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Upper Albian (Cretaceous) Ammonoidea From Texas

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UPPER ALBIAN (CRETACEOUS) AMMONOIDEA FROM TEXAS

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ABSTRACT—This paper brings part of the classification of upper Albian ammonites up to date and up to modern standards for some of the Texas species. Twelve new species are described *(Drakeoceras georgetownense, D. drakei, D. arringtoni, D.kummeli, D. gabrielense, D. dellense, D. lasswitzi, Durnovarites adkinsi, Deiradoceras amsburyi, Pervinquieria whitneyi, P. smedalae, Prohysteroceras, P. atchisoni)* and two previously described species are redescribed. The fourteen species are distributed through six genera, two of which are new *(Drakeoceras* and *Craginites)*; all six genera are classified as Mortoniceratinae (Ammonitina).

INTRODUCTION

MORE refined biostratigraphic studies in the Cretaceous rocks of Texas require the description of many additional species and the completion of more up to date taxonomy for the Gulf Coast ammonites, particularly those of the Lower Cretaceous. Since the papers by Böse (1928) and Adkins (1928, 1929, 1931, 1933), those by Kummel & Decker (1954), Jones (1938), Renz (1936), and Stephenson (1952) are the only ones on the Upper Cretaceous which cover ammonite species pertaining specifically to areas in Texas. Although various workers in Mexico (Humphrey [1949], Imlay [1938, 1940], and others) have aided in the description of Neocomian, Aptian and lower Albian species, some of which may be found in Texas, only Albritton (1937), for the Neocomian, and Scott (1941), for the Upper Aptian and lower Albian, have done any systematic work on Lower Cretaceous ammonites in the Texas area within the last 20 years.

The present paper consists of descriptions of new species from the Upper Albian, and represents only a partial coverage of species representative of the subfamily Mortoniceratinae. Of course the scheme of taxonomy followed by many authors dealing with Cretaceous ammonites, whose works were not directed specifically toward Texas, has a direct bearing on the nomenclature and taxonomy of Texas species. Foremost among these works, which pertain to the present study, are those of Spath (1922, 1923, 1933, and others). Important also are the works of Wright (1952, 1955), Haas (1942), and Van Hoepen (1931, 1941, 1942, 1944, 1946a, 1946b, 1951a, 1951b). On subjective grounds only the taxonomy of Haas (1942) and Van Hoepen (1944 and others) must remain suspect, Haas for being too conservative, Van Hoepen for being insufficiently conservative. In the writer's opinion, the criticism of Van Hoepen by Spath (1933, 1934), and more openly by Haas (1942), was not altogether justified, at least not on the grounds presented by Haas. The writer might prefer to remain out of this argument, but the uncertainty concerning some of this South African material is producing taxonomic problems which are very pertinent to the present study, and which may not be cleared up until a disinterested person restudies the South African collections. Spath (1922) and Haas (1942) both regretted the lack of detailed stratigraphic knowledge concerning their respective collections; Spath's (1922) fauna undoubtedly contains elements of the *dispar zone,* and Spath believed that all of the species were representative of the upper Albian. Haas (1942) likewise took pains to indicate the distribution of his species, but, without definite information, indicated that the conclusions were tentative. Yet both of these authors condemned Van Hoepen (1931, 1941) for his new genera, superficially resembling forms of theirs, but of middle Albian age, and apparently of different lineage.

This predicament has resulted in the writer proposing a new genus in the present paper, which could perhaps be united with one of the Angola stocks (as yet unnamed generically) were we less ignorant of ammonite lineages and ages. Furthermore, the writer believes that less confusion has been caused by naming new genera than by the incorrect application of otherwise valid genera [e.g., the application of *Acanthoceras* to certain horned forms of the basal Cenomanian (Scott, 1926, and others) which almost 30 years ago caused the suspicious and able Emil Böse (1928) to use the term "vicariating" when speaking of these forms of the basal Cenomanian which "recurred" in the upper Cenomanian].

Although certain relationships are suggested in the present paper, no lineages, as such, are proposed. Lineages are not proposed because the status of description is too incomplete. The mere fact that each worker can propose lineages in his part of the world which are completely unacceptable in some other area is in itself an indication of the extremely small sample of species that has so far been described.

I can propose lineages that are reasonable for Texas species, but which not only do not agree with Van Hoepen's (1944), even when his phytogenies are interpreted in my generic terms, but which are completely unacceptable in South Africa. The same lineages will likewise be as unacceptable to European workers as are Van Hoepen's. This probably means one of two things, either there are generic and subgeneric provinces more sharply delineated than heretofore supposed (which might not be surprising if more were known of the distribution of modern cephalopod genera) or the number of species described so inadequately represents the supply that the true picture is still obscured. In any event far less than one-half of the Lower Cretaceous ammonite species of Texas have been named and described.

Taxonomic criteria.—Much has been written concerning the value of different characters for classificatory purposes. Each worker has and will continue to have his own pet characters which, no matter how objective he attempts to be, will prejudice him. I have neglected the suture pattern, largely because the present forms are so preserved as to yield only incomplete and meager sutures for illustrations. In addition a catalogue of well over a thousand sutures, diagrammed, stylized, and natural, has failed to yield criteria valid below the family level except for a few unusual genera. In my opinion, authors who designate genera and/or species on sutures only are daydreaming.

Whorl sections are extremely informative, but useful only between comparable ontogenetic stages (e.g., the sections in Text-fig. **1–h are all taken from the last** volution of an uncrushed internal mold. Unless this were known they might not be assumed to be from the same species).

Spath, Haas, and Van Hoepen are about the only specialists on Cretaceous cephalopod who have consistently given costal sections, and of these only Van Hoepen in sufficient numbers. Haas almost alone illustrates costal and intercostal sections together, but in insufficient number. The lack of costal and intercostal sections has hindered the comparison of different groups from different areas. The preservation of the Texas material is such as to prevent the use of old mouth edges and apertural features, all of which can be extremely important.

