

# A NAUTILOID CEPHALOPOD FAUNA FROM THE PENNSYLVANIAN WINTERSET LIMESTONE OF JACKSON COUNTY, MISSOURI

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## ABSTRACT

A variety of well-preserved nautiloids has been found to occur locally in the upper part of the Winterset limestone of Middle Pennsylvanian age in west-central Missouri. Excepting two specimens from Miami County, Kansas, all of the fossils described in this paper were collected in the vicinity of Kansas City, Missouri. The following genera are represented: *Pseudorthoceras*, *Mooreoceras*, *Bactrites?*, *Liroceras*, *Condraoceras*, *Ephippioceras*, *Knightoceras*, *Metacoceras*, *Domatoceras*, and *Solenochilus*. *Condraoceras* is a new genus related to *Liroceras* and *Coelogasteroceras*.

## INTRODUCTION

The Winterset limestone is of widespread occurrence in the Mid-Continent region. Its outcrops extend from Iowa and Nebraska southwest across Missouri and Kansas into Oklahoma, where it forms the main part of the Hogshooter limestone. It is Middle Pennsylvanian in age and is easily recognized by the large amount of chert that it contains.

In Jackson County, west-central Missouri, the Winterset limestone lies between the Stark shale below and the Fontana shale above. It averages 25 to 30 feet in thickness and is divided into two

quite distinct parts by a prominent shale bed near its mid-portion. The lower half, which contains very little chert, consists largely of thick massive limestone beds, some of which are everywhere extremely fossiliferous. The upper half, which contains an abundance of chert throughout, is thin-bedded and is only locally fossiliferous.

The fauna of the lower Winterset consists largely of fusulinids and molluscoids, whereas that of the upper beds is composed chiefly of mollusks and crustaceans, as well as molluscoids. All but two

of the cephalopods described below came from the upper half of the Winterset. The great majority of them were collected from a dark-brown to purple 1¾-foot crystalline limestone in the Missouri River bluff about half a mile northeast of Sugar Creek station in sec. 22, T. 50 N., R. 32 W., just northeast of Kansas City, Missouri; they were found there in association with fenestellid bryozoans (*Fenestrellina*), brachiopods (*Derbyia*, *Juresania*, *Linoproductus*, and *Composita*), pelecypods (*Pseudomonotis*, *Myalina*, *Schizodus*, *Aviculopecten*, and *Allerisma*), gastropods (*Bellerophon* and *Soleniscus*), and trilobites (*Ameura*).

Quite a few nautiloids have been described previously from the region in which the Winterset limestone is known to outcrop. Some of these may, of course, have come from the Winterset, but the data in regard to their discovery are such that it is not

possible to determine the precise horizon that yielded certain of them. Nevertheless, it should be noted that MILLER, DUNBAR & CONDRA (1933, p. 92) list *Mooreoceras tuba* (GIRTY) as occurring in the upper portion of the Winterset limestone of southeastern Nebraska, and NEWELL (1936, p. 483) indicates that *Liroceras milleri* (NEWELL) occurs in the Winterset at Kansas City, though the exact horizon of the specimens to which he refers seems to be somewhat in doubt.

Many of the specimens on which this report is based were collected by Mr. J. B. KLEIHEGE of Kansas City, Missouri. Acknowledgment is also due to Mr. HOWARD WEBSTER of Iowa City, Iowa, who retouched the accompanying photographs, and to Prof. R. C. MOORE of the University of Kansas, who completed arrangements for the preparation and the publication of this report.

## SYSTEMATIC PALEONTOLOGY

### GENUS *MOOREOCERAS* MILLER, DUNBAR & CONDRA, 1933

#### *Mooreoceras bakeri* MILLER, DUNBAR & CONDRA

Plate 1, figure 10

*Mooreoceras bakeri* MILLER, DUNBAR & CONDRA, 1933, Nebraska Geol. Survey, Bull. 9, 2d ser., p. 92-93, pl. 2, figs. 11-13.

The collections under consideration contain several specimens that seem to be referable to this species, and we are figuring the best one of them. The length of this specimen, which is not complete adapically or adorally, measures about 110 mm, of which about half is phragmacone and half is living chamber. The conch is depressed and is broadly elliptical in cross section. At the adoral end of the phragmacone of the figured specimen, the conch is about 25 mm high and 31 mm wide. At the adapical end of this specimen, which is formed by an impression of a septum, the siphuncle is about 2 mm in diameter and is located about 5½ mm from the venter and some 14 mm (estimated) from the dor-

sum. On the internal mold there is a faint raised line along the venter.

*Remarks.*—This species is readily differentiated from the two congeneric forms that occur in association with it. That is, in *Mooreoceras conicum*, n. sp., the conch is more rapidly expanded orad, and in *M. normale uniconstrictum* MILLER & OWEN it is less strongly depressed dorsoventrally and is constricted near its adoral end, on the internal mold, at least.

*Occurrence.*—The holotype of this species came from the Burlingame limestone (Wabaunsee) of Kansas; the paratypes from the Oread (Shawnee) and Argentine (Kansas City) limestones of Kansas. All of the several conspecific specimens in the collections we are now studying are from a dark-brown to purple 1¾-foot crystalline limestone member of the upper part of the Winterset limestone in the Missouri River bluff about half a mile northeast of Sugar Creek station in sec. 22, T. 50 N., R. 32 W., just northeast of Kansas City, Missouri.

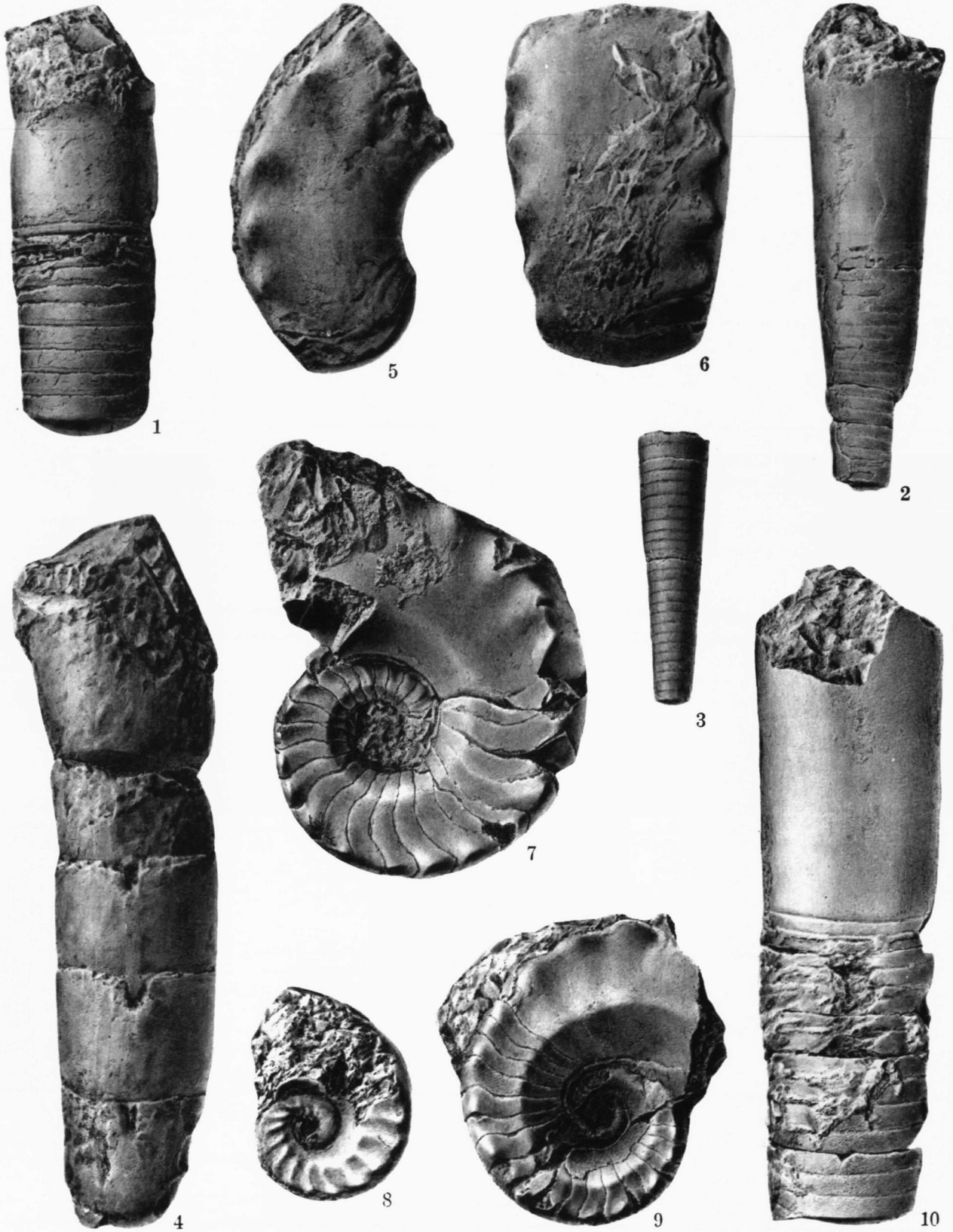
*Repository.*—The University of Kansas no. 551 (figured specimen), no. 552 (unfigured Winterset specimens).

