PART VIII.

THE INVERTEBRATES OF THE BENTON, NIOBRARA AND FORT PIERRE GROUPS.

By W. N. LOGAN.

Plates LXXXVI-CXX.

CONTENTS.

INTRODUCTION.

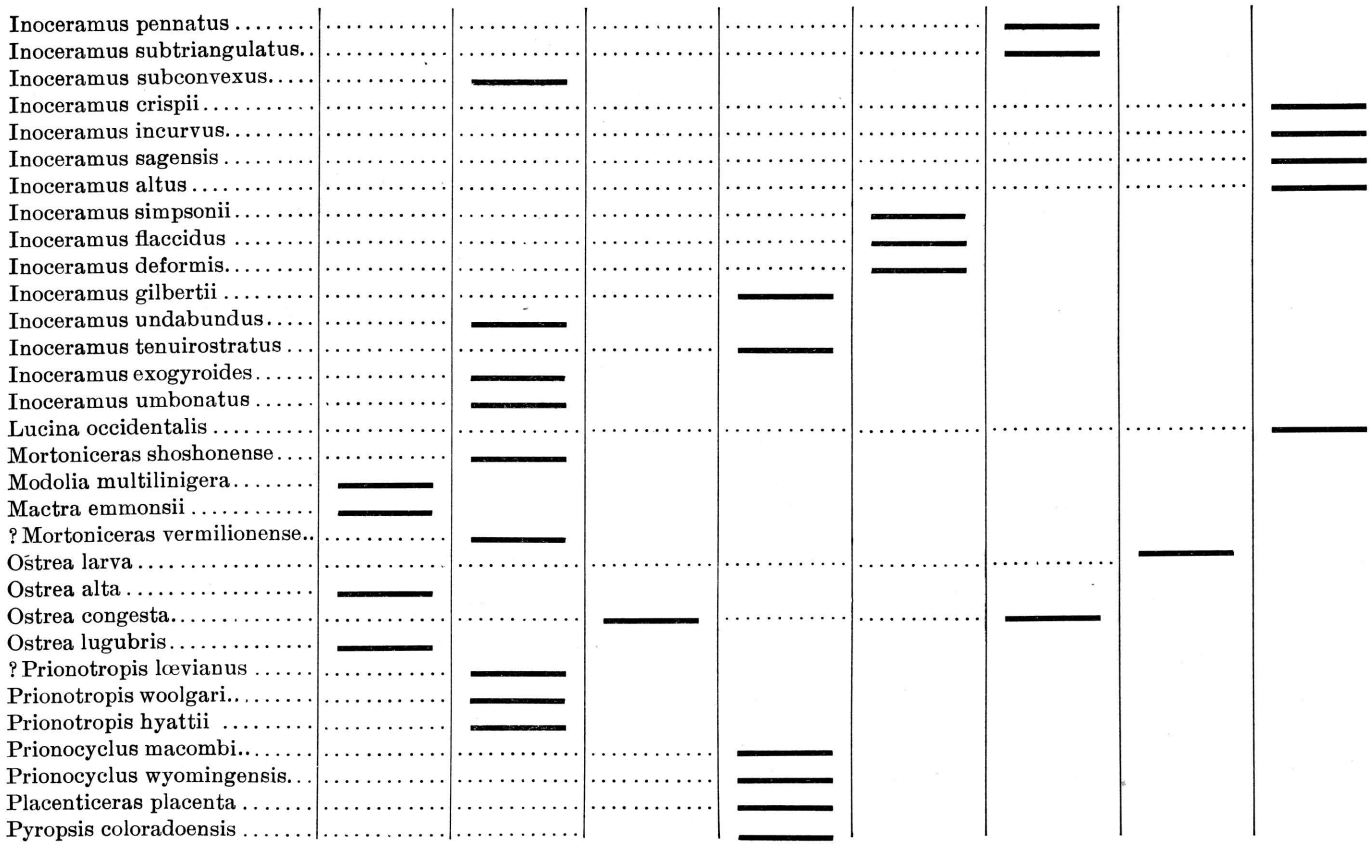
ALTHOUGH the Upper Cretaceous beds of Kansas have been the object of much attention from paleontologists and collectors, yet until recently but little consideration has been given to their invertebrate faunas. The discoveries of such a large list of vertebrate forms as the Kansas Upper Cretaceous has produced have had a tendency to overshadow the importance of its invertebrate forms.

The following review and classification of the invertebrate faunas of three of the Upper Cretaceous divisions of Kansas contain the descriptions and figures of nearly seventy-five forms, embracing seventeen believed to be new to science. It is the direct result of the study of the invertebrate fossils already belonging to the Kansas State University collection, those collected by the writer while working on the stratigraphy of the Upper Cretaceous of Kansas under the direction of the University Geological Survey, and those collected by Doctor Williston and the writer during the summer of 1897. In this classification I have attempted to combine, together with the purely scientific, information that may be utilized by the general reader. This attempt has led to a general rather than a strictly scientific discussion of the subkingdoms of Invertebrata. In order, however, that its value to the scientist may not be impaired, the customary order of scientific description has been retained for both the already-described and the new species. In all species already described the original descriptions and figures, as far as practicable, have been retained.

In the preparation of this report the writer desires to acknowledge his indebtedness to Dr. S. W. Williston for valuable assistance in the laboratory and field; also to the following, for courtesies extended: Mr. T. W. Stanton, of the United States Geological Survey, Washington, D. C.; Mr. W. Madden, Hays City, Kans.; Mr. M. R. Watson, McCracken, Kans.; Prof. H. J. Harnley, McPherson, Kans.; and Mr. Stanley Moore, Pleasanton, Kans.

Outline Showing Distribution of Species in the Upper Cretaceous of Kansas.

Formation.	Fort Benton.				Niobrara.			Fort Pierre.
	Lincoln Marble.	Limestone Group.	Ostrea Beds.	Septaria.	Fort Hays Limestone.	Rudistes Beds.	Hesperornis Beds.	Arickaree Shales.
Avicula gastrodes		—						
Avicula fibrosa								—
Acanthoceras kanabensis				—				
? Anchura sublævis								—
Belemnitella baculus		—						
Baculites ovatus								—
Callista tenuis			—					
Corbula kanabensis	—							
Donax cuneata	—							
Donax oblonga	—							
Exogyra læviuscula	—							
Heliococeras corrugatum				—				
Heteroceras cochleatum								—
Heteroceras angulatum								—
Haploscapha grandis						—		
Haploscapha eccentrica						—		
Haploscapha niobraraensis						—		
Inoceramus brownii					—			
Inoceramus concentricus						—		
Inoceramus truncatus						—		
Inoceramus platinus					—			
Inoceramus fragilis					—			
Inoceramus labiatus		—						
Inoceramus dimidius				—				


Inoceramus pennatus
Inoceramus subtriangulatus
Inoceramus subconvexus
Inoceramus crispii
Inoceramus incurvus
Inoceramus sagensis
Inoceramus altus
Inoceramus simpsonii
Inoceramus flaccidus
Inoceramus deformis
Inoceramus gilbertii
Inoceramus undabundus
Inoceramus tenuirostratus
Inoceramus exogyroides
Inoceramus umbonatus
Lucina occidentalis
Mortoniceras shoshonense
Modolia multilinigera
Mactra emmonsii
? Mortoniceras vermilionense
Ostrea larva
Ostrea alta
Ostrea congesta
Ostrea lugubris
? Prionotropis lœvianus
Prionotropis woolgari
Prionotropis hyattii
Prionocyclus macombi
Prionocyclus wyomingensis
Placenticeras placenta
Pyropsis coloradoensis

Outline Showing Distribution of Species in the Upper Cretaceous of Kansas — *Concluded.*

Formation.	Fort Benton.				Niobrara.			Fort Pierre.
	Lincoln Marble.	Limestone Group.	Ostrea Beds.	Septaria.	Fort Hays Limestone.	Rudistes Beds.	Hesperornis Beds.	Arickaree Shales.
Pharella pealei	—							
Pholadomya papyracea	—							
Parapholas sphenoides					—			
Radiolites maximus						—		
Rostellites willistonii				—				
Scaphites nodosus								—
Stramentum haworthii						—		
Stramentum tabulatum						—		
Squama spissa						—		
Squama lata						—		
Scaphites larvæformis				—				
Scaphites vermiformis				—				
Scaphites warrenii				—				
Scaphites ventricosus				—				
Scaphites mullananus				—				
Serpula intrica						—		
Serpula tenuicarinata						—		
Serpula plana			—					
Teusoteuthis longus							—	
Turritella whitei	—							
Uintacrinus socialis						—		

General Description of Subkingdoms.

THE animal kingdom is divided into eight subkingdoms. Named in order of their development these subkingdoms are: (1) PROTOZOA. (2) CŒLENTERATA. (3) ECHINODERMATA. (4) VERMES. (5) MOLLUSCOIDEA. (6) MOLLUSCA. (7) ARTHROPODA. (8) VERTEBRATA. The first seven divisions comprise the invertebrate animals, and the eighth or last the vertebrate animals. All of these subkingdoms are represented by fossil forms in the Upper Cretaceous of Kansas except the fifth. In abundance of individuals Protozoa is the best represented, as the large chalk beds of the Niobrara division are largely composed of these forms. Diversity of species is undoubtedly best represented by the Mollusca. In order that the general reader may have a better understanding of the following systematic classification, I have added a short description to the principal subkingdoms. For description of the Protozoa, see Part VII.

Cœlenterata.

Coelenterates are aquatic animals which vary much in form, structure, and size. They are either free and independent, or composite and attached. The body is composed of three modified layers of cells. The lowest cœlenterates belong to a class called Porifera. To this class belong the sponges, hydras, sea-anemones and other forms. The sponges have a skeleton and are attached to some submarine object. The horny or flinty skeleton of sponges possesses an internal and external cellular layer. The internal cells have cilia, the whip-like action of which drives the water through the skeletal canals, allowing the cells to grasp their food and oxygen from the flowing water. The external cells can easily procure their food and oxygen from the water which is in continuous circulation about the sponge. The fresh-water hydra attaches itself mouth downwards to objects in the water. A number of tentacles extend

from its mouth. These tentacles possess cells in which jagged, thread-like processes lie coiled up in a narcotic fluid. Objects coming in contact with the tentacle cause the cells to burst and throw the thread like a lasso around the object, which, if it be animate, is poisoned by the fluid. Other marine hydra produce polyps on flinty tubes, from which they project like flowers from the parent, and form a bell-like body with many long, radiating tentacles. In this form the hydra is called a jelly-fish. These jelly-fish produce eggs which in turn produce polyps. The contractile tissues, which are muscle-like in structure, propel the animal through the water.

Echinodermata.

Echinoderms have a well-developed skeleton which is composed of calcareous plates, or of calcareous bodies imbedded in the integument. The subkingdom is represented by rayed animals such as the star-fish, in which the rays spring from a common center; by the sea-lilies, in which they start from a fixed stalk; by the sea-cucumber, which is covered by spicules of calcareous matter; by the sea-urchin, in which the rays are coiled, forming a globular body. The Echinoderms have a digestive tract separate from the body cavity. The sea-water is driven into this cavity, or gastro-vascular space, through canals by cilia. Some of the members of this subkingdom have rudimentary eyes. The star fish has an eye composed of many crystalline lenses at the end of each ray. The test of an Echinoderm is composed of calcareous plates which are arranged in concentric rows. The principal classes of Echinodermata are: Cystidea, Blastoidea, Crinoidea, Asteroidea, Echinoidea, and Holothuroidea.

Vermes.

The representatives of this subkingdom possess a segmented structure. The segmented body of these animals contain a nervous system which consists of a double chain of ganglia passing along the ventral side of the body. Some species are provided with locomotive appendages, while some of the mem-

bers are provided with a calcareous tube or shell into which the soft parts are drawn. Sometimes these tubes are free, but more often they are attached to some submarine object. The tubes are usually calcareous but sometimes they are composed of sand-grains or pieces of shell cemented together.

Mollusca.

This subkingdom is represented by a great diversity of animal organisms, making a specific definition next to impossible. The members of the mollusca differ physiologically, in that some have none or poorly developed heads and hearts, while others have heads and chambered hearts. Some are naked; some have a gristly covering, while others have either a double or single valve or shell composed of calcareous matter. The individuals range in weight from a few grains to 400 or 500 pounds. A marked difference is found in their manner of growth. Some, like the Radiolites, grow in colonies; others, like the majority of the Ostreæ, grow independently. They possess a soft, non-segmented body, and have the power of secreting matter from the surrounding water for the construction of their own shells. They also possess a thick membrane, called the mantle, which secretes the calcareous matter for the shell, and also determines the shape of the shell. Some of the members of this subkingdom are endo-skeletal, *i. e.*, the horny or calcareous part being on the inside; others are exo-skeletal, with the horny or calcareous part on the outside. Many members of this subkingdom are provided with numerous mouths or suckers for capturing their food. It is said "the *Clio borealis* has no less than 360,000 suckers attached to the wing-like organs which spring from its head." The pearly nautilus, the cuttle fish, the octopus, the sea squirts, the oyster and the clam are all representatives of this subkingdom. The Cretaceous seas of Kansas swarmed with mollusks of all kinds, from the small *Ostrea congesta* to the large *Radiolites maximus*.

Arthropoda.

This division comprises those animals which possess a segmented body and jointed appendages which are variable in number. The body and the appendages are usually protected by an external covering or skeleton. This subkingdom comprises four great classes: (1) Crustacea. (2) Arachnida. (3) Myriapoda. (4) Insecta. Among the representatives of these classes are the crabs, crayfish, lobsters, spiders, centipedes, and insects. The Crustaceans are the only representatives of this subkingdom found in the Kansas Cretaceous beds. This class is represented by two genera and at least twice as many species.

FORT BENTON CRETACEOUS FAUNA.

The most abundant forms among the invertebrate faunas of the Fort Benton Cretaceous are *Inoceramus labiatus* and *Ostrea congesta*. In the lower horizon, including the Lincoln marble and its adjacent shale beds, *Ostrea* and *Inoceramus* predominate. The invertebrate forms in the Lincoln marble are associated with sharks' teeth, the remains of fishes, turtles, and plesiosaurs. *Inoceramus labiatus* is the most abundant form in the Fort Benton limestone. One layer is composed almost wholly of this shell, and resembles a mortar bed into which these forms have been placed. Belemnitellæ are also very abundant in this horizon, but good specimens are difficult to obtain. *Prinonotropis* and *Prionocyclus* are both well represented, but *Ostreæ* are rare in the limestone group. In the shale beds (Ostrea beds) overlying the limestone, *Ostrea congesta* is the most abundant form; it occurs either free or attached to *Inocerami*. Sharks' teeth and pavement plates are also abundant in the Ostrea beds.

In the lower horizon of the Blue Hills shales *Serpulæ* are found attached to large *Inocerami*. The middle zone of these shales seems to be devoid of fossil forms, but the upper horizon in which the septaria nodules are imbedded has furnished many invertebrate forms. Of these the *Scaphites* and *Inocerami* are the most abundant. Nearly all the shells of this horizon have the pearly layer preserved; this does not occur in any other Cretaceous horizon except in the Fort Pierre. Four of the subkingdoms are represented in the Fort Benton, viz.: Cœlenterata, Echinodermata, Vermes, and Mollusca. The first three are each represented by a single form. Mollusca, however, are represented by eighteen genera and forty species. I think it may be truly said that more than one-half of these forty species occur in the Septaria zone.

Outline Classification of Fort Benton Species.

CŒLENTERATA.
- Cnydaria.
  - Anthozoa.
    - Hexacoralla.
      - Madreporaria.
        - Aporosa.
          - Stylophonidæ.

ECHINODERMATA.
- Pelmatozoa.
  - Crinoidea.
    - Articulatæ.
      - Encrinidæ.

VERMES.
- Annelida.
  - Tubicola,
    - Serpulidæ.
      - Serpula.
        - Serpula plana.

MOLLUSCA.
- **Pelecypoda.**
  - Ostreidæ.
    - Ostrea.
      - Ostrea congesta.
      - Ostrea lugubris.
      - Ostrea anceps.
    - Exogyra.
      - Exogyra ponderosa.
      - Exogyra læviuscula.
  - Aviculidæ.
    - Avicula.
      - Avicula gastrodes.
    - Inoceramus.
      - Inoceramus fragilis.
      - Inoceramus labiatus.
      - Inoceramus dimidius.
      - Inoceramus simpsonii.
      - Inoceramus gilbertii.
      - Inoceramus umbonatus.
      - Inoceramus exogyroides.
      - Inoceramus tenuirostratus.
      - Inoceramus undabundus.
      - Inoceramus subconvexus.
  - Mytilidæ.
    - Modiola.
      - Modiola multilinigera.
  - Veneridæ.
    - Callista.
      - Callista tenuis.

Pelecypoda—concluded:
- Solenidæ.
  - Pharella.
    - Pharella pealei.
- Mactridæ.
  - Mactra.
    - Mactra emmonsi.
- Pholadidæ.
  - Parapholas.
    - Parapholas sp.
- Turritellidæ.
  - Turritella.
    - Turritella whitei.
- Fusidæ.
  - Pyropsis.
    - Pyropsis coloradensis.
- Volutidæ.
  - Rostellites.
    - Rostelites ambigua?
    - Rostellites willistonii.

Cephalopoda.
- Ammonoidea.
  - Lytoceratidæ.
    - Helicoceras.
      - Helicoceras corrugatum.
  - Amaltheidæ.
    - Placenticeras.
      - Placenticeras placenta.
    - Prionocyclus.
      - Prionocyclus wyomingensis.
      - Prionocyclus macombi.
    - Prionotropis.
      - Prionotropis woolgari.
      - Prionotropis hyattii.
      - Prionotropis lœvianus.
    - Mortoniceras.
      - Mortoniceras shoshonense.
      - Mortoniceras vermilionense.
  - Stephanoceratidæ.
    - Scaphites.
      - Scaphites larvæformis.
      - Scaphites vermiformis.
      - Scaphites warrenii.
      - Scaphites ventricosus.
      - Scaphites mullananus.
- Decapoda.
  - Belemnitidæ.
    - Belemnitella.
      - Belemnitella baculus.

Description of the Fort Benton Species.

CŒLENTERATA.

A fragment of coral, taken from the Lincoln marble a few miles north of Lincoln Center, in Lincoln county, by Mr. Sahlman, of the latter place, probably belongs to the Stylophonidæ family of the Hexacoralla subclass. The specimen in my possession is not sufficiently well preserved to present generic, much less specific, determinative characteristics. In general appearance the coral resembles the Devonian species *Acervularia davidsonii*, but does not present the same regularity of coralla structure. As no species belonging to this subkingdom have as yet been described from the Fort Benton formation, the finding of such a specimen is important. Further search in this horizon will probably result in the discovery of more perfect specimens.

ECHINODERMATA.

A single fragment of a crinoid stem was discovered among Fort Benton rocks on the Cross ranch, in Mitchell county, by Mr. O. S. Sommers, of Buel, Kan. The crinoid probably belongs to the family Encrinidæ, but generic characteristics are not clear. As a careful search of the locality in which this specimen was discovered failed to disclose further specimens, its occurrence in this horizon may be purely accidental. The substance of the crinoid resembles that of the Lincoln marble, but if crinoids are to be found in this horizon, they are not abundant.

VERMES.

Serpula plana, n. sp. Plate CXIX, fig. 2.

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, twenty-four mm.; length of longest fragment of adult, forty mm.; diameter, in excess of two mm. Specimens attached by entire length, up-

per side showing irregular lines (probably lines of segmentation), as of overlapping concentric plates; surface in some specimens rugose, in others smooth.

This species differs from *Serpula tenuicarinata* in not having a carina, having nearly twice the transverse diameter, being more cylindrical, and (possibly) having more than twice the length.

Specimens of *Serpula plana* are very abundant in the upper horizon of the Ostrea shales of the Fort Benton group. Specimens have been collected by the writer from the above-named beds, on the Smoky Hill river, in Ellis and Trego counties; north of Hays City, on the Saline river; and at the southern point of the Blue Hills, in Mitchell county.

MOLLUSCA.

Ostrea congesta Conrad. Plate XCIX, figs. 10, 11, 13.

Ostrea congesta Conrad, 1843, Nicollet's Rep. of Explor. in the Northwest, p. 167; Hall, 1856, Pac. R. R. Reps., vol. III, p. 100, pl. I, f. 11; Meek, 1876, U. S. Geol. Surv., vol. IX, p. 13, pl. IX, ff. 1a–f; White, 1880, 4th Ann. Rep. U. S. Geol. Surv., vol. IX, p. 294, pl. XXXIX, ff. 11, 12, 13; Stanton, 1892, Bull. U. S. Geol. Surv., p. 55, pl. I, ff. 5 and 6.

Meek's description: "Shell elongated; upper valve flat; lower valve ventricose, irregular; umbo truncated by a mark of adhesion.—Conrad.

"This is a small, thin shell, the individuals of which are often crowded together in considerable numbers, so as to assume quite irregular forms. In cases where the individuals had room to grow without interruption, the young shell is usually found to be of an ovate form, and attached by the whole under surface of the lower valve, the beak of which is pointed, provided with a small triangular area, and usually turned a little to the left. In this form they continue to grow to lengths varying from twenty-five hundredths to one inch, when the margins are abruptly deflected upward at right angles to the flat attached base, and produced in this direction often for as much as an inch or more; the greatest extension being on the lateral margins and at the extremity, opposite the beaks. When seen at this stage of their growth, separated from the body to which they were originally attached, and lying partly

imbedded in the matrix, with the beak side down, they look like short, cylindrical tubes, with one end abruptly truncated and closed by the flat surface of attachment; so that what was originally the whole under surface of the valve, now appears like the truncated umbo. The other valve is quite flat, or sometimes a little concave, and always retains the form possessed by the attached valve at the time its margin became deflected upward, after which it seems to have increased very little in size. Its umbo is usually a little less pointed than that of the other valve, and provided with a shorter area, on each side of which its margins are sometimes slightly crenulated. The muscular impressions of each valve are obscure, and the face is nearly smooth, or only marked by fine, indistinct lines of growth."

These shells occur abundantly in the Ostrea beds of the Fort Benton area. So abundant are they that the shale thrown from the wells which pierce the Ostrea beds, after a short weathering, is almost white with them. They may be collected from the Ostrea beds exposures along the Smoky Hill, the Saline and the Solomon rivers, and from numerous smaller streams in the Upper Cretaceous area.

Ostrea lugubris Conrad. Plate XCI.

Ostrea lugubris Conrad, 1857, U. S. and Mex. Bound. Rep., vol. I, p. 156, pl. x, ff. 5a, b; Meek, 1876, Macomb's Expl. Exped. from Santa Fe to Junction of Grand and Green Rivers, p. 123, pl. I, ff. 1a–d; White, 1884, 4th Ann. Rep. U. S. Geol. Surv., p. 297, pl. LI, f. 3; Stanton, 1892, Bull. U. S. Geol. Surv., p. 58, pl. IV, ff. 1–10.

Ostrea belliplicata Shumard, 1816, Trans. St. Louis Acad. Sci., vol. I, p. 608; White, 1879, Ann. Rep. U. S. Geol. Surv. Terr. for 1877, p. 276, pl. IV, ff. 3a, b, and pl. VIII, ff. 2a, b; White, 1884, 4th Ann. Rep. U. S. Geol. Surv. Terr., p. 292, pl. LXXVIII, ff. 1, 2, 3.

Ostrea (*Alectryonia*) *blackii* White, 1880, Proc. U. S. Nat. Mus., vol. II, p. 293, pl. IV, ff. 1, 2; Ann. Rep. U. S. Geol. Surv. Terr. for 1878, p. 11, pl. XIV, ff. 1a, b, and pl. XVII, f. 4; 4th Ann. Rep. U. S. Geol. Surv., p. 292, pl. XLV, f. 1, and pl. XLVI, f. 2.

Stanton's description: "Shell varying in size from small to medium; outline usually broad subovate, but in small specimens often nearly circular and in large ones occasionally subtriangular; lower valve moderately convex, the greatest convexity being along the median line, which is often sub-

angular in large shells; beak usually small and inconspicuous, but sometimes more prominent and curved laterally, often obscured by the scar of attachment, and by strong concentric lines, and sometimes imbrications of growth. The plications are usually simple, but occasionally they bifurcate. Upper valve nearly flat or sometimes slightly concave, with an outline similar to that of the other valve, except that it is somewhat more narrow along the hinge line. Its surface is smooth for some distance around the beak and the plications toward the margin are not so strongly developed as on the lower valve, which it resembles in other respects. The muscular scars are reniform and subcentral; ligamental area varying greatly in size and form, but never very large. Conrad's type (lower valve) measures seventeen mm. from beak to base, fifteen mm. in breadth, and five mm. in convexity, while the corresponding measurements of *Ostrea blackii*, which is the largest variety of the species, are sixty-eight, sixty-two and thirty-two mm., respectively."

The above species is found in Lincoln marble, but is not abundant. Good specimens are difficult to obtain on account of the extreme hardness of the matrix in which they are imbedded. They are usually found associated with sharks' teeth. Only the smallest variety of this species has been found in the Kansas rocks, and as it has been found in one horizon only, I am inclined to think that that horizon is correlative with the "brown calcareous sandstone" horizon of Colorado in which the form *O. lugubris* is so abundant. See Stanton, l. c.

Ostrea anceps, n. sp. Plate CXVII.

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; lig-

mental 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.

Both valves of this form imbedded in a firm matrix of Lincoln marble were found about fifteen miles southwest of Beloit, on the Buel ranch. In the same stone are the impressions of shells which resemble Modiolæ in form and markings. There are also fragments of other shells which resemble *Ostrea subspatulata*, but which I judge to be *Ostrea congesta*. I have found these shells in the Lincoln marble horizon only, and they are not abundant there.

Exogyra ponderosa Roemer.

Exogyra ponderosa Roemer, 1852, Kreid. von Texas, p. 71, pl. IX, ff. 2a, b; White, 1876, U. S. Geog. and Geol. Surv. West 100th Mer., vol. IV, p. 172, pl. XIV, ff. 1a–c; 1884, 4th Ann. Rep. U. S. Geol. Surv., p. 306, pl. L, ff. 1, 2, 3; Stanton, 1893, Bull. U. S. Geol. Surv., p. 65, pl. VII, ff. 1, 2.

Exogyra costata var. Conr., 1857, U. S. and Mex. Bound. Surv., vol. I, p. 154, pl. VIII, f. 3, pl. IX, f. 1.

Exogyra fimbricata Conr., 1857, id., pl. VII, ff. 2a, b.

"Shell large, capacious; marginal outline irregularly subovate; larger valve very gibbous; umbo distinctly spiral, but the coil is usually obscured by a large scar of attachment; umbonal half obtusely carinate, the sides sloping abruptly from the carina to the margins; basal half not so deeply, but more regularly convex than the other. Test very massive, sometimes having a solid thickness of five or six centimeters, lamellose, so much so that the valve often splits into numerous pieces along the surfaces of layers of growth; inner surface smooth; muscular scar of moderate size, somewhat deep, placed about mid-length the valve, and, as usual, a little nearer to the posterior than the anterior side; surface marked by strong, irregular, imbricating lamellæ of growth, which become laciniate at and near the margins; surface also marked by fine concentric striæ, and by irregular, indistinct, radiating costæ, the latter being usually removed by exfoliation from old shells. Upper valve thick, concentrically laminated; smooth within; umbo horizontal; distinctly spiral; length of an example rather under

the average size, from umbo to basal margin, about one cm.; breadth, eight cm.; convexity of larger valve, nearly six cm."

A form found imbedded in a firm matrix of Lincoln marble I think belongs to this species; if so, it is a young individual. Specimen was found associated with *Exogyra læviuscula* in the Lincoln marble outcrops, on Rattlesnake creek, Lincoln county.

Exogyra læviuscula Roemer.

Exogyra læviuscula Roemer, 1852, Kreid. von Texas, p. 70, pl. IX, ff. 3a–c; Conrad, 1857, U. S. and Mex. Bound. Surv., p. 154, pl. VII, ff. 4a, b; White, 1876, U. S. Geog. and Geol. Surv. West 100th Mer., p. 173, pl. XVII, ff. 2a–d; 1884, 4th Ann. Rep. U. S. Geol. Surv., p. 305, pl. LII, ff. 3, 4, 5; Stanton, 1892, Bull. U. S. Geol. Surv. No. 196, p. 64, pl. VIII, ff. 5 and 6.

Ostrea ferdinandi Coquard, 1869, Mon. Gen. Ostrea, Terr. Cret., p. 33.

Exogyra ponderosa Hill, 1889, Check List Cret. Invert. Fossils of Texas, p. 6.

Description: Shell moderately capacious and semiovate in form; test moderately thick; general shape of shell varying in outline from subovate to suborbicular; inferior valve inflated and very much curved and rounded in outline. Superior valve smaller and nearly flat, suborbicular in outline; surface smooth but marked by very faint lines of growth. Umbo small, coiled pirally, forming two volutions which are narrow and closely involuted; hinge line short; scar of attachment small or wanting; umbo in some specimens somewhat free. Diameter from umbo to basal margin, forty-seven mm.; transverse diameter, forty-two mm.; depth of the larger valve, eighteen mm.

Species occurs in the Lincoln marble, but is not abundant. The only specimens found were collected from the outcrops on Rattlesnake creek, in the northern part of Lincoln county.

Avicula gastrodes Meek. Plate LXXXVI, figs. 8, 9.

Avicula (Oxytoma?) gastrodes Meek, 1873, Ann. Rep. U. S. Geol. Surv. fo 1872, p. 491.

Pteria (Oxytoma) gastrodes White, 1879, Ann. Rep. U. S. Geol. Surv. Terr. for 1877, p. 280, pl. x, f. 1a.

Pteria (Oxytoma) erecta White, 1880, Proc. U. S. Nat. Mus., vol. III, p. 157, and vol. IV, ff. 7 and 8 of plate opposite p. 139.

Avicula gastrodes Stanton, 1893, Bull. U. S. Geol. Surv., p. 72, pl. IX, ff. 7–10.

Description: "Shell (as determined from a left valve) attaining a moderately large size, subtrigonal in general outline, rather distinctly convex, and having a very slight backward

obliquity; basal outline very profoundly rounded, the deepest or most prominent part being in advance of the middle; posterior margin moderately sinuous below the wing, from the extremity of which it ranges obliquely forward and downward, rounded regularly into the base below; anterior margin strongly and subangularly sinuous under the wing, thence descending with a slight forward obliquity and rounding rather abruptly into the base; hinge margin longer than the height of the valve, the antero-posterior diameter of which (at any point below) it also decidedly exceeds, ranging nearly at straight angles to the vertical axis of the shell; beaks distinctly convex, rising above the hinge margin, strongly incurved, without obliquity, and situated less than one-third the length of the hinge margin from the extremity of the anterior wing, which is subtrigonal in form, somewhat convex, a little rounded at the extremity, and very strongly separated from the abrupt swell of the umbo by a deep rounded concavity extending from the beak obliquely to the marginal sinus below; posterior wing longer and more compressed, narrower, and more angular than the other; both wings, particularly the posterior one, projecting decidedly beyond the margin of the valve below. Surface only showing more or less distinct lines of growth. Height of left valve, one and five-tenths inches; length of same below the wings, about one and three-tenths inches; length of hinge line, one and nine-tenths inches; convexity of left valve alone, four-tenths inch'' (Meek). The types of *Pteria* (*Oxytoma*) *erecta* are small individuals that apparently belong to the same species.

Two specimens, collected from a thin layer of sandstone underlying the Lincoln marble horizon on Salt creek, in Mitchell county, so closely resemble this species that I have referred them to it, although the specific character of the wings cannot be determined from the specimens which are not very well preserved, especially in the umbonal region. A closer examination of this stratum will probably reveal more perfect specimens. Should the specimens collected belong to this species they are undoubtedly young individuals, as they are not more than one-half the size of the above-described species.