A good many years ago Adkins (1928) divided *Pervinquieria* Böhm), as he knew it, into two groups, those with fine inner costation and those with coarse inner costation. Each of these he then divided into two groups, based on whether or not adult forms were trinodose. Enlarging upon the system then begun by Adkins, a terminology for juvenile costation is used for convenience in classification and description. This classification may have some phylogenetic significance, but experimentation, testing, and checking with other methods of classification and with ideas of other workers will be necessary before any realistic conclusions can be drawn. In the meantime this classification is meant only to be morphologic. The four types of juvenile costation considered in this paper are as follows:

(1) *Goodhallitine*—This type of costation consists of flexiradiate ribbing, weakly or moderately umbilituberculate; ribbing is not coarse, is flexiradiate, and nearly always bifurcates from the umbilical tubercle; it is best exemplified by *Goodhallites goodhalli* var. *tuberculatus* Spath (1934). Some of the costation may be as paucicostate as in the young of *Goodhallites gracillimus* (Kossmat), and in this species appears to be transitional to the mortonicerine type of ribbing described below, but even when paucicostate the goodhallitine type of costation remains flexiradiate. On the evidence in Texas, it appears to be derived directly from a dipolocerine type, and the mortonicerine type, in turn, may be derived from a coarse goodhallitine type. On the other hand, the Angola evidence, as now understood, would not support such derivations.

(2) *Mortonicerine*—This type of costation is coarse, usually rectiradiate, always bifurcating, always bituberculate, and usually umbilituberculation is nodate; costation and tuberculation are strong. An example is *Mortoniceras leonensis* (Conrad, 1857) although the bifurcation is frequently more pronounced than in this species. This type of costation is typical of the group of *leonensis* of Adkins (1928).

(3) *Pervinquieriine*—This type of costation seems also to be derived directly from a dipolocerine ribbing, described below. It may or may not have a very early bituberculate stage, perhaps usually so; not enough very young shells have been examined to be certain. Most important, there is always a juvenile, faintly trituberculate stage, not present in either mortonicerine or goodhallitine types. This juvenile stage takes on the appearance of the costation in *Pervinquieria kiliani* (Lasswitz), and has long been termed *kiliani-ribbing*. Examples would include *Pervinquieria kiliani* (Lasswitz) and the juvenile stages of *Pervinquieria inflata* (J. Sowerby).

(4) *Dipolocerine*—Although *Dipoloceras* is not a member of the subfamily Mortoniceratinae, some of the genera classified in this subfamily (Wright, 1952) possess juvenile ribbing of the dipolocerine type. This costation is typified by the young of many of the species of *Dipoloceras,* but not all at various stages, and is best exemplified by the ribbing of *Dipoloceras pseudaon* Spath var. *moniliforme* Spath (1931). In this type of costation the ribs are relatively densicostate; they are uneven and there may be one, two, or three grades of ribbing: (1) beginning at the umbilicus with a small bullate tubercle and extending ventrad, (2) beginning at about the end of the first third of the flank and extending ventrad, and (3) beginning at about the end of the second third of the flank and extending ventrad. Bifurcations may be present, but most ribs are single. The only tuberculation beside the very small bullate umbilical tubercle consists of spirally arranged papillae which are usually nodate, but more often absent than present. There may be in addition a very weak, bullate shoulder tubercle. Although the young whorls of *Dipoloceras* Hyatt are inflated, the dipolocerine ribbing may occur in the young of genera in which the juvenile whorls possess flattened flanks.

Such a classification for juvenile ribbing is not always discrete and breaks down between certain taxa. There seems to be a plexus between those forms with juvenile mortonicerine ribbing and those forms with juvenile goodhallitine ribbing in the vicinity of certain species described under the genus *Cainoceras* by Van Hoepen (1942, 1951b) and in "*Schloenbachia*" *gracillima* (Kossmat).

There is also a transition from the genus *Goodhallites* to the genus *Drakoceras,* n. gen., in the lower part of the upper Albian of Texas, but thereafter, in Texas at least, the distinction remains quite sharp.

No definite transition from *Goodhallites* to *Pervinquieria* Böhm is apparent, but this may be by definition of the two genera.

Pervinquieria appears to more likely descend from some such form as *Craginites*, n. gen., or other appropriate group with juvenile dipolocerine ribbing. *Goodhallites* likewise is descended from something similar, and in both the lines of descent form plexi or retes in three dimensions, being polyphyletic in the sense that some of Wright's (1952) family units are polyphyletic.

Terminology.—The terminology employed in this paper is that of Spath (1923) and Adkins (1928). The abbreviations used are H = whorl height; W = whorl width (t = thickness in Adkins); D = diameter of shell; and U = diameter of umbilicus. In order to make comparisons on the inner whorls without destroying specimens I have employed another measurement called HF. HF is the direct linear distance from the umbilical suture to the base of the keel. It is not as accurate a measurement as H for descriptive purposes, but many more measurements per individual ammonite may be obtained. Haas (1955) has recently used a similar measurement which he calls H, but he measures to the periphery. The keels are incompletely preserved on most specimens studied by the writer. H′ of Haas is H of the writer.

W is measured intercostally. All measurements except D and HF/W are reported as percentages of D; D is recorded in mm. Under the descriptions of the various species measurements are systematically recorded from left to right in the following manner.

D	U	HF	W	HF/W	Costation			
					T	P	S	B

In the column on costation T is the total number of costae per volution at the designated diameter, P is the number of primary costae (single), S the number of secondary costae (single), and B the number of bifurcating costae, always recorded in pairs (e.g., B = 8 pr). Whorl sections are given at shell diameters in all specimens where such were possible to measure. U is also designated at definite shell diameters.

Occurrence of fossils.—All of the fossils herein described were collected from carbonate rocks, either marls, shaly limestones, or limestones. This does not mean that the same species cannot occur in other rock types. Moreover, all of the fossils herein described were collected from platform sections and from shallow water facies. So far there is no observational data to indicate a preference among non-reef, shallow water carbonate sediment environments. The same fossils may occur with equal abundance in marl, shaly limestone, or limestone. A far greater number of fossils may be collected from marl and shaly limestone than from limestone, but this may be because of easier collecting, the fossils not weathering out of the harder limestone. On the other hand, there is a greater abundance of oysters in the Washita group in those carbonate rocks that weather as marls. The distribution of oysters in turn should have influenced the distribution of other animals. Ammonites are unknown in the Fredericksburg or Washita reef associations.

Craginites, n. gen., has been collected from limestone, shaly limestone, calcareous shale, non-calcareous lutite, and quartz arenite. *Drakeoceras*, n. gen., and *Durnovarites* are known only from calcareous rocks in Texas, but *Pervinquieria* has been collected from a greater variety of lithologies.

All of the fossils except *Craginites* n. sp.,

EXPLANATION OF PLATE 1

Durnovarites adkinsi, n. sp. (p. 6)

FIG. *1, 2, 7*—Lateral, dorsal, and ventral views, ×1; UT 695, lower *Turrilites brazosensis* zone, Georgetown limestone, 500 feet N of McNeil road on the old road to Georgetown from Austin, Travis Co., Texas.

