Cenomanian Ammonite Fauna from the Mosby Sandstone of Central Montana

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By W. A. COBBAN

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CENOMANIAN AMMONITE FAUNA FROM THE MOSBY SANDSTONE OF CENTRAL MONTANA

By W. A. COBBAN

ABSTRACT

The Mosby sandstone member of the Colorado shale contains an ammonite fauna consisting of two new species of *Metoicoceras* and one new species and one new subspecies of *Dunveganoceras*. Associated fossils include gastropods in great abundance but of little variety, and a few pelecypods. A very late Cenomanian age is assigned. The fauna is unknown elsewhere in the United States except for one possible occurrence in north-central Wyoming. Species of *Dunveganoceras* closely related to those of the Mosby sandstone member have been described from the Dunvegan and Smoky River formations of northwestern Alberta and northeastern British Columbia.

The Mosby sandstone member is fine to very fine-grained calcareous sandstone of shallow water origin. A section measured at Mosby, where the Colorado shale is 1,930 ft thick, and the Mosby member lies 743 ft below the top, is recommended as the type section.

INTRODUCTION

The Mosby sandstone member of the Colorado shale contains the ammonite genus *Metoicoceras*, represented by the new species *M. mosbyense* and *M. muelleri*, and the genus *Dunveganoceras*, with the new species *D. parvum* and the new subspecies *D. albertense montanense*. This is a curious mingling of a southern genus (*Metoicoceras*) and a northern genus (*Dunveganoceras*). These are the only ammonite genera that have been found in the member. The fauna is of further interest in that it represents the youngest of the Cenomanian zones recognized in the western interior of the United States.

Ammonites from nine localities were studied. *Metoicoceras* is represented by parts of 75 individuals and *Dunveganoceras* by about 50. Most of the material was collected by Mr. Oscar O. Mueller, attorney at law, of Lewistown, Montana, who kindly donated his collections to the United States Geological Survey. The photographs were made by Mr. Nelson W. Shupe of the Geological Survey. The types are deposited at the United States National Museum.

STRATIGRAPHY OF MOSBY SANDSTONE MEMBER OF COLORADO SHALE

The Mosby sandstone member of the Colorado shale was named by Lupton and Lee (1921, p. 263) for exposures near Mosby P. O. on the Musselshell River in east-central Montana. There the Colorado shale is 1,930 ft thick, and the Mosby sandstone member lies 743 ft below the top.

The member is exposed extensively on the Cat Creek and Devils Basin anticlines and in the intervening area. It also crops out on the flanks of the Little Rocky Mountains and the Judith Mountains.

The member is chiefly light-gray fine to very fine-grained calcareous sandstone that commonly has a concretionary habit. It ranges from massive to shaly in short distances and shows cross bedding and ripple marks. The sandstone is hard and forms an easily recognized low ridge or hogback rising above the softer Colorado shale. At the type locality the member consists largely of two 5.5-ft sandstone beds separated by 11 ft of sandy shale.

Fossils, chiefly gastropods, are locally very abundant, apparently concentrated by current action (pl. 7, fig. 1). A smooth gastropod, *Pseudomelania hendricksoni* Henderson, forms the bulk of the fossils, with many concretions composed almost entirely of this species. Several other gastropod genera, including ornate forms, are present. Pelecypods are limited to *Exogyra columbella* Meek, *Trigonocallista orbiculata* (Hall and Meek), and undescribed species of *Gervillia*, *Inoceramus*, and *Gryphaea*. Of these, only *Trigonocallista orbiculata* is abundant. Ammonites, which are relatively scarce, are represented by *Metoicoceras* and *Dunveganoceras*. The fauna shows a blending of northern and southern types. *Metoicoceras* and *Exogyra columbella* are widely distributed from central Montana south into Texas, but are unknown in Canada, whereas *Dunveganoceras* is a northern genus that is unknown south of central Wyoming.

The following stratigraphic section, measured east of the Musselshell River from ¼-mile east to ½-mile north of Mosby Post Office, in S½ sec. 2 and N½ sec. 11, T. 14 N., R. 30 E., Garfield County, is recommended as the type section for the Mosby sandstone member. Descriptions of part of the Colorado shale above and below the Mosby member are included to show the lithologies of adjoining strata.

Beds equivalent to the lower part of the Carlile shale.

Unit		*Feet*
23.	Shale, dark bluish-gray; forms dark outcrops bare of grass but with abundant trees	36.0
22.	Bentonite, creamy-yellow	0.5

Beds equivalent to the lower part of the Carlile shale—Continued

Unit		Feet
21.	Shale, dark-gray; weathers orange-brown; contains lenses as much as 1.5 in. thick of tan-weathering fossiliferous limestone. Contains fossils of Fairport age. (U.S.G.S. Mes. loc. 21398); *Inoceramus* cf. *I. labiatus* (Schlotheim), *Ostrea* n. sp., *Collignoniceras woollgari* var. *praecox* Haas, *C. woollgari* var. *intermedium* Haas, *Scaphites patulus* Cobban, *Isurus* cf. *I. appendiculatus* (Agassiz), *Isurus* cf. *I. semiplicatus* (Agassiz), *Squalicorax falcatus* (Agassiz), *Ptychodus whipplei* Marcou	5.6
20.	Bentonite, greenish-gray	0.2
19.	Shale, dark-gray; weathers orange brown; contains a few layers of limestone less than ¼-in. thick	3.0
18.	Bentonite, gray and greenish-gray, finely micaceous; weathers whitish	1.0
17.	Limestone and shale, gray	0.1
16.	Shale, black-gray	0.2
15.	Bentonite, creamy and gray	0.2
14.	Limestone and shale, gray; weathers orange brown; limestone layers not more than 2 in. thick; contains a small species of smooth oyster and fish scales, bones, and teeth	1.3
Beds equivalent to the upper part of the Greenhorn formation.		
13.	Shale, gray, calcareous; weathers creamy white; upper part contains a few white-weathering limestone concretions	15.5
12.	Bentonite, creamy-white, stained rusty by limonite; contains at base a few white-weathering limestone concretions	2.8
11.	Shale, dark-gray; weathers medium gray; noncalcareous in lower part but slightly calcareous in upper; contains a few thin shaly siltstone and very fine-grained calcareous sandstone layers	3.5
10.	Shale, gray; contains closely spaced gray calcareous concretions that weather pale lavender gray and contain veins of white, yellow, and brown calcite	1.0
Beds equivalent to the middle part of the Greenhorn formation.		
9.	Shale, dark bluish-gray, noncalcareous	7.5
Mosby sandstone member.		
8.	Sandstone, light-gray, fine to very fine-grained, thin-bedded to shaly, soft, more or less argillaceous; contains dark shale partings and a few buff-weathering calcareous concretions that are septarian with brown, yellow, and white calcite. Top of bed contains a sprinkling of black chert pebbles as much as ¾-in. in diameter. Unit weathers buff gray to tan, and forms an inconspicuous outcrop. Sparingly fossiliferous (U.S.G.S. Mes. loc. 21397); *Trigonocallista orbiculata* (Hall and Meek)	5.6
7.	Shale, dark bluish-gray, noncalcareous; contains numerous very fine-grained sandy partings in lower part	11.0
6.	Sandstone, light-gray, very fine-grained, thin-bedded, ripple-marked, cross-bedded; contains dark shale partings particularly in upper 2 ft.; commonly passes laterally into buff-weathering silty, calcareous concretions. Unit weathers tan and forms a conspicuous ledge. Marine gastropods and pelecypods abundant in distantly spaced calcareous concretionary masses. (U.S.G.S. Mes. loc. 21396); *Gervillia* sp., *Inoceramus* aff. *I. fragilis* Hall and Meek, *Gryphaea* n. sp., *Exogyra columbella* Meek, *Trigonocallista orbiculata* (Hall and Meek), *Pseudomelania hendricksoni* Henderson, *Lunatia* cf. *L. dakotensis* Henderson, *Gyrodes conradi* Meek, *Anchura?* sp., *Trachytriton* n. sp., *Metoicoceras mosbyense* Cobban, *Dunveganoceras albertense* subsp. *montanense* Cobban	5.6
5.	Shale, dark-gray; contains sandy layers up to 1 in. thick	3.5
4.	Sandstone, gray, very fine-grained, thin-bedded; contains dark shale partings	1.5
Beds probably equivalent to part of the Belle Fourche shale.		
3.	Shale, dark bluish-gray; contains a few soft very fine-grained gray sandstone layers as much as 2 in. thick. Few gypsum-encrusted pelecypods (U.S.G.S. Mes. loc. 21395); *Gryphaea* sp., *Exogyra columbella* Meek	23.5
2.	Shale, dark bluish-gray; contains large widely spaced calcareous concretions that weather bluish gray and buff and contain veins of brown and yellow calcite	1.5
1.	Shale, dark bluish-gray	10.0+

AGE OF MOSBY SANDSTONE MEMBER OF COLORADO SHALE

The ammonites of the Mosby sandstone are not known with certainty outside central Montana. The nearest similar fauna occurs in a calcareous sandy unit in the Frontier formation about 100 ft below the Wall Creek ("First") sandstone member on the east flank of the Kaycee anticline, 1.5 miles south of Kaycee, Wyo. The collection from that locality (U.S.G.S. Mes. loc. 23456) consists of fragments of 10 or 11 specimens of a species of *Metoicoceras*. Many of these fragments match specimens of *M. mosbyense*, n. sp., of comparable size in the stoutness of the whorls and coarseness and density of ribbing. A few fragments suggest more slender individuals than are known from the Mosby member. The lack of any specimens referable to the common Mosby species, *M. muelleri*, n. sp., or to the Mosby *Dunveganoceras* is difficult to explain.

