THE GEOLOGICAL SURVEY OF WYOMING

HORACE D. THOMAS, State Geologist

BULLETIN NO. 46

FUSULINIDS OF THE CASPER FORMATION OF WYOMING

PART I

STRATIGRAPHY OF THE CASPER FORMATION

BY

HORACE D. THOMAS, M. L. THOMPSON, AND JOHN W. HARRISON

PART II

SYSTEMATIC PALEONTOLOGY OF FUSULINIDS FROM THE CASPER FORMATION

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UNIVERSITY OF WYOMING
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FUSULINIDS OF THE CASPER FORMATION OF WYOMING

BY

M. L. THOMPSON,[1] HORACE D. THOMAS,[2] AND JOHN W. HARRISON[3]

ABSTRACT

The Casper formation, exposed around the margins of the Laramie Range, Wyoming, comprises an alternating succession of beds made up principally of cross-bedded sandstones and fossiliferous limestones. Fusulinid faunas indicate that the formation ranges from Middle Pennsylvanian (Desmoinesian) to Lower Permian (Wolfcampian) in age. The stratigraphy of the formation is discussed and the fusulinids, represented by four genera and sixteen species, six of which are new, are described. The Wolfcampian species are the first fusulinids of this age to be described from Wyoming.

PART I

STRATIGRAPHY OF THE CASPER FORMATION

BY

HORACE D. THOMAS, M. L. THOMPSON, AND JOHN W. HARRISON

INTRODUCTION

Fossils have been known for about three-quarters of a century from rocks now referred to the Casper formation, which crops out along the flanks of the Laramie Range and around Casper Mountain—the northern terminus of the range (Hayden, 1872; Hague, 1877). Only a minor part of the fauna has been described in detail, however.

Later workers simply referred the Casper to the Carboniferous or the Pennsylvanian without any attempt to determine the time span of the formation. Indeed, as late as 1927, Lee quoted Girty to the effect that the Casper faunas "do not indicate any restricted stage within the Pennsylvanian epoch."

The first detailed report on Casper fossils was published by Miller and Thomas (1936), in which they described and illustrated the cephalopods then known from the formation, one fusulinid foraminifer, and one trilobite,

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[1] Professor of geology, University of Wisconsin, Madison.

[2] Professor of geology, State geologist, University of Wyoming, Laramie.

[3] Consulting geologist, Casper, Wyoming. John Wiley Harrison, loved and respected by all who knew him, died November 17, 1952.

all collected from a bed in a stratigraphic section measured along Gilmore Canyon* near the southern end of the range (Fig. 1). At the same time they discussed the remaining large undescribed invertebrate fauna known from other places along the range. An attempt was made to determine the time span of the formation and they stated (p. 723) that:

> . . . whereas the upper part of the Casper may be Lower Permian in age, it is more probable that the entire formation is referable to the Pennsylvanian. Furthermore, the paleontologic data appear to indicate that both Lower and Upper Pennsylvanian strata are present, and it seems quite probable that the Casper represents the major portion of the Pennsylvanian period.

Fortunately, many beds in the Casper carry fusulinid foraminifers. These have proved to be among the most reliable of the fossils in the American Pennsylvanian and Permian rocks for detailed age determination. The present study of the Casper fusulinids indicates that (1) standard stages may be recognized in the Casper formation of the Laramie Range, (2) there are no Lower Pennsylvanian (Ardian) rocks present, (3) the time span of the Casper extends from medial Pennsylvanian time (early Desmoinesian), through late Pennsylvanian time (Missourian and Virgilian), and into early Permian time (Wolfcampian), and (4) that deposition began earliest in the southern part of the range, the northern part remaining emergent through most of Pennsylvanian time. Not only is it possible, using the fusulinids, to make time correlations of units within the Casper exposed at different places along the range, but it is possible to correlate them with the fusulinid-bearing Pennsylvanian and Permian rocks of other parts of the United States.

Lithologic correlation of beds in the Casper at different places is difficult and uncertain because of complex facies changes (Thomas, 1949b, p. 18, fig. 9). Nor are the relations of the Casper formation to other units, such as Amsden and Tensleep, Minnelusa, and Hartville, clear. Some of the problems of the correlation of the Casper with other formations in other parts of Wyoming have been discussed by Thomas (1940; 1948, pp. 87–89; 1949a, p. 44; 1951, p. 35).

The present report concerns principally a detailed study of the rather large fusulinid fauna obtained from the Casper since 1936 by a number of workers, mainly graduate students at the University of Wyoming. More than three dozen fusulinid collections have been made from strati-

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* The section as given by Miller and Thomas (p. 718) is incorrect in that one unit was omitted. A 34-foot bed of pink cross-bedded sandstone intervenes between the 9-foot bed carrying *Derbyia* and the 9 feet of alternating sandstones and siltstones at the top of the section. It is correctly shown on the correlation chart (Pl. 9) accompanying this paper.

graphic sections measured at twenty localities along the Laramie Range and at Casper Mountain. The accompanying index map (Fig. 1) shows

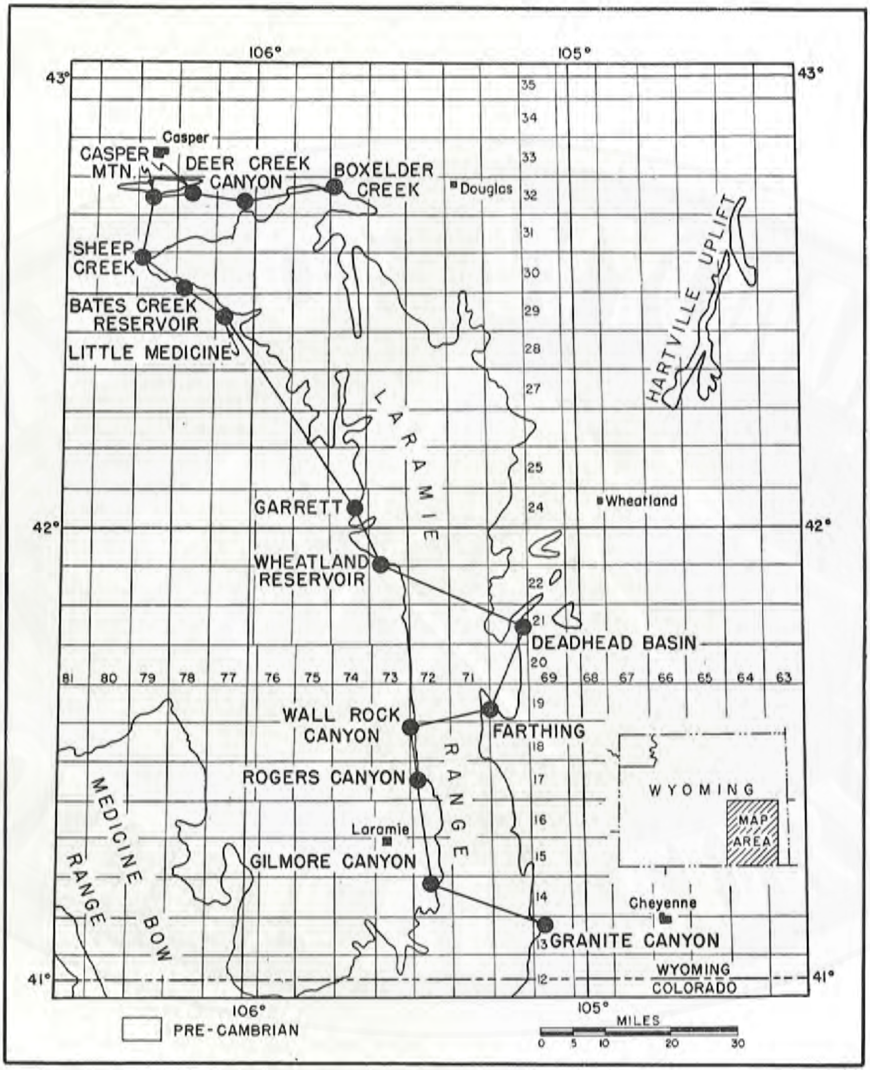

FIG. 1. INDEX MAP OF THE LARAMIE RANGE SHOWING LOCATION OF SECTIONS

the location of many of the sections from which the fusulinids described below were collected. The correlation chart (Pl. 9) shows the generalized lithology of the Casper formation, and typical fusulinids, at various places along the Laramie Range.

ACKNOWLEDGMENTS

The present paper represents the results of a long period of cooperation among many workers. Thompson had identified fusulinids collected from the Casper formation by Thomas prior to 1936, and the two have collaborated on the present work since that time. In 1938, Harrison, then a graduate student at the University of Wyoming, measured sections of the Casper formation around the Laramie Range and collected many fusulinids. His work was supervised by Thomas and the specimens were sent to Thompson. Harrison's field work and collecting were fundamental to this study. Later, other graduate students, working under Thomas, measured other sections and collected fusulinids, and their stratigraphic data and specimens were made available to us for use and study. These persons, to whom we owe great gratitude, are H. R. McCurdy (1941), who measured sections and made collections at Granite Canyon, Farthing and Deadhead Basin; Frank C. Sims (1948) and William A. Sears (1949), who measured sections and made collections at Casper Mountain. C. R. Hammond, John Haun and Dr. Alan Shaw collected fusulinids from the Casper at various places and made them available to us. Dr. George J. Verille, while research assistant at the University of Wisconsin, prepared many of the thin sections used in this study. Financial support for the later technical work was furnished by the Research Committee of the University of Wisconsin from funds furnished by the Wisconsin Alumni Research Foundation.

GENERAL FEATURES OF THE CASPER FORMATION

The Casper formation was defined by Darton (1908) to include the Paleozoic rocks at Casper Mountain, and southward along the flanks of the Laramie Range, which rest on pre-Cambrian rocks and extend upward to the base of the redbeds now known to be Permian in age (Thomas, 1949a, p. 44). Darton recognized that the lower part of the Casper, as thus defined, probably included in the northern part of the Laramie Range equivalents of the Deadwood formation (Cambrian) and of the Madison limestone (Mississippian). Knight (1929) later proposed to redefine and restrict the Casper formation to those rocks of post-Mississippian age included in it by Darton, and to exclude those of Mississippian age or older. Knight further proposed to apply the name Fountain formation to the arkosic clastics below rocks of typical Casper lithology along the southern part of the Laramie Range. Miller and Thomas (1936) employed the term Casper formation in the same general sense as used by Knight, and it is in this latter sense that the name is used in this report.

The Casper varies considerably in lithology along the margins of the Laramie Range, but is composed predominantly of alternating thicker sandstones and thinner limestones. The different sandstone beds in any one stratigraphic section vary in lithology, and any one bed seems to show lateral lithologic variation from place to place. The sandstones are indurated to sub-quartzitic, highly cross-bedded to thin-bedded or massive, fine-grained to conglomeratic, and quartzose to highly feldspathic. Festoon cross-lamination (Knight, 1929), however, is conspicuous in most sandstones. The limestones, in general, are light-colored, many being almost white, but some are marked by pale tints of pink, lavender or purple. Most of the limestones are fossiliferous; brachiopods compose one of the larger faunal elements, but other types of invertebrates are common to rare in many of them.

The Casper ranges in thickness from around 500 feet to over 1000 feet. The greater thicknesses do not necessarily indicate that longer time intervals are represented, for some sections may include rocks of Middle and Upper Pennsylvanian and Wolfcampian (Permian) age, such as the Gilmore Canyon section, and others of comparable thickness are almost entirely of Wolfcampian age, such as those at the north end of the range (Pl. 9).

The Casper rests unconformably on Mississippian limestone (Madison) along the northern part of the range, and the surface on which it lies commonly shows features indicative of an ancient karst topography. The Mississippian rocks thin to the southward, and south of the Little Medicine section the Casper everywhere rests on pre-Cambrian rocks. In the northern part of the range, the Casper is overlain unconformably by the red Opeche shale (probably Leonardian), but the evidence of such a break becomes less clear in the southern part of the range.

Along many parts of the Laramie Range, Tertiary sediments obscure the Paleozoic rocks and lap onto the pre-Cambrian core of the mountains. thus making it impossible to measure sections in many areas. In addition, the upper parts of many sections are mantled by Tertiary rocks, such as those at Garrett, Little Medicine, and others (Pl. 9).

STRATIGRAPHIC SUMMARY

The fusulinids described in Part II of this paper make possible the determination of some of the different ages of rocks included within the Casper formation. Furthermore, they seem to substantiate earlier conclusions concerning tectonic changes that occurred along the Laramie Range during late Paleozoic time (Thomas, 1948, pp. 88–89; 1949b, pp. 17–18), as based on fusulinid determinations made by Thompson. It seems evident that this area was considerably affected by major diastrophic movements during Pennsylvanian and earlier Permian time which, perhaps, were related to the pronounced uplifts to the south known as the "Ancestral Rockies".

Pre-Pennsylvanian rocks.—The oldest Paleozoic unit known along the Laramie Range, the Cambrian Deadwood sandstone, is restricted to the northern end of the mountains. The Deadwood is overlapped to the south by the Madison (Mississippian), which in turn pinches out between the Casper formation, above, and the pre-Cambrian rocks, below, just south of the Little Medicine section. It appears that the extent of the Madison was originally much greater than that of the Deadwood, but that after uplift and truncation by erosion during later Mississippian and earlier Pennsylvanian time, its extent was greatly reduced (Thomas, 1949b, p. 16).

TABLE I. Classification of the Pennsylvanian and Permian Rocks of the United States.

(Pennsylvanian classification after Moore and Thompson, Bull. Amer. Assn. Petrol. Geol., Vol. 33, No. 3, Mar., 1949; Permian classification after "Standard Permian section of North America," *Ibid.*, Vol. 23, No. 11, Nov., 1939.)

SYSTEM	SERIES	STAGE
Permian	Ochoan Guadalupian Leonardian Wolfcampian	No standard stages
Pennsylvanian	Kawvian	Virgilian Missourian
	Oklan	Desmoinesian Atokan
	Ardian	Morrowan Springeran

Pre-Desmoinesian rocks.—No rocks of Ardian age or of early Oklan age have been identified around the Laramie Range. In the Hartville uplift, east of the Laramie Range, middle lower Oklan rocks lie not high above Mississippian limestone. It should be pointed out that we were unable to determine the age of the lower hundred feet or so of beds in some of the sections along the southern part of the mountains. They may be of Atokan age, but since Desmoinesian fusulinids were found only a short distance above pre-Cambrian granite in the Rogers Canyon section and in Telephone Canyon, not far north of Gilmore Canyon, it appears that the basal beds of the Casper through the Gilmore Canyon-Granite Canyon area are no older than Desmoinesian. The lowest beds in the Farthing and Deadhead Basin sections, which lie closer to the Hartville Uplift, may be of early Desmoinesian or pre-Desmoinesian age.

Desmoinesian rocks.—Desmoinesian fusulinids and other sorts of fossils are known from most sections south of Wheatland Reservoir (Fig. 1). Rocks of Desmoinesian age are lacking to the north and were either not deposited north of Wheatland Reservoir or were removed from the northern part of the range by pre-Missourian erosion (Fig. 2). In none of the sections were we able to find Missourian fossils directly above Desmoinesian forms; hence, we were not able to precisely locate the boundary between the two stages. The boundary as shown on Plate 9 is, therefore, only temporized.

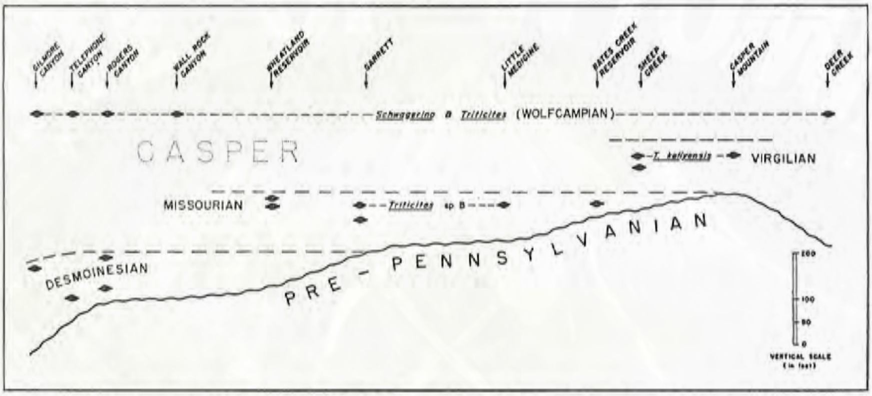

FIG. 2. STRATIGRAPHIC DIAGRAM ALONG THE WEST SIDE OF THE LARAMIE RANGE SHOWING NORTHWARD OVERLAP OF THE STAGES

The datum is the lowest occurrence of Wolfcampian fusulinids and probably is not a line of contemporaneity.

Rocks of Desmoinesian age are widely distributed in Wyoming and, in addition to those in the Laramie Range, have been recognized in the middle part of the Hartville formation of eastern Wyoming and in the lower part of the Tensleep sandstone of north-central and western Wyoming.

Missourian rocks.—Rocks of Missourian age have been dated by fusulinids in a number of sections in the southern part of the Laramie Range, but rocks of this age are probably present at all localities (Fig. 3). To the northward, Missourian rocks are found lower in the sections, until in the Garrett region they appear to rest directly on pre-Cambrian granite (Figs. 2, 4). In the Little Medicine area rocks of definite Missourian age were deposited directly on a deeply channeled erosion surface cut on Mississippian rocks. Missourian rocks wedge out northward from here and may be missing in the Sheep Creek area, since the lowest fusulinids found are lower Virgilian types, although it is possible that the basal beds of sections along the northern part of the range, such as at Sheep Creek and Casper Mountain, may be as old as Missourian. In no section was it possible to definitely locate the Missourian-Virgilian boundary.

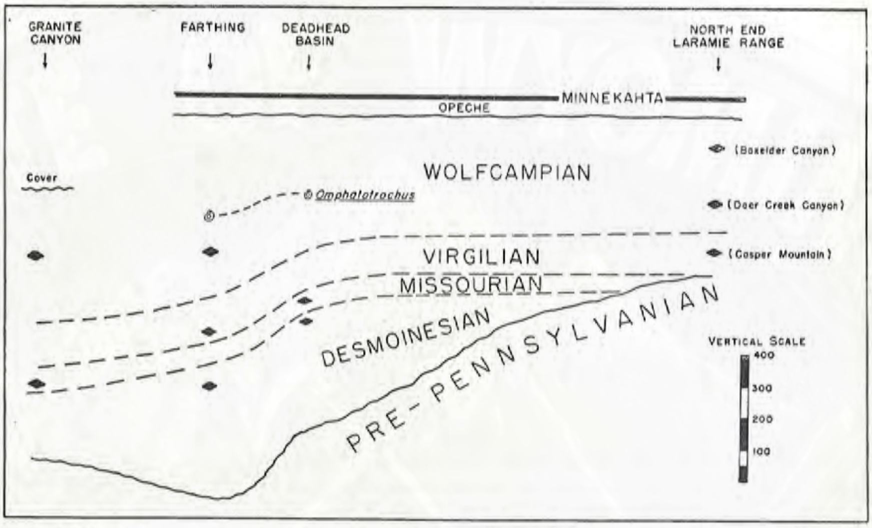

FIG. 3. STRATIGRAPHIC DIAGRAM ALONG THE EAST SIDE OF THE LARAMIE RANGE SHOWING NORTHWARD OVERLAP OF THE STAGES

The datum is the Minnekahta limestone. The California Company No. 1 Morton-King well in the Borie oil field, 10 miles east of Granite Canyon, drilled 1,140 feet of Casper before penetrating granite.

Rocks of Missourian age have been recognized with certainty in Wyoming only in the eastern and western parts of the State. It does not seem likely that the Missourian seas of the two extreme sides of the State were connected across Wyoming. It is possible, however, that the unfossiliferous upper Tensleep of central Wyoming is Missourian in age.

Virgilian rocks.—Virgilian rocks probably occur throughout most of the Laramie Range but have been definitely identified only from the Farthing area on the south, to Casper Mountain on the north (Fig. 3). They perhaps are represented in sections south of Farthing by nonfusulinid-bearing parts of the Casper lying above rocks of Missourian age. At no place were we able to precisely locate the contact of rocks of Virgil age, below, with Wolfcampian beds, above; hence, the Pennsylvanian-Permian boundary has not been definitely placed.

Virgilian fusulinid-bearing beds have been recognized in the Hartville Uplift of eastern Wyoming, but have not been identified in central or western Wyoming. The Wyoming Virgilian faunas closely resemble those of Nebraska and Kansas and probably lived in seas which invaded Wyoming from the southeast.

Wolfcampian rocks.—Wolfcampian rocks have been recognized throughout the length of the Laramie Range. This, however, is the only area in Wyoming in which Wolfcampian rocks, dated on the basis of fusulinids, can be proved definitely to be present. The upper part of the Hartville formation has been thought to be Wolfcampian in age, but no fossils sufficiently diagnostic to prove this belief have yet been found. We feel that Hartville I (Denson and Botinelly, 1949) correlates with the Wolfcampian beds of the Casper formation of the Laramie Range.

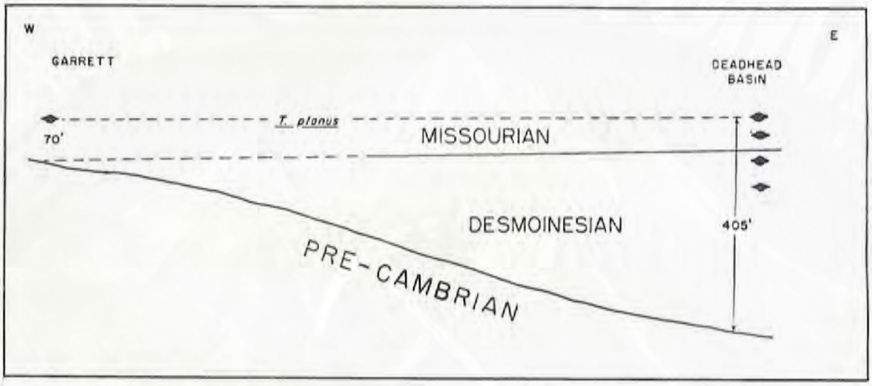

FIG. 4. STRATIGRAPHIC DIAGRAM ACROSS THE LARAMIE RANGE SHOWING THE WESTWARD THINNING OF DESMOINESIAN ROCKS

The Permian Wolfcampian rocks of southeastern Wyoming are more closely related to the subjacent Pennsylvanian rocks than they are to Middle Permian rocks (Opeche, etc.) which overlie them unconformably. Marked changes in paleogeography and in the nature of sedimentation took place in the Permian between early Wolfcampian and Leonardian time.