Inoceramus fragilis M. & H. Plate LXXXVII.

Inoceramus fragilis H. & M., 1856, Mem. Am. Acad. Arts and Sci., n. s., vol. v, p. 388, pl. II, ff. 6a and b; White, 1876, U. S. Geog. and Geol. Surv. West 100th Mer., vol. IV, p. 178, pl. XV, f. 3; Meek, 1876, U. S. Geol. Surv. Terr., vol. IX, p. 42, ff. 1 and 2 in text and pl. v, f. 5; Meek, 1876, Macomb's Expedition from Santa Fe to Junction of the Grand and Green Rivers, Geol. Rep., p. 127, pl. I, f. 6; Whitfield, 1880, Geol. Black Hills of Dak., p. 390, pl. IX, f. 10; Stanton, 1892, Bull. U. S. Geol. Surv. No. 106, p. 76, pl. XI, ff. 1–5.

Inoceramus howelli White, 1876, Geol. Uinta Mts., p. 114; 1879, 11th Ann. Rep. U. S. Geol. Surv. Terr., p. 284, pl. IV., ff. 1a, b, c.

Inoceramus perplexus Whitfield, 1880, Geol. Black Hills of Dakota, p. 392, pl. VIII, f. 3, and pl. x, ff. 4 and 5.

Revised description: "Shell moderately thin, broadly subovate, higher than long, moderately convex; subequivalve; anterior side vertically truncate from the beaks, with slightly concave outline; basal and posterior borders forming a more or less regular, nearly semicircular curve; hinge line rather short, and standing at right angles to the truncate anterior. Beaks pointed, equal, scarcely rising above the hinge, curving inward and slightly forward at the points. Surface marked by fine lines of growth and a few obscure traces of concentric undulations. Height of an average specimen, thirty-five mm.; length, twenty-six mm."

This species occurs in the Fort Benton limestone and also in the Septaria horizon.

Inoceramus labiatus Schlotheim. Plate XCII, fig. 4.

Ostracites labiatus Schloth., 1813, Bronns Jahrb., vol. VII, p. 93.

Mytulites problematicus Schloth., 1820, Petrefactenk. I, p. 302.

Inoceramus mytiloides Mantell, 1822, Geol. of Sussex, p. 215, pl. XXVII, f. 2; Roem., 1852, Kreid. von Texas, p. 66, pl. VII, f. 5.

? *Inoceramus confertim-annulatus* Schiel, 1855, Pac. R. R. Reps., vol. II, pl. II, f. 7.

? *Inoceramus pseudo-mytiloides* Schiel, 1855, ibid., pl. III, f. 5.

Inoceramus mytilopsis Conrad, 1857, U. S. Bound. Surv., vol. I, p. 152, pl. II, ff. 6a and 6b.

Inoceramus problematicus (Schloth.) Meek, 1876, U. S. Geol. Surv. Terr., vol. IX, p. 62, pl. IX, ff. 3a and b.

Inoceramus aviculoides M. & H., 1860, Proc. Acad. Nat. Sci. Phil., p. 181.

Inoceramus problematicus var. *aviculoides* Meek, 1876, U. S. Geol. Surv. Terr., vol. IX, p. 63, pl. IX, f. 4.

Inoceramus labiatus Stanton, 1892, Bull. U. S. Geol. Surv., p. 77, pl. X, f. 4; pl. XIV, f. 2.

Meek's description: "Shell obliquely elongate-oval, subelliptical or ovate, nearly or quite equivalve, rather com-

pressed, thin and fragile; anterior side forming a slightly convex curve from the beaks obliquely downward and backward; postero-basal extremity rather narrowly rounded; postero-dorsal margin very oblique, compressed, nearly straight, or sometimes a little convex in outline below the middle, and slightly concave above; cardinal border short, straight, compressed, and forming an angle of about forty-five degrees with the longest diameter of the shell; beaks terminal, rather small, nearly equal, obtusely pointed, rising little above the hinge, and not much curved. Surface ornamented by more or less regular, concentric undulations, and smaller marks of growth. Greatest length, four inches; breadth at right angles to the longest diameter, about two inches; convexity of the two valves, about eight-tenths inch."

To the above description Stanton added: "The name *Inoceramus aviculoides* was applied by Meek and Hayden to a variety with a longer hinge line, greater convexity, and more prominent beak of the left valve, and with the dorsal region more alate than is usual in the species. After studying larger collections Professor Meek found that there were many gradations between this and the typical form, and he therefore treated it as only a variety. Like all species of the genus, it is subject to considerable variation in form, yet it is always easily recognized by its obliquely elongate outline and by the character of the surface markings.

"It is unfortunate that the law of priority compels us to drop the name that has for many years been applied to this species by all American writers who have referred to it, and it is the more unfortunate because the species is so well known under that name as the most abundant characteristic fossil of the Colorado formation. There is no doubt, however, that the American fossil belongs to the species to which European paleontologists now apply the earliest name *Inoceramus labiatus*."

This fossil is extremely abundant in the Fort Benton limestone of Kansas. In one horizon[68] of the limestone group the rock is composed almost entirely of Inocerami. This horizon is

68. The Inoceramus horizon; see Upper Cretaceous of Kansas, Logan, Kans. Univ. Geol. Surv., vol. II, pp. 216, 217.

persistent throughout the Fort Benton area of Kansas. The fossil exists in all of the Fort Benton limestone layers and in the intercalating shale beds. Its abundance is one of the most convenient means of distinguishing the Fort Benton limestone from the Fort Hays of the Niobrara, since it is not abundant, if it occurs at all, in the Niobrara rocks of Kansas. From other states it is reported as being an abundant and characteristic fossil of the Niobrara. Aside from the *Ostrea congesta*, it is the most abundant species of the Colorado formation in Kansas.

Inoceramus dimidius White. Plate XCVIII, figs. 5, 6.

Inoceramus dimidius White, 1874, Expl. and Surv. West 100th Mer., Prelim. Rep. Inv. Foss., p. 25; 1876, U. S. Geol. and Geog. Surv. West of the 100th Mer., vol. IV, p. 181, pl. XVI, ff. 2a, b, c and d; Stanton, 1892, Bull. U. S. Geol. Surv., p. 78, pl. x, ff. 5 and 6.

Description: "Shell very small for one of this genus, inflated, sometimes much so, obliquely subovate in outline; valves subequal, the left one being a very little more capacious than the other; test thin; beaks small, prominent, acute, incurving, and pointing a very little forward; hinge line straight or nearly so, rather short.

"Surface marked by more or less strong and more or less regular concentric folds or undulations. In some cases these undulations continued to be formed only until the shell attained about half its full size, when they ceased, the remainder of the surface being marked only by ordinary concentric lines of growth. This irregularity in the formation of concentric folds is sometimes connected with considerable distortion of the usual symmetry of the shell.

"The long diameter of an average example, from the umbo to the postero-ventral margin, twenty-six mm.; greatest breadth, eighteen mm.; thickness, sixteen mm. This species is especially distinguished by its small size. Its other more conspicuous specific characters are the small but prominent and pointed beaks, and subequal valves.

"From the young of *I. labiatus*, the valves of which are subequal, it differs in the character of the beaks just mentioned,

the greater convexity of the valves, and other evidences of mature growth."

This fossil has been found in the Septaria horizon only, and there only in a fragmentary condition. Complete specimens are difficult to obtain, on account of the extreme friable condition of the Septaria nodules in which they occur. The fossil is found associated with *I. tenuirostratus* and *I. fragilis*, in the septaria on the Saline south of Plainville. Fragments have also been found in the septaria of Oak creek, in Smith county.

Inoceramus gilbertii White. Plate XCII, figs. 1, 3.

Inoceramus gilbertii White, 1876, Geol. Uinta Mts., p. 113; 1879, 11th Ann. Rep. U. S. Geol. Surv. Terr., p. 285, pl. III, ff. 3 and 4; Stanton, 1892, Bull. U. S. Geol. Surv. No. 106, p. 79, pl. XIV, ff. 3 and 4.

Description: "Shell irregularly subovate in marginal outline, the transverse diameter being greater than the vertical; front more or less flattened; valves nearly or quite equal, the left one, if either, the larger, both of these gibbous, and sometime quite ventricose; umbones broad and elevated; beaks very near the front, incurved, but not projecting beyond the front margin; front nearly straight vertically, or sometimes more rounded, in the former case forming a nearly right angle with the hinge; front margin rounded below to the basal margin, which is broadly convex for more than half the length of the shell; postero-basal margin extended obliquely upward, with a slight emargination, to the posterior extremity, which is abruptly rounded to meet the downward-sloping postero-dorsal margin; dorsal margin straight, its length equaling more than half the long diameter of the shell. Upon each valve there is an obscure radiating depression or ill-defined furrow extending from the umbonal region to the postero-basal border, and ending there at the emargination before mentioned. Surface marked by the usual lines of growth, and also by numerous, extravagant, irregular folds or wrinkles. Length, seventy-five mm.; height, fifty mm."

Inoceramus gilbertii occurs not only in the Septaria horizon but also in the Fort Benton limestone group.

Inoceramus umbonatus M. & H. Plate LXXXIX.

Inoceramus umbonatus M. & H., 1858, Proc. Acad. Nat. Sci. Phil., p. 50; Meek, 1876, U. S. Geol. Surv. Terr., vol. IX, p. 44, pl. III, ff. 1a, b, c, and pl. IV, ff. 1a, b, and 2a and b; Stanton, 1892, Bull. U. S. Geol. Surv. No. 106, p. 81, pl. XVIII, ff. 1 and 2.

Stanton's revised description: "Shell attaining a rather large size, vertically subovate, extremely inequivalve; height more than one-third greater than the antero-posterior diameter; base regularly rounded; hinge and interior unknown. Left valve very convex; beak greatly elevated, gibbous, strongly and somewhat obliquely involute, so as to form one and a half to two entire turns, the point terminating near the anterior side; surface unknown, that of internal casts sometimes showing faint traces of concentric undulations. Right valve subcircular, or a little oval transversely, much compressed or nearly flat, excepting in the central or umbonal regions, which are moderately convex; beaks rather oblique, projecting little above the hinge, and but slightly incurved; surface of an internal cast ornamented with regular, rather prominent, subangular, concentric undulations, separated by wider rounded depressions. Height of left valve, about 7 inches; antero-posterior diameter, 5.19 inches; convexity, 4.50 inches. Right valve, height, about 5.70 inches; antero-posterior diameter, 5.70 inches; convexity, about 1.60 inches."

This species occurs in the Fort Benton limestone group, but it is not abundant.

Inoceramus exogyroides M. & H. Plate LXXXVIII.

Inoceramus exogyroides M. & H. 1862, Proc. Acad. Nat. Sci. Phil., p. 26; Meek, 1876, U. S. Geol. Surv. Terr., vol. IX, p. 46, pl. V, ff. 3a, b, c; Stanton, 1892, Bull. U. S. Geol. Surv., p. 83, pl. XVII, ff. 1 and 2.

Revised description: "Shell medium size, equivalve or nearly so, valves suborbicular, height of the valves being greater than their lengths from the anterior to the posterior side, very gibbous; anterior and posterior sides rounded, and forming with the base about three-fourths of a circle, the posterior curve being broader than the other; cardinal margin comparatively short, and apparently a little arched; beaks large, elevated, gibbous, distinctly incurved and directed obliquely forward, so as to

bring its point near the anterior margin; surface of cast smooth, or marked by obscure concentric undulations. Length from anterior to posterior margin, ten cm.; height, fourteen cm.; convexity, seven cm."

The casts of two valves of this species were obtained from the Fort Benton limestone. The twisted beak precludes the possibility of its belonging to *I. umbonatus*, as suggested by Stanton. (See citation above.)

Inoceramus tenuirostratus M. & H. Plate XCV, figs. 3, 4.

Inoceramus tenuirostratus M. & H., 1862, Proc. Acad. Nat. Sci. Phil., p. 27; Stanton, 1892, Bull. U. S. Geol. Surv. No. 106, p. 83, pl. XVI, ff. 3, 4.
Inoceramus tenuirostris Meek, 1876, U. S. Geol. Surv. Terr., vol. IX, p. 59, f. 5 in text.

Stanton's revised description: "Left valve very gibbous, subquadrate in outline; anterior margin very short or vertically truncated, with a slightly convex outline, immediately in front of the beak, and rounded into the base below; ventral margin nearly semi-elliptical; posterior side rounded, or sometimes subtruncated, with a slightly convex outline above, and a little more prominent and rounded into the base below; hinge of moderate length, with cartilage furrows small, there being about five of them in the space of twenty-hundreths inch; beak very gibbous, prominent, narrowed, strongly incurved, and directed a little forward, its point being directly over the anterior region. Surface of internal cast smooth over the gibbous umbonal region, but showing traces of small, concentric undulations below the middle. Length, 2.10 inches; height from the base to hinge, 1.82 inches; height to tip of umbo, 2.13 inches; convexity of left valve, .90 inch."

A few specimens of this species have been collected from the Septaria horizon of the Fort Benton formation.

Inoceramus undabundus M. & H. Plate XCV, figs. 1, 2.

Inoceramus undabundus M. & H., 1862, Proc. Acad. Nat. Sci. Phil., p. 26; Meek, 1876, U. S. Geol. Surv. Terr., vol. IX, p. 60, pl. III, ff. 2a, b; Stanton, 1892, Bull. U. S. Geol. Surv. No. 106, p. 84, pl. XVI, ff. 1 and 2.

"Shell obliquely rhombic subovate or subquadrate, gibbous; anterior side very short, and rounding obliquely downward into

the base; posterior basal extremity prominently rounded; posterior margin broadly rounded or subtruncated; dorsal and anterior margin diverging from the beaks at an angle of about ninety degrees; hinge short; moderately prominent and nearly terminal, that of the left valve rather strongly incurved and directed obliquely forward, while in the right it is straighter and less elevated; umbonal axis ranging at an angle of about seventy degrees to the hinge line. Surface of both valves (in the condition of casts) ornamented by regular strong, subangular, concentric undulations, separated by wider rounded depressions. Height from the most prominent part of the base to the hinge margin, 2.90 inches; height to top of umbo, 3.36 inches; convexity of left valve, 1.84 inches."

This species occurs in the Fort Benton limestone, but it is not abundant. Specimens seen were imperfect casts only.

Inoceramus subconvexus, n. sp. Plate CXVIII, fig. 1.

Description: Shell oblong oval, nearly if not entirely equivalve, convex, greatest convexity in anterior region; anterior margin triangular; margin opposite hinge curved; hinge straight, long in comparison with length of shell; posterior margin rounded and extended into a narrow, flat flange. Shell curving abruptly upward from the narrowly pointed beaks, then curving gradually backward and downward; beaks terminal, apparently not rising above the hinge and slightly incurved. Surface marked by moderately prominent undulations and rather closely crowded striations. Length of longitudinal axis, fifty mm.; maximum breadth, thirty mm.; diameter at point of greatest convexity, fifteen mm.

This species seems most nearly related to *Inoceramus labiatus*, to which species I was inclined to ascribe it on first examination, thinking it was a young individual. On comparing the specimen with young individuals of *Inoceramus labiatus*, however, I was able to note specific differences. These differences are greater convexity, pointed beak, and abrupt anterior curve of shell.

A right and left valve of this shell were found by the writer

in the Fort Benton limestone on Salt creek, in the southern part of Mitchell county.

The species occurs associated with *I. labiatus*, but it is not at all as abundant as the latter.

Modiola (Brachydontes) multilinigera Meek. Plate LXXXVI, fig. 5.

Modiola (Brachydontes) multilinigera Meek, 1873, Ann. Rep. U. S. Geol. Surv. Terr. for 1872, p. 4922; Stanton, 1892, Bull. U. S. Geol. Surv. No. 106, pp. 86, 87, pl. XIX, f. 3.

Vosella (Brachydontes) multilinigera White, 1880, Cont. to Paleontology, Nos. 2–8, p. 14, pl. XII, ff. 15a, b.; Ann. Rep. U. S. Geol. Surv. Terr. for 1878.

Original description: "Shell rather above medium size, obliquely arcuate subovate; valves strongly convex along the umbonal slopes, thence cuneate 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; hinged margin nearly or quite straight, running at an angle of fifty to sixty degrees above an imaginary line drawn from the beaks to the most prominent parts of the basal outline, and equaling about half of 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, 0.76 inch."

This species occurs in a thin stratum of sandstone underlying the Lincoln marble group of the Fort Benton formation.

Callista* (*Aphrodina*) *tenuis H. & M. Plate XCIX, fig. 8, 9.

Cythera tenuis H. & M., 1856, Mem. Am. Acad. Sci., n. s., vol. v, p. 383, pl. I, f. 5.

Meretrix tenuis M. & H., 1860, Proc. Acad. Nat. Sci. Phil., p. 185.

? Dione tenuis Meek, 1864, Smiths. Check-List, Inv. Foss. of N. A., p. 18.

Callista (*Aphrodina?*) *tenuis* Meek, 1876, U. S. Geol. Surv. Terr., vol. IX, p. 188, pl. v, ff. 1a-d; Stanton, 1893, Bull. U. S. Geol. Surv., p. 109, pl. XXIV, ff. 7 and 8.

Description: Shell equivalve, subcircular or subovate, moderately thin; beaks incurved slightly in specimen and placed in the antero-central region; anterior side of shell moderately short, rounded below and moderately straight above; posterior side somewhat subtruncate; basal margin short, forming a semi-oval curve. Beaks smooth; surface marked by fine concentric lines of growth. Length, twenty-four mm.; height, sixteen mm.; convexity, ten mm.

Specimen was collected by the writer from the Septaria horizon of the Fort Benton, in the vicinity of Williams butte, in Mitchell county. It consists of the right and the left valve united and firmly held together by an internal cast. For that reason none of the internal characteristics can be noted, and its classification is dependent upon its external features, which are none too well preserved. Species of this and kindred genera are not abundant in the Septaria horizon.

Mactra emmonsii Meek. Plate XCII, fig. 11.

? Mactra emmonsii Meek, 1877, U. S. Geol. Expl. 40th Parallel, vol. IV, pt. I, p. 153, pl. XV, f. 8.

Mactra emmonsii Stanton, 1892, Bull. U. S. Geol. Surv., p. 121, pl. XXVII, ff. 9-13.

Revised description: Shell small, compressed, longer than high, equilateral, anterior side in some specimens longer than the posterior side; anterior margin narrowly rounded below the middle; posterior border somewhat broader; basal margin forming a semielliptical curve; dorsal margin sloping before and behind the beaks, the anterior slope being greater, with a concave outline; beaks nearly central, or sometimes placed a little

behind the middle, rather depressed and incurved, with very slight obliquity; posterior umbonal slope very obscurely angular from the beaks to the posterior basal extremity; surface marked by lines of growth. Hinge line short, pallial line obscure. Length of large specimen, twenty mm.; height, fifteen mm.; convexity, eight mm.

A cast of a shell which was taken from a thin stratum of sandstone underlying the Lincoln marble in the southern part of Mitchell county undoubtedly belongs to this genus, and probably to this species, although it resembles *M. huerfanensis* in a few points. Fragment of other forms resembling this one were found in the same horizon on the Solomon river near Beloit. On some of the casts the internal features are but poorly portrayed.

Parapholas, sp.

A piece of fossil wood collected by Mr. Sommers, of Buel, from the Lincoln marble horizon of Salt creek, contains casts of forms which resemble *Parapholas sphenoides*, with the exception that they are shorter and more robust. This species may be synonymous with *Parapholas ?* sp. Stanton, described from the Pugnellus sandstone of Poison cañon, Colorado. Should such be the case, the circumstance points more clearly to the identity of these two horizons.

Turritella whitei Stanton. Plate XCIX, figs. 1–5.

Turritella urasana White, U. S. Geol. Surv. West 100th Mer., vol. IV, p. 195, pl. XVIII, ff. 11a and b. Not *Turritella urasana* Conrad, 1856, Pac. R. R. Rep., vol. V, p. 321.

Turritella whitei, Stanton, 1892, Bull. U. S. Geol. Surv. No. 196, p. 130, pl. XXVIII, ff. 12–16.

Original 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 large volutions, and upon the last one

they are even subspinulose. All the specimens of this species in the collection are more or less broken, but judging from their apical angle as indicated by their sides, the largest must have been about five and a half cm. long, and its last whorl about thirteen mm. in diameter."

The claim of this species to recognition as a Kansas form is based upon a very poorly preserved specimen collected from a thin stratum of sandstone underlying the Fort Benton Limestone group.

Pyropsis coloradoensis Stanton. Plate c, figs. 6–8.

Pyropsis coloradoensis Stanton, 1892, Bull. U. S. Geol. Surv. No. 106, p. 154, pl. xxxii, ff. 6–8.

Original description: "Shell of rather large size, pyriform, consisting of four or five rapidly increasing volutions; spire in some specimens much depressed, in others rather prominent; suture distinct, bordered below by a revolving ridge that gives it a channeled appearance; whorls bicarinate around the middle; the upper carina the stronger; obliquely flattened above and rather abruptly contracted below into the canal, which is moderately long and slightly curved. On the whorls of the spire only the upper slope above the greater carina is exposed. In addition to the carinæ that are prominent and more or less nodose on the body whorl, the surface ornamentation consists of numerous strong, granular, revolving lines, usually alternating with finer ones and crossed by distinct lines of growth. Aperture elongate ovate, suddenly narrowed and slightly produced above to form a short posterior canal, and more gradually contracted below into a rather broad anterior canal. Outer lip thin and slightly dentate within; inner lip comparatively thin, forming a broad, thin glaze on the body whorl above, but thickening and narrowing below until it is free from the columella, leaving a distinct and deep umbilicus. There is a single oblique fold on the columella. Length of one of the types, seventy-seven mm.; greatest breath, forty-nine mm."

This species occurs in the Septaria horizon of the Fort Benton formation.

Rostellites ambigua? Stanton. Plate c, figs. 2–5.

Rostellites ambigua Stanton, 1893, Bull. U. S. Geol. Surv. No. 106, p. 156, pl. XXXIII, ff. 8–10.

Original description: "Shell rather large size, spindle-shaped; spire elevated and rather slender, somewhat more than half the length of the aperture; whorls about seven in number, moderately convex, the last one very large; suture distinct, more or less channeled. Below the rounded border of the suture the whorl is slightly constricted or flattened. Surface ornamented by numerous closely arranged revolving lines and by larger curved transverse costæ that are less conspicuous on the body whorl than on the spire, and that have a tendency to form nodes just below the suture. The aperture narrow, prolonged into a rather short canal, and with a short posterior notch. Outer lip thin, obscurely lirate within, and slightly reflexed; inner lip with a very thin callus. The pillar is slightly arched, with two distinct folds, the anterior of which is the stronger, and faint indications of two others behind them. Length of an average specimen, seventy-seven mm.; greatest breadth, twenty-four mm. Other specimens show that the species attained a considerably greater size and sometimes had a more robust form."

The above-described species occurs in the Septaria horizon of the Fort Benton formation, where it is associated with *R. willistonii*.

Rostellites willistonii, n. sp. Plate CXX, fig. 3.

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 costæ, 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 costæ, and parallel ridges or oblong nodes are formed on each whorl.

This species corresponds more nearly to *R. ambigua* Stanton than to any other form, and may be a variety of that species. The chief differences are found in the nodes and sutures and an absence of folds in the pillar. The specimens of this species were collected by Professor Williston during the past summer from the Septaria of the Blue Hills shales at Williams' Butte, in Mitchell county. Its discovery is interesting from the fact that it is the first gastropod described from this horizon in Kansas. A poorly preserved specimen belonging to this class, but to a different genus, was found imbedded in the same mass of iron pyrites in which the species *R. willistonii* occurred.

? Helicoceras corrugatum Stanton. Plate c, fig. 3.

? Helicoceras corrugatum Stanton, 1892, Bull. U. S. Geol. Surv., p. 165, pl. xxxv, fig. 5.

Original description: "Shell dextral, forming a very low, broad, open spiral; whorls with an ovate cross-section, increasing rapidly in size, apparently not in contact. Surface marked by small, regular, rather closely arranged costæ that pass obliquely entirely around the whorl. The costæ are narrrowly rounded, not quite as broad as the interspaces, and without nodes or spines. Full form of the shell and septa not known. The type specimen, which is about half of one volution, measures 105 mm. in length, with sections 10 by 12 mm. at the smaller end, and 18 by 23 mm. at the larger end."

From Stanton's figure, I am led to believe that a fragment of a shell collected from the Septaria horizon of the Fort Benton belongs to this species.

Placenticeras placenta Dekay.

Ammonites placenta Dekay, 1828, Ann. N. Y. Lyc. Nat. Hist., vol. II, p. 278, pl. v, f. 2, and of various authors.

Ammonites (Placenticeras) placenta Meek, 1870, U. S. Geol. Surv. Terr., p. 297, and 1870, Proc. Amer. Phil. Soc., vol. XI, p. 429.

Placenticeras placenta Meek, 1876, U. S. Geol. Surv. Terr., vol. IX, p. 465; Stanton, 1892, Bull. U. S. Geol. Surv., p. 169, pl. XXXIX, ff. 1–3.

Meek's description: "Shell lenticular in form, attaining a large size; umbilicus small; volutions deeply embracing, compressed laterally, with sides converging from near the umbilicus to near the periphery, which is very narrowly truncated and flattened or a little concave, with its smooth margins becoming more obtuse with age; aperture narrowly sagittate; surface generally smooth or only showing very obscure traces of curved, transversely elongated prominences on each side, with sometimes a row of very small indistinct nodes around the umbilicus; in young exfoliated shells also usually showing small, faintly defined, divaricating corrugations, directed backward around the outer half of each side. Large examples attain two feet or more in their greatest diameter. Young specimens, three and seventy-hundredths inches in breadth, show a thickness of about ninty-hundredths of an inch, while large individuals are proportionally thicker, and on the periphery become more obtuse. Septa with twelve lateral lobes, and as many sinuses on each side, in large examples crowded and very complex."

I obtained a large fragment of this species from the Blue Hills shales in the vicinity of Williams' Butte, in Mitchell county. It is the only specimen known to have been collected from the Fort Benton of this state.

Prionocyclus wyomingensis Meek. Plate CVI.

Ammonites serratocarinatus Meek, 1871, Proc. Am. Phil. Soc., vol. XI, p. 429.

Ammonites (Pleuroceras?) serratocarinatus Meek, 1871, Ann. Rep. U. S. Geol. Surv. Terr. for 1870, p. 298.

Prionocyclus wyomingensis Meek, 1876, U. S. Geol. Surv. Terr., vol. IX, p. 452; White, 1880, Ann. Rep. U. S. Geol. Surv. Terr. for 1878, p. 35. pl. XV, ff. 1a–e; Whitfield, 1880, Geol. Black Hills Dak., p. 440, pl. XIV, ff. 1–3; Stanton, 1893, Bull. U. S. Geol. Surv. No. 106, p. 171, pl. XL, ff. 1–4.

Original description: "Shell attaining a rather large size; discoid, with periphery provided with a very narrow, prominent,

serrated, mesial keel, including the siphuncle. Volutions increased 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 costæ, 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 strongly forward as they pass upon the periphery; spaces between each two of the large nodose costæ occupied by from one to about three smaller ones. Septa unknown."

Stanton adds: "The costæ are very irregular and vary considerably in strength on different individuals, but they retain the same characters throughout all the stages of growth, excepting that the smaller intermediate ones almost disappear from the last whorl of very large specimens. Frequently two costæ spring from the same node near the umbilicus and sometimes are again united in the node near the periphery, but in other cases they continue separate until they disappear near the keel. Very few 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 costæ. The breadth of the whorl is about two-thirds of the height in young specimens; in larger ones it is proportionately somewhat greater. The species sometimes reached a size of not less than twenty-five cm. in diameter. The outer whorl of a specimen that is 125 mm. in diameter measures thirty-eight mm. in width by forty-eight in height."

Specimens from Septaria horizon, near Williams' Butte.

Prionocyclus macombi Meek. Plate CI.

Prionocyclus macombi Meek, 1876, Macomb's Expl. Exp., Geol. Rep., p. 132, pl. II, ff. 3a–d.

Prionocyclus macombi Stanton, 1893, Bull. U. S. Geol. Surv. No. 106, p. 172, pl. XLI, ff. 1–5.

Original description "Shell discoidal; umbilicus shallow; somewhat less than the diameter of the last whorl from the

ventral to the peripheral side, and showing all the inner turns; volutions increasing greatly in size, very slightly embracing, so as to be nearly flat on the sides, but rounding into the umbilicus; periphery rather narrow, nearly flat, and provided with a small mesial carina, which is very slightly waved in outline; lateral margins of the periphery each having a row of small, compressed nodes, arranged at the termination of each of the costæ, with their long diameters nearly parallel to the peripheral keel; sides of each turn ornamented by from thirty-six to forty rather obscure, slightly flexuous costæ, only every second, third or fourth one of which extends across the umbilical margin, where they are usually a little swollen. The septa are generally a little crowded in adult shells, and divided into two very unequal principal lobes on each side. Siphonal lobe rather longer than wide, ornamented by three branches on each side, the two terminal of which are a little larger and much less spreading than the lateral pair, and each ornamented by some five or six sharp digitations along the margin and at the extremity, where the first pair of principal lateral branches above the terminal ones are of nearly the same form as the latter, but more spreading, and the third pair are smaller, and merely provided with a few digitations; first lateral sinus (dorsal saddle of old nomenclature) as long as the siphonal lobe, but much wider, and deeply divided into two unequal parts, of which the one on the siphonal side is larger than the other, each of these principal divisions being ornamented by some four or five short, irregular branchlets, with obtusely digitate margins; first lateral lobe slightly wider than the siphonal, and provided with some seven or eight short, rather unequal, merely digitate, and palmately spreading terminal and lateral branchlets; second lateral sinus narrower, but as long as the first on the outer or siphonal side, and much shorter on the umbilical, having two short, unequal, digitate branches at the end, and some three or four short, irregular divisions along the oblique margins of the umbilical side; second lateral lobe small, or scarcely more than twice as large as the auxiliary lobe of the siphonal sinus, and somewhat irregularly bifid, the divisions

being short, and, like the lateral margins, more or less digitate. Greatest diameter of the specimen, retaining only a small portion of the non-septate outer whorl, four and four-tenths inches; greatest convexity of the same, ninety-five hundredths of an inch; breadth of umbilicus, one and thirty-five hundredths inches; breadth of the last whorl from the siphonal to the umbilical side, one and eight-tenths inches."

Additional description by Stanton: "In the young stages of this species the costæ are simple, linear, closely arranged, and strongly curved forward. The keel is then minutely crenate, with one crenation to each costa. After the third volution, some of the costæ are more strongly developed and bear nodes or small spines at their outer ends, while the intermediate ones become obsolete. The crenations of the keel still continue numerous and small. . . . It can be easily distinguished [from *P. wyomingensis*] by its more compressed form, by the greater regularity of the costæ, and by the much greater difference between its young and adult stages."

A single specimen from Williams' Butte, Mitchell county, in the Septaria horizon.

Prionotropis woolgari Mantell. Plate CII, figs. 1–4.

Ammonites woolgari Mantell, 1822, Geol. of Sussex, p. 197, pl. XXII, ff. 6, 7; Sowerby, 1829, Min. Conch., vol. VI, p. 25, pl. DLXXXVII, f. 1; Sharpe, 1853, Fossil Remains Moll. Chalk of England, p. 27, pl. II, ff. 1, 2; Meek and Hayden, 1861, Proc. Acad. Nat. Sci. Phil., p. 421.