Just below the main group of sandstone beds in the Frontier formation (about 200 ft below the top) on the south side of the Bighorn Mountains, four miles east of Arminto, Wyo. (U.S.G.S. Mes. loc. 23492), is a unit of sandy shale containing *Dunveganoceras* cf. *D. conditum* Haas and a species of *Metoicoceras* closely related to *M. mosbyense*, n. sp. Up to a diameter of 60 to 70 mm this species seems to be identical to *M.*

mosbyense, but at greater diameters the whorls are much more densely ribbed. This densely ribbed *Metoicoceras* and fragments of a *Dunveganoceras* that may be *D. conditum* Haas also have been found together in the Frontier formation on the east side of the Bighorn Mountains near Buffalo, Wyo.

The other species of *Metoicoceras* and *Dunveganoceras* from the western interior differ so much from the Mosby forms that there is no question that they mark separate faunal zones. A continuous sequence of rocks bearing these genera has not been found at any one locality, but a consideration of two fairly fossiliferous sections makes possible the recognition of definite zoning of the *Metoicoceras-Dunveganoceras* faunas. On the north flank of the Black Hills the Greenhorn formation contains at its base *Metoicoceras* cf. *M. praecox* Haas and *Dunveganoceras* cf. *D. pondi* Haas, and near the top, *Metoicoceras whitei* Hyatt. Associated with *M. whitei* are *Sciponoceras gracile* (Shumard) and *Scaphites delicatulus* Warren. Near Buffalo, on the east flank of the Bighorn Mountains, *Sciponoceras gracile* and *Scaphites delicatulus* occur together in the shale less than 100 ft above the Frontier formation, whereas *Metoicoceras* cf. *M. praecox* is present in sandstone about 120 ft below the top of the Frontier formation. Concretions in the upper 50 ft of the Frontier formation contain the densely ribbed *Metoicoceras* and fragments of *Dunveganoceras* cf. *D. conditum.* From these two sections it is apparent that three *Metoicoceras* levels can be recognized which in ascending order are (1) *M. praecox*, (2) a densely ribbed new species, and (3) *M. whitei.* Of these species the Mosby forms are closely related to the densely ribbed species. This close age assignment is also supported by the Mosby species of *Dunveganoceras*, which are much nearer *D. conditum* than *D. pondi.* Inasmuch as the costal cross section of the ultimate whorl is quadrate for *D. pondi*, round for *D. conditum*, and ogival for *D. albertense montanense*, it is probable that the Mosby species is a little younger than *D. conditum*, assuming the evolutionary trend was from a truncate to a sharply arched venter. It thus appears that the following four *Metoicoceras* levels can be recognized in the Montana-Wyoming area:

M. whitei (youngest zone)
M. mosbyense, n. sp
M. n. sp., (densely ribbed species)
M. praecox (oldest zone)

Dunveganoceras albertense montanense, n. subsp., the common representative of this genus in the Mosby sandstone member, so closely resembles *D. albertense* (Warren) that an approximate time equivalence seems certain. The Mosby form, which differs in small details from Warren's species, seems best to be regarded as a geographic subspecies. *D. albertense* is considered by Warren and Stelck (1940, p. 149) to be Upper Cenomanian. This assignment seems reasonable and is further supported by the position of the Mosby fauna in regard to the *Metoicoceras whitei* zone. The zone is considered to mark the base of the Turonian (Spath, 1926, p. 80; Muller and Schenck, 1943, fig. 6). A late Cenomanian age for the Mosby fauna is suggested also by the presence of at least four older Cenomanian faunas in the western interior (Cobban, 1951, p. 2197, fig. 2).

LOCALITIES FROM WHICH FOSSILS HAVE BEEN COLLECTED

Ammonites have been collected from the Mosby sandstone member of the Colorado shale at the following localities in central Montana, for which the U. S. Geological Survey Mesozoic locality number, name of collector, and year of collection are given:

10976. A. J. Collier, 1921. About 7.5 miles northeast of Zortman, in sec. 13, T. 26 N., R. 25 E., Blaine County.

18741. J. B. Reeside, Jr., 1938. Bull Creek, west side of Cyprian dome, on southwest flank of Little Rocky Mountains, in sec. 35, T. 25 N., R. 23 E., Phillips County.

21396. W. A. Cobban, 1948. About ¼-mile northeast of Mosby, in the NE¼ sec. 11, T. 14 N., R. 30 E., Garfield County.

21484. O. O. Mueller, 1948. Near south side of spillway of Yellow Water Reservoir, in the SW¼ sec. 7, T. 13 N., R. 26 E., Petroleum County.

21485. O. O. Mueller, 1948. About ¼-mile north of Yellow Water Reservoir, in the SW¼ sec. 1, T. 13 N., R. 25 E., Petroleum County.

21486. O. O. Mueller, 1948. About 1 mile southwest of Yellow Water Reservoir, in the NE¼ sec. 14, T. 13 N., R 25 E., Petroleum County.

21487. O. O. Mueller, 1948. About 1.5 miles south-southwest of Yellow Water Reservoir, in the NW¼ sec. 23, T. 13 N., R. 25 E., Petroleum County.

21488. O. O. Mueller, 1944. One mile south-southeast of Yellow Water Reservoir, in the SE¼SE¼ sec. 14, T. 13 N., R. 25 E., Petroleum County.

21490. O. O. Mueller, 1944. South side of Yellow Water Reservoir, in the SW¼ sec. 7, T. 13 N., R. 26 E., Petroleum County.

21662. W. A. Cobban, M. M. Knechtel, S. H. Patterson, W. T. Pecora, 1948. East Side of Morrison dome, on south flank of Little Rocky Mountains, in the SE¼NW¼ sec. 7, T. 24 N., R. 25 E., Phillips County.

21955. W. A. Cobban, C. T. Moore, O. O. Mueller, 1949. Six miles west of Winnett, in sec. 1, T. 14 N., R. 25 E., Petroleum County.

DESCRIPTION OF SPECIES

Family Acanthoceratidae de Grossouvre, 1894
Subfamily Metoicoceratinae Hyatt, 1903
Genus Metoicoceras Hyatt, 1903

1903. *Metoicoceras* Hyatt, U. S. Geol. Survey Mon. 44, p. 116.
1920. *Metoicoceras* Hyatt. Böse, Texas Univ. Bull. 1856, p. 200 (dated 1918, issued 1920).

1928. *Metoicoceras* Hyatt. Adkins, Texas Univ. Bull. 2838, p. 248.
1931. *Metoicoceras* Hyatt. Reeside and Weymouth, U. S. Nat. Museum Proc., vol. 78, art. 17, no. 2860, p. 19.
1938. *Metoicoceras* Hyatt. Roman, Les Ammonites jurassiques et crétacées, p. 437.
1942. *Metoicoceras* Hyatt. Moreman, Jour. Paleontology, vol. 16, no. 2, p. 210.
1944. *Metoicoceras* Hyatt. Shimer and Shrock, Index fossils of North America, p. 561.

Metoicoceras mosbyense Cobban, n. sp.

Plate 6, figures 1–14; plate 7, figures 1–3

Shell large for the genus, laterally compressed, moderately involute; umbilicus about $\frac{1}{10}$ the diameter in young stages, gradually widening to $\frac{1}{5}$ the diameter in older stages. Flanks flattened; venter rounded to diameter of 10 mm, flattened or excavated between diameters of 10 to 120 mm, and rounded beyond 120 mm. Sculpture consists of straight to slightly sinuous ribs, less than 36 per whorl, that bear spirally elongated ventral nodes to a diameter of 120 mm, and conical ventrolateral nodes and bullate umbilical nodes to a diameter of 45 mm. Suture complex for the genus.

At the earliest stage observed, about a diameter of 4 mm, the whorls have a broadly rounded venter, sharply rounded ventrolateral shoulder, and flattened flanks. At this early stage the sculpture consists of a row of 5 or 6 large ventrolateral nodes per half whorl that are conical, sharp, and directed straight out. Opposite nodes are connected by a low forward-arched rib bearing on each side of the midline of the venter an inconspicuous low conical ventral node that is barely discernible.