Wolfcampian rocks are known near Three Forks, Montana, to the northwest, but they are of late Wolfcampian age and the containing rocks are considerably younger than any part of the Casper formation. Wolfcampian rocks are widespread in central and northern Utah and southern Idaho. The absence of rocks of this age over great areas in northern Colorado and central Wyoming, however, makes it seem unlikely that the Wolfcampian Casper sea was connected westward with the sea of the Great Basin region. Although definite evidence of the nature of the Wolfcampian invasion of southeastern Wyoming could not be determined from the sections we have studied, it appears that the Wyoming Wolfcampian sea was connected to the southeast with that of Nebraska and Kansas, and that it invaded Wyoming from the southeast.

PART II

SYSTEMATIC PALEONTOLOGY OF FUSULINIDS FROM THE CASPER FORMATION

BY

M. L. THOMPSON AND HORACE D. THOMAS

PALEONTOLOGICAL SUMMARY

Fusulinid foraminifers obtained from localities around the Laramie Range demonstrate that the rocks generally included in the Casper formation are referable to the Oklan Series and the Kawvian Series of the Pennsylvanian System, and to the lower part of the Wolfcampian Series of the Permian System. All collections of Oklan fusulinids from the Casper which we have studied contain representatives of *Fusulina* and indicate that only the Desmoinesian Stage of the series is represented in the fusulinid-bearing part of the formation from which our collections were obtained. No fusulinids, however, have been found in the basal parts of the sections, below rocks carrying lower Desmoinesian fusulinids, at Farthing and Deadhead Basin on the east flank of the mountains, and in the lower parts of the sections at Wall Rock Canyon and Granite Canyon farther south. It is possible, of course, that some of these beds may be as old as Atokan.

Kawvian fusulinids are widespread around the Laramie Range and are represented in at least 17, and perhaps 19, of our collections. The forms in at least 12 collections are of Missourian age, and those in 5 are of Virgilian age. Two collections of uncertain age are, perhaps, to be assigned to the Virgilian. Definite Virgilian fusulinids are found only in the Farthing section, in the southern part of the range, and in the Sheep Creek and Casper Mountain sections in the northern part. No single section has yielded both Missourian and Virgilian fusulinids.

Permian Wolfcampian fusulinids have been found in sections from Granite Canyon on the south to Casper Mountain on the north. All the Permian fusulinids found are evidently of early Wolfcampian age.

Desmoinesian fusulinids.—Desmoinesian fusulinids collected from two measured sections are described below; Colls. 13-D, 13-E, and 13-F from the Deadhead Basin section, and Coll. 4-C from talus on the lower part of the Wheatland Reservoir section. The forms described below as *Fusulina plattensis* Thompson and *F. casperensis*, n. sp., are from Colls. 13-E and 13-F of the Deadhead Basin section, respectively. They both demonstrate clearly that this part of the formation is of about the same age as the Cherokee shale of the type Desmoinesian section. Desmoinesian forms

TABLE 2. Distribution of Species in Sections of the Casper Formation. Figures Indicate the Approximate Height above the Base of the Casper.

STAGE		GRANITE CANYON	GILMORE CANYON	TELEPHONE CANYON	ROGERS CANYON	WALL ROCK CANYON	FARTHING	DEADHEAD BASIN	WHEATLAND RESERVOIR	GARRETT	LITTLE MEDICINE	BATES CREEK RESERVOIR	SHEEP CREEK	CASPER MOUNTAIN	EAST CASPER MOUNTAIN	DEER CREEK CANYON	BOXELDER CREEK
Wolfcampian	*Triticites onustus*					? 400′										234′	
	T. ventricosus			400′	? 390′	400′	? 770′										cf. 407′
	T. notus	630′	520′	400′		400′	aff. 770′										
	Schwagerina	630′	520′				770′										
Virgilian	*T. milleri*						520′								90′		
	T. kellyensis												114′	95′			
	T. sp. C												94′				
Missourian	*T. nebraskensis*								176′								
	T. sp. A							398′				? 20′					
	T. sp. B									101′	86′						
	T. planus							405′		70′							
	T. submucronatus	240′															
	T. wyomingensis								200′								
	Schubertella sp.							398′									
Desmoinesian	*Fusulina retusa*							340′	Talus								
	F. plattensis							298′									
	F. casperensis							289′									
	F. pristina ?				90′												
	F. undet.		180′	50′	25′		310′	165′									

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Kawvian fusulinids are widespread around the Laramie Range and are represented in at least 17, and perhaps 19, of our collections. The forms in at least 12 collections are of Missourian age, and those in 5 are of Virgilian age. Two collections of uncertain age are, perhaps, to be assigned to the Virgilian. Definite Virgilian fusulinids are found only in the Farthing section, in the southern part of the range, and in the Sheep Creek and Casper Mountain sections in the northern part. No single section has yielded both Missourian and Virgilian fusulinids.

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Wolfcampian	*Triticites onustus*					? 400′										234′	
	T. ventricosus			400′	? 390′	400′	? 770′										cf. 407′
	T. notus	630′	520′	400′		400′	aff. 770′										
	Schwagerina	630′	520′				770′										
Virgilian	*T. milleri*						520′								90′		
	T. kellyensis												114′	95′			
	T. sp. C												94′				
Missourian	*T. nebraskensis*								176′								
	T. sp. A							398′				? 20′					
	T. sp. B									101′	86′						
	T. planus							405′		70′							
	T. submucronatus	240′															
	T. wyomingensis								200′								
	Schubertella sp.							398′									
Desmoinesian	*Fusulina retusa*							340′	Talus								
	F. plattensis							298′									
	F. casperensis							289′									
	F. pristina ?				90′												
	F. undet.		180′	50′	25′		310′	165′									

not described were obtained from beds 50 feet above the base of the Casper in Telephone Canyon just north of Gilmore Canyon (Coll. TC-2); from beds 175 feet (Coll. GC-A) and 185 feet (Coll. GC-B) above the base of the Gilmore Canyon section; from beds 25 feet (Coll. RC-3) and 90 feet (Coll. RC-2) above the base in the Rogers Canyon section; from beds 310 feet above the base in the Farthing section (Coll. 1-A); and from beds 165 feet above the base in the Deadhead Basin section (Haun-C). These undescribed fusulinids are of about the same age as species in the Cherokee shale of Kansas and Iowa.

The form described as *Fusulina retusa*, n. sp., from Coll. 13-D of the Deadhead Basin section and Coll. 4-C of the Wheatland Reservoir section seems to be of rather late Desmoinesian age, and is probably equivalent in age to species in the lower Marmaton group of the Midcontinent region. Upper Desmoinesian rocks appear to be thin in the measured sections along the southern part of the Laramie Range. Missourian rocks immediately overlie them and Cherokee equivalents immediately underlie them.

No fusulinids of pre-Missourian age were recognized in collections from the northern part of the range.

Further evidence of the occurrence of rocks of Desmoinesian age is indicated by common specimens of *Mesolobus* which occur from about 300 feet to 355 feet above the base of the Casper at Farthing and about 298 feet above the base at Deadhead Basin. Oddly, no specimens of *Mesolobus* have yet been found on the west flank of the range.

Missourian fusulinids.—Fusulinids of Missourian age described below were obtained from six measured sections; Coll. 1-E from Granite Canyon, Colls. 13-A, 13-B, and 13-C from Deadhead Basin, Colls. 4-A and 4-B from Wheatland Reservoir, Colls. 5-A and 5-B from Garrett, Colls. 8-A, 8-B, and 8-C from Little Medicine, and Coll. 9-A from Bates Creek Reservoir. Thus, it is evident that Missourian rocks occur from near the Colorado border on the south to near the northern end of the Laramie Range. Fusulinids in these collections demonstrate that rocks equivalent in age to both the Kansas City and Lansing groups of the Midcontinent region are represented in the Casper. Although forms similar to those found in the Bethany Falls limestone of the Midcontinent have not been observed in Wyoming, specimens described below as *Triticites nebraskensis* Thompson from the Wheatland Reservoir section (Coll. 4-A) and as *Triticites* sp. A from the Deadhead Basin section (Coll. 13-C), seemingly are from rocks of early Missourian age. Three forms of *Triticites* are discussed below which seem to be of middle Missourian age; *T. planus* from the Deadhead Basin section (Colls. 13-A and 13-B) and the Garrett section (Coll. 5-B), *Triticites* sp. B from the Garrett section (Coll. 5-A) and the Little Medicine section (Colls. 8-A and 8-B), and *Triticites* sp. A (?) from the Bates Creek Reservoir section (Coll. 9-A).

Specimens in Coll. 4-A from the Wheatland Reservoir section are described and illustrated as *Triticites wyomingensis*, n. sp. Numerous *Triticites* of this general type have been found in rocks of late Missourian age in Kansas, Oklahoma, Missouri, Utah, and New Mexico. The ancestral forerunners of these forms have not been recognized with certainty, and post-Missourian descendants, if such exist, have not been identified.

The most advanced fusulinid from collections which seem to be of Missourian age is described below as *Triticites submucronatus* Thompson, and was obtained about 240 feet above the base of the Casper in the Granite Canyon section (Coll. 1-E). This form seems to be late Missourian in age.

Virgilian fusulinids.—Virgilian fusulinids are present in collections obtained on Sheep Creek (Colls. 10-A and 10-B) and in collections obtained from beds 90 to 95 feet above the base of the Casper at Casper Mountain. They also occur in a collection obtained from beds 520 feet above the base in the Farthing section. The form in Coll. 10-B is described below as *Triticites* sp. C, and seems to be early Virgilian in age. Coll. 10-A from Sheep Creek and collections from beds 95 feet above the base of the Casper at Casper Mountain contain abundant specimens of a form described below as *Triticites kellyensis* Needham. This species is similar to *T. cullomensis* Dunbar and Condra, to *T. beedei* Dunbar and Condra, and to several other fusulinids of Shawnee age in the Midcontinent region, and in Ohio, Illinois, Utah, and New Mexico. Collections from beds 90 feet above the base of the Casper in the eastern part of Casper Mountain contain abundant specimens of *Triticites milleri* Thompson. This species was originally described from the Hartville formation of eastern Wyoming and resembles *T. secalicus* of lower Shawnee age, more closely than it does any other form in the genus. *T. milleri* is not described in detail, but illustrations of the Casper specimens (Pl. 8, figs. 3, 4, 7) are included for comparison with topotypes from eastern Wyoming (Pl. 8, figs. 8, 9).

Wolfcampian fusulinids.—Wolfcampian fusulinids are widespread around the margins of the Laramie Range. Descriptions given below are for specimens from the upper part of the Granite Canyon section (Coll. 1-F), the Gilmore Canyon section (Coll. GC-1), the Rogers Canyon section (Coll. RC-1), the Wall Rock Canyon section (Coll. 3-A), and the Farthing section (Coll. 1-H). A probable Wolfcampian form is described from the Deer Creek section (Coll. 11-A). Poorly preserved specimens of *Triticites* of probable Wolfcampian age are present about 290 feet (Coll. 12-B) and 407 feet (Coll. 12-A) above the base of the Casper in the Boxelder Canyon section. An abundant Wolfcampian fusulinid fauna was collected from a limestone about 400 feet above the base of the Casper in Telephone Canyon. A rather large variety of Wolfcampian forms is represented in these collections from the upper part of the Casper of the Laramie Range, and the following forms are described and illustrated below: *Triticites onustus* n. sp. (Coll. 11-A); *T. ventricosus* (Meek and Hayden), (Coll. 3-A); *T. notus*, n. sp. (Colls. 3-A, 1-H and 1-F); and *Schwagerina* sp. (Colls. 1-F, 1-H, GC-3 and TC-3).

The form described below from the Deer Creek section as *Triticites onustus*, n. sp., is closely similar to and presumably closely related in age to fusulinids which are widespread in lower Wolfcampian rocks in the Midcontinent region, north-central Texas, and New Mexico. *Triticites ventricosus* and *T. notus*, or very closely similar forms, are widespread in lower Wolfcampian rocks in the Midcontinent area, Texas, and the southern Rocky Mountain area. These forms are associated with *Schwagerina* sp. in the Granite Canyon section (Coll. 1-F) and in the Farthing section (Coll. 1-H). The form here described as *Schwagerina* sp. is closely similar to and presumably closely related in age to forms of the genus in Wolfcampian rocks in many parts of the south-central and western United States. Although the material available for study was not adequate for a specific identification of the *Schwagerina*, it is evident that the containing beds in the Casper formation are early Wolfcampian in age.

Other fossils found in the upper part of the Casper which seem to have age significance are specimens of a snail, *Omphalotrochus*, which were collected by McCurdy from a limestone in the Farthing section some distance above a bed carrying Wolfcampian fusulinids (Pl. 9). These were submitted to J. Brookes Knight in 1941, prior to the recognition of Wolfcampian fusulinids in lower beds. At that time he wrote (Personal communication to H. D. Thomas):

> The large gastropods from the Casper are very interesting to me for they seem to be examples of the genus *Omphalotrochus*, and, in my opinion, the beds from which they came are no older than Wolfcamp. The species seems to be very close to, if not identical with, *O. whitneyi* Meek hitherto known only from the McCloud of California and from the U.S.S.R. But I need more and better material before I want to make any pronouncement.

The Wolfcampian age postulated by Dr. Knight for the *Omphalotrochus* bed has been substantiated by the identification of Wolfcampian fusulinids in lower beds but, unfortunately, no better material was ever supplied him for further study.

When Miller and Thomas (1936) described the nautiloid fauna from the Gilmore Canyon section, they said:

> . . . whereas the assemblage seems to be more or less typical of the Upper Pennsylvanian, it would not be incompatible with the Lower Permian. The chief difficulty in making a precise age-determination is that we know relatively little about Lower Permian nautiloids . . .

It is now known that the fauna is definitely of Wolfcampian age, since it occurs about 100 feet above a limestone carrying *Triticites notus*, n. sp., and *Schwagerina*, both being diagnostic Wolfcampian forms.

MEASURED SECTIONS AND COLLECTING POINTS

In the following descriptions of locations of measured sections and collecting points, the figure in parentheses immediately following the collection number indicates the approximate height of the collection above the base of the Casper formation.

Granite Canyon Section: Measured by H. R. McCurdy, 1940; sec. 8, T. 13 N., R. 69 W.; Coll. 1-E (240 ft.), *Triticites submucronatus*; Coll. 1-F (630 ft.), *Schwagerina* sp., *Triticites notus*.

Gilmore Canyon Section: Measured by H. D. Thomas, 1935; sec. 3, T. 14 N., R. 72 W. to sec. 2, T. 14 N., R. 73 W.; Coll. GC-A (175 ft.), *Fusulina* sp.; Coll. GC-B (185 ft.), *Fusulina* sp. undesc.; Coll. GC-1 (520 ft.), *Triticites notus*, *Schwagerina* sp.

Telephone Canyon Collecting Points: Coll. TC-2 (50 ft.), H. D. Thomas and Alan Shaw; sec. 14, T. 15 N., R. 72 W., *Fusulina* sp.; Coll. TC-3 (400 ft.), Thomas and Shaw, sec. 15, T. 15 N., R. 72 W., *Triticites notus* n. sp., *Schwagerina* sp.

Rogers Canyon Section: Measured by J. W. Harrison, 1937; secs. 3, 4 and 5, T. 17 N., R. 72 W.; Coll. RC-3 (25 ft.), Alan Shaw, sec. 3, T. 16 N., R. 72 W., *Fusulina* sp.; Coll. RC-2 (90 ft.), Alan Shaw, sec. 3, T. 16 N., R. 72 W., *Fusulina pristina?*; Coll. RC-1 (400 ft.), H. D. Thomas, sec. 5, T. 16 N., R. 72 W., *Triticites ventricosus?*.

Wall Rock Canyon Section: Measured by J. W. Harrison, 1937, sec. 6, T. 18 N., R. 72 W.; Coll. 3-A (400 ft.), *Triticites ventricosus*, *Triticites notus*, *Triticites onustus?*.

Farthing Section: Measured by H. R. McCurdy, 1940; secs. 14, 31 and 36, T. 19 N., R. 70 W.; Coll. 1-A (310 ft.), *Fusulina* sp.; C. R. Hammond Coll. (520 ft.), sec. 14; *Triticites milleri*; Coll. 1-H (770 ft.), *Triticites ventricosus?*, *Schwagerina* sp., *Triticites* aff. *T. notus*.

Deadhead Basin Section: Lower part measured by J. W. Harrison, 1937; sec. 24, T. 21 N., R. 70 W. and sec. 24, T. 20 N., R. 69 W.; Coll. Haun-C (165 ft.), *Fusulina* sp.; Coll. 13-F (289 ft.), *Fusulina casperensis*, *Fusulina* sp.; Coll. 13-E (298 ft.), *Fusulina plattensis*, *Fusulina* sp.; Coll. 13-D (340 ft.), *Fusulina retusa*; Coll. 13-C (398 ft.), *Triticites* sp. A, *Schubertella* sp.; Coll. 13-B (405 ft.), *Triticites planus*; Coll. 13-A (417 ft.), *Triticites planus?*. Upper part of Casper, Opeche, and Minnekahta measured by H. R. McCurdy, 1940.

Wheatland Reservoir Section: Measured by J. W. Harrison, 1937, secs.

20, 29 and 32, T. 23 N., R. 73 W.; Coll. 4-C (talus), *Fusulina retusa*; Coll. 4-B (176 ft.), *Triticites nebraskensis*; Coll. 4-A (200 ft.), *Triticites wyomingensis*.

Garrett Section: Measured by J. W. Harrison, 1937; secs. 11 and 14, T. 24 N., R. 74 W.; Coll. 5-B (70 ft.), *Triticites planus*; Coll. 5-A (101 ft.), *Triticites* sp. B.

Little Medicine Section: Measured by J. W. Harrison, 1937; sec. 21, T. 29 N., R. 77 W.; Coll. 8-C (11 ft.), *Triticites* sp. B?; Coll. 8-B (73 ft.), and Coll. 8-A (86 ft.), *Triticites* sp. B.

Bates Creek Reservoir Section: Measured by J. W. Harrison, 1937; sec. 29, T. 30 N., R. 78 W.; Coll. 9-A (20 ft.), *Triticites* sp. A?.

Sheep Creek Section: Measured by J. W. Harrison, 1937; secs. 5 and 6, T. 30 N., R. 79 W.; Coll. 10-B (94 ft.), *Triticites* sp. C; Coll. 10-A (114 ft.), *Triticites kellyensis*.

Casper Mountain: Measured by Frank C. Sims, 1947; sec. 9, T. 32 N., R. 79 W.; Sims Coll. (95 ft.), *Triticites kellyensis*.

East Casper Mountain: Measured by W. A. Sears, 1948; Casper measured in sec. 22, T. 32 N., R. 78 W., Opeche and Minnekahta in secs. 28 and 30, T. 32 N., R. 78 W.; Sears Coll. (90 ft.), *Triticites milleri*.

Deer Creek Canyon: Measured by Harrison, 1937; sec. 26, T. 32 N., R. 77 W.; Coll. 11-A (234 ft.), *Triticites onustus*.

Boxelder Canyon: Measured by J. W. Harrison, 1937; secs. 6 and 7, T. 32 N., R. 74 W.; Coll. 12-B (290 ft.), *Triticites* sp. indet.; Coll. 12-A (407 ft.), *Triticites* cf. *T. ventricosus*.

SYSTEMATIC PALEONTOLOGY

Family FUSULINIDAE Möller

Subfamily SCHUBERTELLINAE Skinner

Genus SCHUBERTELLA Staff and Wedekind

Schubertella sp.

Plate 2, figure 19

Only one specimen of *Schubertella* sp. was found in our collections from the Casper formation. It contains four volutions and is 0.59 mm long and 0.23 mm wide, giving a form ratio of 2.3. The shell is elongate spindle-shaped, with sharply pointed poles and strongly inflated central area. The first volution is deeply umbilicate with a short axis of coiling that is at an angle of about 90 degrees to the axis of the outer volutions. The axis of the second volution is about 45 degrees from that of the last volution. The form ratios of the first to the fourth volution are 0.6, 1.4, 1.8, and 2.8, respectively.

The spirotheca is exceedingly thin and is composed of a lower layer that is rather transparent in nature and an upper layer, the tectum. A discontinuous layer occurs above the tectum that may be parts of the chomata. The spirotheca of the third volution is about 5 microns thick, and that of the fourth volution is about 6 microns thick.

So far as can be determined, the septa are unfluted.

The tunnel is wide, and the tunnel angle measures 35 and 40 degrees, respectively, in the third and fourth volutions. The chomata are very narrow but distinct. Dense axial fillings are confined to the immediate axial area in the outer two volutions.

Remarks.—The specimen here referred to *Schubertella* sp. resembles in practically all generic respects the type specimens of *Fusiella typica* Lee and Chen, the genotype of *Fusiella* Lee and Chen, except that the spirotheca of our specimen contains an exceedingly thin clear lower layer. It should be pointed out that if this specimen were not well preserved it would be quite difficult or impossible to distinguish it generically from *Fusiella*.

This specimen resembles in general shape *Schubertella kingi* Dunbar and Skinner, a form that is widespread in the Wolfcampian of America. However, it is smaller than *S. kingi*, has axial fillings not found in the latter, and has a different shell shape.

No other similar fusulinid has been described from America.