Prionocyclus (*Prionotropis*) *woolgari* Meek, 1876, U. S. Geol. Surv. Terr., vol. IX, p. 455, pl. VII, ff. 1a–h, and pl. VI, f. 2.

Ammonites percarinatus H. & M., 1856, Mem. Am. Acad. Arts and Sci., 2d ser., vol. V, p. 396, pl. IV, f. 2.

Prionotropis woolgari Stanton, 1892, Bull. U. S. Geol. Surv. No. 106, p. 174, pl. XLII, ff. 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 greater 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 costæ 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, costæ 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 two and one-half to three inches in diameter, costæ, 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, the periphery as seen in profile would seem to be very deeply sulcated on each side of the keel, but this is due to the prominence of the row of nodes on either side of the same. Costæ, when the shell has attained a diameter of four 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 seven inches, the costæ are more distant, greatly elevated, compressed, and almost wing-like, but still retain a large, prominent, subtrigonal 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 either side, the two terminal of which are largest, more or less 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 bipartite, 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 a 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.

"Largest specimen seen, seven inches in its greatest diameter; convexity, measuring between the costæ at the larger, broken end of the last turn, one and sixty-hundredths inches; convexity of the same, measuring so as to include the greatly expanded costæ, three and twenty-five-hundredths inches."

Impressions of these shells occur abundantly in the Fort Benton limestone. They have been found in that horizon in Ellsworth, Lincoln and Mitchell counties.

Prionotropis hyattii Stanton. Plate CII, figs. 5–8.

Prionotropis hyattii Stanton, 1892, Bull. U. S. Geol. Surv., p. 106, pl. XLII, ff. 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 costæ are simple, lineate, and strongly curved forward at the outer ends, without any nodes at first. Usually every third or fourth costa is stronger than the others. Some specimens three-fourths of

an inch in diameter are scarcely distinguishable from the young of *Prionotropis woolgari*, excepting that usually the costæ are slightly more unequal. As the shell continues to grow the costæ become more marked and each of the larger ones develops 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 half way 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 large example the costæ become 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 costæ, though sometimes it is only slightly sinuous, and it is never completely divided into nodes as it is in *Prionotropis woolgari*. Septa very much like those of *Prionotropis woolgari*, as is shown by the figures. None of the specimens shows the complete living chamber, but the well-developed spines and other features of the surface ornamentation seem to be adult characteristics, and it is therefore probable the species never attained a very large size. The largest one before me measures forty-seven mm. in diameter; the outer whorl is sixteen mm. in height, exclusive of the keel, and fifteen mm. in breadth. Some of the spines on specimens of this kind are six mm. or seven mm. long. Some fragments apparently of this species belong to larger individuals."

Numerous impressions of forms which are undoubtedly of this species occur in the Fort Benton limestone in the Salt creek and Rattlesnake creek outcrops.

Prionotropis lœvianus White. Plate CIII, figs. 3, 4.

Prionotropis lœvianus White, 1876, U. S. Geol. and Geog. Surv. West 100th Mer., vol. IV, p. 201, pl. XIX, ff. 1a, b; Stanton, 1892, Bull. U. S. Geol. Surv. No. 106, p. 178, pl. XLIII, ff. 3, 4.

Original description: "Shell moderately large, robust; volutions four or more, increasing rapidly in size, especially the outer one, so that the umbilicus is rather deep, but yet showing all the volutions, each volution embracing between one-quarter and one-third of the width of each preceding one; transverse section of outer volution, between the nodes, oval-subquadrate; surface, upon each side, marked by a row of moderately elevated, transversely elongate nodes, situated about one-third of the distance from the umbilicus to the dorsum; and also by a row of very prominent nodes on each side of the dorsum. Each of these rows consists of the same number of nodes. The dorsal nodes diverge strongly, but are wholly embraced by each succeeding volution, and do not therefore appear in the umbilicus. Between these two rows of dorsal nodes, the dorsum is slightly convex, and the outer surface of the shell appears to have been marked by a small median carina. Between these nodes and the umbilicus the sides of the volution are broadly convex. A greater transverse elongation of the lateral nodes than existed in our example would make each continuous with its corresponding dorsal node, which would give to each lateral pair of nodes the character of a rib. It is not improbable that this modification may be found to exist in some examples of the species. Septa complex; dorsal lobe and part of dorsal saddle unknown; superior lateral lobe moderately large, but not bifid; accessory lobes and saddles more or less deeply lobed or notched. Diameter, 140 mm."

Imperfect specimens of a form which I believe to belong to this species were obtained from the Septaria horizon of the Blue Hills shales on the Saline river north of Hays City. Specimen was imbedded in a hard matrix of one of the Septaria nodules; therefore its determination was difficult.

Mortoniceras shoshonense Meek. Plate CIII, figs. 1, 2.

Mortoniceras shoshonense Meek, 1876, U. S. Geol. Surv. Terr., vol. IX, p. 449, pl. VI, ff. 3a, c, 6b; Stanton, 1892, Bull. U. S. Geol. Surv., p. 179, pl. XLIII, ff. 1, 2.

"Shell compressed-discoidal, with umbilicus apparently nearly or quite twice as wide as the outer whorl; volutions very narrow, with dorso-ventral and transverse diameters equal, and section subquadrangular, those within scarcely one-sixth embraced by the succeeding turn; costæ each mainly represented by two nodes, the inner of which is low, compressed, and elongated so as to extend from near the umbilical margin about half way across the sides, while the outer near the peripheral margin are more prominent, rounded, and directed laterally; keel less prominent than the row of compressed nodes on each side about half way between it and the rounded nodes along the margins of the periphery; compressed nodes on the periphery of each inner turn covered by the succeeding volution, the inner margin of which is indented by the rounded lateral nodes of that next within. Septa moderately approximate; siphonal lobe oblong, about once and a half as long as wide, with small, short, nearly parallel, serrated terminal branches, and three or four very short, digitate and simple branchlets and points on each side; first lateral sinus wider than the siphonal lobe, which it equals in length, unequally bipartite at the anterior end, both divisions being digitate, and the larger one on the siphonal side deeply bifid; first lateral lobe somewhat longer but narrower than the siphonal, and having its terminal division deeply bifid, and its lateral margins bearing a few very simple branchlets; second lateral sinus scarcely more than half as wide as the first, and much shorter on the umbilical side, unequally bifid or trifid at the end, with more or less sinuous margins; second lateral lobe only about half as long and wide as the first, and trilobate, with the small middle division emarginate at the end; third lateral sinus a little shorter and narrower, and irregularly tridentate at the end; antisiphonal lobe about as long as the first lateral, but narrower, with a few short, nearly simple, lateral divisions, and a tridentate posterior extremity."

This fossil occurs in the Septaria horizon of the Fort Benton formation, but so far only fragments or impressions have been found. These were collected from the vicinity of William's Butte, in Mitchell county.

Mortoniceras vermilionense M. & H. Plate CIV, fig. 1.

Ammonites vermilionensis M. & H., 1860, Proc. Acad. Nat. Sci. Phil., p. 77.
Mortoniceras vermilionense Meek, 1876, U. S. Geol. Surv. Terr., vol. IX, p. 450, pl. 7, ff. 2a, b; Stanton, 1892, Bull. U. S. Geol. Surv. No. 106, p. 180, pl. XLIV, f. 1.

"Shell compressed-discoid, with its shallow umbilicus about one-fifth wider than the last turn; volutions increasing gradually in size, with convexity about three-fourths the dorso-ventral diameter, each turn less than one-fifth embraced by the succeeding outer one; costæ simple and closely arranged in the very young shell, but gradually becoming larger, more distant, and a little thickened at their inner and outer extremities, which latter are slightly curved forward, in examples an inch or so in diameter; peripheral keel moderately prominent, with the depression on each side shallow. Septa not crowded; siphonal lobe oblong, about one-fourth longer than wide, with two short, narrow or subequal or equal, nearly simple, lateral branches, the two terminal of which are diverging and moderately distant; first lateral sinus as long and nearly twice as wide as the siphonal lobe, and deeply divided into two nearly or quite equal parts, with merely sinuous and obtuse digitate margins; first lateral lobe slightly longer than the siphonal, and of the same breadth, with some five or six spreading unequal digitations at the posterior end, the middle two of which sometimes become more prominent, so as to give a slightly bifid appearance to the extremity; second lateral sinus short, or scarcely more than half as long on the inner side as the first, subquadrate in form with shallow marginal sinuosities; the mesial very shallow indentations, causing a faint tendency to bilobate outline at the anterior extremity; second lobe very small, or even less than the auxiliary lobe of the first lateral sinus, about twice as long as wide, narrower, and truncated at its posterior end, with a very few shallow sinuosities along its lateral margins; third

lateral sinus hardly half as long or wide as the second, and merely faintly bilobate at the end; third lateral lobe a little oblique, simple and smaller than one of the principal terminal digitations of the first lateral lobe. Greatest diameter, 1.10 inches; convexity, about .26 inch."

This form occurs in both the Fort Benton limestone and the Septaria horizons. In the former it occurs as impressions in the rock; in the latter, as casts in the calcareous nodules which are in the Blue Hills shales.

Scaphites larvæformis M. & H. Plate CIV, fig. 2.

Scaphites larvæformis M. & H., 1856, Proc. Acad. Nat. Sci. Phil., p. 58; Meek, 1876, U. S. Geol. Surv. Terr., vol IX, p. 418, pl. VI, ff. 6a, b, c; Stanton, 1892, Bull. U. S. Geol. Surv. No. 106, p. 182, pl. XLIV, f. 2.

Revised 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 costæ, 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 small linear ribs, all of which pass straight over the periphery. Septa moderately simple, having two main lateral lobes on each side, all of which are only moderately 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 side 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 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 lobe very small and obscurely trifid at the end forming the ventral lobe. Second lateral sinus but little if any larger than the first, and merely obscurely divided into very short, simple, obtusely rounded terminal subdivisions."

Specimens of this species are abundant in the Septaria horizon of the Fort Benton formation. They have been collected from the Blue Hills shales on the Smoky Hill river, and from similar outcrops on the Saline river.

Scaphites vermiformis M. & H. Plate CIV, fig. 3.

Scaphites vermiformis M. & H., 1862, Proc. Acad. Nat. Sci., Phil., p. 22; Meek, 1876, U. S. Geol. Surv. Terr., vol. IX, p. 423, pl. VI, ff. 4a, b; Stanton, 1893, Bull. U. S. Geol. Surv. No. 106, p. 183, pl. XLIV, f. 3.

Revised description: "Shell somewhat less than medium size, ovate subdiscoidal in form; umbilicus moderately small in comparison with the size of the shell; inner volutions closely involute, regularly coiled, 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 contracted and quadrato-subcircular in outline, with a slightly sinuous inner margin; surface ornamented by numerous straight costæ, which are rather small and nearly regular on the inner volutions, but become more distant and larger as well as more prominent, 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 the opposite sides generally alternate; costæ all passing nearly straight across the periphery, on which they are nearly uniform in size, with the exception of their regular enlargement with the whorls. The nodes mentioned above are directed out at right angles to the sides of the shell, and, like the costæ, become again smaller toward the aperture. Most of the large costæ bifurcate at the nodes of 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 oppo-

site side, but in some cases one, and sometimes each division, terminates between two of the nodes on the other side. Siphonal lobe somewhat longer than wide, with a moderately 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, or sharp, nearly or quite simple branchlets. The first lateral sinus scarcely equaling in width the siphonal lobe, but longer and divided at the extremity into two nearly equal branches. The first lateral lobe is irregularly tripartite; the lateral divisions being bifid and sharply digitate, while the terminal, which is not quite central, is longer than the others and has about five pointed digitations or short, simple branchlets. Second lateral lobe (ventral?) moderately small and obscurely bifid. Second lateral sinus small, nearly as long as wide, and regularly tripartite. Length, sixty mm.; height, forty-eight mm.; greatest convexity, measuring from the extremities of the nodes on either side, thirty-six mm."

This species occurs in the Septaria horizon of the Blue Hills shales. It occurs not only free in the shale, but also in the calcareous nodules.

Scaphites warrenii M. & H. Plate CIV, figs. 5–7.

Scaphites warrenii M. & H., 1860, Proc. Acad. Nat. Sci., Phil., p. 185; White, 1876, U. S. Geog. and Geol. Surv. West 100th Mer., vol. IV, p. 299, pl. XIX, f. 3a; Meek, 1876, U. S. Geol. Surv. Terr., vol. IX, p. 420, pl. VI, f. 5; Whitefield, 1880, Geol. Black Hills of Dakota, p. 144, pl. XIII, f. 141; Stanton, 1892, Bull. U. S. Geol. Surv. No. 106, p. 185, pl. XLIV, ff. 4–7.

Description: "Shell medium sized, subovate, compressed; inner volutions nearly circular, closely involute, and composing a comparatively rather large part of the bulk; deflected body portion short and rather more compressed proportionally than the inner turns; surface costate and without proper nodes; costæ 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.'' Septa, as shown in an imperfect specimen, obscure, simple, and provided with at least two lateral lobes which are but obscurely divided. Siphonal lobe not prominent, and has two short terminal divisions. Other details are entirely wanting. Length, thirty-eight mm.; height, thirty mm.; convexity, fourteen mm.

This species occurs moderately abundant in the Septaria horizon of the Fort Benton group in the outcrops on the White Rock in Jewell county, and in similar ones on the Saline river.

Scaphites ventricosus M. & H. Pl. CIV, figs. 8–10.

Scaphites ventricosus M. & H., 1862, Proc. Acad. Nat. Sci. Phil., p. 22; Meek, 1876, U. S. Geol. Surv. Terr., vol. IX, p. 435, pl. VI, ff. 7a, b, and 8a, b; Stanton, 1892, Bull. U. S. Geol. Surv. No. 106, p. 186, pl. XLIV, ff. 8–10; pl. XLV, f. 1.

Revised description: ''Shell medium size, ventricose, oval, broadly rounded over the periphery; inner turns closely involute; deeply embracing, and composing a large portion of the entire body; deflected portion very short; umbilicus very small and deep; aperture transversely sublunate or reniform, but deeply sinuous, and but slightly disconnected from the inner turns on the inner side; surface ornamented with costæ that pass nearly straight over the periphery, where they are of uniform size, excepting their gradual enlargement with the volutions, while on the sides of the last or outer 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 are provided with deeply divided lobes or sinuses. Siphonal lobe longer than wide, and bearing 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 deeply 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 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 terminal divisions. Between the last-mentioned lobe and the umbilicus there is a minute, trigitate lobe, very similar to the auxiliary lobe of the third lateral sinus, but smaller. Length, eighty mm.; height, sixty-nine mm.; convexity, forty-eight mm."

Specimens belonging to this species occur somewhat abundantly in the shales of the Septaria division of the Fort Benton Cretaceous. They have been found in the upper Blue Hills shales in the vicinity of Williams' Butte and in similar outcrops on the Smoky Hill river.

Scaphites mullananus M. &. H. Plate CV, figs. 2–4.

Ammonites mullananus M. & H., 1862, Proc. Acad. Nat. Sci. Phil., p. 63.
? Ammonites mullananus Meek, 1876, U. S. Geol. Surv. Terr., vol. IX, p. 607, pl. VIII, ff. 1a–c.
Scaphites mullananus Stanton, 1892, Bull. U. S. Geol. Surv. No. 106, p. 187, pl. XLV, ff. 2–4.

Description: "Shell compressed subglobose; rounded on the border; umbilicus small, deep, and acutely conical, between one-third and one-half as wide as the breadth of the outer whorl from the dorsal to the ventral side, showing about one-third of each inner volution. Whorls increasing rather rapidly in size, particularly in convexity, sloping on each side from near the umbilicus toward the periphery, and rounding abruptly into the umbilicus on the inner side, each of those within deeply embraced by the succeeding turn. Aperture transversely reniform or sublunate. Surface ornamented by rather small, regu-

lar, rounded costæ, which pass nearly straight across the sides of the whorls, and arch slightly forward in crossing over the periphery on which from thirty-six to forty of them may be counted to every turn; each of those commencing at the umbilicus, usually there a little enlarged, especially on the larger whorls, so as to form a small subnodose prominence. Beyond these they all bifurcate regularly once, near the middle of each side, and on the larger turns others are also intercalated between so as to make the number on the peripheral side five or six times as great as at the umbilicus. The septa are rather crowded, and provided with branched and deeply sinuous lobes and branches. The siphonal lobe is about one-fourth longer than wide, nearly obovate in form, and ornamented with three principal branches on each side, the two terminal of which are larger than the others, and each provided on the outer side with two or three more or less digitate terminal branchlets, while the inner parallel margins are merely sharply serrated. The first lateral sinus is of about the same size as the siphonal lobe, a little oblique, nearly oblong in form, and divided at the extremity into two tripartite and obtusely digitate branches, of which the one on the outer side is larger than the other; behind these it is provided on each side with two alternating lateral branches with sinuous margins. The first lateral lobe is narrower and shorter than the siphonal lobe, and provided with two principal branches on each side, the two terminal of which are much larger than the others and of unequal size, the one on the right or peripheral side being the larger. Both of these terminal branches are distinctly bipartite, the subdivisions being ornamented with several branchlets and digitations. The second lateral sinus is about half as wide and nearly two-thirds as long as the first, more or less oblique, and rather deeply divided at the extremity into two subequal, bifurcating and obtusely digitate terminal branches. The second lateral lobe is as long as the second lateral sinus, but a little narrower, and ornamented with three variously digitate terminal branches, the middle one of which is longer than the others, a little oblique, and not exactly cen-

tral. The third lateral lobe is small, being less than half as long and scarcely two-thirds as wide as the second lateral, and provided with three nearly equal spreading digitate terminal branches. Between the third lateral lobe and the umbilical margin there are two other small, very unequal, lateral lobes, the first of which has two or three digitations on each side, while the second is nearly simple or but slightly sinuous on the margins."

This form occurs associated with *Scaphites warrenii* in the Blue Hills shales of the Fort Benton formation. It is found in the outcrops in the vicinity of the White Rock river, in Jewell county, northeast of Mankato.

Belemnitella baculus, n. sp. Plate cx, fig. 2.

Description: Guard cylindrical, expanding gradually toward the pro-ostracum, and coming to a point at the inferior or guard end. Vascular markings moderately well defined; shell substance thin and marked by parallel lines of growth, curving spirally toward the pro-ostacum. Phragmocone tapering, with a gradually widening superior flange. Length of specimen, 140 mm.; greatest breadth of alveolar cavity, 15 mm.

Specimen was found imbedded in the Fort Benton limestone, and so crystallized as to make its description and determination difficult. Specimen appears to be closely allied to *Belemnitella bulbosa* M. & H., but is much larger, and more conical in form than their type. Species is very abundant in the lower strata of the Fort Benton limestone.

THE NIOBRARA FAUNA.

The Niobrara species are numerous and varied. They represent forms ranging in size from the microscopic rhizopod to the large bivalve mollusk, the Radiolites. Species belonging to six of the invertebrate subkingdoms are found. These are represented by about twelve genera and more than thirty species.

In the lower horizon, that of the Fort Hays limestone, fossils are not abundant, especially in the lowermost beds. Those forms found are Ostreæ and Inocerami, and these occur for the most part in the upper portion of the formation. The lower Ornithostoma beds, and possibly the upper Fort Hays, contain the large Radiolites, which are usually found in colonies. There are also the immense Haploscaphæ, with their adhering forms of *Ostrea congesta*, and the broad, flat Inocerami, measuring three or four feet in height. Numerous other species of Inocerami, much smaller, are also abundant, while the Uintacrinidæ, with their ball-like bodies and long-tentacled arms, occur more rarely.

In the Hesperornis beds Ostreæ occur, but are not particularly abundant. Crustaceans are represented to the extent of at least two genera and twice as many species. These belong to the small cirriped type, and are not abundant. Inocerami representing still smaller species than those in the lower beds are the most abundant types of this horizon. The chalk of which these beds are formed is chiefly composed of protozoa and coccoliths.

It is more than probable that in time a much larger list of invertebrate forms will be found in the Niobrara beds of Kansas, since, as yet, but little systematic collecting has been done. But since, as yet, the Colorado formation has not been separated into faunal divisions corresponding to its stratigraphical divisions by the American invetebrate paleontologists, but has had its faunas grouped as a whole, it is impossible to say what part of the already described species belongs to the Niobrara division, or what ones are likely to be found in our Kansas fields.

Outline Classification of Niobrara Species.

PROTOZOA.
- Rhizopoda.
  - Foraminifera.
    - Vitro-calcarea.
      - Globigerinidæ.
      - Textularidæ.

CŒLENTERATA.
- Porifera.
  - Spongiæ.
    - Silicispongiæ.

ECHINODERMATA.
- Crinoidea.
  - Uintacrinidæ.
    - Uintacrinus.
      - Uintacrinus socialis.

VERMES.
- Serpulidæ.
  - Serpula.
    - Serpula intrica.
    - Serpula tenuicarinata.

MOLLUSCA.
- Pelecypoda.
  - Ostreidæ.
    - Ostrea.
      - Ostrea congesta.
      - Ostrea larva.
  - Aviculidæ.
    - Inoceramus.
      - Inoceramus flaccidus.
      - Inoceramus deformis.
      - Inoceramus simpsonii.
      - Inoceramus pennatus.
      - Inoceramus subtriangulatus.
      - Inoceramus brownii.
      - Inoceramus concentricus.
      - Inoceramus platinus.
      - Inoceramus fragilis.
    - Haploscapha.
      - Haploscapha grandis.
      - Haploscapha eccentrica.
      - Haploscapha niobrarensis.
  - Rudistæ.
    - Radiolites.
      - Radiolites maximus.
  - Pholadidæ.
    - Parapholas.
      - Parapholas sphenoideus.
- Cephalopoda.
  - Decapoda.
    - Teuthidæ.
      - Tusoteuthis.
        - Tusoteuthis longus.

ARTHROPODA.
- Crustacea.
  - Cirripidæ.
    - Stramentum.
      - Stramentum haworthii.
      - Stramentum tabulatum.
    - Squama.
      - Squama spissa.
      - Squama lata.

Description of Species in the Niobrara Formation.

PROTOZOA.

For descriptions and figures of the Protozoa, see Part VII.

CŒLENTERATA.

Sponge spicules occur in the chalk of the Ornithostoma beds, showing the presence of members of this class in the Niobrara seas of Kansas. See Part VII.

ECHINODERMATA.

Uintacrinus socialis Grinnell. Plates LXXI, CXII, CXIII.

Uintacrinus socialis Grinnell, 1876, Am. Jour. Sci., vol. XII, p. 81; Meek, 1876, Bull. U. S. Geol. Surv. Terr., vol. II, p. 375; Clark, 1893, Bull. U. S. Geol. No. 97, p. 21, pl. I, ff. 1a–c, and pl. II, ff. 1a–e; Williston and Hill, 1894, Kans. Univ. Quart., III, 19; Bather, 1895, Proc. Zoöl. Soc. Lond., pp. 974–1004, pls. LIV–LVI.

Revised 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 pinnulæ 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 arm 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, and of many smaller ones, which gradually diminish in size to the apex, forming a short arm. The arrangement of the interradial plates varies, but in some specimens the order is as follows: Commencing below, opposite the first radial, 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 interradial arm is reached. A very small quadrangular plate is inserted between the first

and second radials, and the interradial 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."

Two large slabs of crinoidal limestone in the University collection are almost wholly covered with *Uintacrinus socialis*. The adhering forms on one of these slabs are evidently of adult size; on the other slab are a few individuals approaching adult size, all the others being but one-fourth that size. It was thought that two species are represented in these two slabs, but a careful examination failed to reveal any specific differences except in the matter of size. It is remarkable that there should be such a uniformity of size among all the individuals of one slab.

The limestone to which these two forms adhere is composed almost entirely of the plates of this crinoid, the plates being cemented together by a calcareous matrix. Nearly all of the larger individuals present the lateral surface. This condition is probably due to the stronger arms of the adult causing the crinoid as it lay on the sea floor to be crushed laterally instead of vertically. The fragile condition of the arms of the young individual allowed it to be crushed vertically as it lay on its ventral side. Specimens of *Uintacrinus socialis* are rare in the Kansas fields. The specimens in the University collection were collected from the lower part of the Hesperornis beds.

VERMES.

? Serpula tenuicarinata M. & H. Plate LXXXVI, fig. 4.

? Serpula tenuicarinatus M. & H., 1857, Proc. Acad. Nat. Sci. Phil., p. 134; Meek, 1876, U. S. Geol. Surv. Terr., vol. IX, p. 507, pl. VI, f. 1.

? Serpula tenuicarinata Stanton, 1893, Bull. U. S. Geol. Surv. No. 106, p. 53, pl. I, f. 2.

Revised 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; carina sometimes wavy.

"Length of species unknown; length of longest fragment, fifteen mm.; average transverse diameter, less than two mm.

"As entire specimens of this species have not been seen it is somewhat doubtfully referred to this genus."

The University specimens consist of a fragmentary mass of these forms attached to a portion of a shell of a large *Inoceramus* collected by the writer from the Ornithostoma beds in the Niobrara area of Jewell county.

Serpula intrica White. Plate C, fig. 1.

Serpula intrica White, 1876, U. S. Geol. and Geog. Surv. Terr. West 100th Mer., vol. IV, p. 205, pl. XV, f. 5a; Stanton, 1893, Bull. U. S. Geol. Surv., p. 53, pl. I, f. 1.

Original description: "Tubes small, slender, cylindrical, smooth, very long and very tortuous, not perceptibly increasing in size, so far as our examples show, but neither the distal nor proximal extremity of the tube has been found unbroken. Diameter of the tube a little more than one mm. This species is remarkable for the great length and uniform size of the tubes and for the intricacy of their contortion."

A single coiled specimen attached to the flat surface of a portion of a large *Inoceramus*, and surrounded by small, broken fragments of tubes, is doubtfully referred to this species. In general appearance this specimen resembles *S. tenuicarinata*, and may belong to that species. The absence of a carina and its coiled

condition may be accidental. The specimen was collected from the Ornithostoma beds on the Smoky Hill river, south of Gove City.

MOLLUSCA.

Ostrea (Alectronia) larva Lamarck.

Ostrea falcata Morton, Syn. Org. Rem. Cret. Group, p. 51, pls. III, IX; White, 1884, 4th Ann. Rep. U. S. Geol. Surv., p. 294, pl. XXXIX, ff. 11, 12, 13.
Ostrea mesenterica Morton, ibid.; White, ibid.
Ostrea nasuta Morton, ibid.; White, ibid.
Ostrea larva Lamarck, A. S. V., vol. VI, p. 216; White, ibid.

Description: Shell small, narrow, subelliptical in general shape, diminishing in size posteriorly; posterior dorsal margin deeply crenate or toothed; anterior ventral margin slightly toothed; exterior of shell in some specimens showing lines of growth, in others smooth; interior smooth; beak obliquely rounded; umbonal slope abrupt; hinge line short, almost straight, placed tangentially to the rounded beak.

Length, following central line of curvature, thirty mm.; breadth in antero-central region, ten mm.; height of longest tooth, five mm.

The margins of the two shells when they are fitted together form a zigzag line. This line diminishes in the length of its excursions from a central line as each end of the shell is approached. The distance between the lines of the excursions remains nearly constant. All of the varieties represented by Doctor White's figures in the Fourth Annual Report of the United States Geological Survey are represented in the University collection. These forms represent Morton's three varieties —*falcata*, *mesenterica*, and *nasuta*.

Ostrea larva occurs in both the Hesperornis and the Rudistes beds of the Niobrara Cretaceous, but specimens are not abundant.

Inoceramus flaccidus White. Plate XC.

Inoceramus flaccidus White, 1876, U. S. Geog. and Geol. Surv. West of the 100th Mer., vol. IV, p. 187, pl. XVI, ff. 1a, b; Stanton, 1893, Bull. U. S. Geol. Surv. No. 106, p. 80, pl. XIII, f. 1.

Original description: "Shell large, irregularly subovate in marginal outline, exclusive of the ears; valves subequal, not

much inflated; wing moderately large, well defined at its inner side by an auricular furrow; hinge line not very long, nearly at right angles with the front of the shell, and only a little oblique with the axis; a more or less distinct, but somewhat irregular furrow extending the entire length of the shell from the posterior side of the umbo to the postero-basal margin, giving each valve an obscurely bilobed appearance; crenulated face of the hinge narrow, crenulations small; umbonal region narrow; beaks prominent, curved forward and inward; test comparatively thin throughout the whole shell; surface having the ordinary concentric lines of growth, and the test is also thrown into numerous, rude and irregular concentric undulations. Length of the largest example in the collection, about twenty-two cm.; greatest breadth, about fifteen cm."

This species occurs in the lowermost Ornithostoma beds of the Niobrara Cretaceous.

Inoceramus deformis Meek. Plate XCII, fig. 2.

Inoceramus deformis Meek, 1871, Ann. Rep. U. S. Geol. Surv. Terr. for 1870, p. 296; White, 1876, U. S. Geol. and Geog. Surv. West 100th Mer., vol. IV, p. 179, pl. XV, ff. 1a, b; Meek, 1877, U. S. Geol. Surv. Expl. 40th Par., vol. IV, pt. I, p. 146, pl. XIV, ff. 4, 4a; Stanton, 1893, Bull. U. S. Geol. Surv. No. 106, p. 85, pl. XIV, f. 1, pl. XV. ff. 1, 2.

Haploscapha capax Conrad, 1874, Ann. Rep. U. S. Geol. Surv. Terr. for 1873, p. 456.

? Haploscapha deformis White, 1876, U. S. Geol. and Geog. Surv. Terr., vol. II, pp. 23, 24, pls. LXVI, LXVII.

Inoceramus ———*?* Hall, 1845, Fremont's Rep. Expl. Rocky Mts., p. 310, pl. IV. f. 2.

Meek's description: "Shell attaining 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 irregu-

lar, 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 four and fifty-hundredths inches; length of same, four and thirty-hundredths inches; convexity of right valve, about two and fifty-hundredths inches."

This species is found somewhat abundant in the uppermost Fort Hays limestone of the Niobrara Cretaceous. Should *Haploscapha* be made a subgenus of *Inoceramus*, as I have suggested, the thickness of its test and the depths of its undulations would place this species under that subgenus.

Inoceramus simpsonii Meek. Plate XCVII.

Inoceramus simpsonii Meek, 1860, Proc. Acad. Nat. Sci. Phil., p. 312; 1876, Simpson's Exp. across Great Basin of Utah, p. 360, pl. IV; 1877, U. S. Geol. Expl. 40th Par., vol. IV, pt. 1, p. 142, pl. XIII, f. 4; Whitfield, 1880, Geol. Black Hills of Dakota, p. 395, pl. VIII, f. 1; Stanton, 1893, Bull. U. S. Geol. Surv. No. 106, p. 79, pl. XII, f. 1.

Meek's description: "Shell (right valve) attaining a rather large size, transversely oval suboblong, gibbous, the greater convexity being in the antero-central region, cuneate posteriorly; length nearly twice the height; anterior end very short and rounded from the beaks; base forming a long, semielliptic curve, most prominent near the middle and somewhat straightened, or even sinuous, posteriorly; hinge long, straight, and ranging parallel to the longer axis of the shell; posterior margin subtruncated, with a slight backward slope above, and forming an oblique curve into the posterior basal margin; beaks depressed so as to extend a little above the hinge line, incurved, and placed nearly over the anterior margin. Surface ornamented with moderately distinct regular, concentric undulations and lines of growth. Length, eight and ten-hundredths inches; height, about four and thirty-hundredths inches; convexity of right valve, nearly two inches."

This form is found in the Fort Hays limestone of the Niobrara formation. The species is not abundant in the Kansas area.

Inoceramus pennatus, n. sp. Plate CXVIII, fig. 2; CXX, 2.

