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**DEVONIAN CEPHALOPODS FROM ALPENA
IN MICHIGAN**

**BY
AUG. F. FOERSTE**



**UNIVERSITY OF MICHIGAN
ANN ARBOR**

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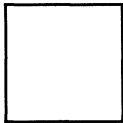
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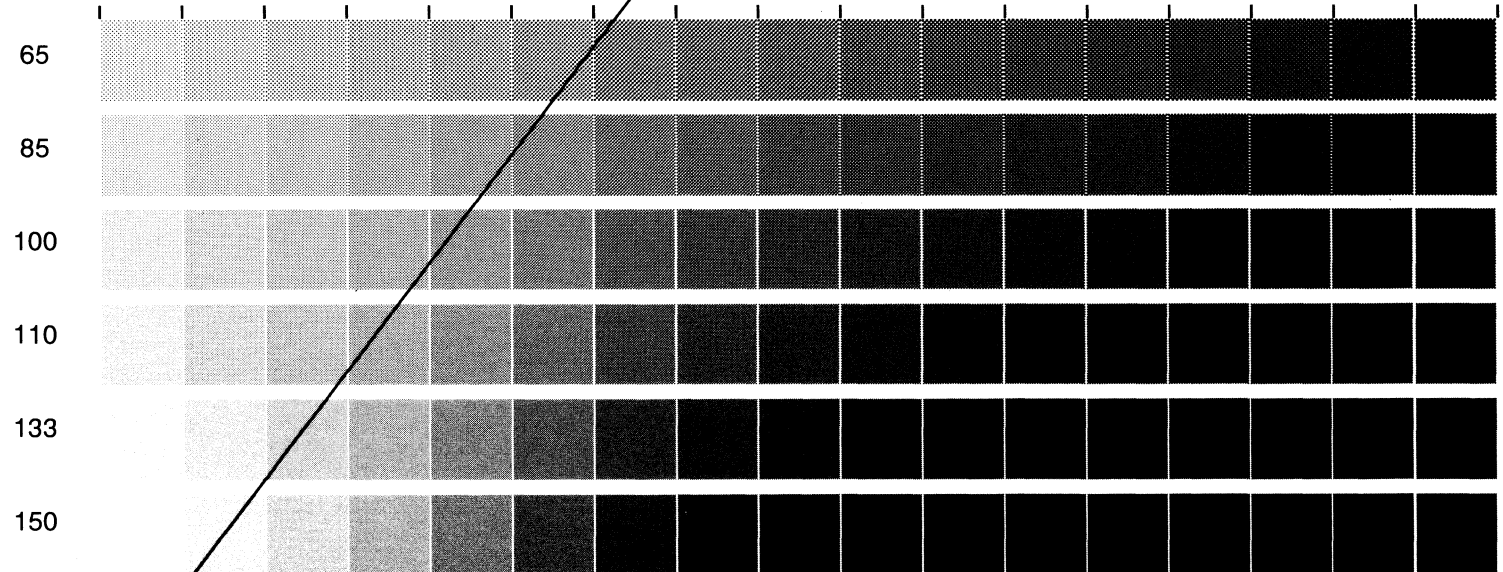
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UNIVERSITY OF MICHIGAN

Editor: EUGENE S. McCARTNEY

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(Continued on inside of back cover)

DEVONIAN CEPHALOPODS FROM ALPENA IN MICHIGAN

AUG. F. FOERSTE

THE northern end of the Southern Peninsula of Michigan is crossed from west to east by the Middle Devonian or Traverse beds. On the eastern side of the peninsula these beds have been divided, in descending order, into the Thunder Bay series, Alpena limestone, Long Lake series, and Bell shale. Of these the upper three divisions are correlated with the Hamilton of New York, while the Bell shale is correlated with the Marcellus of that state. Recently four species of cephalopods have been found in the Alpena limestone, which form the subject of the present paper.

The Alpena limestone specimens are described here under the names *Nephriticerina alpenensis*, *Acleistoceras casei*, *Acleistoceras nummulatum* and *Alpenoceras ulrichi*. The Alpena limestone specimens were obtained in the quarry of the Michigan Alkali Company. Here the quarry is about 121 feet deep, and the cephalopods were found about 30 feet from the bottom. The quarry represents about the full thickness of the Alpena limestone, so that the cephalopods come from the lower part of this limestone. The limestone layer containing these cephalopods is dark, and irregularly bedded, with streaks of black.

Nephriticerina alpenensis evidently is related closely to such forms as *Nephriticeras bucinum*, described by Hall from the Goniatic limestone member of the Marcellus shale and from the Hamilton shale of New York. This species is cited by Stauffer also from the Delaware limestone in the southwestern part of Ontario, in Canada. *Nephriticerina* differs from *Nephriticeras*, however, in being cyrtconic, rather than nautiliconic, in curvature, its conch being scarcely more than half a volution

in length. In this respect, *Nephriticerina* is more primitive in structure than *Nephriticeras*.

In *Acleistoceras nummulatum*, the segments of the siphuncle are slightly longer than broad at earlier stages of growth of the conch, but become distinctly nummuloidal at later stages. The species, therefore, appears to have descended from a form in which the segments of the siphuncle were more or less elongated, rather than nummuloidal in outline. In this respect, *Acleistoceras casei* retains the more primitive form of the segments of the siphuncle, the latter being elongated vertically even at mature stages of growth. Vertically elongated segments of the siphuncle occur also in the species described by Hall as *Gomphoceras impar* from the Onondaga limestone at Columbus, Ohio, and *Gomphoceras poculum* from the Hamilton of New York.

Alpenoceras ulrichi finds its nearest relative in the species described by Hall as *Gomphoceras conradi*, from the Goniatite limestone member of the Marcellus shale of New York. It is less closely related to *Gomphoceras clavatum*, from the Schoharie grit of New York.