Occurrence.—The specimen here referred to *Schubertella* sp. was obtained from about 398 feet above the base of the Casper formation in the section measured at Deadhead Basin (Coll. 13-C). It is associated with the form described below as *Triticites* sp. A.

Subfamily FUSULININAE Rhumbler

Genus FUSULINA Fischer de Waldheim

Fusulina casperensis, new species

Plate 1, figures 3–11

The shell of *Fusulina casperensis*, n. sp., is small and highly inflated fusiform; with sharply pointed poles, slightly curving to irregular axis of coiling, and straight, convex, or irregular lateral slopes. Some specimens have highly inflated central areas, sharply pointed poles, and deeply concave lateral slopes. Specimens of five and a half to six volutions are 3.0 to 3.9 mm long and 0.9 to 1.6 mm wide. The first volution of many specimens is short, and the shell is almost spherical with rounded polar areas. The poles are sharply pointed from the second volution to maturity. Averages of the form ratios of the first to the sixth volution of seven specimens are 1.2, 1.6, 2.1, 2.4, 2.8, and 2.6, respectively.

The proloculus is small, and its outside diameter measures 60 to 100 microns, averaging 76 microns for nine specimens. The inner two volutions are tightly coiled, the following two volutions expand rapidly, and the outer two volutions are inflated. Averages of the heights of the first to the sixth volution of ten specimens are 38, 53, 88, 133, 173, and 205 microns, respectively.

Measurements of *Fusulina casperensis*, n. sp., in millimeters. Specimen 6 is the holotype.

SPECIMEN	L.	W.	RATIO	NO. VOL.	DIAM. OF PROL.	HEIGHT OF VOLUTIONS							FORM RATIO OF VOLUTIONS					
						1	2	3	4	5	6	7	1	2	3	4	5	6
1	3.48	1.40	2.5	6	.063	.037	.053	.092	.179	.194	.194	—	1.1	1.5	2.3	2.7	2.6	2.5
2	—	1.63	—	6	.087	.035	.052	.087	.130	.191	.229	—	1.2	1.7	2.0	2.6	3.5	—
3	3.86	1.57	2.5	6	.097	.036	.060	.111	.145	.204	.218	—	1.1	1.7	1.7	2.1	2.5	2.5
4	3.83	1.62	2.5	6½	.082	.040	.061	.110	.139	.174	.174	.223	1.4	1.8	2.3	2.3	2.5	2.6
5	—	0.89	—	5½	.073	.042	.044	.073	.118	.139	—	—	1.3	1.3	2.0	2.6	2.7	—
6	3.65	1.57	2.3	6	.075	.035	.056	.087	.174	.209	.226	—	1.1	1.9	2.1	2.3	—	—
7	2.96	1.01	3.0	6	.061	.035	.035	.061	.087	.134	.209	—	0.9	1.2	2.3	2.5	2.9	3.0
8	—	0.83	—	4½	.077	.050	.061	.096	.127	—	—	—	—	—	—	—	—	—
9	—	1.18	—	6	.067	.036	.046	.063	.095	.117	.189	—	—	—	—	—	—	—
10	—	0.93	—	5	—	.035	.054	.088	.135	.189	—	—	—	—	—	—	—	—

SPECIMEN	THICKNESS OF SPIROTHECA				SEPTAL COUNT						TUNNEL ANGLE (DEGREES)				
	3	4	5	6	1	2	3	4	5	6	3	4	5	6	7
1	.018	.022	.024	.024	—	—	—	—	—	—	20	24	20	33	—
2	—	.014	.024	.029	—	—	—	—	—	—	21	20	24	37	—
3	.014	.024	.027	.024	—	—	—	—	—	—	22	28	31	38	—
4	.019	.024	.031	.026	—	—	—	—	—	—	20	24	31	32	—
5	—	.019	.024	—	—	—	—	—	—	—	19	22	23	—	—
6	.014	.021	.036	.029	—	—	—	—	—	—	26	—	32	41	—
7	—	.024	.030	.028	—	—	—	—	—	—	16	20	25	26	—
8	.014	.016	—	—	7	15	16	21	—	—	—	—	—	—	—
9	—	.016	.021	.032	9	15	15	19	17	21	—	—	—	—	—
10	—	—	.020	.027	7	12	15	19	21	—	—	—	—	—	—

The spirothecal structure is typical of the genus, but the diaphanotheca is very thin and cannot be recognized in the polar region or in the inner volutions. In some specimens the spirotheca is as thick as 38 microns in the center of the tunnel of the sixth volution, but in other specimens it is only about 25 microns thick in the same part of the shell.

The septa are thin and are highly fluted throughout the length of the shell. The undulations of the septa extend to the tops of the chambers completely across the shell, but the closed chamberlets extend only about half as high as the chambers. Averages of the septal counts of the first to the sixth volution of three specimens are 8, 14, 15, 20, 19, and 21, respectively.

The tunnel is narrow, and its path is straight to slightly irregular. Averages of the tunnel angles of the third to the sixth volution of seven specimens are 21, 24, 27, and 36 degrees, respectively. Chomata are large throughout the shell, except in the outer part of the last volution. However, the chomata spread up onto the sides of the septa, and the septal fluting causes the chomata to seem less massive in axial sections than their cross section demonstrates them to be. The chomata are high and possess steep slopes on both sides near the center of the chambers, but the chomata spread poleward along the septa with slowly decreasing thickness.

Remarks.—*Fusulina casperensis* differs from *F. plattensis* Thompson in its shorter shell, smaller proloculus, more loosely coiled shell beyond the third volution, and smaller form ratios of outer volutions.

A few sections of abnormally elongate specimens were obtained in association with the specimens described above that do not seem to be referable to any previously described species. Their septa do not seem to be closely fluted across the central part of the shell, and their chomata are very broad in the inner volutions and extend into the axial regions. Also, the shell contains more volutions than the specimens described above as *Fusulina casperensis*. Their chambers are much lower in corresponding volutions than those of *F. casperensis*. We do not have enough material to describe this form but have included illustrations of two of the specimens as *Fusulina* sp. (Pl. 1, figs. 1, 2) in order to show the associated fusulinid fauna of *F. casperensis*.

Occurrence.—*Fusulina casperensis* is abundant in Collection 13-F from about 289 feet above the base of the Casper formation at Deadhead Basin where it is associated with specimens here illustrated as *Fusulina* sp.

Fusulina plattensis Thompson

Plate 1, figures 12–14, 16–18

Fusulina plattensis Thompson, 1936, Jour. Paleontology, vol. 10, pp. 109–111, pl. 14, figs. 12–17.

Fusulina sp. Thompson, 1936, *Ibid.*, p. 111, pl. 14, figs. 23, 24.

Fusulina plattensis was described originally from the Hartville limestone near Guernsey, Wyoming (Thompson, 1936). Several specimens associated with its type specimens were referred by Thompson to *Fusulina* sp., all of which we now consider conspecific. The following description is based entirely on specimens from our Collection 13-E from about 298 feet above the base of the Casper formation at Deadhead Basin on the eastern side of the southern portion of the Laramie Range.

The shell of *Fusulina plattensis* is small and elongate fusiform; with a straight axis of coiling, straight to slightly concave lateral slopes, and sharply pointed poles. Specimens of six to seven volutions are 3.2 to 4.5 mm long and 1.1 to 1.6 mm wide. The shell of the first volution is short and inflated, but it increases in length rapidly and almost uniformly toward maturity. Averages of the form ratios of the first to the seventh volution of six specimens are 1.3, 1.7, 2.1, 2.3, 2.7, 2.8, and 2.7, respectively.

The spirotheca contains a moderately thin diaphanotheca, but the tectoria are relatively thick. Averages of the thicknesses of the tectum plus the diaphanotheca of the third to the seventh volution of seven specimens are 14, 20, 27, 30, and 33 microns, respectively.

The septa are thin, and their structure is typical of the genus. They are fluted throughout the length of the shell, and the fluting seems to extend to the tops of the septa with rapidly decreasing intensity. The averages of the septal counts of the first to the sixth volution of two specimens are 10, 15, 18, 20, 24, and 28, respectively.

Measurements of *Fusulina plattensis* Thompson in millimeters

SPECIMEN	L.	W.	RATIO	NO. VOL.	DIAM. OF PROL.	HEIGHT OF VOLUTIONS							FORM RATIO OF VOLUTIONS						
						1	2	3	4	5	6	7	1	2	3	4	5	6	7
1	3.26	1.33	2.4	7	.135	.034	.046	.063	.090	.135	.155	.230	1.1	1.4	1.9	2.1	2.7	2.6	2.4
2	3.51	1.18	3.0	5½	.105	.061	.068	.095	.124	.169	—	—	1.4	2.2	2.4	2.5	2.8	—	—
3	3.51	1.40	2.5	6½	.094	.043	.046	.068	.097	.149	.165	.189	1.4	1.7	2.0	2.3	2.4	2.5	—
4	3.24	1.10	3.0	6	.089	.040	.050	.065	.098	.135	.176	—	1.2	1.6	1.9	2.1	2.6	3.0	—
5	3.38	1.28	2.7	6	.114	.036	.049	.067	.095	.124	.186	—	1.3	1.8	1.9	2.2	2.9	2.7	—
6	4.48	1.55	2.9	7	.104	.036	.047	.067	.085	.135	.203	.203	1.6	1.8	2.2	2.4	2.7	3.0	2.9
7	—	1.35	—	6	.097	.036	.047	.076	.116	.158	.177	—	—	—	—	—	—	—	—
8	—	1.45	—	6	.108	.035	.057	.080	.122	.148	.169	—	—	—	—	—	—	—	—

SPECIMEN	THICKNESS OF SPIROTHECA								SEPTAL COUNT						TUNNEL ANGLE (DEGREES)					
	0	1	2	3	4	5	6	7	1	2	3	4	5	6	2	3	4	5	6	7
1	—	—	—	—	.023	.028	.034	.034	—	—	—	—	—	—	—	—	22	22	30	30
2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	19	24	30	38	—	—
3	—	—	—	.015	.021	.032	.032	.031	—	—	—	—	—	—	—	18	16	27	30	34
4	.008	—	—	.017	.024	.020	.031	—	—	—	—	—	—	—	—	—	20	29	30	—
5	—	—	—	—	—	.026	.034	—	—	—	—	—	—	—	—	—	19	20	26	22
6	—	—	—	.013	.019	.034	.028	—	—	—	—	—	—	—	21	22	32	28	36	—
7	.008	—	—	—	.017	.026	.024	—	9	14	16	19	22	28	—	—	—	—	—	—
8	.013	—	—	.010	.016	.022	.028	—	11	16	20	20	26	28	—	—	—	—	—	—

The tunnel is narrow and relatively straight throughout the shell. Averages of the tunnel angles of the second to the seventh volution of six specimens are 20, 21, 23, 27, 31, and 29 degrees, respectively. The chomata are about two-thirds as high as the chambers in the third to the fifth volution, and they are highly asymmetrical but narrow.

Remarks.—*Fusulina plattensis* is among the smaller of the forms of the genus and seemingly is a moderately early form of the genus. Closely similar, if not specifically identical, specimens of *Fusulina* are very widespread in the central and western states only a short distance above the base of the Desmoinesian Stage. The most closely similar forms so far described from America are *Fusulina leei* Skinner from immediately above the Bluejacket sandstone of northern Oklahoma, in the Boggy formation of southern Oklahoma, in the Cherokee shale of Iowa, and in the Curlew limestone of Illinois, and *F. kayi* Thompson from the Cherokee shale of Iowa. All three of these forms may represent regional variations of the same species, and the differences among them possibly are not of sufficient magnitude to indicate distinct species. All three of them occur at about the same stratigraphic level, further suggesting that they may represent geographic variations of the same species. Comparative studies are being carried further concerning these three forms, and the results will be published at a later date.

Occasional specimens of a highly elongate and tightly coiled form that has weakly fluted septa are associated with the specimens of *Fusulina plattensis* described above. These specimens resemble *Fusulina carmani* (Thompson) from the Vanport limestone of Ohio in some respects. However, we do not have enough specimens from Wyoming to understand most features of this form but are illustrating one of our specimens (Pl. 1, fig. 15) and are referring them with question to *F. plattensis*.

Occurrence.—The above description of *Fusulina plattensis* is based on numerous specimens from Collection 13-E obtained from about 298 feet above the base of the Casper formation at Deadhead Basin. The original types are from about 450 feet above the base of the Hartville formation in the Hartville Uplift near Guernsey, Wyoming.

Fusulina retusa, new species

Plate 1, figures 19, 20; Plate 2, figures 1–9, 10?, 11–14

The shell of *Fusulina retusa*, n. sp., is large and inflated fusiform; with slightly irregular convex lateral slopes, almost straight axis of coiling, and

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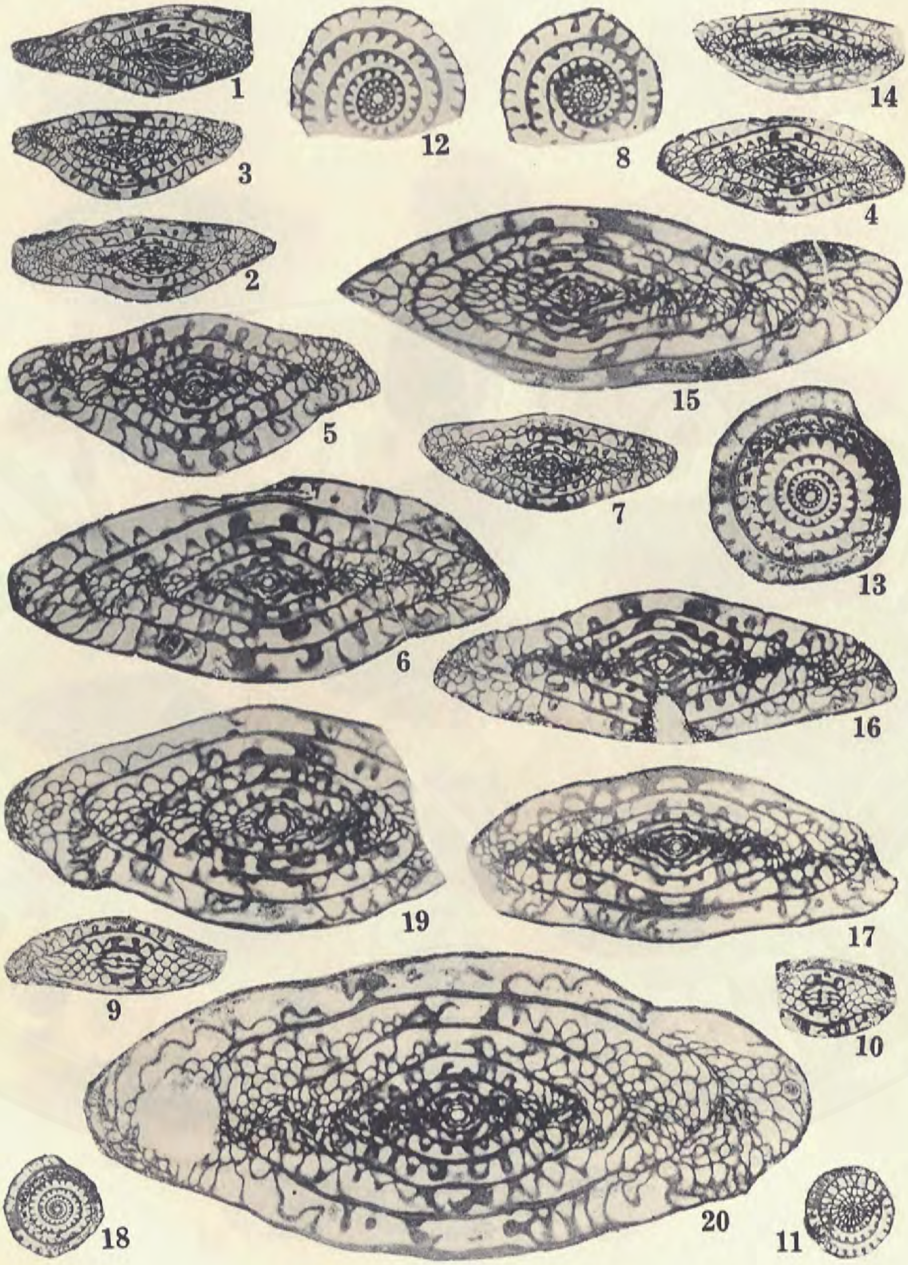
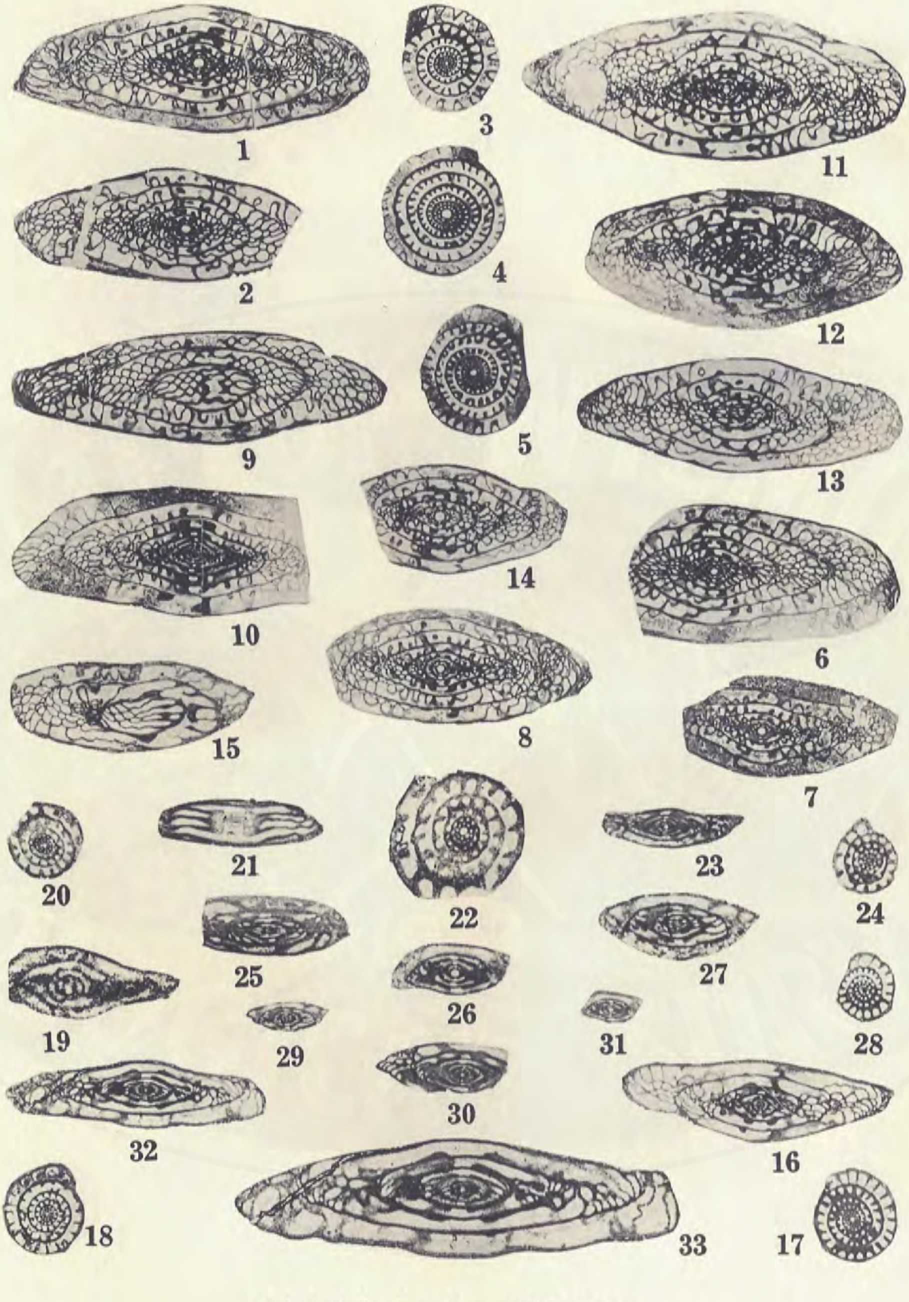
EXPLANATION OF PLATE 1

All illustrations on this plate are unretouched photographs.

FIGURES	PAGE
1, 2—*Fusulina* sp. *1*, Axial section, about ×8.7; and *2*, tangential section, about ×8.7. From Coll. 13-F, Deadhead Basin	*Facing 26*
3–11—*Fusulina casperensis*, n. sp. *3, 5, 7*, Axial sections of paratypes; *4, 6*, axial section of the holotype; *8*, sagittal section of a paratype; *9, 10*, tangential sections of paratypes; and *11*, parallel section of a paratype: *5, 6, 8*, are about ×17.5, and all others about ×8.7. Coll. 13-F, Deadhead Basin	*Facing 26*
12–18—*Fusulina plattensis* Thompson. *12, 13, 18*, Sagittal sections; *14*, axial section; *15*, tangential section of an abnormally long specimen that may not be referable to this form; and *16, 17*, axial sections. *12, 13, 15–17* are about ×17.5, and all others about ×8.7. Coll. 13-E, Deadhead Basin	*Facing 26*
19, 20—*Fusulina retusa*, n. sp. *19*, Axial section of a paratype; and *20*, axial section of the holotype; both about ×17.5. Coll. 13-D, Deadhead Basin	*Facing 26*



Fusulina



Schubertella, *Fusulina*, and *Triticites* bluntly pointed poles. Mature shells of six to seven and a half volutions are 3.7 to 5.6 mm long and 1.5 to 2.3 mm wide. The first volution is ellipsoidal in shape; the next two to three volutions are inflated fusiform with sharply pointed poles; and the outer volutions have slightly extended poles. The averages of the form ratios of the first to the sixth volution of eleven specimens are 1.6, 1.9, 2.1, 2.2, 2.4, and 2.6, respectively. The shell of the holotype specimen departs from these averages in form ratio. It is slightly more highly inflated up to the fifth volution.