3, 6—Lateral and ventral views of holotype, ×1; UT 10064, lower part of *Turrilites brazosensis* zone, 15 feet below top of Georgetown limestone, Pease Park, Shoal Creek, Austin, Texas; collector: K. Young, 1953.

4, 5—Lateral and ventral views, 4×2, 5×1; UT 10824, lower part of *Turrilites brazosensis* zone, Georgetown Limestone, 1.5 mi. E of Brodies Lane on Oak Dale Drive, in creek bottom, Austin, Travis County.


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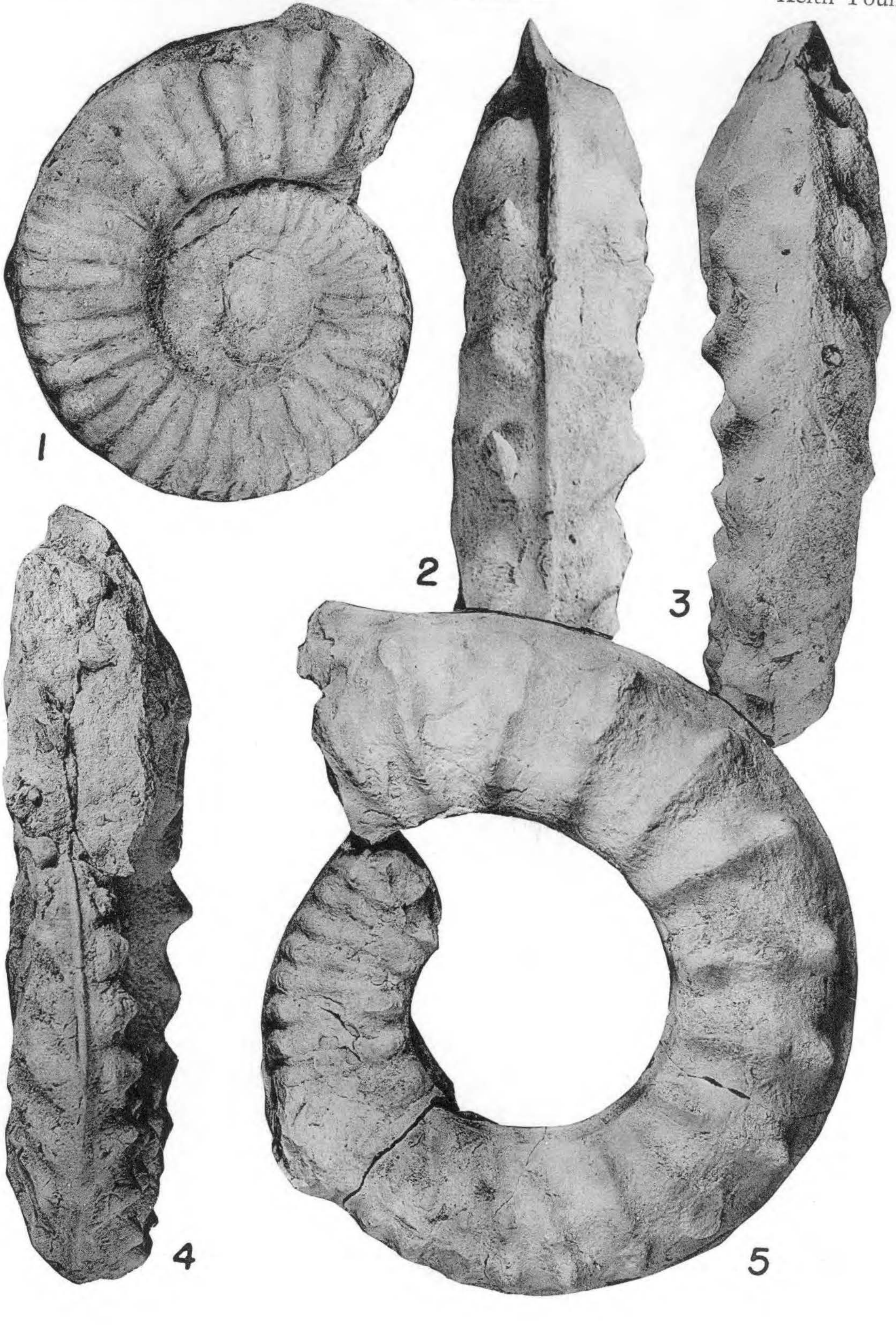
Keith Young



n. gen., are internal molds, and most of the internal molds bear one or more of the attached oysters discussed by Hyatt (1903). Usually the nonseptate body chamber, lacking structural support, has been destroyed or broken, but occasionally the lucky collector finds a complete individual, or perhaps a single body chamber. The individuals have suffered the varying degrees of solution common to carbonate rocks, and the sutures are usually poorly preserved.

Acknowledgments.—Although the paleontological conclusions contained herein are those of the writer, many persons are responsible for bringing together material and ideas. Not least among these are a number of geologists who did at least part of their graduate work at the University of Texas. Particularly valuable has been the work of D. E. Atchison (1954), R. T. Arrington (1954), Gerald F. McCarthy (1952), and Billy Walls (1950). In addition the experience and knowledge of W. S. Adkins has been invaluable, and his concepts have no doubt influenced the writer greatly.

Many students in the geology department at the University of Texas have aided in filing and cataloguing fossils.

Dr. J. T. Lonsdale, Director of the Bureau of Economic Geology, The University of Texas, has made the Bureau collections available and some of the collecting was done under mapping projects for that organization. Prof. R. K. DeFord and his students have supplied collections and information from West Texas and Trans Pecos Texas.

SYSTEMATIC PALEONTOLOGY

The repository abbreviations, UT and BEG, indicate, respectively, the Paleontology Collection, Department of Geology, and the Bureau of Economic Geology, both of The University of Texas, Austin.

Class CEPHALOPODA
Order AMMONOIDEA de Haan, 1825
Suborder AMMONITINA Hyatt, 1889
Superfamily ACANTHOCERATACEAE Hyatt, 1900
Family HYSTATOCERATIDAE Hyatt, 1900
Subfamily MORTONICERATINAE Spath,* 1932
Genus DURNOVARITES Spath, 1932
Type species: *Durnovarites subguadratum* Spath, 1932.

