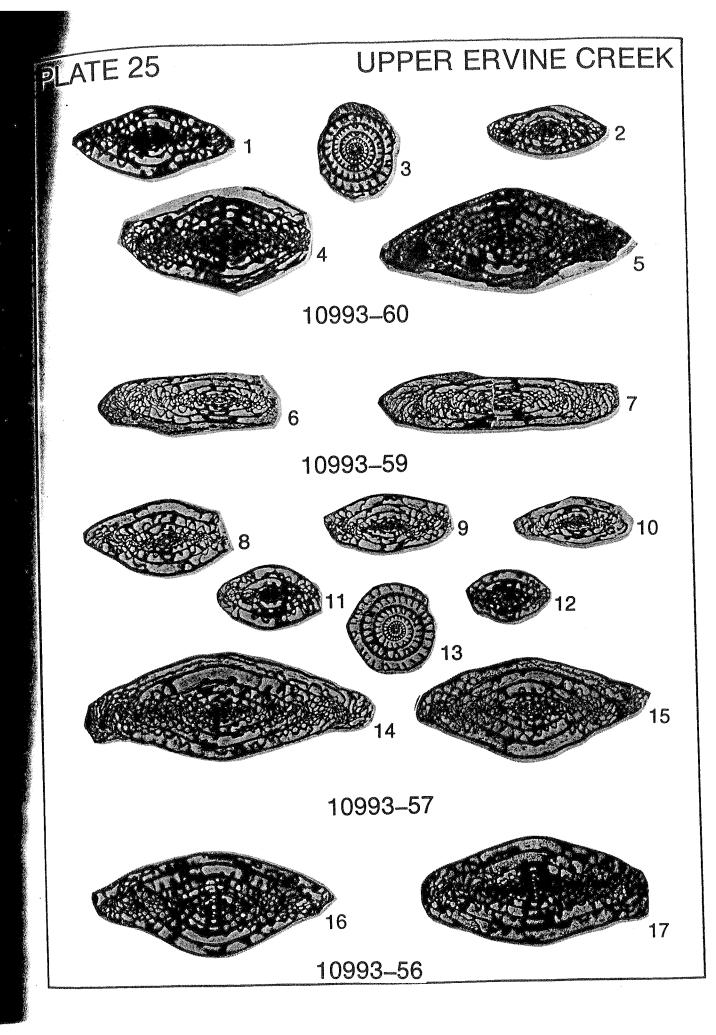
UPPER ERVINE CREEK

Severy Shale	
Topeka Limestone	
Calhoun Shale	
Deer Creek Limestone	
Tecumseh Shale	Shawnee Group
Lecompton Limestone	Shawı
Kanwaka Shale	
Oread Limestone	
	Calhoun Shale Deer Creek Limestone Tecumseh Shale Lecompton Limestone Kanwaka Shale

All Magnifications x10 Unless Otherwise Indicated

Figs.	1-5, 13-17	26504	<u>Triticites</u>	beedei Dunbar & Condra, 1927	(
Figs.	6-7	26497	Triticites	ex. gr. T. oryziformis Newell,	1934

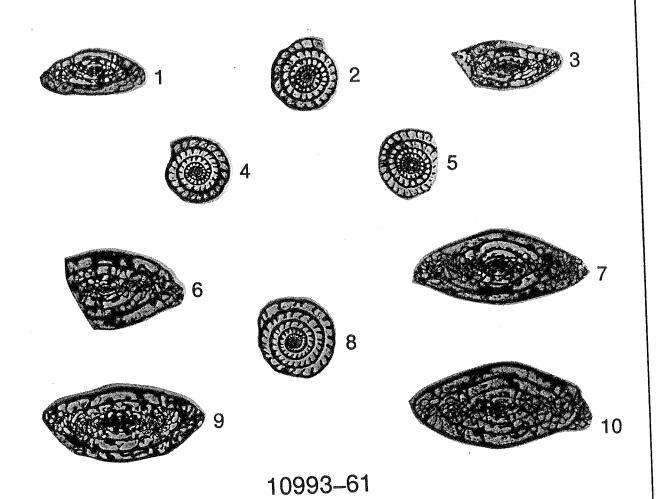
Figs. 8-12 26506 Triticites bungerensis Kauffman & Roth, 1966



(5)		Severy Shale	1
	Coal Creek Ls. Mbr.		
	Holt Shale Member		
	Turner Creek Sh. Mbr.	Topeka Limestone	
4	Sheldon Limestone Mbr.		
	Jones Point Shale Mbr.		İ
	Curzon Limestone Mbr.		
	lowa Point Shale Mbr.		
\ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \	Hartford Ls. Mbr.	011	
/	May-	Calhoun Shale	
	Ervine Creek Ls. Mbr.		
	Larsh & Burroak Sh. Mbrs.	Deer Creek Limestone	
9	Rock Bluff Ls. Mbr.		
	Oskaloosa Shale Mbr.		
Q I	Ozawkie Limestone Mbr.		-81
	<u></u>	Tecumseh Shale	Shawnee Group
	Avoca Limestone Mbr.		me
4===	King Hill Shale Mbr.		Shaw
	Beil Limestone Member	1	
	Queen Hill Shale Mbr.	Lecompton Limestone	
	Big Springs Ls. Mbr.	2000mpton 2miostono	
4====	Doniphan Shale Member	1	
	Spring Branch Ls. Mbr.	7	ļ
	Stull Shale Member		
حتق	Clay Creek Ls. Mbr.	1	
	Jackson Park Sh. Mbr.	Kanwaka Shale	
	Kereford Ls. Mbr.		1
	Heumader Shale Member	_	1
G A	Plattsmouth Ls. Mbr.		
Y = = =	Oread Limestone		
	Leavenworth Ls. Mbr.		
CTIT	Snyderville Shale Mbr.		
The same of the sa			

All Magnifications x10 Unless Otherwise Indicated

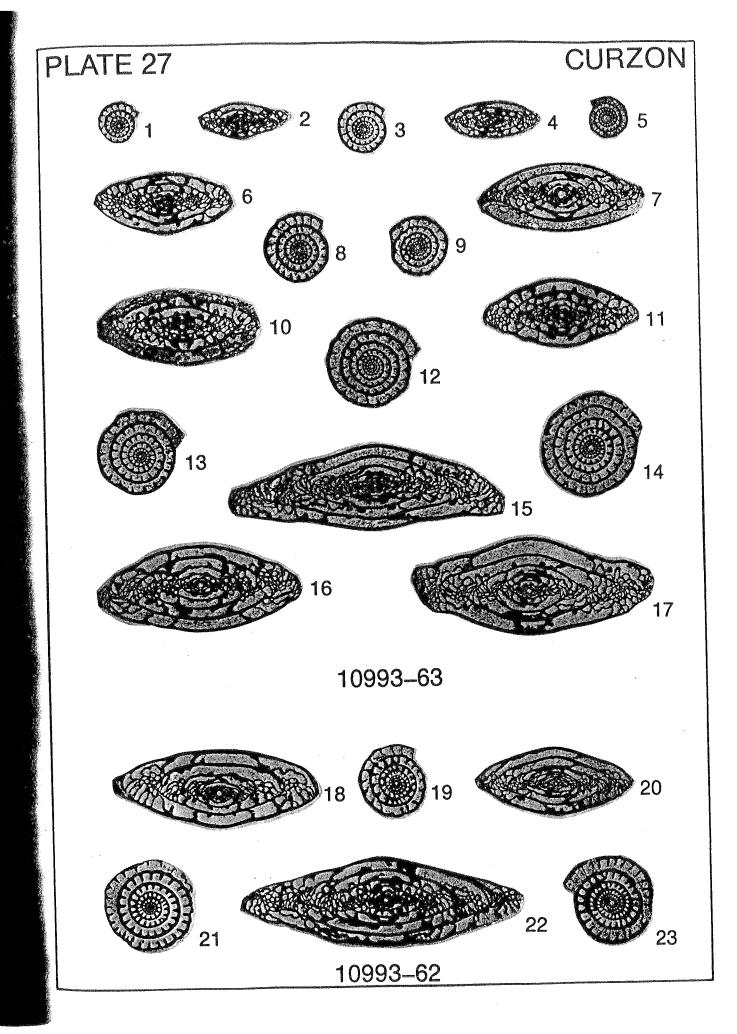
Figs. 1-10 26506 Triticites bungerensis Kauffman & Roth, 1966



James		,
WAR III	Severy Shale	
Coal Creek Ls. Mbr.		
Holt Shale Member		į
Du Bois Limestone Mbr.		
Turner Creek Sh. Mbr.]	
Sheldon Limestone Mbr.	Topeka Limestone	
Jones Point Shale Mbr.		
Curzon Limestone Mbr.		
lowa Point Shale Mbr.]	
Hartford Ls. Mbr.	}	
Secretary without mining	Calhoun Shale	
Ervine Creek Ls. Mbr.		
Larsh & Burroak Sh. Mbrs.		
Rock Bluff Ls. Mbr.	Deer Creek Limestone	
Oskaloosa Shale Mbr.		
Ozawkie Limestone Mbr.	1	
/ 884444488		Shawnee Group
	Tecumseh Shale	2
TOTAL CONTRACTOR CONTR	recumsen Shale	9
Antoniosis Addition Antonios Addition		မ
Avoca Limestone Mbr.		Ş
King Hill Shale Mbr.		20
Beil Limestone Member		22
Queen Hill Shale Mbr.	Lecompton Limestone	
Big Springs Ls. Mbr.		
Doniphan Shale Member		
Spring Branch Ls. Mbr.	1	
Stull Shale Member		
Clay Creek Ls. Mbr.	Kanwaka Shale	1
Jackson Park Sh. Mbr.	Natiwaka Stiate	
Kereford Ls. Mbr.		1
Heumader Shale Member	1	
Plattsmouth Ls. Mbr.	7	1
Heebner Shale Member	Oread Limestone	
Leavenworth Ls. Mbr.	1	
Snyderville Shale Mbr.	7	
Toronto Limestone Mbr.		
		+

Figs. 1-6, 8-11 26506 Triticites bungerensis Kauffman & Roth, 1966

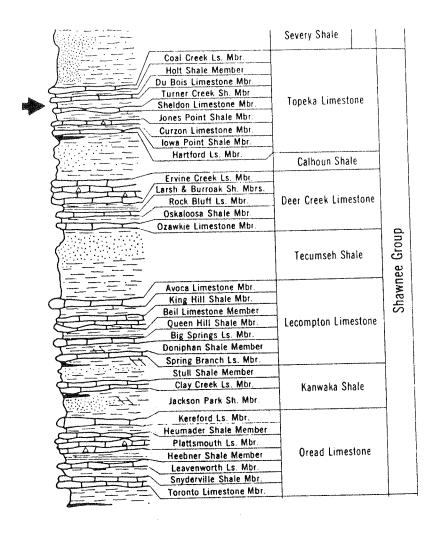
Figs. 7, 12-23 26505 Triticites pierceae Kauffman & Roth, 1966



(mission	Severy Shale	
Coal Creek Ls. Mbr. Holt Shale Member Du Bois Limestone Mbr. Turner Creek Sh. Mbr Sheldon Limestone Mbr. Jones Point Shale Mbr. Curzon Limestone Mbr. Iowa Point Shale Mbr.	Topeka Limestone	
Hartford Ls. Mbr.	Calhoun Shale	1
Ervine Creek Ls. Mbr. Larsh & Burroak Sh. Mbrs. Rock Bluff Ls. Mbr. Oskaloosa Shale Mbr. Ozawkie Limestone Mbr.	Deer Creek Limestone	
Ozawkie Limestone wo	Tecumseh Shale	Shawnee Group
Avoca Limestone Mbr. King Hill Shale Mbr. Beil Limestone Member Queen Hill Shale Mbr. Big Springs Ls. Mbr. Doniphan Shale Member Spring Branch Ls. Mbr	Lecompton Limestone	Shaw
Stull Shale Member Clay Creek Ls. Mbr. Jackson Park Sh. Mbr.	Kanwaka Shale	
Kereford Ls. Mbr. Heumader Shale Member Plattsmouth Ls. Mbr. Heebner Shale Member Leavenworth Ls. Mbr. Snyderville Shale Mbr. Toronto Limestone Mbr.	Oread Limestone	