The proloculus is small, and its outside diameter measures 87 to 223 microns, averaging 152 microns for sixteen specimens. The shell expands slowly to the third or fourth volution, expands rapidly from the fourth to the fifth volution, and again expands slowly from the fifth volution to maturity. Averages of the heights of the first to the seventh volution of sixteen specimens are 46, 68, 100, 141, 197, 221, and 246 microns, respectively. The expansion of the third to the fourth volution of the holotype specimen is considerably more rapid than is shown by the above averages.

The spirothecal structure is typical of the genus, although the tectoria are thinner than those found in most American forms of *Fusulina* from the lower half of the Zone of *Fusulina*. The wall of the proloculus measures about 14 to 21 microns, averaging about 18 microns for six specimens. The wall of the proloculus is too thin to measure accurately, however, and the above figures are only close approximations. The spirotheca is too thin to measure accurately in the first two volutions. The averages of the combined thicknesses of the tectum and diaphanotheca in the third to the sixth volution of fourteen specimens are 16, 22, 25, and 28 microns, respectively.

The septa are thin and are highly and closely fluted throughout the length of the shell. The fluting extends to the top of the chambers. Closed

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EXPLANATION OF PLATE 2

All illustrations on this plate are unretouched photographs.

FIGURES		PAGE
1–14	*Fusulina retusa*, n. sp. *1*, *2*, *6–8*, *12*, Axial sections of paratypes; *3–5*, sagittal sections of paratypes; *9*, *13*, tangential sections of paratypes; *10*, axial section of a specimen referred with question to this form as a possible microspheric individual; *11*, axial section of the holotype. All are magnified about ×8.7. *1–10* are from Coll. 4-C, Wheatland Reservoir, and *11–14*, are from Coll. 13-C, Deadhead Basin	*Facing 27*
15–18	*Triticites* sp. A. *15*, *16*, Tangential sections; *17*, *18*, sagittal sections; all about ×8.7. All from Coll. 13-C, Deadhead Basin	*Facing 27*
19	*Schubertella* sp. Axial section, about ×44, from Coll. 13-C, Deadhead Basin	*Facing 27*
20–33	*Triticites nebraskensis* Thompson. *20*, *22*, *24*, Sagittal sections; *21*, *25*, *27*, *29*, tangential sections; *23*, *26*, *30–33*, axial sections; and *28*, parallel section. *21*, *23*, *25*, and *28–32* are about ×8.7, and *20*, *22*, *24*, *26*, *27*, and *33*, are about ×17.5. Coll. 4-B, Wheatland Reservoir	*Facing 27*

Measurements of *Fusulina retusa*, n. sp., in millimeters, all from Collection 13-D, Deadhead Basin section. Specimen 1 is the holotype.

SPECIMEN	L.	W.	RATIO	NO. VOL.	DIAM. OF PROL.	HEIGHT OF VOLUTIONS							FORM RATIO OF VOLUTIONS						
						1	2	3	4	5	6	7	1	2	3	4	5	6	7
1	5.59	2.33	2.4	7½	.102	.042	.051	.074	.135	.202	.225	.305	1.3	1.4	1.8	1.9	2.1	2.7	2.4
2	4.86	1.96	2.5	6½	.135	.019	.032	.081	.155	.179	.216	.250	1.5	2.2	2.4	—	2.1	2.4	—
3	3.78	1.58	2.4	6	.135	.045	.045	.077	.108	.189	.256	—	1.2	1.8	1.8	2.0	2.4	2.4	—
4	3.92	1.71	2.3	6	.182	.040	.078	.135	.172	.189	.182	—	1.3	1.9	2.0	2.0	2.2	2.3	—
5	3.65	1.62	2.3	5	.189	.046	.072	.128	.151	.250	—	—	1.7	2.0	2.2	2.0	2.3	—	—
6	—	1.46	—	5	.158	.039	.063	.101	.154	.225	—	—	—	—	—	—	—	—	—
7	—	1.66	—	6	.162	.044	.072	.090	.124	.214	.254	—	—	—	—	—	—	—	—
8	—	—	—	3½	.223	.063	.135	.135	—	—	—	—	—	—	—	—	—	—	—

SPECIMEN	THICKNESS OF DIAPHANOTHECA								SEPTAL COUNT					TUNNEL ANGLE (DEGREES)						
	0	1	2	3	4	5	6	7	1	2	3	4	5	1	2	3	4	5	6	7
1	—	—	—	.012	.017	.019	.027	.031	—	—	—	—	—	—	14	13	12	20	22	42
2	—	—	—	—	.024	.024	.021	—	—	—	—	—	—	—	16	18	28	31	45	—
3	—	—	—	—	.016	.027	.032	—	—	—	—	—	—	18	22	19	22	34	40	—
4	—	—	—	.023	.030	.036	.031	—	—	—	—	—	—	—	16	23	19	22	42	—
5	.017	—	—	.018	.027	.027	—	—	—	—	—	—	—	21	22	27	33	32	—	—
6	.019	—	.013	.016	.023	.029	—	—	10	16	20	26	24	—	—	—	—	—	—	—
7	.017	—	—	.012	.022	.024	.024	—	11	16	19	24	26	—	—	—	—	—	—	—
8	.019	—	—	.019	—	—	—	—	12	22	23	—	—	—	—	—	—	—	—	—

Measurements of *Fusulina retusa*, n. sp., in millimeters, all from Collection 4-C, Wheatland Reservoir Section.

SPECIMEN	L.	W.	RATIO	NO. VOL.	DIAM. OF PROL.	HEIGHT OF VOLUTIONS							FORM RATIO OF VOLUTIONS					
						1	2	3	4	5	6	7	1	2	3	4	5	6
1	4.82	1.70	2.8	6	.163	.052	.087	.120	.144	.205	.230	—	1.6	1.7	1.7	1.8	2.2	2.8
2	5.54	1.94	2.8	6½	.170	.053	.073	.112	.160	.194	.218	.218	1.7	2.1	2.3	2.4	2.6	2.8
3	5.54	1.84	3.0	8½	—	—	—	—	—	—	—	—	—	—	—	—	—	—
4	4.30	1.66	2.6	6	.136	.053	.063	.097	.139	.194	.213	—	1.1	1.6	2.1	2.2	2.6	2.6
5	—	—	—	—	.165	.045	.077	.116	.184	.213	—	—	1.7	2.0	2.5	2.9	3.0	—
6	—	2.00	—	6½	.191	.053	.084	.115	.139	.184	.191	.208	—	—	—	—	—	—
7	—	1.74	—	6	.118	.050	.059	.092	.140	.187	.190	—	—	—	—	—	—	—
8	—	1.74	—	6½	.087	.031	.048	.063	.107	.174	.224	—	—	—	—	—	—	—
9	4.28	1.70	2.5	6½	.108	.027	.047	.058	.095	.149	.234	.248	1.5	2.3	2.4	2.4	2.4	2.7
10	3.73	1.45	2.6	6	—	—	—	—	—	—	—	—	1.3	1.7	1.6	1.8	2.4	2.6

SPECIMEN	THICKNESS OF DIAPHANOTHECA								SEPTAL COUNT						TUNNEL ANGLE (DEGREES)						
	0	1	2	3	4	5	6	7	1	2	3	4	5	6	1	2	3	4	5	6	7
1	—	—	—	.016	.023	.020	.027	—	—	—	—	—	—	—	—	12	14	31	29	26	—
2	.021	—	—	.012	.020	.024	.038	—	—	—	—	—	—	—	—	26	24	32	35	54	—
3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	14	18	19	32
4	.014	—	.010	.016	.019	.019	.030	—	—	—	—	—	—	—	—	—	16	22	33	34	—
5	—	—	.013	.010	.017	.027	—	—	—	—	—	—	—	—	—	23	39	43	45	—	—
6	—	—	—	—	—	—	—	—	13	19	24	28	30	35	—	—	—	—	—	—	—
7	—	—	—	—	—	—	—	—	10	16	21	25	29	36	—	—	—	—	—	—	—
8	—	—	—	.016	.019	.026	.026	—	11	16	18	19	21	26	—	—	—	—	—	—	—
9	—	—	—	—	—	—	—	.030	—	—	—	—	—	—	—	—	16	17	27	34	—
10	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	20	28	37	37	—

chamberlets are more than half as high as the chambers in the center of the shell.

The tunnel is narrow, and its path is slightly irregular. Averages of the tunnel angles of the first to the sixth volution of eleven specimens are 20, 19, 22, 26, 33, and 37 degrees, respectively. Chomata are present in all chambers, except those of the outer part of the ultimate volution. In the first two or three volutions the chomata are well defined and extend almost to the polar regions. Beyond the third volution they are narrow and extend up the sides of the septa but are very low in the center of the chambers.

Remarks.—*Fusulina retusa* is moderately large for the genus. Forms of similar or larger size described from America include *Fusulina haworthi* Beede, *F. girtyi* (Dunbar and Condra), *F. megista* Thompson, *F. mysticensis* Thompson, *F. stookeyi* Thompson, *F. eximia* Thompson, *F. illinoisensis* Dunbar and Henbest, *F. piasaensis* Dunbar and Henbest, *F. lonsdalensis* Dunbar and Henbest, and *F. acme* Dunbar and Henbest. Of these numerous forms, *F. retusa* compares somewhat favorably in size with *F. haworthi* from the Fort Scott limestone of Kansas. Its proloculus, however, is smaller than that of *F. haworthi*, its shell is more tightly coiled in the early volutions, and its outer volutions are more inflated.

The stratigraphic age of *Fusulina retusa* is not clearly understood. Its highly fluted septa and large shell suggest that it is equivalent in age to the lower Marmaton group rather than to the upper Cherokee of the Midcontinent area.

Occurrence.—*Fusulina retusa* is abundant in one of our collections from about 340 feet above the base of the Casper formation at Deadhead Basin (Coll. 13-D) and from the talus on the lower part of the Wheatland Reservoir section (Coll. 4-C).

Subfamily SCHWAGERININAE Dunbar and Henbest

Genus TRITICITES Girty

Triticites nebraskensis Thompson

Plate 2, figures 20–33

Fusulina exigua Staff, 1910, Zoologica, vol. 22, pt. 58, p. 39, fig. 25—Staff, 1912, Palaeontographica, vol. 59, pp. 179–180, pl. 15, fig. 4, text fig. 10 [*Not* Schellwien and Dyhrenfurth, 1909].

Triticites exiguus Dunbar and Condra, 1928, Nebraska Geol. Survey, Bull. 2, 2d ser., pp. 111–113, pl. 8, figs. 1–5 (1927).

Triticites nebraskensis Thompson, 1934, Iowa Univ. Studies Nat. History, vol. 16, pp. 281–282—Needham, 1937, New Mexico School Mines, Bull. 14, pp. 30–32, pl. 4, figs. 2, 3.

The specimens of *Triticites nebraskensis* identified from among our Wyoming material are minute in size and elongate fusiform in shape; with acutely pointed poles, straight axes of coiling, and slightly convex lateral slopes. Specimens of four and a half to six volutions are 2.2 to 3.8 mm long and 0.8 to 1.1 mm wide. The form ratios of the first to the sixth volution of our largest specimen of six volutions are 1.5, 2.0, 2.4, 2.7, 3.4, and 3.7, respectively. In another specimen, a form ratio of 3.1 is attained by the fourth volution.

The proloculus is minute in size, and its outside diameter measures 63 to 100 microns, averaging 82 microns for four specimens. The first two volutions are tightly coiled, and the shell expands uniformly from the third volution to maturity. Averages of the heights of the first to the sixth volution of four specimens are 33, 41, 58, 96, 140, and 191 microns, respectively.

Measurements of *Triticites nebraskensis* Thompson in millimeters.

SPECIMEN	L.	W.	RATIO	NO. VOL.	DIAM. OF PROL.	HEIGHT OF VOLUTIONS						FORM RATIO OF VOLUTIONS					
						1	2	3	4	5	6	1	2	3	4	5	6
1	3.78	1.03	3.7	6	.063	.036	.046	.054	.097	.123	.202	1.6	2.3	2.6	2.5	3.4	3.7
2	2.23	0.80	—	4½	.100	.036	.048	.057	.100	.170	—	1.4	2.0	2.6	3.1	—	—
3	—	1.04	—	6	.083	.028	.036	.063	.083	.112	.189	1.4	1.6	2.1	2.4	—	—
4	—	1.12	—	5½	.080	.031	.033	.056	.106	.146	.181	—	—	—	—	—	—
5	—	0.52	—	4½	—	—	—	—	—	—	—	—	—	—	—	—	—

SPECIMEN	THICKNESS OF SPIROTHECA							SEPTAL COUNT						TUNNEL ANGLE (DEGREES)					
	0	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
1	—	—	—	.023	.027	.037	.049	—	—	—	—	—	—	—	—	24	35	51	57
2	.011	—	—	.018	.024	.031	—	—	—	—	—	—	—	—	39	38	59	—	—
3	—	—	—	.014	.019	.031	.048	—	—	—	—	—	—	—	—	—	—	—	—
4	—	—	—	.018	.025	.039	.035	8	11	12	14	15	16	—	—	—	—	—	—
5	—	—	—	—	—	—	—	8	11	12	14	14	—	—	—	20	30	45	43

The spirotheca is very thin and is indistinctly alveolar. Averages of the thicknesses of the spirotheca in the third to the sixth volution of four specimens are 18, 24, 35, and 44 microns, respectively. The spirotheca is too thin in the first two volutions to be measured accurately. The proloculus wall is exceedingly thin and can not be measured with any degree of accuracy.

The septa are thick in comparison to the size of the shell. The spirotheca seemingly extends downward to form the septa with only slightly diminishing thickness. Also, a rapidly thinning wedge of the keriotheca extends down the anterior side of the septa. The septa are almost perfectly straight across the central half of the shell, and they are only slightly fluted in the polar regions. The septal counts of the first to the sixth volution of two specimens are 8, 11, 12, 14, 15, and 16, respectively.

The tunnel is broad, and its path is straight. The averages of the tunnel angles of the third to the sixth volution of three specimens are 27, 41, 48, and 50 degrees, respectively. In one specimen, the tunnel angle of the second volution is about 39 degrees and that of the fourth volution is 59 degrees. Chomata are abnormally massive for the small size of the shell. They are more than half as high as the chambers and extend laterally to the poles in the first three volutions, giving the appearance of axial fillings. In the outer volutions the chomata are highly asymmetrical and have low poleward slopes.

Remarks.—*Triticites nebraskensis* is one of the smallest of the Pennsylvanian forms of the genus. The only forms of *Triticites* to have been described that compare closely in size with it are *T. fresnalensis* Needham and *T. pygmaeus* Dunbar and Condra. The uniformly elongate shell of *T. nebraskensis* and its uniformly expanding shell would serve to distinguish it from *T. pygmaeus*. Its more uniformly expanding shell, less irregular axis of coiling, thicker spirotheca, and less inflated outer chambers distinguish it from *T. fresnalensis*.

Occurrence.—The original type specimens of *Triticites nebraskensis* are from the Lane shale of Nebraska. It was identified by Needham (1937) from lower Missourian rocks in central New Mexico. The above description is based entirely on specimens from about 176 feet above the base of the Casper formation in the Wheatland Reservoir section (Coll. 4-B).

Triticites planus, new species

Plate 3, figures 1–19; (?) Plate 4, figures 1–10

Triticites planus is abundant in several of our collections from the Laramie Range. The following description is based entirely on specimens from Collection 5-B (Garrett) and from Collection 13-B (Deadhead Basin).

The shell of *Triticites planus* is highly elongate subcylindrical in shape; with shifting and irregular axis of coiling, irregular lateral slopes, and blunt polar areas. Specimens of six to seven volutions are 4.6 to 7.6 mm long and 1.4 to 1.8 mm wide, giving form ratios of 3.5 to 4.5. The inner two to three volutions have bluntly pointed poles, strongly convex lateral slopes, and straight axes of coiling. The third to the fourth volutions have sharply pointed poles, but beyond the fourth volution the poles become greatly extended and shift their relative positions. In fact, none of our numerous axial sections intersects the axis of coiling throughout the length of the specimen. Averages of the form ratios of the first to the seventh volution of ten specimens are 1.4, 2.1, 2.9, 3.4, 4.0, 4.0, and 4.5, respectively.

The proloculus is minute, and its outside diameter measures 65 to 112 microns, averaging 85 microns for eighteen specimens. The shell expands uniformly. Average heights of the first to the seventh volution of nineteen

Measurements of *Triticites planus*, n. sp., in millimeters, all from Collection 5-B, Garret section. Specimen 1 is the holotype.

SPECIMEN	L.	W.	RATIO	NO. VOL.	DIAM. OF PROL.	HEIGHT OF VOLUTIONS							FORM RATIO OF VOLUTIONS						
						1	2	3	4	5	6	7	1	2	3	4	5	6	7
1	7.56	1.66	4.5	7	.082	.032	.045	.065	.123	.162	.197	.216	1.2	1.9	3.2	3.5	4.2	4.7	4.5
2	6.29	1.55	4.1	6	.077	.028	.032	.075	.116	.163	.256	—	1.2	2.0	2.8	3.4	4.0	4.1	—
3	5.03	1.05	4.7	5	.091	.028	.074	.100	.156	.221	—	—	1.2	2.0	2.5	3.3	4.7	—	—
4	—	—	—	—	.100	.035	.054	.070	.116	.170	.209	—	—	—	—	—	—	—	—
5	4.57	1.30	3.5	5	.100	.029	.050	.094	.148	.202	—	—	—	—	—	—	—	—	—
6	—	1.39	—	6	.065	.030	.065	.075	.128	.168	.209	—	—	—	—	—	—	—	—
7	—	1.55	—	6½	.097	.043	.053	.068	.127	.148	.203	—	—	—	—	—	—	—	—
8	—	.61	—	4	.081	.037	.042	.075	.105	—	—	—	—	—	—	—	—	—	—

SPECIMEN	THICKNESS OF SPIROTHECA					SEPTAL COUNT						TUNNEL ANGLE (DEGREES)				
	3	4	5	6	7	1	2	3	4	5	6	3	4	5	6	7
1	.017	.024	.041	.054	.061	—	—	—	—	—	—	—	34	50	69	97
2	—	.028	.044	.065	—	—	—	—	—	—	—	23	35	70	—	—
3	—	—	.037	.047	—	—	—	—	—	—	—	23	37	47	—	—
4	—	.025	.042	.051	—	—	—	—	—	—	—	25	38	67	—	—
5	.021	.032	.043	—	—	—	—	—	—	—	—	32	45	70	—	—
6	.013	.027	.035	.054	—	8	13	16	19	21	20	—	—	—	—	—
7	—	.024	.038	.050	.067	9	14	18	19	20	19	—	—	—	—	—
8	—	—	—	—	—	9	13	13	17	—	—	—	—	—	—	—

Measurements of *Triticites planus*, n. sp., in millimeters, all from Collection 13-B, Deadhead Basin section.

SPECIMEN	L.	W.	RATIO	NO. VOL.	DIAM. OF PROL.	HEIGHT OF VOLUTIONS						FORM RATIO OF VOLUTIONS					
						1	2	3	4	5	6	1	2	3	4	5	6
1	3.98	1.03	4.0	5	.082	.034	.045	.078	.121	.155	—	1.5	2.1	3.1	3.8	4.0	—
2	5.90+	1.80	?	6	.112	.033	.053	.097	.145	.201	.242	1.8	2.1	2.7	3.3	3.8	—
3	4.18	1.04	4.0	5	.090	.034	.068	.087	.138	.218	—	1.7	2.7	3.9	4.2	4.0	—
4	5.22	1.33	4.0	5	.087	.032	.053	.008	.141	.243	—	1.6	2.1	3.4	3.7	4.0	—
5	5.91	1.65	3.7	6	—	.034	.051	.084	.121	.218	.243	1.3	1.7	3.5	3.0	3.9	3.7
6	—	1.25	—	5	.065	.031	.048	.082	.178	.243	—	—	—	—	—	—	—
7	—	1.56	—	6	.107	.029	.058	.097	.136	.194	.209	—	—	—	—	—	—
8	—	0.94	—	5	.078	.029	.046	.073	.097	.165	—	—	—	—	—	—	—
9	—	1.16	—	5	.078	.037	.045	.080	.118	.204	—	—	—	—	—	—	—
10	3.73	1.03	3.6	5½	.067	.028	.043	.068	.108	.171	.202	1.5	1.9	2.0	3.0	3.6	—
11	4.66	1.35	3.5	6	.065	.027	.046	.053	.104	.171	.219	1.2	2.1	3.0	3.0	3.6	3.5

SPECIMEN	THICKNESS OF SPIROTHECA							SEPTAL COUNT						TUNNEL ANGLE (DEGREES)				
	0	1	2	3	4	5	6	1	2	3	4	5	6	2	3	4	5	6
1	—	—	—	.017	.024	.048	—	—	—	—	—	—	—	27	30	60	70	—
2	—	—	—	.024	.035	.053	.056	—	—	—	—	—	—	41	46	58	65	70
3	—	—	—	—	.034	.048	—	—	—	—	—	—	—	27	37	57	—	—
4	—	—	—	.014	.025	.048	—	—	—	—	—	—	—	—	44	33	62	70
5	—	—	—	.015	.024	.048	.058	—	—	—	—	—	—	—	24	35	47	69
6	—	—	—	.014	.029	.045	—	8	11	12	16	16	—	—	—	—	—	—
7	.008	—	—	.024	.036	.048	.058	8	12	14	16	17	21	—	—	—	—	—
8	—	—	—	—	—	.035	—	9	12	15	16	17	—	—	—	—	—	—
9	—	—	—	—	.034	.048	—	9	10	14	14	14	—	—	—	—	—	—
10	—	—	—	.020	.031	.035	.051	—	—	—	—	—	—	—	40	44	58	63
11	—	—	—	—	.035	.040	.049	—	—	—	—	—	—	—	20	34	46	64

specimens are 32, 51, 79, 128, 188, 222, and 216 microns, respectively. As the accompanying illustrations demonstrate, the chambers are lowest in the center of the shell and are highest in the end zones of the shell, especially in the outer volutions.