By a diameter of 6 mm the ventral nodes are distinct. Each node of a pair is separated from the other by a distance a little less than the distance between a ventral node and the nearest ventrolateral node. Each ventrolateral node passes into a low inconspicuous rib that trends straight across the flank to the umbilical shoulder. The cross section is rather quadrate with about equal distance from the middle of a ventrolateral node to the umbilicus and to the ventral node on the opposite side of the venter (pl. 6, fig. 14).

At a diameter of 10 mm the middle of the venter is flattened and bordered by the small ventral nodes, which become slightly elongated spirally. The venter narrows and the flanks lengthen radially. The ventrolateral nodes are much reduced in size, becoming more nearly the size of the ventral nodes. Between the ventrolateral nodes on the flank are smaller intercalated ventrolateral nodes. Each ventrolateral node is connected to a ventral node by a low forward inclined rib. The larger ventrolateral nodes terminate low straight flank ribs that extend to the umbilical shoulder. These ribs almost disappear midway on the flank, but become stronger again near the umbilicus.

Between diameters of 10 and 15 mm the ventral and ventrolateral nodes become of equal size. The flank continues to widen and the venter narrows so that at a diameter of 15 mm the flank is as wide as the distance between opposite ventrolateral nodes. Each pair of ventral nodes is connected by a broad straight rib. At a diameter of 15 mm a half whorl has about 11 ventral ribs.

By a diameter of 20 mm the flank is wider than the distance between opposite ventrolateral nodes. These nodes are not placed as far behind the ventral nodes as in younger stages. The umbilical ribs become stronger and even elevated into radially elongated nodes. The density of ribbing increases to 12 ventrolateral ribs per half whorl. Two ventrolateral ribs are present to each umbilical rib.

Between diameters of 20 and 45 mm the whorls continue to become more compressed laterally with the venter progressively narrowed. The ventral nodes become more spirally elongated, whereas the ventrolateral nodes gradually decrease in size and finally disappear at a diameter of about 45 mm. The ribs become straight and strong, attaining their maximum strength at a diameter of about 35 mm. The density of ventrolateral ribs increases from 13 to 15 per half whorl.

Between diameters of 45 and 90 mm. the venter between the spirally elongated nodes becomes smooth or only weakly undulated. The sculpture becomes weak and the umbilical nodes gradually disappear. The number of ventrolateral ribs increases from 14 to 18 per half whorl.

Between 90 and 110 mm diameter there is a marked decrease in rib density from 18 to 12 per half whorl. The ventral nodes weaken and the venter becomes less excavated. These nodes disappear between diameters of 110 and 130 mm, and the venter rounds and becomes broadly undulated by the ribs widening ventrally and crossing the venter as broad swellings. Beyond 130 mm diameter the ribs, which have been straight since the loss of the ventrolateral nodes, may arch forward on crossing the venter. The number remains low—about 11 or 12 per half whorl.

Complete senile specimens were not observed. Fragments of the largest specimens suggest that some individuals attained diameters of more than 200 mm and possibly as much as 250 mm.

The holotype, an incomplete specimen 180 mm in diameter, has an umbilical width of about 36 mm ($\frac{1}{5}$ of diameter), a whorl thickness of about 55 mm (30 per cent of diameter), and a rib density of 12 per half whorl. It is septate to the last quarter whorl.

Dimensions in millimeters, ratios (in parentheses) of the dimensions to the diameters, and the number of ribs per half whorl of the types are as follows:

Kind of specimen and U.S.N.M. number	Diameter (mm)	Umbilical width	Whorl height	Whorl thickness	Ribs per half whorl
Paratype 108316a	13.5	1.5 (0.11)	7.4 (0.55)	6.2 (0.46)	11
Paratype 108316b	20.0	2.0 (.10)	12.0 (.60)	7.8 (.39)	13
Paratype 108317a	37.0	2.5 (.07)	21.0 (.57)	16.0 (.34)	10
Paratype 108319a	39.0	4.7 (.12)	21.0 (.54)	15.2 (.39)	12
Paratype 108318a	42.3	4.2 (.10)	23.2 (.55)	14.8 (.35)	13
Do	58.0	6.6 (.11)	31.6 (.54)	19.9 (.34)	15
Do	87.0	10.5 (.12)	48.2 (.55)	26.2 (.30)	18
Paratype 108318b	60.0	5.0 (.09)	34.7 (.58)	17.7 (.29)	14
Paratype 108317b	57.0	4.8 (.09)	32.3 (.57)	18.7 (.33)	16
Do	79.5	6.4 (.08)	45.5 (.57)	23.0 (.29)	17
Paratype 108319b	110.0	12.7 (.12)	58.4 (.53)	36.0 (.33)	12
Holotype 108315	180.0	36.0 (.20)	82.0 (.45)	55.0 (.30)	12

The nearest described American species is probably *Metoicoceras acceleratum* Hyatt (1903, p. 127, pl. 14, figs. 11–14) from the Eagle Ford shale of Texas. That species is known only from immature specimens that closely resemble the comparable young stages of *M. mosbyense* but lack umbilical nodes and lose the ventrolateral nodes at a smaller diameter. *Metoicoceras whitei* Hyatt (1903, p. 122, pl. 13, figs. 3–5; pl. 14, figs. 1–10, 15) from the basal Turonian of the Western Interior and Texas is readily distinguished from *M. mosbyense* by maintaining ventrolateral nodes out to a much greater diameter. Likewise, *M. swallovii* (Shumard) (1859, p. 591), *M. swallovii* var. *macrum* Stephenson (1952, p. 209, pl. 51, figs. 4–7), *M. crassicostae* Stephenson (1952, p. 210, pl. 58, figs. 6–8), *M. latoventer* Stephenson (1952, p. 209, pl. 53, figs. 1–9; pl. 54, figs. 9–11), *M. gibbosum* Hyatt (1903, p. 121, pl. 15, figs. 5–8), and *M. ornatum* Moreman (1942, p. 211, pl. 32, fig. 4, text fig. 2c), all from the Woodbine and Eagle Ford formations of Texas, carry the ventrolateral nodes to much greater diameters than does *M. mosbyense*. The species from the Woodbine formation (*M. swallovii*, *M. latoventer*, and *M. crassicostae*) are also more evolute. The specimen from the Coleraine formation in Minnesota figured by Bergquist (1944, p. 30, pl. 10, figs. 10–12) as *Metoicoceras* aff. *M. swallovii* (Shumard) is considerably stouter than *M. mosbyense* and the ventrolateral nodes persist to greater diameters. The specimens described by Haas (1949, pp. 15–20, pls. 5–7, text figs. 5–9) as *Metoicoceras whitei* subsp. *praecox* from the lower part of the Cody shale near Greybull, Wyoming, are much more evolute and the loss of nodes and the rounding of the venter occurs much earlier. Haas's form is very different from *M. whitei*, occurs in older strata, and should be regarded as a separate species.

From the Upper Cenomanian or Lower Turonian of Coahuila, Mexico, Böse (1918, p. 205, pl. 12, figs. 1–3) figured as "*Metoecoceras* sp. nov." a specimen about as stout as *M. mosbyense* of comparable diameter with similar rib spacing and with every second or third rib extending to the umbilicus. It differs, however, by its flexuous ribbing and wider umbilicus. Böse's specimen was later assigned by Jones to the new species *M. bösei* Jones (1938, p. 127, pl. 10, figs. 1–3), the holotype of which has ventrolateral nodes persisting to a much greater diameter than on *M. mosbyense*.

Of the European species *M. mosbyense* has the same number and arrangement of ribs and nodes as *M. pervinquierei* (Grossouvre) (1912, p. 19, pl. 2, fig. 3), but differs by its much narrower umbilicus. *Metoicoceras dumasi* (Grossouvre) (1912, p. 23, pl. 2, fig. 1) seems close to *M. mosbyense* although it is stouter and the ventrolateral nodes persist to a greater diameter. *Metoicoceras petraschecki* (Grossouvre) (1912, p. 22, pl. 2, fig. 2), *M. gourdoni* (Grossouvre) (1912, p. 20, pl. 1, fig. 1), and *M. antiquum* Karrenberg (1935, p. 139, pl. 31, fig. 13) are more evolute. The specimens figured by Petrascheck (1902, p. 140, pl. 7, figs. 3–5, text fig. 5) as *Pulchellia gesliniana* (d'Orbigny) from the Upper Cenomanian of Saxony closely resemble *M. mosbyense* in its younger stages, but the Saxon species loses its ventral nodes at a much smaller diameter and the ribs are more flexuous.

Types: Holotype, U.S.N.M. 108315; figured paratypes, U.S.N.M. 108316a–b, 108317a, 108318a, 108320; unfigured paratypes, U.S.N.M. 108317b, 108318b, 108319a–b.

