

A STUDY OF THE INVERTEBRATE FAUNA
OF THE COLORADO GROUP

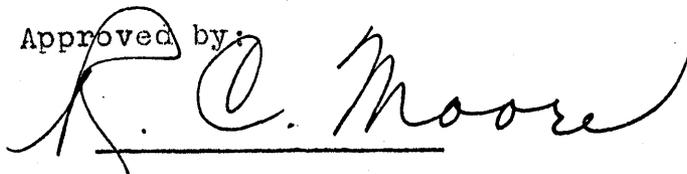
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Approved by:

A handwritten signature in cursive script that reads "R. C. Moore". The signature is written in dark ink and is positioned above a horizontal line.

Head of Department of Geology
February, 1931.

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INTRODUCTION

THE COLORADO GROUP. The Colorado group consists of strata of upper Cretaceous age, lying between the Dakota series and the Pierre shale (Montana). The group has an approximate maximum thickness of 1200 feet in Kansas.

The formations and members of the Colorado group as now recognized follow:

Formation	Member	Thickness
Niobrara		760 ft.
	Smoky Hill chalk	
	Fort Hays chalk	
Carlile		300
	Blue Hill shale	
	Fairport shale	
Greenhorn		90
	Pfeifer shale	} Bridge Creek in Hamilton County
	Jetmore limestone	
	Hartland shale	
	Lincoln limestone	
Graneros shale		40

The outcrop of these formations enters the state in Washington, Republic, Jewell and Smith counties, along the Nebraska line. It trends southwestward in a band approximately four counties in width to Arkansas river

where the formations disappear beneath Tertiary and later deposits. The upper Niobrara crops out along Smoky Hill river as far west as Wallace county where it goes beneath the Pierre shale. Another small outcrop extends down Arkansas river across Hamilton and a portion of Kearny counties.

PREVIOUS WORK. The upper Cretaceous of Kansas has long been known as a collecting field to the vertebrate paleontologist. Specimens of fish and reptiles from the Niobrara chalk are in many of the leading museums of the world. The same cannot be said of the invertebrate fauna of the Colorado group, however, as other areas in the Great Plains region have yielded a greater variety and more perfectly preserved specimens than has the Kansas area. Little has been done during the past thirty years to further knowledge of the upper Cretaceous fauna of Kansas.

1868-Hayden. The Hayden report contains a sketch of the geological formations along the Union Pacific railroad to Fort Wallace.¹ This work was done before the major divisions of the upper Cretaceous in Kansas were generally agreed upon. At Wilson he saw "the chalky limestones of the Niobrara filled with Inoceramus problematicus." (Inoceramus labiatus) These beds

1. Final Rept. U. S. Geol. Survey of Nebr., 1868, pt. 1, chap. 4. (printed 1872)

at Wilson are known now to be lower Benton. This and similar statements became firmly fixed in the literature, and to the present time are responsible for mistaken ideas regarding the range of Inoceramus labiatus.

¹
1876-Mudge. In this report, which is concerned principally with stratigraphic problems, Mudge reported finding a bed of Baculites near Sheridan (McAllaster). Meek stated that they were suggestive of Ft. Pierre or Fox Hills species, and that there was a possibility that Mudge had discovered an outlier of one of these formations. Mudge was strongly of the opinion that the bed was Niobrara. Williston² in 1893 treated the bed as Pierre as Meek suggested. This is the first definite report of Pierre, as distinct from the Niobrara, in Kansas.

³
1898-Logan. The first comprehensive treatment of the invertebrate fauna of the Colorado group in Kansas is contained in this report. The work is of special value in that it brings together material contained in numerous short papers published previously, and gives figures of several new Kansas species.

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1. Geol. and Geog. Surv. Terr., Bull., 2, no. 3, 1876.
 2. Trans. of Kans. Acad. of Sci., 1891-1892.
 3. Univ. of Kans. Geol. Survey, vol. 4, pt. 8.

¹
1925-Rubey and Bass. With the report on the geology of Russell county, Kansas the authors included a list of the fossils which they collected from each formation. No figures are given.

²
1926-Bass. This report on the geology of Ellis county, Kansas includes a list of fossils under each formation, as identified by Dr. J. B. Reeside jr. of the United States Geological Survey.

³
1926-Bass. Notes on fossils in this report are valuable in that exact collecting localities are given.

From fossils collected in the field while preparing these more recent reports Dr. J. B. Reeside jr. has recognized several new species, but their descriptions have not as yet been published.

PRESENT INVESTIGATION. The writer studied the stratigraphy and made faunal collections from the Colorado group in Kansas during the summers of 1929 and 1930. In these collections are several new species but their description does not fall within the scope of this thesis. Only Kansas material is figured, accompanied by quoted or revised descriptions. This report deals only with those species which are represented in the writer's collection or in previous collections belong-

1. Geol. Surv. of Kans., Bull. 10, pt. 1, Russell county.
 2. " " " " " 11, pt. 1, Ellis county.
 3. " " " " " 11, pt. 2, Hamilton county.

ing to the University, exclusive of microscopic forms. Many species have been reported by earlier writers on the Colorado group of Kansas, the specimens of which are not in the University collections, and the figures accompanying the report were taken from previous literature dealing outside the Kansas area. In such cases it is necessary to disregard the report until additional new material is collected. An attempt is made to clarify some of the reported discrepancies regarding the stratigraphic range of some species. It has seemed advisable in a few instances, after examining the types of several Kansas species, to place them in the synonymy of other species. Several already described species are herein reported from the Kansas area for the first time.

ACKNOWLEDGEMENTS. The writer is indebted to Dr. K. K. Landes, under whose supervision he has worked, for his assistance in the field and helpful advice in the preparation of the text; to Dr. R. C. Moore for his criticism of the manuscript and advice regarding preparation of plates; to R. G. Moss for his help in collecting fossils; and to Dr. J. B. Reeside jr. of the United States Geological Survey, who has examined all

of the collections from the Colorado group belonging to the University, and who has kindly furnished the writer with specimens and plaster casts of Kansas fossils that are in the possession of the United States Geological Survey.

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DISTRIBUTION OF SPECIES IN THE
COLORADO GROUP OF KANSAS

Graneros Greenhorn Carlile Niobrara

<i>Uintacrinus socialis</i>				_____
<i>Serpula tenuicarinata</i>				_____
<i>S. logani</i>			_____	
<i>Inoceramus labiatus</i>		_____		
<i>I. labiatus var. latus</i>		_____		
<i>I. grandis</i>				_____
<i>I. fragilis</i>		-----	_____	
<i>I. subtriangulatus</i>				_____
<i>I. deformis</i>				_____
<i>Ostrea anceps</i>		_____		
<i>O. congesta</i>		_____		
<i>Exogyra columbella</i>	_____			
<i>Lithophaga? sp.</i>		-----		
<i>Modiola multilinigera</i>		_____		
<i>Durania maxima</i>				_____
<i>Corbula nematophora</i>	_____			
<i>Callista tenuis</i>	_____			
<i>Volutoderam willistoni</i>			_____	
<i>Turritella whitei</i>		_____		
Gastropod gen. indet.		---		
<i>Tusoteuthis longus</i>				-----
<i>Eutrephoceras sp.</i>				_____
<i>Baculites gracilis</i>		_____		
<i>B. sp.</i>				_____
<i>Helicoceras pariense</i>		_____		
<i>Acanthoceras coloradoense</i>		_____	_____	
<i>Scaphites vermiformis</i>				_____
<i>S. ventricosus</i>				_____
<i>S. larvaeformis</i>			_____	
<i>S. warreni</i>			_____	
<i>Placentoceras pseudoplacenta</i>			_____	
<i>Prionotropis woolgari</i>			_____	
<i>P. hyatti</i>			-----	
<i>Prionocyclus wyomingensis</i>			_____	
<i>Metoicoceras whitei</i>		_____		
Ammonite gen. indet.				---
<i>Stramentum haworthi</i>				_____

SYSTEMATIC PALAEONTOLOGY

Phylum ECHINODERMATA

Subphylum PELMATOZOA Leuckart

Class CRINOIDEA Miller

Order UINTACRINIDAE Zittel

Genus UINTACRINUS Grinnell

Am. Jour. Sci., 3d. ser., vol. 12, p. 81, 1876.

Uintacrinus socialis Grinnell.

Pl. I, fig. 3.

Uintacrinus socialis Grinnell, 1876, Am. Jour. Sci.,

vol. 2, p. 375. Logan 1898, Univ. of Kans. Geol.

Survey, vol. 4, p. 481-483, pl. 112-113.

Logan's description:

"Body subglobose, with ten long radiating arms; basal plate small pentagonal, surrounded by five subradial, quadrangular plates. The six plates (one basal and five subradial) present a stellate appearance, and form an area not much greater in extent than the first radial plate. There are three radial plates, varying in size and shape, either pentagonal, hexagonal, or heptagonal. Of these three radial plates the third or superior seems always the largest and most regular in outline. It is heptagonal in form, with its two longest sides sloping downward from the superior angle. The second radial is about equal in size to the first.

All are wider than high. The third radial bears on its superior sloping sides in immediate succession five secondary radials, irregularly pentagonal, or hexagonal in shape, and all wider than high. The fifth of these approaches in shape the proximal armpiece, to which it gives immediate support.

The arm pieces are thin and horizontally compressed from without inward, their shape being subelliptical. The arms give support to delicate pinnulae or tentacles throughout their entire length. The articulate surfaces of the arm pieces present a radiate structure. There is also on the inner side of each piece a depression, the radial furrow, which gives to the plates a subcrescentoid shape. The arm pieces decrease in size toward the end of the arm. The interradial arms are irregular in shape, somewhat contracted near the middle, becoming wider above and below. They consist of about sixteen plates, large, irregular, and varying widely in size to the apex, forming a short arm. The arrangement of the interradial plates varies, but in some specimens the order is a single plate; next above in line with the second radial, are two; and three opposite the third. Succeeding these, and lying between the first of the second radials, is a single, wide, octagonal plate, and above this eight others, somewhat irregular, extending up in pairs between the fifth

secondary radials. Immediately above these eight follow the smaller plates, diminishing rapidly in size until the apex of the short interradiar arm is reached. A very small quadrangular plate is inserted between the first and second radials, and the interradiar plates, which are opposite these. This arrangement is not constant.

The interaxillary plates vary also with regard to shape and arrangement. In the axillary area of one specimen three pentagonal plates are succeeded above by three pairs of smaller plates of various shapes; these followed, each, by two branches composed of still smaller plates. In another axillary area of the same specimen one pentagonal plate is succeeded above by two heptagonal ones, which are in turn succeeded by three pairs of smaller plates of variable shapes; these each being followed by two branches of smaller plates."

U. socialis occurs with very local abundance in the beds of the Smoky Hill member. The Kansas area has become noted for the fine specimens of this crinoid, but its scarcity makes it of very little stratigraphic value.

This species was described from rocks equivalent to Colorado age from Utah.

Phylum VERMES
 Class ANNELIDA
 Order POLOCHAETA
 Suborder TUBICOLA
 Family SERPULIDAE
 Genus SERPULA Linné

Systema Naturae, ed. 10, 1758, p. 786.