The spirotheca is thin throughout the shell. It is too thin to measure accurately in the inner two volutions. Average thicknesses of the spirotheca in the third to the seventh volution of eighteen specimens are 17, 30, 43, 54, and 64 microns, respectively.

The septa are very thin, and they are practically unfluted throughout the length of the central four-fifths of the shell. Irregular fluting is confined to the polar regions. Septal pores are abundant in outer volutions, but they seem to be unusually small. Average septal counts of the first to the sixth volution of seven specimens are 9, 12, 15, 17, 17, and 20, respectively.

The tunnel is narrow in the first two volutions but expands rapidly beyond the third volution. The average tunnel angles of the second to the seventh volution of twelve specimens are 32, 31, 42, 60, 68, and 97 degrees, respectively. The path of the tunnel seemingly is about straight. The shifting axes of coiling give the tunnel the appearance of having an irregular path. The chomata are very narrow, but they are well defined throughout the shell. Their tunnel sides are steep, and their poleward slopes are low in the inner volutions. In outer volutions, the chomata are low and are semicircular in cross section.

Remarks.—*Triticites planus* is among the most highly elongate and slender of the forms of *Triticites*, and it has the most nearly completely plane septa of any of the highly elongate forms. It compares closely in size and shape with *T. ohioensis* Thompson from the Brush Creek and Cambridge limestones (Conemaugh) of Ohio and the Livingston and Omega limestones (McLeansboro) of Illinois. Its septa, however, are much less closely fluted than are those of *T. ohioensis*. There are many other forms of *Triticites* from the Missourian Stage of the Midcontinent region that compare favorably in size and elongation of shell with *T. planus*, including *T. neglectus* Newell, *T. plicatulus* Merchant and Keroher, *T. caccus* Burma, and *T. irregularis* (Staff), *s.l.* All of these forms have much more highly fluted septa, however, and most of them differ from *T. planus* in many other respects.

The elongate slender nature and almost plane septa of *Triticites planus* indicate that it is Missourian in age, and the parts of the Casper in which it is found are to be correlated with the middle or upper part of the Kansas City group of the Midcontinent region.

We have obtained a number of thin sections from Coll. 13-A from about 417 feet above the base of the Casper formation in the Deadhead Basin section that resemble the holotype and paratype specimens of *Triticites* *planus* in most respects, and they may all be conspecific. These specimens differ from the types of *T. planus* principally in that they have slightly narrower tunnel angles, more nearly symmetrical shells, smaller form ratios for most parts of the shell, slightly thicker spirotheca in the outer volutions, and seemingly more slightly fluted septa in the polar regions. Although these differences between specimens of Collection 13-A and the holotype and paratype specimens are consistent, we are not convinced that these two groups of specimens represent distinct species. For the time being, at least, we are referring the specimens in Coll. 13-A with question to *T. planus*, are illustrating some of them (Plate 4, figures 1–10), and are including statistical data obtained from ten of them.

Occurrence.—*Triticites planus* is abundant in our samples from about 70 feet above the base of the Casper formation from the Garrett section (Coll. 5-B) and from about 405 feet above the base of the Casper formation in the section measured in the Deadhead Basin (Coll. 13-B). Specimens referred with question to this species are from about 417 feet above the base of the Casper in the Deadhead Basin section (Coll. 13-A).

Triticites wyomingensis, new species

Plate 4, figure 21; Plate 5, figures 2–13, 16, 19, 21

The shell of *Triticites wyomingensis*, n. sp., is elongate fusiform in shape; with straight to slightly arcuate axis of coiling, sharply pointed poles, and almost straight to slightly convex but moderately steep lateral slopes. One of our largest specimens of seven volutions, the holotype, is 7.0 mm long and 2.1 mm wide, giving a form ratio of about 3.4. Other specimens of five and a half to seven volutions have form ratios of 3.0 to 3.3 and are 3.9 to 5.4 mm long and 1.3 to 2.0 mm wide. The first volution is ellipsoidal in shape, but beyond the first volution the axis of coiling becomes extended rather rapidly. However, the chambers become inflated rapidly beyond the second volution, and the form ratio increases slowly. The form ratio of the first to the seventh volution of the holotype is 1.6, 1.8, 2.3, 2.3, 2.5, 3.0,

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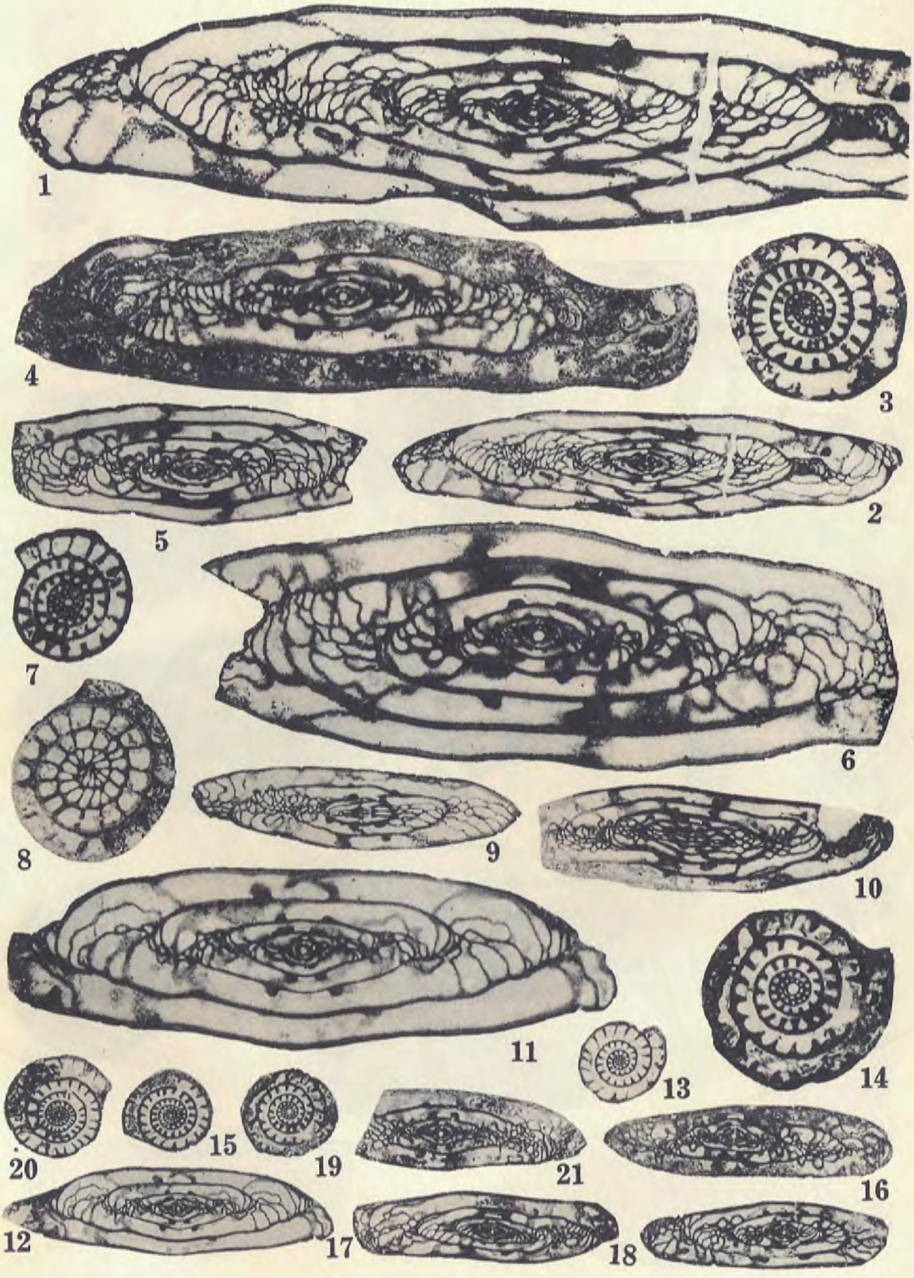
Explanation of Plate 3

All illustrations on this plate are unretouched photographs.

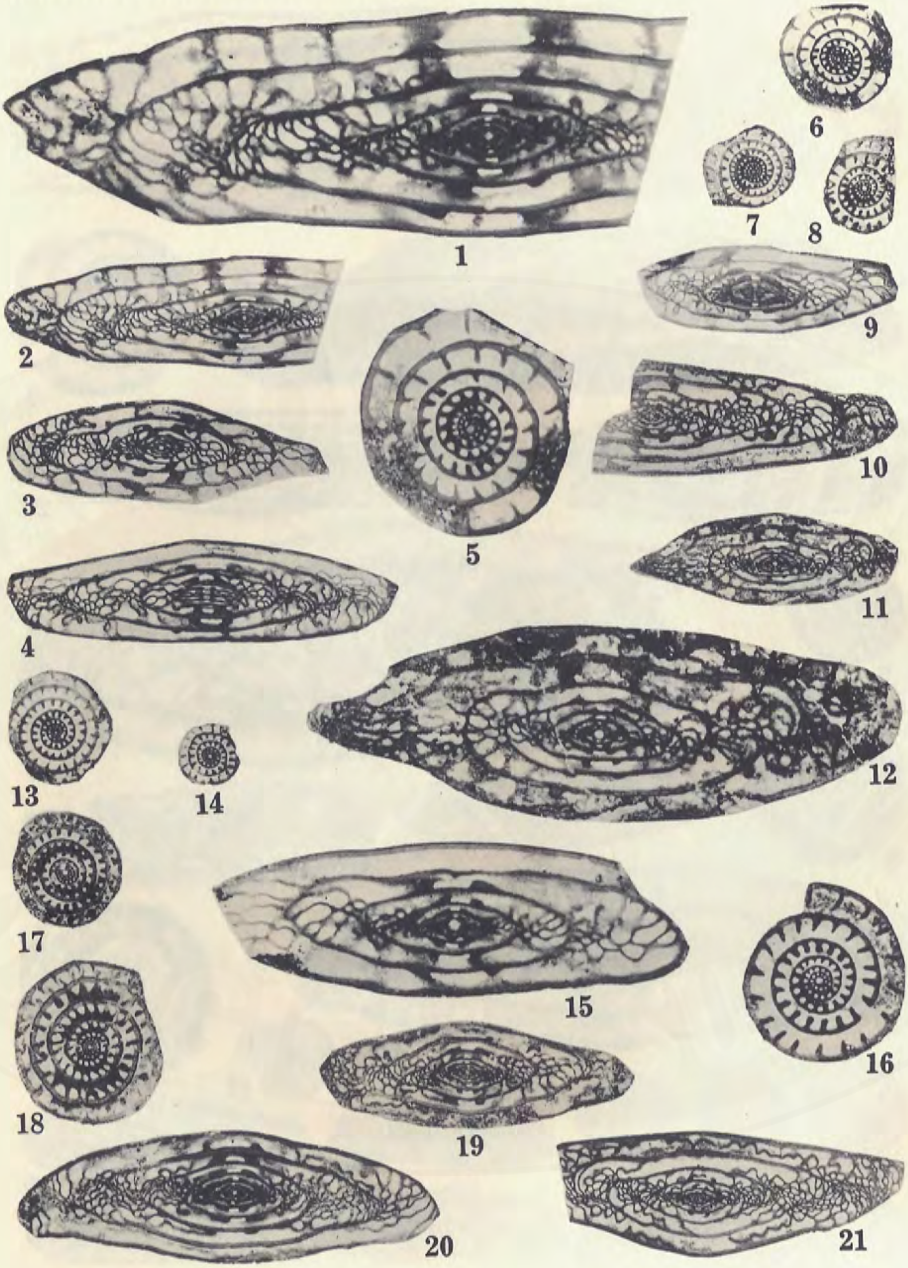
FIGURES PAGE

1–19—*Triticites planus*, n. sp. *1*, *2*, Axial section of the holotype; *3*, *7*, *13–15*, *19*, sagittal sections of paratypes; *4–6*, *11*, *12*, *16–18*, axial sections of paratypes; *8*, parallel section of a paratype; *9*, *10*, tangential sections. *1*, *3*, *4*, *6–8*, *11*, *14*, are about ×17.5 and all others are about ×8.7. *1–3*, *8–10*, *15*, *16* are from Coll. 5-B, Garrett section, and *4–7*, *11–14*, *17–19* are from Coll. 13-B, Deadhead Basin. . . . . *Facing 34*

20, *21*—*Triticites* sp. B (?). *20*, Sagittal section; and *21*, axial section; both about ×8.7. Coll. 8-C, Little Medicine section. . . . . *Facing 34*



Triticites



Triticites

and 3.4, respectively. Averages of the form ratios of the first to the sixth volution of seven paratypes are about 1.7, 2.3, 2.5, 2.6, 2.8, and 2.8, respectively. In some paratypes, a form ratio of 3.0 is attained in the fifth volution.

Measurements of *Triticites wyomingensis*, n. sp. in millimeters. Specimen 1 is the holotype.

SPECIMEN	L.	W.	RATIO	NO. VOL.	DIAM. OF PROL.	HEIGHT OF VOLUTIONS							FORM RATIO OF VOLUTIONS						
						1	2	3	4	5	6	7	1	2	3	4	5	6	7
1	6.99	2.05	3.4	7	—	.028	.037	.047	.089	.151	.198	.294	1.6	1.8	2.3	2.3	2.5	3.0	3.4
2	4.98	1.75	2.8	6½	.072	.027	.034	.061	.096	.180	.240	.270	1.5	1.8	2.2	2.1	2.4	2.7	—
3	—	2.00	—	7	.076	.028	.031	.073	.108	.189	.290	.235	—	—	—	—	—	—	—
4	3.60	1.28	2.8	5	.135	.043	.077	.124	.189	.230	—	—	2.2	2.6	3.0	3.3	2.8	—	—
5	3.68	1.16	3.0	5	.073	.036	.061	.088	.198	.231	—	—	1.6	1.8	2.3	2.5	3.0	—	—
6	4.68	1.51	3.1	5½	.071	.034	.047	.070	.145	.230	.270	—	1.8	2.2	2.2	2.9	3.0	—	—
7	3.51	1.28	2.8	5	.112	.040	.057	.121	.176	.243	—	—	1.8	2.0	2.3	2.3	2.8	—	—
8	5.40	1.62	3.3	6½	.074	.028	.042	.062	.112	.143	.189	.223	1.6	2.4	2.8	2.6	2.9	2.9	—
9	2.70	1.12	2.4	6	.054	.023	.036	.057	.100	.144	.192	—	1.6	2.4	2.8	2.6	2.9	2.9	—
10	—	1.69	—	5½	.078	.027	.051	.097	.214	.302	—	—	—	—	—	—	—	—	—
11	3.93	1.29	3.0	5½	.075	.036	.065	.080	.109	.152	.243	—	1.7	2.4	2.4	2.3	2.7	—	—

SPECIMEN	THICKNESS OF SPIROTHECA								SEPTAL COUNT					TUNNEL ANGLE (DEGREES)						
	0	1	2	3	4	5	6	7	1	2	3	4	5	1	2	3	4	5	6	7
1	—	—	—	.016	.030	.042	.051	.068	—	—	—	—	—	—	22	36	41	65	—	—
2	—	—	—	—	.031	.041	.063	.063	—	—	—	—	—	—	—	—	—	32	48	68
3	—	—	—	.015	.027	.041	.067	.070	—	—	—	—	—	—	—	—	—	—	—	—
4	.013	.013	.018	.031	.049	.044	—	—	—	—	—	—	—	—	30	35	38	59	—	—
5	—	—	—	.028	.039	.057	—	—	—	—	—	—	—	—	—	—	—	—	—	—
6	—	—	—	—	.031	.043	.063	—	—	—	—	—	—	—	—	—	36	46	—	—
7	.015	—	.019	.030	.046	.070	—	—	—	—	—	—	—	—	—	39	47	50	—	—
8	—	—	—	.020	.028	.044	.041	.081	—	—	—	—	—	—	—	—	28	35	36	—
9	—	—	—	.012	.024	.031	.043	—	—	—	—	—	—	—	—	—	—	—	—	—
10	—	—	.015	.020	.031	.050	.070	—	8	12	15	17	26	—	—	—	—	—	—	—
11	—	—	—	.018	.038	.048	.068	—	—	—	—	—	—	—	—	30	33	45	42	—

The proloculus is minute, and its outside diameter measures 54 to 135 microns, averaging 82 microns for ten specimens. The shell expands slowly

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EXPLANATION OF PLATE 4

All illustrations on this plate are unretouched photographs.

FIGURES PAGE

1–10—*Triticites planus*?, n. sp. *1–3*, *9*, *10*, Axial sections; *4*, tangential section; *5–8*, sagittal sections. *1* and *5* are about ×17.5, and all others are about ×8.7. Coll. 13-A, Deadhead Basin........................*Facing 35*

11–16—*Triticites* sp. B. *11*, *12*, *15*, Axial sections; *13*, *14*, *16*, sagittal sections. *12*, *15*, *16* are about ×17.5, and all others are about ×8.7. Coll. 5-A, Garrett........................*Facing 35*

17–20—*Triticites submucronatus* Thompson. *17*, *18*, Sagittal sections; *19*, *20*, axial section. All are about ×8.7. Coll. 1-E, Granite Canyon......*Facing 35*

21—*Triticites wyomingensis*, n. sp. Axial section of the holotype, about ×8.7. Coll. 4-A, Wheatland Reservoir........................*Facing 35* for the first two volutions, but it expands rapidly from the second to the sixth volution. In many specimens, the shell contracts slightly or expands slowly in the seventh volution. The heights of the chambers of the first to the seventh volution of the holotype are 28, 37, 47, 89, 151, 198, and 294 microns, respectively. Average heights of the first to the seventh volution of eleven specimens are 32, 49, 79, 140, 190, 236, and 255 microns, respectively. As can be observed from these figures, the maximum average increase in the height of the chambers occurs from the third to the fourth volution.

The spirotheca is thin in the inner two volutions, but it attains a thickness as great as 81 microns in the seventh volution of some specimens. It is 70 microns thick in the fifth volution of a few specimens. Averages of the thicknesses of the spirotheca in the third to the seventh volution of eleven specimens are 21, 36, 46, 56, and 71 microns, respectively. The proloculus wall is too thin and indistinct to be measured accurately. In two specimens the proloculus wall is about 13 and 15 microns thick. Although alveoli are evident in the spirotheca of our specimens, they are not well enough preserved for us to measure their width.

The septa are very thin, and they have an exceedingly thin pycnotheca. The septa are fluted throughout the length of the shell, and the fluting forms closed chamberlets even over the top of the tunnel in the outer volutions. In some specimens, at least, the fluting brings the septa in contact for about three fourths the heights of the chambers. One sagittal section has a septal count of 8, 12, 15, 17, and 26, respectively, for the first to the fifth volution.

The tunnel expands rather rapidly, and its path is almost straight. Averages of the tunnel angles of the second to the seventh volution of seven specimens are 26, 35, 37, 48, 42, and 68 degrees, respectively. These averages do not give an accurate picture of the increase of the tunnel angle, for in one specimen a tunnel angle of 59 degrees was measured in the fifth volution, and another specimen has a tunnel angle of 65 degrees in the fifth volution. The holotype has a tunnel angle of 22, 36, 41, and 65 degrees in the second to the fifth volution, respectively. The chomata are narrow and low throughout the shell. They become indistinct near the center of the chambers in the outer volutions.

Remarks.—Triticites wyomingensis is a somewhat unique Pennsylvanian species of the genus. Its most distinctive features include the rapidly expanding shell beyond the second volution, its highly fluted septa, its widely spaced septa especially in the first four volutions, its thin spirotheca, the inflated central part of its shell, and its straight lateral slopes. It does not resemble closely any previously described American species.

The magnitude of the septal fluting of *Triticites wyomingensis* compares favorably with that of *T. neglectus* Newell from the Stanton formation of Kansas and *T. osagensis* Newell from limestone of Stanton age in northern Oklahoma. Its chambers, however, are much more inflated, and its shell is shorter and more highly fusiform than those of either of these forms.

The stratigraphic age of this form is not known with certainty.

Occurrence.—Triticites wyomingensis is abundant in our Coll. 4-A from about 200 feet above the base of the Casper formation in the Wheatland Reservoir section measured about three miles north of the reservoir and just north of the point where the Laramie River entèrs the Laramie Range.

Triticites submucronatus Thompson

Plate 4, figures 17–20; Plate 8, figure 6

Triticites submucronata Thompson, 1936, Jour. Paleontology, vol. 10, p. 112, pl. 16' figs. 2–5.

?Triticites newelli Burma, 1942, Jour. Paleontology, vol. 16, pp. 749–751, pl. 118, figs. 7, 10.

The shell of *Triticites submucronatus* Thompson is small, elongate fusiform; with sharply pointed poles, convex to slightly irregular or slightly concave lateral slopes, and slightly irregular axis of coiling. Our largest specimen of seven volutions is 6.3 mm long and 2.1 mm wide, giving a form ratio of about 3.0. The axis of coiling increases in relative length considerably more rapidly than the increase in the width of the shell, as is indicated by the rate of increase of the form ratio of the volutions with growth of the individual. The averages of the form ratios of the first to the seventh volution of two specimens are 1.6, 1.9, 2.0, 2.2, 2.6, 2.9, and 3.0, respectively.

The proloculus is small, and its outside diameter measures 70 to 111 microns, averaging 88 microns for five specimens. The shell increases in size uniformly from the first to the sixth volution, but it increases slowly and non-uniformly from the sixth to the seventh volution. The averages of the heights of the chambers in the first to the seventh volution of five specimens are 32, 48, 75, 123, 184, 246, and 265 microns, respectively.

The spirotheca is relatively thick in the fifth volution to maturity. The proloculus wall is thin and cannot be measured accurately in most of our specimens. One of our specimens has a proloculus wall that seems to be about 14 microns thick. The spirotheca of the first and second volutions is too indistinct to measure with great accuracy. The average thickness of the spirotheca in the third to the seventh volution of five specimens are 24, 36, 50, 69, and 70 microns, respectively.