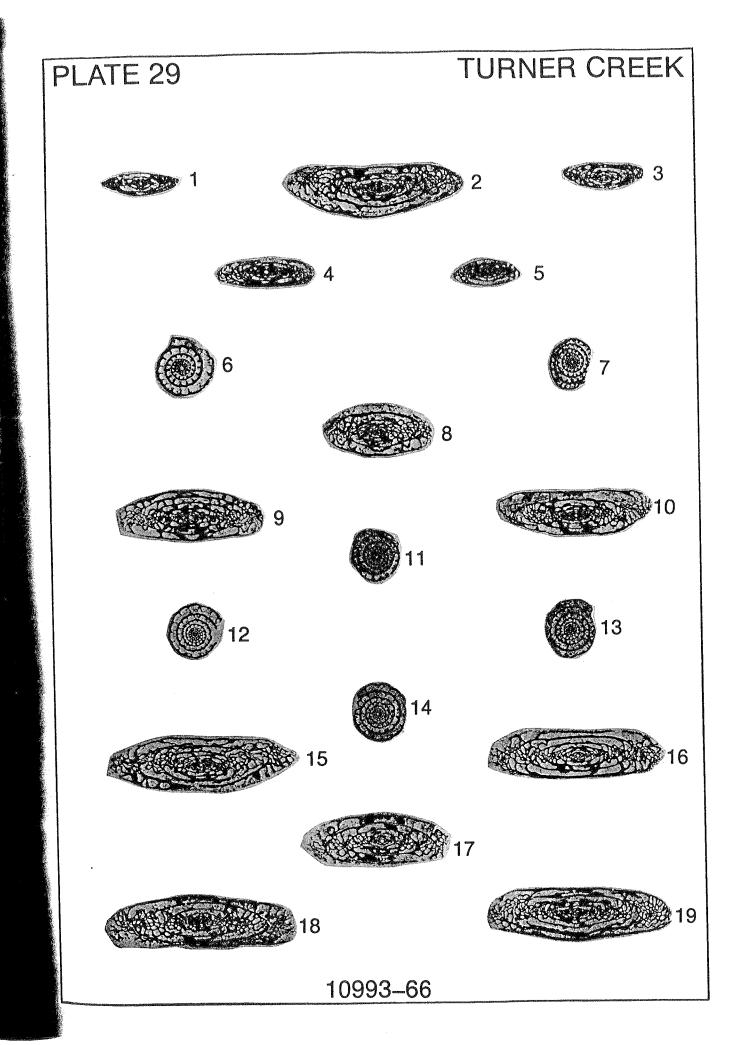
Figs. 1-17 26508 Triticites postoryziformis elongata n.sp. n.var.

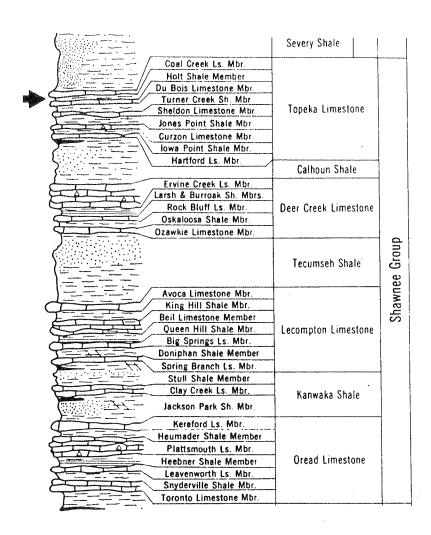
Figs. 18-19 26505 Triticites pierceae Kauffman & Roth, 1966



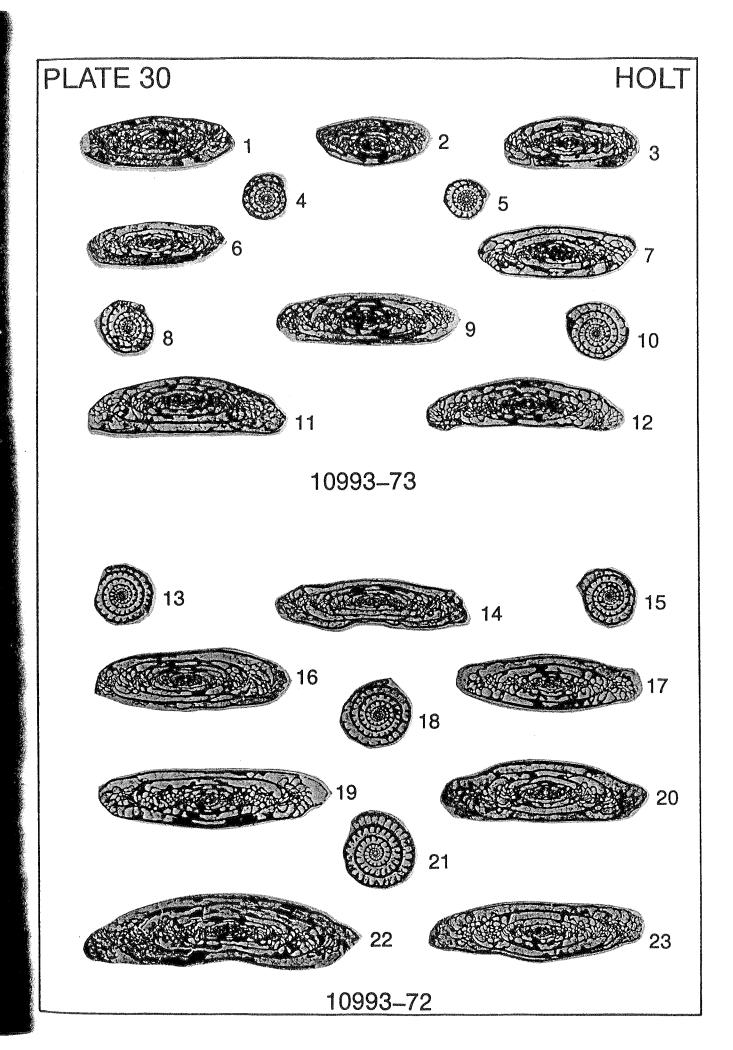
All Magnifications x10 Unless Otherwise Indicated

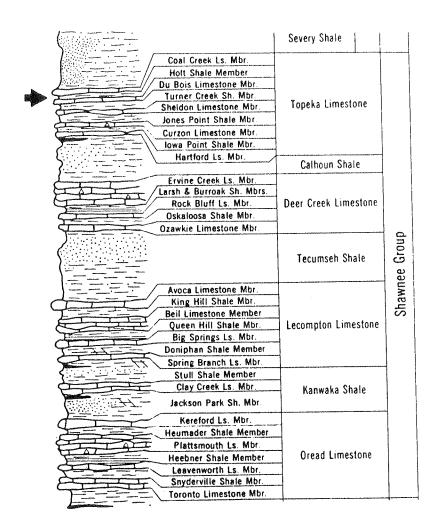
Figs. 1-19 26508 Triticites postoryziformis elongata n.sp., n.var.





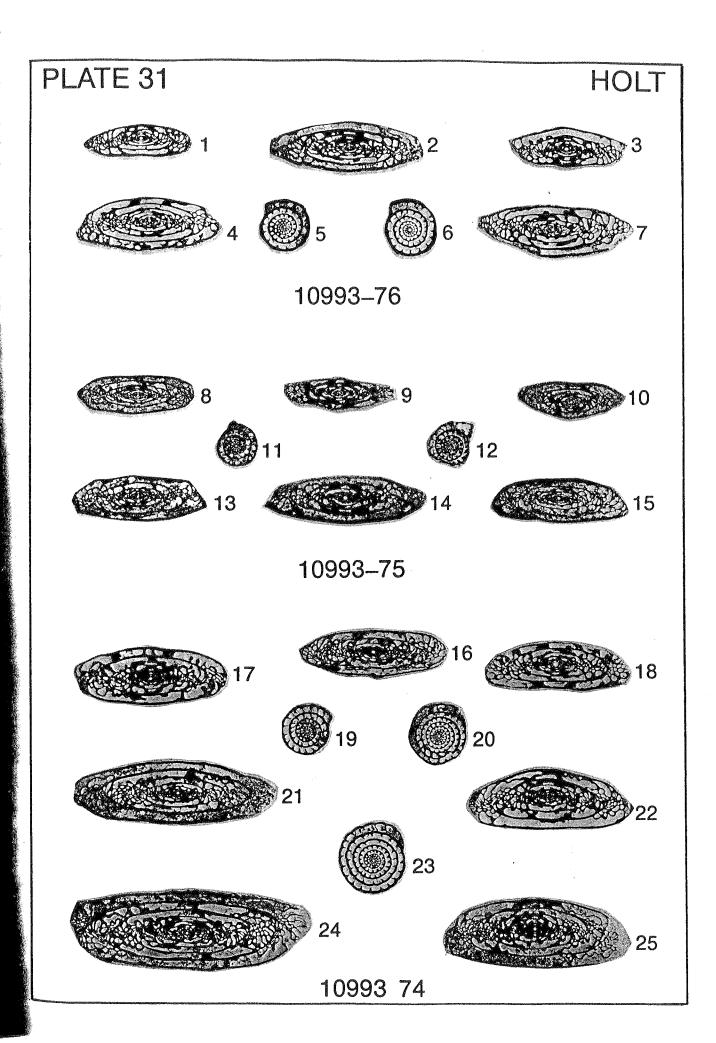
Figs. 1-23 26508 Triticites postoryziformis elongata n.sp., n.var.





Figs. 1-15 26508 Triticites postoryziformis elongata n.sp., n.var

Figs. 16-25 26509 Triticites pseudoryziformis n.sp.



Severy Shale	1
	1
Topeka Limestone Calhoun Shale	
Deer Creek Limestone	
Tecumseh Shale	Shawnee Group
Lecompton Limestone	Shawr
Kanwaka Shale	
r Oread Limestone	
	Calhoun Shale Deer Creek Limestone Tecumseh Shale Lecompton Limestone Kanwaka Shale

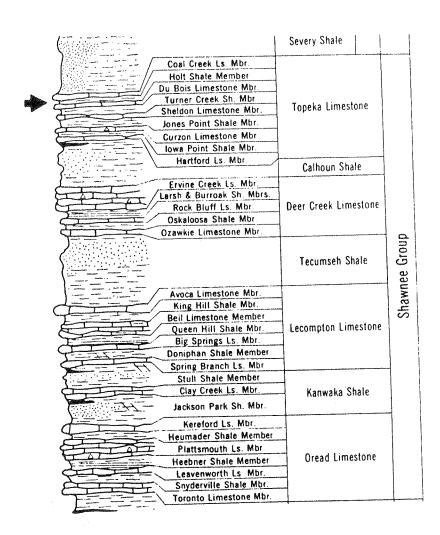
Figs. 1,2,4,5,12,14 26508 Triticites postoryziformis elongata n.sp., n.var

Fig. 3 Microspheric juvenile <u>Triticites</u>

Figs. 6,13 26514 Triticites n.sp. [SP.A]

Figs. 7-11, 15-22 26509 Triticites pseudoryziformis n.sp.