Description: Shell (right and left valves) oblong ovate, moderately thin, slightly convex, greatest convexity in central region; hinge long (sixty mm.), thicker than shell body; marked with transverse grooves two mm. in breadth, upper border of grooves bent inward; grooves marked with striations running parallel and transverse to the groove; hinge raised and curved inward. Interior of shell smooth, showing no marks or undulations; exterior covered with adhering forms of *Ostrea congesta.*

Length of longer diameter, 150 mm.; height, 75 mm.; greatest convexity not more than 10 mm. Type specimen is imbedded in a matrix of chalk, having valves spread out and open, somewhat resembling wings. Both valves taken together somewhat resembling a leaf in general outline, the hinge corresponding to the midrib and stem.

In general form, *Inoceramus pennatus* does not resemble any of the other species belonging to this genus. In thickness of test it resembles *Inoceramus deformis,* but differs from that species materially in other respects, as will be seen by a comparison of their descriptions.

This is common in the upper horizon of the Pteranodon beds, fragments being found in many places, but on account of the fragile nature of the shell whole specimens are difficult to obtain.

Inoceramus subtriangulatus, n. sp. Plate CXX, fig. 1.

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 costæ; length of hinge in type specimen, eighty mm. Interior of shell smooth, ornamented with scarcely visible concentric lines or striæ. 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. A single left valve (the type specimen) is imbedded in a matrix of chalk, from which, owing to the fragile condition of the shell, it cannot be

removed without endangering the specimen. For this reason I have not been able to determine the general character of the exterior of the shell. From the smooth condition of the interior, it seems there are no ridges or undulations such as mark a majority of the species of this genus. Aside from the condition of the hinge and this apparent lack of ridges and the almost total want of convexity, it most closely resembles *Inoceramus deformis*, but has not the thickness of test of that species.

The above specimen was collected from the upper chalk beds (Hesperornis beds) of Gove county. Fragments of the shell, especially of the hinge, are abundant in these beds, but whole specimens are rare.

Inoceramus brownii Cragin.

Inoceramus brownii Cragin, Cont. to the Paleontology of the Plains, Bull. Washb. Coll. Lab. Nat. Hist., 1889.

Original description: "Shell large, fibrous, equivalve, inequilateral, short, broad, elevated, and concentrically ribbed and striate; valves boat-shaped, or unevenly pear-shaped in exterior view, posteriorly shouldered, depressed on the summit of the umbonal region; beaks obtuse, incurved, closely approximated, their cavity capacious, hinge line more or less angulated between the beaks, provided with numerous transverse cartilage grooves; interior of shell bearing, on the distal part of the umbonal cavity (in the right valve at least), several large, compressed teeth; ribs of the shell six or eight on each valve, prominent rounded, broadening from their origins toward the convexities of the valves, more or less folded, grooved, and striated in the direction of their course.

"Dimensions: Height, eight and one-half inches; breadth (distance between greatest exterior convexities of valve), eight inches; approximate length (greatest anterio-posterior diameter measured parallel to hinge line), six inches; thickness, mostly thirteen-hundredths to twenty-five hundredths of an inch. The exterior of the type specimen is more or less studded with the inferior valves of *Ostrea congesta*, but much less thickly than is usual with the common, large Inocerami of the Niobrara.

A considerable fragment of a younger specimen is free from them. Believing that 'he is a thoroughly good naturalist who knows his own parish,' and in recognition of the valuable aid rendered me in my studies of the geology of Kansas by his careful work in the stratigraphy of his district, I have named this shell in honor of its collector, Benjamin Brown, Esq., late of Knebworth, England, who discovered it in the Fort Hays limestone, at some ten to twenty feet above the base of the latter, at a locality known as Devil's Gap, near the post-office of Topley, in Osborne county, Kansas.

"The woodcut of *Inoceramus culverii* given in Mantell's "Medals of Creation" (p. 408) strongly recalls the present shell, but descriptions of the former seem to forbid reference of the latter to it."

It is a fact much to be regretted that no illustrations of this specimen accompanied the above description. Especially as, to my knowledge, none other of the Kansas collections contain specimens of this species; consequently it is not within the power of the writer to figure it. On account of its large size, fibrous structure, and the fact that it occurs in comparatively durable limestone, there is little probability of many good specimens of this species being obtained by collectors.

Inoceramus concentricus, n. sp. Plate CXVI, fig. 1.

Description: Shell semicircular, medium sized, almost flat, slightly convex in anterior region; hinge not prominent, curved, umbonal region showing moderate depression; beaks rounded obtusely; interior of valve smooth, not marked; exterior surface ornamented with concentric, prominent ridges, terminating near beaks; ridges of surface rounded, smooth, marginal border of last one marked by parallel lines of growth. Shell body moderately thick, increasing slightly in thickness from central region toward border.

Length of longitudinal axis, 160 mm.; height, 80 mm.; thickness, 4 mm. at margin, much thinner at greatest convexity. Shell found with *Ostrea congesta* attached to it by their lower valves.

This description is made from two incomplete specimens collected from the Niobrara outcrops north of Ellis, in Ellis county. It occurs in the lowermost horizon of the Pteranodon beds, where it occurs associated with *I. platinus* and *I. truncatus*.

There exists a striking similarity between this species and the description of *Inoceramus brownii* described by Professor Cragin, and it may be that the form just described is a synonym of the latter. But there are certain points of difference, such as the absence of transverse grooves on the hinge line, and compressed teeth on the distal portion of the umbonal cavity in the former. As no figure accompanied Professor Cragin's description of *I. brownii*, I am unable to decide definitely as to whether they are synonyms or not. The two forms occur in different horizons, *Inoceramus concentricus* occurring in the Pteranodon horizon, and *I. brownii* occurring in the Fort Hays limestone horizon.

Inoceramus platinus, n. sp. Plate CXVI.

Description: Shell large, thin, flat, oblong oval; hinge margin long, straight, smooth, marked by shallow pits or undulations, not concentric, and not regular as in *Inoceramus concentricus*. Body of the shell is thin, and increases but slightly in thickness toward the hinge. Shell substance fibrous and the surface somewhat striated, striations giving a banded appearance to the shell in some specimens. Umbonal region slightly depressed; cavity broad, shallow. Length of longer diameter of adult specimen, from three to four feet; height, from one and one-half to two feet.

Fragments of this shell are numerous throughout the Ornithostoma beds, but on account of the extreme fragility of the shell whole specimens are difficult to obtain. I have described the species as seen in the field and from fragments collected for the University collection. I have often found adult specimens of this shell exposed by the weathering of the chalk, but, upon attempting to remove them with the means at hand, they would be broken up into so many fragments as to make restoration next to impossible. Two large fragments of this shell in the University collection measure more than eighteen inches in

longest diameter. The shell is sometimes free from adhering form, but usually has *Ostrea congesta* attached.

These forms are abundant in all the exposures of the Ornithostoma beds which I have visited in the state. Next to *Ostrea congesta*, they are the most abundant forms in the Niobrara Cretaceous of Kansas.

Inoceramus truncatus, n. sp. Plate CXIV.

Description: Shell large, somewhat cordate in outline, thick, moderately convex, convexity in antero-central region; hinge long, straight, formed by reflex fold of shell, not marked, smooth, anterior lateral margin forming a lobe. Shell smooth, marked by small pits on the exterior surface, probably made by some burrowing animal; interior of shell smooth, marked by a prominent groove near the margin; exterior surface marked by broad undulations running parallel with the longitudinal axis; posterior margin truncated, but having a rounded lobe in the central portion of the truncated region. Thickness of shell in central region from eight to twelve mm., gradually decreasing in thickness as the margin is reached. Length of longer axis in adult, three feet; height, from one to one and one-half feet.

The adult specimens of this species are difficult to obtain, but young specimens are obtained more easily. In describing this species, I have used adult specimens as seen in the field and a young individual collected from the Niobrara outcrops on the Saline river, north of Ellis. This form, like *Inoceramus platinus*, which it most nearly resembles, is very abundant in the Ornithostoma area of Kansas, in Jewell, Phillips, Gove, Trego and Ellis counties. This species is comparatively free from adhering forms, but *Serpula tenuicarinata* is often found attached to it.

Haploscapha grandis Conrad. Plate XCIV.

Haploscapha grandis Conrad, 1875, U. S. Geol. Surv. Terr., vol. II, p. 23, pl. LXVI.

Original description: "Shell subovate or subtriangular, hinge long and straight, edentulous, oblique; curved, prominent ridges occupy the upper portion of the interior, the ridges be-

ginning and ending at a distance from the margins of the shell; a singular twisted callus composes the hinge, the back of which is transversely ribbed.

"Length greater than height; hinge line very long; ridges concentric, about twelve in number, extending into the cavity under the hinge, submargin thick; test composed of columnar transverse fibers. No muscular impression can be traced unless the ridges indicate their station. The posterior side of the shell is slightly elongated. The exterior of the shell, and in many specimens the interior, covered with *Ostrea congesta.*"

Stanton[69] has made *H. grandis*, *H. capax* and *H. eccentricca* synonymous with *Inoceramus deformis*. The test of *I. deformis* is much thinner than that of *H. grandis*; the shell is more convex; the ridges more acute; the marginal border narrower; the side more triangular. So, after a careful examination of many specimens, including both adult and young, I decided to return to Conrad's classification. I am inclined to think, however, that *Haploscapha* is better as a subgenus under *Inoceramus*. Should such a classification as I have suggested be made, then *I. deformis* would properly belong to that subgenus, as it corresponds more nearly to the form of *Haploscapha* in general characteristics.

I. deformis occurs near the upper surface of the Fort Hays limestone, but I have never found it in a higher horizon. The different forms of *Haploscapha* occur in the lowermost Ornithostoma beds, and are abundant in this horizon throughout the Niobrara area. They are especially abundant a few miles south of Castle Rock, in Trego county; on the Saline river a few miles north of Ellis, in Ellis county, and near Marvin, in Phillips county.

Haploscapha niobrarensis, n. sp. Plate CXVI, fig. 2.

Description: Shell large, subtriangular, hinge line short; test thick in both young and adult specimens, convex—convexity greater than in any of the other species. Ridges broadly rounded, passing into a smooth margin gradually. Smaller

69. Stanton, T. W., U. S. Geol. Surv. Bull. 106, 1893.

than *H. grandis* or *H. eccentrica;* margin narrower than in the latter. The internal undulations or ridges are more prominent in the young individuals.

The young of this species seem to have nearly twice the thickness of test as the young of the same size belonging to the other species. This form occurs like the other species of this genus in the lowermost Ornithostoma beds of Trego, Gove and Logan counties.

Haploscapha eccentrica Conrad. Plate XCIII.

Haploscapha eccentrica Conrad, 1875, U. S. Geol. Surv. Terr., vol. II, p. 24, pl. LXVII.

Revised description: "Shell subovate, dorsal side straight, hinge line thick, and shorter than in *H. grandis*. Concentric ridges not as well marked, and less numerous. Outer smooth margin showing a well-marked sinus. Cavity more profound. Ridges passing more gradually into the margin, not ending so abruptly as in *H. grandis*. Hood, two and one-half inches in length; length of shell, nine inches; height of valve, ten inches." *H. eccentrica* was placed under the subgenus Cucullifera by Conrad, but I doubt if it has sufficient generic distinctions to warrant such a classification. There is little doubt, however, that it is a species distinct from *H. grandis*, with which it is associated in the Ornithostoma beds.

Radiolites maximus, n. sp. Plate CXV; also, CXIX, fig. 1.

Shell inversely conical; lower valve three to four feet in height; outer surface marked by parallel longitudinal ridges composed of overlapping plates. Inner surface smooth, showing striations formed by intersection of plates and prisms. Valve composed of circular plates placed one upon the other; plates composed of prisms filled with calcareous matter. Upper extremety of lower valve resembling a flange bent upward and outward.

Diameter of lower valve at top, 250 mm.; thickness of outer layer of shell, 75 mm. Prismatic layers of shell ornamented with branching ridges upon the upper surface, with a corresponding depression on the under surface.

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.

Specimens of this mollusk were first observed by Doctor Williston in 1874 on the Saline river; however, nothing but small fragments were secured for the University collection until the past summer, when a few specimens of a large lower valve were obtained from Mr. M. R. Watson, of McCracken. A fragment of another specimen was collected by Doctor Williston from Niobrara outcrops on the Saline river in Ellis county. Other forms belonging to the same species have been collected by Mr. Allen, of Hays City. One of the specimens collected by Mr. Watson has *Ostrea congesta* adhering to the inner surface of the valve. All other forms which I have seen were free from adhering forms.

Radiolites are not abundant in the Kansas fields. They occur at the base of the Ornithostoma beds just above the Fort Hays limestone, and possibly in the upper surface of that formation. None have been reported except from the south-central portion of the Niobrara area in Trego, Gove and Ellis counties. Collectors in looking for these shells will find it to their advantage to follow the line of contact of the Fort Hays limestone with the Ornithostoma beds.

Parapholas sphenoideus White. Plate XCIX, fig. 12.

Turnus sphenoideus White, 1876, Geol. Uinta Mts., p. 117.
Parapholas sphenoideus White, 1879, Ann. Rep. U. S. Geol. Surv. for 1877, p. 300, pl. v, ff. 1a–d; Stanton, 1893, Bull. U. S. Geol. Surv. No. 106, p. 125, pl. XXVII, ff. 1, 2.

Revised description: "Shell elongate, cuneate, inflated in front, narrowed and laterally compressed behind; beaks anterior, incurved, adjacent; dorsal margins of the valves straight and sloping from the beaks to the posterior end, capped or connected by a slender, styliform, plain accessory plate; posterior

extremity small, truncated, or narrowly rounded; basal margins nearly straight, connected by a ventral accessory plate similar to the dorsal one, except that it is shorter, broadest behind, but coming to a slender point in front about midlength the shell, longitudinally divided by a linear groove; front regularly rounded both vertically and laterally; anterior gape consisting of a narrow vertical slit, which occupies the middle of a somewhat prominent projection at the antero-basal portion of the shell, which projection has the shape of a Norman shield, as seen by front view when both valves are in their natural position, and which seems to have been occupied by a much wider gape in the younger than in the adult condition of the shell; both umbonal grooves distinct, both upon the outer surface and upon that of the stony cast; anterior grooves broader and deeper than the other, but both are slender; besides the two umbonal grooves there is another somewhat broader groove or furrow, extending with a broad downward curve from the posterior side of the beak to the posterior end of the shell. This groove, like the others, is distinctly traceable upon the outer surface, but is more distinctly seen upon the stony cast. A broad, subcircular, cake-like umbonal accessory valve covers the beaks and the space between them, the valve being divided by a suture into two nearly semicircular pieces so neatly that it is hardly perceptible until the valves are slightly displaced. The margins of the principal valves between the beaks and the Norman-shield-shaped projection are narrowly but abruptly averted, which, with the beaks above and the borders of the projection below, bound a distinctly hollow space each side and below each beak. Besides the grooves before mentioned, the surface is marked by fine concentric, distinctly raised lines on each side of the shell, but they are less distinct upon the surface of the Norman-shield-shaped projection than elsewhere. Between the posterior grooves or furrow before mentioned as ending at the posterior margin of the shell and the dorsal margin, the surface is occupied by strong, irregular scales and laminæ that were successively increased as the shell increased in size. Length, thirteen mm.; greatest height, seven mm.; breadth at front, six mm."

A piece of fossil wood collected from the Niobrara beds near Hays City contains the casts of forms very similar in general character to the above-described species. The fossils occur either in the uppermost horizon of the Fort Hays limestone or in the lowermost horizon of Ornithostoma beds.

Tusoteuthis, gen. nov.

Gladius moderately convex, lanceolate, corneous in texture, having greatest breadth centrally; inferior point obtuse, rounded, partly covered with a calcareous layer. Striation on the surface of the gladius running parallel with the border. Midrib at base broad and rounded. Shaft cylindrical, inclosing a hollow cone; striations in midrib run parallel with edges.

The genus seems nearest related to *Teuthopsis* (Zittel), but differs from that genus in having a lanceolate instead of a spatulate gladius, and a thicker, shorter shaft. It differs from *Phylloteuthis* Meek and Hayden, in general shape and in not being angular posteriorly as in this genus.

Tusoteuthis longus, n. sp. Plate CX, fig. 1.

Endoskeletal corneous portion composed of blade and shaft; blade moderately convex, with a midrib which is broad and rounded at the base; inferior point obtuse, rounded, and partly covered with a calcareous layer; striated, with striations running parallel with the border; marginal border rounded.

Shaft cylindrical, inclosing a hollow cone; length of shaft, 120 mm.; length of form, 520 mm.; maximum breadth, 160 mm.; diameter of shaft, 25 mm.

The above genus and species are founded upon a single specimen from the Hesperornis beds of the Niobrara Cretaceous on the Smoky Hill river, collected by Mr. Martin. Its discovery was referred to by Professor Williston in his report on the Niobrara of Kansas in vol. II of the University Geological Survey. The form was found imbedded in a matrix of chalk, and had on the under side the contents of the ink sac. A part only of the shaft was obtained, and a portion of the upper part of the gladius near the central region is wanting.

Fragments of the shafts of *Tusoteuthis longus* or allied forms are abundant in the Ornithostoma beds, but complete specimens are extremely rare.

ARTHROPODA.

Stramentum.

Stramentum Logan, 1897, Kans. Univ. Quart., VI, p. 198.

Capitulum composed of eight or nine plates; plates of the peduncle narrow, with the ends turned down, presenting a thatched appearance; plates each with a groove running longitudinally. The two known species of this genus are evidently from a higher horizon than those of *Squama*, coming from the yellow chalk, the same beds which contain the toothed birds.

Stramentum haworthii Williston. Plate CXI.

Pollicipes haworthii Williston, 1896, Univ. Geol. Surv., vol. II, p. 243, pl. XXXVI.

Stramentum haworthii Logan, 1897, Kans. Univ. Quart., vol. VI, No. 4, Oct., series A, p. 188.

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, seven-

teen mm. The type specimen is attached to an *Ostrea congesta* by the extremity of its peduncle. It was discovered by Professor Haworth, and placed provisionally in the genus *Pollicipes* by Professor Williston in the work cited. Its horizon is the yellow chalk from the vicinity of Gove City, in Gove county.

Stramentum tabulatum Logan.

Stramentum tabulatum Logan, 1897, Kans. Univ. Quart., vol. VI, No. 4, Oct., series A, p. 189.

Description: Capitulum composed of eight plates, viz.: Terga (2), scuta (2), lateralia (4); height, five mm.; breadth, seven mm. The plates are flat and marked by lines, and the whole capitulum is short and pointed. Terga triangular, the longest side of the triangle adjoining the carino-lateral, the shortest side adjacent the superior lateral; breadth at base, two mm.; height, five mm. Scuta small, but one-half the size of the terga; triangular, almost equilateral. Carino-lateral long, moderately narrow, triangular, the most acute angle at the apex; height and breadth about the same as those of the terga. Superior laterals small, in the form of an isosceles triangle, and of about the same size of the scuta. Peduncle short, rounded, composed of six, or possibly seven, rows of plates, with about sixteen plates in each row; plates less than one mm. in width, their length more than two mm.; turned downward at the ends and overlapping in rows.

Type specimen was collected by Mr. H. T. Martin from the Upper Niobrara chalk of the Smoky Hill river.

Squama.

Squama Logan, 1897, Kans. Univ. Quart., VI, 187.

Description: Capitulum composed of from nine to twelve plates of medium size and subtriangular; peduncle short, composed of seven rows of plates, tapering gradually to near the extremity, and ending in a rapidly, almost abruptly, diminishing reflex area of smaller plates; form adhering to *Inoceramus* by its entire length.

Squama spissa Logan. Plate cx, fig. 3.

Squama spissa Logan, 1897, Kans. Univ. Quart., vol. vi, No. 4, Oct., series A, p. 187.

Description: Capitulum composed of twelve plates, viz.: Carina, terga (2), scuta (2), rostrum, subrostrum, subcarina, superior laterals (2), and carino-laterals (2). Height of capitulum from base to tip, nineteen mm.; width (lateral) from carina to subrostrum, seventeem mm. Carina long, narrow, somewhat shield-shaped, and slightly convex; length, five mm.; maximum breadth, two mm., overlapping lateral in specimen. Terga triangular, with apex pointing toward base of capitulum, and base somewhat rounded; very slightly convex, smooth; length, ten mm.; breadth (maximum), fifteen mm., joined closely with laterals in one specimen. Scuta large, convex, in general shape triangular; superior border almost straight; rostral border convex, base smooth, slightly concave; length, ten mm.; maximum breadth, seven mm., adhering closely to superior lateral and overlapped by rostrum. Rostrum club-shaped, slightly convex; length, six mm.; breadth, two mm. Subrostrum with the same characteristics as rostrum, except that it is smaller. Carino-laterals long, triangular, with apex distal, smooth; length, ten mm.; maximum breadth, four mm. Superior laterals shorter, three mm.; otherwise much the same as carino-laterals. Peduncle short, composed of seven rows of plates; plates oblong, narrow, overlapping, short; maximum breadth, six mm.

The type specimen was collected from the base of the Ornithostoma beds by the writer, in the northern part of Jewell county. A group of these forms were found adhering to a fragment of a shell of *Inoceramus*.

Squama lata Logan. Plate cx, fig. 4.

Squama lata Logan, 1897, Kans. Univ. Quart., vol. vi, No. 4, Oct., series A, p. 188.

Description: Capitulum composed of ten plates, viz.: Carina, terga (2), scuta (2), subcarina, superior laterals (2), carino-laterals (2); height, eight mm.; width, sixteen mm. Carina long,

narrow, rounded, slightly convex, the surface marked by parallel striæ; height, four mm.; breadth, two mm. Terga triangular, with the base rounded; slightly convex, the surface smooth; length, eight mm.; maximum breadth, four mm. Scuta large, convex, quadrangular, its superior lateral border somewhat rounded; rostral border straight, surface marked; length, eight mm.; maximum breadth, five mm. Carino-laterals long, triangular in outline, the surface marked by transverse lines; length, eight mm.; breadth, three mm. Superior laterals shorter, resembling the carino-laterals in general shape. Peduncle short; its maximum breadth, six mm.; composed of seven rows of plates; plates quadrangular, with the upper border curved; six or seven larger plates in the upper part of a row, succeeded below by about ten very much smaller ones. Type specimen adhering to the shell of an *Inoceramus* by its entire length.

The type specimen was presented by Mr. M. R. Watson, of Trego county, and had evidently come from the lowermost beds of the Upper Niobrara, probably from the Hesperornis beds.

THE FORT PIERRE FAUNA.

The Fort Pierre area of Kansas has not been productive of a very great number or diversity of invertebrate forms. Fossils were collected in an early day from a Fort Pierre outcrop on Butte creek, by Prof. B. F. Mudge, and, later on, some specimens were collected from the same locality by Prof. S. W. Williston. Fort Pierre fossils were collected also by Judge West, Professor Williston and Mr. Cooper from the Fort Pierre shales on the North Fork of the Smoky Hill river, near McAllaster, in Wallace county. But no very extensive outcrops of the Fort Pierre formation occur in Kansas except in Cheyenne county, and these outcrops were thought to be barren until recently. In the summer of 1895 I collected a few fossils from the Cherry creek and Arickaree outcrops, in the northern part of Cheyenne county. These fossils were determined through the kindness of Mr. T. W. Stanton, of the United States Geological Survey. In the summer following, in company with Prof. H. J. Harnley, of McPherson, I again visited the Arickaree outcrops, and an outcrop in Rawlins county, a few miles north of Atwood, and secured additional forms.

The form which occurs most abundantly in the Fort Pierre of Kansas is *Baculites ovatus;* but it is not the most characteristic one, as it is also found in the Fox Hills formation. *Lucina occidentalis*, one of its characteristic forms, is abundant in one Arickaree horizon. Both of these fossils occur free in the shales, as do a few other forms, but many of the Fort Pierre fossils are imbedded in argillaceous nodules, which are scattered throughout the shale beds.

All told, the Fort Pierre formation in Kansas has furnished fifteen species, none of which are new to science. It is more than probable that a careful examination of the outcrops in the localities above mentioned will reveal many of the hundred or more species which have been described from this formation in

other states. The following species have already been described from the Fort Pierre:

Hemiaster humphreysiana,
Ostrea patina,
O. inornata,
Gryphea vesicularis,
Inoceramus sublævis,
I. proximus,
I. cripsii,
I. incurvus,
I. convexus,
I. sagensis,
I. altus,
I. balchii,
Pholadomya hodgei,
Trigonarca exigua,
Volsella meekii,
Yoldia ventricosa,
Nemodon sulcatinus,
Nuculana bisulcata,
N. equilateralis,
N. obsoletiatriata,
Nucula planimarginata,
N. subplana,
Nuculata subnasuta,
Pteria fibrosa,
P. linguiformis,
P. haydenii,
P. nebrascensis,
Anomia subtrigonalis,
Syncyclonema rigida,
Chlamys nebrascensis,
Gervillia subtortuosa,
Protocardia rara,
Lucina subundata,
Veniella subturnida,
Crassitella evansii,
Thetis circularis,
Eriphyla gregaria,
Callista pellucida,
Neaera moreauensis,
Corbulamella gregaria,
Corbula crassimarginata,
Callista deweyi,
Tellina cheyennensis,
Mactra gracilis,
Teredo selliformis,
Acma parva,
A. occidentalis,
Anisomyon alveolus,
A. patelliformis,
A. subovatus,
A. shumardii,
A. sexsulcatus,
A. borealis,
Haninea subcylindrica,
H. occidentalis,
Dentalium gracile,
Entalis paupercula,
Odontobasis ventricosa,
Fasciolaria cheyennensis,
F. flexicostata,
Anchura sublævis,
A. para,
A. nebrascensis,
Aporrhais biangulata,
Trachytriton vinculum,
Margarita nebrascensis,
Closteriscus tenuilineatus,
Margaritella flexisticata,
Vanikoro ambigua,
Pyrifusus intertextus,
Amauropsis puludiniformis,
Actæon attenuata,
Baculites ovatus,
B. compressus,
Ptychoceras mortonii,
Ancycloceras uncum,
Heteroceras cheyennense,
H. angulatum,
H. cochleatum,
H. mortonii,
H. tortum,
H. umbilicatum,
Placenticeras placenta,
Ammonites complexus,
Phylloceras hallii,
Scaphites nodosus, var. brevis,
S., var. quadangulatus,
S. nodosus, var. plenus,
Nautilus dekayii,
N. dekayi, var. montanensis.

Outline Classification of Fort Pierre Species.

MOLLUSCA.
- Pelecypoda.
  - Aviculidæ.
    - Avicula.
      - Avicula fibrosa.
    - Inoceramus.
      - Inoceramus cripsii.
      - Inoceramus incurvus.
      - Inoceramus sagensis.
      - Inoceramus altus.
  - Lucinidæ.
    - Lucina.
      - Lucina occidentalis.
- Gastropoda.
  - Aporrhaidæ.
    - Anchura.
      - ? Anchura sublævis.
- Cephalopoda.
  - Lytoceratidæ.
    - Baculites.
      - Baculites ovatus.
  - Stephanoceratidæ.
    - Scaphites.
      - Scaphites nodosus.
  - Turrilitidæ.
    - Heteroceras.
      - ? Heteroceras cochleatum.
      - ? Heteroceras angulatum.

Inoceramus cripsii, var. *barabina*, Morton. Plate CIX, fig. 2.

Inoceramus barabina Morton, 1854, Stn. Org. Rem. 62, pl. XVII, f. 3.
Inoceramus gibbus Tuomey, 1854, Proc. Acad. Nat. Sci. Phil., VII, 170.
Inoceramus cuneatus M. & H., 1860, ibid. 181.
Inoceramus cripsii, var. *barabina*, Meek, 1876, U. S. Geol. Surv. Terr., vol. IX, pp. 49, 50, pl. XIII, ff. 1a, b, c; and pl. XII, f. 3.

Meek's description: "Shell transversely ovate, moderately gibbous in the anterior and umbonal region and cuneate posteriorly, very nearly or quite equivalve, rather thin; anterior margin descending from the beaks, at first almost at right angles to the hinge, after which it gradually curves obliquely backward and downward, so as to pass by a graceful sweep into the base; posterior side long, compressed and rather regularly rounded; hinge long and straight, ventral margin forming a broad semiovate curve; beaks nearly terminal or located directly over the anterior margin, rather prominent, but rising little above the hinge, equal, oblique, somewhat incurved, and nearly contiguous. Surface ornamented with moderately distinct, more or less regular concentric undulations. Length of a large, rather long specimen, three and ninety-hundredths inches; height, two and seventy-five hundredths inches; convexity of both valves, two inches."

In the summer of 1896, I collected some casts of young individuals of this species from shale thrown from a well a few miles north of Atwood, in Rawlins county. There are also some adult forms in the University collection, which were col-

lected by West and labeled *Inoceramus cuneatus*, following Meek and Hayden's classification. (See reference above.) The specimens collected by West were from the Fort Pierre shales near Wallace, on the Nork Fork of the Smoky Hill river.

Inoceramus incurvus M. & H.

Inoceramus incurvus M. & H., 1876, U. S. Geol. Surv. Terr., vol. IX, p. 61, pl. XII, ff. 4a, b.

Meek's description: "Shell subglobose, oval or ovate cardiform, very gibbous, nearly or quite equivalve; beaks oblique, placed a little back of the anterior side, strongly incurved; umbonal elevated above the hinge and points of the beaks and very ventricose in both valves. Surface ornamented by concentric undulations, which become sharply elevated over the most prominent portions of the umbones, but are less distinct or nearly obsolete toward the base and extremities of the shell.

"Judging from the curve of the undulations near the beaks, young individuals of this species must have been nearly ovate in form, the posterior side being broader than the other. At this stage of its growth, the shell seems to have been much less convex, and the beaks more nearly terminal; but as it advanced in age it became rapidly more ventricose and extended somewhat in front of the beaks. The surface was probably marked by lines of growth, but, owing to the exfoliation of the external fibrous layer, they are not preserved on our specimens, none of which are in a condition to give a very clear idea of its general form. The peculiar and equally incurved character of the beaks, together with the ventricose, elevated umbonal region and sharply prominent undulations, when taken together, will serve to distinguish it from any other species known from these rocks."

A rather incomplete cast of what is evidently a young individual occurring associated with *I. cripsii*, I somewhat doubtfully refer to this species. The specimen was collected from Fort Pierre shales, a few miles northwest of Atwood, in Rawlins county. Fragments of nodules containing similar casts were found in the shale thrown from a well a few miles west of this locality.

Inoceramus sagensis, var. *nebrascensis* Owen. Plate CIX, fig. 2.

Inoceramus nebrascensis Owen, 1852, Rep. Minn., Iowa, and Wis., 582, pl. VIII, f. 1.

Inoceramus sagensis Owen, 1852, ibid., pl. VII, f. 3.

Inoceramus sagensis, var. *nebrascensis*, Meek, 1876, U. S. Geol. Surv. Terr., pl. XIII, ff. 2a, b.

Description: "Shell large, obliquely broad ovate or subcircular, moderately gibbous, about as high as long; anterior side short, making a very broad oblique curve from the beaks to the base; ventral and postero-ventral margins nearly regularly rounded; hinge rather short, forming an angle of about fifty degrees with the axis of the umbones; beaks moderately convex, rising little above the hinge, oblique, scarcely incurved, located about one-fifth the horizontal diameter (length) of the shell behind the anterior border. Surface ornamented by regular, distinct, concentric undulations. Length, about five and seventy-hundredths inches; height, five and sixty-hundredths inches. These measurements are taken from a medium-sized specimen."

After a comparison of specimens Meek concludes that *Inoceramus nebrascensis* Owen is but a variety of *Inoceramus sagensis* Owen. The specimen in the University collection was collected by Prof. B. F. Mudge, from the Butte creek Fort Pierre shales, and is a smaller specimen than that described by Meek.