Strata equivalent to the Alpena limestone occur also in the southwestern part of Ontario, between 25 and 35 miles north-east of Goderich. With regard to this Ontario equivalent of the Alpena limestone, Stauffer stated that "certain aspects of its fauna bear a marked resemblance to that of the purer portion of the Onondaga limestone." Moreover, "it is a noticeable fact that whenever the Hamilton is represented by limestone, there its fauna resembles more nearly the older Onondaga fauna, as if there were a tendency to revert to those ancestral forms" (*The Devonian of Southwestern Ontario*, by Clinton R. Stauffer, Memoir 34, Geological Survey of Canada, 1915, pp. 148, 149, 226)

With these statements by Stauffer in regard to the general Hamilton fauna, the few cephalopods known so far from the Alpena limestone of Michigan agree. These Alpena cephalopods readily could be of Onondaga age, though similar forms are known in the Hamilton.

Paleogeographically, the Alpena limestone appears much more closely related to the Middle Devonian of Ontario, Ohio and

New York, than to the Milwaukee limestone of Wisconsin or the Cooper limestone of northern Missouri and Iowa.

The correlation of the Thunder Bay series may require revision, at least in part. Recently Professor E. C. Case found some fish in the Thunder Bay series which, he states, are similar to specimens found elsewhere in beds of Chemung age.

In the Zittel-Eastman *Text-book of Paleontology*, Hyatt established the family *Rhadinoceratidae* for the genera *Rhadinoceras* and *Nephriticeras*. To these genera, two new genera, *Lyrioceras* and *Nephriticerina*, are here added and described. The generic name *Alpenoceras* is added to the slowly increasing list of endogastric Devonian cephalopods.

NEPHRITICERAS Hyatt

Genotype: *Nautilus bucinum* Hall, *Palaeontology of New York*, 5, pt. 2, 1879, p. 412, Pl. 60.

Nephriticeras Hyatt, *Proc. Boston Soc. Nat. Hist.*, 22, 1884, p. 300; also *Proc. Amer. Phil. Soc.*, 32, 1894, p. 531.

Volutions about one and a half or two, in contact with each other along the upper part of the phragmacone and the lower part of the living chamber, resulting here in a narrow and shallow dorsal impressed zone. Cross-section approximately elliptical, but more or less flattened dorsally. The ratio of the dorso-ventral to the lateral diameter is as three to four, three to five, or as five to seven, varying in different parts of the same specimen. The aperture of the living chamber is directly transverse to the central axis of the conch, its margin curving slightly downward both dorsally and ventro-laterally. According to Hyatt, the sutures of the septa in the young have ventral and dorsal saddles; only in later stages are these saddles replaced by broad and shallow lobes; but in some specimens the sutures are nearly straight, or may retain slight saddles on their ventral side. The siphuncle is located about one fourth or one third of the dorso-ventral diameter from the dorsal side of the conch. The shape of the segments of the siphuncle has not been determined in the genotype, but is assumed to be oblong vertically.

The surface of the shell is ornamented by sharply elevated longitudinal raised lines, with finer intermediate longitudinal lines, both crossed by very fine transverse lines.

In the genotype, *Nautilus bucinum*, and in the closely related *Nautilus acraeus*, the umbilical opening appears to have been relatively large.

In the much larger species, *Nautilus oriens*, on the contrary, the umbilical opening either was a very narrow slit or was entirely closed. In the equally large species, *Nautilus maximus* and *Nautilus magister*, the character of the umbilical opening is not known definitely. *Nautilus cavus* apparently belongs to the same group as the three preceding species.

Nautilus bucinum was described by Hall from the Goniatite limestone member of the Marcellus shale, and from the Hamilton beds of New York. It is cited by Stauffer from the Delaware limestone at St. Marys, and from the Widder beds of the Hamilton at Arkona; both in southwestern Ontario.

The segments of the siphuncle of *Nautilus magister* are elongated vertically in an oblong manner, similar to those of *Nephriticerina alpenensis*.

RHADINOCERAS Hyatt

Genotype: *Nautilus cornutum* Hall, Palaeontology of New York, 5, pt. 2, 1879, p. 414, Pl. 60.

Rhadinoceras Hyatt, Proc. Amer. Phil. Soc., 32, 1894, p. 530.

Volutions about two, in contact with each other along the upper part of the phragmacone and the lower part of the living chamber, resulting in a distinct, but narrow and shallow, dorsal impressed zone. Cross-section subcircular. Conch enlarging much less rapidly in a lateral direction than in *Nephriticeras bucinum*. The margin of the aperture is approximately at right angles to the central axis of the conch, curving slightly downward and backward along its ventral margin. According to Hyatt, the sutures of the septa are similar to those of *Nephriticeras*, with slight ventral and dorsal lobes, and rather narrow

lateral lobes. The siphuncle is dorsad of the center; the form of its segments is unknown. The surface of the shell is marked by distinct, somewhat irregular, lamellose striae of growth, which are crowded into folds toward the margin of the aperture. These transverse striae are crossed by fine, somewhat distant and irregular, elevated longitudinal striae, which, on some parts of the shell, give a regularly cancellated surface.

Radinoceras differs from typical *Nephriticeras* in enlarging more slowly, especially in a lateral direction, in consequence of which it has a more circular cross-section. Moreover, the impressed dorsal zone begins its formation only at later stages of growth.

Nautilus cornulum was described by Hall from the Hamilton beds of New York.

LYRIO CERAS, gen. nov.

Genotype: *Nautilus liratus* Hall, Palaeontology of New York, 5, pt. 2, 1879, p. 407, Pls. 57, 60.

Volutions about two, barely in contact along the lower part of the living chamber, without any dorsal impressed zone. Cross-section subcircular, changing with increasing age to broad depressed oval. The margin of the aperture is at right angles to the longitudinal axis of the living chamber, and there is no trace of a sinus. The siphuncle is central or subcentral. The phragmacone is obscurely annulated, the annulations being less frequent than the septa, and becoming obsolete on the living chamber. The phragmacone also is boldly ribbed longitudinally, the crest of the ribs being rounded, and the intermediate grooves concave below, becoming flattened toward the upper part of the living chamber. These ribs are most prominent dorsally and laterally, but become more or less obsolete along the ventral side of the living chamber. In addition to the longitudinal ribs there are fine, thread-like, transverse striae. The ribs are conspicuous also on casts of the interior of the conch.