Serpula? tenuicarinata, Meek and Hayden.

Pl. I, fig. 1.

Serpula? tenuicarinata, Meek and Hayden, 1876, U. S.

Geol. Surv., Terr., vol. 9, p. 507, pl. 6, fig. 1.

Stanton, 1893, U. S. Geol. Surv. Bull. 106, p. 53,

pl. 1, fig. 2. Logan, 1898, Univ. of Kans. Geol.

Surv., vol. 4, p. 484, pl. 86, fig. 4.

Meek's description:

"Tubes growing in groups, or rarely single, nearly cylindrical, increasing very gradually in size, irregularly curved, but apparently never spirally coiled, attached by the under side throughout most of the entire length; upper side having a distinct, rather sharply elevated, flexuous, longitudinal carina; surface smooth.

Length unknown; average transverse diameter, .14 in."

S. tenuicarinata is easily distinguished from *S. logani* by the presence of the distinct carina. This

species was questionably placed in the genus *Serpula* because no complete specimens were found. The specimens belonging to the University are also fragmentary.

S. tenuicarinata is typical of the Smoky Hill chalk, usually being found attached to *Inoceramus* shells. It was originally described from upper Cretaceous rocks at the mouth of Vermilion river, South Dakota.

Serpula logani, n. n.

Pl. I, fig. 2.

Serpula plana, Logan, 1898, Univ. of Kans. Geol. Surv., vol. 4, p. 443, pl. 119, fig. 2.

Original description:

"Cylindrical tubes growing in groups on the outer surface of the large *Inocerami* of the *Ostrea* shales; irregularly curved, gradually increasing in size, neither regularly coiled nor curved, but grouped irregularly, sometimes lying almost straight. Length of young individual, 24 mm.; diameter, in excess of 2 mm. Specimens attached by entire length, upper side showing irregular lines (probably lines of segmentation), as of overlapping concentric plates; surface in some specimens rugose, in others smooth."

Serpula logani differs from *S. tenuicarinata* in the absence of the carina, more regular habit of growth,

and in the presence of concentric lines of segmentation.

Dr. J. B. Reeside jr. has indicated that the name Serpula plana was first used by Samuel Woodward in 1831, "An Outline of the Geology of Norfolk," Norwich, 1831. A brief description of the species, accompanied by a figure is given by Brown¹; "convoluted, depressed; surface smooth; aperture circular." The British name has been accepted and used by many writers so it is necessary to rename Logan's species. The British form is Turonian to lower Senonian in age.

In Kansas this species is restricted to the Carlile shale formation. It has not been reported outside the Kansas area.

Phylum MOLLUSCA

Class PELECYPODA

Order PRIONODESMACEA

Superfamily PTERIACEA

Family PERNIIDAE

Genus INOCERAMUS Parkinson

Trans. Geol. Soc., London, 1819, vol. 5, p. 59.

1. Thos. Brown, An Atlas of the Fossil Conch. of Gt. Britain and Ireland, 1889.

Inoceramus labiatus, (Schlotheim).

Pl. I, figs. 5, 6.

Ostracites labiatus Schlotheim, 1813, Bronn's Jahrb.,
vol. 7, p. 93.

Inoceramus labiatus Stanton, 1893, U. S. Geol. Survey
Bull. 106, p. 77, pl. 10, fig. 4, pl. 14, fig. 2.
Logan, 1898, Univ. of Kans., Geol. Survey, vol. 4,
p. 450, pl. 92, fig. 4.

Shell thin, moderately depressed, subelliptical,
or acutely ovate, nearly equivalve, anterior margin
forming an almost uniformly convex curve from beak to
anterio-basal margin, postero-basal margin more
sharply curved, postero-dorsal margin slightly convex
and considerably depressed; cardinal border straight,
moderate in length, forming an angle of approximately
45 degrees with the axis of greatest elongation of
the shell; beaks terminal, rather small, curved in-
ward and forward; surface ornamented with regular,
concentric undulations and fine concentric lines of
growth. Approximate ratio of length, breadth, and con-
vexity, (single valve) 5:2:1.

Length of largest specimen noted, 10 inches, breadth
4 inches, convexity of single valve 1.5 inches.

Inoceramus labiatus is the most characteristic and
abundant fossil in the Greenhorn formation. It ap-
pears in the Lincoln limestone member and is quite

abundant throughout the formation, attaining its maximum development, both in size and numbers in the beds of the upper Jetmore.

I. labiatus is very widespread throughout the Interior Province, occurring in the Greenhorn formation or its equivalent, and is a valuable guide fossil to rocks of this age. It was originally described from the Turonian of Europe.

Inoceramus labiatus, var. *latus*, Sowerby.

Pl. I, fig. 4.

Shells have been assigned to this European variety which are shorter, less convex, and more nearly circular than I. labiatus, with the concentric undulations less prominent. In some specimens the growth lines are the most striking feature of surface ornamentation. There is a smaller average size in this variety than in typical I. labiatus. The approximate ratio of length, breadth, and convexity, is 4:3:1.

The most marked difference between shells of this type and the young individuals of I. labiatus is that the latter is more convex at corresponding growth stages. This variety is practically restricted to the lower half of the Jetmore member in a large part of the Kansas Cretaceous area and adults of typical I. labiatus are not commonly found associated with it.

Inoceramus grandis (Conrad).

Pl. II, fig. 5.

Haploscapha grandis Conrad, 1875, U. S. Geol. Survey, Terr., vol. 2, p. 23, pl. 64. Logan, 1898, Univ. of Kans. Geol. Survey, vol. 4, p. 492, pl. 94.

Haploscapha niobrarensis Logan, 1898, Univ. of Kans. Geol. Survey, vol. 4, p. 493, pl. 116, fig. 2.

Haploscapha eccentrica Conrad, 1875, U. S. Geol. Survey, Terr., vol. 2, p. 24, pl. 67.

Inoceramus pennatus Logan, 1898, Univ. of Kans. Geol. Survey, vol. 4, p. 488, pl. 118, fig. 2, pl. 120, fig. 2.

Inoceramus concentricus Logan, 1898, Univ. of Kans. Geol. Survey, vol. 4, p. 490, pl. 116, fig. 1.

Inoceramus truncatus Logan, 1898, Univ. of Kans. Geol. Survey, vol. 4, p. 492, pl. 114.

Shell large, subovate, subcircular, or subtriangular. Hinge straight, medium to long, irregularly twisted, being transversely ribbed on the back, occupying the upper portion of the interior and extending into the cavity under the hinge. Shell composed of columnar transverse fibers. Margin smooth and considerably thickened. Central portion exceedingly thin in adult shells. Exterior almost always covered with Ostrea congesta.

Specimens were measured in the field which were only slightly under 4 feet in diameter.

Several species of Inoceramus and Haploscapha have been described which seem to fall within the range of variation of Inoceramus grandis. Furthermore these species have no stratigraphic significance, all of them being associated in the Smoky Hill chalk. Haploscapha niobrarensis Logan, was described from specimens having a thicker shell and shorter hinge than the more typical shell. Haploscapha eccentrica Conrad, represents a type of variation having a slightly more convex shell, a shorter hinge, and less pronounced eccentric ridges, passing more gradually into the margin. The type specimen of Inoceramus truncatus Logan, has been closely examined and compared with large adult specimens of Inoceramus grandis and found to be undoubtedly a fragment from the smooth margin near the hinge, of a shell many times the size of the type specimen. Logan states that he observed several adult shells in the field and that the type which he collected is a young individual, but by reconstruction it is certainly a fragment of an adult. The type specimen of Inoceramus concentricus Logan, is a small fragment, unusually free of Ostrea therefore showing the external marking, but showing nothing of the hinge or the internal ridges, the fragment coming from the wide, rather smooth marginal area.

It seems doubtful if this specimen is characteristic enough to deserve specific rank. Inoceramus pennatus Logan, was described from two young and incomplete specimens, the thickened marginal area of both being absent. The smallest shows a portion of the hinge and the eccentric ridges. The other shows a part of both valves which have been considerably distorted and broken, destroying the clearness of the internal surface features.

The variations seen in Inoceramus grandis may have been caused by the great burden of Ostrea congesta which it so commonly carried. It is true that O. congesta occasionally attached itself to the shells after the death of the Inoceramus as specimens are sometimes seen incrusting the interior of the shell. This is a rare occurrence however and it seems plausible to assume that they preferred to attach themselves to the living Inoceramus. This added weight would more than equal the weight of the shell as specimens have been observed as small as 9 inches in diameter, having a thickness of Ostrea of 3 inches attached. Any organism would certainly react in many ways to so great an impediment. These reactions may have resulted in irregular growth of the shell, difference in convexity, and thickness of the shell, changes in the prominence

of surface ornamentation, and differences in size, all of which features have been used as specific characters. The abundance of the Ostrea would vary the intensity of the reactions. This feature is of course only one of the many factors which might contribute to individual variations.

Inoceramus grandis is not known to occur outside the Smoky Hill chalk member of the Niobrara in Kansas. It is quite abundant at the base of the member and continues in prominence throughout, being the most characteristic fossil of the member.

This species is reported from rocks of Niobrara age in many localities in the Interior Province.

Inoceramus fragilis Hall and Meek.

Pl. III, figs. 1, 7.

Inoceramus fragilis Hall and Meek, 1856, Mem. Am. Acad.

Arts and Sci. n. s., vol. 5, p. 388, pl. 2, fig. 6a-b.

Stanton, 1893, U. S. Geol. Surv. Bull. 106, p. 76, pl.

11, figs. 1-5. Logan, 1898, Univ. of Kans. Geol.

Survey., vol. 4, p. 450, pl. 87.

Shell thin, ovate, subelliptical or subcircular, moderately convex, height slightly to considerably greater than length, sub-equivalve, anterior side strongly to vertically truncate from the beaks, straight or slightly concave in outline, hinge line straight,

moderate to short, making an angle of approximately 90 degrees with the anterior side, beaks pointed, equal, curved forward and in some cases inward at the points. Surface marked by fine lines of growth and prominent to obscure, concentric undulations.

No other species in the Colorado group shows such strikingly different types, yet lends itself more difficult to a satisfactory classification. Specimens from the Fairport shale member usually exhibit more typical characteristics of the species. One specimen from the Lincoln limestone (lower Greenhorn) has an angle of 115 degrees between the anterior side and the hinge margin, the shell being nearly as long as high. This specimen is quite suggestive of Inoceramus perplexus Whitfield. The greatest variation in form is seen in specimens from concretions in the Blue Hill shale. Specimens which conform closely to the original description are rarely encountered in this member. Several shells very closely resembling Inoceramus howelli White, were collected from these concretions. Small, strongly convex shells from the uppermost beds of the Greenhorn which are assigned to this species are common in Kansas.

Inoceramus fragilis is usually considered a Carlile species, but locally it is quite abundant in Greenhorn

rocks, being confined mostly to the upper member.

This species occurs in rocks of Benton age throughout the Interior Province.

Inoceramus subtriangulatus, Logan.

Pl. II, fig. 1.

Inoceramus subtriangulatus Logan, 1898, Univ. of Kans.