Generic characters.—*Durnovarites* Spath is an ammoniticone with U = 25–45. The ribs are coarse and bituberculate in early stages (mortonicerine), becoming quadrituberculate in the later neanic stage, and in some forms, becoming more densicostate, before becoming paucicostate on the body chamber. More typical species have an extremely low H/W ratio (H/W = ca. 0.75), less typical forms have a higher H/W ratio, but width is always greater than height. Umbilical, flank and double shoulder tubercles produce the quadntuberculate appearance so characteristic in this genus, and in the type species the ventral element of the shoulder tubercle is almost texanitid.

Observations.—According to Spath (1932, 1942) *Durnovarites* is characteristic of the

* Unlike Wright (1952) I prefer to credit Spath (1932) with the family name. This for the simple reason that Douvillé (1911) did not refer to the present family but to the group now called *Texanites* Spath, which is placed in the Peroniceratidae by Wright (1952). I still think it proper to thus indicate that Spath's usage is being followed rather than the usage of Douvillé.

EXPLANATION OF PLATE 2

FIG. *1*—*Prohysteroceras atchisoni,* n. sp. Lateral view of holotype ×½; UT 10529, zone of *Eopachydiscus brazoense,* 4 feet above the base, bed 8, section 8, loc. 11 of D. E. Atchison (1954); Georgetown limestone, Lake Creek, southwest Round Rock, Williamson Co. Texas; collector: D. E. Atchison. (p. 13)

2,5—*Pervinquieria smedalae,* n. sp. Lateral and ventral views of holotype, ×½; UT 10106, zone of *Drakeoceras maximum,* Georgetown limestone, Berry Creek, ¼ mi. down stream from the U. S. highway 81 bridge, Williamson Co., Texas; collector: R. T. Arrington, 1953. (p. 10)

3,4—*Pervinquieria whitneyi ,* n. sp. Ventral views of holotype ×1; UT 10530, zone of *Oxytropidoceras bravoense,* Georgetown limestone, bed 4, section 8, loc. 11 of Atchison (1954), from beneath railroad bridge over Lake Creek, southwest Round Rock, Williamson Co., Texas; collector: D. E. Atchison, 1954. (p. 10) *dispar* zone. The Texas species, to be described below, occurs in the youngest Mortoniceratinae-bearing strata in central Texas. The genus appears to be unrelated to *Angolaites* Spath, and the group of *D. perinflatum* (Spath) could be descended from some such a leonitid as *Mortoniceras wintoni* (Adkins), which, with its low H/W ratio, by the addition of a true flank tubercle and reduction of the umbilical tubercle could lead to the group of *D. perinflatum* very easily. However, forms such as *D. postinflatum* Spath, with more robust juvenile ribbing, or the more spinose species such as *D. subquadratum* Spath and especially *D. spinosum* (Pervinquiere) (non *Durnovarites spinosum* Van Hoepen), seem to be more difficult to evolve from such an ancestor. Such larger forms as *D. perinflatum* (Spath), *D. adkinsi,* n. sp., and *D. quadratum* Spath, become more paucicostate on the outer whorl. Most species of *Durnovarites* have yet to have the body chamber described. *Durnovarites* is not related to *Angolaites* Spath (1932), not only because of the difference in general appearance, but because of the juvenile mortonicerine ribbing in *Durnovarites* and juvenile pervinquieriine costation in *Angolaites. Drakeoceras,* n. gen., never has a true flank tubercle and has goodhallitine juvenile costation.

DURNOVARITES ADKINSI, n. sp.

Pl. 1, fig. 1–7; Pl. 7, fig. 4; Text-fig. 1g,k,m

Holotype.—UT 10064, from 15 feet below the top of the Goergetown limestone, from the top of the *Drakeoceras drakei zone,* Pease Park, Shoal Creek and 18th Street, Austin, Travis County, Texas.

Specific characters.—Oligogyral, concentrumbilicate, gradumbilicate, widely subangustumbilicate to narrowly sublatumbilicate, carinate; whorl section wider than high (HF/W = 0.75 to 0.90), the holotype at a diameter of 82 mm. being widest intercostally between the umbilical tubercle and the flank tubercle and widest costally at the flank tubercle. UT 10864, at a diameter of 18 mm., is widest just dorsad of the ventral tubercle (only two tubercles at this stage). UT 695, at a diameter of 75 mm., is widest at mid flank. The widest part of the shell appears to migrate dorsad with age. Flanks and venter are rounded intercostally, and the keel is low and rounded.

Costation is moderate to paucicostate in the early neanic stage, is dense to a diameter of about 75 mm. where it then becomes less dense, there being 40 more or less ribs per volution at a diameter of 75 mm. and about 28 costae per volution at a diameter of 35 mm. The costae are weakest between the umbilical and flank tubercles. Most ribs are bifurcating at the umbilical tubercle, a few primary and single, and there are scattered intercalations beginning just dorsad of the position of the flank tubercle.

The umbilical tubercle is low and bullate, hanging over the umbilical wall which is at right angles to the overlapped flank. The flank tubercle is slightly bullate. The shoulder tubercle is double, the dorsal element nodate, the ventral element bullate, elongated with the rib allignment, the ribs swinging orad on the venter. At a diameter of 20 mm. this form is bituberculate (costation is mortonicerine). It could not be ascertained how the other two tubercles were derived, but the flank tubercle probably arises independently as a low swelling on the rib at mid flank. The ventral element of the shoulder tubercle would seem to arise later than the dorsal element, developing first as a low swelling on the end of the rib extending as a ventrad tapering of the dorsal element. (This is similar to the development of the double shoulder tubercle in *Mortoniceras,* and the juvenile of this species at a diameter of 20 mm. is very similar to individuals of *Mortoniceras* at the same diameter.).

Overlap is dorsad of the dorsal element of the shoulder tubercle, so that only the umbilical and flank tubercles can be observed on the inner whorls when the outer whorl is in place. On the holotype septation ceases at a diameter of 60 mm., and costation is coarser and less dense on the last 2/3 of the last whorl or the body chamber,* and tubercles are larger and more pronounced; the apertural margin is not present on this specimen, but most of the body chamber is present. UT 10824 is septate through 88

* Most textbooks call this the living chamber, which is certainly a misnomer in fossils. I prefer body chamber which parallels nicely the use of body whorl in Gastropoda.

mm., the maximum diameter of the individual, and UT 695 appears to have been septate through at least 75 mm. As in many Mortoniceratinae the costation and tuberculation are coarser and more widely spaced on the body chamber.