In the closely similar species, *Nautilus subliratus*, there is a conspicuous dorsal impressed zone along the living chamber.

The cross-section is broader and more nephritic in outline. The longitudinal ribs are confined to the dorsal half of the conch, the ventral half presenting only relatively distant, fine, sharply impressed, longitudinal striae, cancelled by finer transverse striae.

Compared with *Nephriticeras* and *Rhadinoceras*, *Lyrioceras* is characterized chiefly by the presence of bold longitudinal ribs, the presence of the latter being indicated even upon casts of the interior of the shell.

Nautilus liratus was described by Hall from the Goniatic member of the Marcellus shale in New York. It is listed by Stauffer also from the Hamilton of Ontario (*The Devonian of Southwestern Ontario*, Memoir 34, Geological Survey of Canada, 1915, p. 236), though nowhere mentioned in his detailed lists of fossils from the individual localities in this area.

Another species of *Lyrioceras* was published recently by Professors G. M. Ehlers and R. C. Hussey (*Papers of the Michigan Academy of Science, Arts and Letters*, 1, 1921, p. 249, pl. 37, fig. 4; pl. 38) under the name *Nephriticeras hindshawi*. It was found in the Long Lake member of the Traverse formation about five miles southwest of Rogers, in Presque Isle County, Michigan. It is closely related to *Lyrioceras liratus*, and assists in establishing the relationship of the Traverse faunas with those occurring in the Middle Devonian of southern Ontario and New York.

NEPHRITICERINA, gen. nov.

Genotype: *Nephriticerina alpenensis* Foerste.

Nephriticerina differs from typical *Nephriticeras* chiefly in its smaller lengthwise curvature, the conch being scarcely more than half a revolution in length. In consequence, there is no dorsal impressed zone. Moreover, the margin of the aperture rises conspicuously in a ventrad direction, producing a convex angulation along the median part of its ventral side. Owing to its cyrtocoenic form, *Nephriticerina* may be regarded as more primitive in type than the more closely coiled *Nephriticeras*.

It should be noted in this connection that neither *Nautilus juvenis* nor *Nautilus hyatti* is known to have a dorsal impressed zone. The assumption that the specimens so named are immature forms, and for this reason show no dorsal impressed zone, may be gratuitous. In *Nautilus juvenis*, however, the aperture is described as transverse to the direction of the conch, and no mention is made of a strong rise of its margin in a ventrad direction, so that it may be distinct from *Nephriticerina*. It agrees with the latter, however, in presenting no sinus along the ventral margin of the aperture.

NEPHRITICERINA ALPENENSIS, sp. nov.

(Plate I, Figs. 1A, B; Plate II; Plate V, Fig. 5)

Conch breviconic, rapidly enlarging, strongly curved lengthwise, but cyrtconic, not completing even a single volution. Length of specimen, measured along its convexly curved ventral outline, about 110 mm.; the corresponding concave dorsal outline being only 40 mm. in length. The dorso-ventral diameter enlarges from 16 mm. at the base of the specimen to 32 mm. on a level with the dorsal margin of the suture at the base of the living chamber, and to 42 mm. on a level with the dorsal margin of the aperture. The corresponding lateral diameters are 19 mm., 42 mm. and 51 mm. The conch evidently is depressed dorso-ventrally, although in the specimen at hand this dorso-ventral depression has been increased somewhat by crushing. Ten camerae are preserved. Measured along the ventral outline of the specimen, the lower three camerae occupy a total length of 11 mm.; the next three, of 19 mm.; the next three, of nearly 25 mm.; and the last or tenth camera, of 5 or 6 mm. The sutures of the septa are straight and directly transverse at the base of the specimen, but near the top of the phragmacone they rise slightly along the ventral half of the conch in a ventrad direction. Along their dorsal half, however, they curve distinctly downward, and end in a broad, shallow dorsal lobe about 3 mm. in depth at the top of the phragmacone. The living chamber is much taller along its ventral outline than dorsally. Its aperture

rises strongly in a ventrad direction, forming an angle of at least 20 degrees with a plane directly transverse to the central axis of the conch at this point. At the top of the fourth camera from the base of the specimen, where the dorso-ventral diameter of the conch is 21 mm., the center of the siphuncle is located 10 mm. from the dorsal margin. At the septal neck, the siphuncle is 2.75 mm. in diameter, but within the camerae the siphuncle enlarges into oblong segments. Within the fifth camera from the base, the enclosed segment is at least 4 mm. in length and is 3.5 mm. in diameter. The shell is about two fifths of a millimeter in thickness. Its surface is longitudinally ribbed with elevated raised lines which leave no trace upon the cast of the interior of the shell. There are about seventy of these vertical ribs within the circumference of the conch along its phragmacone. In addition to these longitudinal ribs there are intermediate and relatively inconspicuous raised lines. The latter number only one or two between adjacent ribs at the base of the specimen, but become relatively numerous along the living chamber. In addition to these vertical markings there are fine, transverse, raised lines, which at the top of the phragmacone number twelve to fourteen in a length of 3 mm.

Locality and Horizon. — From the quarry of the Michigan Alkali Company, at Alpena, Michigan; in the Alpena limestone. Geno-holotype No. 10029 in the Museum of Geology, University of Michigan.

ACLEISTOCERAS Hyatt

Genotype: *Apioceras olla* Saemann, *Palaeontographica*, 3, 1854, p. 163, Pl. 19, Figs. 1 A-C.

Acleistoceras Hyatt, *Proc. Boston Soc. Nat. Hist.*, 22, 1884, p. 277; also Foerste, *Denison Univ. Bull.*, 21, 1926, p. 336, Pl. 44, Figs. 6 A-C.