Geol. Survey, vol. 4, p. 488, pl. 120, fig. 1.

Logan's description:

"Shell (left valve) large, subtriangular, slightly convex, fibrous, greatest convexity in the antero-central region; hinge long, straight, composed of columnar fibers and crossed transversely by costae; length of hinge in type specimen, 80 mm. Interior of shell smooth, ornamented with scarcely visible concentric lines or striae. Length of longitudinal axis, 200 mm.; height of shell, 120 mm. Anterior lateral margin forming an angle with the longer axis of the shell equal to the hinge angle. Posterior margin curved, oval in outline."

The holotype is a left valve which is imbedded in a matrix of chalk, and cannot be removed without damaging the specimen. For this reason Logan was not able to determine the general characters of the exterior of the shell. From the rather smooth interior it seems probable that the exterior is unusually smooth for a

species of this genus. An interesting feature which was pointed out by Dr. J. B. Reeside jr. regarding the holotype is the presence of distinct, original color markings, a very unusual condition of preservation for fossils in this area.

The holotype is the only individual of this species in the University collections. It was found in the upper Smoky Hill chalk in Gove county, Kansas. No report of this species has been made from other areas.

Inoceramus deformis Meek.

Inoceramus deformis Meek, 1871, U. S. Geol. Survey, Terr. Ann. Rept. for 1870, p. 296. Stanton, U. S. Geol. Survey Bull. 106, p. 85, pl. 14, fig. 1; pl. 15, figs. 1, 2.

Meek's description:

"Shell attaining a rather large size, obliquely ovate, and rather compressed in young examples, but more rounded, gibbous, and irregular, as well as much less oblique, in adult specimens; more or less inequivalve, but never very decidedly so; posterior and basal margins rounded; the latter curving up more gradually and obliquely to the short anterior margin; hinge short and usually not very oblique; beaks moderately prominent, and placed between the middle and anterior margin; neither greatly more elevated than

the other. Surface ornamented with large, strong, concentric undulations, which are sometimes moderately regular, but often very irregular, and generally becoming rather abruptly smaller on the umbones, where their curves indicate the greater obliquity of the young shell.

Height of a medium-sized specimen, about 4.50 in.; length of same, 4.30 in.; convexity of right valve, about 2.50 in."

I. deformis is distinguished from I. grandis by its greater convexity, much more regular outline and ornamentation, and smaller average size. Ostrea congesta is not so commonly attached to I. deformis as it is to I. grandis.

This species is quite common throughout the Fort Hays chalk and in Kansas appears to be restricted to this member.

It is reported from the Niobrara and equivalent formations over a great part of the Interior Province.

Superfamily OSTRACEA

Family OSTREIDAE

Genus OSTREA Lamarck

Prodrome, 1799, p. 81.

Ostrea anceps Logan.

Pl. III, fig. 4.

Ostrea anceps Logan, 1898, Univ. of Kans. Geol. Survey,
vol. 4, p. 446, pl. 117.

Original description:

"Shell elongate, moderately subovate, dorsal margin straight; ventral margin curved; beak truncated by mark of attachment; surface of truncated portion marked by parallel lines of indentation. Upper valve having an elongate, subovate, internal cavity; lower valve very capacious, hollowed under truncated beak. Internal surface of shell smooth; exterior surface not entirely discernible in type specimen, but appearing rugose at margins; hinge moderately long; ligemental groove deep and containing numerous cartilage pits; test thick; thicker on hinge side. Length of longitudinal axis, seventy mm.; maximum breadth, forty mm.; thickness of test, four to ten mm."

This species is quite distinct from the smaller and more irregular O. congesta. O. anceps appears to be restricted to the Lincoln limestone, the lowest member of the Greenhorn formation. The type specimens were collected by Logan in Mitchell county, 15 miles southwest of Beloit. Several shells which are referred to this species have been added to the collection from various outcrops of Lincoln limestone. No other reference to this species has been noted from other areas.

Ostrea congesta Conrad.

Pl. II, figs. 2, 3.

Ostrea congesta Conrad, 1843, Nicollet's Rept. of Expl.

in the Northwest, p. 167. Meek, 1876, U. S. Geol.

Survey, vol. 9, p. 13, pl. 9, figs. 1a-f. Stanton,
1893, U. S. Geol. Survey Bull. 106, p. 55, pl. 2, figs. 2-4.

Shell small, thin, individuals often crowded in great numbers, producing irregular forms. When isolated the shell is often quite regular, being sub-ovate in form. Lower valve completely attached, beak pointed. The margins of the flat attached lower valve are sharply deflected upward in a vertical position. Growth in this direction may exceed in height the diameter of the attached portion, producing a closed cylindrical tube. The upper valve is nearly flat or slightly concave, closely resembling in shape the attached portion of the lower valve. Surface smooth or marked by fine lines of growth.

The shell often reflects the nature of the surface on which it attached. One specimen was noted which showed clearly the ribbing of *Inoceramus*. Shells attached to *Inoceramus grandis* are crowded and seldom attain a large size, the elevated margin being well developed. Those living in less cramped conditions have a more regular form and a greater diameter with

the reflected margin of the lower valve less prominent.

Ostrea congesta occurs in rocks of Colorado age in a large part of the Interior Province.

Genus EXOGYRA Say.

Am. Jour. Sci., 1st. ser., vol. 2, 1820, p. 43.

Exogyra columbella Meek.

Pl. III, figs. 2, 3.

Exogyra columbella Meek, 1876, Macomb's Expl. Exped.

Santa Fe to junction of Grand and Green rivers, p.

124, pl. 1, figs. 3a-d. Stanton, 1893, U. S. Geol.

Survey Bull. 106, p. 63, pl. 8, figs. 2-4.

Meek's description:

"Shell small, rather thin, ovate; posterior side forming a semioval curve from the umbo to the ventral edge; anterior side rounded below the beak; ventral margin rounded. Lower valve convex, the most gibbous part sometimes forming an obtuse umbonal prominence, which is not separated from the front by a sulcus; beak slender, pointed, and distinctly coiled to the left; surface ornamented by small, but distinct, rather regular, radiating costae, which bifurcate along the umbonal ridge; marks of growth rather obscure.

Length from the most prominent part of the umbo to the ventral margin, 1 inch; transverse breadth, .72 inch; depth or convexity, about .42 inch."

There is considerable variation in shape and ornamentation within this species. Some specimens are narrow and produced toward the beak; others show several rude, concentric folds across the most gibbous part of the shell, the beak being more strongly curved than in typical specimens. There is also a variation in the intensity of the radiating costae irrespective of the size of the shell. These variations however do not seem to warrant further subdivision as these different types may all be associated in the same stratum and seem to grade imperceptibly from the typical form. No other species in the Colorado group closely resembles E. columbella.

This species appears to be restricted to the shales and sandstones of the Graneros where locally it occurs in great abundance. On Smoky Hill river, south of Gorham, Ellis county, an iron cemented sandstone bed 4 inches thick is composed almost entirely of this form.

E. columbella has been reported from the Woodbine in Texas, from the Graneros in Colorado and from lower horizons in New Mexico.

Superfamily MYTILACEA

Family MYTILIDAE

Genus LITHOPHAGA Bolten

Museum Boltenianum, 1788, p. 156.

Lithophaga? sp.

Pl. IV, fig. 6.

Internal molds of borings which are questionably placed in this genus, have been found in the Greenhorn limestones. No shells have been seen. The tubes inclosing the mold, are slightly curved, circular in cross-section, flask-shaped, and smooth, composed of thin calcareous material. Length of largest individual, 2 inches; diameter .25 inch.

Genus MODIOLA Lamarck

Modiola (*Brachydontes*) *multilinigera* Meek.

Pl. II, fig. 4.

Modiola (*Brachydontes*) *multilinigera* Meek, 1873, U.

S. Geol. Survey, Terr., Ann. Rept., 1872, p. 422.

Stanton, 1893, U. S. Geol. Survey Bull. 106, p. 86,

pl. 19, fig. 3. Logan, 1898, Kans. Geol. Survey,

vol. 4, p. 457, pl. 86, fig. 5.

Original description:

"Shell rather above medium size, obliquely arcuate-subovate; valves strongly convex along the umbonal slopes, thence cuncate posteriorly, and abruptly curved inward below the middle in front; posterior margin forming a broad, regular, convex curve, from the end of the hinge downward to the anterior basal extremity, which is very narrowly and abruptly rounded; anterior margin ranging obliquely backward and downward to the

narrow basal extremity, and strongly sinuous along the middle, above which it projects more or less beyond the umbonal ridge, so as to form a moderately prominent, somewhat compressed protuberance; hinge margin nearly or quite straight, running at an angle of 50 degrees to 60 degrees above an imaginary line drawn from the beaks to the most prominent parts of the basal outline, and equaling about half the greatest oblique length of the valves; beaks nearly terminal, rather compressed, very oblique, and scarcely rising above the hinge margin; umbonal slopes prominent and more or less strongly arcuate. Surface ornamented by fine lines of growth, crossed by regular radiating lines that are very fine and crowded on the anterior part of the valves, but become coarser above and behind the umbonal ridge, the largest being near the dorsal side, where they bifurcate so as to become very fine, and curve more or less upward before reaching the cardinal margin.

Greatest length, measuring obliquely from the beaks to the most prominent part of the basal margin of a large specimen, 1.90 inches; greatest breadth at right angles to the same, 1 inch; convexity, .76 inch."

Logan gives a description of this species but does not use Kansas specimens for his figure. He reports

the species to be common in the sandstones just below the Lincoln marble. No such occurrence has been noted in the field nor have specimens from the sandstone been found in the University collections. The individuals herein figured occur on the same slab of Lincoln limestone with Logan's types of O. anceps.

Modiola multilinigera has been reported by Meek and Stanton from Utah, Wyoming and Colorado.

Order TELEODESMACEA

Superfamily RUDISTACAE

Family RADIOLITIDAE Gray

Genus *Durania*

Durania maxima (Logan).

Pl. III, figs. 5, 6.

Radiolites maximus Logan, 1898, Univ. of Kans. Geol.

Survey, vol. 4, p. 494, pl. 65, fig. 1.

Shell inversely conical, lower valve two to three feet in height. Outer surface marked by coarse, broadly rounded, irregularly spaced, horizontal ribs, crossed by fine, rather sharp longitudinal ribs. Inner surface smooth, marked by distinct horizontal and vertical striations. The upper rim of the shell is smooth and slightly undulating, bearing widely spaced, radial impressions, with a low, very narrow carina bounding the inner margin of the rim.

"Diameter of lower valve at top, 250 mm.; thickness of outer layer of shell, 75 mm.

Although sometimes found singly, they are more often found in groups. Adults often found with young attached to them by their lower valves. Type specimens are adult forms united by their entire lengths; one of the specimens having three young ones attached to it near its upper extremity by their lower valves."

According to the present classification of rudistids Logan's species seems to properly belong in the genus *Durania*. It is clearly distinct from the species described by Stephenson¹ and Stanton² from the upper Cretaceous of Mexico.