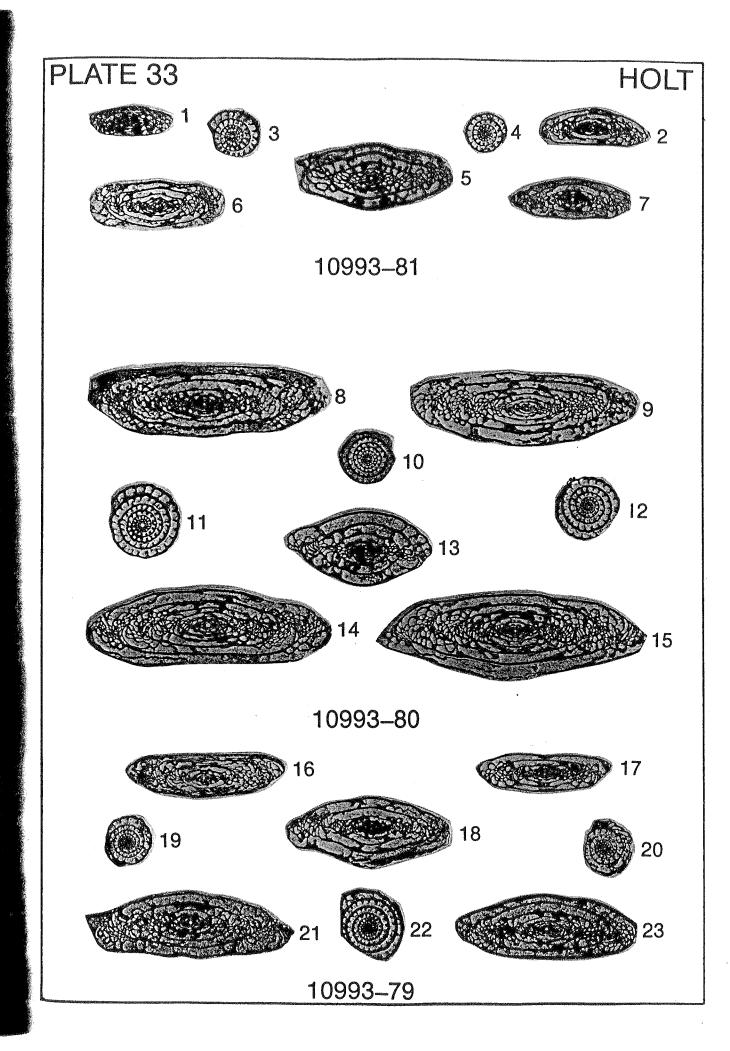
var.

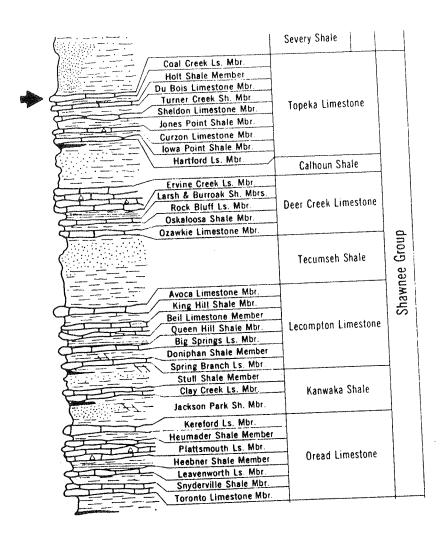


Figs. 1-4, 6,7,16,17,19,20 26508 Triticites postoryziformis elongata n.sp.,

Figs. 5,13,18 26514 <u>Triticites</u> n.sp. [SP.A]

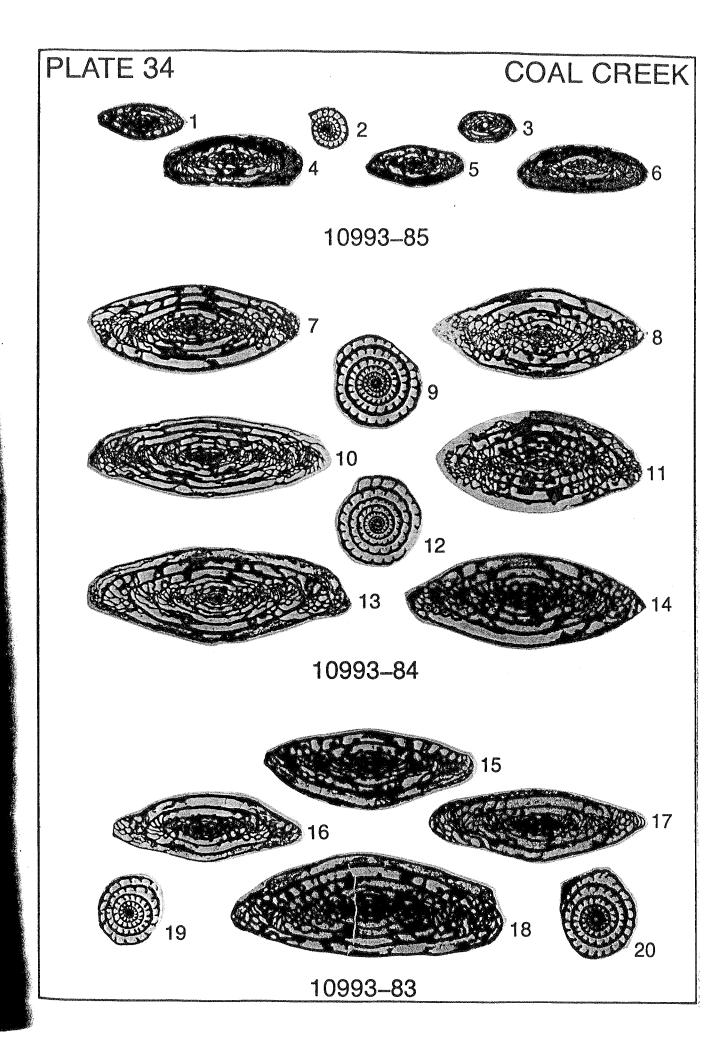
Figs. 8-12,14,15, 21-23 26509 Triticites pseudoryziformis n.sp.





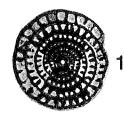
Figs. 1-6, 16,17,19 26514 Triticites n.sp. [SP.A]

Figs. 7-15, 18,20 26500 Triticites cullomensis Dunbar & Condra, 1927



Brownville Ls. Mbr. Pony Creek Shale Mbr. Grayhorse Ls. Mbr. Plumb Shale Member Nebraska City Ls. Mbr. French Creek Sh. Mbr. Jim Creek Ls. Mbr. Friedrich Shale Mbr. Grandhaven Ls. Mbr. Dry Shale Member Dover Limestone Mbr.	Wood Siding Formation Root Shale Stotler Limestone Pillsbury Shale	Richardson Subgroup	
Maple Hill Ls. Mbr. Wamego Shale Member	Zeandale Limestone		
Tarkio Limestone Mbr.	Willard Shale	dn	dn
Elmont Limestone Mbr. Harveyville Shale Mbr.	- Emporia Limestone	Nemaha Subgroup	Wabaunsee Group
Reading Limestone Mbr.	Auburn Shale	naha	bauns
Wakarusa Ls. Mbr. Soldier Creek Sh. Mbr. Burlingame Ls. Mbr.	Bern Limestone	Nen	Wa
Silver Lake Shale Mbr. Rulo Limestone Member			
Cedar Vale Shale Mbr.	Scranton Shale	dn	
Happy Hollow Ls. Mbr. White Cloud Shale Mbr.		Sacfox Subgroup	
Utopia Limestone Mbr. Winzeler Shale Member Church Limestone Mbr. Aarde Shale Member	Howard Limesto	Sacfox	
Bachelor Cr. Ls. Mbr.	Severy Shale		
	•		

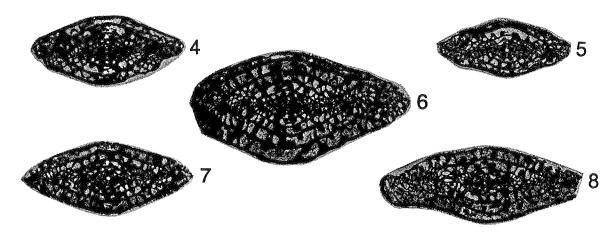
All Magnifications x10 Unless Otherwise Indicated Figs. 1-8 26511 <u>Triticites</u> postcallosus n.sp.







10993-90



10993-89

LOWER HAPPY HOLLOW

Brownville Ls. Mbr.			
Pony Creek Shale Mbr.	Wood Siding		
Grayhorse Ls. Mbr.	Formation		
Plumb Shale Member		E	1
Nebraska City Ls. Mbr.		250	
French Creek Sh. Mbr.	Root Shale	9	
Jim Creek Ls. Mbr.	KOOL Shale	S	1
Friedrich Shale Mbr.		0	
Grandhaven Ls. Mbr.	Stotler Limestone	qs	1
Dry Shale Member	2(0ffet Filliegrous	Richardson Subgroup	
Dover Limestone Mbr.	Dill Chalo	2	
)===V===	Pillsbury Shale	2	
Maple Hill Ls. Mbr.	Zeandale		
Warnego Shale Member	Limestone		
Tarkio Limestone Mbr.	Limestone	1	į
	Willard Shale		
	Millain Sugar	S	=
Elmont Limestone Mbr.	p	1 2	0.0
Harveyville Shale Mbr.	Emporia	I P	83
Reading Limestone Mbr.	Limestone] ∽	Se
Reading Limestons was	A. L Cholo	13	5
	Auburn Shale	l a	pa
Wakarusa Ls. Mbr.		Nemaha Subgroup	Wabaunsee Group
Soldier Creek Sh. Mbr.	Bern Limestone	: =	
Burlingame Ls. Mbr.			-
Silver Lake Shale Mbr.			
Rulo Limestone Member			
Cedar Vale Shale Mbr.	Scranton Shale	e <u>e</u>	L
Happy Hollow Ls. Mbr.		5	
White Cloud Shale Mbr.		one Suharoun	
Utopia Limestone Mbr.		ئِ ا	2
Winzeler Shale Member		ي امو	ğ
Church Limestone Mbr.	Howard Limest	טוופן ט	
Aarde Shale Member			
Bachelor Cr. Ls. Mbr.	\supset	-	
	Severy Shal	e	

All Magnifications x10 Unless Otherwise Indicated

Fig. 1 Fig. 2 Fig. 3 Figs. 4,14,16 Fig. 5 Fig. 6,9 Fig. 7,8,12,13,15,17	26513 26515 22321 26504 26512	Dunbarinella wildei Kauffman & Roth, 1966, Triticites happyhollowensis n.sp. [immatus Triticites n.sp. [SP.B] Dunbarinella ervinensis Thompson, 1942 Triticites beedei Dunbar & Condra, 1927 Triticites plummeri Dunbar & Condra, 1927 Triticites beedei Dunbar & Condra, 1927 Triticites happyhollowensis n.sp.
Fig. 10,11	20113	