The genotype preserves only the living chamber and the upper six camerae of the phragmacone; it was described by Saemann from the equivalent of the Onondaga limestone at Columbus, Ohio. The species described by Hall, from the same horizon and locality, as *Gomphoceras plenum*, is closely related

and may be identical. In it, the conch is erect, with the ventral outline more convex than the dorsal one. The point of maximum gibbosity of the ventral outline is four or five camerae beneath the living chamber. The apical end of the conch is not preserved, but it is assumed that, if it were present, there would be a slightly concave vertical curvature along its dorsal outline. The ventral vertical outline of the living chamber inclines backward more strongly than the dorsal outline inclines forward. Along the upper third of the living chamber there is a slight increase in the rate of contraction of the living chamber which finds expression in a reversal of curvature of these vertical outlines from convex to slightly concave. The aperture tends to be triangular, with its dorsal outline distinctly straightened, and its hyponomic sinus angular and slightly produced in a forward direction. In such species as *Gomphoceras eximium* and *Gomphoceras mitra* the segments of the siphuncle are nummuloidal in form but not very broad. In *Gomphoceras impar* these segments are elongated vertically, and have an oblong outline. All of these specimens are from the equivalent of the Onondaga limestone at Columbus, Ohio, and all have the siphuncle located close to the ventral side of the conch, but not in contact with the latter.

Among other species of *Acleistoceras*, not mentioned so far, are those described by Hall under *Gomphoceras gomphus* and *Gomphoceras crenatum* from the equivalent of the Onondaga in Delaware County, Ohio; *Gomphoceras fischeri* from the Goniatile member of the Marcellus shale of New York; and *Gomphoceras cammarus* from the Hamilton in Scott County, in southern Indiana. One specimen, identified by Hall with *Gomphoceras fischeri*, was found in the glacial drift at Ann Arbor, Michigan, and appears lithologically to have come from some part of the Hamilton of the Southern Peninsula of Michigan.

Gomphoceras eximium is cited by Stauffer, under the generic name *Poterioceras*, from the Onondaga of the southwestern corner of Haldimand County, about 25 miles south of Hamilton, Ontario. *Gomphoceras raphanus* is cited by him, also under *Poterioceras*, from the equivalent of the Alpena limestone 30 miles

northeast of Goderich, Ontario. The species last named may be closely related to the species described by Cleland under the name *Gomphoceras whitfieldi*, from the equivalent of the Hamilton at Milwaukee, Wisconsin.

In the second specimen figured by Professor H. F. Cleland from the Hamilton at Milwaukee, Wisconsin, under the name *Gomphoceras calvini* (*The Fossils and Stratigraphy of the Middle Devonian of Wisconsin*, 1911, pl. 37, pl. 36, fig. 2 only), the dorsal outline of the conch is gibbous along the upper part of the phragmacone and slightly concave along the upper part of the living chamber. The sutures of the upper septa curve downward along their dorsal side, but much less than in the specimen figured first (*Ibid.*, pl. 35, pl. 36, fig. 1 only). The siphuncle is located near the ventral wall of the conch. This species differs from typical *Acleistoceras* in the presence of dorsal lobes along the upper sutures of the septa.

Recently E. B. Branson and J. S. Williams (*The Devonian of Missouri*, Missouri Bur. Geol. and Mines, 1922, pp. 158-160) identified from the Grand Tower limestone of southeastern Missouri the species *Gomphoceras* cf. *impar* Hall, *G.* cf. *plenum* Hall, *G. hyatti* Whitfield, and described the new species *G. grand-towerensis*. All these evidently belong to the genus *Acleistoceras*, and indicate the relationship of the Grand Tower fauna with the Middle Devonian faunas of New York and Ohio.

To judge from the change in form of the segments of the siphuncle in *Acleistoceras nummulatum*, in proceeding from the more apical parts of the conch toward the top of this siphuncle, it is assumed that this genus originated from forms in which these segments were elongated vertically, so as to present oval or oblong outlines, but that later these segments became more nummuloidal, so that the latter form appears to predominate in most species of the genus *Acleistoceras*, as far as known at present.

ACLEISTOCERAS CASEI, sp. nov.

(Plate III, Figs. 1 A, B; 2 A, B; Plate V, Figs. 1 A, B, C, 4)

Specimen (Plate V, Figs. 1 A, B, C) consisting of a living chamber, with the upper part of its ventral side still attached. This living chamber is 35 mm. in height; the dorso-ventral diameter at its base is 38 mm., and its lateral diameter is 42 mm.; the corresponding diameters at its aperture are 32 mm. and 34 mm. The vertical outline of the ventral side of the specimen is convex, this convexity being greatest along the lower part of the living chamber and the upper part of the phragmacone. The vertical outline of the dorsal side of the living chamber is slightly concave at mid-height, but it is known, from other specimens, that the dorsal outline of the original complete conch was distinctly gibbous along the lower part of this chamber and the upper part of the phragmacone. The dorsal side of the chamber is slightly flattened, especially along its upper half. The median part of the ventral outline of the aperture is slightly more narrowly rounded, which results in a faint triangularity of the aperture as a whole. The margin of the aperture rises slightly from the dorsal toward the ventral side of the specimen, and then, for a width of about 16 mm. along the median part of this ventral side, the margin of the aperture curves downward 6 mm., forming a relatively conspicuous hyponomic sinus. The suture of the septum at the base of the living chamber slopes slightly downward from the dorsal toward the ventral side of the conch. The concavity of this septum equals 5 mm. Three segments of the upper part of the siphuncle are exposed. Of these, the uppermost segment is 3.5 mm. in length, and the two next beneath are nearly 5.5 mm. in length, measured along their ventral sides. The dorso-ventral diameter of these segments is 3.5 mm. They are about 1 mm. distant from the ventral wall of the conch. Their dorso-ventral vertical section is oval in outline, enlarging somewhat toward the top. The shell is 2 mm. thick ventrally and 1 mm. dorsally. Its surface is striated transversely, the striae being relatively low and indistinct. Dorsally they are directly transverse, but along the median part of the

ventral side they curve downward. This downward curvature is slight along the lower part of the living chamber, but it increases on approaching its upper part, becoming conspicuous at the hyponomic sinus. Holotype No. 10023 in the Museum of Geology, University of Michigan.

