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## *Paracanthoceras wyomingense* (Reagan) from the Western Interior of the United States and from Alberta (Ammonoidea)

BY OTTO HAAS<sup>1</sup>

### INTRODUCTION

In the fall of 1961 Dr. Avery E. Wood of Watsonville, California, called my attention to a large, horned ammonite from an area about 6 miles east and 7 miles north of Greybull, Wyoming, and gave me a photograph of the specimen, which is here designated as hypotype (figs. 10–12). In the spring of 1962, Dr. Wood put this specimen, with a whorl fragment of a larger one and a smaller disk, at my disposal, generously donating all three specimens to the American Museum of Natural History. My belief that this form was conspecific with the “three giant conchs with imposing tubercles” collected by Barnum Brown in 1903 near Edgemont, South Dakota, and doubtfully referred by me (1946, pp. 153 ff.) to the typical form of *Collignoniceras woollgari* (Meek, ?*non* Mantell) and mentioned in my report of 1949 (p. 29, footnote 2) proved correct as soon as I compared it with the specimens from near Edgemont that Dr. Norman D. Newell kindly lent me for this purpose.

Meanwhile, W. A. Cobban had identified the photographed specimen with “*Metoicoceras Wyomingensis*” Reagan, 1924, the holotype of which I borrowed from Stanford University through the courtesy of Dr. A. Myra

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Keen. In the course of an extended correspondence, Dr. Cobban sent me various specimens from Wyoming and Montana which he considers referable to Reagan's species. Close study of them eventually convinced me of the correctness of his identifications.

Because the species under consideration appears in the literature under five different generic names other than Reagan's, a summary of these earlier reports and a redescription seem to be desirable.

My sincere thanks are due to the late Dr. Wood for bringing the material newly found near Greybull to my attention and for giving me the opportunity to study it, to Dr. W. A. Cobban, United States Geological Survey, Denver, Dr. Norman D. Newell, the American Museum of Natural History, Dr. A. Myra Keen, Stanford University, and Dr. Erle G. Kauffman, United States National Museum, for the loan of specimens from the collections in their care, and to Dr. Cobban, furthermore, for first suggesting the conspecificity of the horned specimens from near Greybull with Reagan's all but forgotten species and for other valuable hints concerning its synonymy. I am also indebted to Mr. G. Robert Adlington of the American Museum of Natural History for devoting his expert skill to the preparation of the photographs accompanying this report.

The following abbreviations are used to designate collections:

A.M.N.H., the American Museum of Natural History

S.U., Stanford University

U.A., University of Alberta Geological Museum

U.S.N.M., United States National Museum, Smithsonian Institution

## SYSTEMATIC PALEONTOLOGY

### SUBCLASS AMMONOIDEA

### ORDER AMMONITIDA

### SUPERFAMILY ACANTHOCERATAEAE

### FAMILY ACANTHOCERATIDAE

### SUBFAMILY ACANTHOCERATINAE

### PARACANTHOCERAS, NEW GENUS

**DIAGNOSIS:** Involute in youth, becoming increasingly more evolute with growth. Whorl section rectangular to subquadratic, with gently convex flanks and truncate venter. Ornamentation consisting of radial ribs which gradually disappear, circumumbilical tubercles gradually shifting away from umbilical shoulder and developing into horns, inner and outer lateroventral tubercles, outer ones more pronouncedly elongated spirally; both eventually merging into large horns that point outward and upward. Inconspicuous median tubercles, present in youth

only, forming an intermittent keel which soon fades. Suture line characterized by particularly high outer main stem of very large external saddle and by wide first lateral lobe which is mostly bifid.

TYPE SPECIES, HERE DESIGNATED: "*Metoicoceras Wyomingensis*" Reagan.

*Paracanthoceras wyomingense* (Reagan)

Figures 1-12

*Metoicoceras Wyomingensis* N.S., REAGAN, 1924, p. 181, pl. 19, figs. 1, 2.

*Pronotrophis woollgari* Meek (?non Mantell), *forma typica?*, HAAS, 1946, pp. 153, 157, 159, 161, 164, 172, 185, 197, pl. 14, fig. 11.

?*Collignoniceras woollgari*, typical form, HAAS, 1949, p. 29, footnote 2.

"*Mammites*' n. sp.," HAAS, 1949, pp. 28, 29.

*Dunveganoceras* sp. indet., HAAS, 1949, p. 30, fig. 10, pl. 15, figs. 1-3.

*Acanthoceras* ? n. sp., COBBAN, 1951, p. 2182, fig. 2.

*Acanthoceras* ? sp. A, COBBAN AND REESIDE, 1952a, pp. 1954, 1961, fig. 4.

*Acanthoceras* ? sp. A, COBBAN AND REESIDE, 1952b, p. 1017, chart 10B.

*Acanthoceras* ? n. sp., HOSE, 1955, pp. 61, 100.

*Acanthoceras athabascense* WARREN AND STELCK, 1955, p. 71, *cum synon.*, pl. 6, figs. 5, 6, pl. 7, figs. 1, 3, 4, pl. 8, figs. 1-3, pl. 9, fig. 2.

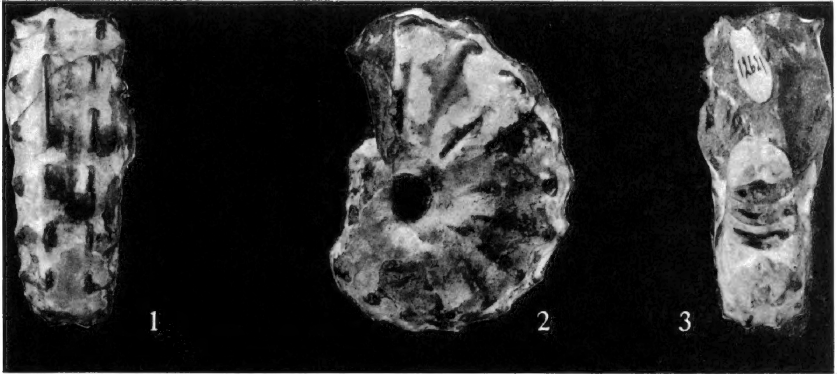
*Acanthoceras athabascense* Warren and Stelck, HAAS, 1955, p. 1070.