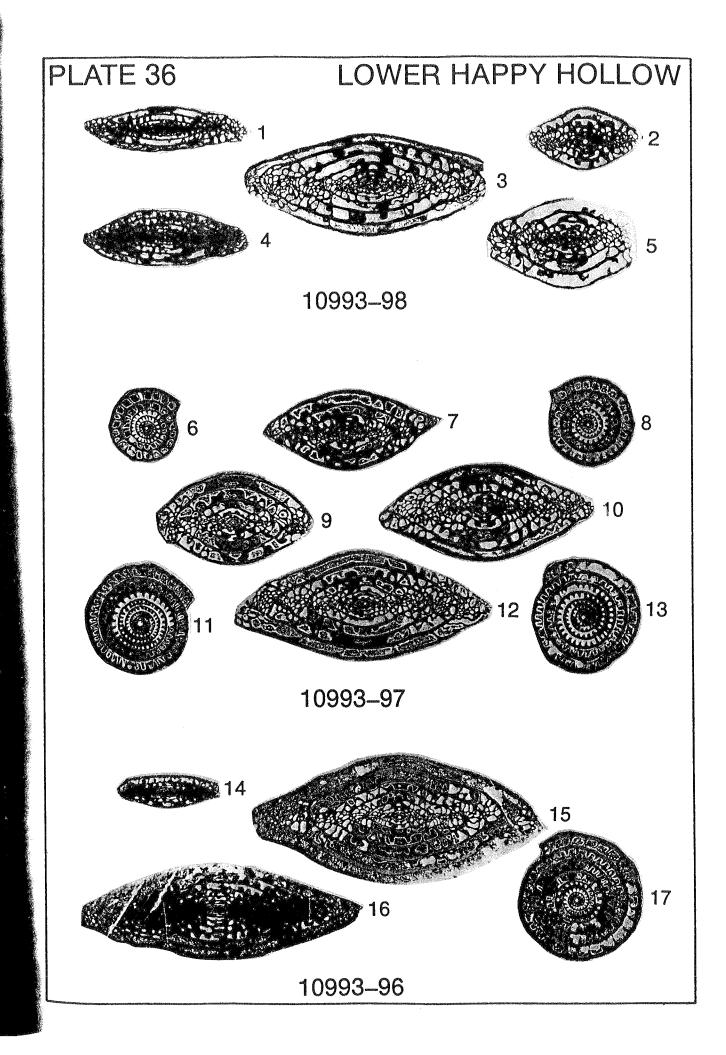


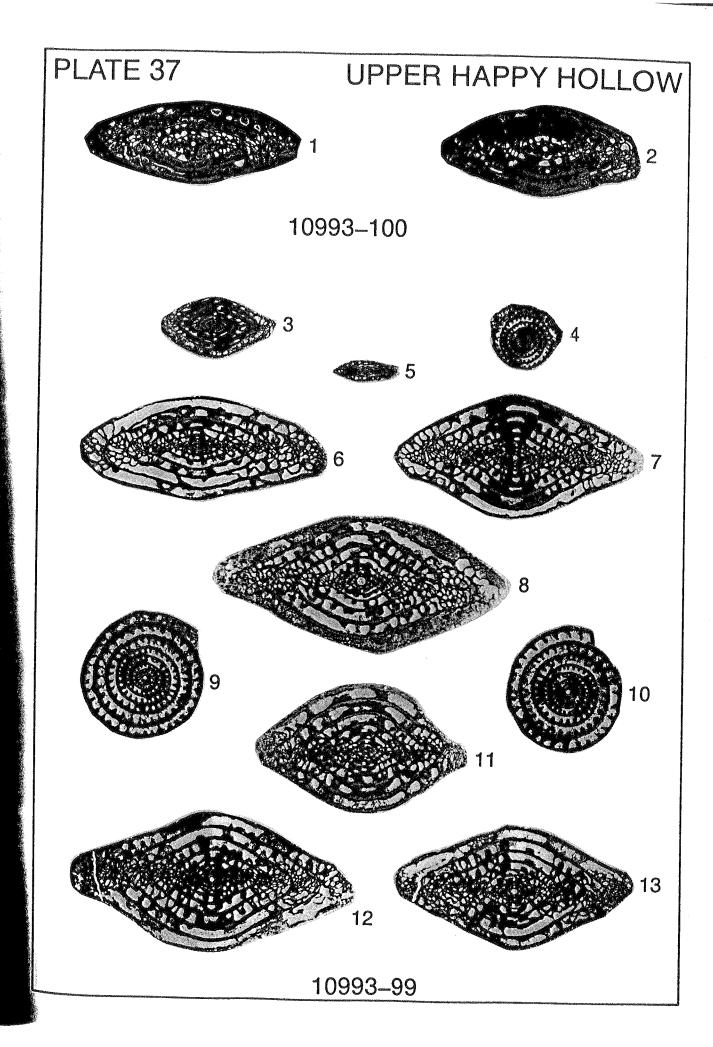
PLATE 37

UPPER HAPPY HOLLOW

		and a second second	- Andrewson
Brownville Ls. Mbr. Pony Creek Shale Mbr. Grayhorse Ls. Mbr. Plumb Shale Member Nebraska City Ls. Mbr.	Wood Siding Formation	roup	
French Creek Sh. Mbr. Jim Creek Ls. Mbr. Friedrich Shale Mbr.	Root Shale	Subg	
Grandhaven Ls. Mbr. Dry Shale Member Dover Limestone Mbr.	Stotler Limestone	Richardson Subgroup	
Dover Emissions mo.	Pillsbury Shale	Ric	
Maple Hill Ls. Mbr. Wamego Shale Member Tarkio Limestone Mbr	Zeandale Limestone		
	Willard Shale	ds	dn
Elmont Limestone Mbr. Harveyvijle Shale Mbr.	Emporia Limestone	Nemaha Subgroup	Wabaunsee Group
Reading Limestone Mbr.	Auburn Shale	laha	Sauns
Wakarusa Ls. Mbr. Soldier Creek Sh. Mbr.	Bern Limestone	Nen	Wat
Burlingame Ls. Mbr. Silver Lake Shale Mbr.			
Rulo Limestone Member			1
Cedar Vale Shale Mbr.	Scranton Shale	g	
Happy Hollow Ls. Mbr.	_	2	1
White Cloud Shale Mbr.		Sacfox Subgroup	
Utopia Limestone Mbr. Winzeler Shale Member		Color	
	Howard Limesto	ne¦ 💸	5
Church Limestone Mbr.			
Aarde Shale Member			1
Bachelor Cr. Ls. Mbr.	Severy Shale	:	

PLATE 37 All Magnifications x10 Unless Otherwise Indicated

Figs. 1,2	26516	Triticites n.sp. [SP.C]
Figs. 3,4	26617	Triticites [microspheric form]
Fig. 5	26477	Dunbarinella [immature specimen]
Fig. 6	26515	Triticites n.sp. [SP.B]
Figs. 7-10, 12,13		Triticites happyhollowensis n.sp.
Fig. 11	26512	Triticites plummeri Dunbar & Condra, 192



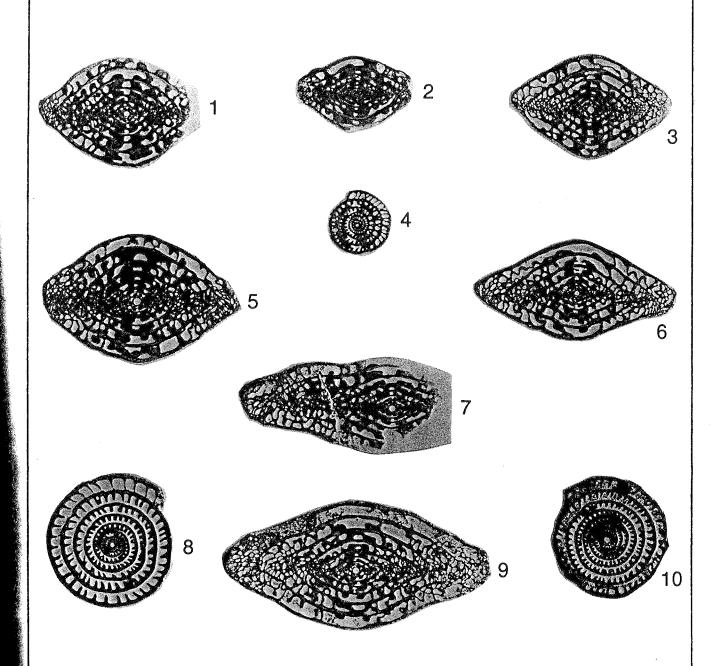
		-	-
Brownville Ls. Mbr.	:		
Pony Creek Shale Mbr.	Wood Siding		
Grayhorse Ls. Mbr.	Formation		
Plumb Shale Member		=	
Nebraska City Ls. Mbr.		2	
French Creek Sh. Mbr.	0 . 0 . 1	4	
Jim Creek Ls. Mbr.	Root Shale	22	
Friedrich Shale Mbr.		=	ì
Grandhaven Ls. Mbr.		SC	
Dry Shale Member	Stotler Limestone	Richardson Subgroup	
Dover Limestone Mbr.		Ë	
	Pillsbury Shale	20	
Maple Hill Ls. Mbr.	Zanadolo		
Wamego Shale Member	Zeandale		
Tarkio Limestone Mbr	Limestone		
	Willard Shale	۵.	a
Elmont Limestone Mbr.		Nemaha Subgroup	Wabaunsee Group
Company of the second of the s	Emporia	g	ပ
Harveyville Shale Mbr.	Limestone	S	8
Reading Limestone Mbr.		ro	IIS
	Auburn Shale	=	ag.
Wakarusa Ls. Mbr.		E	95
(Bern Limestone	2	3
Soldier Creek Sh. Mbr.	Dern Emicatoric	Ì	l i
Burlingame Ls. Mbr.		 	1
Silver Lake Shale Mbr.			
Rulo Limestone Member			1
Cedar Vale Shale Mbr.	Scranton Shale	a	
Happy Hollow Ls. Mbr.]	100	1
White Cloud Shale Mbr.		Sacfox Subgroup	
Illegia Limatoga Affr		×	
Utopia Limestone Mbr. Winzeler Shale Member	-	1 5	Ì
	Howard Limeston	SS	1
Church Limestone Mbr.	-		1
Aarde Shale Member			
Bachelor Cr. Ls. Mbr.	1 2 21 1	7	
	Severy Shale		

Figs. 1, 3-10 26513 Triticites happyhollowensis n.sp.

Figs. 2,4 26617 <u>Triticites</u> [microspheric form]

PLATE 38A

BURLINGAME

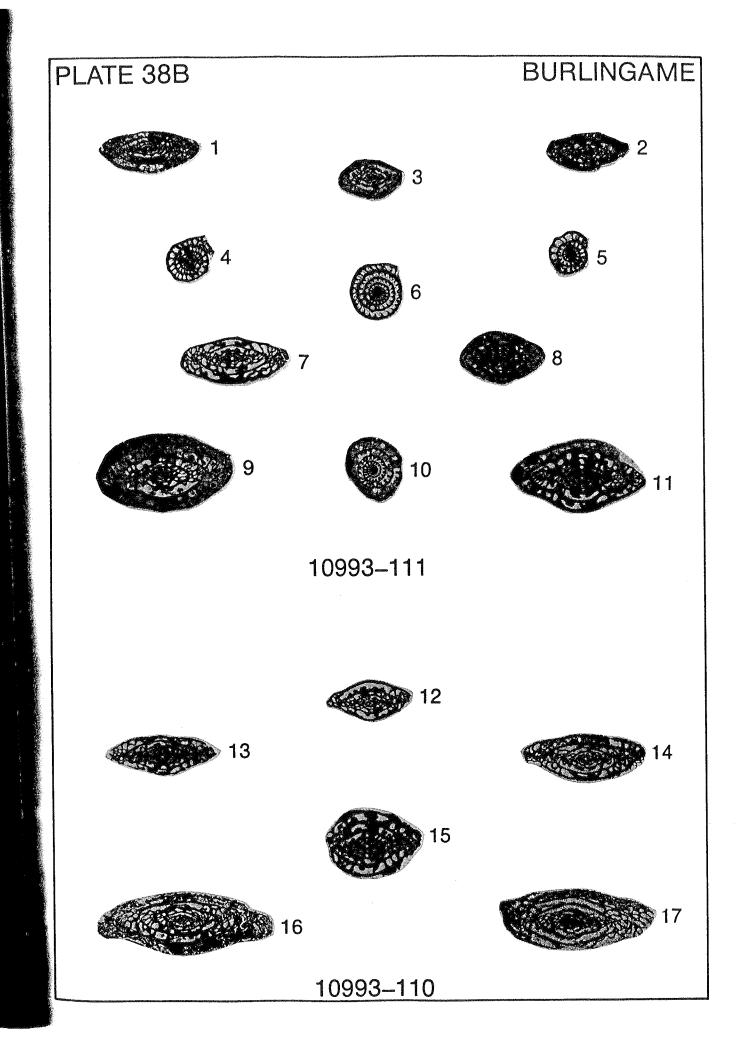


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Brownville Ls. Mbr.		1	
Pony Creek Shale Mbr.	Wood Siding	İ	1
Grayhorse Ls. Mbr.	Formation		Ì
Plumb Shale Member	TOTTING COOL	d	Ì
Nebraska City Ls. Mbr.		2	
French Creek Sh. Mbr.		<u>8</u>	
Jim Creek Ls. Mbr.	Root Shale	Subgroup	
Friedrich Shale Mbr.		=	
Grandhaven Ls. Mbr.		So	
Dry Shale Member	Stotler Limestone	5	
Dover Limestone Mbr.		13	
	Pillsbury Shale	Richardson	
Maple Hill Ls. Mbr.	7		
Wamego Shale Member	Zeandale		i
Tarkio Limestone Mbr	Limestone	ļ	
	Willard Shale	a	
		Nemaha Subgroup	Wabaunsee Group
Elmont Limestone Mbr.	Emporia	50	5
Harveyville Shale Mbr.	Limestone	3	ا به ا
Reading Limestone Mbr.	Limestone	S	ISE
	Auburn Shale	2	5
		139	2
Wakarusa Ls. Mbr.	1	9	Na Na
Soldier Creek Sh. Mbr.	Bern Limestone	e	
Burlingame Ls. Mbr.			4
Silver Lake Shale Mbr.			
Rulo Limestone Member			'
Cedar Vale Shale Mbr.	Scranton Shale		
Harm Hallam to AAbe	Jordinon Shale	=	
Happy Hollow Ls. Mbr.	=	228	.
White Cloud Shale Mbr.		Sacfox Subgroup	
Utopia Limestone Mbr.		ŏ	
Winzeler Shale Member		25	1
Church Limestone Mbr.	Howard Limestone	\cdot\)	Ì
Aarde Shale Member	-	1	1
			1
Bachelor Cr. Ls. Mbr.	Causau Chala		
	Severy Shale		
Supremental Control of the Control o			