A second specimen (Plate III, Figs. 1 A, B), 85 mm. in length, preserves all but the apical end of the phragmacone. Its living chamber is 35 mm. long. At the base of the specimen, where its dorso-ventral diameter is 13 mm., its cross-section is nearly circular. At the base of the living chamber this diameter is 38 mm., and the lateral one is 45 mm. At the aperture of the chamber the corresponding diameters are 30.5 mm. and 37.5 mm. The maximum convexity of the ventral side and the maximum gibbosity of the dorsal side are both at about the second camera beneath the living chamber. The dorsal outline is faintly concave both along mid-height of the phragmacone and along mid-height of the living chamber. The hyponomic sinus is as conspicuous as in the specimen described first. Where the phragmacone is 33 mm. in lateral diameter, a break across the specimen exposed the siphuncle with a diameter corresponding to that of the preceding specimen, but an attempt to work out the form of its segments failed. The shell is thinner than in the preceding specimen, but its surface is similarly striated. Paratype No. 10024 in the Museum of Geology, University of Michigan.

A third specimen (Plate III, Figs. 2 A, B; Plate V, Fig. 4), 88 mm. in length, is closely similar to the preceding. Its living chamber is 30 mm. in height. Its maximum diameter is at the second camera beneath the living chamber. Its cross-section, at the base of the specimen, is nearly circular, and is 18 mm. in diameter. From this it enlarges to a dorso-ventral diameter of 42 mm. and a lateral one of 44.5 mm. at the point of greatest gibbosity of the conch, diminishing to a dorso-ventral diameter of 31.5 mm. and a lateral one of 39 mm. at the aperture. At mid-height of the living chamber, the transverse striae curve downward about 2.5 mm. in a width of 20 mm., but at the aperture the hyponomic sinus has a depth of only 1.5 mm. in a

width of 6 mm. The concave curvature of the dorsal vertical outline is more conspicuous than in the preceding specimen. About 10 camerae occupy a length equal to the maximum lateral diameter of the conch, when counted downward from this diameter. Of these, the upper 4 camerae occupy a total length of 24 mm.; the next 3, of 14 mm.; and the lower 3, of 7 mm. Where the dorso-ventral diameter of the conch is 25 mm., that of the siphuncle is 2.5 mm. and its distance from the ventral wall of the conch is half a millimeter. Its segments are elongated in a vertical direction, and are oval in outline, but oblique in dorso-ventral sections, owing to the slant of the septa in the immediate vicinity of the shell of the conch. The segments are strongly contracted at the septal necks. These segments are exposed only along the lower half of the phragmacone, and it is assumed that the segments of its upper half are elongated similarly in a vertical direction. Paratype No. 10030 in the Museum of Geology, University of Michigan.

Locality and Horizon.— From the quarry of the Michigan Alkali Company at Alpena, Michigan; in the Alpena limestone. Named in honor of Professor E. C. Case, the distinguished paleontologist of the University of Michigan.

ACLEISTOCERAS NUMMULATUM, sp. nov.

(Plate IV, Figs. 1, 2, 3; Plate V, Fig. 3)

Specimen 90 mm. long (Plate IV, Fig. 1; Plate V, Fig. 3), badly crushed in a dorso-ventral direction, but preserved sufficiently well to indicate a form of conch similar to that of *Acleistoceras casei*. The living chamber is 36 mm. in length along its dorsal side; the lateral diameter narrowing from 50 mm. at the base of the chamber to 43 mm. at its top. The upper part of the siphuncle is exposed for a length of 5 segments by the breaking away of the ventral wall of the upper part of the phragmacone. These 5 segments occupy a total length of 22 mm. The fifth segment from the top of the series is 7 mm. in diameter, and the second from the top has a diameter of 8 mm. Three of the segments, the second, fourth, and fifth from the

top of the series, are 4 mm. in height, the corresponding measurements of the other two segments being nearer 3 mm. The segments slope from the ventral side of the conch inward and downward at an angle of 70 degrees with the vertical outline of the conch. The form of these segments is distinctly nummuloidal. Beneath the 5 segments just described, an additional series of 8 segments has been exposed by cutting a vertical dorso-ventral groove into the median part of the ventral side of the conch. Of these, the upper 3 segments occupy a length of 14 mm.; the next 2, of 7.5 mm.; and the lower 3, of 8 mm. The third segment from the base of the series is 3 mm. in diameter dorso-ventrally, and of about the same length vertically, when measured at right angles to the slope of the septa. The 2 underlying segments are slightly narrower than long. From this it is inferred that the nummulitic species here discussed originated from an ancestor in which the segments of the siphuncle were elongated vertically, rather than flattened vertically into nummuloidal forms. Holotype No. 10025, in the Museum of Geology, University of Michigan.

A second specimen (Plate IV, Fig. 2), 82 mm. in length, presents the original form of a closely similar conch without distortion. The ventral side of this specimen is distinctly curved vertically in a convex direction. The dorsal outline is strongly gibbous along the lower part of the living chamber and the upper part of the phragmacone. Above and below this gibbosity the dorsal outline of the conch is distinctly concave. At maximum gibbosity, the dorso-ventral diameter of the conch is 47 mm., and the lateral diameter is 49 mm., the cross-section here being nearly circular. A similar nearly circular cross-section is shown by the remainder of the phragmacone, as far as preserved. Above the gibbosity, however, the living chamber is more strongly depressed dorso-ventrally, especially along its dorsal side, so that at the aperture of this chamber its dorso-ventral diameter is 36 mm., and its lateral diameter is 42 mm. At the hyponomic sinus, the margin of the aperture curves downward 3 mm. in a width of 17 mm. The living chamber is 40 mm. in height. The segments of the siphuncle are nummuloidal in outline. The

third segment from the top of the siphuncle is 3.5 mm. in height and 6.5 mm. in lateral diameter. Paratype No. 10026, in the Museum of Geology, University of Michigan.