*Acanthoceras* ? *wyomingense* (Reagan), COBBAN, 1958, p. 118, fig. 2.

The conspecificity of the "three giant disks" from near Edgemont, South Dakota, with the form newly found near Greybull, Wyoming, is mentioned above. It extends to the three whorl fragments from the Belle Fourche shale of locality U.S.G.S. Mesozoic 12621, hitherto labeled "*Mammites*' n. sp." in the collections of the United States National Museum, the close identity of which, at a comparable growth stage, with the Edgemont disks I pointed out in 1949. Cobban suggested the conspecificity, despite considerable intraspecific variation, of the Greybull form with Reagan's holotype and also with the forms appearing, with or without question mark, under the generic name *Acanthoceras* in the above synonymy. Finally, I realized in the course of the present study the identity of the specimen I described in 1949 as *Dunveganoceras* sp. indet. with Reagan's holotype which it resembles most closely among all those included in the synonymy.

Even if the extraordinarily involute holotype is not considered, table 1 still indicates a remarkable decrease in the degree of involution with growth. Similarly, W tends to decrease with growth, though less markedly. (A.M.N.H. No. 26417 and U.S.N.M. No. 131907 are conspicuous by being extraordinarily thin at an early stage.)

A large whorl fragment from near Greybull (A.M.N.H. No. 28111:3) nearly corresponds in size to the largest of the three crushed disks (A.M.N.H. No. 25986:1). The latter is preserved up to the apertural



FIGS. 1-3. *Paracanthoceras wyomingense* (Reagan), U.S.N.M. No. 131905. All  $\times 1$ .

margin (Haas, 1946, p. 161) and thus permits an estimate of the full size attained by complete disks of this species. However, its diameter of 356 mm. is still considerably surpassed by that of a specimen from near Greybull in the possession of W. J. Greene of Greybull that, according to Wood (letter, October 24, 1961), measures fully 420 mm. in diameter.

TABLE 1  
DIMENSIONS OF *Paracanthoceras wyomingense* (REAGAN)

Specimens	D <sup>a</sup>	H	H'	W	W'	U
U.S.N.M. No. 131905	38½	52	43	39	43	17
U.S.N.M. No. 131909 <sup>b</sup>	105½	44	36	?	?	24½
A.M.N.H. No. 26417	106	49	42½	33	35	19½
S.U. No. 119 <sup>c</sup>	120	50½	?37	38	39	18
U.S.N.M. No. 131907	172	38½	ca. 33½	33½	40	38½
A.M.N.H. No. 28111:1	207½	ca. 37	?	?21½	?28½	35
A.M.N.H. No. 28111:2 <sup>d</sup>	318	40	ca. 33	ca. 30	41	37½
A.M.N.H. No. 25986:1 <sup>e</sup>	ca. 356	38½	?	?	?	37½

<sup>a</sup> Symbols: D, the greatest diameter that can be measured; H, the height of the outer whorl from the umbilical seam to the periphery; H', its height from dorsum to venter; W, the width of the intercostal or internodal section; W', that of the costal or nodal one; U, the width of the umbilicus. The height of external tubercles (horns) is included in D and H. D is expressed in millimeters and halves thereof; all other dimensions are expressed in per cent of D, decimals having been reduced or increased, respectively, to full or half per cent.

<sup>b</sup> Crushed.

<sup>c</sup> Holotype.

<sup>d</sup> Hypotype.

<sup>e</sup> Crushed. Difference in H from Haas (1946, p. 157) due to fact that there height of horn was left out of account.

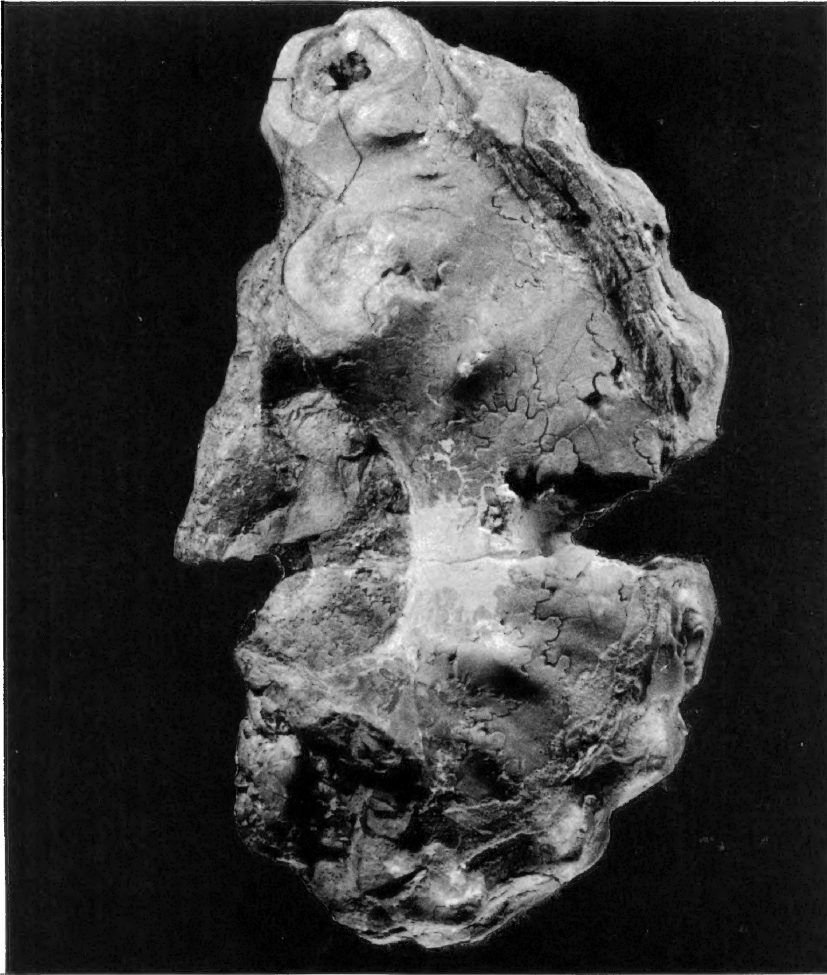


FIG. 4. *Paracanthoceras wyomingense* (Reagan), U.S.N.M. No. 131906.  $\times 1$ .