Figs. 1-7, 10, 12-14,16,17 26514 <u>Triticites</u> n.sp. [SP.A]

Fig. 8 26617 <u>Triticites</u> [microspheric form]

Figs. 9,11,15 26504 <u>Triticites beedei</u> Dunbar & Condra, 1927



SOLDIERS CREEK

	****		Secretarion of
Brownville Ls. Mbr.			1
Pony Creek Shale Mbr.	Wood Siding		
Grayhorse Ls. Mbr.	Formation		İ
Plumb Shale Member	10/11/01/01/	9	1
Nebraska City Ls. Mbr.		2	İ
French Creek Sh. Mbr.		gq	Ì
Jim Creek Ls. Mbr.	Root Shale	Su	
Friedrich Shale Mbr.		=	1
Grandhaven Ls. Mbr.			Ì
Dry Shale Member	Stotler Limestone	3.0	
Dover Limestone Mbr.		Richardson Subgroup	
	Pillsbury Shale	2	
Maple Hill Ls Mbr.	Zeandale		
Wamego Shale Member	Limestone		
Tarkio Limestone Mbr	Limestone		
	Willard Shale	읔	=
Elmont Limestone Mbr.		2	0
Harveyville Shale Mbr.	Emporia	pg	G
	Limestone	S	99
Reading Limestone Mbr.		9	II.
	Auburn Shale	134	วลถ
Wakarusa Ls. Mbr.		Nemaha Subgroup	Wabaunsee Group
Soldier Creek Sh. Mbr.	Bern Limestone	e Z	-
Burlingame Ls. Mbr.			
Silver Lake Shale Mbr.			
Rulo Limestone Member	_		
Cedar Vale Shale Mbr.	Scranton Shale	g	1
Happy Hollow Ls. Mbr.	_	1 2	,]
White Cloud Shale Mbr.		Subg	<u> </u>
Utopia Limestone Mbr.		ξŢ	
Winzeler Shale Member		ဒ္ဓ	1
	Howard Limestor	1e; ∽	1
Annual Control of the		-	
Dactivior of Es. Mor.	Severy Shale		
WW III	Jevery Ullaic		
Utopia Limestone Mbr	Howard Limestor Severy Shale	Sacfox Subgroup	

All Magnifications x10 Unless Otherwise Indicated

Figs. 1,2, 4-6 26514 <u>Triticites</u> n.sp. [SP.A]

Fig. 3 26617 Triticites [microspheric form]

Figs. 7,8 26517 Triticites n.sp. [SP.D]

PLATE 39

SOLDIERS CREEK



1















10993-115

Brownville Ls. Mbr. Pony Creek Shale Mbr. Grayhorse Ls. Mbr. Plumb Shale Member Nebraska City Ls. Mbr. French Creek Sh. Mbr. Jim Creek Ls. Mbr. Friedrich Shale Mbr. Grandhaven Ls. Mbr. Dry Shale Member Dover Limestone Mbr. Maple Hill Ls. Mbr.	Wood Siding Formation Root Shale Stotler Limestone Pillsbury Shale Zeandale	Richardson Subgroup	
Wamego Shale Member	Limestone	1	
Tarkio Limestone Mbr	Willard Shale	dno	dno
Elmont Limestone Mbr.	Emporia	pgd	5
Harveyville Shale Mbr. Reading Limestone Mbr.	Limestone	S	See
	Auburn Shale	Nemaha Subgroup	Wabaunsee Group
Wakarusa Ls. Mbr.	Bern Limestone	Se	W
Soldier Creek Sh. Mbr.	Beth Fillieztone	1	
Burlingame Ls. Mbr. Silver Lake Shale Mbr.			
Rulo Limestone Member	-		
Cedar Vale Shale Mbr.	Scranton Shale	gi	-
Happy Hollow Ls. Mbr.	_	D D	ام
White Cloud Shale Mbr.		Sacfox Subgroup	3
Utopia Limestone Mbr.	_	J.	3
Winzeler Shale Member	Howard Limesto	one S	2
Church Limestone Mbr.			
Aarde Shale Member			
Bachelor Cr. Ls. Mbr.	Severy Shall	е	

Figs. 1-7, 13 26517 <u>Triticites</u> n.sp. [SP.D]

Figs. 8-12,15,16 26486 Leptotriticites elkensis n.sp.

Figs. 14, 17-19 26513 Triticites happyhollowensis n.sp.

PLATE 41

Brownville Ls. Mbr. Pony Creek Shale Mbr. Grayhorse Ls. Mbr. Plumb Shale Member Nebraska City Ls. Mbr. French Creek Sh. Mbr. Jim Creek Ls. Mbr. Friedrich Shale Mbr. Grandhaven Ls. Mbr.	Wood Siding Formation Root Shale Stotler Limestone	Richardson Subgroup		
Dry Shale Member Dover Limestone Mbr.	Pillsbury Shale	Richar		
Maple Hill Ls. Mbr. Wamego Shale Member Tarkio Limestone Mbr	Zeandale Limestone			
	Willard Shale		2	dio
Elmont Limestone Mbr. Harveyville Shale Mbr. Reading Limestone Mbr.	Emporia Limestone	Atomoby Subgroup	Sans	Wabaunsee Group
Heading Limestone with	Auburn Shale	2	Hand	abaun
Wakarusa Ls. Mbr. Soldier Creek Sh. Mbr.	Bern Limeston	e	a e	W
Burlingame Ls. Mbr. Silver Lake Shale Mbr.				
Rulo Limestone Member Cedar Vale Shale Mbr.	Scranton Sha	le	d	
Happy Hollow Ls. Mbr.			bgrou	
White Cloud Shale Mbr.			x Sul	
Utopia Limestone Mbr. Winzeler Shale Member Church Limestone Mbr. Aarde Shale Member	Howard Limes	tone	Sacfox Subgroup	
Bachelor Cr. Ls. Mbr.	Severy Sha	le		

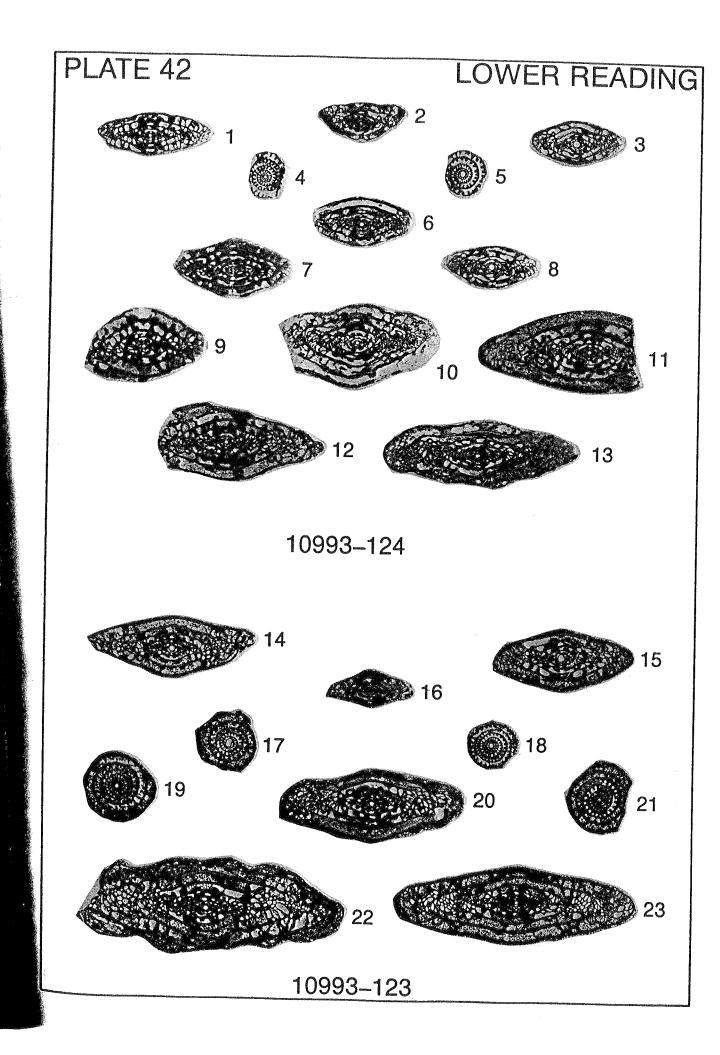
All Magnifications x10 Unless Otherwise Indicated

Fig. 1-13 26618 <u>Triticites</u> ex. gr. <u>T</u>. <u>asperoides</u> Ross, 1965

Brownville Ls. Mbr. Pony Creek Shale Mbr. Grayhorse Ls. Mbr.	Wood Siding		
Plumb Shale Member Nebraska City Ls. Mbr.	Formation	roup	
French Creek Sh. Mbr. Jim Creek Ls. Mbr.	Root Shale	Subg	
Friedrich Shale Mbr. Grandhaven Ls. Mbr. Dry Shale Member	Stotler Limestone	Richardson Subgroup	
Dover Limestone Mbr.	Pillsbury Shale	Rich	
Maple Hill Ls. Mbr. Wamego Shate Member Tarkio Limestone Mbr	Zeandale Limestone		
	Willard Shale	dn	5
Elmont Limestone Mbr. Harveyville Shale Mbr. Reading Limestone Mbr.	Emporia Limestone	Nemaha Subgroup	Wabaunsee Group
Reading Linestone mor	Auburn Shale	naha	bauns
Wakarusa Ls. Mbr. Soldier Creek Sh. Mbr.	Bern Limestone	Nen	Wa
Burlingame Ls. Mbr. Silver Lake Shale Mbr.			
Rulo Limestone Member	_		
Cedar Vale Shale Mbr.	Scranton Shale	dn	
Happy Hollow Ls. Mbr. White Cloud Shale Mbr.		Sacfox Subgroup	
Utopia Limestone Mbr.		ĝ.	
Winzeler Shale Member	IIad Limanta	Sac	
Church Limestone Mbr.	Howard Limeston	16 0	
Aarde Shale Member			
Bachelor Cr. Ls. Mbr.	Severy Shale		

Figs. 1-6, 8-15, 17-23 26618 <u>Triticites</u> ex. gr. <u>T</u>. <u>asperoides</u> Ross, 1965

Figs. 7,16 26617 <u>Triticites</u> [microspheric form]