Occurrence: U.S.G.S. Mes. loc. 21396, 21484–21487, 21490, 21662, 21955.

Metoicoceras muelleri Cobban, n. sp.

Plate 6, figures 15, 16; plate 8, figures 1–7; plate 9

Shell large for the genus; larger, thinner, more involute, and smoother than *M. mosbyense*. Flanks flattened; venter rounded to diameter of 10 mm, flattened or excavated between diameters of 10 and 140 mm, and gradually rounded between 140 and 190 mm. Ribs weak, straight to sinuous, and as numerous as 46 per whorl. Ventrolateral nodes disappear by diameter of 11 mm and ventral nodes are lost between diameters of 100 and 150 mm. Suture complex for the genus.

The growth stages are shown by paratype U.S.N.M. 108322a, an adult specimen of 215 mm diameter. This specimen was broken up and the inner whorls freed to a diameter of about 9 mm.

At a diameter of 9 mm the whorl cross section is nearly quadrate, with broadly rounded venter, sharply rounded ventrolateral shoulder, and flat, nearly smooth flanks. On each side of the venter is a row of small rounded nodes. The nodes of a row occur in pairs as shown by Hyatt (1903, p. 119, pl. 11, fig. 14) for the early stages of *Metoicoceras swallovii* (Shumard). Five ventrolateral nodes are present on the half whorl of 9 mm diameter. At that diameter they are rounded and as large as the ventral nodes, but below that diameter they are larger than the ventral nodes and quite pointed. Each ventrolateral node is situated back from the apicad node of a ventral pair by an angle of about 30 degrees, and is separated from it by a distance comparable to that between the two rows of ventral nodes. A low inconspicuous straight rib trends from each ventrolateral node about half way to the umbilicus.

Between 9 and 11 mm diameter a small node appears in the space between the pairs of nodes of a ventral row, and by 13 mm all ventral nodes are of equal size. The ventrolateral nodes rapidly become smaller than the ventral nodes and disappear by a diameter of 11 mm. From each ventral node a small rib extends back to the ventrolateral node, or after that node disappears, to the position where it would occur, then bends and trends straight toward the umbilicus, although rapidly weakening and disappearing high on the flank.

Between 9 and 17 mm diameter the venter gradually narrows and the flank widens. At a diameter of 17 mm the ventral nodes elongate spirally, and the ribs number 14 per half whorl. Between 17 and 24 mm the venter continues to narrow, the flanks continue to widen, the whorls become more laterally compressed, and the ventrolateral margin shifts to the position of the ventral nodes. The ribbing becomes more pronounced and the density increases to 15 ribs per half whorl. The ribs, which are somewhat sigmoidal, extend gradually farther down the flank.

Between 24 and 40 mm the rib density increases to 16 per half whorl, and the ribbing attains its maximum strength. The ribs are sigmoidal, strongest near the venter, and about every third one extends to the umbilicus. The venter, which is flat, has an excavated appearance owing to the rim of closely spaced spirally elongated ventral nodes. On this specimen the venter has a slight constriction just ahead of the nodes terminating those ribs that extend to the umbilicus. There are six constrictions on the half whorl of 40 mm diameter.

At diameters greater than 40 mm the sculpture gradually weakens and the ribs become straight and broad. By a diameter of 100 mm they are so broad and flat that the spaces separating them are only half as wide. The ventral nodes are low and rather poorly defined.

Between diameters of 135 and 150 mm the rib density is reduced to 10 per half whorl, the nodes disappear, and the venter is flat but no longer excavated. However, the ribs become stronger and cross the venter as broad folds. Between 150 and 200 mm the venter gradually rounds, the ribbing remains strong, and the intercoastal areas become as broad as the ribs. There are about 10 ribs per half whorl. At diameters greater than 200 mm the ribs become weaker, narrower, and more numerous. At a diameter of 210 mm the rib count increases to 14 per half whorl.

Metoicoceras muelleri becomes progressively more evolute throughout its growth after the first few whorls. Measurements of 21 specimens show a gradual increase in the ratio of the umbilical diameter to the diameter of the shell from 6 percent at a shell diameter of 62 to 68 mm to 21 to 24 percent in shells more than 230 mm in diameter. The whorls are at first stout with quadrate cross sections, but rapidly become laterally compressed as growth continues. The ribbing shows a progressive increase in number per half whorl from 13 at shell diameter of 15 mm to 23 at a diameter of 94 mm. It abruptly decreases to 11 to 15 between 116 and 118 mm diameter, and then gradually declines to about 10 at 150 mm. The number remains low to a diameter of about 210 mm, but at greater diameters the rib count increases to 15 at a diameter of 300 mm.

About seven volutions make up an adult shell. The species is large for the genus. One of the largest specimens at hand, unfigured paratype U.S.N.M. 108325, attains a diameter of 301 mm. The body chamber is incomplete, but a full half whorl is preserved.

The dimensions in millimeters ratios of the dimensions to the diameters, and the number of ribs per half whorl of the types are as follows:

Kind of specimen and U.S.N.M. number	Diameter	Umbilical width	Whorl height	Whorl thickness	Ribs per half whorl
Paratype 108322a	14. 5		8. 2 (0. 57)		13
Do	17. 0				14
Do	20. 0				15
Do	39. 3	4. 0 (0. 10)	22. 5 (. 57)	12. 8 (0. 33)	16
Do	50. 0				16
Do	135. 0				10
Do	150. 0				10
Do	170. 0				10
Do	210. 0				14
Paratype 108323a	43. 5	4. 0 (. 09)	24. 3 (. 56)	12. 6 (. 29)	18
Paratype 108324	60. 5	4. 3 (. 07)	34. 5 (. 57)	17. 6 (. 29)	19
Paratype 108323b	81. 5				22
Do	113. 0	11. 5 (. 10)	62. 0 (. 55)	29. 0 (. 26)	
Paratype 108322b	92. 4	9. 4 (. 10)	52. 1 (. 56)	23. 2 (. 25)	18
Do	147. 3	21. 3 (. 14)	73. 1 (. 49)	37. 0 (. 25)	12
Paratype 108322c	62. 5	4. 0 (. 06)	36. 7 (. 59)	17. 0 (. 27)	19
Do	151. 0	22. 5 (. 15)	75. 0 (. 49)	35. 5 (. 23)	9
Paratype 108322d	151. 3	21. 0 (. 14)	74. 5 (. 48)	35. 0 (. 23)	10
Do	190. 0				13
Holotype 108321	118. 0	7. 2 (. 06)	68. 0 (. 58)	28. 6 (. 24)	15
Do	222. 0	36. 0 (. 16)	107. 0 (. 48)	51. 3 (. 23)	10
Paratype 108322e	254. 0	56. 3 (. 22)	111. 0 (. 44)	55. 7 (. 22)	13
Paratype 108325	301. 0	65. 0 (. 21)	132. 0 (. 44)	68. 5 (. 23)	15

Metoicoceras muelleri can be ordinarily readily distinguished from its associate, *M. mosbyense*, by its thinner whorls, weaker sculpture, and persistency of a flattened venter to a much greater diameter. It is also more involute, lacks umbilical nodes, and loses the ventrolateral nodes at a much younger stage. There are a few specimens with characters of each species. These may have a combination of the whorl and umbilical proportions of *M. muelleri* and the coarse sculpture of *M. mosbyense*, or the ventrolateral nodes may persist out to diameters of 20 or 30 mm, which is greater than on typical *M. muelleri* and smaller than on *M. mosbyense*.

Metoicoceras muelleri differs in many respects from other American species with thin whorls and weak sculpture. *Metoicoceras acceleratum* Hyatt (1903, p. 127, pl. 14, figs. 11–14), *M. kanabense* Hyatt (1903, pl. 15, figs. 9–11), and *M. irwini* Moreman (1927, p. 92, pl. 13, figs. 3, 4) are all weakly ribbed compressed forms that lack umbilical nodes, but these species retain their ventrolateral nodes to greater diameters than does *M. muelleri*. The compressed specimen with flexuous ribs from Utah figured by Stanton (1893, p. 168, pl. 38, figs. 1, 2) as "*Buchiceras swallovi*" differs from *M. muelleri* by maintaining ventrolateral nodes out to a greater diameter. The specimen described from New Mexico by Herrick and Johnson (1900, p. 213, pl. 27, figs. 3, 4) as "*Buchiceras swallovi* var. *puercoensis*" shows some resemblance to *M. muelleri* by its fairly smooth shell, but the New Mexico form is stouter and has smaller umbilicus, fewer ribs, and simpler suture.

The nearest described European species is *Metoicoceras bureaui* (Grossouvre) (1912, p. 22, pl. 1, fig. 2) from the Upper Cenomanian, which seems to differ from *M. muelleri* only by lacking distinct ventral nodes and by having the ribs curved back on the outer part of the flank. *Metoicoceras pontieri* Leriche (1905) from the base of the Turonian of northern France is a thin densely ribbed species like *M. muelleri* that differs chiefly by the rounding of the venter at a much earlier stage.