Preservation of all three specimens is such that a suture could not be satisfactorily reproduced.

type species. The groups of *D. subquadratum* and *D. perinflatum* show a somewhat different ontogenetic development. Of the species Haas (1942) allied to this group, *Pervinquieria bassleri* and *P. ferecostata,* the former he associates with *Hysteroceras varicosum,* making it older than known species of *Durnovarites.* The two species described by Haas also have finer costation on the juveniles than do *D. perinflatum, D. adkinsi,* or *D. subguadratum.* Species of similar development to those described by Haas, from just above the *varicosum* zone equivalents in Texas, have no relation to *Durnovarites* but represent some side branch of *Pervinquieria.*

Measurements

UT 695; approximately ½ volution at a diameter of about 75 mm.

108			UT 10064 (holotype)					
100	32.0	37.0	43.0	0.86	38	2	2	17pr
75	30.5	40.0	50.5	0.79	40	0	2	19pr
60	35.0	38.5	50.0	0.77				
50	40.0	39.5	47.0	0.83				
40	42.5	37.5	47.5	0.79				
				UT 10824				
88	29.5	38.0	49.5	0.77	34			
75	30.0	39.5	53.0	0.75				
60	33.5	41.0	52.0	0.79				
37	36.5	42.0	55.5	0.76	28±			
20	30.0	42.5	52.5	0.81				

Observations.—*Durnovarites adkinsi,* n. sp., is the first really authentic *Durnovarites* to be described from Texas. It is so close to *D. perinflatum* (Spath) that there can be no question that these two species are congeneric; *D. adkinsi* could be considered a geographic subspecies of *D. perinflatum.* The ribs are rounder and not as sharp in the former, but the Texas specimens are internal molds which may account for the rounded costae (e.g., Spath's 1932 illustration of *D. perinflatum* [pl. 40, fig. 2] also shows rounded costae). The flanks of *D. perinflatum* are less tumid in whorl section, and converge more rapidly toward the venter than in *D. adkinsi.* The young of *D. perinflatum* are much more coarsely ornate (cf. Spath, 1932, pl. 40, fig. 52b) than are the young of *D. adkinsi.* UT 695 has a somewhat different whorl section than the holotype of *D. adkinsi* and may not belong to this species, but the lack of a larger number of good specimens prevents a final decision at this time.

Although Spath (1932) ostensibly named *Durnovarites* "for the late quadrituberculate *perinflata* group." he made a more evolute, more spinose species, *D. subquadratum,* the

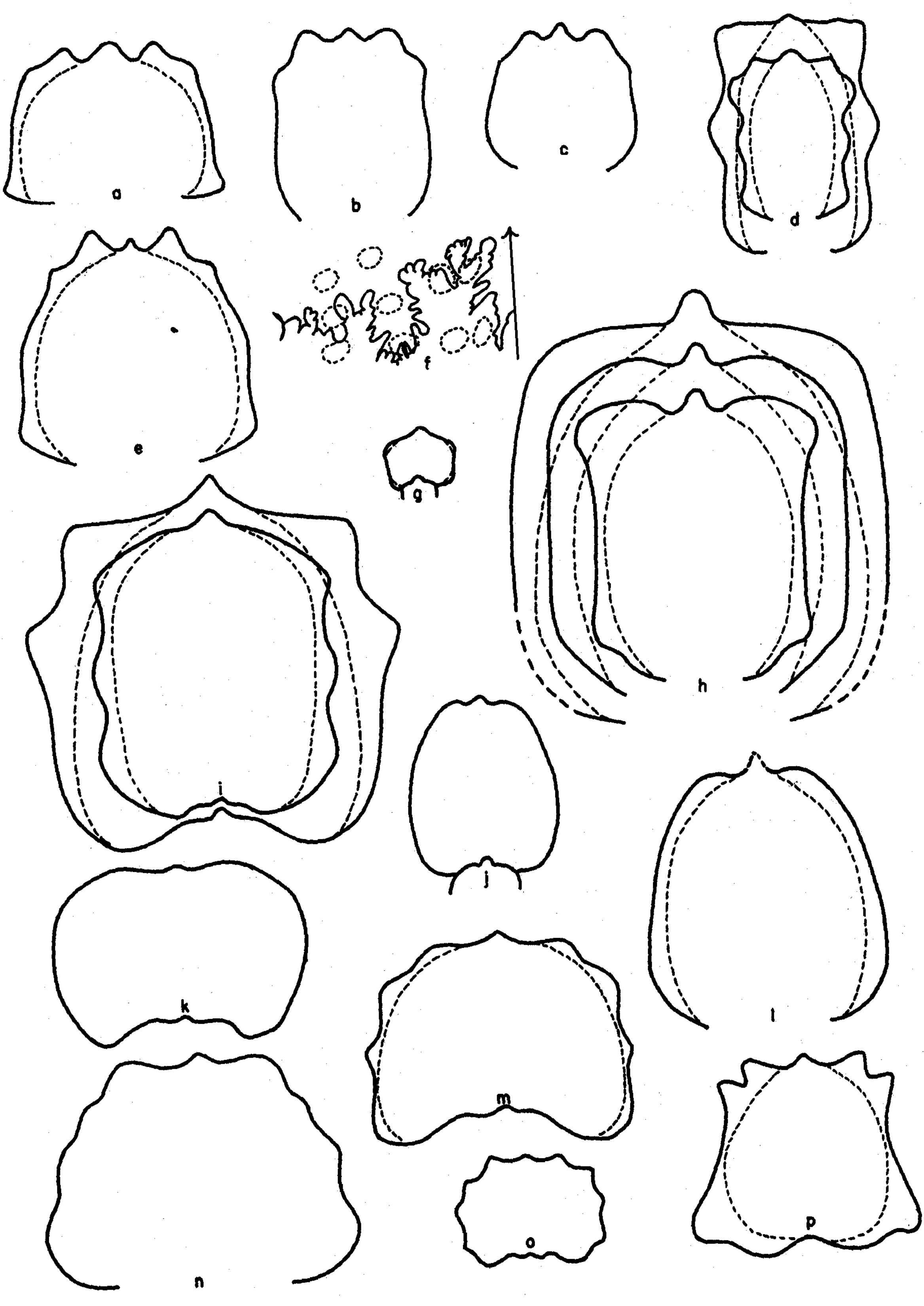
Horizon and locality.—*D. adkinsi,* n. sp., is known so far only from Travis County, central Texas, where it occurs with *Drakeoceras dellensis,* n. sp., *D. gabrielensis,* n. sp., *Turrilites brazosensis* (Römer), and an undescribed species of *Stoliczkaia.* It is known only from the lower part of the zone of *Turrilites brazosensis* and the upper part of the zone of *Drakoceras drakei,* upper part of the Georgetown limestone, Travis County.