Similar sizes may have been reached by the shells whorl fragments of which have been collected at locality U.S.G.S. Mesozoic 12621 and near Greybull (see above). Thus, the sizes here mentioned greatly exceed the maximum diameter of 250 mm. reported by Warren and Stelck (1955) for their *Acanthoceras athabascense*.

As pointed out earlier (1946, p. 161), the last septum cannot be located in the largest disk present which is preserved to the apertural margin, so that the length of its body chamber cannot reliably be given. In the hypotype, which is not complete, the anterior third of the outer whorl

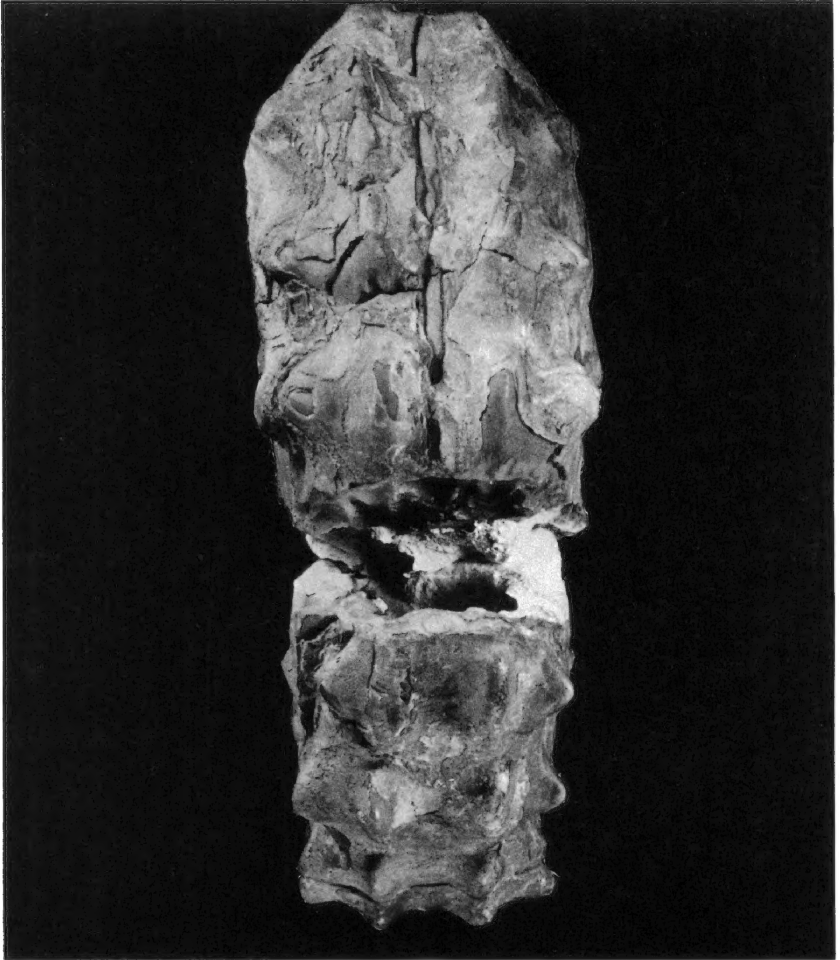


FIG. 5. *Paracanthoceras wyomingense* (Reagan), U.S.N.M. No. 131906.  $\times 1$ .

belongs to it. In the largest whorl fragment from locality U.S.G.S. Mesozoic 12621 (U.S.N.M. No. 131773), the last septum marks the rear end and is located at a diameter of about 250 mm.

TYPES: Whatever forms are included above in the synonymy of "*Metioiceras Wyomingensis*," here renamed *Paracanthoceras wyomingense* (Reagan), the only specimen described and illustrated by that author in 1924 is and remains the holotype, although it deviates considerably from the mean of the material under study both in its higher degree of involution and in the weakness of its ornamentation. This case is one of those unfor-

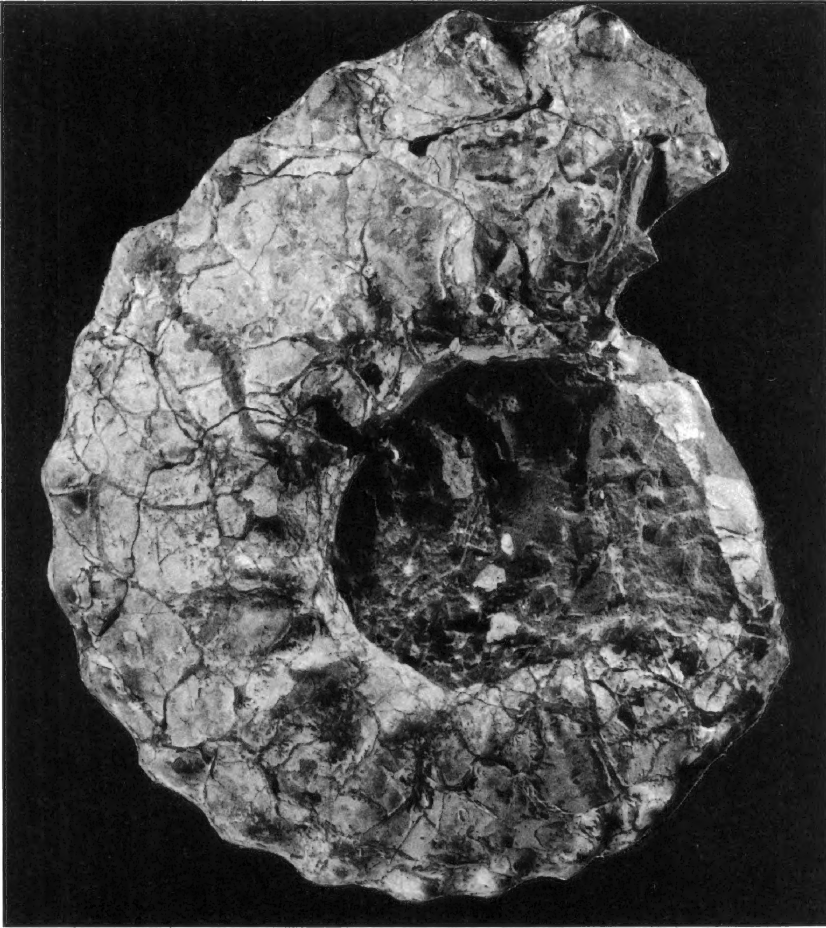


FIG. 6. *Paracanthoceras wyomingense* (Reagan), U.S.N.M. No. 131907.  $\times \frac{3}{4}$ .