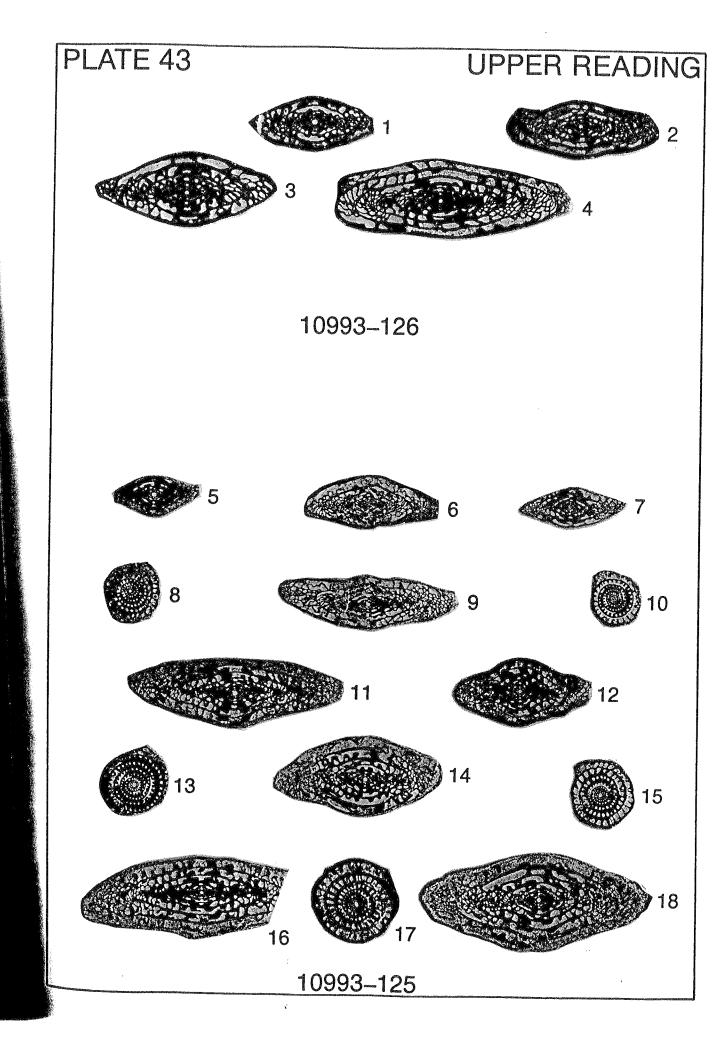


processing the second s			
Brownville Ls. Mbr.			
Pony Creek Shale Mbr.	Wood Siding		1
Grayhorse Ls. Mbr.	Formation	0	
Plumb Shale Member	İ	=	
Nebraska City Ls. Mbr.		Richardson Subgroup	
French Creek Sh. Mbr.	Root Shale	g	-
Jim Creek Ls. Mbr.	ROOL Shale	S	
Friedrich Shale Mbr.		5	į
Grandhaven Ls. Mbr.	Stotler Limestone	otlar Limostona S	
Dry Shale Member	200161 Filliezione	<u>ca</u>	
Dover Limestone Mbr.		5	
	Pillsbury Shale	œ	
Maple Hill Ls. Mbr.	Zeendala		
Wamego Shale Member	Zeandale		
Tarkio Limestone Mbr	Limestone		
	Willard Shale	a	<u></u>
The second secon		no	00
Elmont Limestone Mbr.	Emporia	180	ت
Harveyville Shale Mbr.	Limestone	Nemaha Subgroup	9
Reading Limestone Mbr.		S	JSC
	Auburn Shale	1	30
		ΙĔ	Wabaunsee Group
Wakarusa Ls. Mbr.	D Limentone	\ \frac{1}{2}	3
Soldier Creek Sh. Mbr.	Bern Limestone	-	
Burlingame Ls. Mbr.		 	1
Silver Lake Shale Mbr.			
Rulo Limestone Member		1. 1	1
Cedar Vale Shale Mbr.	Scranton Shale	<u>a</u>	
Happy Hollow Ls. Mbr.		1 5	
White Cloud Shale Mbr.		Sacfox Subgroup	
Utopia Limestone Mbr.		Õ	
Winzeler Shale Member		3	, 1 i 1
Church Limestone Mbr.	Howard Limestor	ie 🕠	'
Aarde Shale Member	-		
Bachelor Cr. Ls. Mbr.		_	
Bachelor Cr. Es. Mul.	Severy Shale		

Figs. 1-4 26519 Triticites n.sp. [SP.F]

Figs. 5-13, 16 26486 <u>Leptotriticites</u> elkensis n.sp.

Figs. 14,15,17,18 26618 <u>Triticites</u> ex.gr. <u>T. asperoides</u> Ross, 1965

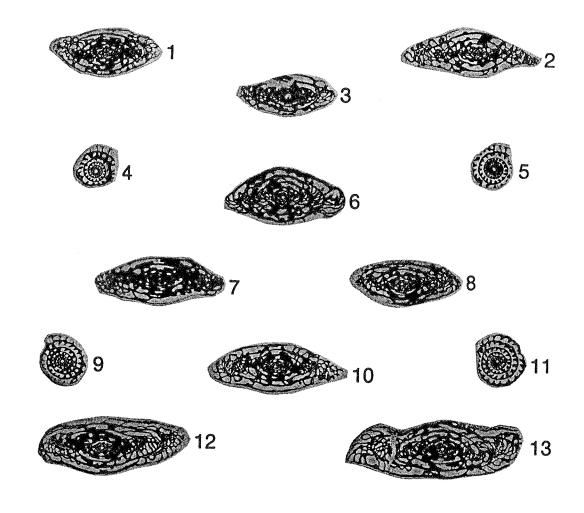


Brownville Ls. Mbr. Pony Creek Shale Mbr. Grayhorse Ls. Mbr. Plumb Shale Member Nebraska City Ls. Mbr. French Creek Sh. Mbr. Jim Creek Ls. Mbr. Friedrich Shale Mbr. Grandhaven Ls. Mbr. Dry Shale Member Dover Limestone Mbr. Maple Hill Ls. Mbr.	Wood Siding Formation Root Shale Stotler Limestone Pillsbury Shale Zeandale	Richardson Subgroup		
Warnego Shale Member Tarkio Limestone Mbr.	Limestone			
	Willard Shale	dno	dno	
Elmont Limestone Mbr.	Emporia	180	5	
Harveyville Shale Mbr.	Limestone	120	မှ	
Reading Limestone Mbr.		9	nse	ì
	Auburn Shale	Nemaha Subgroup	Wabaunsee Group	
Wakarusa Ls. Mbr.	Bern Limestone		3	
Soldier Creek Sh. Mbr			1	-
Burlingame Ls. Mbr.			7	Ì
Silver Lake Shale Mbr.				
Rulo Limestone Member				
Cedar Vale Shale Mbr.	Scranton Shale	g	-	
Happy Hollow Ls. Mbr.	-	1 2		ļ
White Cloud Shale Mbr.		Sacfox Subgroup		
Utopia Limestone Mbr.		J.∂	2	
Winzeler Shale Member		2	(-
Church Limestone Mbr.	Howard Limesto	ille O		
Aarde Shale Member			1	
Bachelor Cr. Ls. Mbr.			ļ	
	Severy Shale			

All Magnifications x10 Unless Otherwise Indicated Figs. 1-13 26518 <u>Triticites</u> n.sp. [SP.E]

PLATE 44

HARVEYVILLE



10993-129

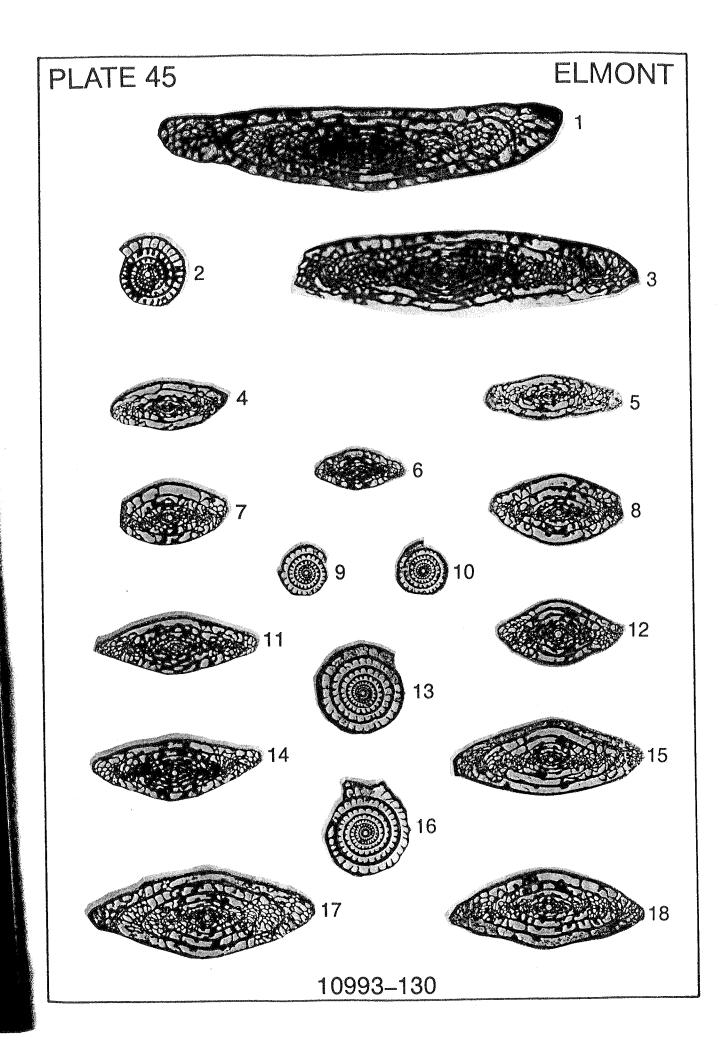
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Brownville Ls. Mbr			
Pony Creek Shale Mbr.	Wood Siding		
Grayhorse Ls. Mbr.	Formation	İ	1
Plumb Shale Member	romation	d	1
Nebraska City Ls. Mbr.		2	
French Creek Sh. Mbr.		pg	
Jim Creek Ls. Mbr.	Root Shale	Su	
Friedrich Shale Mbr.		=	
Grandhaven Ls. Mbr.		Richardson Subgroup	
Dry Shale Member	Stotler Limestone	2	
Dover Limestone Mbr.		은	ļ
)V ===	Pillsbury Shale	Z.	
Maple Hill Ls. Mbr.	Zeandale		
Warnego Shale Member			
Tarkio Limestone Mbr	Limestone		
	Willard Shale	a	CL.
The second of th		8	no
Elmont Limestone Mbr.	Emporia	50	ق
Harveyville Shale Mbr.	Limestone	1 =	بو
Reading Limestone Mbr.	Emicatoric	S	136
	Auburn Shale	Nemaha Subgroup	Wabaunsee Group
		E	pg
Wakarusa Ls. Mbr.	4	0	W
Soldier Creek Sh. Mbr	Bern Limestone		
Burlingame Ls. Mbr.			-
Silver Lake Shale Mbr.			
Rulo Limestone Member			
Cedar Vale Shale Mbr.	Scranton Shale		
Happy Hollow Ls Mbr.		Sacfox Subgroup	Ì
The state of the s		PQ	
White Cloud Shale Mbr.		3	
人 特别的第三			
Utopia Limestone Mbr.		Q Q	
Winzeler Shale Member		35	3
Church Limestone Mbr.	Howard Limesto	ne ∽	,]
Aarde Shale Member			
Bachelor Cr. Ls. Mbr.		_	
DBUILTOI UT. LS. HIDT.	Severy Shale		
V W THE	Severy Smale		1
Character and the second secon			

All Magnifications x10 Unless Otherwise Indicated

Figs. 1,3 26488 Leptotriticites n.sp. [SP.A]

Figs. 2, 7-18 26519 <u>Triticites</u> n.sp. [SP.F]

Figs. 4-6 26518 Triticites n.sp. [SP.E]



and the section of th			And the second second
Brownville Ls. Mbr.		į.	
Pony Creek Shale Mbr.	Wood Siding	- 1	1
Grayhorse Ls. Mbr.	Formation	ο.	ļ
Plumb Shale Member		3	
Nebraska City Ls. Mbr.		150	ł
French Creek Sh. Mbr.	Root Shale	9	1
Jim Creek Ls. Mbr.	KOUL Silate	S	
Friedrich Shale Mbr.		5	
Grandhaven Ls. Mbr.	Stotler Limestone	Richardson Subgroup	
Dry Shale Member	Stotler Limestone	2	
Dover Limestone Mbr.		2	
	Pillsbury Shale	<u>~</u>	
Maple Hill Ls. Mbr	Zeandale		
Wamego Shale Member	Limestone		
Tarkio Limestone Mbr	Limestone		
	Willard Shale	0	으
The state of the s		5	5
Elmont Limestone Mbr.	- Emporia	go	ت
Harveyville Shale Mbr.	Limestone	J.	66
Reading Limestone Mbr.		G	IIS
	Auburn Shale	2	3.0
Wakarusa Ls. Mbr.		Nemaha Subgroup	Wabaunsee Group
Soldier Creek Sh. Mbr.	Bern Limestone	2	-55
Burlingame Ls. Mbr.			ļ
Duringanie 23. mai.			1
Silver Lake Shale Mbr.			
Rulo Limestone Member			1
Cedar Vale Shale Mbr.	Scranton Shale	٩	
Happy Hollow Ls. Mbr.		100	1
White Cloud Shale Mbr.		Sacfox Subgroup	
Utopia Limestone Mbr.		Š	
Winzeler Shale Member		38	-
Church Limestone Mbr.	Howard Limestor	ie ∽	1
Aarde Shale Member	-		
Bachelor Cr. Ls. Mbr.		┥.	
Doubleton of, 23. Will.	Severy Shale		.
以	Sereily Silate		

All Magnifications x10 Unless Otherwise Indicated

Figs. 1-8 26487 Leptotriticites taylori n.sp.