A third specimen (Plate IV, Fig. 3), 85 mm. long, has a dorso-ventral diameter of 56 mm., and a lateral one of 60 mm., at the base of the living chamber, the dorso-ventral depression being relatively slight. In this specimen the cross-section of the phragmacone is nearly circular for a vertical height of 37 mm., the more apical part of the phragmacone not being preserved. The conch is most gibbous at about the second camera beneath the living chamber. Above and below this gibbosity the dorsal outline of the conch is only faintly concave. Toward its aperture the living chamber contracts gradually and becomes more depressed dorso-ventrally, especially along its dorsal side. At the aperture, its dorso-ventral diameter is 38 mm., and its lateral one is 47 mm. The segments of the siphuncle are nummuloidal in form. The third segment from the top of the siphuncle is 8.5 mm. in diameter and nearly 4 mm. in height. At the septal neck its diameter is contracted abruptly to slightly less than 4 mm., the neck being very short. Between 15 and 40 mm. beneath the top of the phragmacone, the transverse striae on the surface of the shell curve downward between 2 and 3 mm. in a width of 20 mm., the striae being low and broad, but occurring at rhythmic intervals, about 15 in a length of 10 mm. Paratype No. 10027, in the Museum of Geology, University of Michigan.

Locality and Horizon. — From the quarry of the Michigan Alkali Company, at Alpena, Michigan; in the Alpena limestone.

Remarks. — The general outline of the conch of *Acleistoceras nummulatum* is so closely similar to that of *Acleistoceras casei* that it will probably be difficult or even impossible to distinguish these species without sections exposing the outlines of the segments of the siphuncle. In general, the cross-section of the phragmacone of *Acleistoceras nummulatum* is more circular, and enlarges more rapidly. Moreover, the diameter of its siphuncle, compared with that of the conch, is relatively larger.

ACLEISTOCERAS SP.

(Plate IV, Fig. 4)

Specimen 80 mm. long, enlarging from a lateral diameter of 11 mm. at its base to 30 mm. at a point 40 mm. farther up. Within the following 10 mm. the specimen enlarges to only 32 mm., and then enlarges within the following 12 mm. to 50 mm., above which the conch contracts moderately for a length of 15 mm. The point of maximum enlargement of the conch is about 5 mm. below the suture of the septum at the base of the living chamber. The lower part of the phragmacone, for a length of 40 mm., is curved lengthwise in a slightly concave direction along the median part of the face of the conch best exposed. If this specimen be an *Acleistoceras*, then this concavely curved face must be assumed to be dorsal. Unfortunately, no trace of the siphuncle can be detected, all trace of the structure of the interior of the conch having disappeared, with the single exception of the septum at the top of the phragmacone, and at this level the ventral side of the specimen is missing.

Apparently the specimen enlarged at a normal rate for a length of 40 mm.; then its enlargement was very much retarded for a length of 10 mm.; above this point its rate of enlargement was accelerated so much that the conch attained a lateral diameter slightly in excess of the normal diameter at the top of the phragmacone, and apparently then contracted again along the living chamber at about the same rate as an ordinary specimen. The specimen, therefore, is regarded as a very interesting case of a first normal growth, followed then by retarded growth, next by accelerated growth, returning finally to normal growth. In other words, there is no evidence of this specimen's constituting a distinct species.

Locality and Horizon. — From the quarry of the Michigan Alkali Company, at Alpena, Michigan; in the Alpena limestone. No. 10028 in the Museum of Geology, University of Michigan.

ALPENOCERAS, gen. nov.

Genotype: *Alpenoceras ulrichi* Foerste.

Conch breviconic, slightly curved lengthwise, endogastric, its ventral outline slightly concave along the phragmacone, though slightly convex along the living chamber. The siphuncle is close to the ventral side of the conch, if not in contact with the latter. The segments of the siphuncle are nummuloidal, but only of moderate width. The interior of the siphuncle is coated with a calcareous deposit, but no converging vertical lamellae are present. The margin of the aperture curves more strongly downward, thus forming a shallow hyponomic sinus.

In the genotype of *Danaoceras* Foerste (*Denison Univ. Bull.*, vol. 21, 1926, p. 346, Pl. 36, Figs. 2A-C), namely *Cyrtoceras danai* Barrande, only the lower third of the conch is distinctly curved, the remainder being relatively straight. The siphuncle is located close to the concavely curved ventral side of the conch, but its segments are more nearly globular, and its interior is filled with converging vertical lamellae. The margin of the aperture curves downward both ventrally and dorsally, but the median part of this downward curvature is more angular on the ventral side of the aperture, thus faintly indicating the location of the hyponomic sinus. However, there is no abrupt downward curvature of the ventral margin of the aperture along its median part, as in typical *Alpenoceras*.

The species described by Hall as *Gomphoceras conradi*, from the Goniatite limestone in the Marcellus shale, in New York, appears to be congeneric with *Alpenoceras*. This species is much smaller in size. The ventral outline is faintly concave along the phragmacone, and faintly convex along the living chamber. The hyponomic sinus is distinctly developed, and along the phragmacone the transverse striae curve faintly downward along the median part of its ventral side.

The species described by Hall as *Gomphoceras clavatum*, from the Schoharie grit of New York, also may belong here, but the maximum ventral gibbosity of this species is much greater

than in the genotype of *Alpenoceras*, and is located at the base of the living chamber, rather than at mid-height of this chamber. This also is a small species.

Between 25 and 35 miles northeast of Goderich, in the western part of Ontario, there is an area of limestone including great stromatoporoid reefs, which is correlated by Stauffer with the Alpena limestone in the Traverse or Hamilton group of eastern Michigan. From this Alpena limestone he doubtfully identified two of the species here discussed as probably related to *Alpenoceras ulrichi*, namely *Gomphoceras conradi* and *Gomphoceras clavatum*.

ALPENOCERAS ULRICHI, sp. nov.