tunate examples of types of which the quality as name bearers is unassailable but which are not all characteristic of their species. The writer has previously (1942, pp. 98, 124, 125) pointed out similar cases and has more recently (1958, p. 630) discussed at greater length the problem of "typical vs. characteristic" and its taxonomic implications. Since this "atypical" specimen, which is nonetheless the type, and those few others that closely resemble it, such as U.S.N.M. No. 131909 and A.M.N.H. No. 26417, are connected by intergradations with the more common form of this species, which is more evolute and more robustly sculptured, no useful purpose is served by relegating the latter to variety rank and restricting

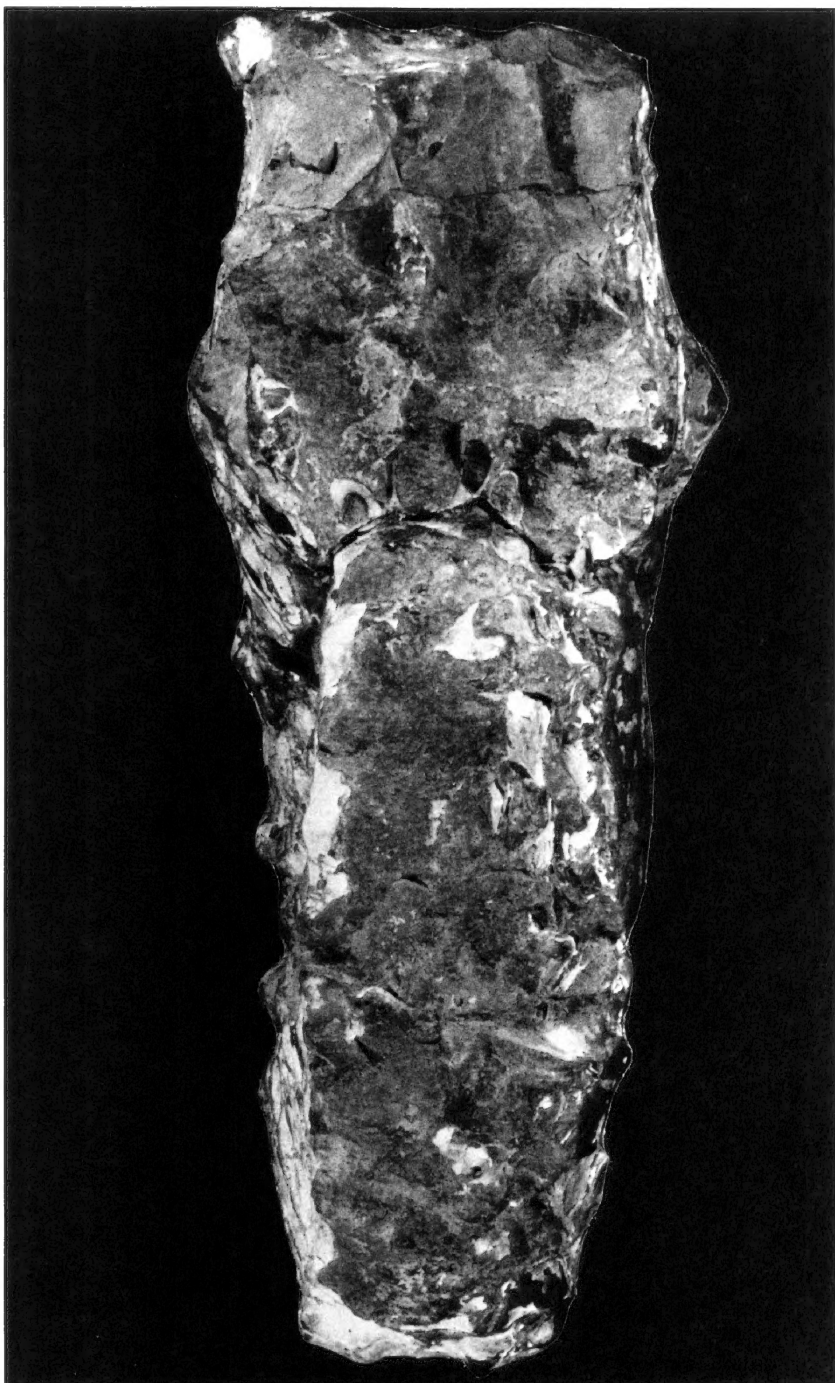


FIG. 7. *Paracanthoceras wyomingense* (Reagan), U.S.N.M. No. 131907.  $\times 1$ .