The species is named for Mr. Oscar O. Mueller of Lewistown, Montana, whose large collections of Mosby ammonites made possible this study.

Types: Holotype, U.S.N.M. 108321; figured paratypes, U.S.N.M. 108322c, 108323a–b, 108324; unfigured paratypes, U.S.N.M. 108322a–b, 108322d–e, 108325.

Occurrence: U.S.G.S. Mes. loc. 10976, 21484, 21486, 21487, 21955.

Subfamily Acanthoceratinae Wright, 1951

Genus Dunveganoceras Warren and Stelck, 1940

1940. *Dunveganoceras* Warren and Stelck, Royal Soc. Canada, Trans., 3d ser., vol. 34, sec. 4, p. 149.

1949. *Dunveganoceras* Warren and Stelck. Haas, Am. Mus. Nat. History Bull., vol. 93, art. 1, p. 20.

1951. *Dunveganoceras* Warren and Stelck. Haas, Am. Mus. Novitates, no. 1490, p. 14.

Dunveganoceras albertense (Warren) subsp. montanense Cobban, n. subsp.

Plate 10, figures 1–7; plate 11; text figures 3b–e

The holotype of *Dunveganoceras albertense* (Warren) (1930, p. 21, pl. 1, figs. 1, 2) is a large shell of 350 mm diameter with an umbilical width of 140 mm (40 percent of diameter). The nodes disappear on the ultimate whorl and the whorl cross section becomes ogival. The ribs are strong, straight, and moderately spaced, with 18 on the last whorl.

Nearly all the specimens of *Dunveganoceras* from the Mosby sandstone member seem to fall within the scope of *D. albertense* (Warren). The umbilical widths are similar, the strength of ribs and nodes seems identical, and the last whorls have about the same number

of ribs, lose their nodes, and assume an ogival cross section. However, there are some differences that seem to warrant treating the Mosby form as a subspecies. The inner whorls are more densely ribbed, with 16 to 18 ribs per whorl between diameters of 70 and 100 mm in comparison with 13 to 14 at similar diameters on the holotype of *D. albertense;* the nodes are lost at a smaller diameter; the venter rounds earlier where the ribs cross it; and the ultimate whorl is stouter.

The holotype of *Dunveganoceras albertense montanense* is a shell of 320 mm diameter, with umbilical width of 140 mm (44 percent of diameter). The last whorl attains a coastal height of 95 mm and a thickness of about 100 mm. About half the body chamber is preserved. The nodes are lost by a diameter of 200 mm, and by a diameter of 240 mm the coastal whorl section is distinctly ogival. The ribs, which number 20 per whorl, are straight and inclined slightly forward. The suture is unusual in that the ventral lobe has shifted away from the median plane on the younger part of the last septate whorl (pl. 10, fig. 7).

The dimensions in mm, ratios of the dimensions to the diameters, and the number of ribs per whorl of the types are as follows:

Kind of specimen and U.S.N.M. number	Diameter (mm)	Umbilical width	Whorl height	Whorl thickness	Ribs per whorl
Paratype 108327a	67.2	18.8 (0.28)	29.5 (0.44)	28.8 (0.43)	16
Do	91.0	28.5 (.31)	36.5 (.40)	36.7 (.40)	17
Paratype 108328	133.5	45.0 (.33)	54.5 (.41)	54.2 (.46)	18
Do	185.0	61.0 (.33)	73.3 (.40)	72.0 (.39)	19
Do	265.0	95.0 (.36)	102.0 (.38)	91.0 (.34)	18
Paratype 108327b	255.0	96.0 (.38)	92.5 (.36)	72.2 (.28)	18
Do	310.0	122.0 (.39)	98.0 (.32)	80.0±(.26±)	18
Holotype 108326	250.0	100.8 (.40)	87.7 (.35)	70.0±(.28±)	20
Do	320.0	140.0 (.44)	95.0 (.30)	100.0±(.31±)	20
Paratype 108327c	----------	----------	130.0	112.0	----------

Measurements of 16 specimens show a gradual widening of the umbilicus from 28 percent at a diameter of 67 mm to 44 percent at a diameter of 320 mm. The number of ribs per whorl increases from 16 at diameter of 67 mm to an average of 18 at diameter of 150 mm, and at all later stages the rib count remains between 18 and 20. The largest specimen examined (unfigured paratype U.S.N.M. 108327c), a fragment of a body whorl with a height of 130 mm and thickness of 112 mm, indicates that the subspecies attained diameters of more than 400 mm.

Types: Holotype, U.S.N.M. 108326; figured paratypes, U.S.N.M. 108327a–b, 108329; unfigured paratypes, U.S.N.M. 108327c, 108328.

Occurrence: U.S.G.S. Mes. loc. 18741, 21396, 21484, 21486–21488, 21662, 21955.

Dunveganoceras parvum Cobban, n. sp.

Plate 12, figures 1, 2; text figure 3a

Shell small for the genus, moderately evolute with umbilical width about 35 percent of the diameter. Whorls stout, about as wide as high; umbilical wall steep; flanks broadly rounded; venter of ultimate whorl rounded. Sculpture consists of forwardly inclined ribs, which on the septate whorls bear ventral and ventrolateral nodes.

The holotype, an adult shell with a little more than half the body chamber preserved, has the following dimensions in millimeters:

Diameter: 178
Umbilical width: 62.6 (35 percent of diameter)
Whorl height: 63.4
Whorl thickness: 65±

Whorls below a diameter of 60 mm are not preserved. The ribs on the holotype are narrow, inclined forward, extended to the umbilical shoulder, and number 19 on the last whorl. On the last septate whorl each rib is strongly bent forward on leaving the umbilical shoulder, but abruptly curves back a little on the lower part of the flank, straightens, and crosses the rest of the flank with a forward inclination of about 20 degrees. On the body chamber the ribs become straighter and less inclined. Up to a diameter of about 70 mm each rib terminates in strong ventral and ventrolateral nodes. Between diameters of 70 to 90 mm these nodes merge into large rounded nodes, and the ribs cross the venter. By a diameter of 120 mm the ribs absorb the nodes and become high, but flat-crested, on crossing the venter. By a diameter of 150 mm both the costal and intercostal cross sections of the whorl are rounded on the venter.

This is the smallest known species of *Dunveganoceras.* It is readily distinguished from *D. albertense* (Warren) by its small size and early loss of nodes. The smallest species described from Canada, *D. poucecoupense* Warren and Stelck (1940, p. 150, pl. 2; pl. 3, figs. 2, 5), is larger and has a truncate venter. *D. conditum* Haas (1951, p. 5, text figs. 2–9) from the Frontier formation of Wyoming attains a much larger size and is more densely ribbed.

Types: Holotype, U.S.N.M. 108330; unfigured paratype, U.S.N.M. 108331.

Occurrence: U.S.G.S. Mes. loc. 21484, 21486, 21487, 21662.