Genus PERVINQUIERIA Böhm, 1910

(=*Inflaticeras* Stieler, 1921; =*Subschloenbachia* Spath, 1922; =*Ophryoceras* Van Hoepen, 1942; =*?Rusoceras* Van Hoepen, 1946; =*Collignonia* Van Hoepen, 1951; =*Omocrateceras* Van Hoepen, 1951; =*Styphloceras* Van Hoepen, 1951)

Type species: *Ammonites inflatus* J. Sowerby.

This genus needs little further designation of characteristics, it has been described



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and emended so often. If the subgenera of Spath (1932) are removed (i.e., remove *Cantabrigites, Angolaites, Mortoniceras* [= *Leonites*], and *Durnovarites)* the genus then consists of several groups of species which seem to be fairly closely knit, providing the groups of *"Pervinquieria" barbouri* Haas and *"Elobiceras" serratescens* (Cragin) are also excluded. The two best known species groups are those of *P. inflata* (Sowerby) and *P. rostrata* (Sowerby), the former having mortonicerine costation in the very young, becoming *kiliani*-like in the early stages. In the group of *P. rostrata* mortonicerine costation may be entirely absent, *kiliani* (pervinquieriine) costation being present throughout the juvenile stages. The *P. inflata* group is weakly trinodose to strongly trinodose; the *P. rostrata* group is more strongly trituberculate in the adult.

A third group of *Pervinquieria* is allied to *P. rostrata,* differing mainly in the adult form. This group has been described by Van Hoepen under the generic name *Ophryoceras* (Van Hoepen, 1942). The group is similar to *P. rostrata* in the early costation, but in the adult the umbilical tubercles become reduced, the flank tubercles become very weak or disappear altogether, and the shoulder tubercles become extremely prominent and peculiar (e.g., *Ophryoceras jugosum* Van Hoepen, 1942). This development is entirely different from **that** of *Pervinquieria orientalis* (Kossmat, 1898) which belongs to the group of *P. rostrata* (Sowerby).

The forms described by Van Hoepen (1951b) under the generic names *Styphloceras* and *Omocrateceras* are pervinquieriines with hyper-nodosity, whereas the forms described under *Collignonia* Van Hoepen (1951b) constitute a fifth group in which the tuberculation is reduced, particularly the median or flank tuberculation, and in which the ribs trend forward on the venter in long, bullate, extremely weak ventral tubercles; and this group is unlike a sixth group typified by *P. fissicostatum* Spath, 1932, in which the juvenile ribbing is more *kiliani-like* than in the species grouped under *Collignonia* by Van Hoepen. *P. fissicostatum* then belongs to a sixth group which may include all of the forms included in the genus *Rusoceras* by Van Hoepen (1946a), except perhaps *R. nothum,* the type species of *Rusoceras.*

The validity of the Van Hoepen genera has been debated in arguments that do not always do credit to the authors involved. The present writer is withholding judgment but believes that there must be one large genus *Pervinquieria* or a number of smaller genera. If *Craginites,* n. gen., *Durnovarites, Goodhallites, Cantabrigites, Mortoniceras, Spathiceras, Deiradoceras, Arestoceras* Van Hoepen (1942), *Neokentroceras, Elobiceras,* the group of *"Pervinquieria" barbouri* Haas (1942), *Mimeloceras* Van Hoepen (1946a), and *Drakeoceras,* n. gen., be removed from

TEXT–FIG. *1*

a—Drakeoceras georgetownense, n. gen., n. sp. Whorl section of holotype, × 1 , at 75 mm. diam.; UT 863.

b—Angolaites sp. aff. A. gregoryi (Spath, 1922) [holotype of *A. vicina* (Haas, 1942)]; figure from Spath's pl. 3, fig. 2c.

c—Angolaites cf. *A. angolaense* (Boule, Lemoine, & Thevenin, 1907); figure after Spath (1922, pl. 4, fig. 9b).

d,f—Pervinquieria whitneyi, n. sp. Holotype, ×1; UT 10530. *d,* whorl sections (crushed) at 60 and 100 mm. diam.; *f,* suture.

e—Drakeoceras drakei, n. gen., n. sp. Whorl section, ×1, BEG 2451.

g, k, m—Durnovarites adkinsi, n. sp. Whorl sections, ×1. *g,* at 18 mm. diam.; UT 10824. *k,* at ca. 75 mm. diam.; UT 695. *m,* holotype) at 82 mm. diam.; UT 10064,

h—Deiradoceras amsburyi, n. sp. Whorl sections of holotype, ×1, at 150, 200, and 250 mm. diam.; UT 1341.

i—Pervinquieria smedalae, n. sp. Whorl sections of holotype, ×1, at 160 and 200 mm. diam.; UT 10106.

j—Prohysteroceras wordiei Spath, 1922. Whorl section taken from Spath's pl. 3, fig. 4b.

l—Prohysteroceras atchisoni, n. sp. Whorl section of holotype, ×1, at 125 mm. diam.; UT 10529.

n—Durnovarites sp. aff. *D. perinflata* (Spath, 1922). After Spath, p. 114, fig. 1a.

o—Durnovarites depressa (Spath, 1922). After Spath, 1922, p. 114, fig. 2b.

p—Schloenbachia sp, M. Adkins & Winton, 1920, ×1. After Adkins & Winton, pl. 5, fig. 3. It cannot represent the same species as their pl. 5, fig. 4, the whorl section of which is illustrated as Text–fig. 2–1 of this paper.

Pervinquieria Böhm, my catalogue still shows 103 trivial names preceded by *Pervinquieria.* Although some of these are probably synonyms, my records must also be incomplete. If taxonomy is the science of orderly classification and arrangement, *Pervinquieria,* even after the removal of all of the above taxa, is still too inclusive, for it presents neither classification nor arrangement in any form; in fact, without further breakdown into genera, subgenera, or species groups, it is unmanageable, being the catch-all of Albian Mortoniceratinae. This is a regrettable state for what Böhm (1910) must have intended to be a usable taxon. On the other hand our incomplete record, and therefore lack of knowledge, seems to require such polyphyletic (catch-all) taxa.