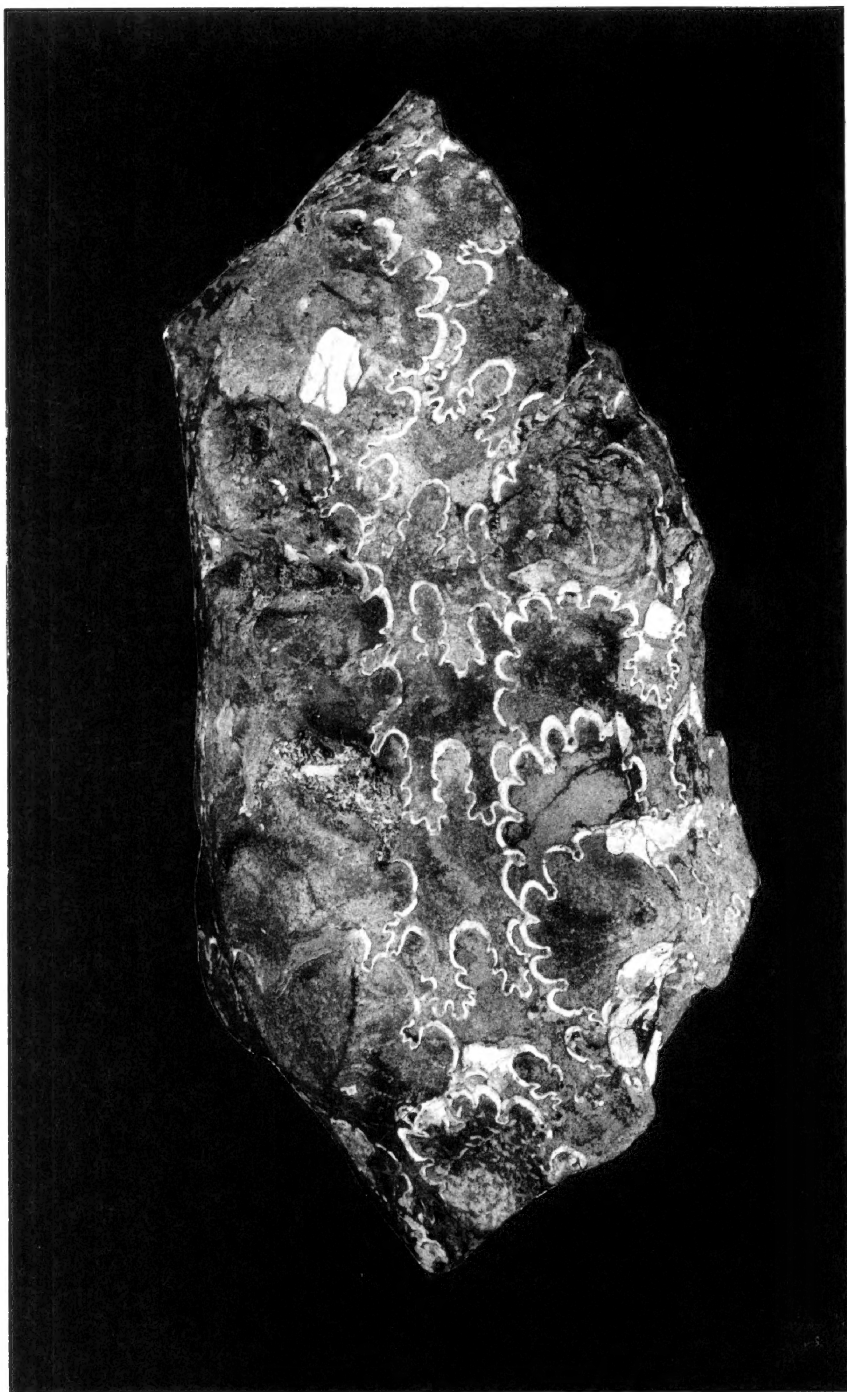


FIG. 8. *Paracanthoceras wyomingense* (Reagan), U.S.N.M. No. 131908.  $\times 1$ .

the typical form to the holotype and individuals that closely resemble it. Rather, all specimens under study are here included in Reagan's species, with his holotype considered "a poorly preserved example of the weakly sculptured end of this variation series" (Cobban, letter, May 8, 1962). The entirely different aspect of heavily sculptured, mature individuals is allowed for by my designating here the best-preserved of them (A.M.N.H. No. 28111:2) as the hypotype<sup>1</sup> of this species.

**DESCRIPTION:** Conch discoidal, involute in the young and also in some somewhat larger individuals (such as the holotype and A.M.N.H. No. 26417), almost fully evolute in maturity. Whorl section rectangular in the more involute shells, subquadratic in the evolute ones, all specimens with gently convex flanks and truncate venter.<sup>2</sup>

The greatest width, in most specimens, is at the inner third; in a few exceptions, as in the holotype, it is at the middle of the sides. In the course of development internodal and nodal whorl sections become increasingly more different from one another (fig. 12), the former assuming elliptic shape, the latter becoming dominated by the extremely strong inner and outer tubercles.

The ornamentation undergoes thorough changes in the course of ontogeny. At the earliest stage studied (U.S.N.M. No. 131905, figs. 1, 2), corresponding to a diameter of less than 40 mm., nine ribs are counted on the last half-whorl; they end near the ventrolateral shoulder in tubercles that gradually become elongated spirally. No circumumbilical tubercles are present, but here and there the inner portion of a rib is somewhat raised. The aforementioned shoulder tubercles are ventrad accompanied by an outer row of tubercles which are much more elongated spirally; two, on the left side, even merge. Between these tubercles the venter carries extremely low median tubercles which are also spirally elongated and can thus be considered a faint, intermittent keel as well. All these tubercles agree in position and number with the corresponding ribs. On the penultimate whorl of A.M.N.H. No. 28111:1 (fig. 9), corresponding to a diameter of about 80 mm., there are still ribs which have increased in number to about 13 per half-whorl; here every third one carries a strong, radially elongated circumumbilical tubercle that occupies the inner third

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<sup>1</sup> As understood in Frizzell's (1933, p. 653) definition: "A described or figured specimen, used in publication in extending or correcting the knowledge of a previously defined species." The fact that Warren and Stelck (1955, pp. 72, 80, pl. 7, fig. 4, pl. 8, fig. 2) call two specimens (U.A. Nos. Ct. 769 and Ct. 1044) of their *Acanthoceras athabascense* hypotypes is not believed to obstruct this designation.

<sup>2</sup> Called "dorsum (abdomen)" or simply "dorsum" in Reagan's original description.