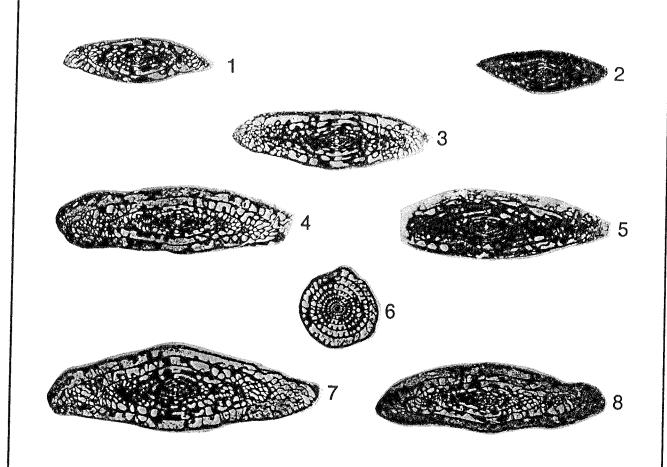
Fig. 9 26518 Triticites n.sp. [SP.E]

Fig. 10 26493 Schubertella Gen.

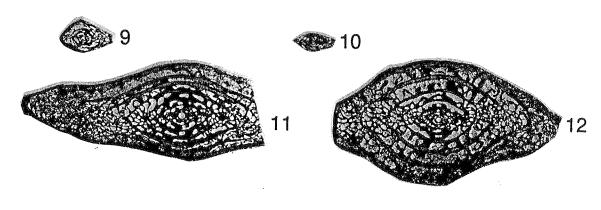
Figs. 11,12 26521 Triticites ex.gr. T. subventricosus Dunbar & Skinner, 1937

PLATE 46

LOWER DOVER



10993-140



10993-138

UPPER DOVER

Brownville Ls. Mbr. Pony Creek Shale Mbr.			
	Wood Siding	İ	ļ
Grayhorse Ls. Mbr.	Formation	ام	
Plumb Shale Member		Richardson Subgroup	
Nebraska City Ls. Mbr.		20	
French Creek Sh. Mbr.	Root Shale	9	ì
Jim Creek Ls. Mbr.	Koot Silate	S	
Friedrich Shale Mbr.		5	
Grandhaven Ls. Mbr.	Ct. Han Limpotone	dSC	
Dry Shale Member	Stotler Limestone	2	
Dover Limestone Mbr.		등	
	Pillsbury Shale	20	
Maple Hill Ls. Mbr.	Zeandale		
Wamego Shale Member	Limestone		
Tarkio Limestone Mbr.	Limestone		
	Willard Shale	0	₽.
The second secon		Nemaha Subgroup	Wabaunsee Group
Elmont Limestone Mbr.	- Emporia	58	Ö
Harveyville Shale Mbr.	Limestone	夏	9
Reading Limestone Mbr.		- 6	TS(
	Auburn Shale	34,	=
P		I E	ĝ
Wakarusa Ls. Mbr.		0	W
Soldier Creek Sh. Mbr.	Bern Limestone		
Burlingame Ls. Mbr.			
Silver Lake Shale Mbr.			
Rulo Limestone Member			
Cedar Vale Shale Mbr.	Scranton Shale	a.	
Happy Hollow Ls. Mbr.		100	
White Cloud Shale Mbr.		Sacfox Subgroup	
Utopia Limestone Mbr.		100	
Winzeler Shale Member		ac	1
Church Limestone Mbr.	Howard Limestor	ie s	
Aarde Shale Member			
Bachelor Cr. Ls. Mbr.		_	
Dacheloi Ci. Ls. mor.	Severy Shale		
以	Severy Strate		

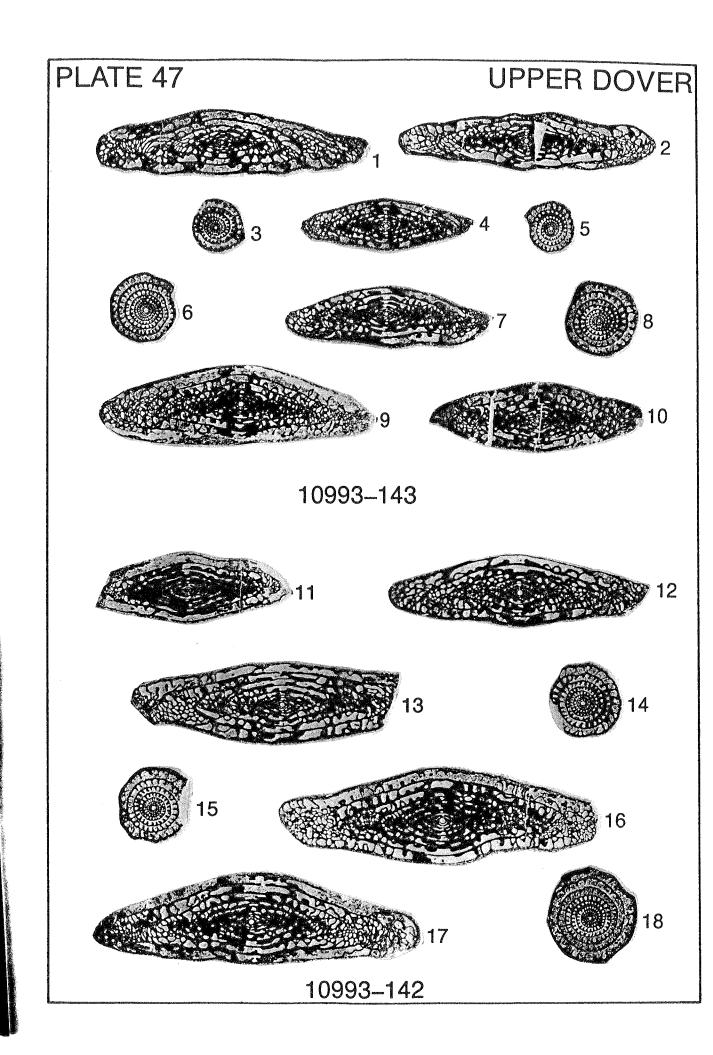
PLATE 47

E

All Magnifications x10 Unless Otherwise Indicated

Figs. 1,2 26520 Triticites n.sp [SP.G]

Figs. 3-18 26487 Leptotriticites taylori n.sp.



	·		
Brownville Ls. Mbr.		1	1
Pony Creek Shale Mbr.	Wood Siding	1	
Grayhorse Ls. Mbr.	Formation	1	
Plumb Shale Member	1 onnation	읈	1
Nebraska City Ls. Mbr.		2	
French Creek Sh. Mbr.	1	20	}
Jim Creek Ls. Mbr.	Root Shale	SE	į
Friedrich Shale Mbr.		Richardson Subgroup	- 1
Grandhaven Ls. Mbr.	-	20	
Dry Shale Member	Stotler Limestone	2]]
Dover Limestone Mbr.		픙	
	Pillsbury Shale	ž	
Maple Hill Ls. Mbr.			
Wamego Shale Member	Zeandale		
Tarkio Limestone Mbr.	Limestone		
Tarkio Limestolle Mol	:		
	Willard Shale	a	ς.
		Nemaha Subgroup	Wabaunsee Group
Elmont Limestone Mbr.	- Emporia	158	5
Harveyville Shale Mbr.	Limestone	===	به
Reading Limestone Mbr.	Limestone	S	156
	Auburn Shale	1	=
	7,000,000	E	pg
Wakarusa Ls. Mbr.	J	(e)	NS
Soldier Creek Sh. Mbr.	Bern Limestone		
Burlingame Ls. Mbr.			+
Silver Lake Shale Mbr.			
Rulo Limestone Member]		
Cedar Vale Shale Mbr.	Scranton Shale	ē	
Happy Hollow Ls. Mbr.		5	
White Cloud Shale Mbr.		Sacfox Subgroup	
Utopia Limestone Mbr.		Q Q	
Winzeler Shale Member		36	
Church Limestone Mbr.	Howard Limesto	ne 🗸	,
Aarde Shale Member			
Bachelor Cr. Ls. Mbr.		_	
Dadricki di. Es. Mar.	Severy Shale		
WWW.III	Jevery Julio	l	

All Magnifications x10 Unless Otherwise Indicated

Figs. 1-3

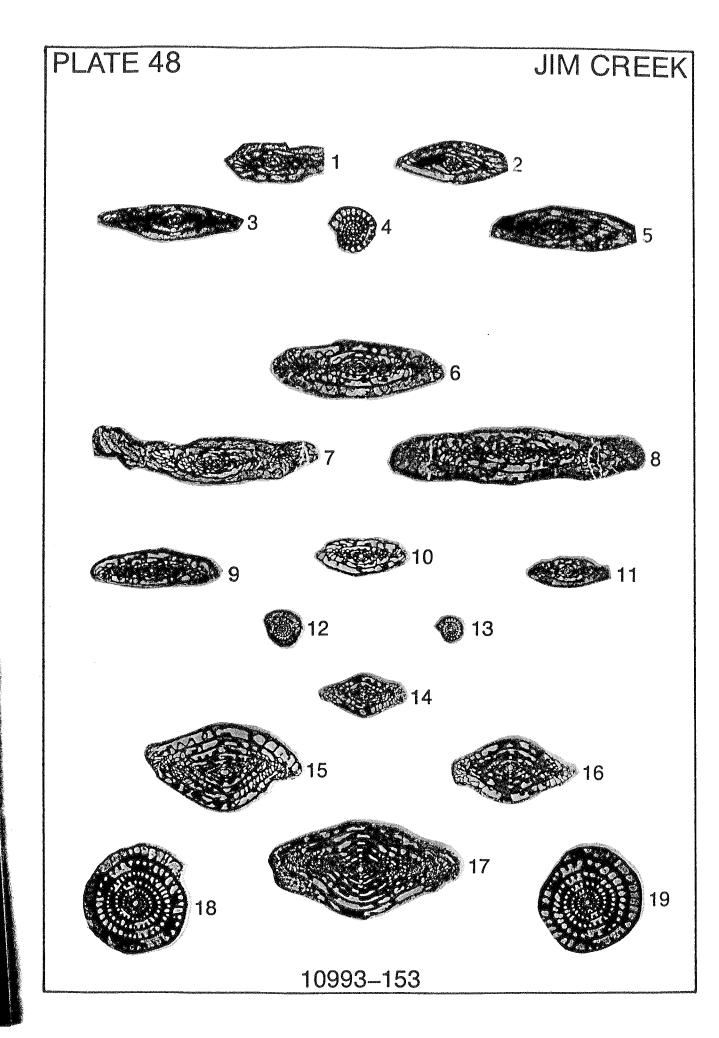
PLATE 48

All Magnifications x10 Unless Otherwise Indicated

26619 <u>Schubertella</u> ex.gr. <u>S. kingi</u> Dunbar & Skinner, 1937 [x40] Figs. 1-5