The septa are thin and are closely spaced. Average septal counts of the first to the seventh volution of three specimens are 9, 13, 15, 16, 20, 24, and 27, respectively. The septa are fluted in the extreme polar regions, they are almost plane across the center of the shell in the inner volutions, but they are slightly fluted across the center of the shell in the outer volutions.

The tunnel is narrow in the inner two to three volutions, but it increases in width rapidly from the fifth to the sixth volution. The path of the tunnel is almost straight. Averages of the tunnel angles in the fourth to the seventh volution of two specimens are 24, 31, 30, and 45 degrees, respectively. The chomata are unusually massive for a primitive type of *Triticites.* The floor of the tunnel in the outer volutions is covered by a thin layer of chomata deposit. The chomata extend to the poles in the inner three volutions, beyond the fourth volution they rapidly decrease in width, but they remain high to the sixth volution in specimens of seven volutions.

Measurements of *Triticites submucronatus* Thompson in millimeters.

SPECIMEN	L.	W.	RATIO	NO. VOL.	DIAM. OF PROL.	HEIGHT OF VOLUTIONS							FORM RATIO OF VOLUTIONS						
						1	2	3	4	5	6	7	1	2	3	4	5	6	7
1	6.26	2.09	3.0	7	.111	.036	.053	.097	.146	.204	.233	.267	1.7	1.9	2.0	2.2	2.6	3.1	3.0
2	4.52	1.39	3.3	6½	.073	.030	.042	.056	.108	.162	.226	—	1.4	1.9	2.0	2.1	2.5	2.6	—
3	—	2.44	—	7	.084	.024	.048	.097	.145	.243	.315	.315	—	—	—	—	—	—	—
4	—	1.78	—	6½	.104	.037	.045	.075	.127	.157	.209	.273	—	—	—	—	—	—	—
5	—	0.96	—	5	.070	.035	.052	.052	.087	.153	—	—	—	—	—	—	—	—	—

SPECIMEN	THICKNESS OF SPIROTHECA								SEPTAL COUNT							TUNNEL ANGLE (DEGREES)			
	0	1	2	3	4	5	6	7	1	2	3	4	5	6	7	4	5	6	7
1	—	—	—	—	.039	.063	.063	.068	—	—	—	—	—	—	—	23	33	31	44
2	—	—	—	—	—	.033	.069	—	—	—	—	—	—	—	—	24	28	29	45
3	—	—	—	—	.036	.063	.072	.073	9	12	15	17	21	24	27	—	—	—	—
4	.014	—	—	.024	.044	.048	.072	.068	8	13	15	14	19	24	—	—	—	—	—
5	—	—	—	.024	.024	.043	—	—	9	13	14	16	20	—	—	—	—	—	—

Remarks.—Our specimens here referred to *Triticites submucronatus* resemble *Triticites newelli* Burma in regard to chomata size, form ratios of the first six volutions, and the general nature of the septal fluting. The fol-

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EXPLANATION OF PLATE 5

All illustrations on this plate are unretouched photographs.

FIGURES	PAGE
1, 14, 15, 17, 18, 20—*Triticites* sp. C. *1, 18, 20,* Axial sections; *14, 15,* sagittal sections; *17,* tangential section. *1* is about ×17.5, and all others are about ×8.7. Coll. 10-B, Sheep Creek	*Facing 38*
2–13, 16, 19, 21—*Triticites wyomingensis,* n. sp. *2, 3,* Sagittal sections of a paratype; *4, 5,* parallel sections of paratypes; *6,* axial section of the holotype; *7, 9–11, 16, 19,* axial sections of paratypes; *8, 12, 13, 21,* tangential sections of paratypes. *2, 6, 7, 11,* and *21* are about ×17.5, and all others are about ×8.7. Coll. 4-A, Wheatland Reservoir	*Facing 38*


1

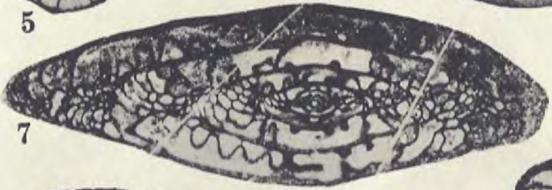

2


3


4


5


6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Triticites


1


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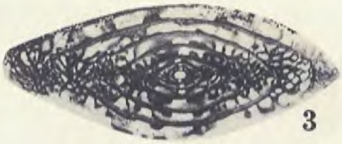
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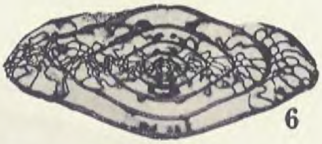
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21

Triticites

lowing points of difference should be pointed out, however. The average thicknesses of the spirotheca of our specimens are greater, their proloculi are smaller, and their septal counts are smaller. The number of volutions of our specimens and of the original specimens of *T. newelli* from Kansas are about the same—although stated by Burma to contain six or six and a half volutions, the figured axial section of *T. newelli* is composed of at least seven and a half volutions. Although they may be distinct species, until *T. newelli* is studied in more detail we prefer to refer it to *T. submucronatus* with question.

Triticites submucronatus can be distinguished from *T. collus* Burma by its more inflated and larger shell, more massive chomata, and thicker spirotheca. It can be distinguished from *T. secalicus* (Say) by its more sharply pointed poles, more massive chomata, larger form ratios of all outer volutions, and smaller shell.

Triticites submucronatus is among the more advanced of the forms of *Triticites* in the Missourian of the Midcontinent and Rocky Mountain areas.

Occurrence.—The above description of *Triticites submucronatus* is based entirely on specimens from about 240 feet above the base of the Casper formation in Granite Canyon (Coll. 1-E) on the southeast side of the Laramie Mountains, about 18 miles west by slightly south of Cheyenne, Wyoming. The original types were obtained from the upper part of the Hartville limestone of the Platte River Canyon of eastern Wyoming. *T. newelli*, here referred with question to this form, is from the Stanton formation of Kansas.

Triticites kellyensis Needham

Plate 6, figures 6–21

Triticites kellyensis Needham, 1937, New Mexico School Mines, Bull. 14, pp. 35, 36, pl. 5, figs. 2–5, 7.

The shell of *Triticites kellyensis* Needham is of medium size and is inflated fusiform; with convex lateral slopes in the inner volutions and

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EXPLANATION OF PLATE 6

All illustrations on this plate are unretouched photographs, and all of them are magnified about ×8.7.

FIGURES	PAGE
1–5—*Triticites onustus*, n. sp. *1*, Axial section of the holotype; *2*, sagittal section of a paratype; *3–5*, axial sections of paratypes. Coll. 11–A, Deer Creek Canyon	*Facing 39*
6–21—*Triticites kellyensis* Needham. *6, 7, 9, 11, 16, 18, 19, 21*, Axial sections; *8, 13, 15, 20*, sagittal sections; *10, 12, 17*, tangential sections; *14*, parallel section. *6, 7, 9, 11*, and *13–15* are from Sims Coll., Casper Mountain, and all others are from Coll. 10-A, Sheep Creek	*Facing 39*

slightly concave lateral slopes in the sixth to eighth volutions, sharply pointed poles, and straight to slightly irregular axis of coiling. Our larger specimens of six to eight volutions are 3.1 to 6.5 mm long and 1.5 to 2.8 mm wide, giving form ratios of 2.1 to 2.3. The shell is short in early volutions and becomes only slightly more highly elongate as maturity is approached. The form ratio increases slightly from the first to the third volution and increases slowly from there to maturity. Average form ratios of the first to the eighth volution of ten specimens are 1.4, 1.7, 1.9, 1.9, 2.0, 2.2, 2.2, and 2.2, respectively.

The proloculus is small, and its outside diameter measures 80 to 155 microns, averaging 113 microns for sixteen specimens. The chambers increase in height almost uniformly with growth of the shell. Average heights of the first to the eighth volution of seventeen specimens are 36, 57, 92, 142, 200, 247, 284, and 310 microns, respectively. As the form ratios above would indicate, the chambers are of closely similar height throughout the length of the shell in the inner five volutions, but they increase in height in the polar regions of the outer volutions of specimens with six to eight volutions.

The spirotheca is moderately thin for a form of *Triticites* of this size. Average thicknesses of the spirotheca in the second to the eighth volution of seventeen specimens are about 18, 28, 44, 60, 76, 82, and 102 microns, respectively. The proloculus wall of most specimens is too thin to be measured accurately, and the spirotheca of the first two volutions of most specimens are too thin for accurate measurements. However, the proloculus wall of three specimens are seemingly about 9 to 17 microns thick, averaging 13 microns.

The septa are closely spaced and are thin. Average septal counts of the first to the eighth volution of eight specimens are 10, 14, 16, 19, 23, 23, 27, and 32, respectively—the measurement for the eighth volution is based on a single specimen. The septa are moderately highly fluted for the genus. Fluting is evident even in the path of the tunnel in some sagittal sections. The fluting seemingly is not uniform and exactly duplicated in adjacent septa. This conclusion is based on observations of parallel, tangential, and axial sections.

The path of the tunnel is relatively straight, and the tunnel expands in width rapidly. Averages of the tunnel angles in the second to the eighth volution of ten specimens are 31, 24, 29, 32, 38, 43, and 46 degrees, respectively. The chomata are narrow and relatively low. Both slopes of the chomata are similar near the center of the chambers. Adjacent to the septa, the chomata are asymmetrical with steep slopes on the tunnel sides and lower poleward slopes.

Remarks.—*Triticites kellyensis* can be distinguished from most species of the genus by its inflated shell, narrow chomata, uniformly expanding

Measurements of *Triticites kellyensis* Needham in millimeters, all from Collection 10-A Sheep Creek section.

SPECIMEN	L.	W.	RATIO	NO. VOL.	DIAM. OF PROL.	HEIGHT OF VOLUTIONS								FORM RATIO OF VOLUTIONS							
						1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8
1	6.52	2.78	2.3	7	.145	.040	.082	.131	.194	.262	.330	.330	—	1.8	2.0	2.0	1.6	1.6	2.0	2.3	—
2	5.57	2.52	2.2	8	.111	.029	.048	.082	.111	.179	.243	.315	—	1.4	1.6	1.7	1.8	1.8	1.9	2.1	2.2
3	3.48	1.54	2.3	6	.109	.034	.058	.092	.136	.194	.218	—	—	1.4	1.7	1.9	1.9	2.1	2.3	—	—
4	4.96	2.30	2.2	7	.121	.048	.082	.116	.160	.218	.257	.242	—	1.5	1.8	1.6	1.8	1.9	2.0	—	—
5	—	2.35	—	7	.109	.036	.055	.082	.136	.184	.218	.262	—	—	—	—	—	—	—	—	—
6	—	1.98	—	6	.107	.034	.048	.073	.121	.175	.267	.243	—	—	—	—	—	—	—	—	—
7	—	1.91	—	6	.155	.048	.073	.107	.194	.252	—	—	—	—	—	—	—	—	—	—	—
8	—	1.56	—	6	.097	.024	.039	.073	.121	.194	.242	—	—	—	—	—	—	—	—	—	—
9	—	2.61	—	8	.082	041	.053	.087	.121	.145	.267	.315	.364	—	—	—	—	—	—	—	—
10	—	1.84	—	7	.098	.042	.070	.109	.135	.176	.243	—	—	—	—	—	—	—	—	—	—
11	5.13	2.18	2.3	8	.108	.032	.041	.068	.111	.149	.189	.243	.257	1.4	1.5	1.9	2.3	2.0	2.0	2.1	—

SPECIMEN	THICKNESS OF SPIROTHECA									SEPTAL COUNT								TUNNEL ANGLE (DEGREES)							
	0	1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8
1	—	—	—	.038	.048	.073	.111	.097	—	—	—	—	—	—	—	—	—	—	—	20	36	38	47	66	—
2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	25	25	35	31	51
3	—	—	—	.031	.036	.068	.072	—	—	—	—	—	—	—	—	—	—	—	25	23	25	30	46	—	—
4	—	—	—	.033	—	.063	.087	.078	—	—	—	—	—	—	—	—	—	—	—	20	26	28	30	50	—
5	—	—	—	.031	.034	.044	.058	.080	—	10	13	16	19	24	24	27	—	—	—	—	—	—	—	—	—
6	.013	—	—	.024	.040	.060	.072	.072	—	10	14	14	19	22	23	—	—	—	—	—	—	—	—	—	—
7	.017	—	—	—	.048	.060	—	—	—	12	17	18	23	27	—	—	—	—	—	—	—	—	—	—	—
8	—	—	—	.019	.031	.053	.068	—	—	9	12	17	19	23	24	—	—	—	—	—	—	—	—	—	—
9	—	—	—	—	—	.048	.063	.097	.120	11	13	15	17	24	26	30	32	—	—	—	—	—	—	—	—
10	—	—	—	.034	.044	.061	.061	—	—	10	12	14	18	21	20	27	—	—	—	—	—	—	—	—	—
11	.009	—	.019	.027	.038	.059	.067	.081	.085	—	—	—	—	—	—	—	—	—	—	26	29	22	36	35	40

Measurements of *Triticites kellyensis* Needham in millimeters, all from 95 feet above the base of the Casper formation on west side Casper Mountain.

SPECIMEN	L.	W.	RATIO	NO. VOL.	DIAM. OF PROL.	HEIGHT OF VOLUTIONS							FORM RATIO OF VOLUTIONS						
						1	2	3	4	5	6	7	1	2	3	4	5	6	7
1	5.36	2.26	2.4	7	.080	.027	.048	.078	.150	.204	.315	.388	1.2	1.5	2.0	2.0	2.1	2.5	2.4
2	4.87	2.05	2.4	6	.121	.034	.063	.097	.184	.257	.306	—	1.3	1.8	1.9	1.9	2.0	2.4	—
3	3.13	1.46	2.1	6	.092	.029	.058	.097	.131	.204	.218	—	1.4	1.9	1.9	1.8	2.0	2.1	—
4	—	1.86	—	7	.111	.024	.053	.073	.097	.194	.218	.267	—	—	—	—	—	—	—
5	—	1.88	—	7	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
6	3.32	1.57	2.1	7	—	—	.034	.070	.115	.162	.203	.230	1.1	1.5	1.7	1.7	1.7	2.3	2.1
7	4.05	1.89	2.1	5½	.155	.047	.067	.115	.189	.236	.270	—	1.3	2.0	2.0	2.0	2.0	—	—

SPECIMEN	THICKNESS OF SPIROTHECA						SEPTAL COUNT							TUNNEL ANGLE (DEGREES)						
	2	3	4	5	6	7	1	2	3	4	5	6	7	1	2	3	4	5	6	7
1	—	—	.039	.058	.087	.087	—	—	—	—	—	—	—	—	—	17	21	26	30	29
2	—	.031	.041	.058	.073	—	—	—	—	—	—	—	—	—	21	24	38	49	49	—
3	.019	.024	.048	.063	.097	—	—	—	—	—	—	—	—	—	49	35	30	38	35	—
4	.015	.024	.044	.068	.097	.082	11	14	16	18	21	21	24	—	—	—	—	—	—	—
5	—	.024	.041	.056	.068	—	11	13	15	18	23	23	25	—	—	—	—	—	—	—
6	—	—	.024	.045	.054	.063	—	—	—	—	—	—	—	—	—	—	26	25	33	31
7	—	—	.045	.074	.074	—	—	—	—	—	—	—	—	—	28	29	31	43	—	—

but tightly coiled shell, small proloculus, thin spirotheca, and the nature of the septal fluting. The most closely similar forms include *T. beedei* Dunbar and Condra, *T. cullomensis* Dunbar and Condra, *T. plummeri* Dunbar and Condra, *T. skinneri* Thompson, *T. turgidus* Dunbar and Henbest, and *T. hobblensis* Thompson, Verville, and Bissell. All of these species are closely similar in age and most of them are widespread in the lower part of the Virgilian Stage in the central part of the continental United States and as far west as Utah and Arizona. As was pointed out by Dunbar and Henbest (1942), forms of *Triticites* similar to *T. cullomensis* are difficult to distinguish. It seems likely that most of them are closely related biologically, and they can be distinguished from one another best from detailed statistical measurements of the various shell features, the nature of the chomata, and the nature and degree of septal fluting.

Triticites kellyensis is closely similar in many respects to *T. cullomensis* Dunbar and Condra from the Big Springs limestone of Kansas. Its walls, however, are thinner, its shell is somewhat shorter, it has more sharply pointed poles, and its lateral slopes are more concave. All of these differences are of small magnitude, and it is not at all certain that they are of specific value.

Needham based the original description of *Triticites kellyensis* on specimens from near the top of the Pennsylvanian in the Magdalena Mountains near Kelly, New Mexico, and from near the top of the marine part of the Pennsylvanian at Jemez Springs, New Mexico. We are here selecting the specimen from near Jemez Springs illustrated by Needham as figure 7 on his Plate 5 as the holotype specimen of this species.

Occurrence.—The specimens on which the above description of *Triticites kellyensis* is based were obtained from about 114 feet above the base of the Casper formation in the Sheep Creek section (Coll. 10-A) and from about 95 feet above the base of the Casper formation at the west end of Casper Mountain (Sims Coll.). The localities of Needham's original specimens were given above.

Triticites onustus, new species

Plate 6, figures 1–5

Our collection contains twelve specimens here described as *Triticites onustus*, n. sp.; four axial sections and one sagittal section, all of which are illustrated, and seven less well oriented additional sections. All of them are from Coll. 11-A of the Deer Creek Canyon section from about 234 feet above the base of the Pennsylvanian at that locality.

The shell of *Triticites onustus* is of medium size for the genus and is inflated fusiform in shape; with straight axis of coiling, convex lateral slopes, and sharply pointed poles. Our largest specimens of six and a half to seven volutions are 4.2 to 5.0 mm long and 1.9 to 2.4 mm wide, giving form ratios of 2.2 to 2.5. The shell expands almost uniformly throughout growth of the individual, and the mature shape of the shell is first attained in the third or fourth volution. In some specimens, the form ratio decreases slightly from the third to the fifth volution and increases slightly with further growth. Average form ratios of the first to the sixth volution of four specimens are 1.7, 1.9, 2.0, 2.0, 2.0, and 2.1, respectively.

The proloculus is minute, and its outside diameter measures 100 to 160 microns, averaging 125 microns for five specimens. The volutions increase in height about uniformly throughout the shell. Average heights of the first to the seventh volution of five specimens are 43, 64, 109, 164, 183, 233, and 278 microns, respectively.

Measurements of *Triticites onustus*, n. sp., in millimeters. Specimen 1 is the holotype.

SPECIMEN	L.	W.	RATIO	NO. VOL.	DIAM. OF PROL.	HEIGHT OF VOLUTIONS							FORM RATIO OF VOLUTIONS					
						1	2	3	4	5	6	7	1	2	3	4	5	6
1	5.28	2.13	2.5	6½	.121	.040	.064	.104	.163	.189	.239	.233	1.9	2.0	2.2	2.0	1.9	2.1
2	4.18	1.91	2.2	6½	.118	.037	.049	.113	.139	.191	.191	.278	1.7	1.9	2.0	2.1	2.0	2.0
3	5.22	2.19	2.4	6½	.156	.056	.063	.101	.174	.174	.226	.290	1.6	1.8	1.8	2.0	2.3	2.3
4	—	2.38	—	7	.121	.043	.070	.129	.174	.191	.278	.313	1.7	1.8	1.9	1.9	1.7	2.2
5	—	1.74	—	6	.107	.039	.073	.097	.170	.170	.233	—	—	—	—	—	—	—

SPECIMEN	THICKNESS OF SPIROTHECA								SEPTAL COUNT						TUNNEL ANGLE (DEGREES)						
	0	1	2	3	4	5	6	7	1	2	3	4	5	6	1	2	3	4	5	6	7
1	—	—	—	—	.049	.052	.066	.078	—	—	—	—	—	—	—	33	41	26	25	46	—
2	—	—	—	—	.042	.052	.071	.087	—	—	—	—	—	—	—	24	24	22	28	37	—
3	—	—	—	—	.040	.057	.066	.087	—	—	—	—	—	—	—	—	20	24	26	40	47
4	—	—	—	.026	.052	.056	.078	.087	—	—	—	—	—	—	—	23	24	15	25	31	43
5	—	—	—	.020	.034	.058	.072	—	8	13	17	23	20	22	—	—	—	—	—	—	—

The spirotheca is very thin and is difficult to measure accurately in the early volutions. The average thicknesses of the spirotheca in the third to the seventh volution of five specimens are 23, 43, 55, 71, and 85 microns, respectively. Deposits extending poleward from the chomata give the spirotheca the appearance of an upper tectorium. Unlike most forms of *Triticites*, chomata-like deposits completely cover the floors of the tunnel. These deposits give the spirotheca across the tunnel an upper layer similar in nature to the upper tectoria as found in forms of *Profusulinella*, *Fusulinella*, and *Fusulina*.

The septa are very thin and are closely spaced. The septal counts of the first to the sixth volution of one specimen are 8, 13, 17, 23, 20, and 22, respectively. The septa are closely fluted in the polar regions but are almost plane across the central part of the shell.

The tunnel is almost straight throughout its length. It is narrow in the inner volutions but becomes wide as the shell approaches maturity. The averages of the tunnel angles in the second to the seventh volution of four specimens are 27, 27, 22, 26, 39, and 45 degrees, respectively. The chomata of this form are among the most massive for the genus. Their tunnel sides are steep, but the poleward slopes are low. In the second, third, and fourth volutions the chomata are about two-thirds as high as the chambers, and they extend almost to the poles with slowly diminishing height. As mentioned above, chomata deposits occur completely across the floor of the tunnel in most parts of the shell.

Remarks.—The evolutionary changes in the massiveness of the chomata that took place within the genus *Triticites* have not been determined. In general, the chomata of forms of *Triticites* are narrow but well defined in all parts of the shell, except in the last half of the ultimate volution and, in some forms, in the first one or two volutions. *T. onustus* contains more massive chomata than are found in most Pennsylvanian forms of the genus. The general shape of the shell, size and nature of the chomata, and the degree of septal fluting of *T. onustus* resemble these structures as found in a group of forms from Kansas, Oklahoma, Texas, and New Mexico. Early members of this group are first known in the stratigraphic section from near the middle of the Waubunsee group (Virgilian) of the northern Midcontinent region, and later members are known to extend into the Wolfcampian over much of western United States. All of the Pennsylvanian forms of this group are small, are much more highly elongate and have thinner spirotheca than the spirotheca of the Wolfcampian forms.