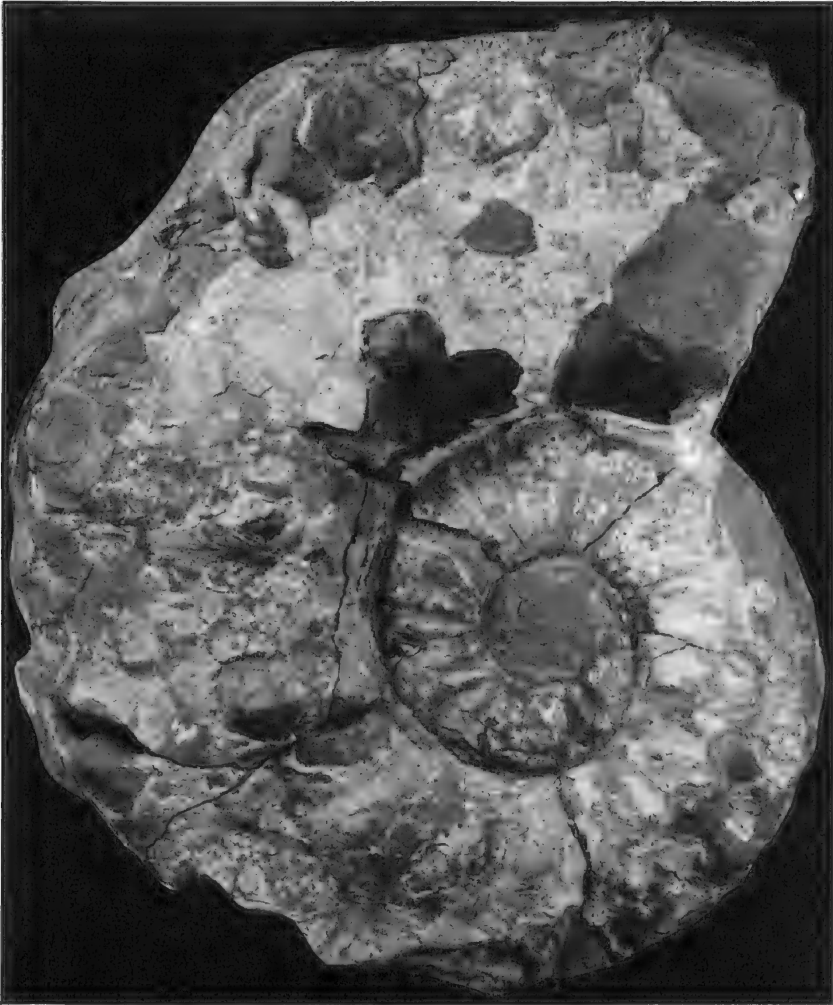


FIG. 9. *Paracanthoceras wyomingense* (Reagan), A.M.N.H. No. 28111:1.  $\times \frac{2}{3}$ .

or more of the flanks. The next sculptural stage can be studied in U.S.N.M. No. 131906 (figs. 4, 5) at an only slightly greater size. Here the sculpture of the flanks is restricted to strong circumumbilical tubercles which have begun to move away from the umbilical shoulder. On the lateroventral shoulder there are about twice as many (nine or 10 per half-whorl) outer tubercles, pointing outward, and on the venter those of the outermost row which are still spirally elongated. Only at the posterior

end of this fragment does the last residue of the intermittent median keel show, but it gradually fades. With that exception, the same sculptural elements as in this fragment can be observed, though greatly subdued, in the holotype and in A.M.N.H. No. 26417. A somewhat later stage of the ornamentation can be studied in U.S.N.M. No. 131907 (figs. 6, 7) at diameters up to 170 mm. The ribs have condensed into the circumumbilical nodes, seven of which can be counted on the anterior half of the outer whorl, but there are nearly twice as many pairs of lateroventral tubercles, both rows of which show less spiral elongation than did those at an earlier stage; those on the shoulder are markedly more prominent than those on the venter. In the anteriormost quarter of the outer whorl the internodals between both circumumbilical and lateroventral tubercles increase markedly in width. They do so even faster in the holotype of *Acanthoceras athabascense* Warren and Stelck (1955, pl. 8, fig. 3) in which this change occurs quite abruptly at a diameter of about 180 mm., apparently at the beginning of the living chamber.

The merging of the two outer tubercles into a single horn also must occur rather suddenly; it cannot actually be observed in any of the individuals under examination. In the anteriormost part of A.M.N.H. No. 28111:1, as well as in three large whorl fragments, corresponding to diameters between 200 and 300 mm., this merger has been achieved with no observable transition. Simultaneously, the inner tubercles also have strongly developed and moved farther from the umbilical shoulders. Both they and the outer horns number three per quarter-whorl.

No further change in the character of the sculpture is observable between this stage and the last which is represented by Warren and Stelck's holotype (1955, pl. 8, figs. 1, 3), by the hypotype (the present paper, figs. 10-12), by the largest whorl fragment from near Greybull, and by that from locality U.S.G.S. Mesozoic 12621 (U.S.N.M. No. 131773), and by the three crushed disks from near Edgemont, except that the horn character of both inner and outer tubercles (of which there are still six per half-whorl) has become more pronounced. The inner horns point outward; the outer ones, upward and outward at an angle of 45 degrees. In some cases the outer horns project farther from the median line, as in Warren and Stelck's illustrations (1955, pl. 8, fig. 1, pl. 9, fig. 2); in others, the inner ones, as in the hypotype (figs. 11, 12 of the present paper).

Suture lines could be studied at diameters of about 15 mm. (fig. 2), 60 mm. (Haas, 1949, fig. 10), 70-110 mm. (fig. 4), 90-120 mm. (in the holotype, Reagan, 1924, pl. 19, figs. 1, 2), and 180-210 mm. (fig. 8). The suture line of the holotype has been described, though somewhat clum-

sily,<sup>1</sup> by Reagan, and his figures show it quite distinctly. From them as well as from my own 1949 drawing the following main features are recognizable: The external saddle is not only extremely wide, extending, as is quite common in this family, from near the median line across the shoulder to the outer third of the flanks, but also, especially in its outer main stem, unusually high, as compared with the lateral saddle; the first lateral lobe is very wide. In details, however, there is much variation. For example, this lobe is distinctly bifid in most individuals (U.S.N.M. Nos. 131905, 131908, A.M.N.H. No. 26417), with a well-developed, upright leaf separating the two main points, but trifid in others (U.S.N.M. No. 131906). Its two main points in turn are three-pronged in some individuals, but two-pronged in others as in the holotype. For more details, reference should be made to Reagan's (1924) and my own (1949, p. 31) descriptions and to the figures quoted above.

**OCCURRENCE:** The holotype, recorded by Reagan from the "Coloradan series of the Salt Creek region (Big Horn), Wyoming," was found, according to Cobban, near Casper, Wyoming. Later I (1946) recorded this species, as now understood, from the "'Ft. Pierre,' probably Benton" shale, now believed to be the Belle Fourche shale, near Edgemont, South Dakota, and (1949) from the Cody shale near Greybull, Wyoming, which has recently yielded also A.M.N.H. Nos. 28111:1-28111:3, including the hypotype. This species is further recorded by Cobban (1951) from the Belle Fourche shale of central Montana, by Cobban and Reeside (1952a, 1952b) and Hose (1955) from rocks of Belle Fourche age of the Frontier and Cody formations of Wyoming and Montana, by Cobban (1958) from the Belle Fourche shale of the Powder River Basin, Wyoming and Montana, and by Warren and Stelck (1955) from the lower beds of the Labiche shale, near the "fish scale" horizon, of Alberta. *Paracanthoceras wyomingense* has also been found in the upper part of the Belle Fourche shale at locality U.S.G.S. Mesozoic 22871, 6 miles northwest of Alzada, Carter County, Montana.