Earlier workers in the upper Cretaceous of Kansas collected several specimens of this pelecypod. No additional material has been added to the more recent collection. Logan states that *Durania maxima* occurs in the lowermost Smoky Hill, near its contact with the Fort Hays in the south-central portion of the Niobrara area in Trego, Gove, and Ellis counties.

The species has not been reported from other areas.

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1. Stephenson, L. W., Some upper Cretaceous shells of the rudistid group from Tamaulipas, Mexico, Proc. U. S. Nat. Mus., vol. 61, 1922, pp. 1-13, pl. 1-15.
 2. Stanton, T. W., A new Cretaceous rudistid from the San Filipe formation of Mexico, Proc. U. S. Nat. Mus., vol. 59, 1922, p. 453-454, pl. 96.

Superfamily MYACEA

Family CORBULIDAE Fleming.

Genus CORBULA Brugiere

Encyclopedie Methodique, 1792, pl. 230.

Corbula nematophora Meek.

Pl. IV, fig. 1, 2.

Corbula nematophora Meek, 1873, U. S. Geol. Survey,
Terr., Ann. Rept. for 1872, p. 496. Stanton, U. S.
Geol. Survey Bull. 106, p. 124, pl. 27, figs. 3, 4.

Original description:

"Shell of about medium size, ovate-subtrigonal, nearly equivalve and moderately convex, with height equaling two-thirds the length; anterior outline rounded; base semiovate; posterior extremity somewhat produced and subangular or minutely truncated in outline below; dorsal outline sloping from the beaks, the anterior slope being more abrupt and slightly concave in outline above, and the posterior longer and nearly straight, with a greater obliquity; posterior umbonal slopes more or less angular in each valve from the beak to the posterior extremity; beaks rather prominent and placed about one-third the length of the valves from the front. Surface ornamented by small, regular, concentric ridges, or strong lines and furrows, both of which are more distinct on the right valve than on the left, where they are sometimes obsolete.

Length of largest specimen seen, .50 inch; height, .32 inch; convexity, .25 inch."

Most of the specimens collected are impressions in thin sandstones. Plaster casts have been made of these molds which show the ornamentation and outline quite clearly. The occurrence in Kansas is restricted to the Graneros and is quite common in the thin sandstones of this formation. It is abundant in the outcrops on Smoky Hill river in Russell and Ellis counties.

Corbula nematophora is reported from all of the formations of the Colorado group in eastern Colorado, from the upper Cretaceous in Utah and from equivalents of Carlile and Niobrara in Montana.

Superfamily VENERACEA

Family VENERIDAE

Genus CALLISTA Poli

Test. Utr. Sic., 1, 30, 1791.

Callista tenuis (Hall and Meek).

Pl. IV, figs. 3-5.

Cythera tenuis Hall and Meek, 1856, Mem. Am. Acad.

Sci., n. ser., vol. 5, pp. 383, pl. 1, fig. 5.

Callista (Aphrodina) tenuis Meek, 1876, U. S. Geol.

Survey, Terr., vol. 9, p. 188, pl. 5, figs. 1a-d.

Stanton, 1893, U. S. Geol. Survey, Bull. 106, p.

109, pl. 24, figs. 7-8. Logan, 1898, Univ. of Kans.

Geol. Survey, vol. 4, p. 458, pl. 99, fig. 8-9.

Stanton's description:

Shell thin, varying in form from subcircular to transversely ovate, rather gibbous at maturity. Anterior side rather short, obliquely subtruncate above, and abruptly rounded below; base forming a semiovate curve, being a little more prominent before than behind the middle; posterior side narrowly rounded, or subtruncate; beaks moderately prominent, somewhat gibbous in old shells, incurved, continuous, and placed nearly halfway between the middle and anterior side; lunule obovate, flat and not very distinctly defined; surface marked by fine, crowded, concentric striae, and sometimes a few, obscure, parallel furrows near the border.

Length of an adult shell, 1 inch; height, .78 inch; convexity, .56 inch."

Several specimens in the University collection have been noted which have a length of over 1.5 inches, but the proportional dimensions agree very closely with Stanton's measurements. This shell does not closely resemble other pelecypods in the Colorado formation, being most like an undescribed species of *Mactra*, with which it is associated in the Graneros, but differing from it in the marked anterior position of the beaks, and more prominent surface ornamentation.

Callista tenuis occurs with considerable abundance

throughout the Graneros formation in Kansas, and is apparently restricted to this horizon, being found as casts and molds in the shale and sandstone, and unusually well preserved in some of the scattered calcareous concretions near the top of the formation.

This species is reported from the beds of the lower Benton in the Black Hills region and from the Carlile in eastern Colorado, therefore its use as a zone fossil is of only local value.

Class GASTROPODA

Order CPENOBANCHIATA

Suborder TOXOGLOSSA

Family VOLUTIDAE Gray

Genus VOLUTODERMA Whitfield

Geol. Survey, N. J., vol. 2, 1892, p. 89.

Volutoderma willistoni (Logan)

Pl. IV, fig. 11.

Rostellites willistoni Logan, 1898, Univ. of Kans.

Geol. Survey, vol. 4, p. 461, pl. 120, fig. 3.

Logan's description:

"Shell rather large, spindle-shaped; spire passing gradually to a point, equally as long as the aperture; whorls six in number, the body whorl being much larger than the first in the spire. Whorls slightly constricted both above and below the suture, which has a slightly

raised border, which is somewhat rounded. Suture not especially distinct. Surface marked by parallel revolving lines and by curved, prominent costae, forming oblong nodes or ridges on each whorl, but more prominent ones on the body whorl than on the spire. Nodes decreasing in prominence as the apex is approached. Aperture inversely conical, prolonged into a moderately long canal.

Length of a medium-sized specimen, fifty mm.; greatest breadth, fifteen mm. Pillar arched but apparently without folds. There seems to be no well marked irregularity in the costae, and parallel ridges or oblong nodes are formed on each whorl."

No other specimens of Logan's species are known to have been found. The cotypes are in the University collection and consist of several very good casts of this gastropod, preserved in a fragment of a pyritized concretion.

Nothing can be said concerning the distribution of this species, its only known occurrence being at Williams Butte, Mitchell county, Kansas, where it was found in the concretions of the upper Blue Hill shale.

Suborder STREPTODONTA

Superfamily PTENOGLOSSA

Family TURRITELLIDAE Gray

Genus TURRITELLA Lamarck

Prodrome, 1799, p. 74.

Turritella whitei Stanton.

Pl. IV, fig. 12.

Turritella uvasana White, 1876, U. S. Geog. and Geol.Survey. W. 100th Mer., vol. 4, p. 195, pl. 18, figs.
11a-b.*Turritella whitei* Stanton, 1893, U. S. Geol. SurveyBull. 106, p. 130, pl. 28, figs. 12-16. Logan, 1898,
Univ. of Kans. Geol. Survey, vol. 4, p. 459, pl. 99,
figs. 1-5.

White's description:

"Shell of ordinary size, elongate, slender; sides straight; volutions numerous, apparently reaching eighteen or twenty when full-grown; the sides of the volutions nearly straight or only slightly convex; suture broad, deeply impressed.

Surface marked by numerous revolving raised lines, six or eight of which are moderately large, the smaller ones alternating with them. The larger lines are minutely nodose upon the larger volutions, and upon the last one they are even subspinulose.

All the specimens of this species in the collection are broken, more or less, but judging from the apical angle indicated by their sides, the largest must have been about $5\frac{1}{2}$ centimeters long, and its last whorl about 13 millimeters in diameter."

The specimens from which White wrote this description were obtained from near the base of the upper Cretaceous in Utah, and were doubtfully referred to Turritella uvasana, a California species occurring much higher stratigraphically. Stanton with better and more complete material from Colorado showed the two species to be distinct.

No good specimens of this species are available. An internal mold and several fragments were collected by Rubey and Bass in Ellis county.

Turritella whitei has considerable stratigraphic range. In Colorado it occurs in the Pugnellus sandstone which very likely corresponds to the top of the Carlile in Kansas. In the Kansas area however, it is only known to occur in the Graneros formation.

Gastropod Genus indet.

Pl. IV, fig. 7.

A rather large unidentified gastropod was found in the University collection, labeled "west of Hays, Cretaceous." From the lithologic character it is almost certainly from the Greenhorn limestone. Nothing resembling it has been found figured in the Cretaceous literature. So many necessary features have been destroyed that the advisability to attempt to classify the specimen is doubtful. It appears to be most like the Paleozoic forms of Pleurotomariidae.

Class CEPHALOPODA

Subclass DIBRANCHIATA Owen

Family BELEMNOTEUTHIDAE Zittel

Genus TUSOTEUTHIS Logan

Kans. Univ. Geol. Survey, vol. 4, p. 497.

Tusoteuthis longus Logan.

Pl. IV, fig. 8.

Tusoteuthis longus Logan, 1898, Univ. of Kans. Geol. Survey, vol. 4, p. 497, pl. 110, fig. 1.

Gladius moderately convex, corneous, lanceolate. Greatest breadth midway between center and anterior end. Marginal border sharply rounded. Midrib longitudinally striated. Shaft long, cylindrical. Central area with rudely radiating undulations and fine striations, both disappearing before reaching the margin. Length of gladius 13.5 inches; width 6.25 inches.

These features have been noted from a plaster cast of a Kansas specimen which is in the possession of the U. S. National Museum. The collector stated that several feet of the shaft was left in the matrix. Logan's specimen is rather incomplete, showing nothing of the central area nor anterior end, except a portion of the shaft.

The exact locality where these two specimens were collected is not known. Logan's specimen is labeled

"Smoky Hill chalk, on the Smoky Hill river." The U. S. National Museum specimen is from the "Smoky Hill chalk of Kansas." Tusoteuthis longus is a very rare species, these being the only specimens known.

Subclass TETRABRANCHIATA

Order NAUTILOIDEA

Suborder ORTHOCHOANITES

Family NAUTILIDAE Owen

Genus EUTREPHOCERAS Hyatt

Proc. Am. Phil. Soc. 1893, 1894, p. 555.

Eutrephoceras sp.

Pl. IV, figs. 9, 10.

A single fragmentary specimen which shows some of the generic characters of Eutrephoceras was found in the chalk of the upper Smoky Hill member of the Niobrara. The specimen is of valve only to show the presence of this rather rare nautiloid in the Kansas area. It was found in the upper part of a 20 feet exposure, N. E. $\frac{1}{4}$, Sec. 2, T. 3 S., R. 20 W., Phillips county.

Order AMMONOIDEA

Suborder EXTRASIPHONATA

Family LYTOCERATIDAE Neumayr

Subfamily MACROSCAPHITINAE Hyatt.

Genus BACULITES Lamarck

Prodr. de Pal., 1799, p. 80.

Baculites gracilis Shumard.

Pl. V, figs. 7, 8.

Baculites gracilis Shumard, 1859, Trans. Acad. Sci.

St. Louis, vol. 1, 1856-1860, p. 596. Stanton,
1893, U. S. Geol. Survey, Bull. 106, p. 166, pl.
36, figs. 1-3.