## EXPLANATION OF PLATE 1

Except figures 4-6, all specimens illustrated on this plate are from a dark-brown to purple 1¾-foot crystalline limestone member of the upper part of the Winterset limestone in the Missouri River bluff about half a mile northeast of Sugar Creek station, just northeast of Kansas City, Missouri. Figure 4 is from the upper part of the Winterset in a quarry on the east bank of the Big Blue River a quarter of a mile north of 15th Street in Kansas City, Missouri; and the specimen represented by figures 5 and 6 was found in the lower portion of the Winterset near the center of the south side of sec. 10, T. 18 S., R. 24 E., Miami County, east-central Kansas.

### FIGURE

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**Mooreoceras conicum**, new species

Plate 1, figures 2, 3

Conch straight, rapidly expanded orad, and sub-circular in cross section but slightly depressed dorso-ventrally. Seemingly the conch attains a length of much more than 125 mm. At the junction of the phragmacone and the living chamber of the specimen represented by figure 2 on Plate 1, the conch



FIGURE 1.—Median longitudinal dorsoventral section of three camerae of a paratype of *Mooreoceras conicum*, n. sp., showing the siphuncle at maturity,  $\times 2$ .

is about 16 mm high and 19 mm wide. The portion of this specimen that represents living chamber is about 36 mm long, and it is incomplete adorally. The conch is expanded orad rather rapidly, and the angle between its lateral zones measures about 9 degrees.

Portions of the test that adhere to the holotype show that it was marked (probably on an inner layer) by fine longitudinal lines. On the surface of the internal mold there is a fine raised line along the venter.

The camerae are short, and there are from five to six of them in a length equal to the height of the conch. The sutures are straight, or nearly so, and directly transverse—those of both the types figured on Plate 1 are slightly sinuous, probably as a result of distortion during preservation.

At the adapical end of the paratype shown in figure 3 on Plate 1, the siphuncle is only slightly ventrad of the center of the conch, but at the adoral end of this specimen it is distinctly nearer the venter, as in the other types, which represent mature portions of the phragmacone. As shown by Figure 1, the septal necks are short and rather strongly recurved, and the connecting rings are subspherical in shape.

**Remarks.**—By far the most significant characteristic of this species seems to be the rapid rate of adoral expansion of the conch. This feature serves to distinguish it from all known congeneric forms.

**Occurrence.**—Dark-brown to purple 1¼-foot crystalline limestone member of the upper part of the Winterset limestone in the Missouri River bluff about half a mile northeast of Sugar Creek station in sec. 22, T. 50 N., R. 32 W., just northeast of Kansas City, Missouri.

**Types.**—The University of Kansas, holotype, no. 553; figured paratype, no. 554; paratype represented by Figure 1, no. 555; and two unfigured paratypes, no. 556.

**Mooreoceras normale uniconstrictum**

MILLER &amp; OWEN

Plate 1, figure 1

*Mooreoceras normale uniconstrictum* MILLER & OWEN, 1934, Iowa Univ. Studies Nat. History, vol. 16, p. 194, 204-205, pl. 11, figs. 7, 8.

We are referring to this species a single specimen which is an internal mold of the adoral ten camerae of the phragmacone and much of the living chamber. The over-all length of this specimen, which is incomplete both adorally and adapically, measures about 62 mm, of which about 23 mm represent living chamber and 39 mm phragmacone.

The conch is broadly elliptical in cross section, being depressed dorsoventrally, and is gradually expanded orad. Its larger diameter increases from about 21½ mm near its adapical end to about 26 mm near its adoral end. Near the mid-length of the preserved portion of the living chamber the two diameters of the conch measure about 22 mm and 26 mm.

In the adoral portion of the internal mold of the living chamber there is a shallow rounded transverse constriction about 8 mm wide and, at a maximum, only about 1 mm deep. This constriction seems to be deepest on the narrower zones of the conch, but can be discerned throughout its entire circumference. It may, of course, be due entirely to an internal thickening of the test and therefore be limited to the internal mold. No trace of the surface ornamentation of the test is preserved, but there is a faint raised line along the venter of the holotype, an internal mold.

The sutures are essentially straight and directly transverse and therefore form simple ellipses. The camerae are moderate in length, and in the adapical portion of the holotype there are about five camerae in a distance equal to the longer diameter of the conch. The adoral two camerae of the phragmacone of the holotype are considerably shorter than the preceding ones, indicating that the specimen represents a fully mature individual. The septa are only moderately convex apicad. No trace of the siphuncle is visible.

**Remarks.**—Most of the characters of the above-described specimen are very similar to those of the holotype of this variety, which, however, is much smaller. The taxonomic significance of difference in size is, to be sure, a matter of opinion, and in this case we believe that, for the present at least, it will be best not to attribute a specific or even subspecific value to it. After more specimens have been collected and studied and we are able to determine the size-range in the two formations concerned, we may wish to revise our opinion.

*Occurrence.*—The holotype and the paratype of this variety came from immediately above the Tebo coal member of the Cherokee formation in Henry County, west-central Missouri. The specimen under consideration came from a dark-brown to purple 1 $\frac{3}{4}$ -foot crystalline limestone member of the upper part of the Winterset limestone in the Missouri River bluff about half a mile northeast of Sugar Creek station in sec. 22, T. 50 N., R. 32 W., just northeast of Kansas City, Missouri.

*Repository.*—The University of Kansas no. 557 (figured specimen).

## GENUS *BACTRITES* SANDBERGER, 1843

### *Bactrites?* *winteretensis*, new species

Plate 1, figure 4

The only known representative of this species is a somewhat crushed and not too well preserved internal mold, which represents the adoral four camerae of the phragmacone and the adapical part of the living chamber. The conch is straight, is gradually and regularly expanded orad, and is believed to be circular or nearly so in cross section—although the holotype is broadly elliptical in cross section, it has obviously been crushed and distorted during fossilization. The preserved portion of the holotype, which is not complete adorally or adapically, is about 110 mm long, and near its mid-length its two diameters (in its present distorted state) measure about 32 mm and 27 mm.

No trace of surface ornamentation of the test is retained on the holotype. However, its preservation is such that it is unlikely that any but very prominent ornamentation would have been retained.

The camerae are long, and those of the holotype average about 20 mm in length. The two adoral camerae of this specimen are slightly shorter than the preceding one, suggesting that it is a fully mature individual. Except possibly along the venter, the sutures are straight and directly transverse. The siphuncle is small and is ventral and marginal in position, apparently being in contact with the conch along the venter.