Cobban (1951) and Cobban and Reeside (1952a, 1952b) recognized this species first under the name *Acanthoceras* ? new species, then under that of *Acanthoceras* ? sp. A, and Cobban (1958) has recognized it under the name *Acanthoceras* ? *wyomingense* as the index fossil of a zone of its own, which lies above that of *Acanthoceras* ? *amphibolum* on the one hand and below that of *Dunveganoceras pondi* on the other, thus indicating a late Cenomanian age.

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<sup>1</sup> He calls the lobule dividing the external saddle "first lateral (small) lobe" and the real first lateral lobe "first (large)," thus arriving at a total of "four lateral lobes in all" which, however, includes also the first of at least two auxiliary lobes.

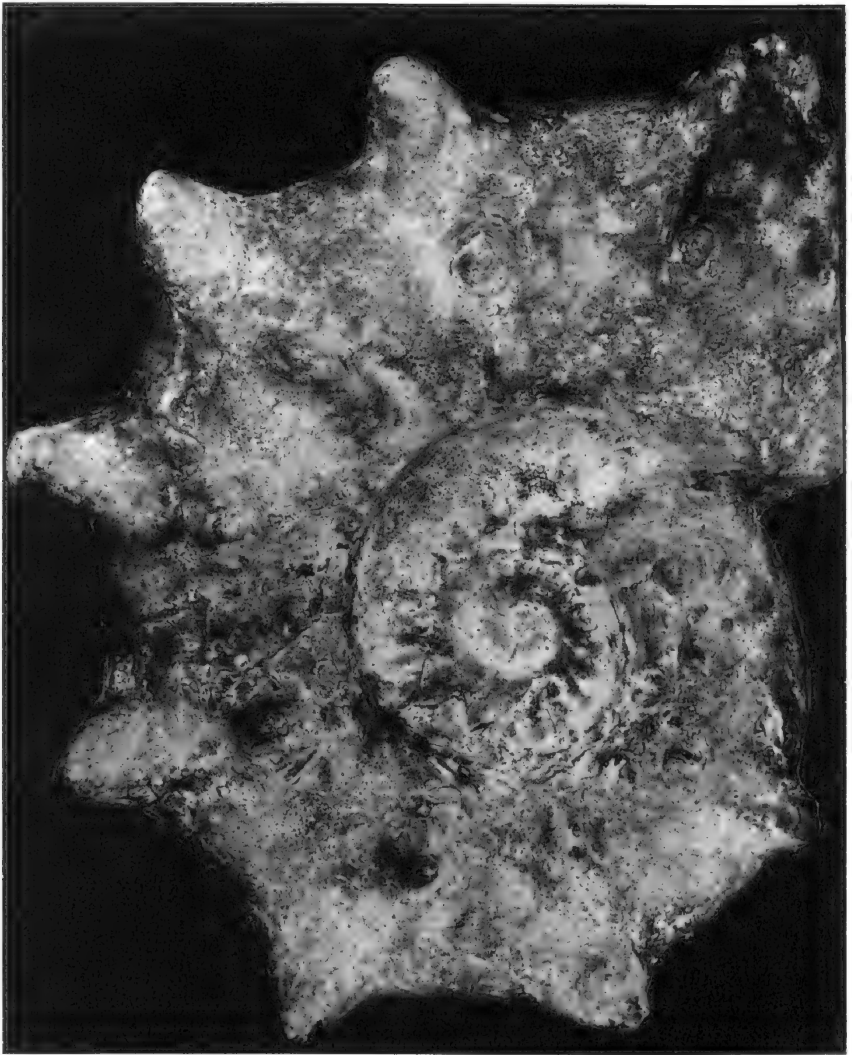


FIG. 10. *Paracanthoceras wyomingense* (Reagan), A.M.N.H. No. 28111:2, hypotype.  $\times \frac{1}{2}$ .

That this species has been found near Greybull associated in the same area with *Dunveganoceras pondi* Haas, *Mantelliceras canitaurinum* Haas, and *Metoicoceras praecox* Haas, all representative of the next younger zone of *D. pondi*, can be explained by the fact that none of the ammonites collected there was found *in situ*, but all were enclosed in concretions.

The localities enumerated above do not cover the full geographic range of *Paracanthoceras wyomingense*, which has been circumscribed by Cobban (letter to Wood, January 29, 1962) as follows: "along the flanks of the Bighorn Mountain uplift, around the Black Hills, at localities near Lander, Rawlins, and Medicine Bow, and south as far as El Paso, Texas."

REMARKS: When first dealing with this form, Reagan referred it to *Metoicoceras*, which is not surprising in view of the weak ornamentation of his single, immature specimen. Since then, specimens here included in it have been referred to *Collignoniceras* (= "*Prionotropis*"), "*Mammites*," *Acanthoceras*, and *Dunveganoceras*. Reagan's original generic reference proves untenable since the heavily sculptured, horned, adult individuals of this species have become known, because such sculpture does not occur in *Metoicoceras*. Doubtful generic assignment to "*Prionotropis*" was triggered by labels in the American Museum of Natural History collections and supported by the similarity of the horns that occur in the present species and in the variety *alata* of *Collignoniceras woollgari*. In 1955 I discussed this similarity as a case of homeomorphy between single structures, stressing the fact that they occur in different families, but was unaware that I myself had fallen, nine years earlier, a victim to that very homeomorphy. As I pointed out in 1955, the persistence of the median keel in maturity warrants distinction of the younger *Collignoniceras* from *Paracanthoceras*.