Inoceramus altus Meek. Plate CVII, fig. 1.

Inoceramus altus Meek, 1878, Hayden's Rep. Geol. Surv. Terr., 302; 1876, U. S. Geol. Surv. Terr., vol. IX, pl. XIV, ff. 1a, b.

Meek's description: "Shell attaining a medium size, vertically or a little obliquely subovate, being in the adult higher than long, and widening from the hinge downward, moderately convex, equivalve, very inequilateral; hinge very short and ranging nearly at right angles to the longer axis in the adult, but a little more oblique in young shells; anterior side straight, long, and truncated vertically, or nearly at right angles to the hinge, immediately in front of the beaks; base regularly rounded; posterior outline forming a broad, somewhat oblique, gentle curve from the posterior end of the hinge into the base;

beaks nearly or quite equal, rising little above the hinge line, pointed, obliquely incurved, and placed immediately over the anterior margin. Surface of cast showing more or less regular, rather obscure, concentric undulations, and faint tracing of radiating markings; the latter probably not being defined on the exterior. Height, about six and fifty-hundredths inches; length, about four and ninety-hundredths inches; convexity, two and seventy-hundredths inches; length of hinge, about two and forty-hundredths inches."

A specimen of this species was collected from the Fort Pierre shales, a few miles from Atwood, in Rawlins county. The species is not abundant in the Kansas area.

Lucina occidentalis Morton. Plate CVII, fig. 3.

Tellina occidentalis Morton, 1842, Journ. Acad. Nat. Sci. Phil., VIII, p. 210, pl. XI, f. 3.

Mould of lucina Owen, 1852, Rep. Geol. Surv. Wis., Iowa, and Minn., tab. VII, f. 8.

Lucina occidentalis ? M. & H., 1856, Proc. Acad. Nat. Sci. Phil., VIII, 272.

Lucina occidentalis Meek, 1876, U. S. Geol. Surv. Terr., vol. IX, pl. XVII, ff. 4a, b, c, d.

Meek's description: "Shell transversely broad oval, rather thick, moderately convex; anterior side broadly rounded; basal border semiovate in outline, the most prominent part being toward the front; posterior side narrower, and subtruncated at the extremity, usually having a nearly obsolete flattening, extending from the beaks above the umbonal slopes obliquely backward and downward to the posterior extremity; dorsal border nearly straight, or faintly sinuous, and declining very slightly in front of the beaks, convex, and more obliquely sloping behind; beaks depressed, small, and nearly central; lunule lanceolate, small, and shallow, or somewhat excavated. Surface ornamented by very distinct, rather regular, concentric lines; exfoliated specimens also showing obscure, radiating marks on the inner laminæ.

"Length of a large specimen, one and eighty-five hundredths inches; height, one and fifty-eight hundredths inches; convexity, ninety-three hundredths inch. The hinge of this species shows the two cardinal teeth to be rather small in the

right valve, the posterior one being a little larger than the other, and faintly emarginate at the extremity. Between these two teeth there is a little larger pit, and further back a smaller one for the reception of the two cardinal teeth under the beak of the left valve. Each valve has one small, obtuse, anterior lateral tooth, situated some distance in advance of the beaks, with apparently very faint traces of a remote posterior lateral in one or both valves. The posterior muscular impression is shallow, subquadrate in form, and usually bounded in front by a faint linear ridge, extending obliquely up toward the beaks. The upper part of the anterior muscular impression has the same form, while its prolonged portion below is slender, a little arcuate, rather long, and directed obliquely downward toward the middle of the basal margin. Just above this impression of the anterior adductor, the small, oval scar of the pedal muscle is seen quite detached from it."

In the summer of 1896 I collected a large number of this species from an outcrop of Fort Pierre shales in Cherry creek cañon, in Cheyenne county, a few miles west of Jackson's ranch. Aviculæ and Ostreæ were found associated with them. The horizon in which they occur is probably near the upper horizon of the Fort Pierre formation. They have not been found in the lower beds of the North Fork of the Smoky Hill river or on Butte creek.

? Anchura sublævis M. & H.

Aporrhais sublævis M. & H., 1860, Proc. Acad. Nat. Sci. Phil., XII, 178.
Aporrhais sublevata (misprint) M. & H., 1860, ibid., 428.
? Anchura sublævis Meek, 1864, Smiths. Check-List, N. Am. Cret. Foss., 19; Meek and Hayden, 1876, U. S. Geol. Surv. Terr., vol. IX, pl. XIX, ff. 3a, b.

Description: "Shell unequally fusiform; spire elevated; volutions seven or more, convex, and separated by a rather distinct, though not deep suture, last one convex above and abruptly contracted below, with a single, small, revolving angle, which passes, around to the suture, but is not visible on the succeeding turns of the spire; surface polished, and marked by moderately distinct arcuate lines of growth, which are crossed by rather obscure revolving lines, nearly equaling the spaces between on the spire, but more distant, with sometimes a few

indistinct, irregular, very fine, parallel striæ between on the body whorl; aperture and lip unknown.

"Length, about fifty-four hundredths inch; breadth of body whorl, twenty-six hundredths inch; apical angle, slightly convex; divergence, thirty-seven degrees."

In Meek's type specimen the lip and apex are wanting; in those collected by the writer the spire is entire but the lip is wanting. The spire is much as he restored it, but consists of two more whorls than is represented in his specimen. I collected a few imperfect specimens of this species a few miles west of Jackson's ranch, in Cherry Creek cañon, in Cheyenne county. They were found associated with *Lucina occidentalis*, and probably occur near the upper limit of the Fort Pierre.

Baculites ovatus Say. Plate CIX, fig. 3.

Baculites ovatus Say, 1821, Silliman's Am. Journ. Sci., Phil., VI, 196, pl. v, ff. 5, 6; and 1830, Am. Journ. Sci. and Arts, XVIII, 248, pl. I, ff. 6, 7, 8; also 1834, Syn. Org. Rem. Cret. Group U. S., 42, pl. v, ff. 5, 6, Hall and Meek, 1854, Mem. Am. Acad. Arts and Sci., V (n. s.), 399, pl. v, ff. 1a, b, pl. VI, ff. 1–7; Meek, 1876, Geol. Surv. Terr., pl. XX, ff. 1a, b, and 2a, b, d.

Baculites baculus M. & H., 1861, Proc. Acad. Nat. Sci. Phil., XXII, 442.

Meek's description: "Shell attaining a large size, elongated, and rather gradually tapering; section ovate, the antisiphonal side being more broadly rounded than the opposite; aperture of the same form as the transverse section; extension of the lip on the siphonal side long, tapering, and narrowly rounded at the end; lateral sinuses of the same depth and about half to one-third the greater diameter of the shell; antisiphonal margin of the lip prominently rounded in outline; surface of young and medium-sized specimen generally nearly smooth, while the non-septate part of the adult shell is provided with broad, undefined, obliquely transverse ridges or undulations that are parallel to the obscure lines of growth, and become nearly or quite obsolete as they approach the siphonal side, on which they are rarely represented by very small irregular ridges, scarcely distinct from the marks of growth.

"Septa moderately closely arranged, or sometimes a little crowded; siphonal lobe nearly twice as wide as long, and provided with two large terminals widely separating more or less

spreading branches, each of which has sometimes three and sometimes two nearly equal, digitate branchlets at the end, and two or three similar ones on the other side; first lateral sinus about as wide as long, but narrower than the siphonal lobe and divided at the free end into two short, nearly equal free branches, each of which is again less deeply subdivided into about two or three or four sinuous, spreading and digitate branchlets; first lateral lobe oblong ovate, being longer and narrower than the siphonal lobe, and deeply divided at its end into two very nearly equal branches, with each from four to five spreading and digitate subdivisions, in part so arranged as to give the main branches a tripartite appearance at their extremities; second lateral sinus of nearly the same size as the first, and, excepting in unimportant details, similarly branched and subdivided; second lateral lobe broader and shorter than the first, and bearing two large, equal, tripartite, sinuous and digitate terminal branches, and small digitate and simple lateral branches; third lateral sinus much smaller than either of the others, with two unequal, short, dentate terminal divisions, and a few irregular, short, smaller spurs; dorsal or antisiphonal lobe (ventral lobe of d'Orbigny and others) scarcely as large as three or four small lateral branches, and normally a trifid free extremity."

No complete specimens of *Baculites ovatus* have been collected from the Kansas Fort Pierre area. In the summer of 1896 I collected several large fragments of the shell from Devil's Cañon of the South Fork of the Republican, in Cheyenne county. The longest of these fragments measured fifteen inches in length. It is the most common form in the Arickaree shales, where it occurs free. Other specimens of this species now in the University collection were obtained by Williston from the Fort Pierre formation on the North Fork of the Smoky Hill river, near McAllaster. The interior of many of these specimens is filled with beautiful crystals of barite. These latter specimens were from the large mass discovered many years previously by Prof. B. F. Mudge, and to which the letter from Meek refers, as quoted on page 20 of this volume.

Scaphites nodosus, var. *brevis* Meek. Plate CVIII, fig. 3.

Scaphites (*Ammonites?*) *nodosus* Owen, 1852, Rep. Geol. Surv. Iowa, Wis., and Minn., 580, tab. VIII, f. 4; Meek and Hayden, 1860, Proc. Acad. Nat. Sci. Phil., XII, 420; Gabb, 1861, Syn. Cret. Fauna, 32; Meek, 1864, Smiths. Check-List N. Am. Cret. Foss., 28.

Scaphites nodosus, var. *brevis* Meek, 1876, U. S. Geol. Surv. Terr., vol. IX, pp. 426, 427, pl. XXV, ff. 1a, b, c.

Description: "Shell longitudinally oval, moderately convex; volutions generally higher than convex, inner ones forming a considerable portion of the entire bulk; deflected or body portions high, moderately; but short and only becoming a little free at the aperture, periphery rounded throughout; umbilicus small; aperture oval subquadrate, being higher than wide, and more or less sinuous on the inner side; surface ornamented by small, bifurcating costæ, that are somewhat flexuous on the sides, but becoming even and nearly straight on the periphery; each side of body portion also bearing near the periphery a row of rather prominent, subquadrangular nodes, and a few smaller ones about one-third the height from the umbilicus.

"Septa divided into rather deep lobes, and sinuous; siphonal lobe longer than wide, nearly oblong in form, and provided on each side with two principal slender branches, the two terminal of which are parallel, longer than the others, and each subdivided into two unequal, variously sinuous and subdivided branchlets; first lateral lobe narrower and shorter than the siphonal lobe, and provided with two nearly equal bifid and sharply digitate terminal branches, and on each side with one smaller, nearly simple, lateral division; second lateral lobe not more than half as long and wide as the first, but very similarly branched; third lateral sinus much smaller than the second, and divided at the end into two equal, slightly sinuate terminal branches, with some small, obtuse, lateral projections; third lateral lobe not longer than one of the terminal branches of the second, and trifid at the end, the division being very small and nearly or quite simple. Farther in there is a minute simple projection, that probably represents the minute fourth lobe in some of the other varieties."

A fragment of a specimen belonging to this species was collected from the upper Fort Pierre shales of Devil's Cañon, in Cheyenne county. It was found associated with *Baculites ovatus*, which occur free in the shales.

? Heteroceras cochleatum M. & H. Plate CVII, fig. 2.

Turrilites (*Helicoceras*) *cochleatus* M. & H., 1858, Proc. Acad. Nat. Sci. Phil., x, 55.

Helicoceras cochleatum Meek, 1864, Smiths. Check-List, N. Am. Cret. Foss., 25.

? Heteroceras cochleatum Meek, 1876, U. S. Geol. Surv., vol. IX, pp. 477, 478, 479, pl. XXII, ff. 2a, b.

Description: "Shell sinistral, very thin, and composed of rounded nearly or quite contiguous whorls, which gradually increase in size from the smaller to the larger extremity; umbilicus slightly wider than the largest whorl: surface ornamented by numerous rather regular bifurcating annular costæ, which first pass obliquely backward and outward from the umbilicus above, then curve so as to cross the ventral or outer side obliquely downward and forward; but on reaching the under side, they curve backward as they reach the umbilicus. There are also two rows of irregular obscure, flattened, or depressed oval nodes, one of which rows passes around nearly over the siphuncle, which is located near the middle of the outer side of the whorls, while the other is placed less than one-fifth the circumference of the whorl lower.

"The septa are distant, and divided into complex lobes and sinuses, which are a little unsymmetrical in their subordinate details, but of about the same size and general form on opposite sides of the siphuncle. The siphonal lobe is comparatively small, and ornamented at the extremity by four small branches, the two terminal of which are a little larger than the others, slightly dissimilar, and each provided with five or six unequal, sharp digitations; the other two branches are not exactly opposite, differ slightly in form, and are each armed with from three to five or six unequal, sharp digitations; the other two branches are not exactly opposite, differ slightly in form, and are each armed with from three to five or six

unequal serrations; in advance of these principal terminal divisions, there are, along the sides of the lobe, a few very small, alternating, subordinate, lateral branchlets and sinuosities. The first lateral sinus is small, very oblique, much contracted at base, and divided at the extremity into two unequal, variously subdivided, sinuous branches. The first lateral lobe is much larger than the first siphonal one, and very deeply divided into two great, spreading subequal branches, the larger of which is on the ventral side, and unequally subdivided into three bifurcating branchlets, the two terminal of which are much larger than the others, and more or less digitate, while the other main branch has two bifurcating branchlets, with many smaller digitations and sinuosities. The second lateral sinus is not so oblique, but in other respects very similar to the first; while the second lateral lobe is smaller than the first, and very much like it in its mode of branching.

"The largest and best specimen of this species that has been found consists of a little more than half of one volution, the greatest transverse breadth of which is two and thirty-four hundredths inches; diameter at larger end (which is a little oval), seventy-three hundredths by sixty-four hundredths inch; breadth of umbilical space, eighty-five hundredths inch. In form and other external characters, even fragments of this shell will be at once distinguished from *H. mortonii* by its shorter curve and proportionally thicker whorls, which also differ in being nearly or quite in contact. Its costæ are also smaller in proportion to the diameter of the whorls, and more regular."

The determination of this species as belonging to the Fort Pierre fauna of Kansas is based upon a single fragment imbedded in a hard, nodular mass of stone. The specimen was collected from the lower Fort Pierre shales of Butte creek, and is associated with *I. altus*.

? ***Heteroceras angulatum*** M. & H. Plate CVIII, fig. 2.

Helicoceras angulatum M. & H., 1860, Proc. Acad. Nat. Sci. Phil., XII, p. 176.
? *Heteroceras angulatum* Meek, 1876, U. S. Geol. Surv. Terr., vol. IX, p. 485, pl. XXI, ff. 3a, b, c; 1864, Smiths. Check List N. Am. Cret. Foss., 25.

Description: "Of this shell we have a single non-septate fragment, two and seventy-eight hundredths inches in length, with a diameter of one and fifty-hundredths inches at the large end, and one and thirty-seven hundredths inches at the smaller extremity. It is rounded or subcylindrical, and makes a broad (dextral?) curved spiral, in such a manner that, if continued around, the volutions would be disconnected and encircle an umbilical cavity apparently more than three times their own breadth. The surface is ornamented by distinct angular costæ, which pass around the whorls obliquely, where they sometimes bifurcate. I have not yet seen the septa of this species, but its large size and very broad curve will distinguish it from any other known species of this type in these rocks, excepting the last (*H. cochleatum*), from which it differs in having angular instead of rounded costæ and in being coiled in the opposite direction. Its angular costæ will equally distinguish it from any of the others, even should they be found attaining as large a size, and in such short fragments as not to show the exact nature of the curve. Like the last, it is only referred provisionally to this genus upon the supposition that it belongs to the deflected part of the body of the shell."

The specimen in the University collection is a small, non-septate fragment, having a length of about fifty mm., its circumference, at the larger end, being thirty-three mm. and at the smaller end, twenty-six mm. The specimen was collected by Mr. George Cooper from Wallace county, probably from the Fort Pierre shales on the North Fork of the Smoky Hill river, near McAllaster.

EXPLANATION OF PLATES.

(Pages 519 to 583.)

PLATE LXXXVI.—*Placenticeras placenta* Dekay ?. Fig. 1, septum of inner volution, magnified; figs. 2, 3, two views of small specimen.
Serpula tenuicarinata M. & H. Fig. 4, copy of White's figure.
Modiola (*Brachydontes*) *multilinigera* Meek. Fig. 5, left valve (after White).
Avicula gastrodes Meek. Figs. 8, 9, two left valves (after Stanton).

PLATE LXXXVII.—*Inoceramus fragilis* H. & M. Fig. 1, right valve of one of Whitfield's types of *I. perplexus;* fig. 2, a large right valve (after Meek); figs. 3, 4, two views of *I. howellii* (after White); fig. 5, a large example (after Stanton).

PLATE LXXXVIII.—*Inoceramus exogyroides* M. & H. Figs. 1, 2, two views of left valve, cast (after Meek).

PLATE LXXXIX.—*Inoceramus umbonatus* M. & H. Fig. 1, dorsal view of cast of left valve (after Meek); fig. 2, anterior view (after Meek).

PLATE XC.—*Inoceramus flaccidus* White. Fig. 1, left valve (after White).

PLATE XCI.—*Ostrea lugubris* Conrad. Fig. 1, small lower valve (after Conrad); figs. 2 to 10, other views (after Stanton).

PLATE XCII.—*Inoceramus deformis* Meek. Fig. 2, anterior view of small specimen (after Stanton).
Inoceramus gilberti White. Figs. 1, 3, two views of left valve (after White).
Inoceramus labiatus Schloth. Fig. 4, small right valve (after Stanton).
Mactra emmonsi Meek. Fig. 11, cast of left valve (after Stanton).

PLATE XCIII.—*Haploscapha eccentrica* Conrad. Fig. 1, interior view of valve; fig. 2, exterior view of same (after Meek).

PLATE XCIV.—*Haploscapha grandis* Conrad. Figs. 1, 4, interior views of valve (after Meek); figs. 2, 3, views of hinge.

PLATE XCV.—*Inoceramus undabundus* M. & H. Figs. 1, 2, two views of left valve (after Meek).
Inoceramus tenuirostratus M. & H. Figs. 3, 4, two views of type specimen (after Meek).

PLATE XCVI.—*Inoceramus deformis* Meek. Fig. 1, view of small specimen (after Stanton); fig. 2, a large right valve (after Meek).
Mactra emmonsi Meek. Figs. 3, 4, two views of a large left valve.

PLATE XCVII.—*Inoceramus simpsonii* Meek. Fig. 1, right valve of type specimen.

PLATE XCVIII.—*Donax cuneata* Stanton. Fig. 1, cast of right valve.
Donax oblonga Stanton. Fig. 2, cast of a large left valve.
Exogyra columbella Meek. Figs. 3, 7, views of lower valve; fig. 8, view of both valves united (after White).
Inoceramus labiatus Schloth. Fig. 4, right valve (after Meek).
Inoceramus dimidius White. Figs. 5, 6, views of both valves.
Pholadomya papyracea M. & H. Fig. 11, left valve of type specimen (after Meek).
Pholadomya coloradoensis Stanton. Fig. 12, left valve of type specimen.
Parapholas sphenoideus White. Fig. 10, view of type specimen.

PLATE XCIX.—*Turritella whitei* Stanton. Figs. 1, 2, 3, 4, 5, views of type specimen.
? Pharella pealei Meek. Figs. 6, 7, two views of type specimen (after White).
Callista (Aphrodina?) tenuis M. & H. Figs. 8, 9, two views of type (after Meek).
Ostrea congesta Conrad. Figs. 10, 11, 13, views of upper and lower valves (after Meek).
Parapholas sphenoideus White. Fig. 12, another view.

PLATE C.—*Serpula intrica* White. Fig 1, type specimen.
Rostellites ambigua Stanton. Figs. 2, 4, 5, views of type specimen.
Pyropsis coloradoensis Stanton. Figs. 6, 7, 8, views of type.
? Helicoceras corrugatum Stanton. Fig., basal view of type.

PLATE CI.—*? Prionocylus macombi* Meek. Figs. 1, 2, side view of small specimen (after Stanton); fig. 3, septum, magnified; figs. 4, 5, two views of type (after Meek).

PLATE CII.—*Prionotropis woolgari* Mantell. Figs. 1, 2, two views of small specimen (after Meek); fig. 3, view of fragment of large specimen (after Meek); fig. 4, septum, magnified.
Prionotropis hyattii Stanton. Figs. 5, 6, two views of type; fig. 7, side view; fig. 8, septum of small specimen, magnified.

PLATE CIII.—*Mortoniceras shoshonense* Meek. Figs. 1, 2, two views of type specimen.
Prionotropis lœvianus White. Fig. 3, portion of septum of type (after Stanton); fig. 4, side view of type.

PLATE CIV.—*Mortoniceras vermilionense* M. & H. Fig. 1, side view of type (after Meek).
Scaphites larvœformis M. & H. Fig. 2, side view of type (after Meek).
Scaphites vermiformis M. & H. Fig. 3, side view of type (after Meek).

Scaphites warrenii M. & H. Fig. 4, side view of type (after Meek); fig. 5, side view of specimen referred to *S. wyomingensis* (after Whitfield); fig. 6, side view of another specimen (after Whitfield); fig. 7, septum of a large specimen (after Whitfield).

Scaphites ventricosus M. & H. Fig. 8, septum, magnified (after Meek); fig. 9, side view of inner volutions (after Meek); fig. 10, side view of another specimen (after Stanton).

PLATE CV.—*Scaphites ventricosus* M. & H. Fig. 1, view of large specimen (after Meek).

Scaphites mullananus M. & H. Fig. 2, septum, magnified (after Meek); figs. 3, 4, two views of type (after Meek).

PLATE CVI.—*Prionocyclus wyomingensis* Meek. Fig. 1, septum of type (after Stanton); figs. 2, 3, 4, views of type specimen.

PLATE CVII.—*Inoceramus altus* Meek. Fig. 1, view of type.

? Heteroceras cochleatum M. & H. Fig. 2, view of type (after Meek).

Lucina occidentalis Morton. Fig. 3, view of specimen (after Meek).

? Acanthoceras kanabense Stanton. Fig. 4, side view of specimen, enlarged; fig. 5, septum, enlarged; fig. 6, view of large specimen.

Avicula gastrodes Meek. Fig. 7, large left valve (after Stanton).

PLATE CVIII.—Fig. 1, *Scaphites conradii*, side view (after Meek); fig. 2, *Heteroceras angulatum*, view of type (after Meek); fig. 3, *Scaphites nodosus*, var. *brevis*, side view (after Meek).

PLATE CIX.—Fig. 1, *Inoceramus sagensis*, var. *nebrascensis*, side view of type (after Meek); fig. 2, *Inoceramus cripsii*, var. *barabina*, side view of type (after Meek); fig. 3, *Baculites ovatus*, transverse section of shell (after Meek).

PLATE CX.—*Tusoteuthis longus*, n. sp. Fig. 1, view of type specimen.

Belemnitella baculus, n. sp. Fig. 2, view of type.

Squama spissa Logan. Fig. 3, view of type; fig. 5, view of plates.

Squama lata Logan. Fig. 4, view of type.

PLATE CXI.—*Stramentum haworthii* Williston, figure of type specimen, enlarged.

PLATE CXII.—*Uintacrinus socialis* Grinnell, portion of large slab in the University museum.

PLATE CXIII.—*Uintacrinus socialis* Grinnell.

PLATE CXIV.—*Inoceramus truncatus*, n. sp., type specimen.

PLATE CXV.—*Radiolites maximus*, n. sp., interior view of three young specimens.

PLATE CXVI—Fig. 1, *Inoceramus concentricus*, n. sp., fragments of large valve.

Fig. 2: Large figure, *Haploscapha niobrarensis*, n. sp.; left-hand lower figure, *Inoceramus platinus;* middle figure, *Serpula plana;* right figure, *Inoceramus subconvexus.*

PLATE CXVII.—*Ostrea anceps*, n. sp., interior view of type.

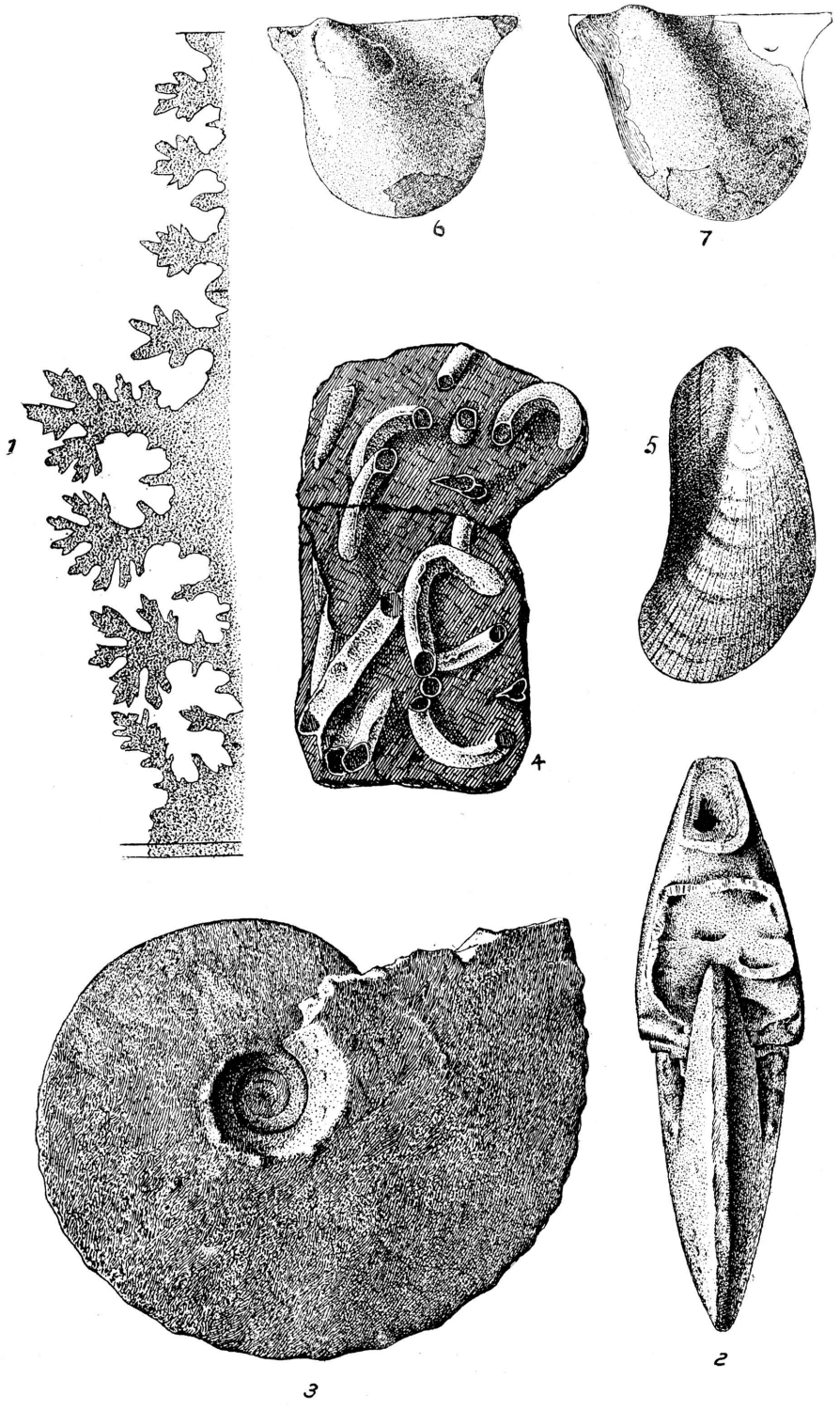
PLATE CXVIII.—Fig. 1, *Inoceramus subconvexus*, n. sp., exterior view of both valves.

Fig. 2, *Inoceramus pennatus*, n. sp., interior view of one valve.

PLATE CXIX.—Fig. 1, *Radiolites maximus*, n. sp., fragment of large specimen.