26520 Triticites n.sp. [SP.G] Figs. 6-13

Figs. 14-19 23196 Leptotriticites eoextentus (Thompson, 1954)



NEBRASKA CITY

and the second s			-	1
Brownville Ls. Mbr.		1		
Pony Creek Shale Mbr.	Wood Siding	1		
Grayhorse Ls. Mbr.	Formation	0		
Plumb Shale Member		E		
Nebraska City Ls. Mbr.		18		1
French Creek Sh. Mbr.	Root Shale	9		
Jim Creek Ls. Mbr	KOOL Share	S		
Friedrich Shale Mbr.		5		
Grandhaven Ls. Mbr.	Stotler Limestone	g	1	
Uty Stiele memo	Stotles Ellione	13	1	
Dover Limestone Mbr.	Ditt I Chola	Richardson Subgroup		
	Pillsbury Shale	(IE		
Maple Hill Ls. Mbr.	Zeandale			
Wamego Shale Member	Limestone			
Tarkio Limestone Mbr	Linicatoria	-	-	
	Willard Shale	1_		\
	Willaid Silaid			=
Elmont Limestone Mbr.	Emporia	Subgroup	0 6	5
Harveyville Shale Mbr.	1 '	3	3	اده
Reading Limestone Mbr.	Limestone	10	2 3	136
MESOLIIR ETHIOSOM	Auburn Shale	3	=	
	Auburn onare	£	월 .	Wabaunsee Group
Wakarusa Ls. Mbr.		Auburn Shale		Š
Soldier Creek Sh. Mbr.	Bern Limeston	Bern Limestone		
Burlingame Ls. Mbr.				
Silver Lake Shale Mbr.				
Rulo Limestone Member				
Cedar Vale Shale Mbr.	Scranton Sha	le	9	
Happy Hollow Ls. Mbr.		- 1	018	
White Cloud Shale Mbr.		_	Sacfox Subgroup	
Utopia Limestone Mbr			93	
Winzeler Shale Member	Howard Limes	tone	Sa	
Church Limestone Mbr	noward Ellies			
Aarde Shale Member		l		
Bachelor Cr. Ls. Mbr.				
	Severy Sha	e e		
			J.,	

PLATE 49

All Magnifications x10 Unless Otherwise Indicated

Figs. 1-3

26619 Schubertella ex.gr. S. kingi Dunbar & Skinner, 1937

[x40]

Figs. 4-7

26520 Triticites n.sp. [SP.G.]

Figs. 8,9,11, 16,18

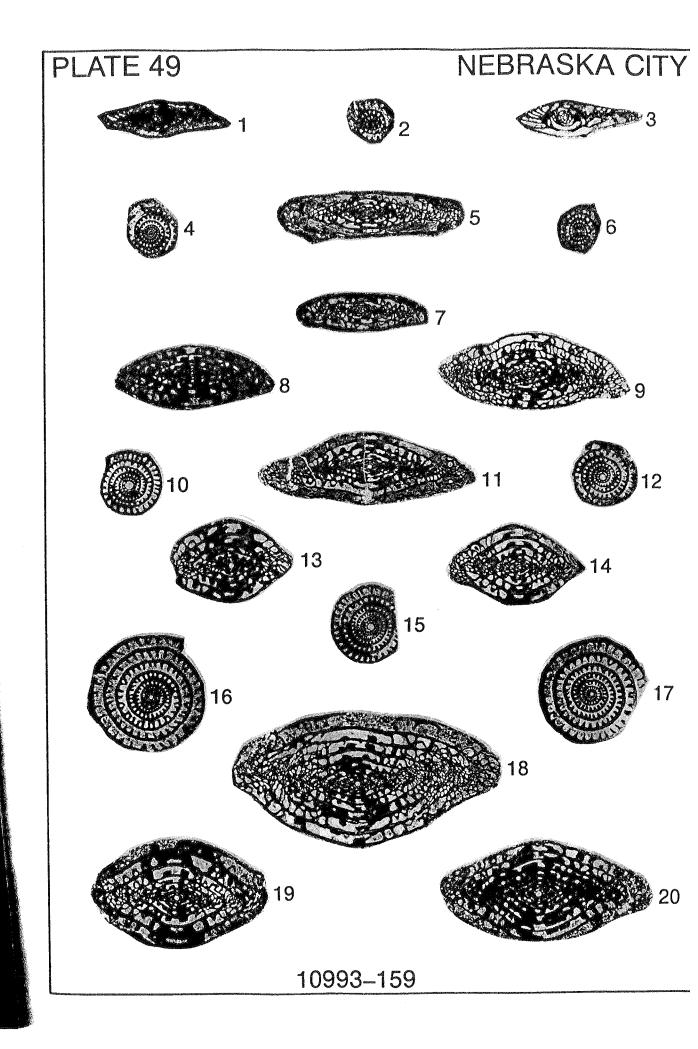
26484 Leptotriticites brownvillensis Douglass, 1962

Figs. 20

23196 Leptotriticites eoextentus (Thompson, 1954)

Figs. 10, 12-15, 17,19

26620 Triticites n.sp. [SP.H]

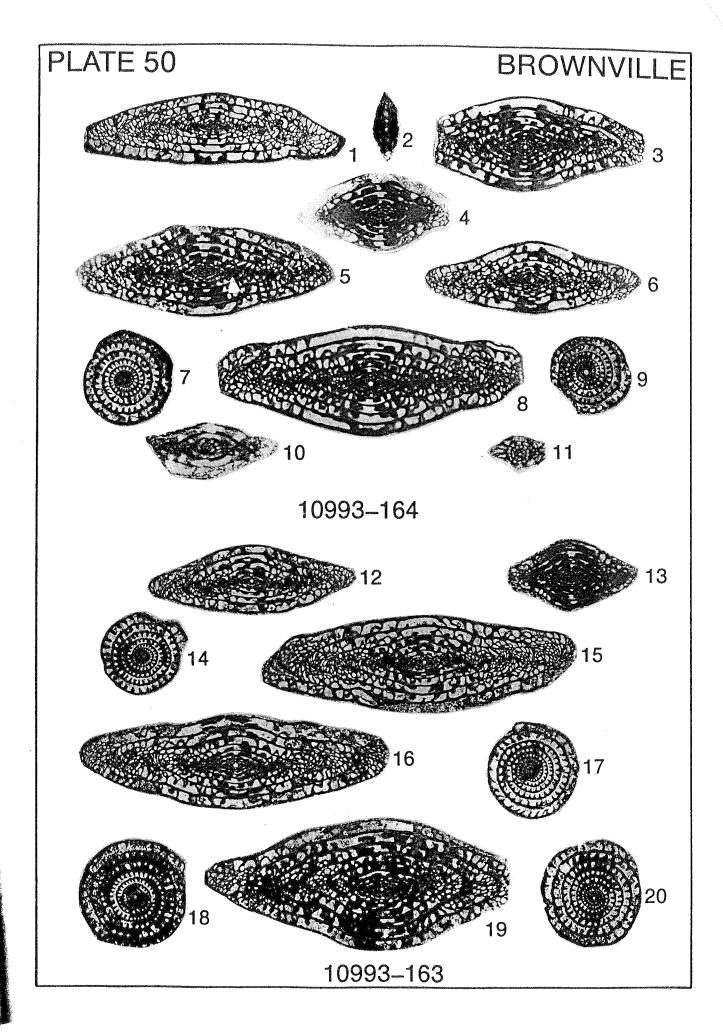


BROWNVILLE

Brownville Ls. Mbr. Pony Creek Shale Mbr. Grayhorse Ls. Mbr. Plumb Shale Member Nebraska City Ls. Mbr. French Creek Sh. Mbr. Jim Creek Ls. Mbr. Friedrich Shale Mbr. Grandhaven Ls. Mbr. Dry Shale Member Dover Limestone Mbr.	Wood Siding Formation Root Shale Stotler Limestone	Richardson Subgroup		
Dover Filliezone mon	Pillsbury Shale	Ric		
Maple Hill Ls Mbr. Wamego Shale Member Tarkio Limestone Mbr	Zeandale Limestone			
	Willard Shale	dn	5	
Elmont Limestone Mbr. Harveyville Shale Mbr.	Emporia Limestone	Nemaha Subgroup	Wabaunsee Group	
Reading Limestone Mbr.	Auburn Shale	aha	Janns	
Wakarusa Ls. Mbr. Soldier Creek Sh. Mbr.	Bern Limestone	Nem	Wab	
Burlingame Ls. Mbr. Silver Lake Shale Mbr.				
Rulo Limestone Member				
Cedar Vale Shale Mbr.	Scranton Shale	e 🖺	2	
Happy Hollow Ls. Mbr. White Cloud Shale Mbr.		e look Suharollin	Sanc	
Utopia Limestone Mbr.		غ ا	2	
Winzeler Shale Member Church Limestone Mbr.	Howard Limesto	one S	0	
Aarde Shale Member Bachelor Cr. Ls. Mbr.	Severy Shale			

PLATE 50 All Magnifications x10 Unless Otherwise Indicated

Figs. 1,3,5 6-9, 12, 14-20	26484	Leptotriticites brownvillensis Douglass,
Fig. 2	01942	Millerella inflata (Thompson, 1954) [x40]
Figs. 4,13	26617	Triticites [microspheric form]
Figs. 10,11	26619	Schubertella ex.gr. S. kingi Dunbar & Skinner, 1937 [x40]



AMOCO PRODUCTION COMPANY Tulsa, Oklahoma September 17, 1981 81260ART0014

TO:

Chief Geologist - Amoco Canada

Division Geologists Regional Geologists

Managers, Geology - APC (USA and Int'l), Chicago

SUBJECT:

Transmittal of Geological Research Department Report M81-G-11

Entitled "Upper Pennsylvanian (Virgilian) Fusulinid

Biozonation - Preliminary Report

The subject report documents a continuous stratigraphic succession which forms the basis for biostratigraphic zonation of the Kansas Virgilian. Fusulinids from the Kansas Virgilian are being studied to provide diversely existing biotic coverage in the relevant portion of the U Composite Standard. Sample processing is completed and interpretive study of the fusulinids, which will require a quantitative approach, has begun. This is a preliminary report for Research Proposal 80-3.

Eric R. Michaelis sul

ARO:srb Attachment

cc: Regional Exploration Libraries

Exploration Systems Manager, Tulsa Data Center

Amoco Preduction Company Exploration Library

Research Center—Geological Research Division

FUSULINID RANGE PLOT

(TOPS)

INTERPRETATION BY: G. A. Sanderson & G. J. Verville

LOCALITY FILE (NO)S.: 10993

"MOCIO PRODUCTION COMMANY AND OTHER PRODUCTION COMMANY AND OTHER PRODUCTION COMMANY AND OTHER PRODUCTION COMMANY AND OTHER PRODUCTION COMMANY AND OTHER PRODUCTION COMMANY AND OTHER PRODUCTION COMMANY AND OTHER PRODUCTION COMPANY (INDIANA)."

FIGURE 5

KGS OFR 2000-12

G-18

NO.: F83

INTERPRETATION BY: G. A. Sanderson & G. J. Verville
LOCALITY FILE (NO)S.: 10993

9

REPORT FIGURE

"PROPRIETARY-FOR THE EXCLUSIVE USE OF AMOCO PRODUCTION COMPANY AND OTHER WHOLLY OWNED SUBSIDIARIES OF THE STANDARD OIL COMPANY (INDIANA)."

PLO1

FUSULINID RANGE (BASES)