Stanton's description:

"Shell small, very slender; transverse section varying from broad ovate to subelliptical; surface sometimes nearly smooth, but usually with numerous distinct rounded costae or undulations that are strongest on the siphonal side from which they curve backward parallel with the lines of growth, gradually becoming fainter and disappearing before reaching the opposite side. In addition to the costae there are broad, rather obscure constrictions at intervals of about half an inch that completely encircle the shell. They are also more distinct on the siphonal side and are parallel with the lines of growth, passing nearly straight across the siphonal and antisiphonal sides and curved sharply backward on the flank.

Septum with six lobes and six saddles, all of the latter, excepting the antisiphonal one, symmetrically

but not deeply divided; lobes much more slender than the saddles."

Due to the simplicity of its ornamentation and small size, Baculites gracilis is not easily confused with the Baculites of the Niobrara.

This species is very abundant in the Jetmore member of the Greenhorn in Kansas, being practically restricted to this member. It is the only fossil observed which consistently occurs in the limestones bearing very abundant Inoceramus labiatus. Other genera of ammonites in particular, are found almost always in limestone which is relatively free of Inocerami.

It occurs in the great plains area in Greenhorn and Carlile rocks. Shumard described the species from the Eagle Ford of Texas, and Stanton reports it from Colorado and Utah.

Baculites sp.

Pl. V, fig. 6.

Several poorly preserved and distorted fragments of the genus Baculites were found in the Smoky Hill chalk member of the Niobrara, associated with Scaphites vermiformis and Scaphites ventricosus. One fragment shows faint but unquestionable undulations. No trace of nodes can be found which makes even a provisional

specific assignment difficult. No sutures are preserved. The fragment figured is 5 inches in length and .9 inch in width, but it is so greatly compressed that the original diameter was considerably less. This constitutes the first definite report of Baculites from the Niobrara of Kansas.

The specimens are from the Smoky Hill chalk of the "Pyramids" near Ft. Monument, Trego county, Kansas.

Subfamily TURRILITINAE Hyatt

Genus HELICOCERAS d'Orbigny.

Helicoceras pariense White.

Pl. V, fig. 9.

Helicoceras pariense White, 1876, U. S. Geog. and Geol. Survey, W. 100th Mer., vol. 4, p. 203, pl. 19, figs. 2a-d. Stanton, 1893, U. S. Geol. Survey, Bull. 106, p. 164, pl. 35, figs. 2-4.

White's description:

"Shell dextral; spire much depressed; whorls distinct, subcircular or very broadly oval in transverse section, increasing somewhat rapidly in size; surface marked by comparatively strong, rather abruptly rounded annulations, which cross the whorls obliquely; annulations only slightly prominent upon the upper and under sides; upon the outer side of the whorl each annulation bears a pair of prominent nodes, one on each side of

siphuncle, forming two dorsal rows of nodes along the whole length of the shell, the portion of the annulation between each pair of nodes being straightened and slightly flattened upon the back. The annulations are apparently always simple, never coalescing, and never prominent upon exfoliated specimens, and where the test is preserved they are seen to be subspinous or sharply nodose.

Septa moderately distant, sometimes embracing two annulations, but toward the aperture only one. Lobes all smaller than the saddles, the size in each transverse series gradually diminishing from the dorsal to the ventral one; the smallest saddle, the ventral, not being larger than the largest lobe, the dorsal; lobes all bifurcate, except the ventral, the inferior lateral lobe being but slightly so; the anterior portion of the space between the branches of the dorsal lobe occupied by two backward projecting points; the ventral lobe is simple, small, narrow, and serrate upon both sides. The saddles of the different longitudinal series all similar in shape diminishing gradually in size from the dorsal to the ventral series; all broader than long, except the ventral one, the length and breadth of which are about equal; each partially parted at the middle; edges of all the lobes and saddles serrated

or toothed."

The University collection does not include any examples of this species. Rubey and Bass collected a specimen from the Jetmore member of the Greenhorn in Russell county while working in cooperation with the United States Geological Survey. The figure shown is taken from a plaster cast of this specimen.

The writer is uncertain as to the range of Helicoceras pariense. It is described from "Crataceous strata southeast of Paria, Utah" and has been reported from the Ft. Pierre in New Mexico.

Family COSMOCERATIDAE Zittel

Subfamily ACANTHOCERATINAE Hyatt

Genus ACANTHOCERAS Neumayr

Acanthoceras coloradoense Henderson.

Pl. V, figs. 12, 13.

Acanthoceras coloradoense Henderson, 1908, U. S. Nat.

Mus. Proc., vol. 34, p. 259, pl. 13, figs. 10, 11.

Original description:

"Shell discoidal; whorls convex, oblong in cross-section, their height greater than width; umbilicus well defined, about equal to the greater diameter of the outer whorl; abdomen rounded, ornamented by two rows of sharp longitudinally compressed nodes, each

about midway between the medial line and the peripheral margin; each side of whorls ornamented by two other sets of nodes, one at the margin of the umbilicus, the other near the abdomen; nodes of all four sets connected by costae which nearly encircle the whorls, some curving slightly but mostly passing somewhat forward in a straight diagonal line as they pass from the umbilicus to the abdomen, the greater axes of the lateral nodes being parallel with the costae, while the greater axes of the abdominal nodes are at right angles to the costae; whorl found exposed as on the largest whorls and the nodes develop at an early stage; septa can not be figured from the specimens at hand; diameter of the type specimen 80 mm., outer whorl 31 mm. high and 14 mm. wide between the nodes, some fragments being larger than this."

This species is distinguished from other ammonites of the Colorado group by the absence of a keel; presence of a set of prominent nodes on the venter, one row on each side of the medial line; another set on the side of the whorl just dorsal to the ventral nodes; and a third set along the margin of the umbilicus; all of these nodes being connected by rather prominent, costae. Henderson confused "set of nodes" with "row of nodes" in his description. He refers to the two

ventral rows and the two sets on the sides, making a total of four sets, but the two ventral rows only constitute one set as they are on opposite sides of the shell, thereby making only three sets.

Acanthoceras coloradoense is quite abundant in the Greenhorn and Carlile formations, though strictly typical specimens are not common. There is considerable variation in the prominence of the nodes and costae. In the type most frequently encountered in the field there is an underdevelopment of these features. Several specimens were collected from the lower Bridge Creek in Hamilton county which show a very strong development of the nodes.

The species was described from the upper Benton, near Boulder Colorado, associated with Inoceramus labiatus. Nothing concerning its occurrence outside these areas is known.

Subfamily SCAPHITINAE Meek

Genus SCAPHITES Parkinson

Organic Remains of a Former World, vol. 3.

1811, p. 145.

Scaphites vermiformis Meek and Hayden.

Pl. V, fig. 5.

Scaphites vermiformis Meek and Hayden, 1863, Acad.

Nat. Sci. Phila. Proc., vol. 14, p. 22. Meek, 1876,

U. S. Geol. Survey, Terr. Rept., vol. 9, p. 423,
pl. 6, fig. 4. Reeside, 1928, U. S. Geol. Survey
P. P. 150, pl. 6, figs. 9-10, p. 7.

Meek's description:

Shell under medium size, ovate-subdiscoidal in form; umbilicus very small; inner regularly coiled volutions closely involute, deeply embracing, and composing a rather large portion of the entire shell; deflected part very short so as only to be slightly disconnected from the inner turns at the aperture, which is a little constricted and quadrato-subcircular in outline, with a slightly sinuous inner margin; surface ornamented by numerous straight costae, which are rather small and nearly regular on the inner volutions but become more prominent, and larger, as well as more distant, on the inner half of each side of the body portion, where they each support a prominent node at the outer end, so arranged that those on opposite sides generally alternate; costae all passing nearly straight across the periphery, on which they are of nearly uniform size, with the exception of the irregular enlargement with the whorls.

The nodes mentioned above are directed out at right angles to the sides of the shell, and like the costae, become again smaller toward the aperture. Most of the

large costae bifurcate at the nodes on the body part of the shell, but their number is also increased by the intercalation of others between. Where they thus branch at the nodes on one side, the two divisions crossing over the periphery from the point of bifurcation never both connect at a node on the opposite side, but in most cases one and sometimes each division terminates between two of the nodes on the outer side.

The septate portion of the only specimen of this species in the collection being highly crystalline, the structure of its septa can not be very clearly traced out. The siphonal lobe, however, can be seen to be a little longer than wide, with a rather narrow body, provided with three branches on each side, the upper pair of which are small and nearly simple, while the next pair are longer and each bifid, and the terminal pair (which are larger than the second) are each ornamented by three small pointed branchlets, or digitations, on the outer side. The first lateral lobe is somewhat irregularly tripartite, the lateral divisions being bifid and sharply digitate, while the terminal, which is not exactly central, is longer than the others, and has about five pointed digitations, or sharp, nearly or quite simple branchlets. The first lateral sinus can be seen to be deeply divided

at the extremity into two nearly equal branches. The second lateral sinus can also be so far traced as to show that it is not more than about one-third as large as the first, nearly as long as wide, and regularly tripartite; and this is as far as the structure of the septa can be made out from the specimen."

This species is distinguished from its associate in the Niobrara, Scaphites ventricosus, by the possession of coarse, rather sharp ventral ribs, two to each umbilical rib. It also has a row of prominent, conical nodes along the ventral margins of the living chamber, one primary rib for each node. The shell is moderately compressed.

A fragment of this species 3 inches in greatest diameter was found associated with S. ventricosus and Baculites sp. in the Smoky Hill chalk near Ft. Monument, Trego county Kansas.

Logan also reported this species in the concretion zones of the Blue Hill shale, but like S. ventricosus, the specimens were found by Reeside to have been misidentified.

This species is widespread in the Interior Province, and is a very useful guide fossil for Niobrara time.

Scaphites ventricosus Meek and Hayden.

Pl. V, fig. 4.

Scaphites ventricosus Meek and Hayden, 1863, Acad.

Nat. Sci. Phila. Proc., vol. 14, p. 22. Meek, 1876,

U. S. Geol. Survey, Terr. Rept., vol. 9, p. 425, pl.

6, figs. 7, 8. Reeside, 1928, U. S. Geol. Survey,

P. P. 150, p. 6, pl. 3; figs. 11-18; pl. 4, figs. 1-6.

Meek's description:

"Shell attaining a medium or larger size, oval, ventricose, broadly rounded over the periphery; inner turns closely involute, deeply embracing, and composing a large portion of the entire bulk; deflected portion very short; umbilicus very small and deep; aperture transversely sublunate or reniform, being deeply sinuous, and but slightly disconnected from the inner turns on the inner side; surface ornamented with costae that pass nearly straight over the periphery, where they are of uniform size, excepting their gradual enlargement with the volution, about every fifth or sixth one is larger and more prominent than the intermediate ones, which latter do not extend inward to the umbilical margin.