*Remarks.*—This species resembles rather closely *Bactrites? cherokeensis* MILLER & OWEN of the Cherokee of west-central Missouri, *B.? collinsi* MILLER & UNKLESBAY of the Conemaugh of southwestern Pennsylvania, and *B.? mexicanus* MILLER of the Middle and Upper Permian of southwestern Coahuila. The first two of these species, which, like the one under consideration are known from only unique specimens, have relatively short camerae. *B.? mexicanus*, like *B.? winteretensis*, has very long camerae, and these two species seem to resemble each other very closely; however, in view of the difference in their age, it seems probable that the relationship between them is more apparent than real. *B.? carbonarius* SMITH of the Moorefield shale of northern Arkansas and possibly northwestern Peru (H. D. THOMAS, 1928, p. 290), *B.? quadrilineatus* Girty of the Caney shale of southeastern Oklahoma, and *B.? postremus* MILLER of the Gaptank formation of western Texas, may also belong with this group of species. Although these several species seem to possess all of the features that are generally regarded as characteristic of *Bactrites*, in general physiognomy they do not resemble typical representatives of that genus, for example, *B. subconicus* SANDBERGER of the Middle Devonian of Germany.

*Occurrence.*—Upper part of Winterset limestone in a quarry on the east bank of the Big Blue River a quarter of a mile north of 15th Street in Kansas City, Missouri.

*Holotype.*—The University of Kansas no. 558.

## GENUS *LIROCERAS* TEICHERT, 1940

### *Liroceras milleri* (NEWELL)

Plate 2, figures 1-6

*Coloceras milleri* NEWELL, 1936, Jour. Paleontology, vol. 10, p. 481-483, pl. 68, figs. 1a-4; pl. 69, figs. 1, 2; pl. 70, fig. 1.

Two of the paratypes of this species are from near Kansas City, probably from the Winterset limestone, and in addition we have three small con-

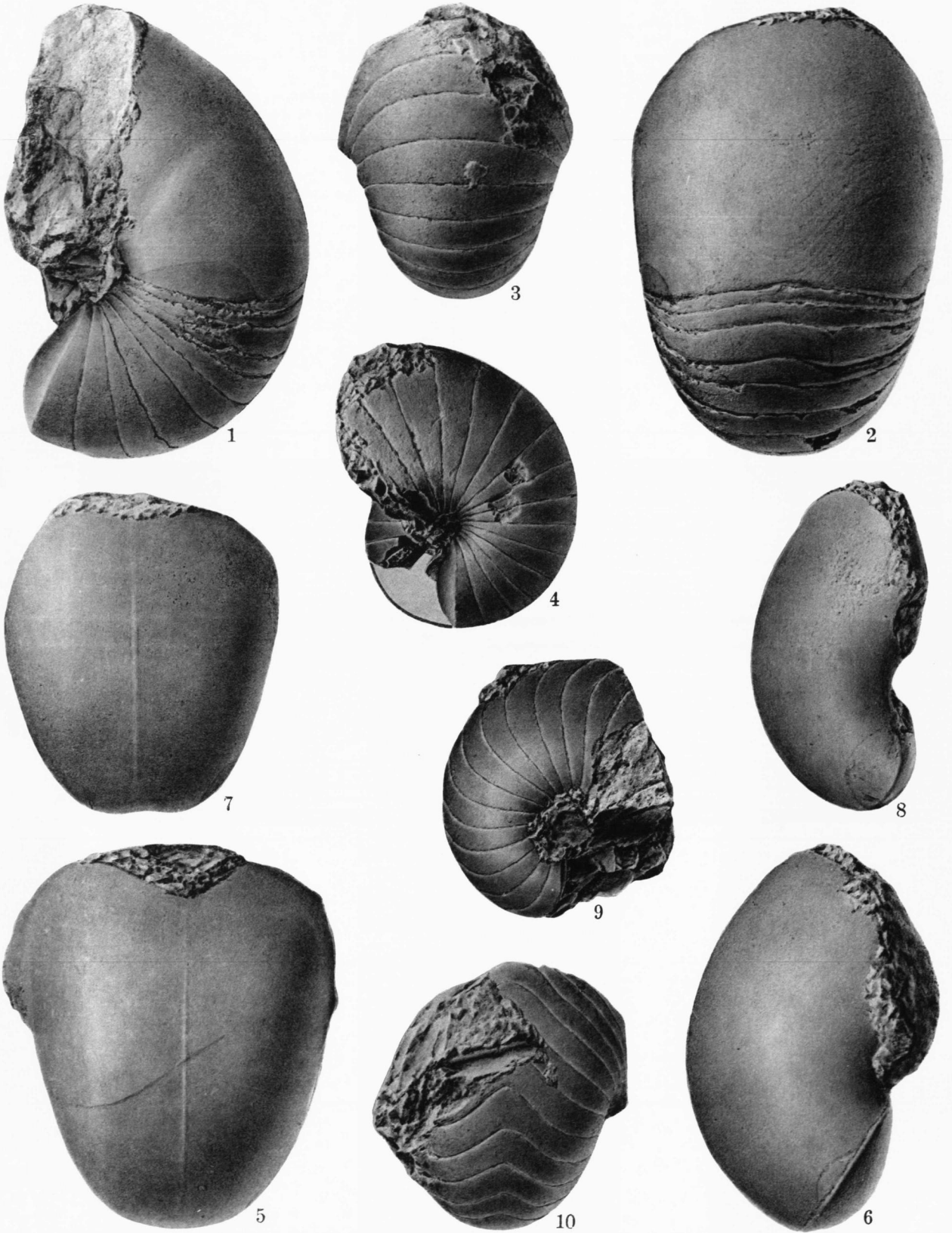
## EXPLANATION OF PLATE 2

With the possible exception of figures 1, 2 and 5, 6, all specimens illustrated on this plate are from a dark-brown to purple 1 $\frac{3}{4}$ -foot crystalline limestone member of the upper part of the Winterset limestone in the Missouri River bluff about half a mile northeast of Sugar Creek station, just northeast of Kansas City, Missouri. The two specimens represented by figures 1, 2 and 5, 6 are also from near Kansas City, probably from the Winterset.

### FIGURE

1-6—*Liroceras milleri* (NEWELL). Two of the paratypes (figs. 1, 2 and 5, 6) and a hypotype (figs. 3, 4),  $\times 1$ ..... 4  
7-10—*Ehippioceras ferratum* (Cox). Two hypotypes,  $\times 1$ ..... 6

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specific specimens from that formation just northeast of Kansas City. Both of the paratypes show on the lateral zones of the adapical portion of the living chamber the structures that NEWELL interpreted as scars of attachment of the muscles to the shell. The surface of the internal mold of the living chamber bears fine longitudinal lines as well as traces of the growth-lines—the latter form a deep rounded hyponomic sinus. The larger of the paratypes that we are illustrating has very closely spaced adoral septa, suggesting that it is a fully mature individual, and in the adoral portion of its phragmacone the sutures form a distinct ventral saddle, as noted by NEWELL. Throughout the rest of the phragmacone of this individual, the sutures are essentially straight and directly transverse as they are in the smaller specimen represented by figures 3 and 4 on Plate 2.

The other paratype that we are figuring (Pl. 2, figs. 5, 6) represents only the living chamber, but it is remarkably complete and unusually well preserved. The hyponomic sinus in this specimen is rather narrowly rounded and is about 17 mm deep.

*Remarks.*—This species was described in detail by NEWELL. His type specimens are available to us for study, and they fully substantiate his statements in regard to the various morphological features of the conch. As noted by NEWELL, this species can be readily distinguished from all of the congeneric forms known from America, at least, by its small closed umbilicus, deeply impressed whorls, and relatively large size.

*Occurrence.*—The holotype and several of the paratypes of this species came from the oölitic Farley limestone along Kill Creek at De Soto, Johnson County, Kansas. The two paratypes we are figuring came from near Kansas City, Missouri, probably from the Winterset limestone. The specimen represented by figures 3 and 4 on Plate 2, and two smaller unfigured specimens are from a dark-brown to purple 1¼-foot crystalline limestone member of the upper part of the Winterset limestone in the Missouri River bluff about half a mile northeast of Sugar Creek station in sec. 22, T. 50 N., R. 32 W., just northeast of Kansas City, Missouri. It should also be stated that NEWELL indicates that this species may occur in the upper part of the Argentine limestone near Welborn, Wyandotte County, Kansas.

*Repository.*—The University of Kansas, two paratypes, no. 2178; a hypotype, no. 559 (Pl. 2, figs. 3, 4); two unfigured specimens, no. 560.