(Plate I, Figs. 2A, B; Plate V, Fig. 2)

Conch 100 mm. in length along its convex dorsal outline. Its ventral outline has a concave curvature of almost 3 mm. along the lower 70 mm. of its length, apparently reversing to faintly convex along the upper part of the living chamber. The cross-section of the conch has been distorted by the oblique crushing in of its dorsal side. Apparently the original cross-section was nearly circular, with a slight lateral compression. The dorso-ventral diameter of the conch enlarges from 16.5 mm. at the base of the specimen to 47 mm. at a point of 70 mm. farther up, above which point the enlargement appears to have been slight. The sutures of the septa appear to be approximately parallel to the transverse striae on the surface of the shell. In that case, they rise in a dorsad direction, but possibly with a slight downward curvature laterally. The concavity of the septa, where 28 mm. in diameter, equals at least 3 mm. Immediately below this level, about 11 camerae occur in a length equal to the dorso-ventral diameter at the top of the series counted. The camerae above this level are not exposed, so that it is not possible to determine the total length of the phragmacone. The siphuncle is located close to the ventral wall of the conch. In its present condition it is 2 mm. distant from the ventral wall of the conch where the dorso-ventral diameter of the latter is

28 mm., but the siphuncle is separated here from the ventral wall of the conch by a deposit of calcite in which there is no trace of the septa. The contact of the siphuncle with this deposit of calcite is similar to that of a siphuncle in contact with the ventral wall of a conch. The diameter of the siphuncle enlarges from 2.5 mm. at the base of the specimen to 5 mm. at a point 25 mm. farther up. At the latter point the dorso-ventral diameter of the conch is 28 mm. The segments of the siphuncle are obliquely disk-shaped, being 3 mm. in height where their diameter is 5 mm. The septal necks here are slightly more than half a millimeter in length; their diameter is slightly over 3 mm. where the diameter of the connecting rings is 5 mm. The latter present convex vertical outlines, more rapidly curved along their upper margins than along their lower parts. The inner walls of the lower 7 segments are lined with calcite for a thickness of about half a millimeter. Above this level, the segments are empty.

The surface of the specimen is ornamented by transverse striae, of which some tend to be somewhat more conspicuous than the remainder, at rhythmic intervals. Along mid-height of the conch 10 of the more conspicuous striae occur in a length of 21 mm., but there is no constancy in these intervals, some of the more conspicuous striae occurring at intervals of 3.5 or 4 mm. along the lower part of the specimen. Along one of the lateral sides these transverse striae rise at an angle of 10 degrees with a horizontal plane at right angles to the ventral outline of the conch; on the other lateral side this angle is 15 degrees, the specimen being distorted by pressure, as stated before. Along the median part of the ventral side of the conch these striae curve more strongly downward, indicating a relatively shallow and narrow hyponomic sinus at former stages of growth of the conch. At mid-height of the specimen this sinus is 10 mm. wide and about 2 mm. in depth. The margin of the aperture apparently rises in a dorsad direction as far as the median part of the dorsal side of the conch.

Locality and Horizon. — From the quarry of the Michigan Alkali Company, at Alpena, Michigan; in the Alpena limestone.

Geno-holotype No. 10031 in the Museum of Geology, University of Michigan. Named in honor of Dr. E. O. Ulrich, for many years the leading student of American Paleozoic paleontology and stratigraphy.

PLATE I

- FIG. 1. *Nephriticerina alpenensis* Foerste. — *A*, dorsal view, showing suture of septum at base of living chamber and another suture near lower end of specimen. A part of the shell is retained, showing the narrow vertical ridges. *B*, lateral view, with several sutures at the top of the phragmacone, and others near its base. From Alpena, Michigan; in the Alpena limestone. Geno-holotype No. 10029 in the Museum of Geology, University of Michigan. See also Plate II, Fig. 1; Plate V, Fig. 5.
- FIG. 2. *Alpenoceras ulrichi* Foerste. — *A*, ventral view, showing the narrow and very shallow downward curvature of the hyponomic sinus at numerous stages of growth of the conch. *B*, lateral view, with ventral side on left. From Alpena, Michigan; in the Alpena limestone. Geno-holotype No. 10031 in the Museum of Geology, University of Michigan. See also Plate V, Fig. 2.

PLATE I



PLATE II

Nephrificerina alpenensis Foerste. — An obliquely ventral view, oriented so as to show the narrow vertical ridges on the surface of the shell. The close-set transverse striae are detected most readily between 20 and 25 mm. from the upper right margin of the phragmacone in the figure. Some of the sutures of the septa are shown, both at the top and near the base of the phragmacone. From Alpena, Michigan; in the Alpena limestone. Geno-holotype No. 10029 in the Museum of Geology, University of Michigan. Same specimen as that figured on Plate I, enlarged 2 diameters.

PLATE II



PLATE III

- FIG. 1. *Acleistoceras casei* Foerste. — *A*, ventral view, showing the hyponomic sinus at the margin of the aperture, and a glimpse of the suture of the septum at the base of the living chamber. *B*, lateral view, with the ventral side on the left. From Alpena, Michigan; in the Alpena limestone. Paratype No. 10024 in the Museum of Geology, University of Michigan.
- FIG. 2. *Acleistoceras casei* Foerste. — *A*, lateral view, with the ventral side on the left, showing traces of the sutures of two septa at the top of the phragmacone, and of another septum near its base. *B*, ventral view, showing the very narrow as well as shallow hyponomic sinus at the margin of the aperture, also corresponding downward curvatures, but over a broader area, along the median part of the course of the transverse striae. Paratype No. 10030 in the Museum of Geology, University of Michigan. See also Plate V, Fig. 4.