The septa, as made out from the specimen represented by our figures 8, a, b, (which is believed to be the inner volutions of this species, as represented by figures 7, a, b), are provided with deeply-divided lobes and sinuses. Siphonal lobe longer than wide, and bear-

ing on each side of its very slender body three branches, the two terminal of which are slightly larger than the succeeding lateral ones, and each unequally bifid and digitate; first lateral sinus as large as the siphonal lobe, very narrow at its base, and profoundly divided at its extremity into two unequal branches, of which the one on the siphonal side is larger than the other, and, like the latter, deeply bifid, with sinuous and obtusely digitate margins; first lateral lobe as wide as the siphonal lobe, but somewhat shorter, and provided with two nearly equal, bifurcating, and digitate terminal branches; second lateral sinus not more than half as long, and little more than half as wide as the first, and somewhat similarly divided and subdivided; second lateral lobe about half as long and wide as the first, but tripartite at the extremity, the divisions being nearly equal and digitate; third lateral sinus small and nearly equal and digitate; third lateral sinus small and merely provided with two nearly equal terminal branches, with more or less sinuous margins; third lateral lobe hardly more than half as large as the second, and bearing two very short, digitate, terminal divisions. Between the last-mentioned lobe and the umbilicus there is a minute, tridigitate lobe, very similar to the auxiliary lobe of the third lateral

sinus, but smaller."

This species is distinguished from S. vermiformis by its finer ribs, lack of nodes, and its more evenly rounded whorls.

The specimens in the possession of the University were collected by the writer from the Smoky Hill chalk in the vicinity of Ft. Monument, Trego county, Kansas. They are poorly preserved and much compressed but there is little doubt that they belong to this very characteristic Niobrara species. It is found associated with Baculites. Logan reported this species from the concretionary zone of the upper Blue Hill shale but the specimens have been examined by Dr. Reeside and are said to be S. larvaeformis. This therefore clears one of the apparent discrepancies in the stratigraphic range of this Scaphite, it being, except for a few reported exceptions, a strictly Niobrara species. This is the first report of S. ventricosus from the Niobrara in Kansas.

This species is widespread and valuable as a guide fossil in rocks of Niobrara age in the Interior Province.

Scaphites larvaeformis Meek and Hayden.

Pl. V, figs. 1, 2.

Scaphites larvaeformis Meek and Hayden, 1859, Acad.

Nat. Sci. Phila. Proc., vol. 10, p. 58. Meek, 1876,
U. S. Geol. Survey, Tern, Rept., vol. 9, p. 418, pl.
6, fig. 6.

Meek's description:

"Shell small, transversely subovate, compressed, evenly rounded on the periphery; volutions slender, nearly round, the inner or coiled ones forming only a very small part of the entire shell, and so closely involuted as to leave only a very small umbilical pit; extended body-portion rather long, slender, and straight to the recurvature, thence continued backward until it comes nearly in contact with coiled inner volutions; aperture apparently circular; surface ornamented by small costae, which pass from the inner side of the volutions to about half way across their lateral surfaces, where they swell into small, obscure, transversely-elongated nodes, and then branch each into two or three smaller linear ribs, all of which pass straight over the periphery.

The septa of this species are comparatively rather simple, being each provided with but two principal lateral lobes on each side, none of which are deeply divided. The siphonal lobe is longer than wide, and has two very small, short, nearly parallel, obscurely

bifid, terminal divisions, with a more oblique, somewhat similar branch on each of the sides above. The first lateral sinus is wider than the siphonal lobe, and nearly as long, with its extremity deeply divided by a slender, obscurely trifid, auxiliary lobe, into two very unequal, more or less sinuous, and obtusely digitate branches. First lateral lobe about half as wide as the siphonal, but somewhat shorter, and bearing two very small terminal divisions, similar to those of the siphonal lobe. Second lateral sinus not larger than the outer division of the first, and merely obscurely divided into two very short, simple, obtusely-rounded, terminal subdivisions. Second lateral lobe very small, and obscurely trifid at the end. Whether this last is what is usually called a ventral lobe, or whether there is another still smaller one beyond it, the specimen is scarcely in a condition to show."

The small size, extended living chamber, small costae, and rather prominent transversely-elongated nodes on the sides of the body portion are the most distinctive characters of this species.

Scaphites larvaeformis is common in the Carlile formation, especially in the calcareous concretions of the Blue Hill shale member. In Kansas it is restricted to the Carlile. It is very widespread throughout the Interior Province in rocks of Benton age.

Scaphites warreni Meek and Hayden.

Pl. V, fig. 3.

Scaphites warreni Meek and Hayden, 1860, Acad. Nat.

Sci. Phila. Proc., p. 177. Meek, 1876, U. S. Geol.

Survey, Terr. Rept., vol. 9, p. 420, pl. 6, fig. 6;

text figs. 61-63.

Meek's description:

"Shell small, transversely subovate, moderately compressed; inner volutions nearly circular, closely involute, and composing a comparatively rather large part of the entire bulk; deflected body-portion short and rather more compressed proportionally than the inner turns; surface costate, and without proper nodes; costae small on the inner volutions, where they do not differ materially in size, but on the body-part about every fourth or fifth one becomes more prominent than the others, and extends entirely across from the inner side to and over the periphery, in passing upon which they bifurcate, or give off lateral branches, so that the whole, with some intercalated ones, assume there a uniform size; aperture and septa unknown."

Meek, in the later publication includes with the original description of S. warreni a discussion and comparison of better specimens from Wyoming, with the type. The figures show the external form and marking along with the suture. The Kansas specimens agree

well with those from Wyoming. No specimens showing the septa are in the University collection.

This species is not as abundant in Kansas as its associate, S. larvaeformis. It is a valuable guide fossil throughout a large part of the Interior Province, for rocks of Carlile age.

Subfamily PLACENTICERATINAE Hyatt

Genus PLACENTICERAS Meek

Proc. Am. Philos. Soc., vol. 11, 1870, p. 429.

Placenticeras pseudoplacenta? Hyatt.

Pl. VI, fig. 7.

Placenticeras pseudoplacenta Hyatt, 1903, U. S. Geol.

Survey, Mon. 44, p. 216, pl. 43, figs. 3-11; pl. 44.

Reeside, 1928, U. S. Geol. Survey. P. P. 150, p. 8,

pl. 2, figs. 1, 2.

Reeside has extracted from Hyatt's figures and discussion a few of the most significant characters of P. pseudoplacenta; "moderately stout shell, with height of whorl about twice the width; flanks of whorl flattened in younger stages, very gently arched in later stages; narrow umbilicus; venter moderately broad, about as in P. planum Hyatt and P. stantoni Hyatt; nodes and ribs inconspicuous or absent at all stages; suture with first three lobes and first three saddles subequal; all the parts of the suture short, very

solid, and only moderately incised; fourth lateral lobe much shorter than the third."

A small fragment of a shell which seems quite probably to belong to this species was found in a calcareous concretion near the top of the blue Hill shale member just south of Osborne, Osborne county Kansas. All of the features shown by the fragment agree with those of P. pseudoplacenta.

This species has been reported from rocks of Colorado age in Colorado, Utah, Wyoming, and Texas.

Family PRIONOTROPIDAE Zittel

Genus PRIONOTROPIS Meek.

U. S. Geol. Survey, Terr., vol. 9, p. 453, 1876.

Prionotropis woolgari (Mantell).

Pl. V, figs, 10, 11.

Ammonites woolgari Mantell, 1822, Geol. of Sussex, p. 197, pl. 22, figs. 6, 7.

Prionocyclus (Prionotropis) woolgari Meek, 1876, U. S. Geol. Survey, Terr., vol. 9, p. 455, pl. 7, figs. 1a-h; pl. 6, fig. 2.

Prionotropis woolgari Stanton, U. S. Geol. Survey, Bull. 106, p. 174, pl. 42, figs. 1-4.

Meek's description:

"Shell attaining a medium size, more or less compressed discoidal, the outer turn being proportionally

more convex (including nodes) than those within; umbilicus about equaling the greatest dorso-ventral diameter of the last turn; each volution embracing about one-fifth of the next within, and having its umbilical margin slightly indented by the uncovered nodes forming the inner of the two outer rows on the succeeding volution within. Young examples, half an inch to one inch in diameter, with costae linear, closely arranged, of nearly uniform size, and manifesting scarcely any tendency to develop nodes, but already showing the forward curve of their outer ends well defined, while the peripheral keel is low, narrow, and simple, and the furrow on each side shallow. At a somewhat larger size costae usually more or less unequal in size, the larger ones now beginning to develop the two nodes at their outer curved ends, and to become a little more prominent and compressed at their inner extremities, while the rather more prominent keel begins to develop its crenate outline, and the nodes nearest it to assume their compressed form and parallel arrangement. On attaining to $2\frac{1}{2}$ to 3 inches in diameter, costae, nodes, and keel becoming more prominent, the latter being strongly compressed and deeply and largely scalloped, with divisions rounded in outline; while at this stage of growth, on each side of the keel, but this is due

to the prominence of the row of nodes on either side of the same. Costae, when the shell has attained a diameter of 4 inches, much depressed in the middle, with the nodes at their inner ends thicker and more obtuse, and those nearest the keel more depressed or nearly obsolete, while those of the third series, near by, become much enlarged and produced obliquely outward as short, thick, spine-like projections. Soon the outer compressed nodes disappear, and the keel is only represented by distinctly separated, low, elongated nodes; and when the shell has attained a diameter of 7 inches, the costae are more distant, greatly elevated, compressed, and almost wing-like, but still retain a large, prominent, sub-trigonal node or projection at their outer ends, and again become, as it were, pinched up at their inner extremities, which do not quite reach the umbilical margin.

Septa moderately close together; siphonal lobe longer than wide, with three or four short branches on each side, the two terminal of which are largest, more or less nearly parallel, and merely serrated; first lateral sinus broader than the siphonal lobe, more or less deeply divided into two subequal branches with short, irregular branchlets and digitations; first lateral lobe somewhat longer than the siphonal and tripartite,

with short, irregular branchlets and digitations occasionally in small specimens, with the middle terminal branch proportionally broad and so deeply sinuous at the end as to impart more nearly the appearance of a bipartite arrangement of the whole; second lateral sinus nearly resembling one of the divisions of the first, and in the adult with merely a number of marginal digitations; second lateral lobe little more than one-third as long, and from one-third to one-half as wide as the first, generally tripartite at the end, but sometimes, in large specimens, bipartite on one side of the shell the divisions being very short and simple, or serrated; third lateral sinus very small and merely bilobate, or in large specimens digitate along the margins; third lateral lobe hardly half as long as the second, and in small specimens merely tridentate at the end."

The largest specimen Meek reported was 7 inches in diameter.

P. woolgari is quite common in the Carlile shale formation of Kansas. It has been supposed to be restricted to this formation, but in Kansas it has been noted in the limestones of the upper Greenhorn formation. This species is widespread throughout the Interior Province, occurring in rocks of Carlile age. It was described from the Turonian of Europe.

Prionotropis hyatti Stanton.

Pl. V, figs. 5, 6.

Prionotropis hyatti Stanton, 1893, U. S. Geol. Survey Bull. 106, p. 176, pl. 42, figs. 5-8. Logan, 1898, Univ. of Kans. Geol. Survey, vol. 4, p. 468, pl. 102, figs. 5-8.