### GENUS *CONDRAOCERAS*, new genus

Genotype: *Condraoceras primum*, new species

Conch moderate in size, thickly subdiscoidal in shape, and nautiliconic in its mode of growth, with whorls that are subcircular in cross section but are impressed dorsally to about two-sevenths their height. Umbilicus moderately small and umbilical shoulders rounded. Sutures form slight ventral lobes, similar ventrolateral saddles, somewhat deeper lateral lobes, umbilical saddles, and dorsal lobes. Siphuncle subcentral in position, small (at least at

its passage through the septa), and most probably orthochoanitic in structure.

This genus is named in honor of Dr. G. E. CONDRA of the Nebraska Geological Survey. It is perhaps closest to *Liroceras* TEICHERT and *Coelogasteroceras* HYATT. It differs from the former particularly in that its whorls are about as high as wide; and from the latter it is readily differentiated by the fact that its venter is not retuse.

Only one species is known that belongs in this genus. It occurs in the Winterset limestone of west-central Missouri.

### *Condraoceras primum*, new species

Plate 3, figures 5, 6; Plate 4, figures 1, 2

This species is being based on two moderately well preserved internal molds. The larger of them (Pl. 4, figs. 1, 2), classed as the holotype, shows that the phragmacone attains a maximum diameter of at least 100 mm. Near the mid-length of the preserved part of the outer volution of this specimen (which seems to be essentially free from distortion), the conch is about 41 mm high and 43 mm wide. The other specimen (Pl. 3, figs. 5, 6) is completely septate, and it attains a maximum diameter of about 90 mm. At a break near the mid-length of the outer volution of this specimen (which seems to be slightly crushed laterally) the conch is about 40 mm wide and 45 mm high, and the dorsal impressed zone is about 13 mm deep.

The umbilicus is moderately small, and the umbilical shoulders are rounded and indefinite. The maximum diameter of the umbilicus of the paratype measures some 18 mm, which is approximately one-fifth the corresponding diameter of the conch.

No trace of surface ornamentation is preserved on either of the types, internal molds.

The camerae are moderate in length. Each suture forms a broad shallow broadly rounded ventral lobe and on either side of it a similar ventrolateral saddle, a somewhat deeper and broader lateral lobe, and a low umbilical saddle that extends to the rounded dorsal lobe.

The siphuncle is small, at least at its passage through the septa, and is subcentral in position. Where the conch of the paratype is about 45 mm high, the siphuncle is about 3½ mm in diameter and its center is some 20 mm from the venter and some 12 mm from the dorsum (the bottom of the impressed zone).

*Remarks.*—This species is the only known representative of the new genus *Condraoceras*. In view of the fact that no congeneric forms are known, detailed specific comparisons are superfluous.

*Occurrence.*—Upper part of Winterset limestone about half a mile northeast of Sugar Creek station, Jackson County, Missouri.

*Types.*—The University of Kansas, holotype, no. 561; paratype, no. 562.

GENUS **EPHIPPIOCERAS** HYATT, 1884**Ephippioceras ferratum** (COX)

Plate 2, figures 7-10

- Nautilus ferratus* COX, 1857, Kentucky Geol. Survey, Rept. 3, p. 574-575, pl. 10, figs. 2, 2a.
- (?) *Nautilus divisus* WHITE & ST. JOHN, 1867, Chicago Acad. Sci., Trans., vol. 1, p. 124.
- Ephippioceras ferratum* HYATT, 1883, Boston Soc. Nat. History, Proc., vol. 22, p. 290. —(?) HYATT, 1894, Am. Philos. Soc., Proc., vol. 32, p. 539, pl. 10, figs. 23-26. —MORGAN, 1924, [Oklahoma] Bur. Geology, Bull. 2, pl. 51, fig. 7. —MILLER, DUNBAR & CONDRA, 1933, Nebraska Geol. Survey, Bull. 9, 2d ser., p. 112, 113, 114-118, pl. 3, figs. 14-17. —MILLER & OWEN, 1934, Iowa Univ. Studies Nat. History, vol. 16, p. 194, 195, 209-211, 213, pl. 12, figs. 3, 4. —MILLER & UNKLESBAY, 1942, Carnegie Mus., Ann., vol. 29, p. 128, 129, 130, 136, pl. 1, figs. 14, 15. —STURGEON, 1946, Jour. Paleontology, vol. 20, p. 11, 12, 18-19, pl. 4, figs. 2-4. —MILLER & UNKLESBAY, 1947, Carnegie Mus., Ann., vol. 30, p. 320, pl. 1, figs. 7, 8.
- Ephippioceras clitellarium?* [part] FOORD, 1891, Cat. foss. Ceph. British Mus., pt. 2, p. 101-103.
- Ephippioceras (Nautilus) ferratum* HYATT, 1891, Texas Geol. Survey, Ann. Rept. 2, p. 352.
- Ephippioceras ferratus* SCHMIDT, 1929, Tierische Leitfossilien des Karbon, p. 60.
- Ephippioceras divisum?* SAYRE, 1930, Univ. Kansas Sci. Bull., pt. 2, vol. 19, p. 82, 153-154, pl. 20, figs. 1-2a.

This ubiquitous species is represented in the collections we are studying by three specimens, all of which are internal molds. One of them (Pl. 2, figs. 9, 10), though well preserved, is incomplete and represents only part of a phragmacone. Its maximum diameter measures only about 24 mm. This specimen shows the characteristic subglobular rapidly expanded conch, small umbilicus, and external sutures which form prominent narrowly rounded ventral saddles and broad shallow rounded lateral lobes.

The specimen represented by figures 7 and 8 on Plate 2 is an essentially complete internal mold of a living chamber. It is particularly noteworthy in that it retains the apertural margins. The over-all length of this specimen measures about 55 mm, and near its mid-length the height of the conch is about 25 mm and the corresponding width about 44 mm; the dorsal impressed zone is about 16 mm wide and 6 mm deep. The adapical end of this specimen is formed by an impression of the adoral septum of the phragmacone. It shows that the sutures are typical of the species and that the siphuncle is small and is subcentral in position but is distinctly closer to the dorsum than the venter. The apertural

margins form a broad rounded ventral or hyponomic sinus that is about 9 mm deep.

The other specimen is intermediate in size between the two figured. It represents most of the phragmacone and the living chamber, but it is somewhat distorted and not very well preserved. Its maximum diameter, which was affected somewhat by the distortion that it has obviously undergone during preservation, measures about 47 mm.

*Remarks.*—This species was described in detail by MILLER, DUNBAR & CONDRA. The specimens under consideration coincide well with their diagnosis, but they show that the living chamber, when complete, is almost one-half (rather than one-third) of a volution in length.

*Occurrence.*—This species is widely distributed in the Pennsylvanian of North America. It is known to range from Pennsylvania on the east to Nebraska on the west, and stratigraphically from the base of the Cherokee (Atoka of Arkansas) to the top of the Lansing (South Bend of Nebraska). All three of the specimens discussed above came from a dark-brown to purple 1¼-foot crystalline limestone member of the upper part of the Winterset limestone in the Missouri River bluff about half a mile northeast of Sugar Creek station in sec. 22, T. 50 N., R. 32 W., just north-east of Kansas City, Missouri.

*Repository.*—The University of Kansas no. 563 (two figured specimens), no. 564 (unfigured specimen).

GENUS **KNIGHTOCERAS** MILLER & OWEN, 1934**Knightoceras abundum**, new species

Plate 3, figures 1-4

The Winterset limestone has yielded five specimens that represent a new species of this rare genus. The conch of this new form consists of at least two and one-half volutions. It is moderately large, subglobular in shape, and rapidly expanded orad—the largest specimen, designated as holotype (Pl. 3, figs. 1, 2), attained a maximum diameter of more than 100 mm.

The inner volutions of the conch are sublenticular in cross section, being rather strongly depressed dorsoventrally, broadly rounded ventrally, subangular laterally, and in general broadly rounded dorsally but slightly impressed along the dorsum. The ventral side of the conch is less highly arched than is the dorsal. At full maturity the conch is subelliptical in cross section as the whorls become narrowly rounded, rather than subangular, laterally; and in the adoral portion of large individuals the ventral zone becomes slightly but distinctly con-

## EXPLANATION OF PLATE 3

All specimens illustrated on this plate are from the upper part of the Winterset limestone about half a mile north-east of Sugar Creek station, just northeast of Kansas City, Missouri.