A single somewhat similar specimen (Pl. 7, fig. 9) occurs in our Coll. 3-A from the Wall Rock Canyon section on the west side of the southern Laramie Range associated with *Triticites ventricosus* (Meek and Hayden). The Wall Rock Canyon specimen is sectioned slightly obliquely and is difficult to compare statistically. Evidently it is not conspecific with the specimens described above as *T. onustus*, and it may be considerably different in age from them.

Occurrence.—*Triticites onustus* is common in a small sample (Coll. 11-A) from about 234 feet above the base of the Casper formation in the Deer Creek Canyon section in the central part of the north margin of the Laramie Range.

Triticites ventricosus (Meek and Hayden)

Plate 7, figures 1–4

Fusulina cylindrica var. *ventricosa* Meek and Hayden, 1858, Acad. Nat. Sci. Philadelphia, Proc., vol. 10, p. 261.

Fusulina cylindrica Meek and Hayden [part], 1865, Smithsonian Contrib. to Knowledge, vol. 14, art. 5, p. 14, pl. 1, figs. 6a–6i.

Triticites ventricosus Dunbar and Condra [part], 1928, Nebraska Geol. Survey, Bull. 2, 2d ser., pp. 84–91, pl. 1, fig. 2, pl. 3, figs. 1–6, pl. 4, fig. 4, (1927)—White [part], 1932, Texas Univ. Bull. 3211, pp. 70–74, pl. 7, figs. 7–9, [*Not* pl. 7, figs. 1–6].

The shell of *Triticites ventricosus* is large and elongate fusiform; with straight axis of coiling, low lateral slopes, and pointed poles. Our largest specimen of eight volutions is 9.2 mm long and 3.2 mm wide, giving a form ratio of 2.9. The shell is inflated in the first two to three volutions, but beyond the third volution the axis becomes greatly extended. Averages of the form ratios of the first to the seventh volution of four specimens are 1.5, 1.9, 2.1, 2.2, 2.4, 2.7, and 2.9, respectively.

Measurements of *Triticites ventricosus* (Meek and Hayden) in millimeters, all from Collection 3-A, Wall Rock Canyon section.

SPECIMEN	L.	W.	RATIO	NO. VOL.	DIAM. OF PROL.	HEIGHT OF VOLUTIONS								FORM RATIO OF VOLUTIONS							
						1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8
1	9.22	3.22	2.9	8	.261	.075	.087	.139	.140	.209	.209	.286	.286	1.4	1.5	2.0	2.4	2.6	2.9	2.9	2.9
2	—	2.70	—	7½	.191	.070	.104	.115	.161	.191	.209	.244	—	1.5	2.2	2.3	2.2	2.3	2.4	—	—
3	—	2.78	—	7	.313	.078	.115	.113	.162	.226	.261	.348	—	1.5	2.0	2.3	2.2	2.6	—	—	—
4	—	1.89	—	5½	.238	.061	.078	.137	.174	.244	.278	—	—	1.6	2.0	1.9	1.9	2.1	—	—	—
5	—	2.70	—	7	.244	.087	.104	.162	.200	.238	.331	.261	—	—	—	—	—	—	—	—	—
6	—	2.47	—	5	.296	.087	.139	.191	.296	.365	—	—	—	—	—	—	—	—	—	—	—
7	—	2.40	—	6	.204	.066	.113	.165	.244	.261	.261	—	—	—	—	—	—	—	—	—	—
8	—	2.00	—	6	.235	.061	.083	.122	.153	.174	.278	—	—	—	—	—	—	—	—	—	—
9	—	1.74	—	5	.261	.083	.109	.127	.157	.191	—	—	—	—	—	—	—	—	—	—	—

SPECIMEN	THICKNESS OF SPIROTHECA									SEPTAL COUNT						TUNNEL ANGLE (DEGREES)						
	0	1	2	3	4	5	6	7	8	1	2	3	4	5	6	1	2	3	4	5	6	7
1	.042	—	—	.035	.042	.070	.087	.110	.121	—	—	—	—	—	—	18	20	34	31	39	42	67
2	—	—	—	.028	.061	.063	.080	.078	—	—	—	—	—	—	—	—	—	13	26	51	37	38
3	.036	—	.024	.031	.056	.087	.087	.121	—	—	—	—	—	—	—	—	11	19	25	32	37	44
4	.022	—	—	.047	.066	.087	.087	—	—	—	—	—	—	—	—	—	—	23	27	32	37	—
5	.024	.014	.031	.041	.063	.082	.097	.111	—	10	17	19	22	23	24	—	—	—	—	—	—	—
6	—	.024	.042	.052	.087	.121	—	—	—	11	17	19	22	24	—	—	—	—	—	—	—	—
7	.019	—	.020	.031	.053	.087	.087	—	—	12	17	18	20	23	23	—	—	—	—	—	—	—
8	—	—	—	.039	.048	.068	.111	—	—	11	17	19	19	22	22	—	—	—	—	—	—	—
9	—	—	.031	.038	.050	.087	—	—	—	12	21	23	22	23	—	—	—	—	—	—	—	—

The proloculus is large, and its outside diameter measures 190 to 313 microns, averaging 250 microns for eight specimens. Averages of the heights of the first to the eighth volution of eight specimens are 74, 104, 141, 189, 232, 261, 285, and 286 microns, respectively.

The spirotheca is thick in the outer volutions where it is coarsely alveolar. However, it is too thin to measure accurately in the inner one or two volutions. Average thicknesses of the spirotheca in the second to the eighth volution of eight specimens are 30, 38, 58, 84, 91, 105, and 121 microns, respectively. The spirotheca is of closely similar thickness throughout the central two-thirds of the shell.

The septa are thin, and they contain a thin but distinct pycnotheca. Average septal counts of the first to the sixth volution of four specimens are 11, 18, 20, 21, 23, and 23, respectively. The septa are fluted in the extreme polar regions, but they are almost plane across the central part of the shell.

The tunnel is wide and almost straight. The tunnel angles of the first to the seventh volution in our largest specimen are 18, 20, 34, 31, 39, 42, and 67 degrees, respectively. Averages of the tunnel angles of the third to the seventh volution of four specimens, including that of the specimen mentioned above, are 22, 27, 39, 38, and 50 degrees, respectively. Chomata are high and distinct in all but the outer volutions. They are more than half as high as the chambers immediately adjacent to the septa in the central volution.

Remarks.—Triticites ventricosus is perhaps one of the most widely identified of the American forms of the genus. For many years, most abnormally large *Triticites* have been referred to this species. Studies that have been carried on during recent years, however, indicate that *T. ventricosus* is rather closely restricted stratigraphically and probably is one of the more highly diagnostic forms of the genus *Triticites* in the lower part of the Permian. Seemingly the species is restricted to a stratigraphic zone closely related in age to the Hughes Creek shale of the Wolfcampian Series. Dunbar and Condra (1928) gave the species a stratigraphic range in the northern Midcontinent region from the Tarkio limestone of the upper part of the Pennsylvanian to the Florence limestone of the Wolfcampian. Numerous other workers have identified this form from Upper Pennsylvanian and Lower Permian rocks. Although many references have been made in the literature to this form, we are listing only a few of them in the above synonymy.

Meek and Hayden's type specimens of *Triticites ventricosus* are being restudied, and the species will be discussed in more detail at a later date.

The above description is based entirely on specimens from 400 feet above the base of the Wall Rock Canyon section (Coll. 3-A). We are referring a rather large variety of specimens from the Casper formation to *Triticites ventricosus*, some are referred with question to it and others seem to have affinities with it (Pl. 8, figs. 1, 2). Seemingly not all of them are conspecific. The Wall Rock Canyon specimens are associated with common specimens of *Triticites notus*, n. sp., and scarce specimens referred with question to *T. onustus*, n. sp. Probably conspecific but incomplete specimens are common 354 feet above the base of the Casper formation at

Rogers Canyon (Coll. 2-A). Rather scarce specimens that possibly are conspecific with this form were obtained from about 770 feet above the base of the Casper formation at Farthing (Collection 1-H) where they are associated with *Schwagerina* sp. and *T.* aff. *T. notus*. Very poorly preserved specimens that seem to be closely similar to *T. ventricosus* are abundant in a sample from about 407 feet above the base of the Casper formation at Boxelder Canyon (Coll. 12-A) at the extreme northern margin of the Laramie Range.

The large and highly elongate shell of *Triticites ventricosus* serves to distinguish it from other Lower Permian forms of the genus that have somewhat similar thick spirotheca and large proloculi. Also, the rate of expansion of the shell of *T. ventricosus* is different from that of most other lower Permian forms of the genus.

Occurrence.—The occurrences of *Triticites ventricosus* in the Casper formation have been discussed above. Meek and Hayden's original description was based on specimens from Juniata on the Blue River and Manhattan on the Kansas River, Kansas. This species occurs abundantly in the Hughes Creek shale in southern Nebraska, across the State of Kansas, and in northern Oklahoma, and abundantly in the Saddle Creek limestone of about the same age in northcentral Texas.

Triticites notus, new species

Plate 7, figures 5–15

Triticites ventricosus (?) Miller and Thomas, 1936, Jour. Paleontology, vol. 10, pp. 724–726, pl. 96, figs. 1–5.

Most of our collections from the Wolfcampian part of the Casper formation contain specimens here referred to as *Triticites notus*, n. sp. The following description is based on specimens from about 520 feet above the base of the Casper formation in the Gilmore Canyon section (Coll. GC-1), about 400 feet above the base of the formation in the Wall Rock Canyon section (Coll. 3-A), about 770 feet above the base of the formation in the Farthing section (Coll. 1-H), and about 630 feet above the base of the formation at Granite Canyon (Coll. 1-F).

Shell of medium size and inflated fusiform, with convex lateral slopes, pointed poles, and straight axis of coiling. Specimens of five to seven volutions are 3.6 to 6.4 mm long and 2.0 to 3.0 mm wide. The shell is fusiform throughout growth. Averages of the form ratio of the first to the fifth volution of eleven specimens are 1.4, 1.8, 1.9, 2.0, and 2.0, respectively.

The proloculus is large, and its outside diameter measures 200 to 435 microns, averaging 327 microns for twenty specimens. The shell expands rapidly to the fourth or fifth volution, but the outer volutions remain of approximately the same height. Averages of the height of the chambers in the first to the sixth volution of twenty specimens are 96, 136, 197, 260, 293, and 296 microns, respectively. The last volution of some specimens of six or seven volutions is slightly more tightly coiled than the penultimate volution.

The spirotheca is thick and is coarsely alveolar. Averages of the thickness of the spirotheca of the first to the sixth volution of twenty specimens are 28, 41, 62, 81, 81, and 92 microns, respectively. The proloculus wall measures 24 to 50 microns, averaging 34 microns for twenty specimens.

Measurements of *Triticites notus*, n. sp., in millimeters. Specimen 1 is the holotype. Specimen 1–3 are from Collection 1-F, Granite Canyon section; 4–7 are from the Gilmore Canyon section; and 8 and 9 are from Collection 1-H, Farthing section.

SPECIMEN	L.	W	RATIO	NO. OF VOL.	DIAM. OF PROL.	HEIGHT OF VOLUTIONS						FORM RATIO OF VOLUTIONS				
						1	2	3	4	5	6	1	2	3	4	5
1	5.50	3.15	1.8	5½	.374	.087	.153	.261	.320	.320	.348	1.2	1.3	1.3	1.4	1.5
2	4.34	2.72	1.6	5	.331	.121	.209	.313	.331	.313	—	1.7	1.6	1.6	1.6	1.6
3	—	3.57	—	6	.348	.139	.226	.313	.313	.348	.348	—	—	—	—	—
4	4.52	2.58	1.8	5	.348	.121	.147	.221	.348	.348	—	1.3	1.7	1.9	1.8	1.8
5	—	2.75	—	5½	.296	.073	.127	.209	.261	.348	.350	—	—	—	—	—
6	—	2.09	—	4½	.305	.073	.100	.191	.290	—	—	—	—	—	—	—
7	—	2.16	—	4	.392	.116	.183	.249	.226	—	—	—	—	—	—	—
8	3.50	1.91	1.8	4	.382	.139	.174	.174	.305	—	—	1.6	1.6	1.7	1.8	—
9	—	1.56	—	4	.252	.087	.104	.174	.217	.244	.313	—	—	—	—	—

SPECIMEN	THICKNESS OF SPIROTHECA							SEPTAL COUNT						TUNNEL ANGLE (DEGREES)				
	0	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5
1	.031	.034	.032	.078	.094	.127	—	—	—	—	—	—	—	—	20	23	26	30
2	.034	.029	.048	.080	.095	—	—	—	—	—	—	—	—	—	18	20	25	—
3	.056	.031	.042	.092	.082	.136	.100	12	22	25	31	34	30	—	—	—	—	—
4	.037	.017	.036	.083	.107	.122	—	—	—	—	—	—	—	—	12	20	26	30
5	.031	—	.024	.063	.073	.082	.097	—	—	—	—	—	—	—	24	25	23	22
6	.038	—	.024	.038	.063	.073	—	—	—	—	—	—	—	16	14	17	22	—
7	.050	.024	.035	.056	.063	—	—	13	22	25	26	—	—	—	—	—	—	—
8	.044	.024	.038	.052	.087	—	—	—	—	—	—	—	—	—	10	17	23	26
9	.029	.019	.029	.048	.063	—	—	12	15	20	24	—	—	—	—	—	—	—

The septa are thin but contain distinct pycnothecae. Narrow septal fluting is confined to the extreme axial area, but more open and irregular fluting extends to the margins of the tunnel. Averages of the septal count of the first to the fifth volution of seven specimens are 12, 20, 23, 24, and 30, respectively.

The tunnel is narrow, and its path is straight. Averages of the tunnel angle of the first to the sixth volution of thirteen specimens are 20, 17, 20, 25, 25, and 33 degrees, respectively. The chomata are massive, and in the third and fourth volutions they extend up the septa to the tops of the chambers near the tunnel. They are about four-fifths as high as the chambers midway between septa, resulting in small circular lateral openings poleward from the tunnel. The chomata are asymmetrical and have steep to overhanging tunnel sides and steep poleward slopes. Thin layers of the chomata deposits extend almost to the poles on the floors of the chambers, however, and chomata deposits extend along the septa above the tunnel.

Remarks.—*Triticites notus*, n. sp., was referred with question to *T. ventricosus* (Meek and Hayden) by Miller and Thomas (1936). This general type of *Triticites* is very widespread in lower Permian rocks in central United States and seems to be restricted to the lower portion of the Wolfcampian. It resembles *T. pinguis* Dunbar and Condra from the lower Wolfcampian of Texas in many measurable features except that its walls are considerably thinner than those of *T. pinguis*, its form ratios are considerably greater, and seemingly its chomata are less massive.

Triticites notus resembles *T. californicus* Thompson and Hazzard in many respects and seems to differ from that form principally in that its proloculus is larger, its outer volutions seem more tightly coiled, its inner volutions are more loosely coiled, and its spirotheca increases in thickness more rapidly.

Occurrence.—*Triticites notus* is common to abundant 520 feet above the base of the Casper formation in Gilmore Canyon (Coll. GC-A), 370 feet above the base of the Casper in Wall Rock Canyon where it is associated with *T. ventricosus* (Meek and Hayden) (Coll. 3-A), about 770 feet above the base of the Casper in the Farthing section where it is associated with *T. ventricosus* and *Schwagerina* sp. (Coll. 1-H), and about 630 feet above the base of the Casper at Granite Canyon where it is associated with *Schwagerina* sp. (Coll. 1-F).

Triticites sp. A

Plate 2, figures 15–18

Numerous thin sections of a minute form of *Triticites* were obtained from Coll. 13-C from about 398 feet above the base of the Casper formation in the Deadhead Basin section that do not seem to be referable to any of the forms described above. Unfortunately, we do not have enough specimens of this form to describe it thoroughly but for the sake of completeness are including the statistical data obtained from some of them and are illustrating four of our specimens that seem to show some of its pertinent features.

This form is among the most minute of the *Triticites*. It resembles *Triticites nebraskensis*, described above, except that its chomata are much narrower, its form ratio is much smaller for all corresponding volutions except the first one, and its septa are considerable more highly and narrowly fluted.

A few specimens from our Coll. 9-A, obtained from about 20 feet above the base of the Pennsylvanian in the Bates Creek Reservoir section, resemble this form.

Occurrence.—The specimens here illustrated as *Triticites* sp. A came from Coll. 13-C of the Deadhead Basin section where it is associated with rare *Schubertella* sp., about 45 feet above the probable base of the Missourian Stage and 398 feet above the base of the Casper. Specimens referred with question to this form were obtained from Coll. 9-A from about 20 feet above the base of the Casper in the Bates Creek Reservoir section.

Measurements of *Triticites* sp. A in millimeters, all from Collection 13-C, Farthing section.

SPECIMEN	L.	W.	RATIO	NO. VOL.	DIAM. OF PROL.	HEIGHT OF VOLUTIONS						FORM RATIO OF VOLUTIONS					
						1	2	3	4	5	6	1	2	3	4	5	6
1	2.52	0.97	2.6	5	.082	.034	.048	.078	.087	.152	—	1.5	1.9	2.0	2.4	2.6	—
2	—	1.44	—	6	.073	.029	.042	.073	.110	.146	.218	—	—	—	—	—	—
3	—	1.04	—	5	.073	.031	.053	.069	.112	.146	—	—	—	—	—	—	—
4	—	1.29	—	5	.097	.029	.053	.073	.097	.170	.243	—	—	—	—	—	—
5	—	1.16	—	5½	.097	.032	.047	.068	.089	.146	.177	—	—	—	—	—	—
6	—	—	—	4	—	—	—	—	—	—	—	—	—	—	—	—	—
7	3.78	1.28	3.0	6	—	—	—	.067	.098	.148	.175	—	1.3	1.9	2.2	2.6	3.0

SPECIMEN	THICKNESS OF SPIROTHECA							SEPTAL COUNT						TUNNEL ANGLE (DEGREES)			
	0	1	2	3	4	5	6	1	2	3	4	5	6	2	3	4	5
1	—	—	—	.011	.017	.034	—	—	—	—	—	—	—	25	20	30	41
2	.008	—	—	.012	.019	.037	.049	8	12	13	15	17	19	—	—	—	—
3	—	—	.010	.015	.024	.031	—	7	12	14	17	23	—	—	—	—	—
4	—	—	—	.019	.024	.038	.058	9	13	16	16	21	23	—	—	—	—
5	.007	—	—	.018	.024	.033	.049	9	13	15	18	20	—	—	—	—	—
6	—	—	—	—	—	—	—	—	—	—	—	—	—	26	46	52	54
7	—	—	—	.016	.020	.033	.034	—	—	—	—	—	—	—	35	40	47

Triticites sp. B

Plate 4, figures 11–16; (?) Plate 3, figures 20, 21

A small number of specimens have been sectioned from our Coll. 5-A obtained from the Garrett section and from Coll. 8-A, Coll. 8-B, and Coll. 8-C obtained from the Little Medicine section that seem to be distinct from the other forms of *Triticites* described above. The specimens from the last two collections possibly are conspecific with the specimens from Coll. 13-A referred with question to *Triticites planus*, n. sp., but we do not have enough material for direct comparison. The specimens from Coll. 5-A do not seem to be referable to any of the forms described above. Although we do not have enough material to describe this form thoroughly, we are illustrating a few of our better specimens that may lend to their later identification. Seemingly this form is upper middle Missourian in age.

Occurrence.—The specimens illustrated as *Triticites* sp. B from Coll. 5-A were obtained from about 101 feet above the base of the Pennsylvanian and above the pre-Cambrian surface in the Garrett section. Other specimens referred to this form are from Coll. 8-A and Coll. 8-B obtained from about 86 and 73 feet, respectively, above the base of the Casper formation in the Little Medicine section. Questionable specimens of it were obtained from 11 feet above the base of the Casper in the Little Medicine section (Coll. 8-C).

Measurements of *Triticites* sp. B in millimeters, all from Collection 5-A, Garret section.

SPECIMEN	L.	W.	RATIO	NO. VOL.	DIAM. OF PROL.	HEIGHT OF VOLUTIONS							FORM RATIO OF VOLUTIONS				
						1	2	3	4	5	6	7	1	2	3	4	5
1	4.89	1.39	3.5	5½	.106	.031	.031	.084	.157	.177	.201	—	1.9	2.4	2.4	2.8	3.5
2	3.34	1.18	2.9	5	.121	.040	.044	.087	.136	.174	—	—	—	—	—	—	—
3	—	1.48	—	6½	.087	.030	.042	.061	.073	.139	.194	.213	—	—	—	—	—
4	—	1.74	—	6½	.077	.038	.056	.094	.150	.174	.198	.191	—	—	—	—	—
5	—	1.34	—	5½	.073	.029	.042	.076	.121	.179	.272	—	—	—	—	—	—
6	—	1.04	—	4½	.092	.049	.057	.097	.137	—	—	—	—	—	—	—	—
7	3.73	1.11	3.3	5½	.088	.032	.036	.058	.093	.142	.171	—	1.4	1.9	2.5	3.1	4.0
8	3.73	1.10	3.4	5½	—	.026	.043	.068	.101	.135	.181	—	1.9	2.1	2.2	2.6	3.2
9	—	0.70	—	4	.093	.041	.054	.108	.135	—	—	—	—	—	—	—	—

SPECIMEN	THICKNESS OF SPIROTHECA								SEPTAL COUNT						TUNNEL ANGLE (DEGREES)						
	0	1	2	3	4	5	6	7	1	2	3	4	5	6	1	2	3	4	5	6	7
1	—	—	.023	.023	.035	.059	.052	—	—	—	—	—	—	—	—	—	45	42	49	—	—
2	—	—	—	—	.043	.059	—	—	—	—	—	—	—	—	—	—	35	50	56	—	—
3	—	—	.019	.021	.026	.033	.047	.059	—	—	—	—	—	—	—	—	32	31	39	53	39
4	—	—	—	.021	.040	.044	.057	.061	7	11	14	17	20	22	—	—	—	—	—	—	—
5	—	—	—	.016	.029	.044	.053	—	9	13	15	17	19	—	—	—	—	—	—	—	—
6	—	—	—	.017	.030	.052	—	—	9	12	15	17	—	—	—	—	—	—	—	—	—
7	—	—	—	—	.023	.034	.041	—	—	—	—	—	—	—	—	—	23	37	63	—	—
8	—	—	—	—	.024	.035	.047	—	—	—	—	—	—	—	—	—	28	26	33	40	—
9	—	—	.015	.022	.027	—	—	—	11	15	19	22	—	—	—	—	—	—	—	—	—

Triticites sp. C

Plate 5, figures 1, 14, 15, 17, 18, 20

We have obtained a number of thin sections from Coll. 10-B of the Sheep Creek section that represent an unnamed species of *Triticites*. Although this form is unnamed, we do not have enough material to be sure that we understand all of its characteristics, and we hesitate to establish a species based on our material. We are, however, illustrating four of our specimens, are including statistical data obtained from seven specimens, and have drawn up the following description based on ten specimens.