PLATE III



PLATE IV

- FIG. 1. *Acleistoceras nummulatum* Foerste. — Ventral view, exposing the sutures of two septa at the top of the phragmacone, and 5 segments of the upper half of the phragmacone; the lower segments later were exposed by filing a vertical dorso-ventral section into the lower part of this ventral side. From Alpena, Michigan; in the Alpena limestone. Holotype No. 10025 in the Museum of Geology, University of Michigan. See also Plate V, Fig. 3.
- FIG. 2. *Acleistoceras nummulatum* Foerste. — Lateral view, with the ventral side on the right. This ventral side is broken, so that, when loosened by soaking away the glue, the interior of the fragment exposes three of the upper segments of the siphuncle, their form being distinctly nummuloidal. From Alpena, Michigan; in the Alpena limestone. Paratype No. 10026 in the Museum of Geology, University of Michigan.
- FIG. 3. *Acleistoceras nummulatum* Foerste. — Lateral view, exposing sutures of several septa at the top of the phragmacone. The ventral side is on the left, and here a dorso-ventral vertical section of the siphuncle, produced by filing, exposes three of the upper segments of the siphuncle, their form being distinctly nummuloidal. From Alpena, Michigan; in the Alpena limestone. Paratype No. 10027 in the Museum of Geology, University of Michigan.
- FIG. 4. *Acleistoceras* sp. — Apparently a dorsal view, with the conch abnormally enlarged at the top of the phragmacone, contracting along the living chamber, of which only the basal part remains. The lower part of the phragmacone presents a faintly concave vertical outline. From Alpena, Michigan; in the Alpena limestone. Specimen No. 10028 in the Museum of Geology, University of Michigan.

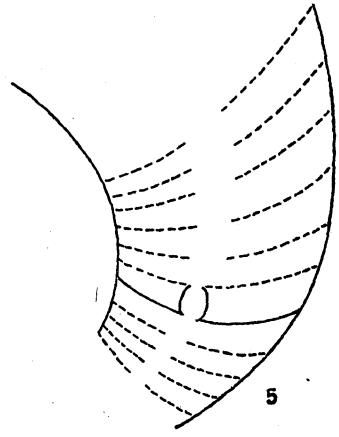
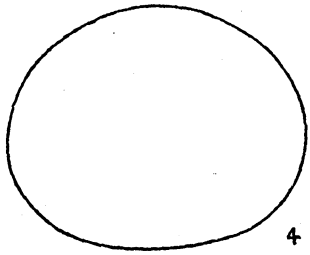
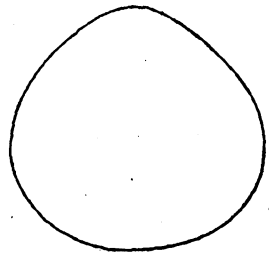
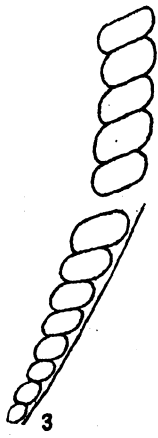
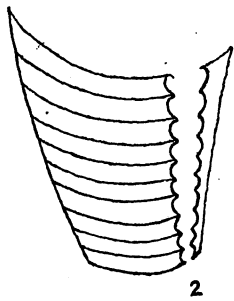
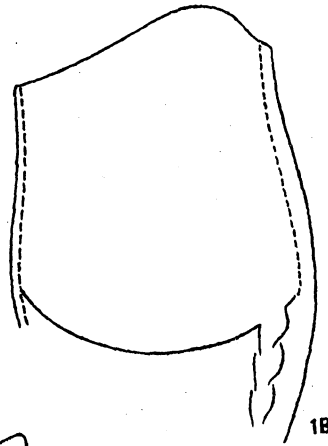
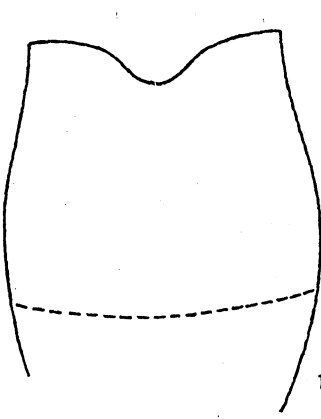
PLATE IV



PLATE V

- FIG. 1. *Acleistoceras casei* Foerste. — *A*, ventral view, showing hyponomic sinus and height of living chamber. *B*, lateral view, showing outline of aperture, septum at base of living chamber, and three segments of the siphuncle. *C*, outline of aperture, with the hyponomic sinus along the upper margin of the figure. From the Michigan Alkali Company, at Alpena, Michigan; in the Alpena limestone. Holotype No. 10023 in the Museum of Geology, University of Michigan.
- FIG. 2. *Alpenoceras ulrichi* Foerste. — Dorso-ventral vertical section through the siphuncle at the lower end of the specimen represented on Plate I by Figs. 2*A*, *B*.
- FIG. 3. *Acleistoceras nummulatum* Foerste. — Dorso-ventral vertical section through the siphuncle of the specimen represented on Plate IV by Fig. 1. The lower part of this siphuncle is slightly disjointed from the upper 5 segments.
- FIG. 4. *Acleistoceras casei* Foerste. — Outline of aperture, with hyponomic sinus along upper margin of figure. Same specimen as that represented on Plate III by Figs. 2*A*, *B*.
- FIG. 5. *Nephriticerina alpenensis* Foerste. — Dorso-ventral vertical section through the phragmacone, showing one of the segments of the siphuncle. Same specimen as that represented on Plate I by Figs. 1*A*, *B*; and on Plate II.

PLATE V



(Continued from inside of front cover)

9. Devonian Cephalopods from Alpena in Michigan, by Aug. F. Foerste. Pages 189-208, with 5 plates. Price, \$.35.
10. The Vertebral Column of *Coelophysis* Cope, by E. C. Case. Pages 209-222, with 1 plate and 9 text figures. Price, \$.25.
11. A New Species of Trionychid Turtle, *Amyda nelsoni*, from the Eocene Beds of Southwestern Wyoming, by E. C. Case. Pages 223-226, with 1 plate and 3 text figures. Price, \$.20.
12. A Complete Phytosaur Pelvis from the Triassic Beds of Western Texas, by E. C. Case. Pages 227-229, with 1 plate. Price, \$.20.
13. Discovery of a Hamilton Fauna in Southeastern Michigan, by G. M. Ehlers and Mary E. Cooley. Pages 231-236. Price, \$.15.
14. *Anisotrypa waynensis*, a New Bryozoan from the Warsaw Formation of Kentucky, by Charles F. Deiss, Jr. Pages 237-239, with 2 plates. Price, \$.20.