PERVINQUIERIA SMEDALAE, n. sp.
Pl. 2, fig. 2,5; Text-fig, 1i

Holotype.—UT 10106, from the *Drakeoceras lasswitzi* zone, Georgetown limestone, Berry Creek, Williamson County, Texas.

Specific characters.—Oligogyral, concentrumbilicate, sublatumbilicate, gradumbilicate, carinate. Intercostal section higher than wide, H/W roughly 1.1 to 1.15. Costal section higher than wide at a diameter of 150 mm. with H/W equal to about 1.0 on the body chamber (particularly at a diameter of 200 mm.). At a diameter of 150 mm. the costal section is arched ventrally; at a diameter of 200 mm. the venter is almost flat in costal section.

From what can be seen of costation prior to the body chamber juvenile costation is pervinquieriine, the first ¼ of the last volution containing costae quite similar to those of *Pervinquieria kiliani* (Lasswitz), but more robust; that is, the costae are closely spaced, trinodose, slightly prosiradiate, straight, mostly bifurcating from umbilical tubercles; here and there occurs a single secondary rib without an umbilical tubercle. At this stage (diameter of 150 mm.) the costae are wider than the intercostae. There is only one bifurcating pair of costae beyond the 160 mm. diameter. Since septation ceases at 150 mm., the change from densicostate to paucicostate occurs at the beginning of the body chamber. This change is very marked. Of 27 costae on the last volution, 11 are on the first ¼ volution and 16 on the last 3/4 volution, or 17 are on the penultimate ½ volution and 10 on the ultimate ½ volution. On the last half of the body whorl, which is broken just orad of the rise in the keel to meet the rostrum, all ribs are single, and intercostae are at least twice as wide as the costae. Ribs are prosiradiate on the penultimate ½ volution, rectiradiate on the ultimate ½ volution, except the last two ribs which are prosiradiate.

The rostrum appears to be raised as in *Pervinquieria inflata* (Sowerby) (illustrated by Spath, 1932, p. 403, fig. 173d).

The costae are trinodose, and tubercles are nodate, the umbilical tubercles becoming bullate on the last ½ of the body whorl. The flank tubercle is ventrad of mid flank, about 3/5 of the flank from the umbilicus. The shoulder tubercles do not rise ventrad but are projected laterad, emphasizing the height of the already high keel.

The body chamber encompasses about 290 degrees of the last volution, and the preceding whorl is overlapped so as to just cover the shoulder tubercle.

Measurements of holotype

217					27	12	1	7pr
200	44.5	29.0	26.5	1.10				
150	43.0	32.5	28.5	1.14				

Observations—Pervinguieria smedalae, n. sp., resembles none of the Gault species so far described, being more like *P. stoliczkai* (Spath, 1922, p. 120, fig. 1-2) than any others in the spacing of the costation, but without the ventral prolongation of the shoulder tubercles. The tubercles are positioned somewhat as in the holotype of *Pervinguieria rostrata* (Sowerby) (Spath, 1932, p. 402, fig. 136), but the flank tubercle is less prominent and of different shape, and the umbilical tubercle much more nodate. The costation actually recalls that figured by Stoliczka (1865, pl. 29, fig. 4,4a) except the flank tubercle is displaced more ventrad and is less spinose in *P. smedalae.*

Horizon and locality.—See above under Holotype.

PERVINQUIERIA WHITNEYI,* n. sp.
Pl. 2, fig. 3,4; Pl. 3, fig. 1; Text-fig. 1d,f

Holotype.—UT 10530, from the zone of *Oxytropidoceras bravoense,* Georgetown limestone, at Round Rock, Williamson County, Texas.

* Atchison, MS, 1954, University of Texas thesis, illustrated this species in his Pl. I, fig. 2.

Specific characters.—Oligogyral, concentrumbilicate, sublatumbilicate, gradumbilicate, carinate, intercostally convexifastigate; whorl section higher than wide (crushing of the specimen exaggerates this feature, and the effects of crushing have not been removed from Text–fig. 1d), moderately costate up to a diameter of 80 mm., paucicostate in later whorls; costae rectiradiate, quadrituberculate on the last whorl and probably earlier whorls, there being a double shoulder tubercle, of which the ventral element is clavate and the dorsal element is bullate; umbilical tubercle nodate to about 85 mm., then bullate; on the last half of the last (preserved) whorl the two shoulder tubercles merge into one large tubercle which is directed laterad rather than ventrad. Costation is typically pervinquieriine except for the extra shoulder tubercle.

The holotype of P. *whitneyi,* n. sp., is septate through all of its 125 mm. diameter. The sutures are not well preserved (Text-fig. 1f), and vary from one to the next because of the peculiar tuberculation. The suture is mortoniceratine with a long ventral lobe and narrow, short, ventral saddle; the first lateral saddle is wide, the first lateral lobe is normal but with secondary elements distorted by closely spaced tubercles; second lateral lobe present, but small.

Measurements of the holotype

125	40.0	37.0	21	20	1	0
100	38.5	38.5	24	19	3	1pr
75	37.0	44.5	27			
60	38.5	42.5				
50	31.0	34.0				

Observations.—*Pervinquieria whitneyi,* n. sp., is the oldest *Peninguieria* so far recorded from Texas. It would therefore be expected to be atypical, if it can be even properly placed in that genus. *P. whitneyi* has more the appearance of the *P. rostrata* group than the *P. inflata* group, but the double shoulder tubercle is atypical. The typical flank ribbing of *Pervinquieria* is present. In addition to the general appearance, the neanic pervinquieriine costation and the whorl sections prevents it from being included in the later quadrituberculate genus *Durnovarites* Spath, and it differs from another geologically later quadrituberculate genus, *Angolaites,* in whorl section.

P.? nanum Spath (1933) is a quadrituberculate form questionably placed in *Pervinquieria* by that author. Van Hoepen placed such quadrituberculate forms as *P. ornata* Van Hoepen (1944) in *Pervinquieria.* Both of these species appear to be juveniles and their taxonomic position remains questionable; neither of them is closely related to P. *whitneyi,* n. sp.

Horizon and locality.—*Pervinguieria whitneyi,* n. sp., is from beds of Kiamichi age, zone of *Oxytropidoceras bravoense,* the holotype occurring in place 1.9 feet above the top of the Edwards limestone, and 2 feet below *Oxytropidoceras* cf. *O. belknapiand* 3.4 feet below the base of the zone of *Eopachydiscus brazoense,* Georgetown limestone, Williamson County, Texas. The fossil was collected at the railroad bridge across Lake Creek in southwest Round Rock. When Dick E. Atchison collected the holotype in the fall of 1953, the writer revisited the locality with him; the external mold from which the holotype had been removed was still intact in the ledge.