Stanton's description:

"Shell of rather small size, compressed discoidal, consisting of five or six whorls; volutions gradually increasing in size, embracing the earlier ones but very slightly so that the umbilicus is broad, though different specimens vary somewhat in this respect. In very young examples the height of the whorls is greater than the breadth, the keel is small, and more or less crenate, and the costae are simple, linear, and strongly curved forward at the outer ends, without any nodes at first. Usually every third or fourth costa is stronger than the other. Some specimens three-fourths of an inch in diameter are scarcely distinguishable from the young of P. woolgari excepting that usually the costae are slightly more unequal. As the shell continues to grow the inequality of the costae becomes more marked and each of the larger ones develop two nodes near the outer end where it curves forward, and on some of them there is also an elongated node near the umbilicus. At first the two outer nodes are equal, one being just

on the angle between the side and the abdomen and the other about halfway between it and the keel, but at a later stage the nodes nearest the keel become obsolete, while the others rapidly increase in size, and some of them are developed into prominent sharp spines that are directed obliquely outward and backward. On the outer whorl of the larger example the costae becomes distant, apparently by the suppression of the intermediate smaller ones.

While these changes in the surface ornamentation are developing, the form of the volution is also considerably altered. The abdomen becomes flattened on each side of the narrow, prominent keel, the sides become less convex, and the breadth of the whorl is finally almost equal to the height, so that its cross section is subquadrate.

The keel in all the larger specimens is usually more or less serrate, the serration equaling the costae, though sometimes it is only slightly sinuous and it is never completely divided into nodes as it is in P. woolgari. Septa very much like those of P. woolgari, as shown by the figures."

There is one example of this species in the University collection. It was found in the concretion zone of the upper Blue Hill shale.

P. hyatti is described from specimens found in the Pugnellus sandstone in Huerfano Park, Colorado, and has been reported from many localities in the Interior Province from rocks of Benton age.

Genus PRIONOCYCLUS Meek

U. S. Geol. Survey, Terr., vol. 9, p. 452, 1876.

Prionocyclus wyomingensis Meek.

Pl. VI, figs. 2-4.

Prionocyclus wyomingensis Meek, 1876, U. S. Geol. Survey, Terr., vol. 9, p. 452. Stanton, 1893, U. S. Geol. Survey, Bull. 106, p. 171, pl. 40, figs. 1-4. Logan, 1898, Univ. of Kans. Geol. Survey, vol. 4, p. 463, pl. 106.

Original description:

"Shell attaining a rather large size; discoid, with periphery provided with a very narrow, prominent, serrated mesial keel, including the siphuncle. Volutions increasing rather gradually in size, somewhat compressed laterally, and a little excavated without being distinctly channeled on each side of the ventral keel; inner ones but slightly embraced by each succeeding turn, and consequently well exposed in the wide umbilicus. Surface ornamented with numerous unequal costae, some of the larger of which bear a small, somewhat

elongated node near the umbilicus, and two closely approximated small nodes around the ventro-lateral margins, where they all curve very strongly forward as they pass upon the periphery; spaces between each two of the large nodose costae occupied by from one to about three smaller ones. Septa unknown."

Further description by Stanton:

"The costae are very irregular and vary considerably in strength on different individuals, but they retain the same character through all the stages of growth, excepting that the smaller intermediate ones almost disappear from the last whorl of very large specimens. Frequently two costae spring from a single node near the umbilicus and sometimes are again united in the node near the periphery, but in other cases specimens show more than one row of nodes near the periphery, and these are never developed into spines. The serrations of the keel are small and somewhat more numerous than the costae."

The septa, as shown in Stanton's figure, has the same general character as that of Prionotropis woolgari, the principal difference being in the greater breadth of the first lateral lobe. The breadth of the whorls is about two-thirds of the height in young specimens; in large ones it is proportionally somewhat greater.

This species may be distinguished from P. woolgari by an examination of the keel. The other characters of these two species are variable and cannot be relied upon with certainty.

P. wyomingensis occurs in the concretion zones of the Blue Hill shale in Kansas. It also is found in similar horizons in Wyoming, Colorado, South Dakota, and Utah.

Family METOICOCERATIDAE Hyatt

Genus METOICOCERAS Hyatt

U. S. Geol. Survey Mon. 44, p. 116, 1903.

Metoicoceras whitei Hyatt.

Pl. IV, fig. 1.

Metoicoceras whitei Hyatt, 1903, U. S. Geol. Survey Mon. 44, p. 122, pl. 13, figs. 3-5; pl. 14, figs. 1-10, 15.

Hyatt's description is for the most part a comparison of M. whitei with M. swallowi, consequently the detailed features of the shell are mostly given in relative terms.

Volutions quite compressed, umbilicus small. Nodes on the umbilical shoulders inconspicuous, forming a part of the costae. Costae, prominent, nearly straight, and radiating. The inner row of the two outer lines of tubercles elongated longitudinally and parallel with the outer rows. Shell smooth in young stages, with the living chamber occupying nearly three-fourths of a volution. In the adult stage the living chamber is one-

half a revolution in length. Venter moderately broad and flattened.

Rubey and Bass collected a very good specimen from the Jetmore member in Ellis county, a plaster cast of which is shown in the figure. Several specimens were found in the Lincoln limestone member which closely resemble this species in the external characters. No suture is available.

M. whitei was originally described from the Eagle Ford of Texas and has been reported from several localities in the Interior Province. It appears to be restricted to rocks of Benton age.

Ammonite genus Indet.

Pl. IV, fig. 8.

A small fragment of a large ammonite was found in material weathered from the Ft. Hays chalk. Any identification was impossible and the specimen is mentioned only to show the presence of ammonites in the Ft. Hays in Kansas.

The specimen comes from Sec. 24, T. 14 S., R. 24 W. in Trego county, Kansas.

Phylum ARTHROPODA

Subphylum BRANCHIATA

Class CRUSTACEA

Subclass CIRRIPIEDIA Latreille

Genus STRAMENTUM Logan

Kans. Univ. Quart., 6, p. 198, 1897.

Stramentum haworthi (Williston).

Pl. VI, fig. 9.

Pollicipes haworthi Williston, 1896, Univ. of Kans.

Geol. Survey, vol. 2, p. 243, pl. 36.

Stramentum haworthi Logan, 1897, Kans. Univ. Quart.,

vol. 6, no. 4, Oct., ser. A, p. 188; Logan, Univ.

of Kans. Geol. Survey, vol. 4, p. 498, pl. lll.

Logan's description:

"Capitulum small, composed of nine plates, viz.;

Carina, scuta (2), terga (2), lateralia (4); height, five mm.; breadth eight mm. Terga triangular, with the apex pointing toward the base of the capitulum; surface marked by striations, moderately indented in the type specimen; height, ten mm.; greatest breadth four mm. Superior laterals triangular, with apex rounded; convex, overlapping scuta in the single specimen; height, nine mm.; breadth at base, thirteen mm. Scuta shorter than the superior laterals, their edges slightly rounded; moderately convex; triangular, with the apex truncated by a line parallel with the base, which is inclined at an angle of thirty degrees toward the base of the capitulum; height, ten mm.; breadth at base, two mm. Carina long, narrow, rounded; height, ten mm.; breadth at base, two mm. Peduncle composed

of nine rows of plates; plates narrow, one mm. in breadth and four mm. in length, with about thirty plates in each row; plates turned downward at the end, grooved along central line. Height of specimen, twenty-seven mm.; height of capitulum, ten mm.; height of peduncle, seventeen mm. The type specimen is attached to an Ostrea congesta by the extremity of its peduncle."

No additional specimens of S. haworthi have been added to the University collection. Little is known regarding the species stratigraphic range. The holotype, shown in the figure, comes from the "yellow horizon of the Smoky Hill chalk near Gove City," in Gove county, Kansas.

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PLATE I

PLATE I.

- Figure 1. Serpula tenuicarinata, Meek and Hayden. Niobrara, Trego county, Kansas. xl.
2. S. logani Morrow. Type, Niobrara, Western Kansas. xl.
3. Uintacrinus socialis Grinnell. Smoky Hill chalk, Elkader, Logan county, Kansas. xl/3.
4. Inoceramus labiatus, var. latus Sowerby. Lower Jetmore, Hodgeman county, Kansas. xl.
- 5, 6. Inoceramus labiatus Schlotheim. Typical specimens from the upper Jetmore of Mitchell county, Kansas. 5, xl; 6, x $\frac{1}{2}$.



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4



5

PLATE II

PLATE II.

- Figure 1. Inoceramus subtriangulatus Logan. Type,
Niobrara, Gove county, Kansas. $x\frac{1}{2}$.
- 2, 3. Ostrea congesta Conrad. Lower Fairport, Ellis
county, Kansas. xl.
4. Modiola multilinigera Meek. Lincoln lime-
stone, Mitchell county, Kansas. xl.
5. Inoceramus grandis Conrad. Smoky Hill chalk,
Gove county, Kansas. $x\frac{1}{3}$.



PLATE III

PLATE III.

- Figure 1, 7. Inoceramus fragilis Hall and Meek. Blue Hill shale, Osborne county, Kansas. xl.
- 2, 3. Exogyra columbella Meek. Graneros, south of Walker, Ellis county Kansas. xl.
4. Ostrea anceps Logan. Lincoln limestone, Mitchell county, Kansas. $x\frac{1}{2}$.
- 5, 6. Durania maxima Logan. Lower Smoky Hill, Trego county, Kansas. 5, fragment of large individual, $x\frac{1}{2}$; 6, group of young attached to adult, xl.