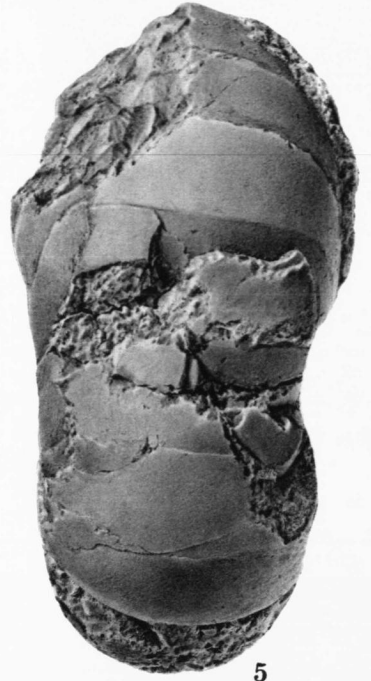
| FIGURE                                                                                                                     | PAGE |
|----------------------------------------------------------------------------------------------------------------------------|------|
| 1-4— <i>Knightoceras abundum</i> , n. sp. 1, 2, Lateral and ventral views of the holotype, × 1; 3, 4, a paratype, × 1..... | 6    |
| 5, 6— <i>Condraoceras primum</i> , n. sp. A paratype, × 1. See, also, Plate 4.....                                         | 5    |



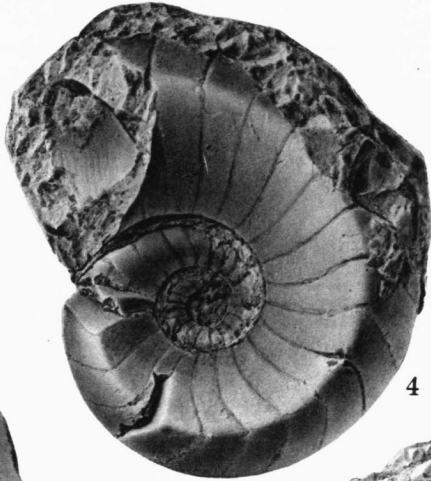
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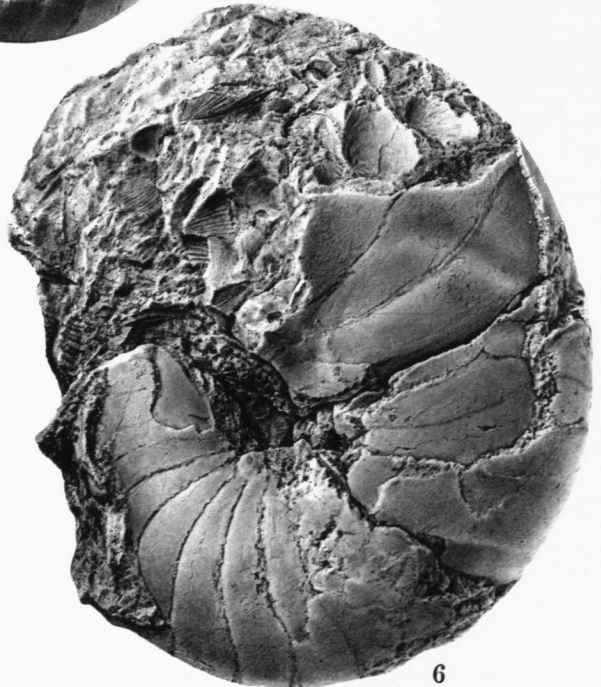
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6





cave. The dorsal impressed zone is rather shallow throughout ontogenetic development.

The large specimen (holotype) represented by figures 1 and 2 on Plate 3 represents only the living chamber, and it is about one-third of a volution in length. The adapical end of this specimen is formed by an impression of a septum, and at the junction of the phragmacone and the living chamber, the conch was about 55 mm wide and 31 mm high, and the dorsal impressed zone was about 22 mm wide and 3 mm deep. Near the mid-length of the outer volution of the paratype represented by figures 3 and 4 on Plate 3, the conch is about 34 mm wide and 17 mm high.

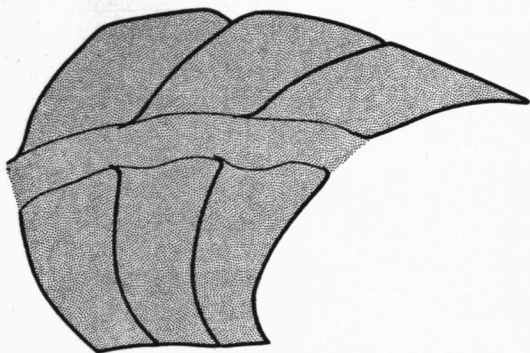


FIGURE 2.—Median longitudinal dorsoventral section of three camerae of one of the paratypes of *Knightoceras abundum*, n. sp., showing the siphuncle at full maturity,  $\times 2$ .

The umbilicus is large and deep and almost certainly is perforate. Its diameter is equal to almost two-thirds that of the conch. The umbilical walls are moderately steep and are considerably convex.

Growth-lines are preserved on the umbilical wall of an inner volution of one of the paratypes. They are fine and are very slightly sinuous but are essentially straight and directly transverse. Another specimen has fine longitudinal lines on a comparable portion of the conch; inasmuch as these are not crossed by transverse lines, it seems probable that they are located on an inner layer of the test.

The camerae are rather short, and in the adoral volution of the figured phragmacone there are 21 camerae. Each suture forms a broad rounded ventral lobe and on either side of it a subangular (at full maturity narrowly rounded) lateral saddle (which centers on the umbilical shoulder), a rather shallow broadly rounded lobe on the umbilical wall, and centering on the umbilical seam a low saddle which extends to a broad shallow rounded dorsal lobe.

The siphuncle is small and is subcentral in position but is distinctly closer to the venter than the dorsum. The structure of the siphuncle is ortho-

choanitic, and the septal necks are short and are only about one-eighth as long as the connecting rings, which are essentially cylindrical. The size and structure of the siphuncle are elucidated by Figure 2.

*Remarks.*—This species seems to resemble rather closely the genotype, *Knightoceras missouriense* MILLER & OWEN of the Cherokee of west-central Missouri. However, only one representative of that species is known, and it is a living chamber of a relatively small specimen that throughout its entire length is subangular laterally. *K. abundum* bears a striking resemblance to *K. [Planetoceras] tiltoni* (MILLER, DUNBAR & CONDRA) of the Kansas City group (Bethany Falls limestone) of south-central Iowa, but at full maturity that species attains a much larger size. Only one representative of it is known. *K. subcariniferum* (TZWEATEV) of the Lower Pennsylvanian (Dewiatowo oölite) of central European Russia is also similar; as in *K. tiltoni*, its conch attains a larger size than does that of our species.

*Occurrence.*—Dark-brown to purple 1¼-foot crystalline limestone in the upper part of the Winterset limestone in the Missouri River bluff about half a mile northeast of Sugar Creek station in sec. 22, T. 50 N., R. 32 W., just northeast of Kansas City, Missouri.

*Types.*—The University of Kansas, holotype, no. 565; paratype (Pl. 3, figs. 3, 4), no. 566; paratype (Fig. 2), no. 567; unfigured paratypes, no. 568.

## GENUS METACOCERAS HYATT, 1883

### *Metacoceras jacksonense*, new species

Plate 1, figure 9

The holotype of this species is an internal mold that represents all the phragmacone and the adapical quarter-volution of the living chamber. The conch is thickly subdiscoidal in shape, and the holotype is about 53 mm in diameter. The whorls are irregularly hexagonal in cross section, being convex ventrally, slightly concave laterally, essentially flat dorsolaterally, and slightly concave dorsally. Near the mid-length of the adoral quarter-volution of the phragmacone, the conch is about 18 mm high and 20 mm wide, the maximum width being attained at the umbilical shoulders, inasmuch as the lateral zones of the conch are slightly converged ventrad.