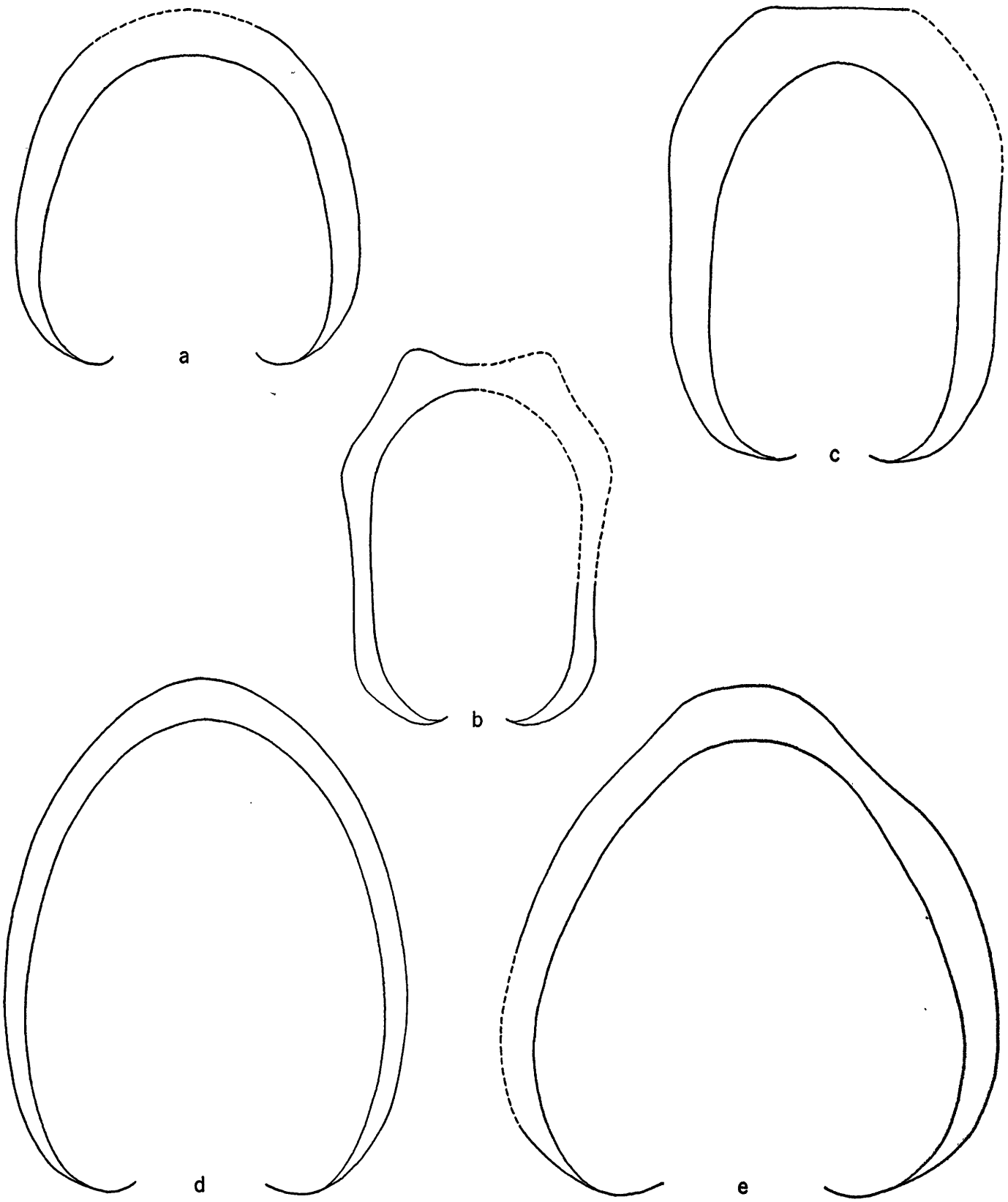


FIGURE 3.—Whorl sections, natural size, of *Dunveganoceras* from Mosby sandstone member. a, *Dunveganoceras parvum* Cobban (holotype, U.S.N.M. 108330) at diameter of 168 mm; b-d, *Dunveganoceras albertense* (Warren) subsp. *montanense* Cobban (paratype, U.S.N.M. 108327b) at diameters of 170, 200, and 265 mm illustrating changes in costal cross section; e, *D. a. montanense* Cobban (holotype, U.S.N.M. 108326) at diameter of 283 mm.

REFERENCES

Bergquist, H. R., 1944., Cretaceous of the Mesabi iron range, Minnesota: Jour. Paleontology, vol. 18, no. 1, pp. 1–30, pls. 1–11.

Böse, Emil, 1918, On a new ammonite fauna of the Lower Turonian of Mexico: Texas Univ. Bull. 1856, pp. 173–257, pls. 12–20, text figs. 1–7.

Cobban, W. A., 1951, Colorado shale of central and northwestern Montana and equivalent rocks of the Black Hills: Am. Assoc. Petroleum Geologists Bull., vol. 35, no. 10, pp. 2170–2198.

De Grossouvre, Albert, 1912, Le Crétacé de la Loire-Inférieure et de la Vendée: Soc. sci. nat. Ouest France Bull., ser. 3, vol. 2, pp. 1–38, pls. 1–3, text figs. 1–8.

Haas, Otto, 1949, Acanthoceratid Ammonoidea from near Greybull, Wyoming: Am. Mus. Nat. History Bull., vol. 93, art. 1, pp. 1–39, pls. 1–15, text figs. 1–17.

——— 1951, Supplementary notes on the ammonoid genus *Dunveganoceras:* Am. Mus. Novitates, no. 1490, pp. 1–21, text figs. 1–9.

Herrick, C. L., and Johnson, D. W., 1900, The geology of the Albuquerque sheet: Denison Univ., Sci. Lab., Bull., vol. 11, art. 9, pp. 175–239, pls. 27–58, map in pocket.

Hyatt, Alpheus, 1903, Pseudoceratites of the Cretaceous: U. S. Geol. Survey Mon. 44.

Jones, T. S., 1938, Geology of Sierra de la Peña and paleontology of the Indidura formation, Coahuila, Mexico: Geol. Soc. America Bull., vol. 49, pp. 69–150, pls. 1–13, text figs. 1–4.

Karrenberg, Herbert, 1935, Ammonitenfauna aus der nordspanischen Oberkreide: Palaeontographica, Band 82, Abt, A, pp. 125–161, pls. 30–33, text figs. 1–5.

Leriche, Maurice, 1905, Sur la présence du genre *Metoicoceras* Hyatt dans la Craie du Nord de la France et sur une espèce nouvelle de ce genre (*Metoicoceras pontieri*): Soc. géol. Nord Annales, tome 34, pp. 120–124, pl. 2, text figs. 1–3.

Lupton, C. T., and Lee, Wallace, 1921, Geology of the Cat Creek oil fields, Fergus and Garfield Counties, Montana: Am. Assoc. Petroleum Geologists Bull., vol. 5, no. 2, pp. 252–275, pls. 1, 2, text fig. 1.

Moreman, W. L., 1927, Fossil zones of the Eagle Ford of north Texas: Jour. Paleontology, vol. 1, no. 1, pp. 89–101, pls. 13–16, text fig. 1.

——— 1942, Paleontology of the Eagle Ford group of north and central Texas: Jour. Paleontology, vol. 16, no. 2, pp. 192–220, pls. 31–34, text figs. 1, 2.

Muller, S. W., and Schenck, H. G., 1943, Standard of Cretaceous system: Am. Assoc. Petroleum Geologists Bull., vol. 27, no. 3, pp. 262–278, text figs. 1–7.

Petrascheck, Wilhelm, 1902, Die Ammoniten der sächsischen Kreideformation: Beitr. Paläontologie Oesterr.-Ungarns u. des orients, Band 14, pp. 131–162, pls. 7–12, text figs. 1–8.

Reeside, J. B., Jr., and Weymouth, A. A., 1931, Mollusks from the Aspen shale (Cretaceous) of southwestern Wyoming: U. S. Nat. Mus. Proc., vol. 78, art. 17, pp. 1–24, pls. 1–4.

Shumard, F. B., 1859, Descriptions of new Cretaceous fossils from Texas: Acad. Sci. St. Louis Trans., vol. 1, pp. 570–610.

Spath, L. F., 1926, On new ammonites from the English chalk: Geol. Mag., vol. 63, pp. 77–83.

Stanton, T. W., 1893 (issued 1894), The Colorado formation and its invertebrate fauna: U. S. Geol. Survey Bull. 106.

Stephenson, L. W., 1952, The larger invertebrate fossils of the Woodbine formation (Cenomanian) of Texas: U. S. Geol. Survey Prof. Paper 242.

Warren, P. S., 1930, Three new ammonites from the Cretaceous of Alberta: Royal Soc. Canada Trans., 3d ser., vol. 24, sec. 4, pp. 1–26, pls. 1–4.

Warren, P. S., and Stelck, C. R., 1940, Cenomanian and Turonian faunas in the Pouce Coupe district, Alberta and British Columbia: Royal Soc. Canada Trans., 3d ser., vol. 34, sec. 4, pp. 143–152, pls. 1–4.