Fig. 2. *Serpula plana.*

PLATE CXX.—Fig. 1, *Inoceramus triangulatus;* fig. 2, *Inoceramus pennatus*, n. sp.; fig. 3, *Rostellites willistonii*, enlarged.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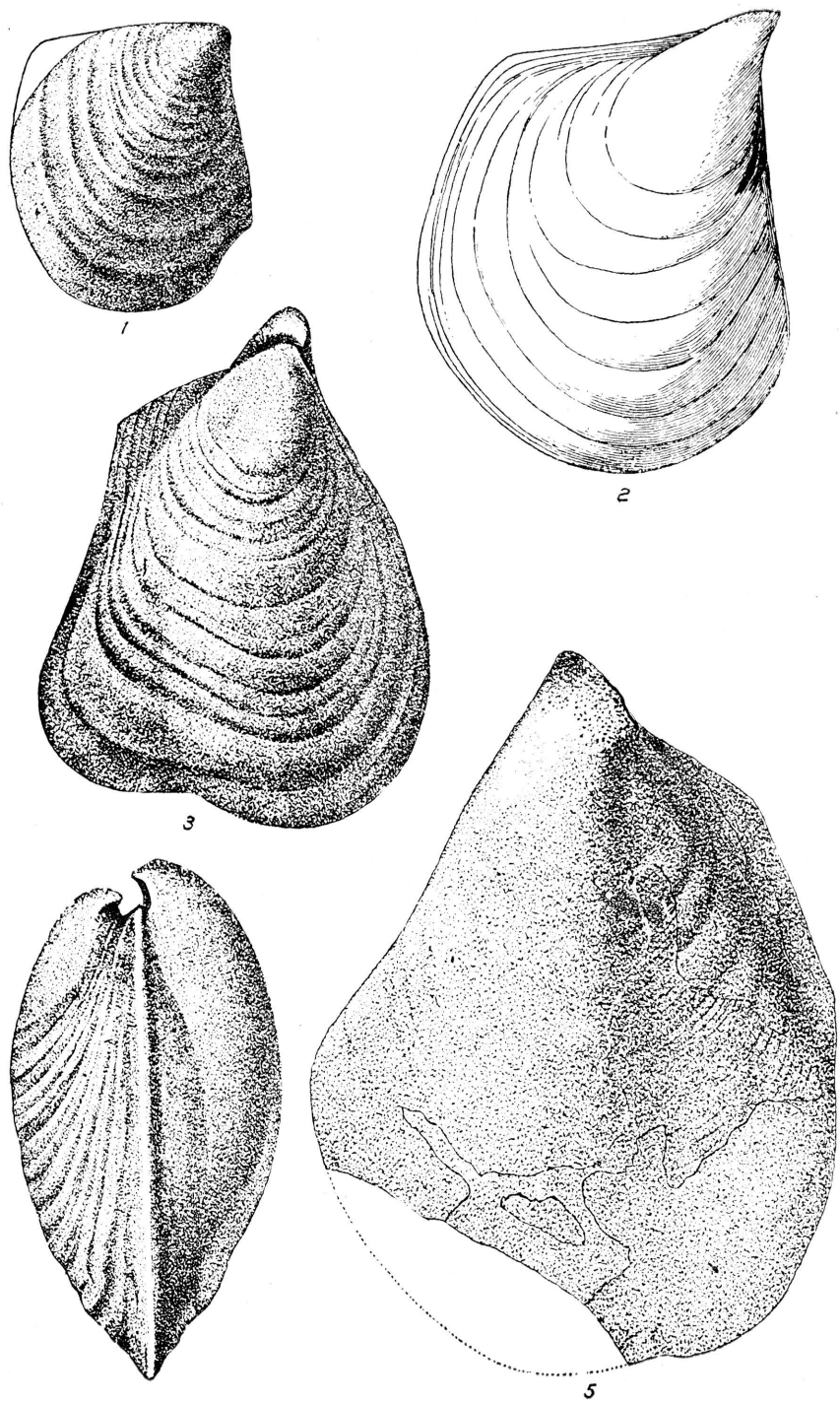
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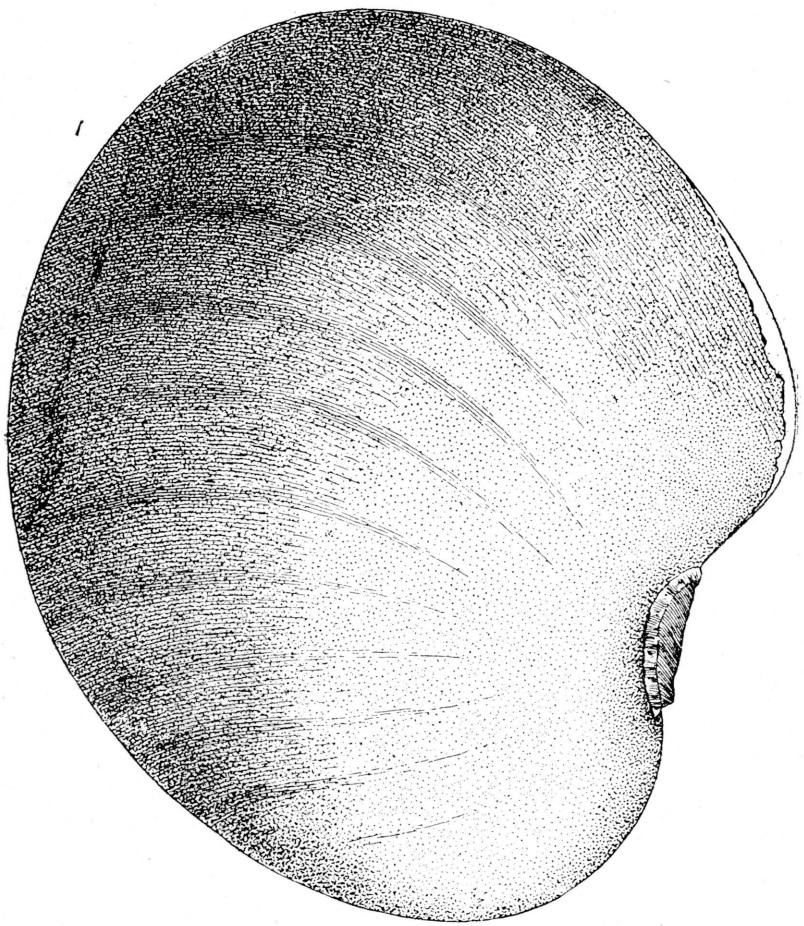

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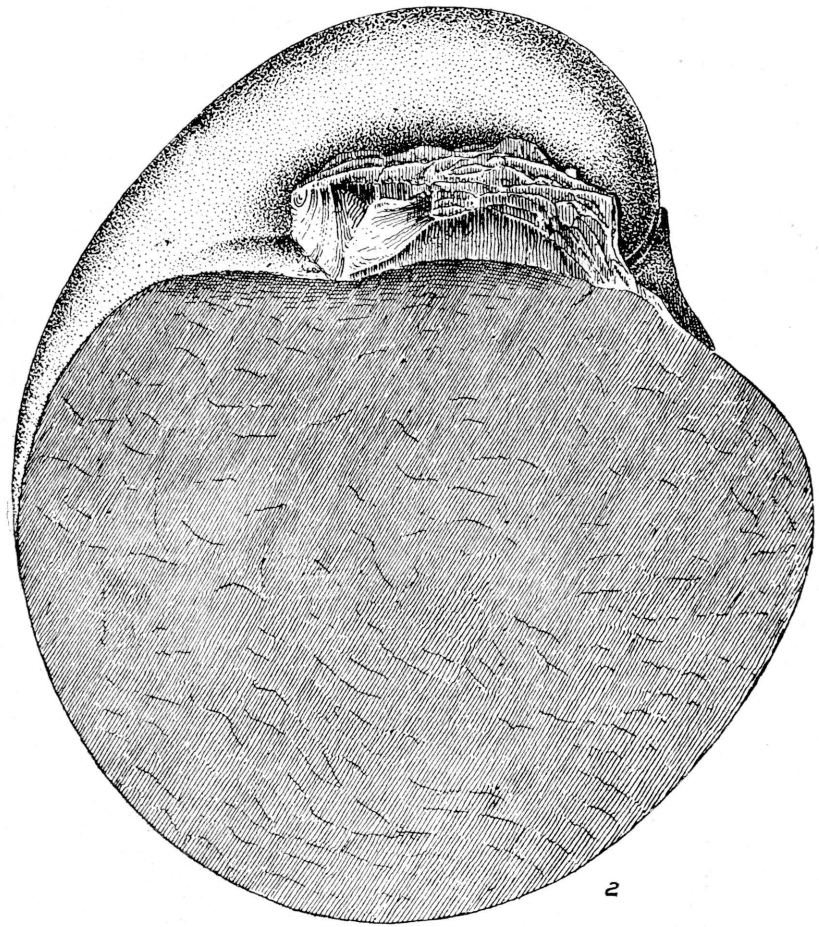

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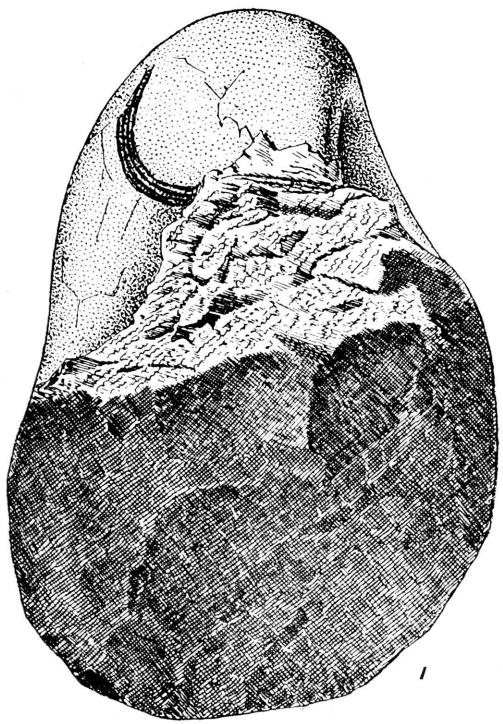

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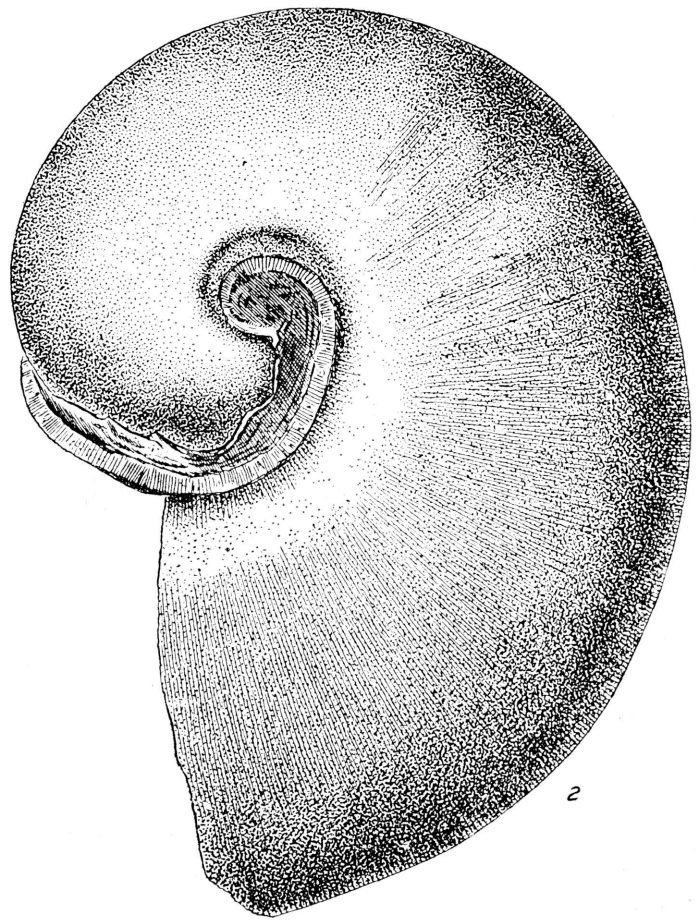

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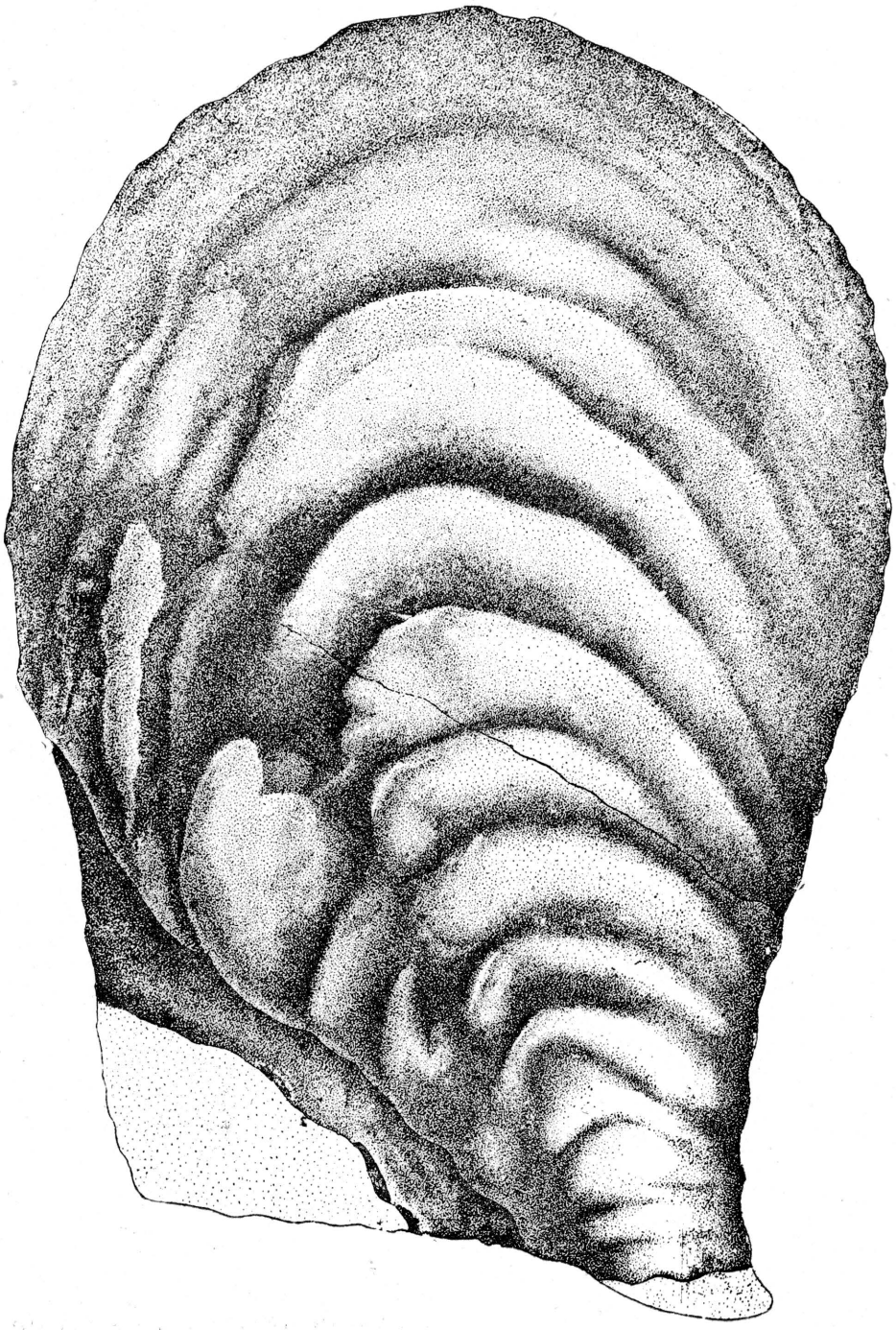

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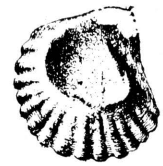

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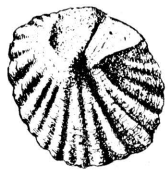

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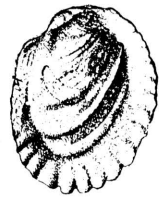

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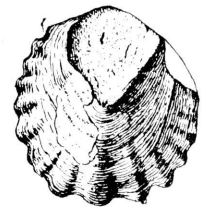

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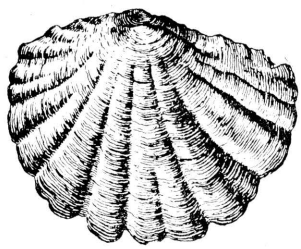

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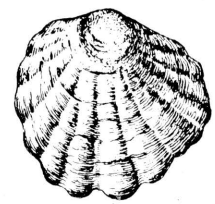

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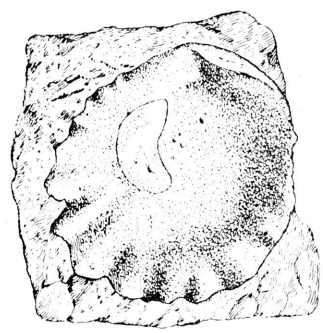

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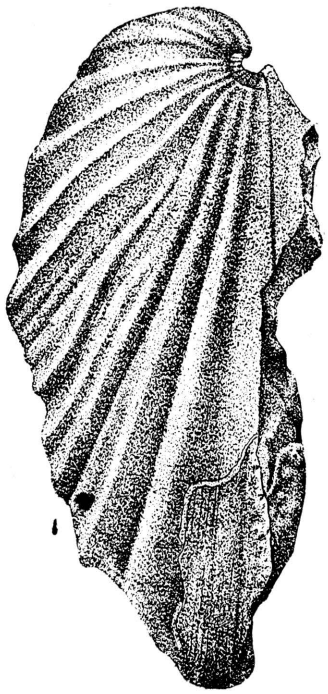
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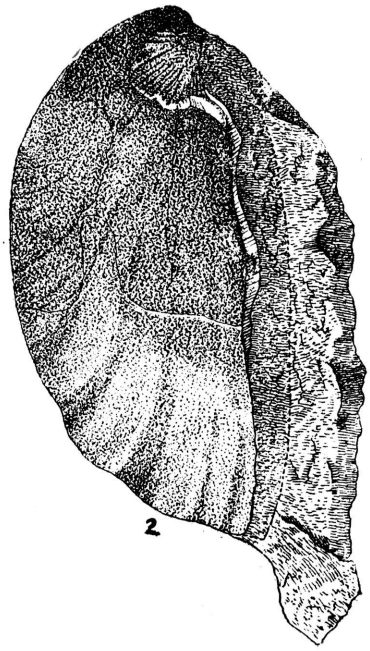
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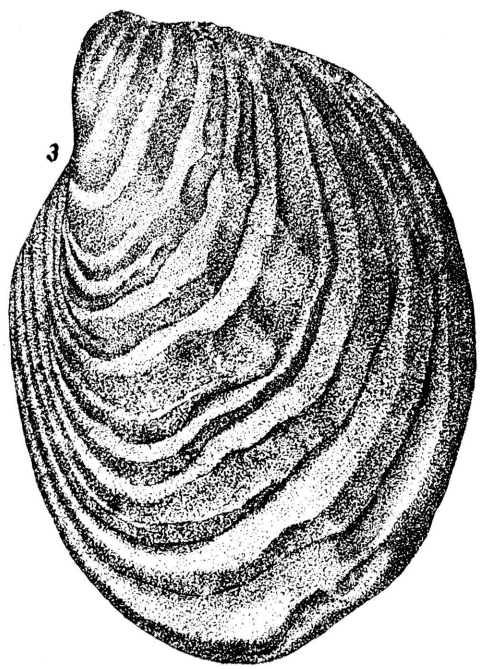
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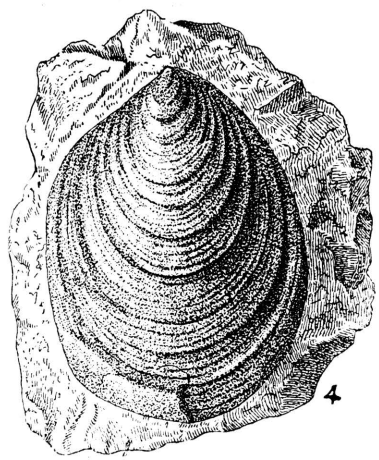
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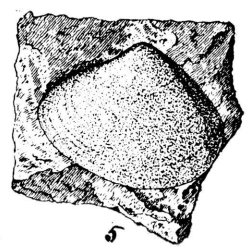
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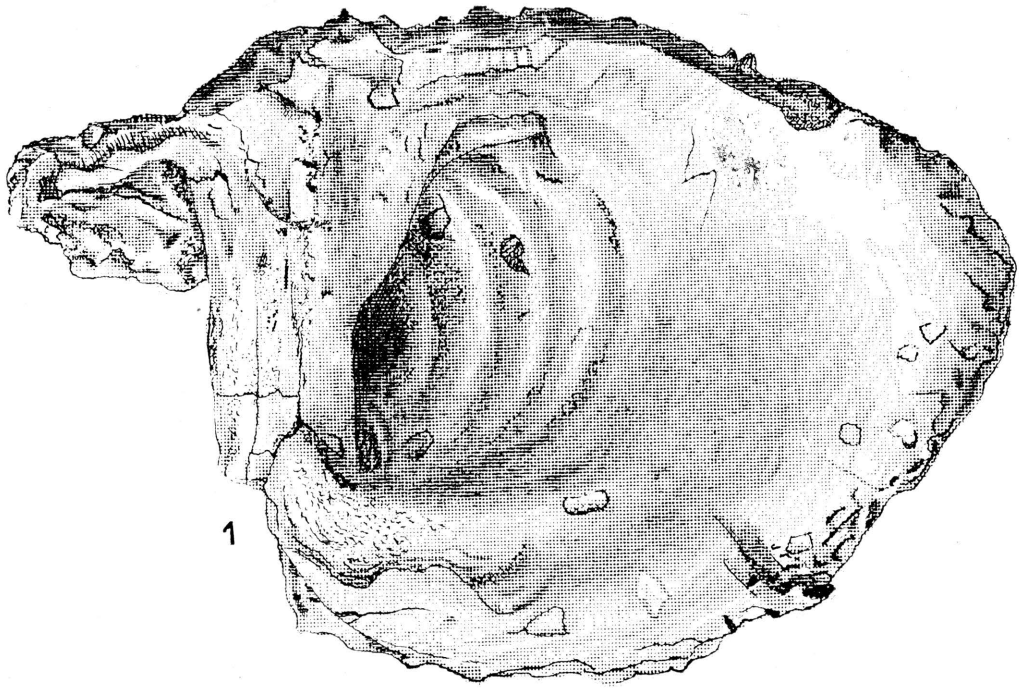
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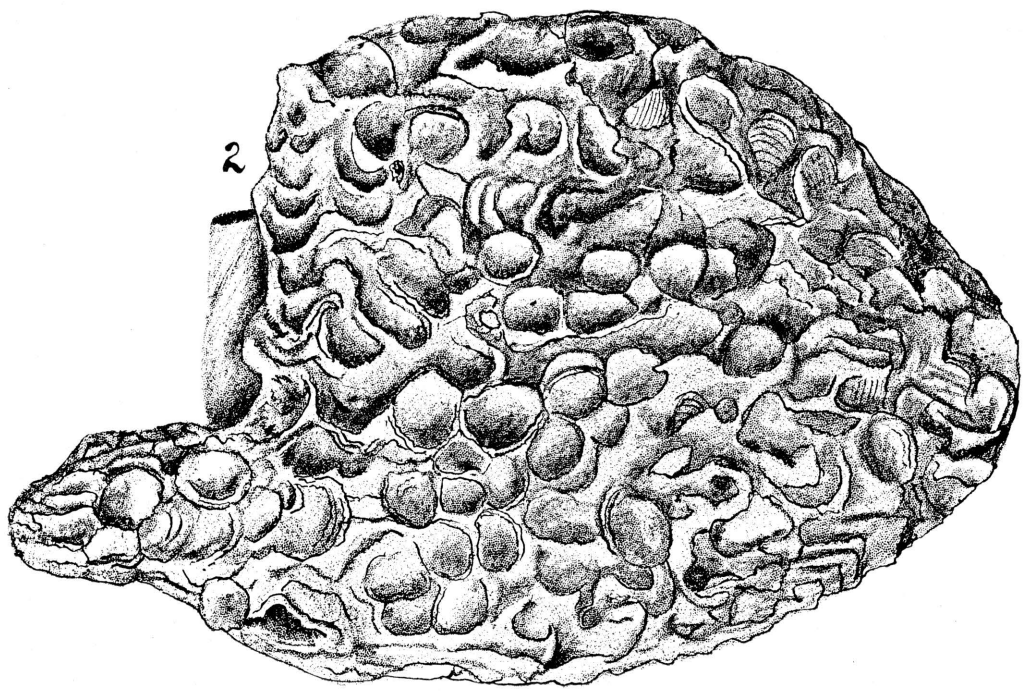
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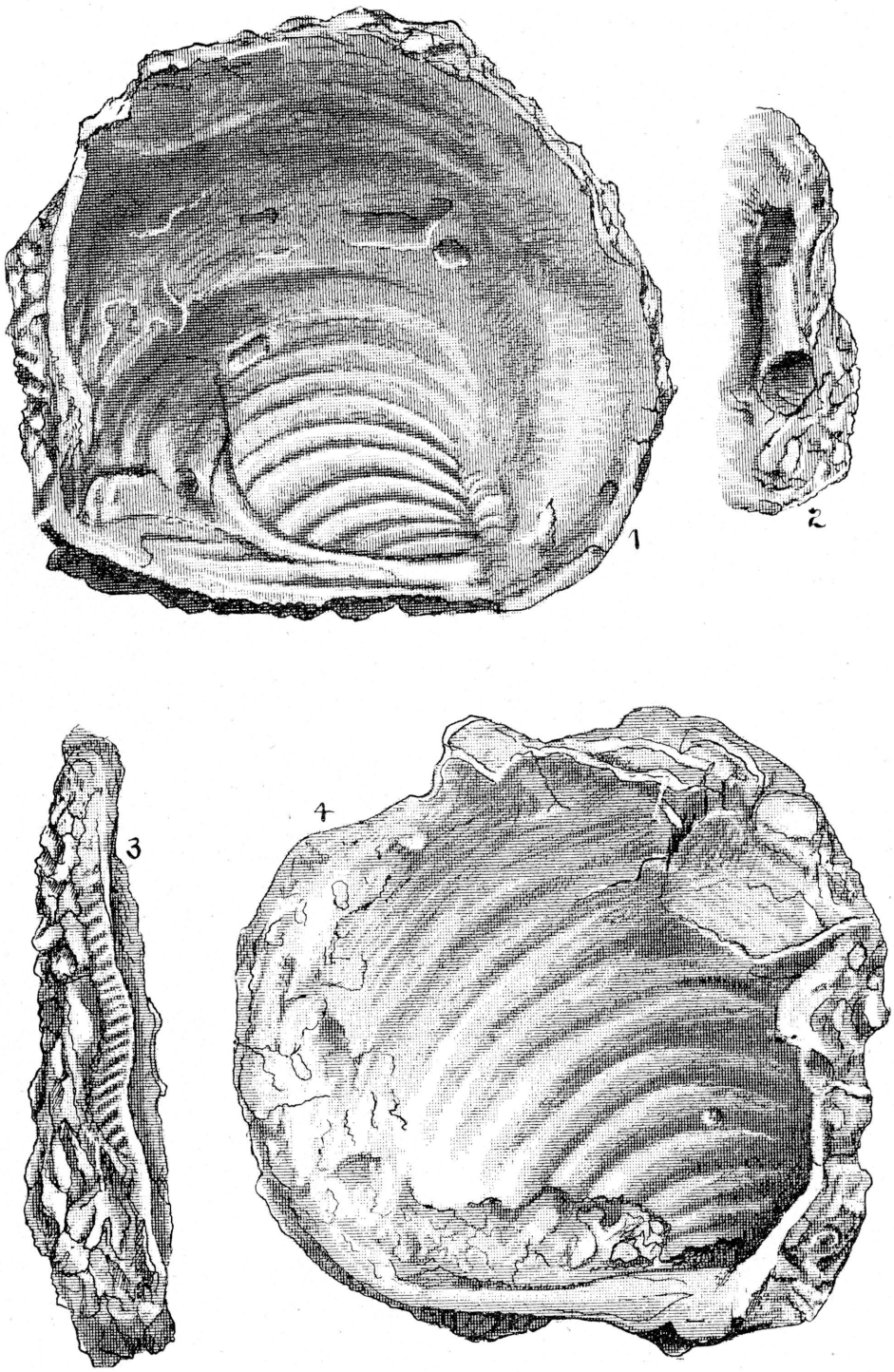
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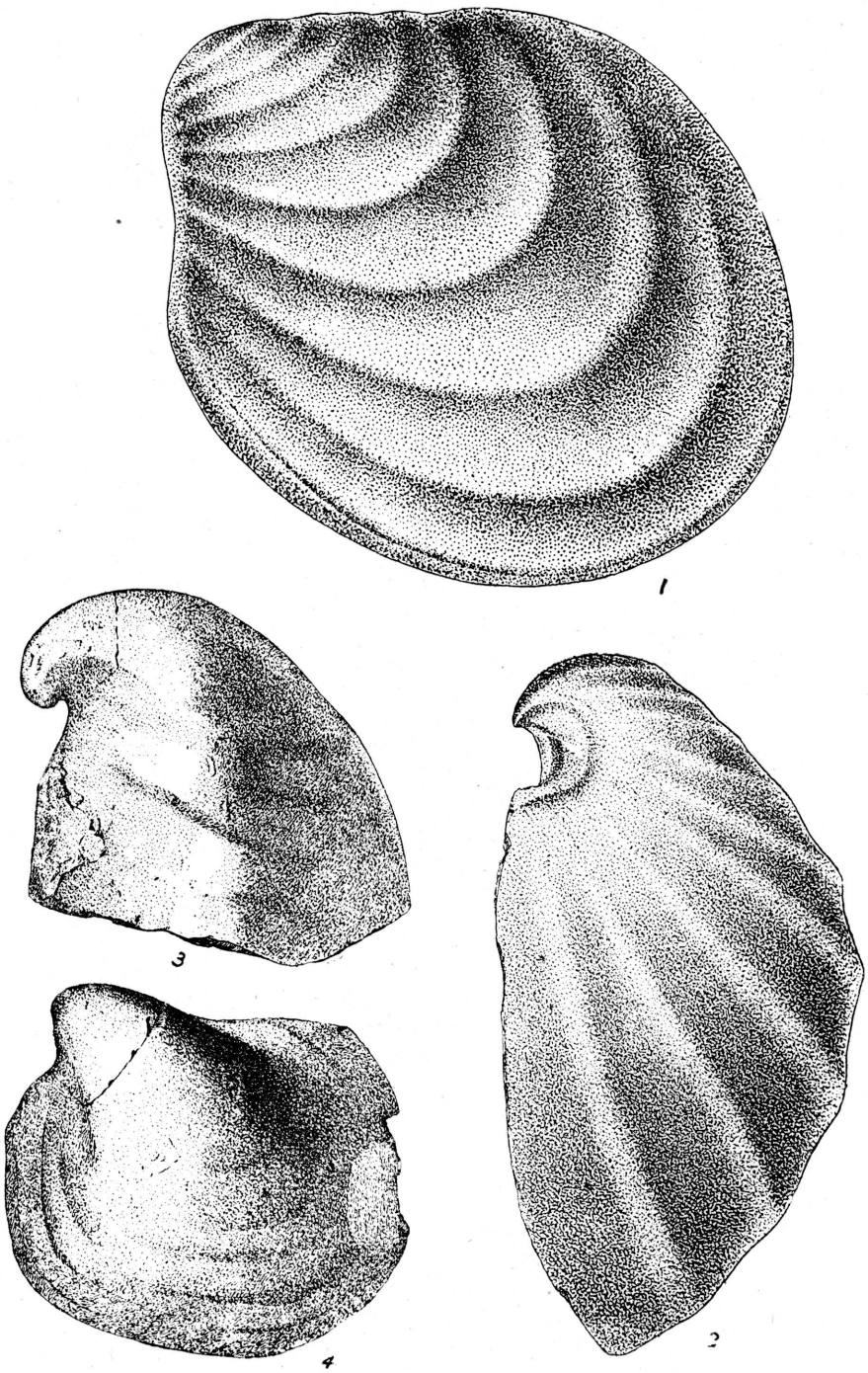
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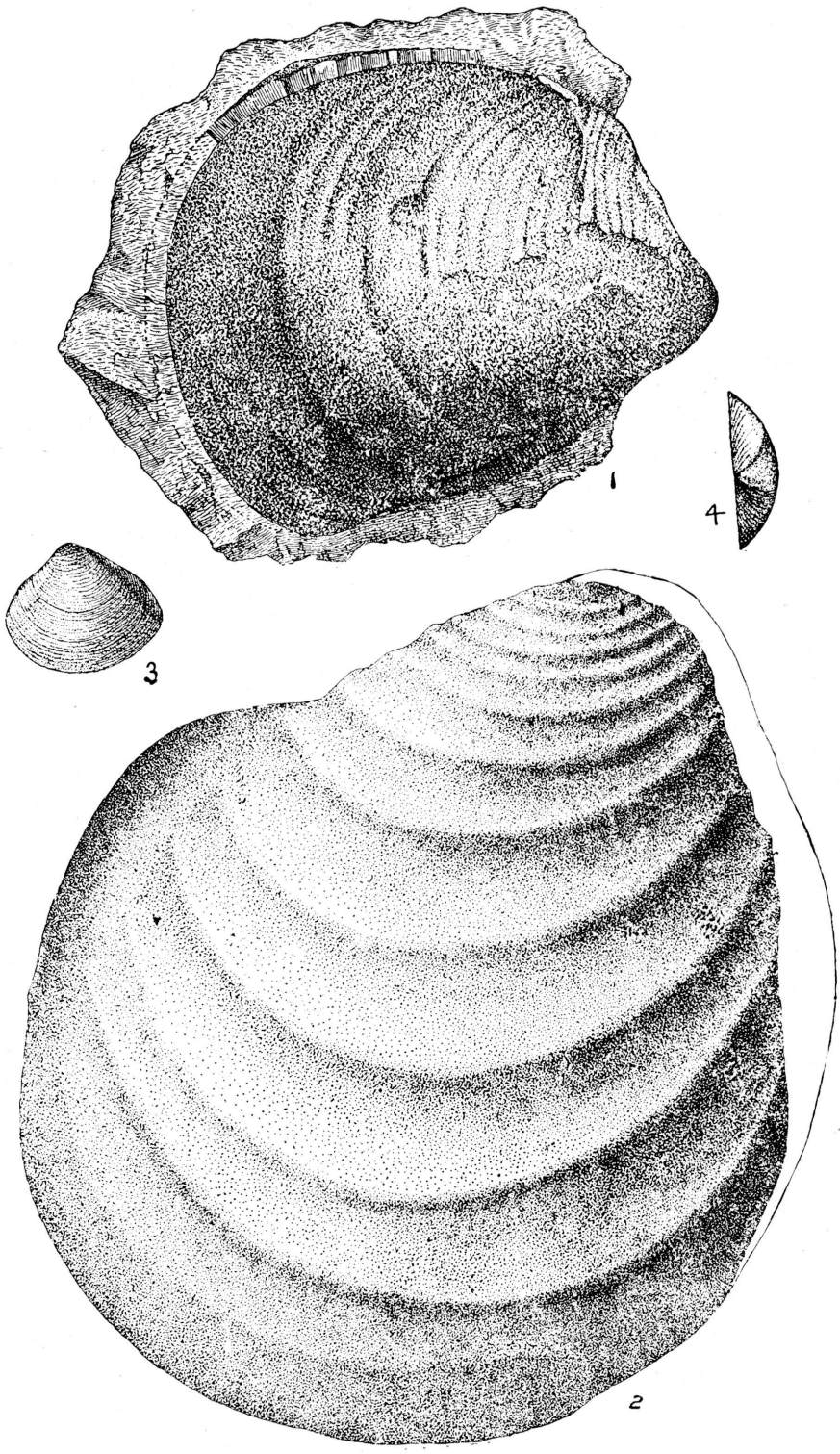
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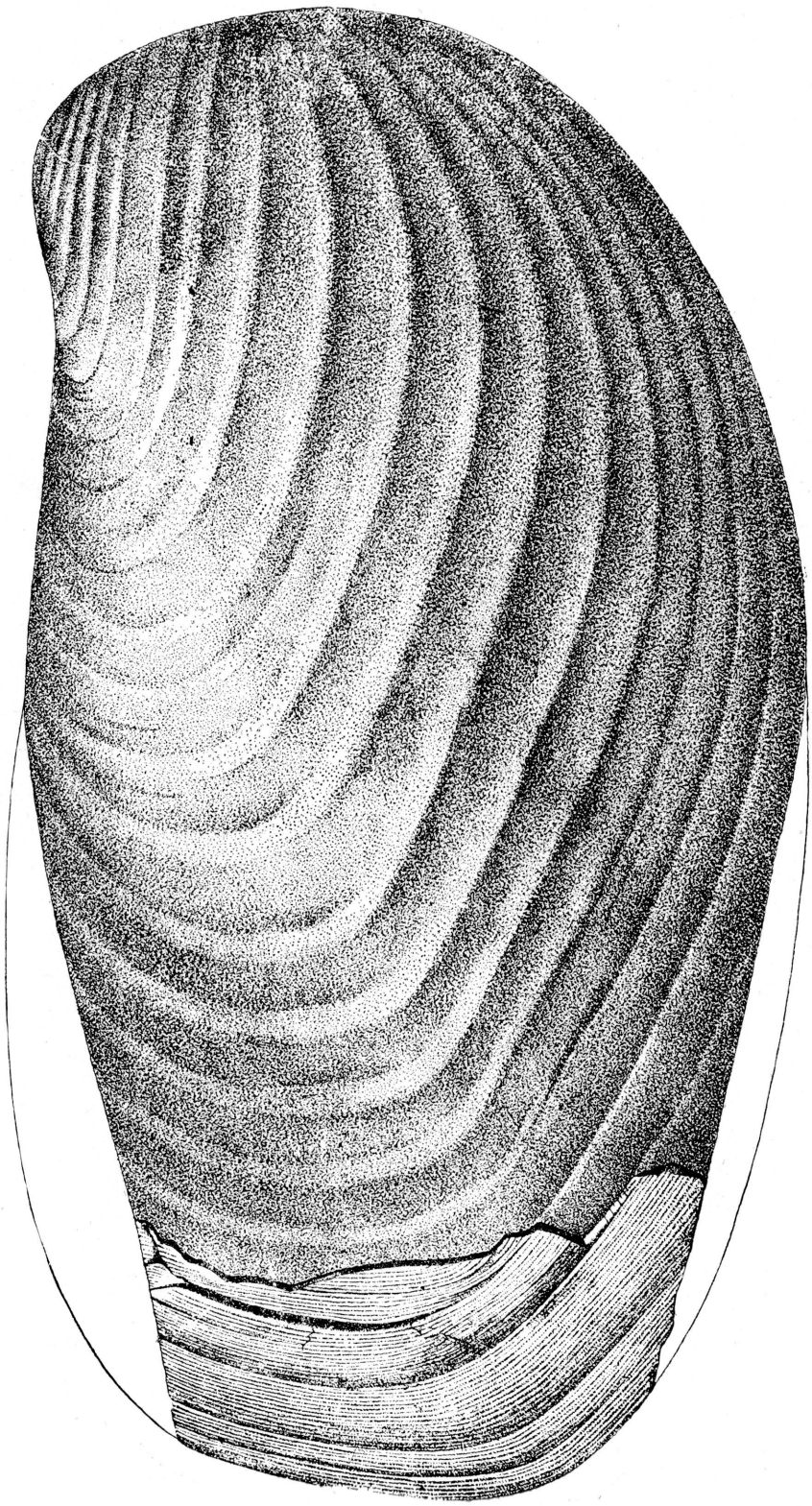