Measurements of *Triticites* sp. C in millimeters.

SPECIMEN	L.	W.	RATIO	NO. VOL.	DIAM. OF PROL.	HEIGHT OF VOLUTIONS							FORM RATIO OF VOLUTIONS						
						1	2	3	4	5	6	7	1	2	3	4	5	6	7
1	4.92	1.86	2.7	7	—	—	.048	.073	.121	.182	.233	.291	1.7	1.7	2.1	2.2	2.2	2.8	2.7
2	5.40	1.98	2.7	7	.097	.039	.058	.092	.097	.145	.281	.310	1.7	1.8	2.0	2.3	2.8	2.5	2.7
3	—	1.83	—	6	—	—	—	—	.139	.226	.243	—	—	—	—	—	—	—	—
4	—	1.70	—	5½	.113	.031	.045	.096	.150	.244	.218	—	—	—	—	—	—	—	—
5	5.13	1.74	2.9	6½	.098	.040	.054	.093	.135	.189	.250	—	1.1	1.6	2.0	2.0	2.0	2.8	—
6	3.65	1.40	2.6	6½	—	—	.040	.068	.108	.149	.223	—	1.3	1.6	1.9	2.3	2.3	2.6	—
7	3.96	1.50	2.7	5½	.101	.028	.036	.067	.148	.203	.230	—	1.6	2.1	2.1	2.5	2.6	—	—

SPECIMEN	THICKNESS OF SPIROTHECA								SEPTAL COUNT						TUNNEL ANGLE (DEGREES)						
	0	1	2	3	4	5	6	7	1	2	3	4	5	6	1	2	3	4	5	6	7
1	—	—	—	—	.029	.049	.068	—	—	—	—	—	—	—	—	25	31	35	44	55	—
2	—	—	—	—	.029	.048	.073	.073	—	—	—	—	—	—	—	—	—	31	35	40	52
3	—	—	—	—	—	.059	.078	—	10	11	13	16	19	22	—	—	25	28	33	52	—
4	.011	—	—	.027	.035	.063	.053	—	11	13	17	16	21	—	—	—	—	—	—	—	—
5	—	—	—	.024	.043	.068	.074	—	—	—	—	—	—	—	—	—	—	—	—	—	—
6	—	—	—	.020	.036	.050	.081	.088	—	—	—	—	—	—	—	—	32	30	37	48	—
7	—	—	—	.023	.038	.054	.067	—	—	—	—	—	—	—	—	—	25	28	33	—	—

The shell is short and inflated fusiform; with almost straight axis of coiling, distinctly concave lateral slopes, and bluntly pointed poles. The lateral slopes are near parallel across the central two-thirds of the shell. In some specimens the shell is constricted toward the poles, giving rise to

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EXPLANATION OF PLATE 7

All illustrations on this plate are unretouched photographs, and all of them are magnified about ×8.7.

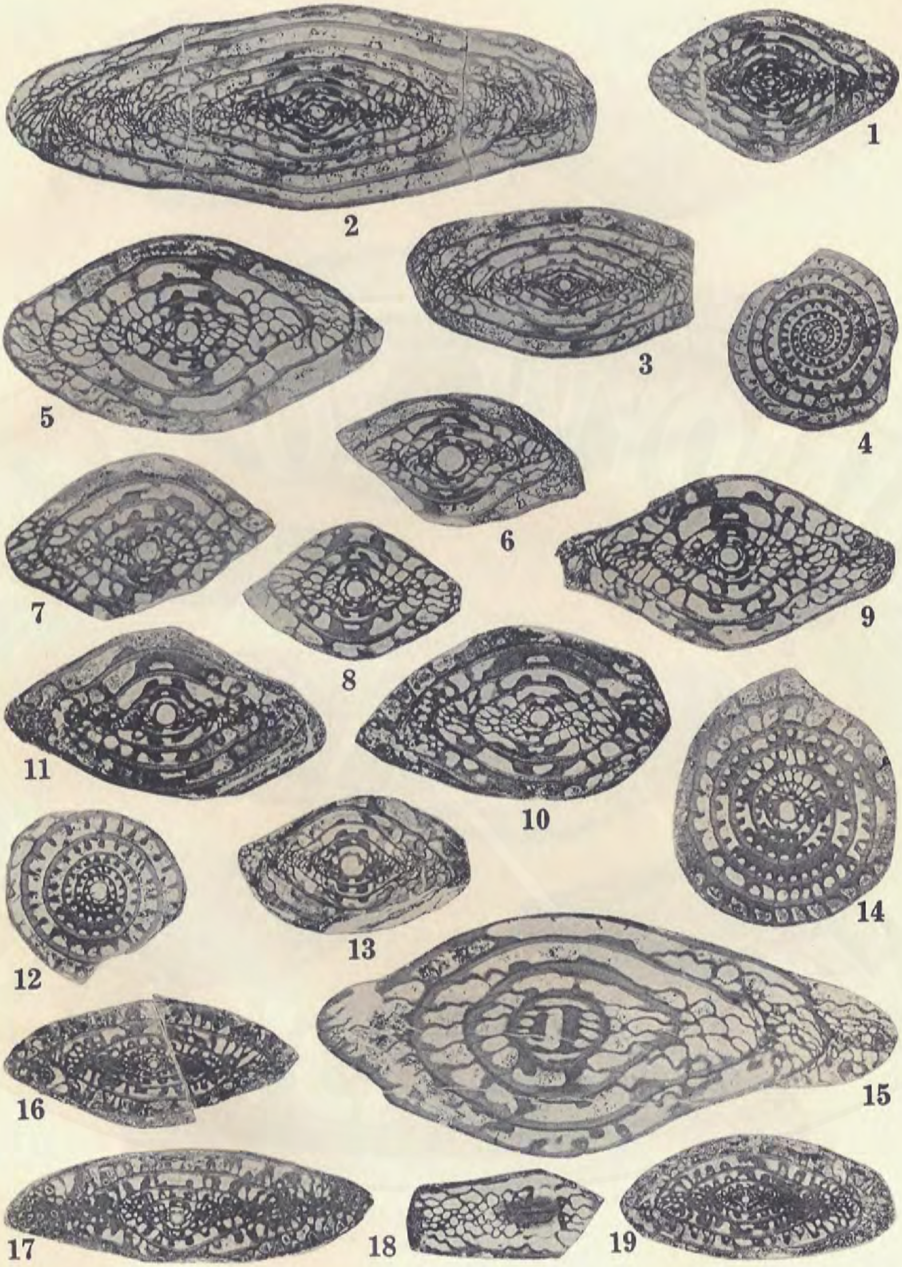
FIGURES PAGE

1—*Triticites* aff. *T. onustus*, n. sp. Axial section. Coll. 3-A, Wall Rock Canyon .... *Facing 52*

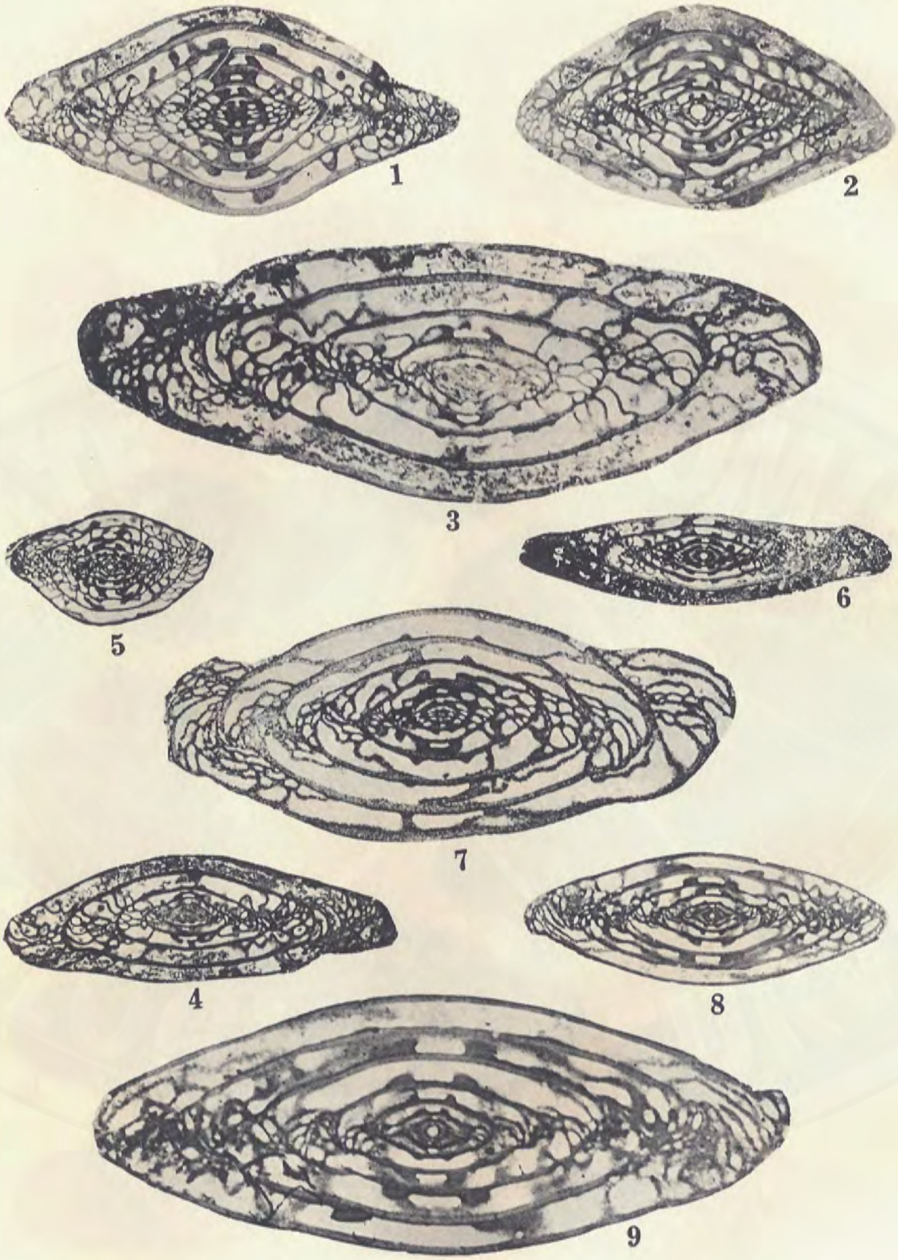
2–4—*Triticites ventricosus* (Meek and Hayden). *2*, *3*, Axial sections; *4*, sagittal section. Coll. 3-A, Wall Rock Canyon .... *Facing 52*

5–15—*Triticites notus*, n. sp. *5*, Axial section of the holotype; *6–11*, *13*, axial sections of paratypes; *12*, *14*, sagittal sections of paratypes; *15*, tangential section of a large specimen. *5*, *7*, *14*, and *15* are from Coll. 1-F, Granite Canyon; *6*, *12*, and *13* are from Coll. 3-A, Wall Rock Canyon; and *8–11* are from Coll. GC-A, Gilmore Canyon section .... *Facing 52*

16–19—*Schwagerina* sp. *16*, *17*, *19*, Axial sections; *18*, tangential section showing the nature of the septal fluting. *16 and 17* are from Coll. 1-F, Granite Canyon, and *18* and *19* are from Coll. 1-H, Farthing section .... *Facing 52*



Triticites and *Schwagerina*



Triticites

deeply concave lateral slopes. Specimens of six and a half to seven volutions are 3.7 to 5.4 mm long and 1.4 to 2.0 mm wide. Averages of the form ratios of the first to the seventh volution of five specimens are 1.5, 1.8, 2.0, 2.3, 2.4, 2.7, and 2.7, respectively.

The proloculus is small and has an outside diameter of 97 to 113 microns, averaging 102 microns for four specimens. Average heights of the first to the seventh volution of seven specimens are 35, 47, 82, 128, 191, 240, and 300 microns, respectively. Thus, it is evident that the shell expands slowly and uniformly.

The spirotheca is relatively thick. Average thicknesses of the spirotheca in the third to the seventh volution of seven specimens are 27, 35, 56, 71, and 80 microns, respectively. The spirotheca is thinnest for any given chamber near the anterior part of the chamber.

The septa are thin, but they contain distinct pycnotheca. The keriotheca of the spirotheca of the following chamber extends down the anterior side of the septa, especially near the center of the shell. The septal counts of the first to the sixth volution of two specimens average 11, 12, 15, 16, 20, and 22, respectively. Heavy deposits of dense calcite that extend from the chomata cover the septa near the center of the shell. The septa are closely fluted in the polar region, but the fluting decreases rapidly toward the tunnel. Closed chamberlets are present near the base of the chambers adjacent to the tunnel. Seemingly the fluting is not uniformly spaced along the septa.

The tunnel is broad and its path is straight. Averages of the tunnel angles in the third to the sixth volution of five specimens are 28, 30, 36, and 49 degrees, respectively. Chomata are broad in the inner three volutions, and they extend almost to the poles. Beyond the third volution, the chomata are broad and are highly asymmetrical.

EXPLANATION OF PLATE 8

All illustrations on this plate are unretouched photographs. Figures *3*, *7*, *9* are magnified about ×17.5, and all others are magnified about ×8.7.

FIGURES	PAGE
1, *2*—*Triticites* aff. *T. ventricosus* (Meek and Hayden). *1*, Tangential section; *2*, axial section. Coll. 1-F, Granite Canyon section	*Facing 53*
3, *4*, *7*-*9*—*Triticites milleri* Thompson. *3*, *4*, Axial section from 90 feet above the base of the Casper formation (Sears Coll.), Casper Mountain; *7*, tangential section from 520 feet above the base of the Casper formation in the Farthing section; *8*, *9*, an axial section of a topotype specimen from the Platte River Canyon, Hartville Uplift	*Facing 53*
5—*Fusulina* sp. Axial section from 180 feet above the base of the Casper formation in Gilmore Canyon	*Facing 53*
6—*Triticites submucronatus* Thompson. Axial section of a topotype from the Platte River Canyon, Hartville Uplift	*Facing 53*

Discussion.—*Triticites* sp. C is closely similar to a form abundant in the Shawnee group of lower Virgilian age of Kansas. Although unnamed at the present time, the Kansas form is recognized to be an excellent index fossil. Our form is more or less intermediate between *Triticites secalicus* (Say) and *T. cullomensis* Dunbar and Condra. It is similar also to *T. milleri*, but is shorter, has heavier chomata, and has more concave lateral slopes than the latter.

Occurrence.—*Triticites* sp. C is common about 94 feet above the base of the Casper formation and about 10 feet above the top of the basal conglomeratic sandstone at Sheep Creek (Coll. 10-B).

Genus SCHWAGERINA Möller

Schwagerina sp.

Plate 7, figures 16–19

Four of our collections of Wolfcampian fusulinids contain a number of specimens of a form of *Schwagerina*, one from 520 feet above the base of the Casper in Gilmore Canyon (Coll. GC-1), another from the Farthing section (Coll. 1-H), a third from the Granite Canyon section (Coll. 1-F), and the fourth from the upper part of the Casper in Telephone Canyon (Coll. TC-3). Although some of our sections of this form are well oriented, we do not have any sagittal sections of it and are unable to determine all of its specific characteristics. However, enough information is available from our specimens that probably will permit its identification with specimens in connection with further work in this region or in other areas. For this reason and for the sake of completeness we have drawn up the following description based on more than half a dozen of our sections.

The shell of this form is small for the genus. It is elongate fusiform; with sharply pointed poles, straight axis of coiling, and convex lateral slopes. Specimens of four to five and a half volutions are 3.7 to 4.9 mm long and 1.4 to 1.8 mm wide, giving form ratios of 2.3 to 3.4. Some specimens show remarkably uniform shapes throughout all volutions, and their form ratio increases only slightly for the first four volutions. The average form ratios of the first to the fourth volution of four specimens are 1.8, 2.2, 2.5, and 2.6, respectively.

The proloculus is of moderate size. Its outside diameter measures 145 to 290 microns, averaging 217 microns for six specimens. The shell is rather tightly coiled. Average heights of the first to the fifth volution of six specimens are 58, 103, 158, 210, and 275 microns, respectively.

Our axial sections show the septa to be narrowly and highly fluted throughout the length of the shell. Seemingly the fluting extends to the top of the spirotheca even across the tunnel.

The spirotheca is moderately thin but contains relatively coarse alveoli. The average thickness of the spirotheca in the first to the fifth volution of six specimens are 12, 28, 38, 58, and 71 microns, respectively. The proloculus wall measures 24 to 54 microns in thickness, averaging 33 microns for five specimens.

The tunnel is narrow and straight. Chomata are low and narrow. Averages of the tunnel angles of the first to the fifth volution of five specimens are 20, 20, 25, 30, and 29 degrees, respectively. Fillings of dense calcite are heavy along the immediate axial zone in all parts of the shell, except in the first volution and in the outer one to two volutions.

Remarks.—The specimens described above as *Schwagerina* sp. are closely similar to and presumably are closely related in age to several forms described from the lower Wolfcampian of the Midcontinent area, including *S. emaciata* (Beede), *S. longissimoidea* (Beede), *S. forakerensis* (Skinner), *S. turki* (Skinner) and *S. gracilitatis* Dunbar and Skinner. The first of these is from the Florena shale of Kansas, the next three are from the Foraker shale of Kansas and Oklahoma, and the last is from the Wolfcamp of Texas. Of these, our form resembles most closely the last one.

Occurrence.—The occurrence of *Schwagerina* sp. was given above.

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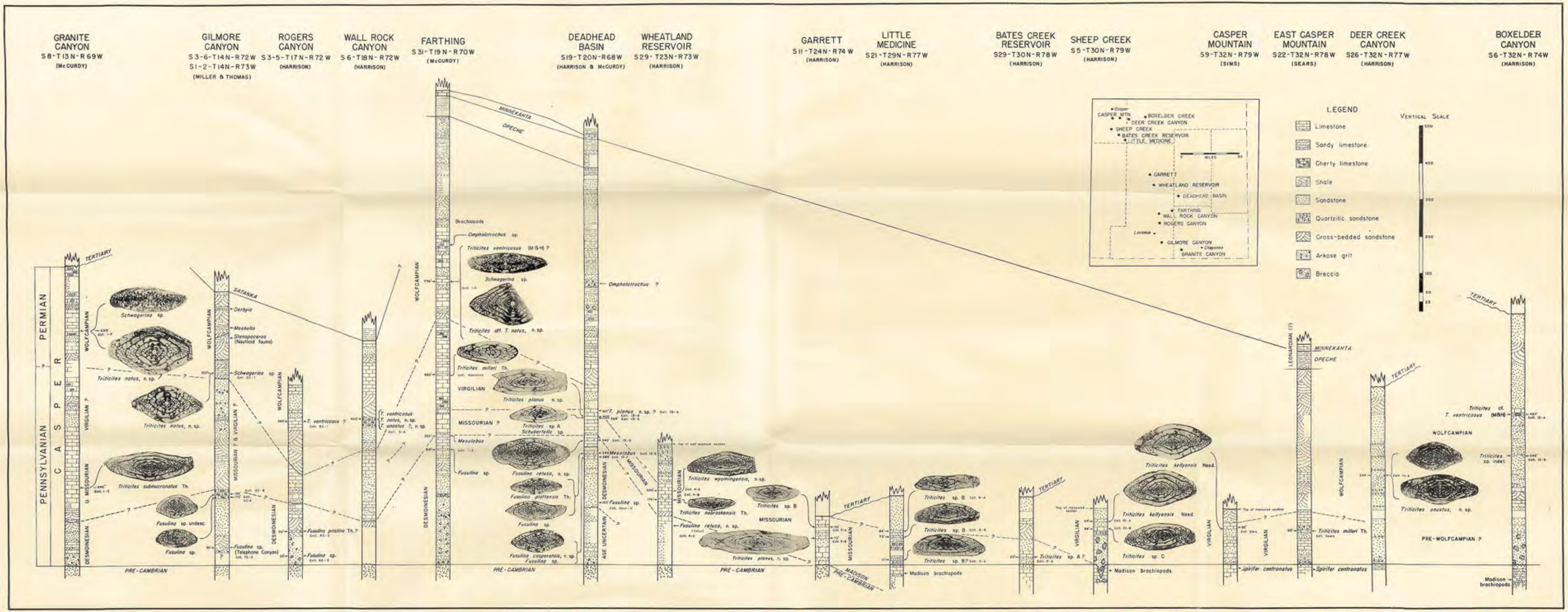

Plate 9. Correlation chart of stratigraphic sections along the Laramie Range and typical fusulinids of the Casper formation. All fusulinid illustrations ×6.