INDEX

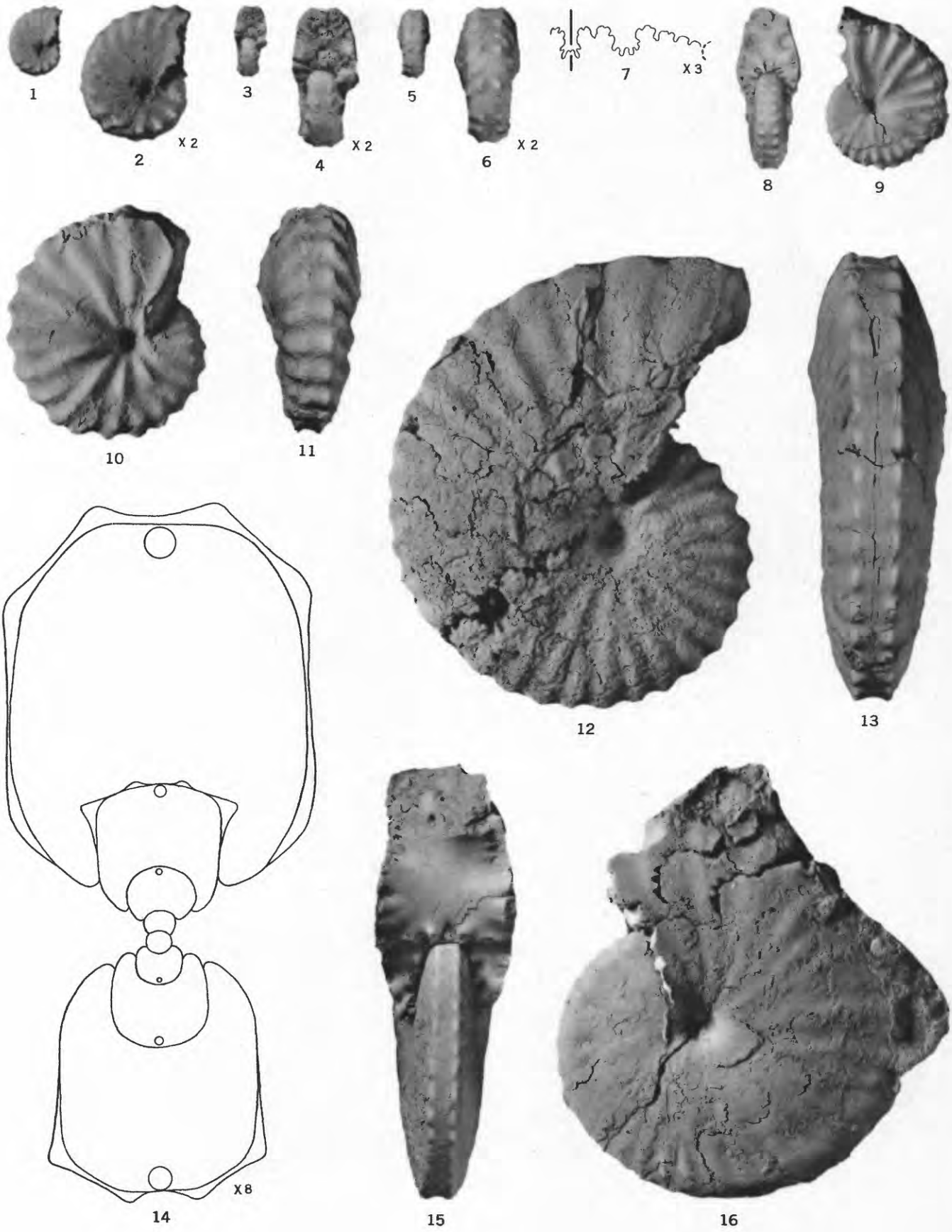
[Italic numbers indicate descriptions]

PLATES 6–12

PLATE 6

[All figures natural size except as indicated on plate]

FIGURES 1–14. *Metoicoceras mosbyense* Cobban, n. sp. (p. 48).
1–7, Side, front, and rear views, and suture of a small internal mold, paratype U.S.N.M. 108316a, from locality 21955.
8, 9, Front and side views of a larger specimen, paratype U.S.N.M. 108316b, from the same locality, showing the first appearance of umbilical nodes.
10, 11, Side and rear views of a stout paratype retaining the shell, U.S.N.M. 108317a, from locality 21484. Shows the disappearance of the ventrolateral nodes and the elevation of the umbilical ribs into radially elongated nodes.
12, 13, Side and rear views of an internal mold, paratype U.S.N.M. 108318a, from locality 21487, showing the disappearance of umbilical and ventrolateral nodes.
14, Cross section of the internal whorls of paratype U.S.N.M. 108320, from locality 21662.
15, 16. *Metoicoceras muelleri* Cobban, n. sp. (p. 49).
Front and side views of paratype U.S.N.M. 108324, an internal mold from locality 21487.



METOICOCERAS

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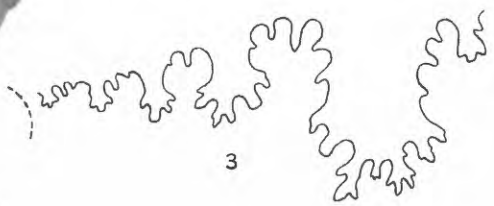

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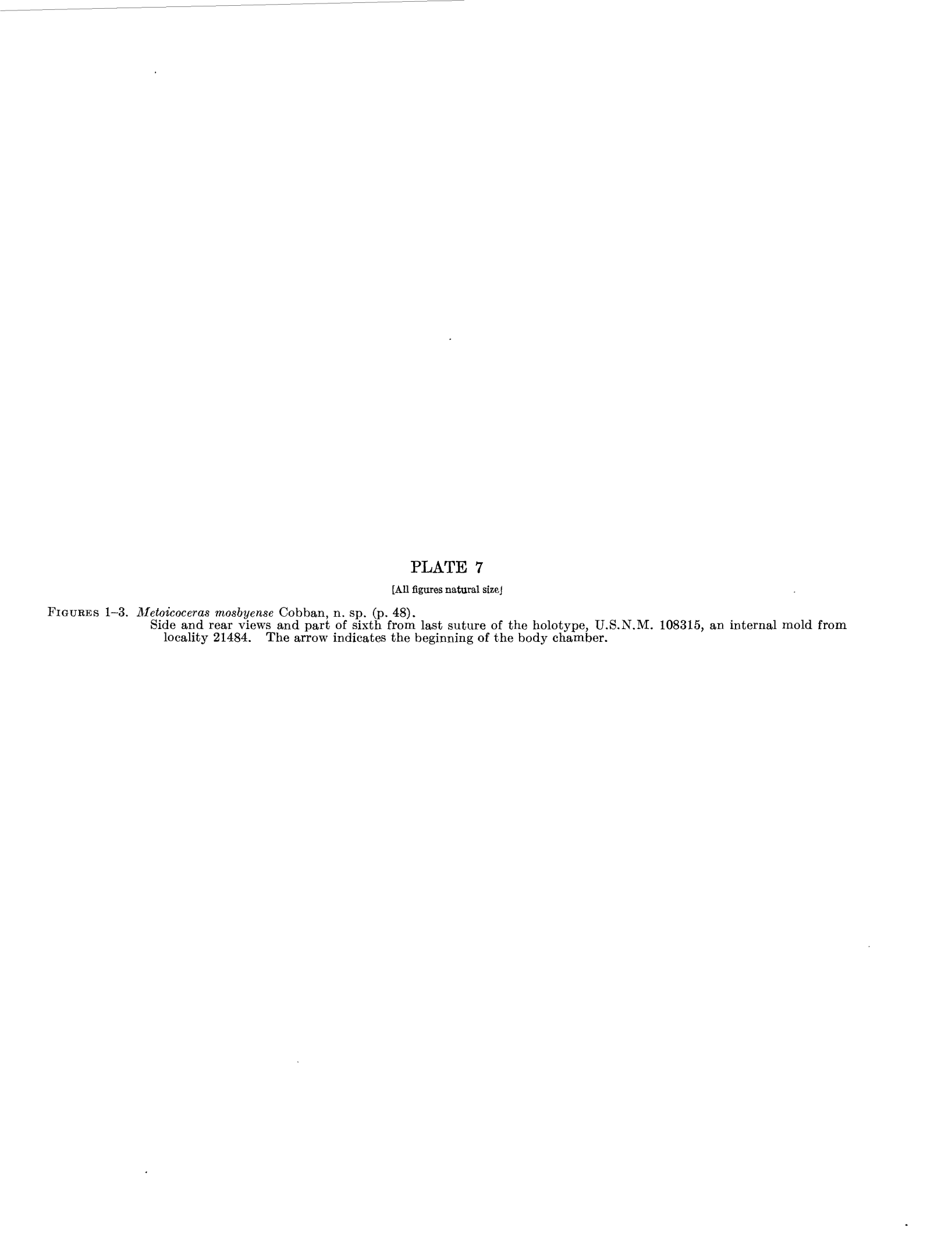
2

METOICOCERAS

PLATE 7

[All figures natural size.]



FIGURES 1–3. *Metoicoceras mosbyense* Cobban, n. sp. (p. 48).
Side and rear views and part of sixth from last suture of the holotype, U.S.N.M. 108315, an internal mold from locality 21484. The arrow indicates the beginning of the body chamber.