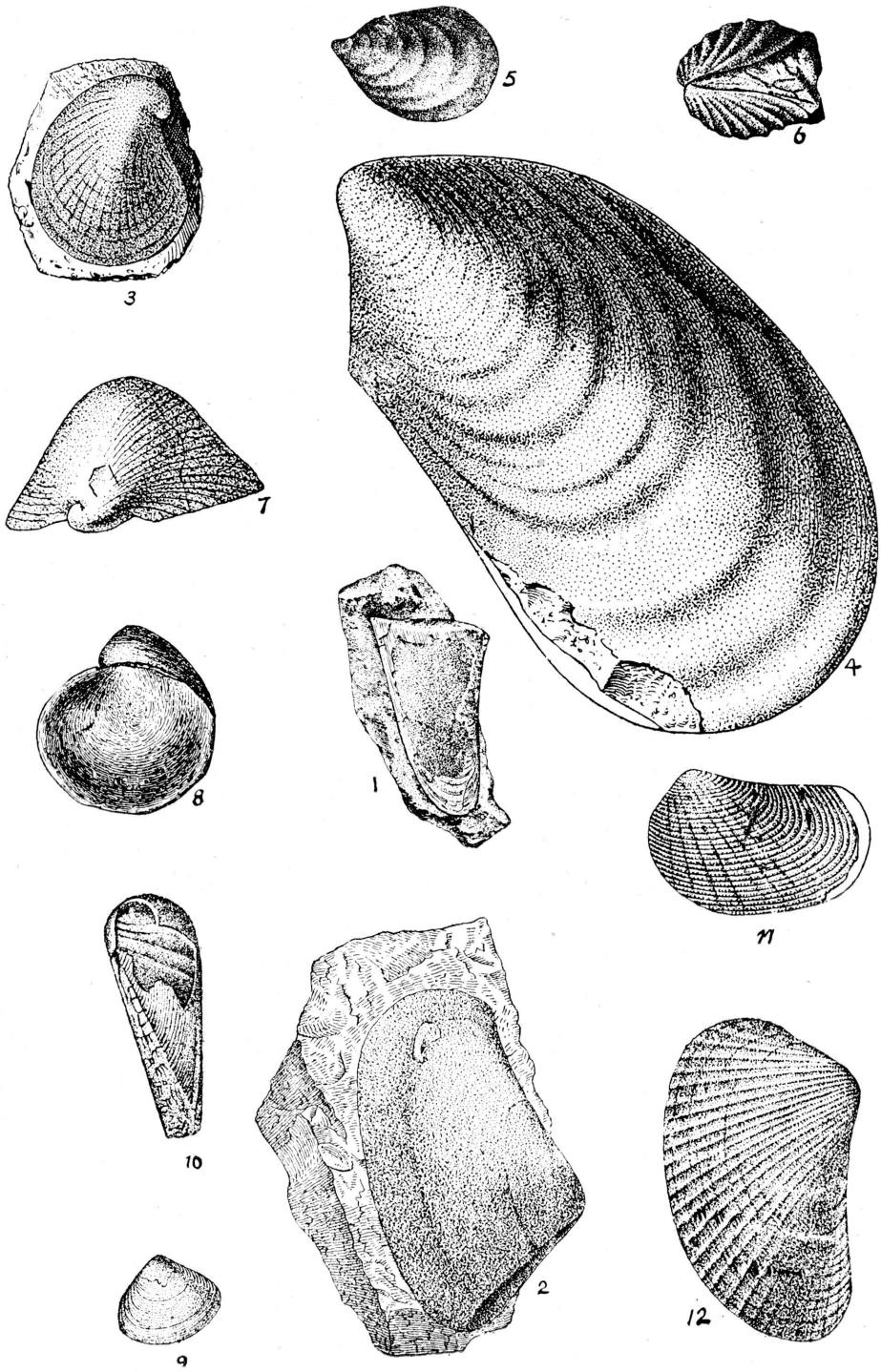
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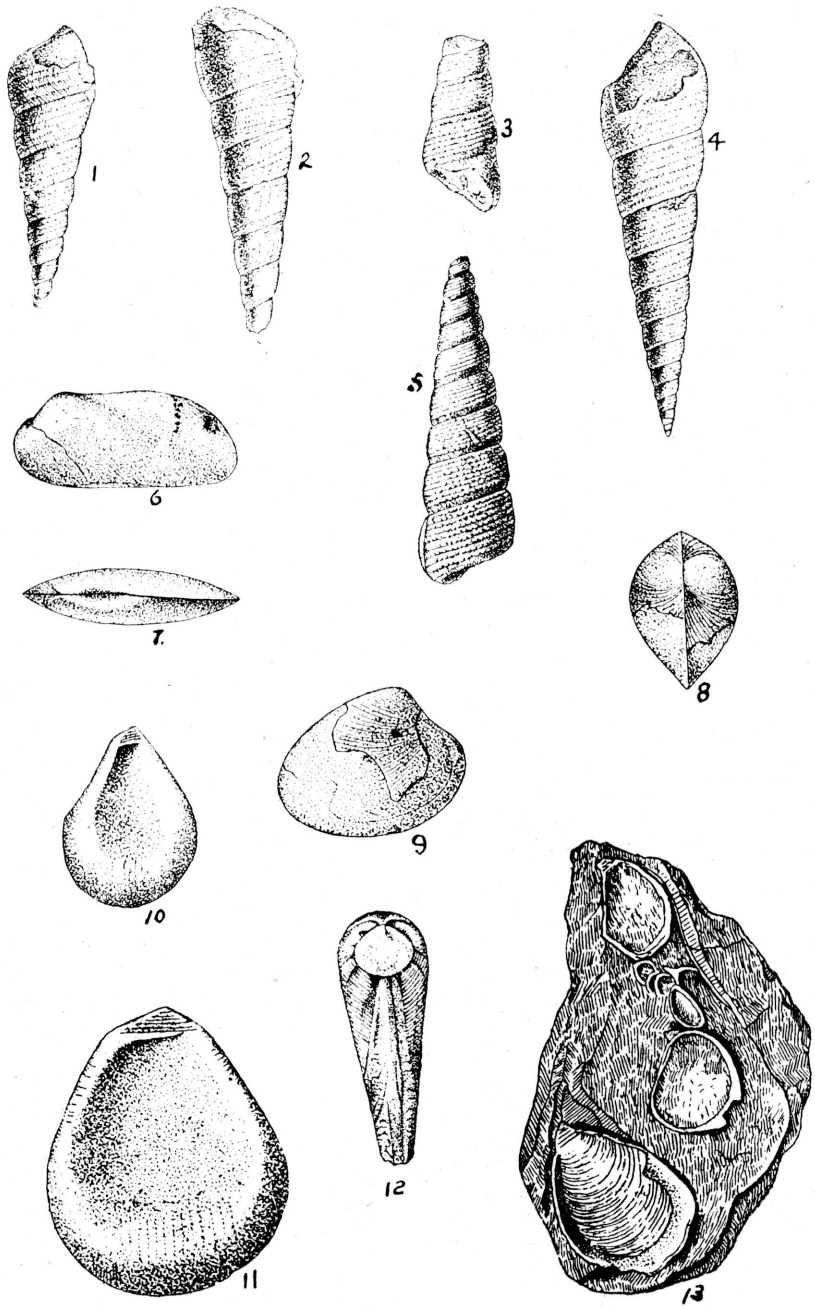
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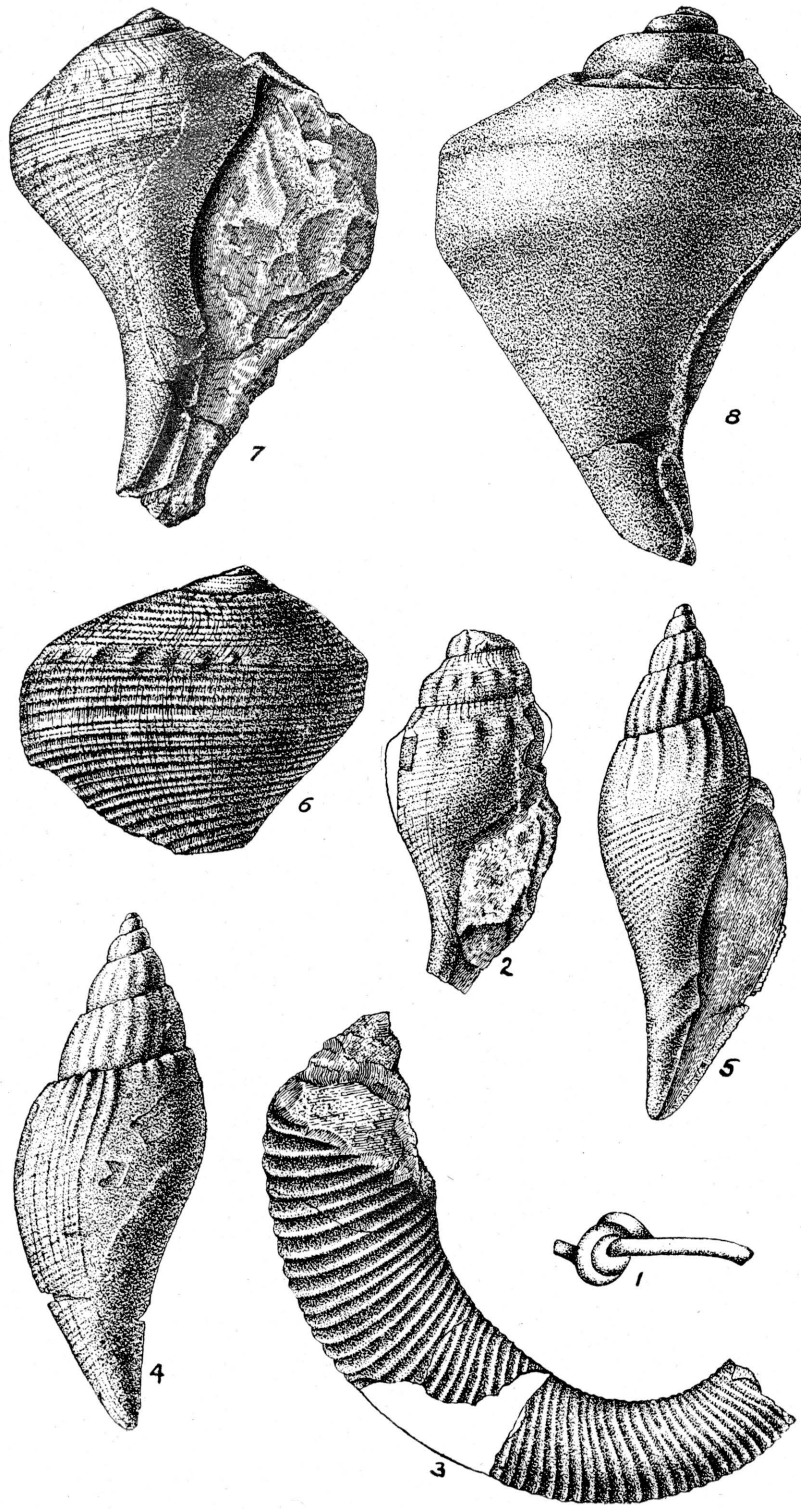
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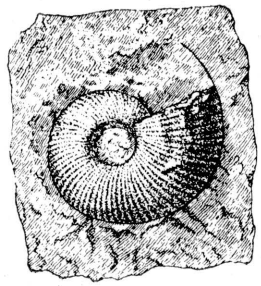

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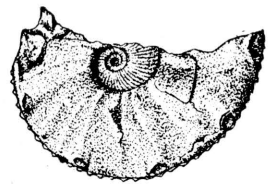

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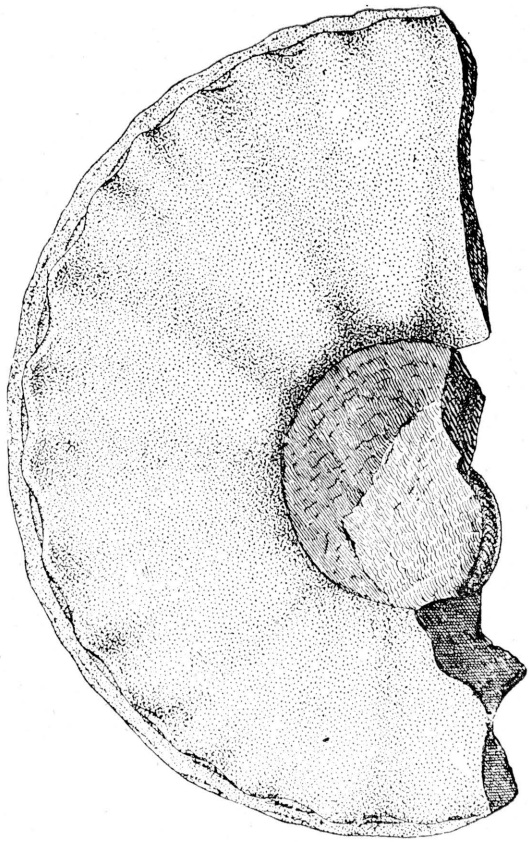

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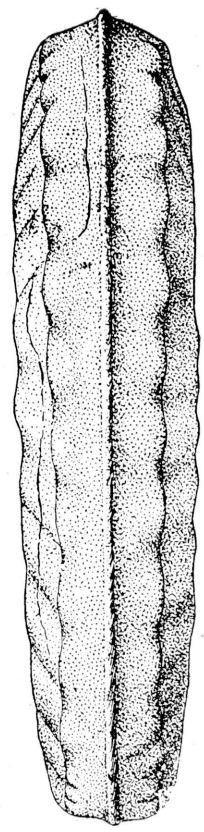

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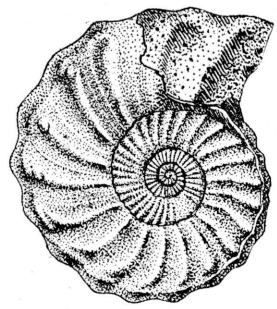

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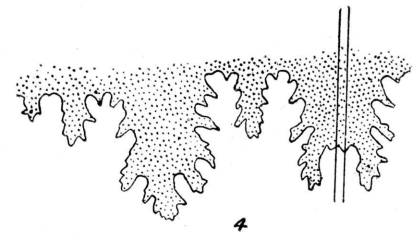

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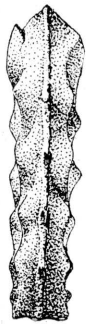

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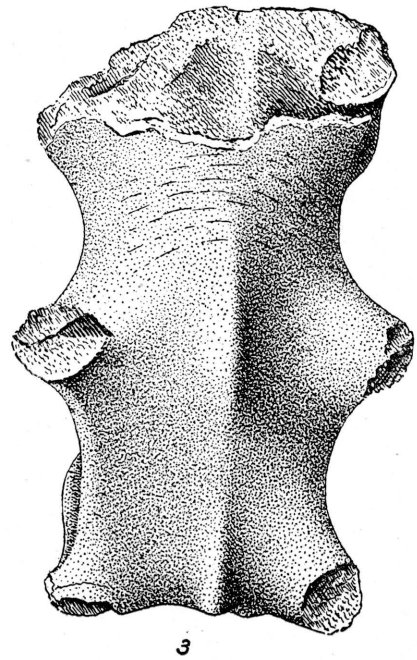

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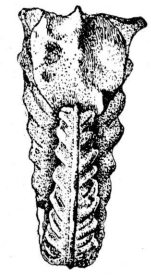

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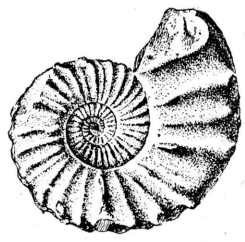

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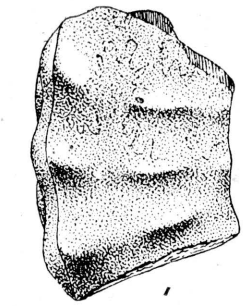

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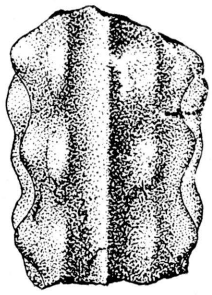

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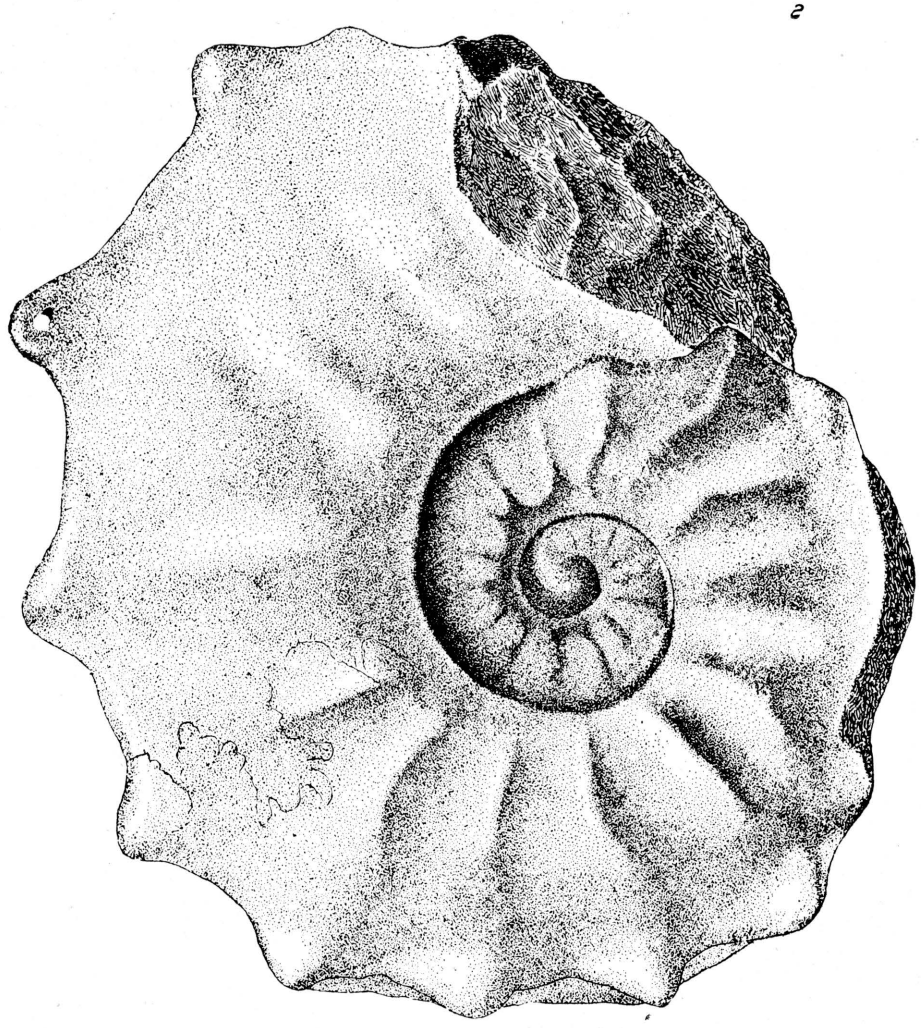

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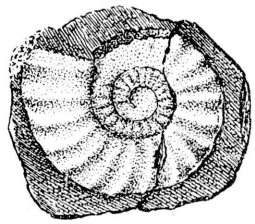

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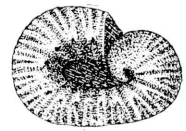

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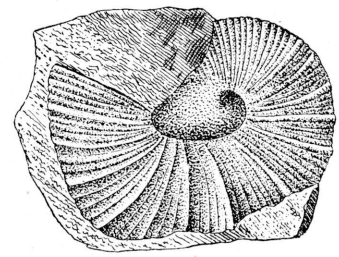

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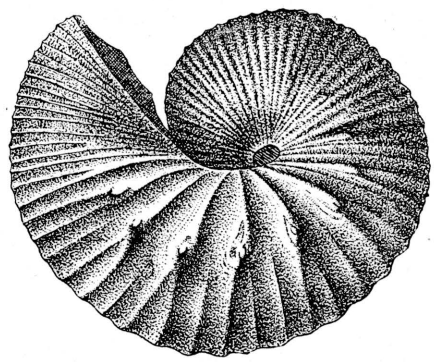

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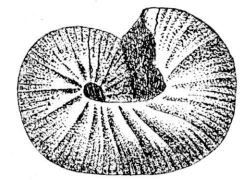

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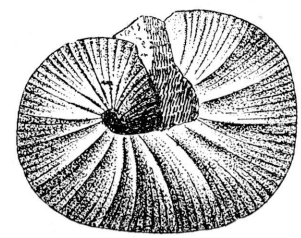

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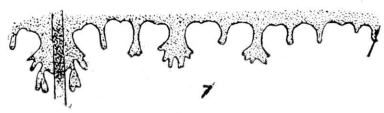

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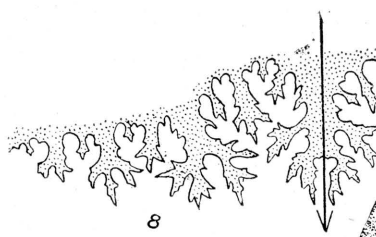

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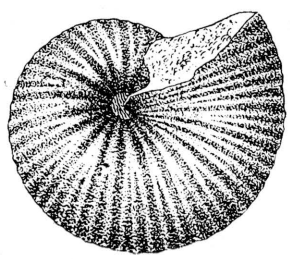

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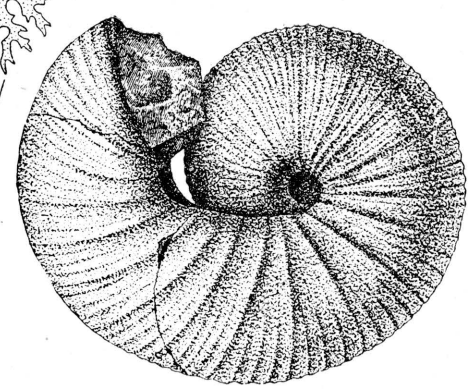

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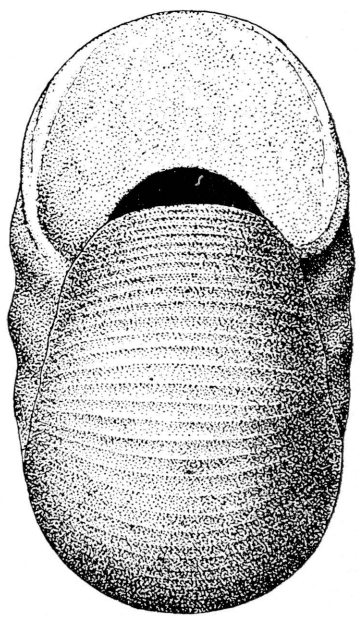

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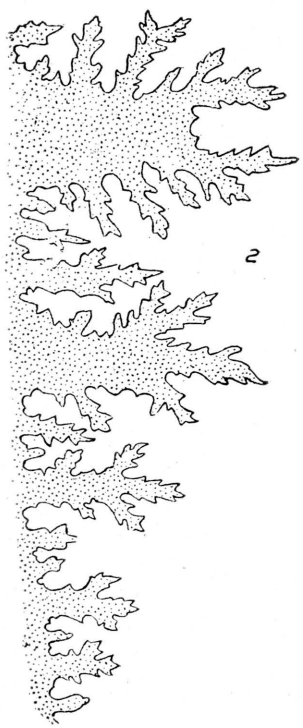

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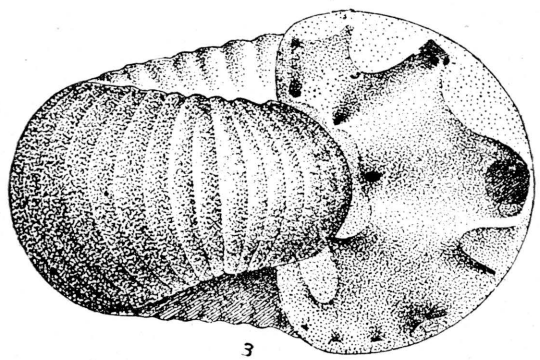

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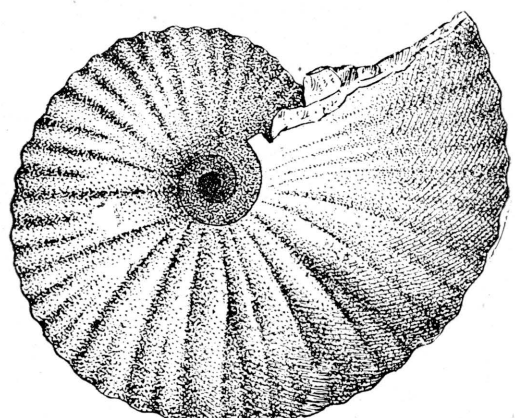