The tentative reference in the labels of the United States National Museum of the specimens from locality U.S.G.S. Mesozoic 12621 to *Mammites* also cannot be maintained. In the latter genus the outer tubercles remain blunt and rounded and do not fuse into the pointed horns so characteristic of mature individuals of the present form.<sup>1</sup>

That I mistook the Greybull specimen here included in the synonymy of the present species but described and illustrated in 1949 as *Dunvegano-ceras* sp. indet. for a member of the latter genus would probably not have happened had I then been familiar with Reagan's "*Metoicoceras wyomingensis*." At any rate, mature individuals of *Dunveganoceras* are easily distinguished from those of the present form by the persistence of strong ribs and by the far lesser development of the outer tubercles. At an earlier stage, however, there is considerable similarity in ornamentation; the ventral view of the penultimate whorl of the holotype of *D. pondi* (Haas,

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<sup>1</sup> It has, however, at a passing stage, one feature in common with *Mammites nodosoides* (Schlotheim) (see Wright, 1957, fig. 535, 4a). There are two lateroventral tubercles to each circumumbilical tubercle. This similarity may well be due to a common origin, both forms belonging to the Acanthoceratidae.



FIG. 11. *Paracanthoceras wyomingense* (Reagan), A.M.N.H. No. 28111:2, hypotype.  
 $\times \frac{1}{2}$ .



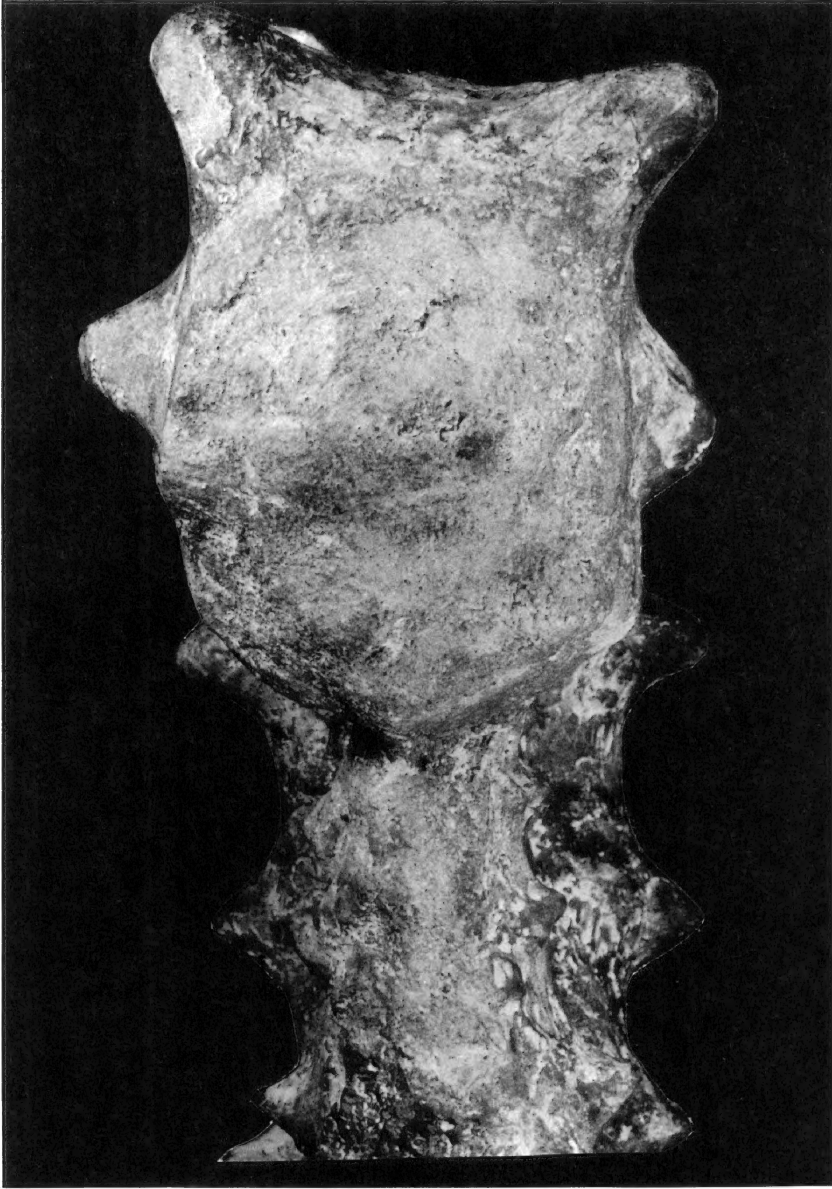


FIG. 12. *Paracanthoceras wyomingense* (Reagan), A.M.N.H. No. 28111:2, hypotype.  
×  $\frac{2}{3}$ .

1949, pl. 8, fig. 1) is hardly distinguishable from that which is shown in the lower part of figure 5 of the present paper.

Cobban and Reeside, since they first dealt with this species, recognized that it is not a *Metoicoceras* and doubtfully assigned it to *Acanthoceras* instead, and Warren and Stelck did so without question. After the other genera mentioned in the preceding paragraphs are eliminated, there remains the question, most difficult of all, whether or not to leave the present species with *Acanthoceras*. Although it could just be accommodated in the diagnosis given for that genus by Wright (1957, p. L414), it is believed that a comparison with its type species, *A. rhotomagense*, precludes such a generic assignment. In the latter species, the median tubercles persist to maturity in equal strength with the outer ventrolateral ones, whereas in *Paracanthoceras wyomingense* they are, even at an early stage, very inconspicuous and strongly clavate and then assume the aspect of an intermittent keel which soon fades away. Also the ribs persist into maturity in *A. rhotomagense*, in contrast to the present form. By contemporary standards of circumscription of genera, such differences are believed to call for the generic separation of the species under discussion from *Acanthoceras*.

For this new genus the name *Paracanthoceras* is proposed, in allusion to its close relationship to the true *Acanthoceras*. *Acanthoceras* ? *amphibolum* Morrow (1935, p. 470, fig. 4, pl. 49, figs. 1-4, pl. 51, figs. 3, 4) is believed also to belong to the new genus but, owing to its more depressed whorl section and its less developed horns, to be specifically different from *P. wyomingense*. Suturally, however, the two species resemble each other closely.

The genus *Euomphaloceras* Spath should also be compared with *Paracanthoceras*. It shows the early development of outer spines, but differs in its much smaller size, the presence on the venter of three rows of small tubercles more numerous than those spines, and the occurrence of shallow ventral constrictions.

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