PLATE 8

[All figures natural size except as indicated on plate]

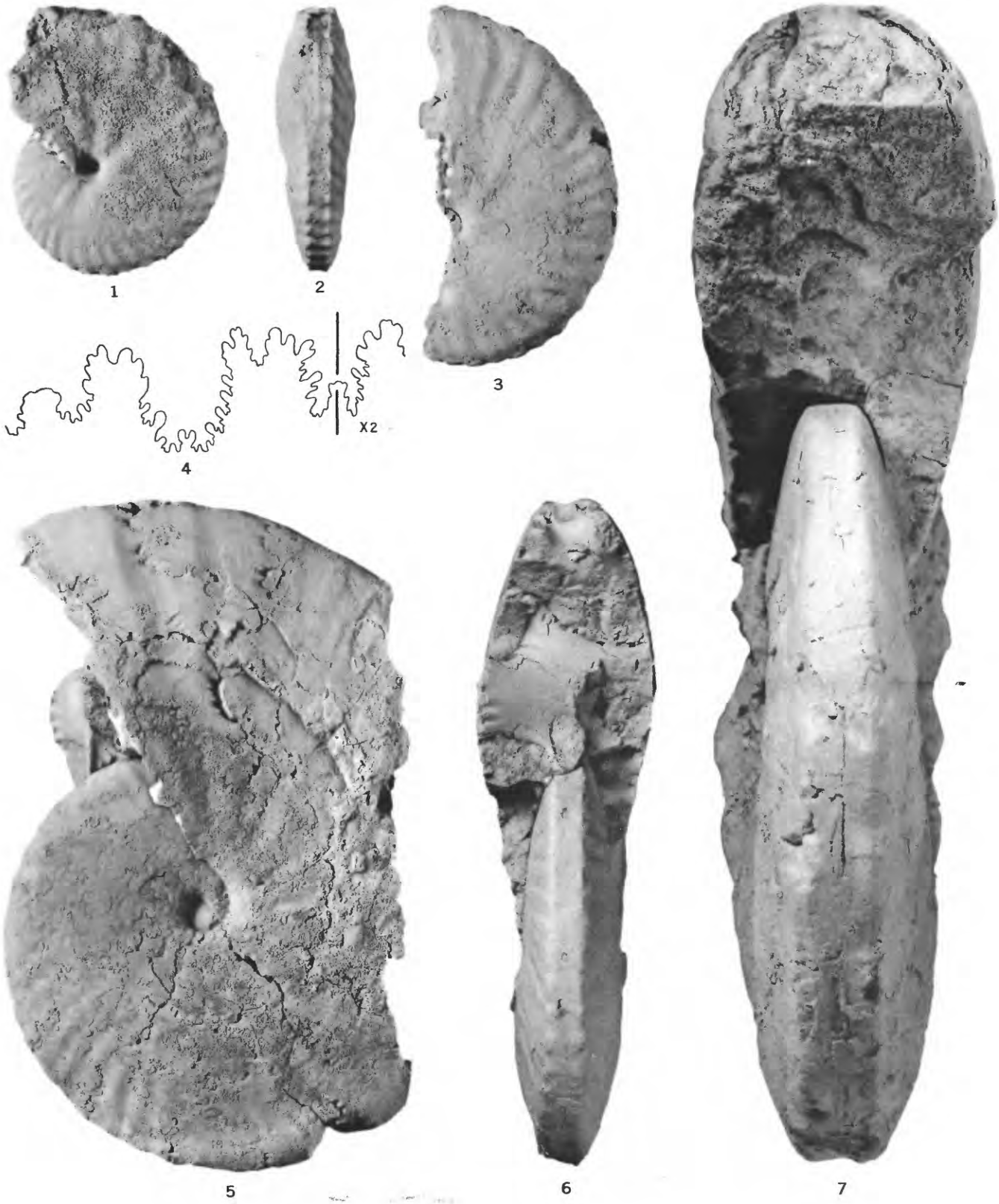
FIGURES 1–7. *Metoicoceras muelleri* Cobban, n. sp. (p. 49).

1, 2, Side and rear views of a small internal mold, paratype U.S.N.M. 108323a, from locality 21484. Shows weakness of sculpture and early disappearance of ventrolateral nodes.

3, 4, Side view and suture of a slightly larger internal mold, paratype U.S.N.M. 108322c, from locality 21486.

5, 6, Side and front views of a larger almost smooth internal mold, paratype U.S.N.M. 108323b, from locality 21484.

7, Front view of the holotype, U.S.N.M. 108321, from locality 21487. Shows change in venter from a flattened to a rounded form.



METOICOCERAS

METOICOCERAS

PLATE 9

Metoicoceras muelleri Cobban, n. sp. (p. 49).

Side view, natural size, of the holotype, U.S.N.M. 108321, from locality 21487. The arrow indicates the beginning of the body chamber.

PLATE 10

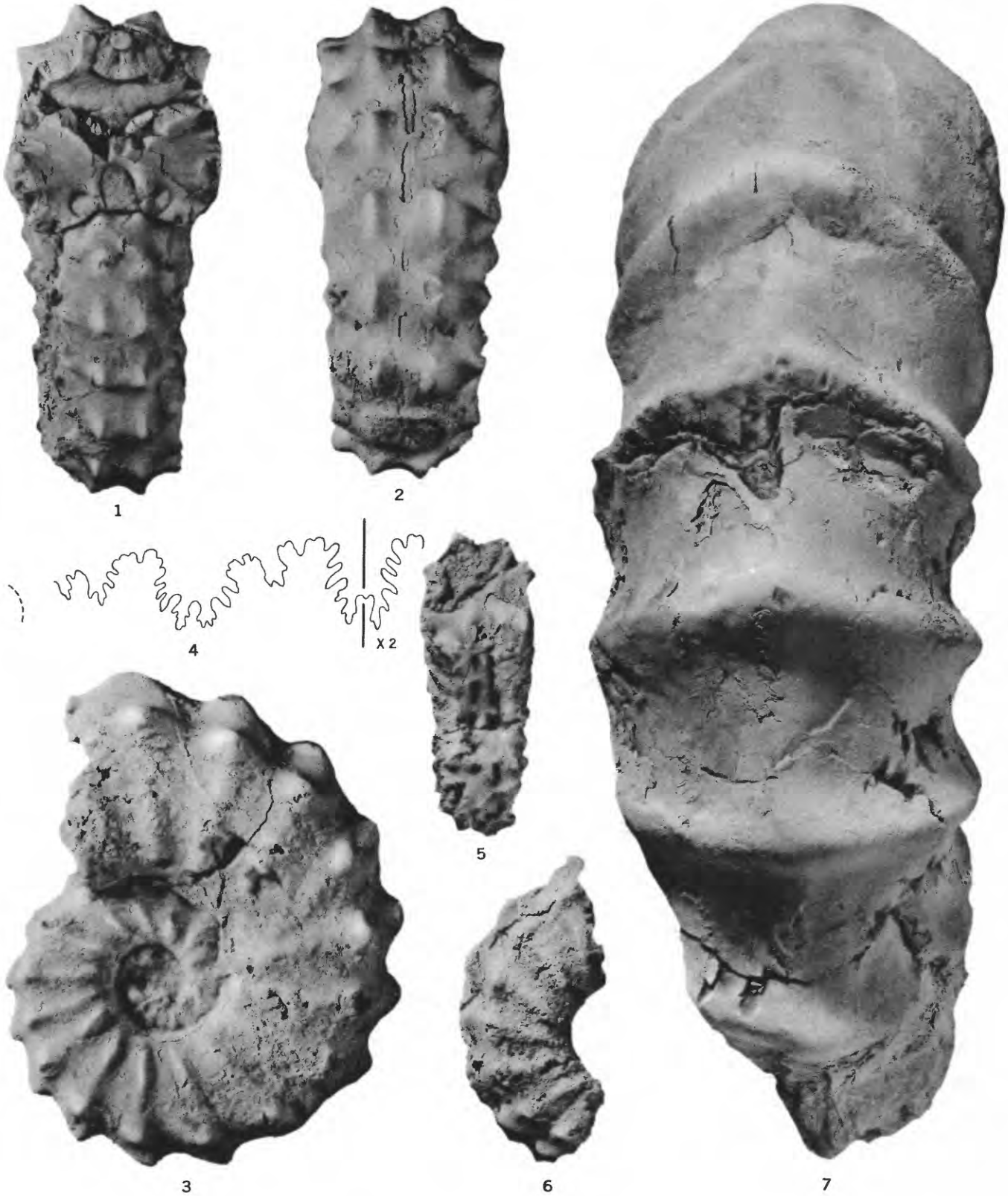
[All figures natural size except as indicated on plate]

FIGURES 1–7. *Dunveganoceras albertense* (Warren) subsp. *montanense* Cobban, n. subsp. (p. 51).

1–4, Front, rear, and side views, and suture at diameter of 45 mm of an internal mold, paratype U.S.N.M. 108327a, from locality 21955.

5, 6, Front and side views of a smaller paratype, U.S.N.M. 108329, from locality 21662.

7, Rear view of the holotype, U.S.N.M. 108326, from locality 21488. Shows ogival shape of the ultimate whorl and the asymmetrical suture.



DUNVEGANOCERAS

DUNVEGANOCERAS

PLATE 11

[Figure three-fourths natural size]

Dunveganoceras albertense (Warren) subsp. *montanense* Cobban, n. subsp. (p. 51).
Side view of the holotype, U.S.N.M. 108326, a large internal mold from locality 21488. The arrow indicates the beginning of the body chamber.

PLATE 12

[Both figures natural size]

FIGURES 1, 2. *Dunveganoceras parvum* Cobban, n. sp. (p. 52).
Side and rear views of the holotype, U.S.N.M. 108330, an internal mold from locality 21484. The arrow indicates the beginning of the body chamber.

1

2

DUNVEGANOCERAS