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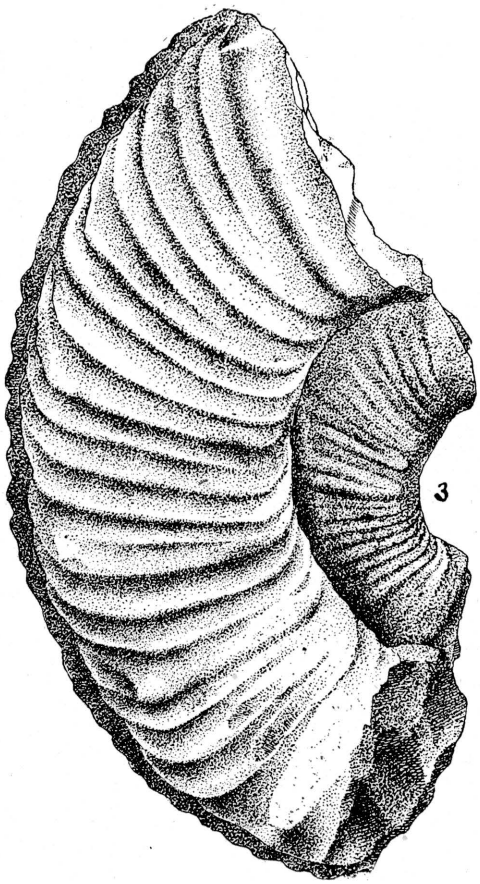
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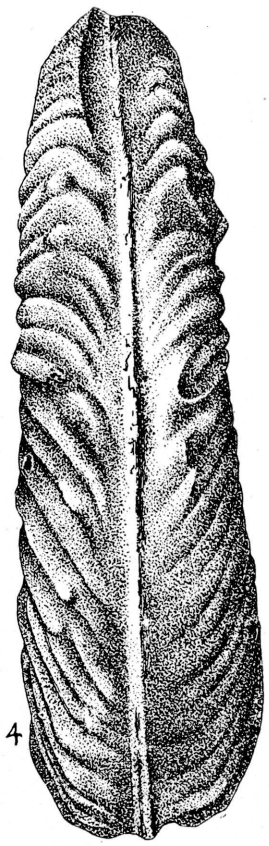
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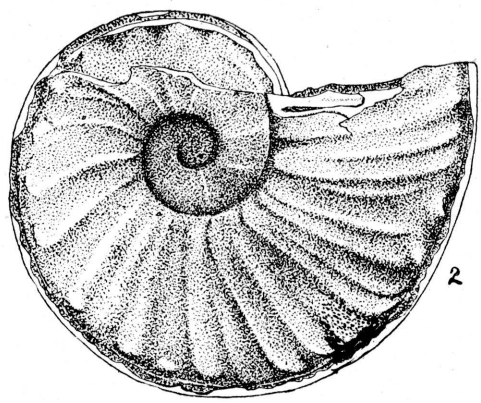
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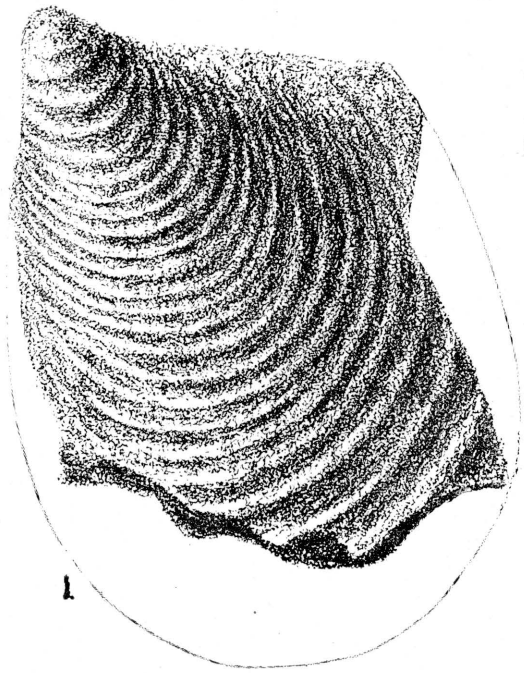
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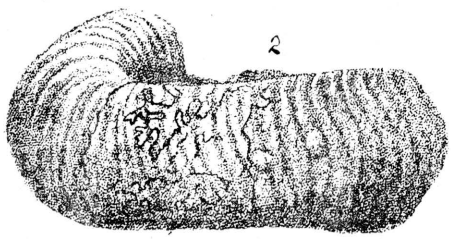
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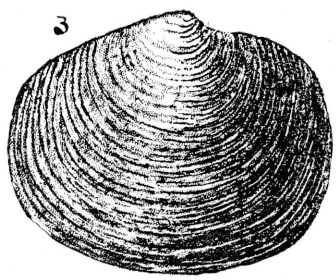
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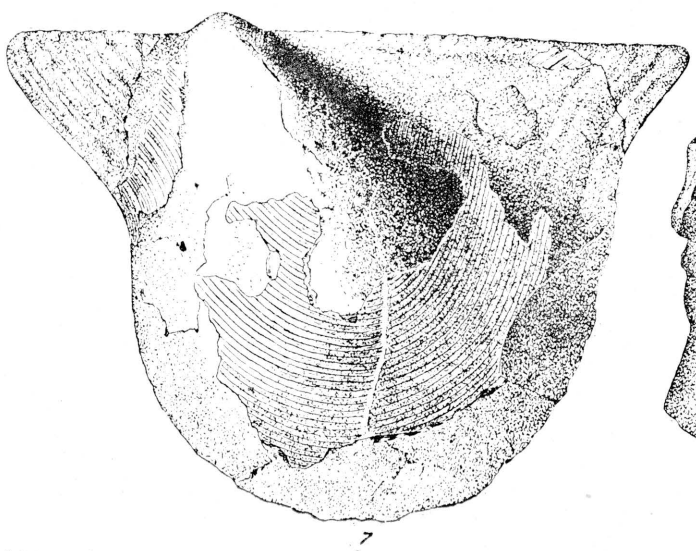
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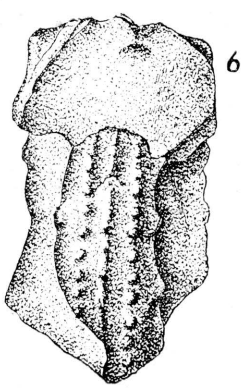
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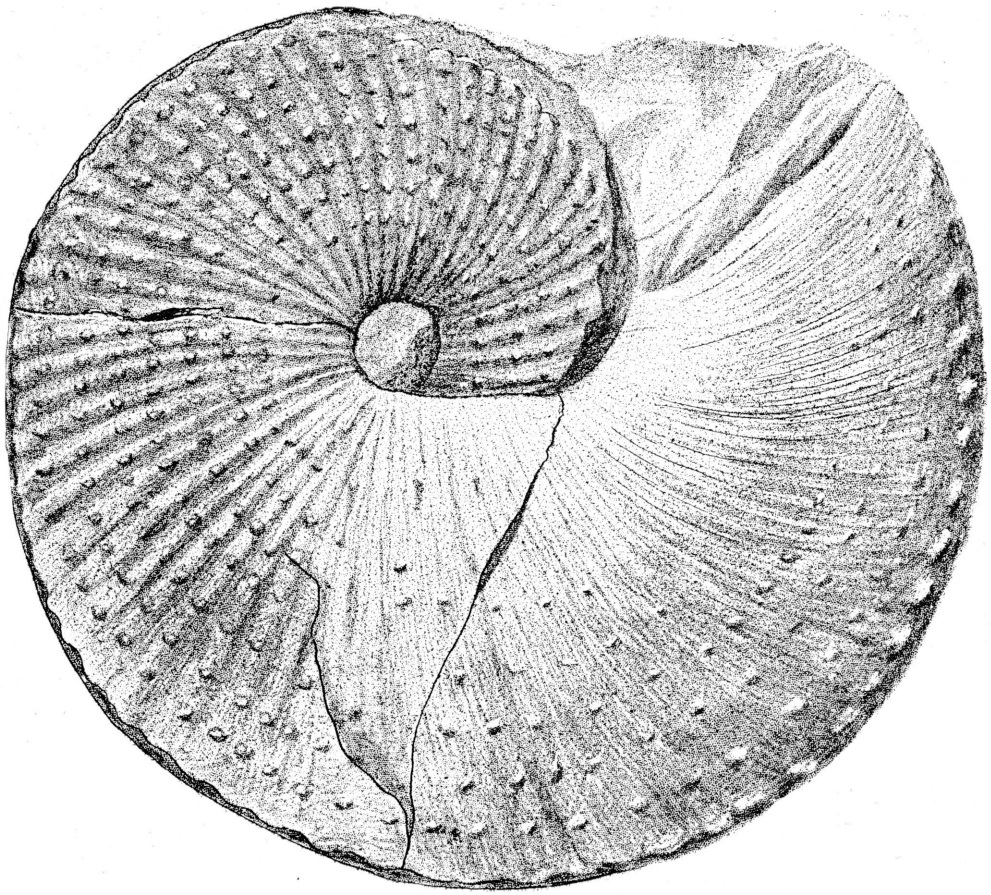

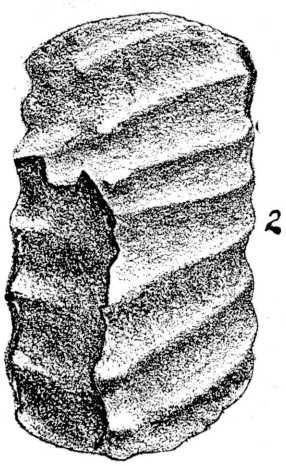

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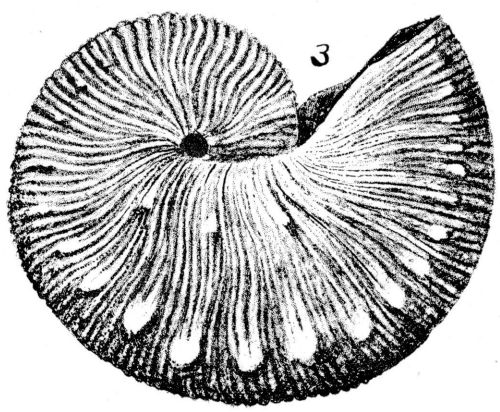

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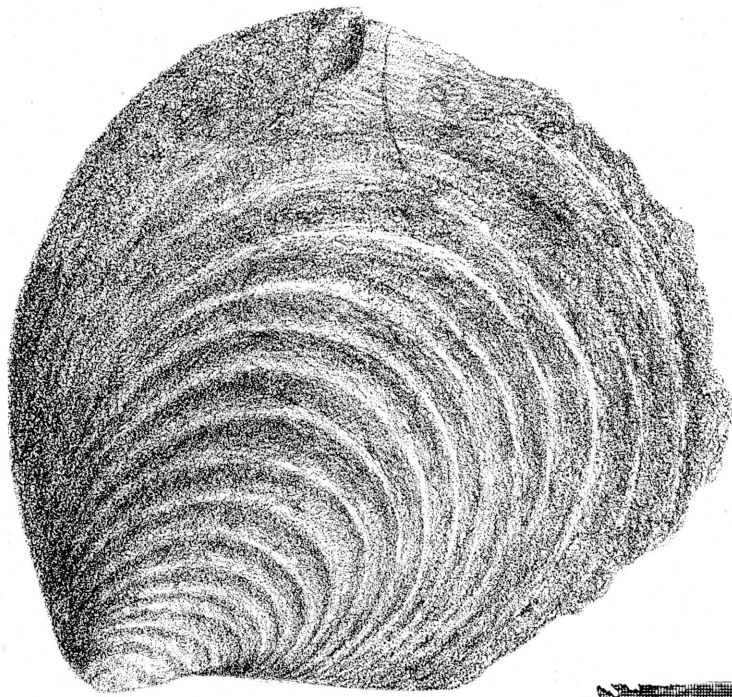

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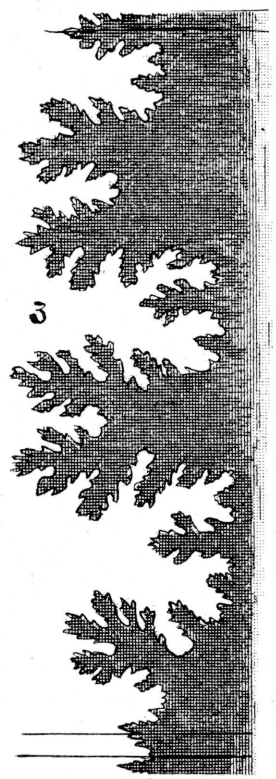

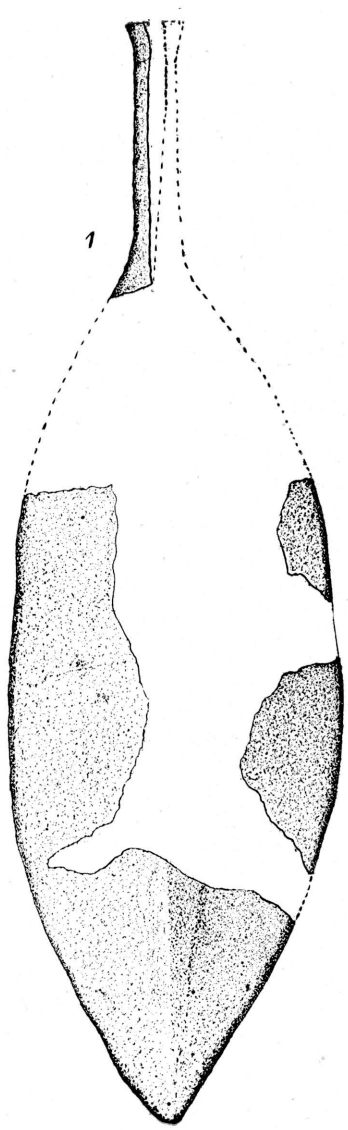
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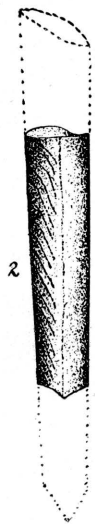
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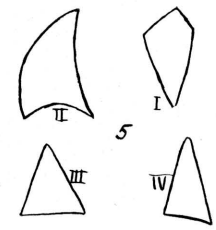
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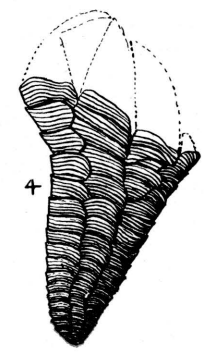
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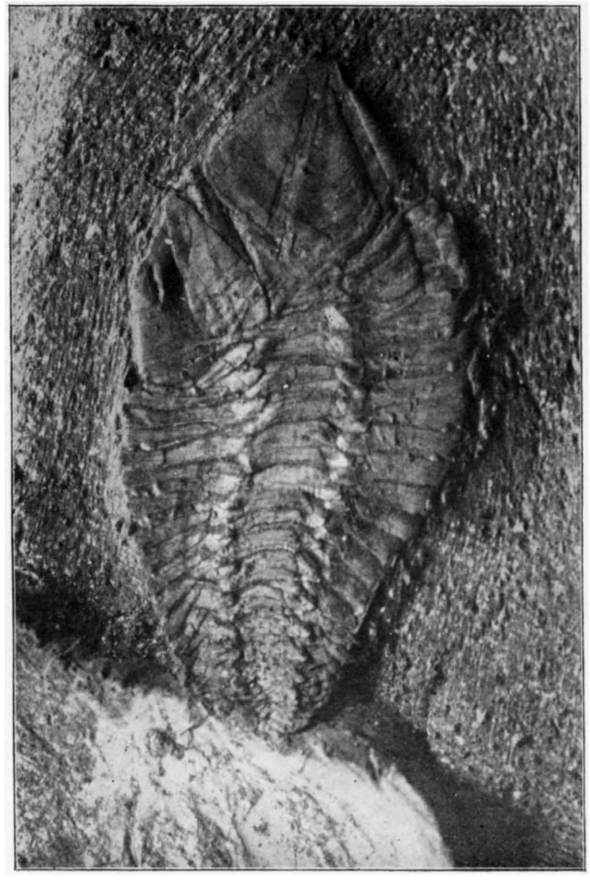

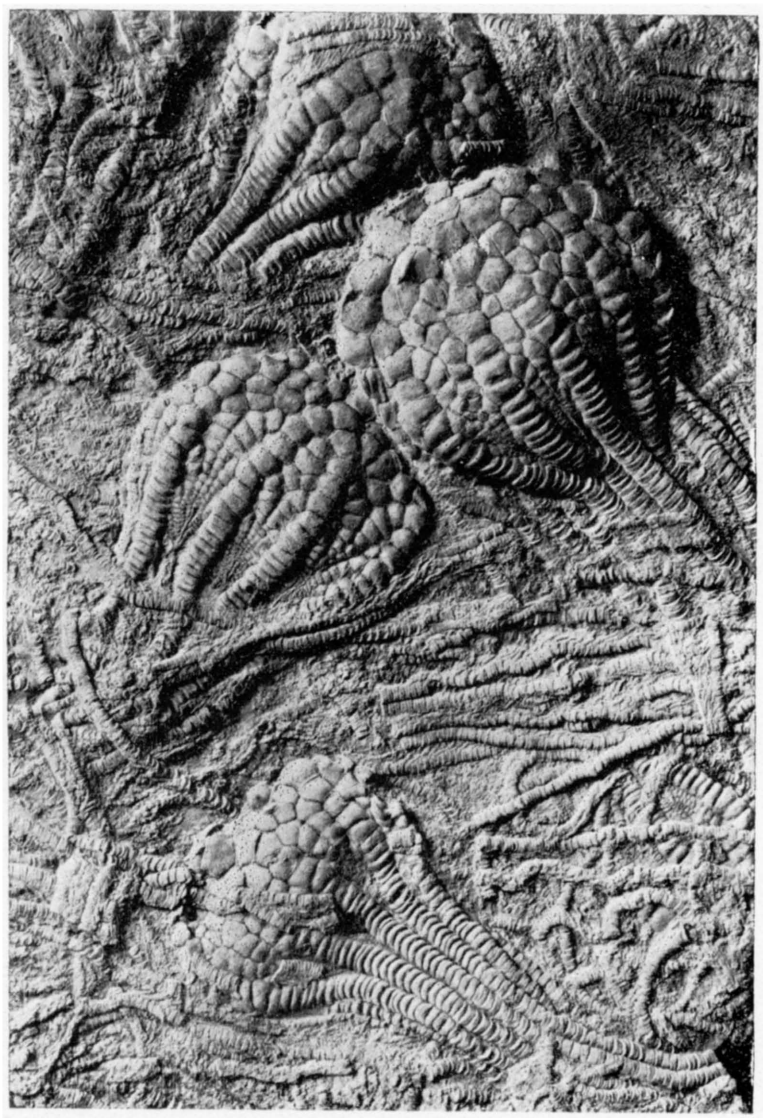

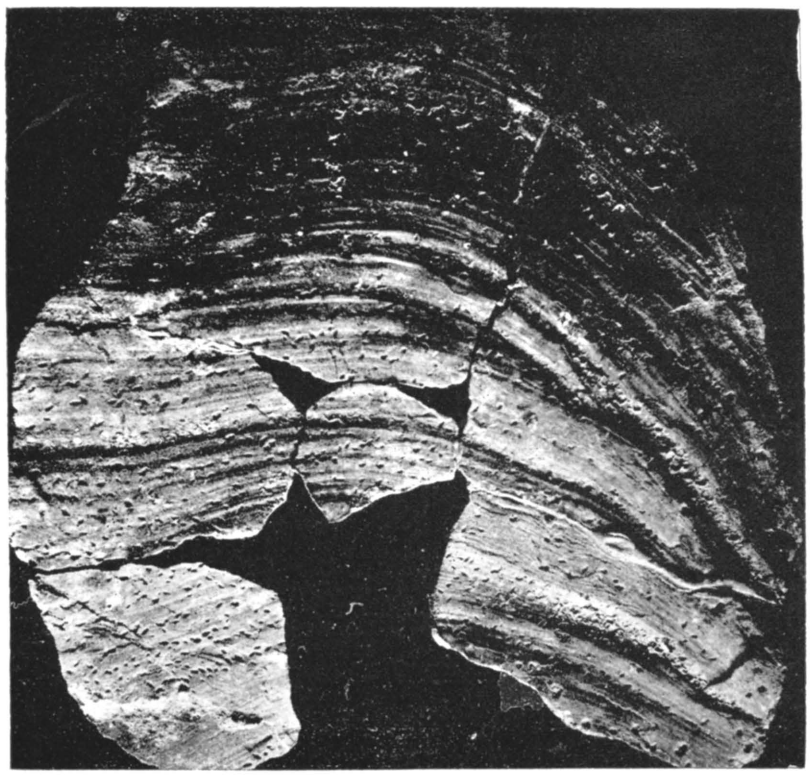

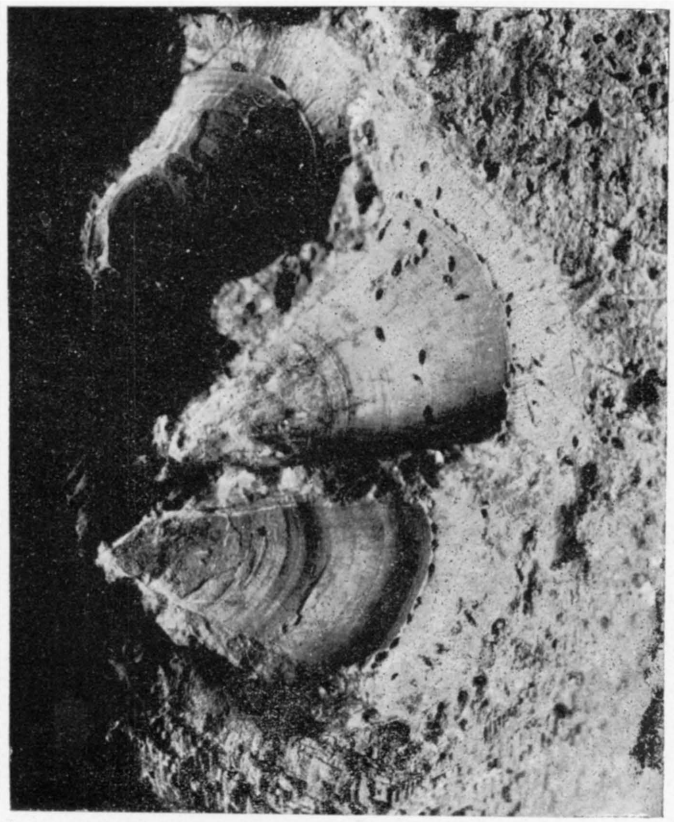

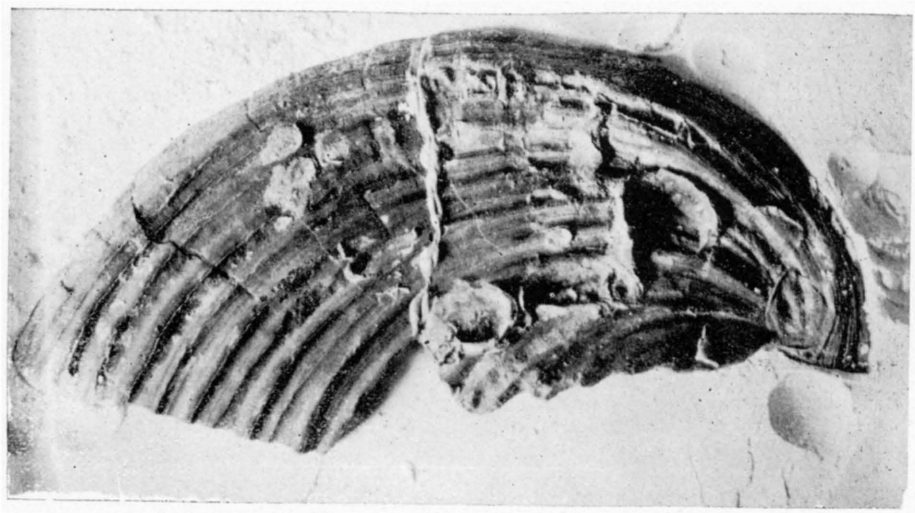

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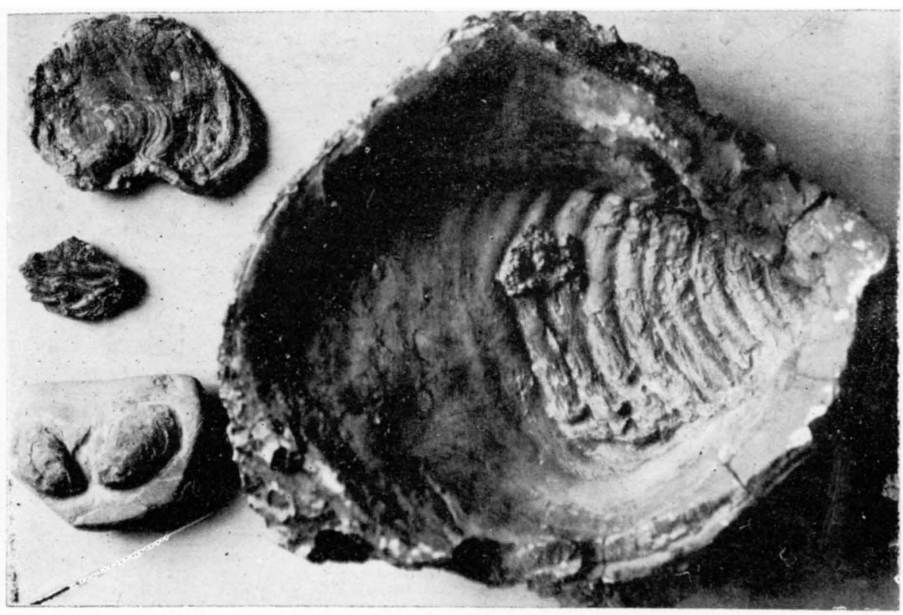

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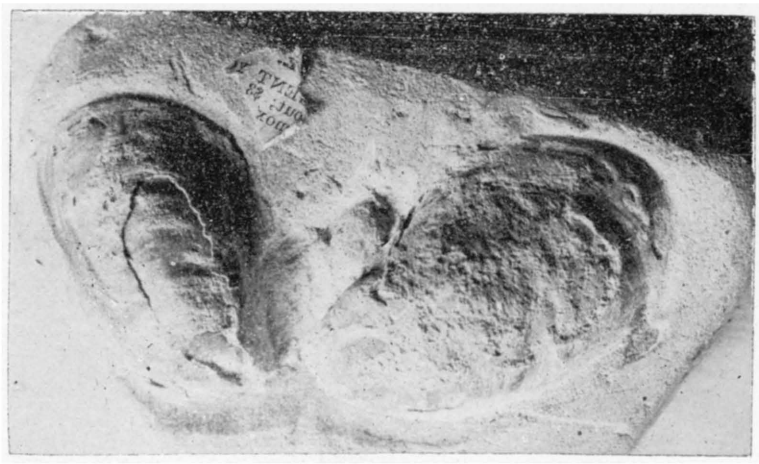

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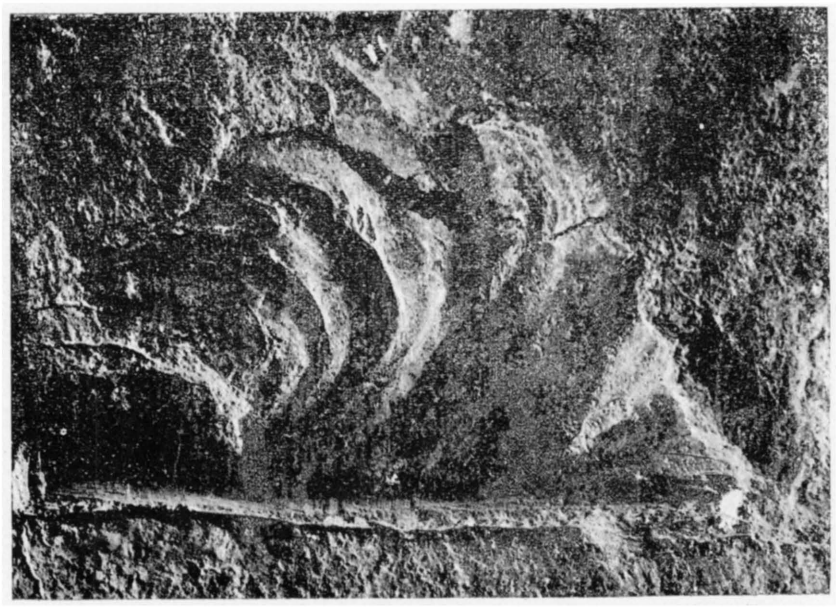

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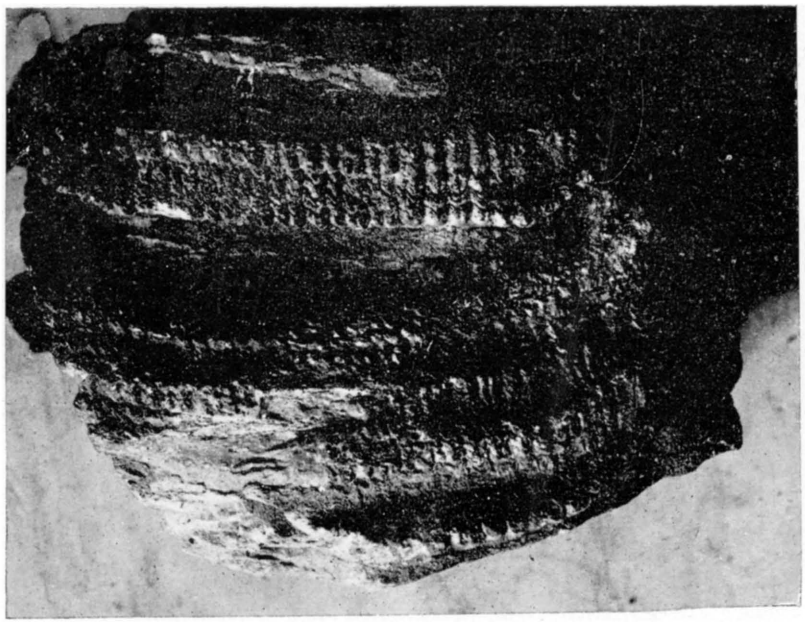

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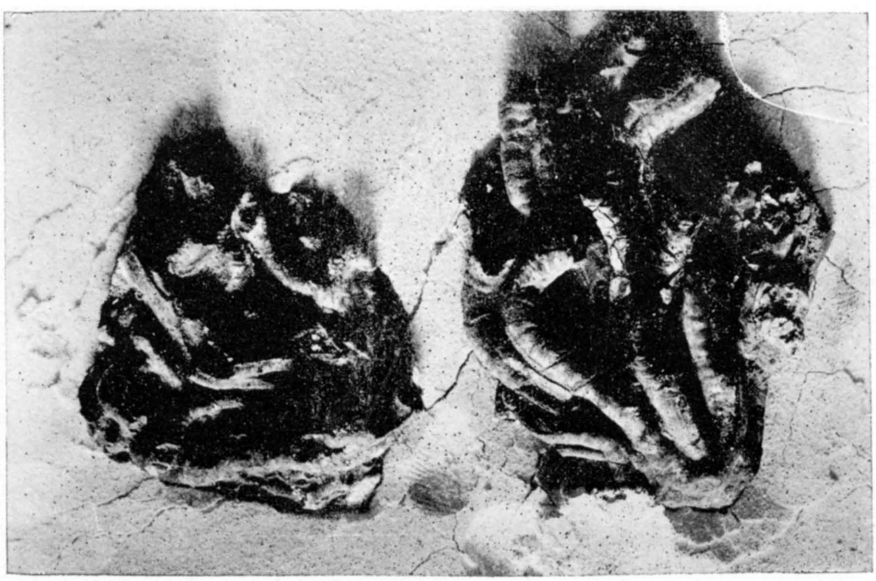

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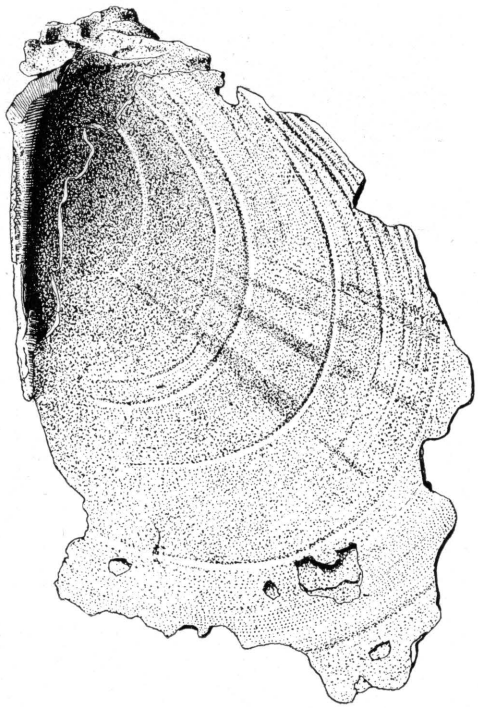

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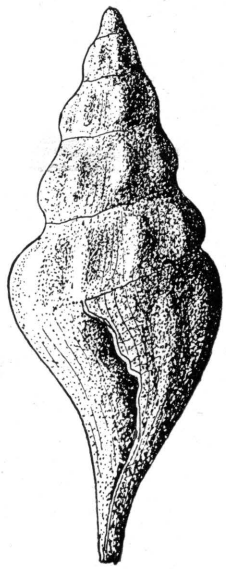

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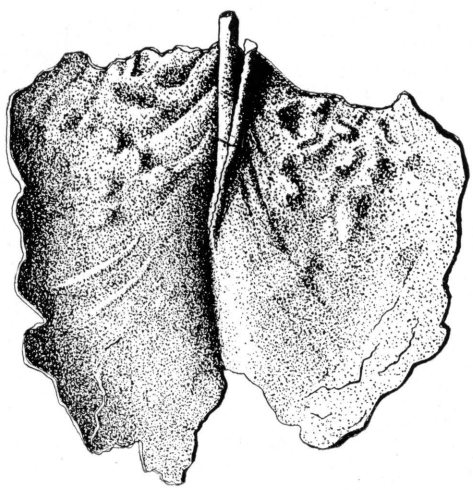

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