The umbilicus is large and that of the holotype attains a maximum diameter of about 34 mm. The umbilical walls are broad and are not steep, being inclined to the nearly flat lateral zones of the conch at an angle of some 45 to 50 degrees. The umbilical perforation is ovate, and its two diameters measure about 4 mm and 6 mm.

The adapical portion of the conch seems to be circular or nearly so in cross section and to be ex-

panded orad very rapidly. At least by the time the conch had completed one full volution, it had developed both ventrolateral and dorsolateral nodes. The ventrolateral nodes seem to have been developed first, and there are no dorsolateral nodes on the adapical half-volution of the conch. Furthermore, throughout the length of the holotype, the ventrolateral nodes are more prominent than the dorsolateral ones, though both became progressively larger as ontogenetic development progressed. The ventrolateral nodes are rounded and are quite distinct from one another, but the dorsolateral ones are longitudinally elongate so as to form an almost continuous ridge along the umbilical shoulder.

Small fragments of the test, which adhere to the umbilical wall of the first volution of the holotype, show that the growth-lines there are almost directly transverse and essentially straight, though they are somewhat curved in the immediate vicinity of the nodes.

Each external suture forms a broad shallow rounded ventral lobe, a subangular ventrolateral saddle, a shallow slightly asymmetrical rounded lateral lobe, a low dorsolateral saddle on the umbilical shoulder, and a very slight lobe on the umbilical wall.

*Remarks.*—We are referring with question to this species a large only moderately well preserved specimen from a lower horizon in the Winterset than that which yielded the holotype. It attains a maximum diameter of about 87 mm and is not complete adorally. The portion of this specimen that represents living chamber is about one-third of a volution in length. The adoral camera of the phragmacone is only about half as long as the preceding one, suggesting that the specimen represents a fully mature individual. On the adoral half-volution of this specimen there are about ten prominent rounded ventrolateral nodes on each side of the conch and about eight dorsolateral nodes—the latter seem to be obliquely elongate. The umbilical walls are broad and are inclined to the lateral zones of the conch at an angle of some 45 degrees.

This species is readily differentiated from *Metacoceras mutabile*, n. sp., with which it is associated, by the fact that the ornamentation of its test increases rather than decreases in prominence during ontogenetic development. It can be distinguished from other similar congeneric forms by its dorso-lateral nodes.

*Occurrence.*—The holotype is from a dark-brown to purple 1¼-foot crystalline limestone in the upper part of the

Winterset limestone in the Missouri River bluff about half a mile northeast of Sugar Creek station in sec. 22, T. 50 N., R. 32 W., just northeast of Kansas City, Missouri. The specimen we are referring with question to this species was found by NORMAN D. NEWELL in the lower part of the Winterset limestone near the center of the south side of sec. 10, T. 18 S., R. 24 E., Miami County, east-central Kansas.

*Repository.*—The University of Kansas, holotype, no. 569; specimen referred with question to this species, no. 7428.

### *Metacoceras mutabile*, new species

Plate 1, figures 5-8

Five specimens from the upper part of the Winterset limestone near Kansas City and one from the lower part of the same formation at a nearby locality constitute the basis for this species. The conch is thickly subdiscoidal in shape and at full maturity consists of about two and one-half volutions. The holotype (Pl. 1, fig. 7) is about 67 mm in diameter, and near its adoral end its conch is about 29 mm high and 40 mm wide. The living chamber of a paratype (Pl. 1, figs. 5, 6) attains a maximum width and height of conch of about 42 mm and 33 mm, respectively. At the adoral end of this specimen the dorsal impressed zone is about 18 mm wide but only about 1½ mm deep.

Small specimens like the paratype illustrated by figure 8 on Plate 1 show that the umbilicus is perforate, that the adapical portion of the conch is rapidly expanded orad, and that during adolescence the conch bears both dorsolateral and ventrolateral nodes which are connected by transverse extensions so as to form lateral ribs. The nodes in the two series are of about equal prominence. Similar ornamentation occurs on the adapical portion of the holotype. This specimen shows that after the conch has completed about one and one-quarter volutions, the dorsolateral (umbilical) nodes become obsolete and the umbilical shoulders subangular. The ventrolateral nodes, however, continue throughout ontogenetic development, but they lose their lateral extensions at about the same stage of development at which the dorsolateral nodes disappear.

The extreme adapical portion of the conch seems to be circular, or nearly so, in cross section. However, the fully mature portions are, in general, convex ventrally (though essentially flat along the venter) and almost flat laterally; the umbilical walls are slightly convex, and the dorsal zone is distinctly concave.

The surface of the test bears fine growth-lines. These are almost straight on the umbilical walls

#### EXPLANATION OF PLATE 4

Both specimens illustrated on this plate are from the upper part of the Winterset limestone about half a mile northeast of Sugar Creek station, just northeast of Kansas City, Missouri.

#### FIGURE

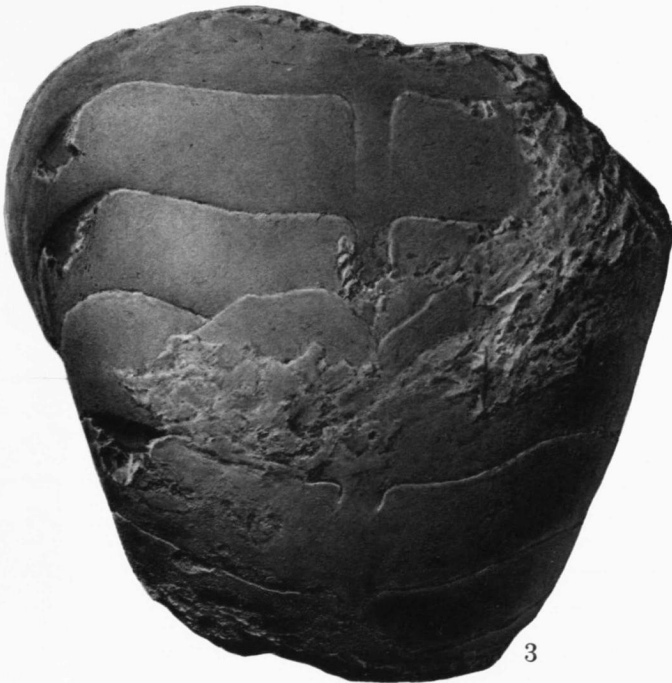
- |                                                                                      |           |
|--------------------------------------------------------------------------------------|-----------|
| 1, 2— <i>Condraoceras primum</i> , n. sp. The holotype, × 1. See, also, Plate 3..... | PAGE<br>5 |
| 3, 4— <i>Solenochilus missouriensis</i> , n. sp. The holotype, × 1.....              | 10        |



1



2



3



4





and the lateral zones of the conch, but they form a broad deep rounded ventral sinus.

The sutures are like those of other congeneric species—that is, each forms a broad rounded ventral lobe, and on either side of it a subangular ventrolateral saddle, a broad rounded lateral lobe, and a small low dorsolateral saddle on the umbilical shoulder; they are essentially straight and directly transverse on the umbilical walls, and form a broad rounded dorsal lobe. The siphuncle is small in size, subcentral in position (but closer to the venter than the dorsum), and orthochoanitic in structure, being composed of cylindrical segments.

*Remarks.*—The specific name is given in reference to the variation in the surface ornamentation of the test during ontogenetic development. *Metacoceras mutatum* MILLER of the Middle Permian Leonard formation of western Texas also changes its surface markings greatly during ontogenetic development, but in that species the prominence of the ornamentation increases rather than decreases adorally. In *M. jacksonense*, n. sp., there are dorsolateral nodes at full maturity but not during adolescence, which is just the reverse of the situation in *M. mutabile*, which occurs in association with it. *M. angulatum* SAYRE of the Kansas City group (Westerville limestone) of Kansas has relatively small ventrolateral nodes.

*Occurrence.*—The holotype and four of the paratypes are from a dark-brown to purple 1¼-foot crystalline limestone in the upper part of the Winterset limestone in the Missouri River bluff about half a mile northeast of Sugar Creek station in sec. 22, T. 50 N., R. 32 W., just northeast of Kansas City, Missouri. The fifth paratype (Pl. 1, figs. 5, 6) was found by NORMAN D. NEWELL in the lower part of the Winterset limestone near the center of the south side of sec. 10, T. 18 S., R. 24 E., Miami County, east-central Kansas.