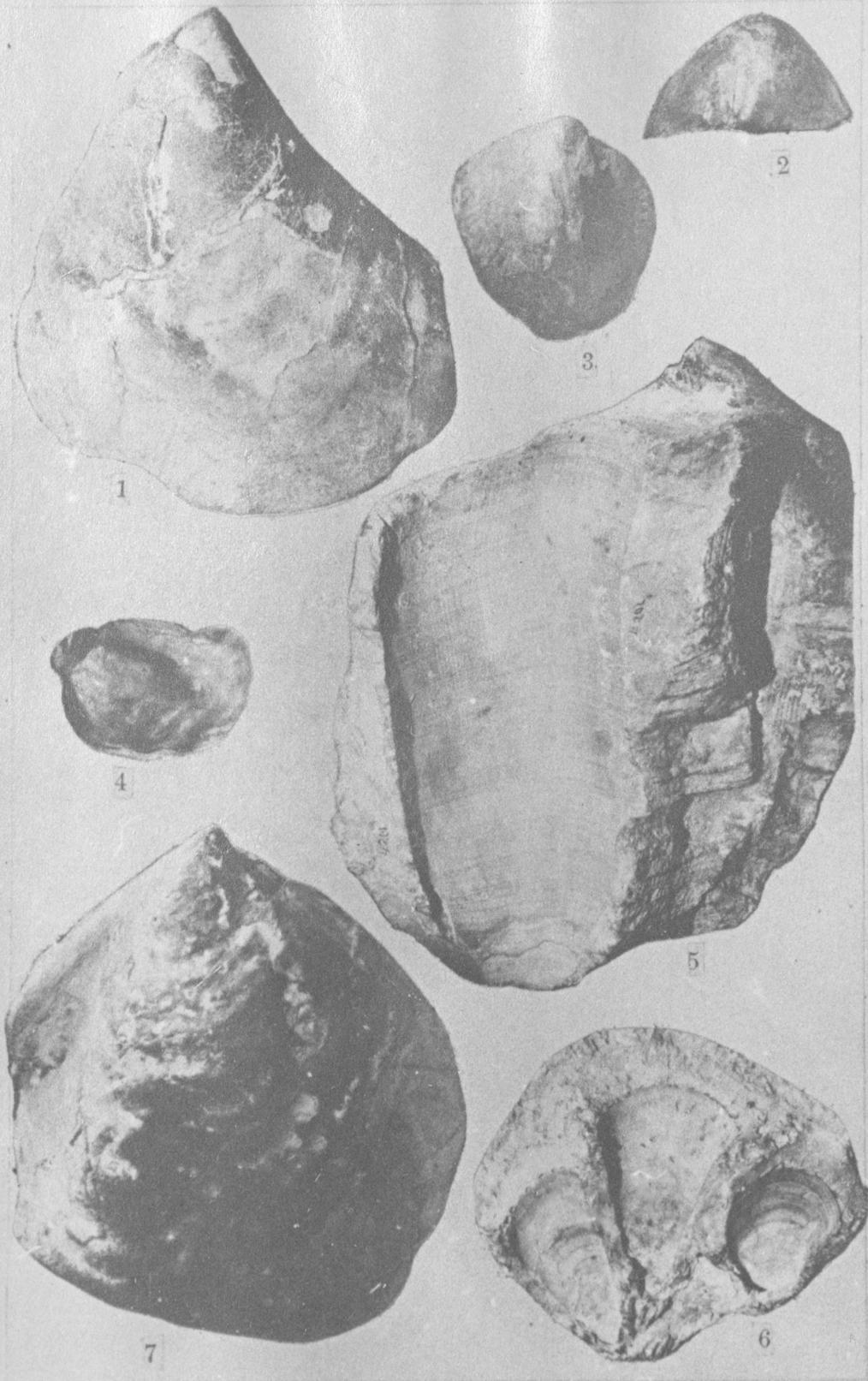


PLATE IV

PLATE IV.

- Figure 1, 2. Corbula nematophora Meek. Graneros, Ellis county, Kansas. 1, plaster cast of mold, x2; 2, external molds in sandstone, xl.
- 3-5. Callista tenuis Hall and Meek. Graneros, Russell county, Kansas. 3 and 4, side and front view; 5, side view of sandstone cast. xl.
6. Lithophaga? sp. Greenhorn limestone, Hodgeman county, Kansas. Casts of borings. xl.
7. Gastropod gen. indet. Greenhorn limestone, Ellis county, Kansas. xl.
8. Tusoteuthis longus Logan. Plaster cast of U. S. Nat. Mus. Cat. no. 73418. Smoky Hill chalk, 1 mile southwest of Russell Springs, Logan county, Kansas. $x\frac{1}{2}$.
- 9, 10. Eutrephoceras sp. Ventral and side view. Upper Smoky Hill chalk, 8 mi. south, Long Island, Phillips county, Kansas. xl.
11. Volutoderma willistoni Logan. Type from Blue Hill shale, Williams Butte, Mitchell county, Kansas. xl.
12. Turritella whitei Stanton. Sandstone mold from Graneros, Russell county, Kansas. Rubey and Bass collection.



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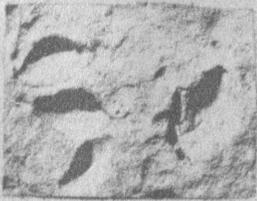
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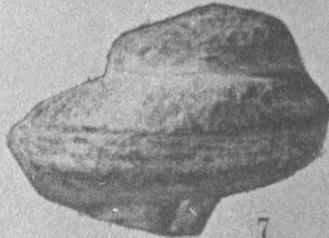
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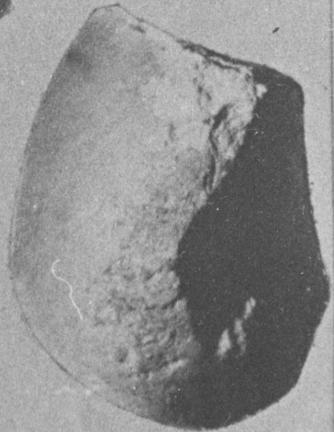
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PLATE V

PLATE V.

- Figure 1, 2. Scaphites larvaeformis Meek. Upper Blue Hill shale, Mitchell county, Kansas. xl.
3. S. warreni Meek. Upper Fairport, Ellis county, Kansas. xl.
4. S. ventricosus Meek. Fragment from Smoky Hill chalk, 'Pyramids', Trego county, Kansas. xl.
5. S. vermiformis Meek. Fragment from Smoky Hill chalk, 'Pyramids', Trego county, Kansas. xl.
6. Baculites sp. Fragment from Smoky Hill chalk, 'Pyramids', Trego county, Kansas. xl.
- 7, 8. Baculites gracilis Shumard. Greenhorn limestone, Republic county, Kansas. xl.
9. Helicoceras pariense White. Jetmore limestone, Russell county, Kansas. x2/3.
- 10, 11. Prionotropis woolgari Mantell. Lower Fairport, Hodgeman county, Kansas. xl.
- 12, 13. Acanthoceras coloradoense Henderson. Lower Bridge Creek, Hamilton county, Kansas. xl.

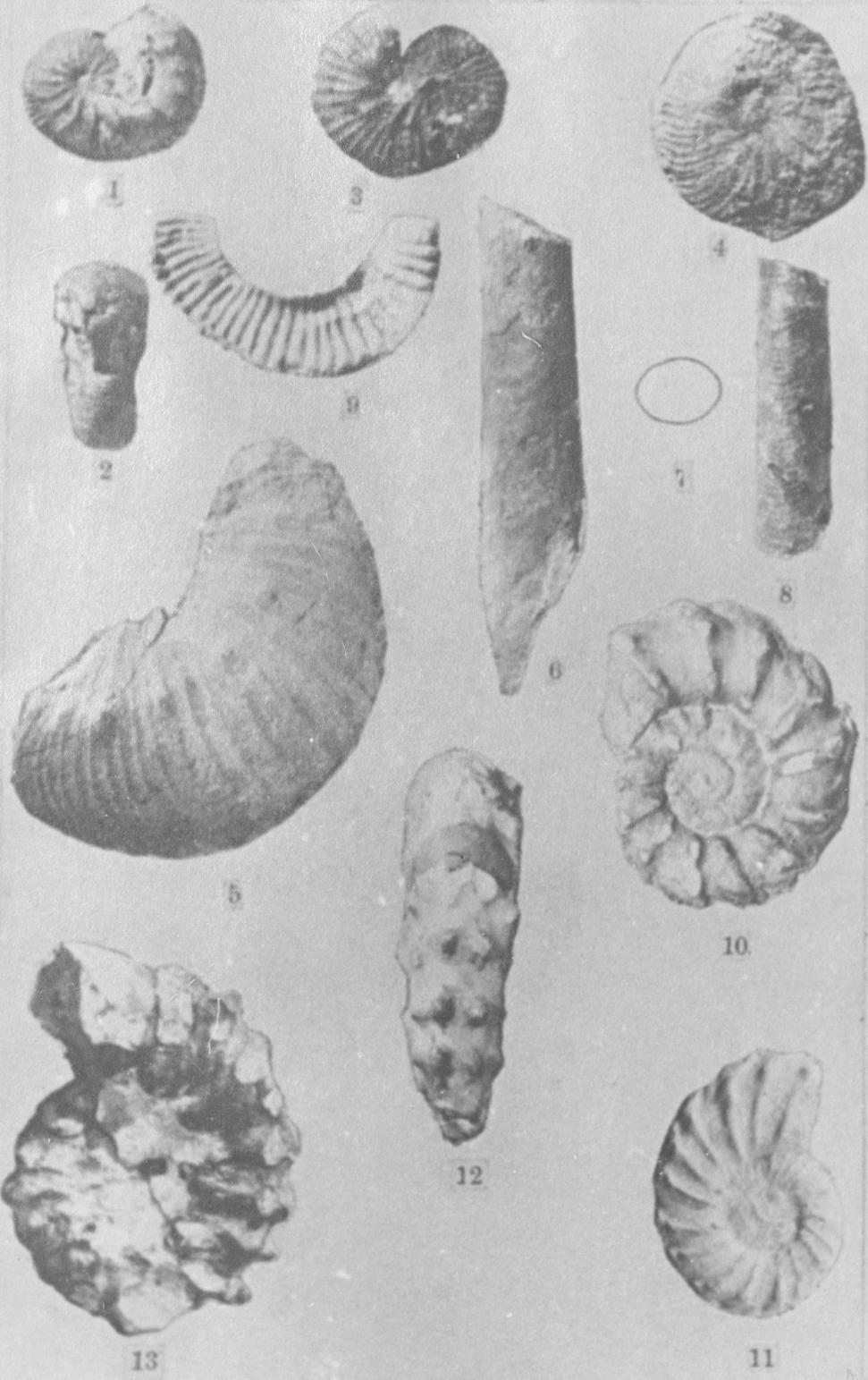
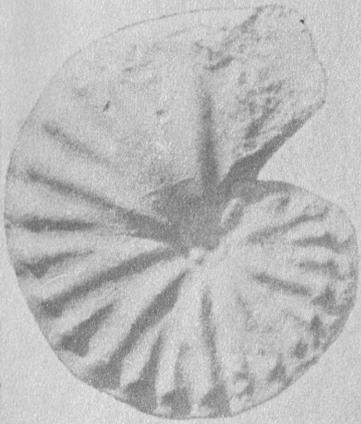


PLATE VI

PLATE VI.

- Figure 1. Metoicoceras whitei Hyatt. Pfeifer member, near Pfeifer, Ellis county, Kansas. x2/3.
- 2-4. Prionocyclus wyomingensis Meek. 2, mold from Fairport shale, Ellis county, Kansas. xl. Another specimen, x4; 4, very small specimen, showing keel, x8. Upper Blue Hill shale, Osborne county, Kansas.
- 5, 6. Prionocyclus hyatti Stanton. Upper Blue Hill shale. xl.
7. Placentoceras pseudoplacenta Hyatt. Upper Blue Hill shale, Osborne county, Kansas. xl.
8. Ammonite fragment from Ft. Hays chalk, Gove county, Kansas. xl.
9. Stramentum haworthi Williston. Type, Smoky Hill chalk, Gove county, Kansas. x2.



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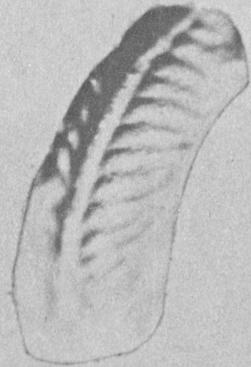
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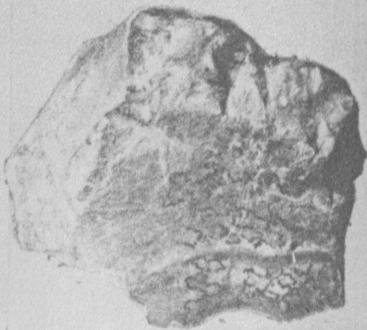
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