*Types.*—The University of Kansas, holotype, no. 570; figured paratypes from near Kansas City, no. 571; figured paratype from Miami County, Kansas, no. 572; unfigured paratypes, no. 573.

## GENUS *DOMATOCERAS* HYATT, 1891

### *Domatoceras kleihegei*, new species

Plate 5, figures 1-6

The holotype of this species (Pl. 5, figs. 1-3) is an essentially complete internal mold of a mature specimen. Its maximum diameter measures about 102 mm. The conch is discoidal in shape, as the whorls are strongly compressed, flattened laterally, subangular ventrolaterally, and slightly but distinctly concave ventrally. The ventral side of the outer volution of the holotype is concave throughout all of its length. However, in the adoral half of the living chamber, the amount of concavity becomes very small indeed; also, in this portion of the specimen the ventrolateral shoulders become rounded, the umbilical shoulders subangular and distinctly flared, and the umbilical walls very steep.

The flattened lateral zones of the conch are slightly but distinctly converged ventrad, particularly in the adoral half of the living chamber. At the junction of the phragmacone and the living chamber of the holotype, the conch is about 24 mm wide and 40 mm high and the ventral zone is about 16 mm wide. The living chamber is about half a volution in length. The apertural margins form broad rounded lateral salients and a narrowly rounded ventral or hyponomic sinus which is about 23 mm deep.

The umbilicus is small for this genus and that of the holotype attains a maximum diameter of only about 17 mm. The umbilical shoulders are rounded except in the adoral part of the living chamber where they become subangular.

The camerae are moderately short, and the adoral two of the holotype are particularly so, suggesting that the specimen represents a fully mature individual. Each external suture forms a broad rounded ventral lobe, and on either side of it a subangular ventrolateral saddle, a very broad rounded lateral lobe, and a small rounded saddle on the umbilical shoulder. The ventral lobe of the adoral sutures is rather deep, whereas that of the other sutures is shallow.

The siphuncle is small and is located fairly close to the venter. At the adoral end of the phragmacone of the holotype the distance from the siphuncle to the ventral wall of the conch is about 5 mm.

The small paratype represented by figures 4-6 on Plate 5 came from the same horizon and locality as the holotype and presumably is conspecific with it. It is septate throughout and therefore represents only phragmacone. Its maximum diameter measures about 34 mm, and near its adoral end its conch is about 20 mm wide and 22 mm (estimated) high. The maximum diameter of the umbilicus of this specimen measures about 10 mm. As shown by figure 6 on Plate 5, the umbilicus is perforate during at least early growth stages.

The extreme adapical portion of the conch is expanded orad very rapidly and is subcircular in cross section. However, before the conch had completed one full volution, the dorsal side of it became somewhat flattened. The first sutures are essentially straight and directly transverse and are therefore simple circles. However, at the adoral end of the first volution of the conch, the sutures form shallow lateral lobes and a distinct ventral saddle which is rounded; this portion of the conch is not flattened ventrally. In the next quarter-volution, the conch becomes flattened ventrally and laterally and subangular ventrolaterally, and the sutures become straight across the ventral zone but continue to form broad shallow lateral lobes. In the next quarter-volution the sutures develop slight ventral lobes, but the ventral side of the conch remains flat. A third specimen, not figured, is almost 50 mm in

diameter, and even the adoral portion of its conch has a flat ventral zone. Except possibly in the adapical half-volution of the conch, the siphuncle is small and is located fairly close to the venter.

*Remarks.*—This species is named in honor of Mr. J. B. KLEIHEGE of Kansas City, Missouri, who collected many of the specimens on which the present report is based. It is not very similar to *Domatoceras umbilicatum* HYATT of the Cherokee of Kansas, but it resembles very closely *D. moorei* MILLER, DUNBAR & CONDRA of the Kansas City group (Corbin City limestone) of the same state, in which, however, the ventral zone of the conch is flat throughout maturity. These two species are more or less intermediate between typical *Domatoceras* and typical *Stenopoceras*, but in our opinion they are closer to the genotype of the former than to that of the latter.

*Occurrence.*—Dark-brown to purple 1¼-foot crystalline limestone in the upper part of the Winterset limestone in the Missouri River bluff about half a mile northeast of Sugar Creek station in sec. 22, T. 50 N., R. 32 W., just north-east of Kansas City, Missouri.

*Types.*—The University of Kansas, holotype, no. 574; paratype (Pl. 5, figs. 4-6), no. 575; unfigured paratype, no. 576.

GENUS **SOLENOCHILUS** MEEK & WORTHEN,  
1870

***Solenochilus missouriensis***, new species

Plate 4, figures 3, 4

- (?) *Solenochilus collectus* RAYMOND [not MEEK and WORTHEN], 1910, Carnegie Mus., Ann., vol. 7, p. 156. — RAYMOND [not MEEK and WORTHEN], 1911, Pennsylvania Topog. and Geol. Survey Comm., Rept. 1908-1910, p. 86, 88, 96.
- (?) *Solenochilus brammeri*? MILLER & UNKLESBAY, 1942. Carnegie Mus., Ann., vol. 29, p. 128, 130, 144-145, pl. 6, figs. 1, 2; pl. 7, figs. 3-6.

The specimen on which we are basing this species is a moderately well preserved internal mold representing all or part of eight camerae of the phragmacone. The conch is subglobular in shape and is rapidly expanded orad. The whorls are very broadly rounded (almost flat) ventrally, rounded ventrolaterally, slightly concave laterally, subangular dorsolaterally, and almost certainly impressed dorsally. The umbilicus is small, the umbilical shoulders are abrupt and prominent, and the umbilical walls are wide and steep, being almost perpendicular

to the lateral zones of the conch. Near the mid-length of the holotype, the conch is some 50 mm high and some 77 mm wide—the maximum width of conch is attained near the mid-height of the whorls—and the width of the umbilical walls measures about 27 mm and that of the dorsal impressed zone about 18 mm.

No trace of surface ornamentation is present on the holotype, an internal mold. The camerae are moderately long, and the length of those of the holotype (measured along the venter) average almost 17½ mm, but range from about 16 mm to 18½ mm. Each suture forms a broad shallow broadly rounded ventral lobe and on either side of it a rounded ventrolateral saddle, a similar lateral lobe, a subangular dorsolateral saddle (which centers on the umbilical shoulder), and seemingly a very shallow lobe on the umbilical wall.

The siphuncle is ventral and marginal in position, being in contact with the ventral wall of the conch. That of the preserved part of the holotype attains a diameter of at least 6 mm. The septal necks are straight, or nearly so, and are almost half as long as the camerae. Only traces of the connecting rings are preserved in the holotype, but they seem to have been cylindrical.

*Remarks.*—The genus *Solenochilus* is known to occur at many localities in both Europe and North America and to range stratigraphically from the Lower Mississippian to the Lower Permian. In general physiognomy, the species under consideration seems to resemble more closely than any other described form *S. brammeri* MILLER, DUNBAR & CONDRA of the Middle Pennsylvanian Argentine limestone of eastern Nebraska. However, in that species the sutures are essentially straight on the lateral zones of the conch. Also, there is no good reason to believe that *S. missouriensis* attained the gigantic proportions of the holotype of *S. brammeri*. The specimens from the Conemaugh of southwestern Pennsylvania that we described in 1942 as *Solenochilus brammeri*? seem to be closer to the holotype of this species than to that of *S. brammeri*, and they may well belong in *S. missouriensis*.

*Occurrence.*—Dark-brown to purple 1¼-foot crystalline limestone in the upper part of the Winterset limestone in the Missouri River bluff about half a mile northeast of Sugar Creek station in sec. 22, T. 50 N., R. 32 W., just northeast of Kansas City, Missouri.

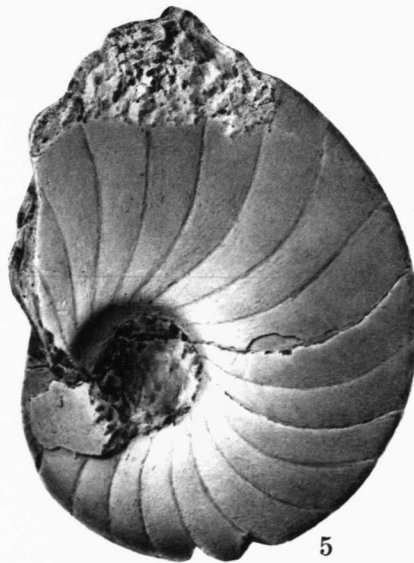
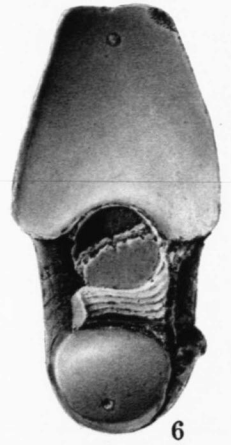
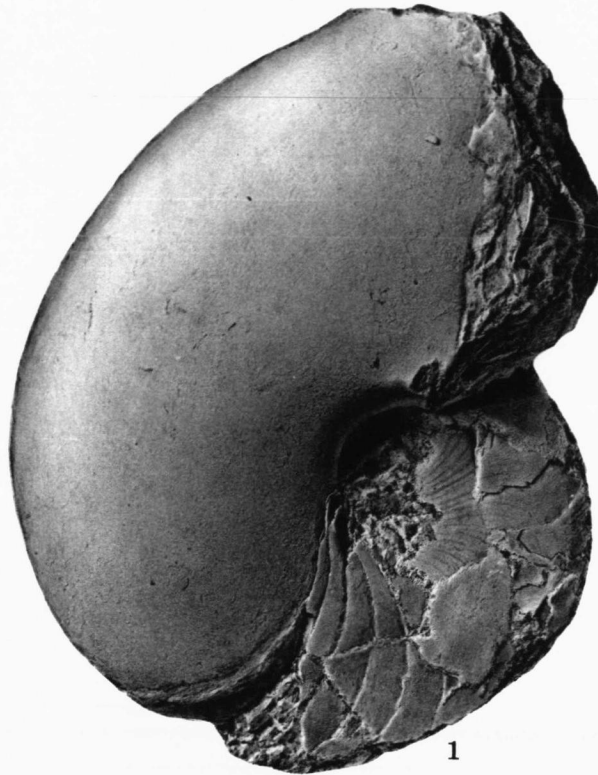
*Holotype.*—The University of Kansas no. 577.

EXPLANATION OF PLATE 5

Both specimens illustrated on this plate are from a dark-brown to purple 1¼-foot crystalline limestone member of the upper part of the Winterset limestone in the Missouri River bluff about half a mile northeast of Sugar Creek station, just northeast of Kansas City, Missouri.

FIGURE

1-6—*Domatoceras kleihegei*, n. sp. The holotype (figs. 1-3), × 1; and a paratype (figs. 4-6), × 2. . . . . 9

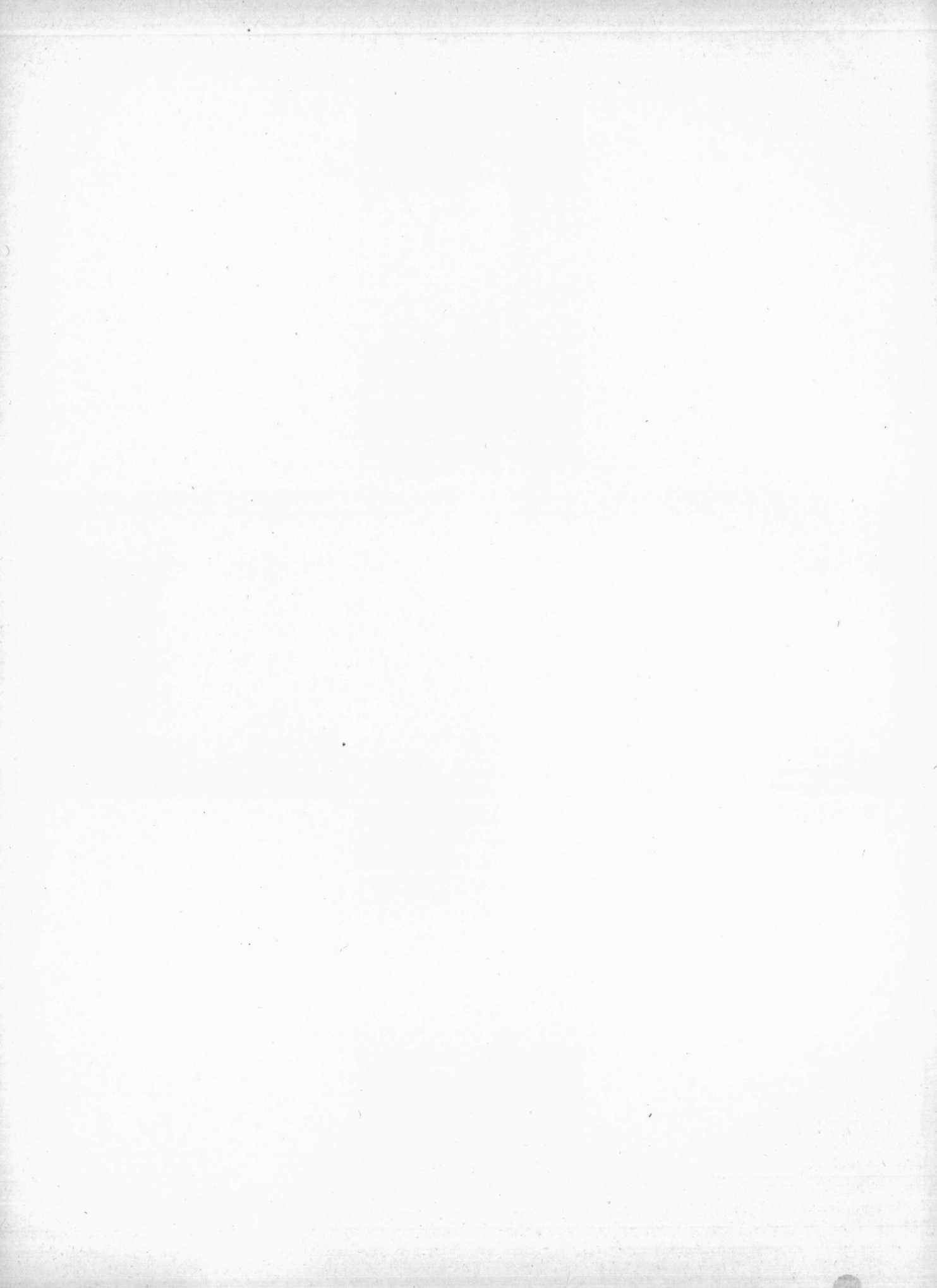






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UNIVERSITY OF KANSAS  
PALEONTOLOGICAL CONTRIBUTIONS

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PUBLICATIONS ISSUED

|                                                                                                                                                                                                                                     | SERIAL<br>NUMBER |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|
| JEFFORDS, R. M., Pennsylvanian lophophyllidid corals: <i>Coelenterata</i> , Article 1, pp. 1-84, pls. 1-28, figs. 1-9. (Issued January 20, 1947.)                                                                                   | 1                |
| MILLER, A. K., and YOUNGQUIST, WALTER, Lower Permian cephalopods from the Texas Colorado River Valley: <i>Mollusca</i> , Article 1, pp. 1-17, pls. 1-3, figs. 1-4. (Issued August, 1947.)                                           | 2                |
| MILLER, A. K., LANE, J. H., JR., and UNKLESBAY, A. G., A nautiloid fauna from the Pennsylvanian Winterset limestone of Jackson County, Missouri: <i>Mollusca</i> , Article 2, pp. 1-11, pls. 1-5, figs. 1-2. (Issued August, 1947.) | 3                |

IN PRESS

THOMPSON, M. L., Studies of American fusulinids: *Protozoa*, Article 1, pp. ●, pls. 1-38, figs. 1-7.