Genus MIMELOCERAS Van Hoepen, 1946

(=*Mimoceras* Van Hoepen, 1941, non Hyatt; =*Mimelocems* Van Hoepen, 1944, nomen nudum*)

Type species: *Mimeloceras binodosum* (Van Hoepen, 1941) Van Hoepen, 1946.

Generic characters.—Relatively evolute, oligogyral and concentrumbilicate, widely sublatumbilicate to latumbilicate; subgradumbilicate; carinate. Juvenile costation pervinquieriine, bifurcating from a usually nodate umbilicate tubercle situated on the margin of the umbilicus. Adult costation bituberculate; single primary ribs or single primary and secondary ribs, or bifurcating at a large umbilical tubercle removed from the flank.

Observations.—*Mimeloceras* Van Heopen

* Van Hoepen (1941) first used the name *Mimoceras,* not knowing that this name was preoccupied by one of Hyatt's nautiloids. Van Hoepen (1944) then thought that he had corrected this error when he first used the name *Mimeloceras,* but this name remained a nomen nudum because of improper designation as prescribed by the Rules of Zoological Nomenclature. In 1946 Van Hoepen (1946a) still did not properly designate the type species preceding the description of further species of the genus, and by a strict application of the rules, if any now apply, the name is still a nomen nudum even though Van Hoepen's intent is perfectly clear.

is to *Deiradoceras* Van Hoepen as *Pervinquieria* Böhm is to *Mortoniceras* Meek. In other words *Mimeloceras* is the form with pervinquieriine (trinodose) juvenile costation, whereas *Deiradoceras* has mortonicerine juvenile costation. *Mimeloceras* is strongly bituberculate in the adult.

Genus DEIRADOCERAS Van Hoepen, 1931

Type species: *D. prerostratum* (Spath, 1922).

Generic characters.—Relatively evolute, oligogyral and concentrumbilicate, widely sublatumbilicate to narrowly latumbilicate; subgradumbilicate; carinate. Juvenile costation is coarse and mortonicerine, bifurcating from a tubercle located ventrad of the umbilical margin; adult ribbing as in juvenile, or single and primary, or single and primary and secondary. Primary ribs in the adult are binodose; secondary ribs with shoulder tubercles only; tubercles may be nodate or bullate, never clavate. Some species have spiral ornamentation, but this is never a generic character. Because the ribs are bituberculate the costal section is usually concave on the flanks.

Observations.—*Mimeloceras* should not be carried in synonomy with *Deiradoceras.* If *Mimeloceras* must be a synonym of something, it should be synonymous with *Pervinquieria. Mimeloceras* bears the same relationship to *Deiradoceras* that *Pervinquieria* bears to *Mortoniceras. Mimeloceras* and *Pervinquieria* have the finer, pervinquieriine (*kiliani*-like) juvenile costation, whereas *Mortoniceras* and *Deiradoceras* have the coarsely bifurcating juvenile costation of *Mortoniceras leonensis* (Conrad). If there are morphological reasons for separating *Mortoniceras* and *Pervinquieria,* those same reasons separate *Deiradoceras* from *Mimeloceras.* The arguments are not so strong for separating *Deiradoceras* from *Mortoniceras* or for separating *Mimeloceras* from *Pervinquieria.*

DEIRADOCERAS AMSBURYI, n. sp.
Pl. 4, fig. 4; Pl. S, fig. 3; Text–fig. 1h

Holotype.—UT 1341, from near the base of the Espy formation, Ocotillo Quadrangle, east of the Chinati Mountains, Trans Pecos Texas.

Specific characters.—Oligogyral, concentrumbilicate, widely sublatumbilicate to narrowly latumbilicate, gradumbilicate, carinate; intercostal whorl section higher than wide, oval; costal section subquadrate with concave flanks at a diameter of 150 mm., flanks in costal section becoming convex by a 200 mm. diameter and continuing slightly convex to more advanced stages.

Costation bituberculate, single and primary (all ribs of the same grade) on the last whorl, bituberculate and bifurcating (mortonicerine) in part on earlier whorls; moderately costate. Costae and intercostae are about equal in width. The ventral ends of the ribs swing forward as the ventral node tapers to the venter. Costae slightly rursiradiate on the last whorl, usually rectiradiate on preceding whorls. Apertural margin straight and bounded by a rib. Rostrum is spirally coiled and short. In earlier whorls and the early part of the last whorl the bullate ventral tubercles flare out to be properly designated horns; ventral tubercules later reduced in size. Ventral and umbilical tubercles bullate throughout. Keel is high, somewhat eroded on the holotype.

The overlap does not conceal the shoulder tubercle; the shell of the holotype is septate to a diameter of 180 mm., and the body chamber occupies about 210 degrees of the last volution.

EXPLANATION OF PLATE 3

FIG. *1*—*Pervinguieria whitneyi*, n. sp. Lateral view of holotype, ×1; UT 10530. (p. 10)
2—*Drakeoceras drakei,* n, gen., n. sp. Ventral view, ×1; UT 1460, lower part of the *Turrilites brazosensis* zone, Georgetown limestone, i mi. above the highway 104 bridge across Smith's Branch, 1 mi. E of Georgetown, Williamson Co., Texas; collector: K. Young, 1950. (p. 26)
3—*Drakeoceras gabrielense,* n. gen., n. sp. Ventral view, ×1; BEG 186. This is the specimen figured by Adkins & Winton (1920) in their pl. 5, fig. 4. (p. 22)
4—*Drakeoceras maximum* (Lasswitz, 1904), n. gen. Lateral view of cast of holotype in the Bur. Econ. Geol., Univ. Texas, ×½. (p. 29)


1
2
3
4


1
2
3
4

Measurements of holotype

250	49.5	27.0	20.5	1.31	36	36	0	0
200	56.6	28.0	21.0	1.32				
150	50.0	30.0	19.5	1.55				
100	47.0							

Observations.—*Deiradoceras amsburyi,* n. sp., resembles *D. bispinosum* (Spath) so thoroughly that it might be considered a geographic subspecies, could the ages of the two species be proved comparable. The adult diameter of *D. bispinosum* (see Van Hoepen, 1941, pl. 12) is about 290 mm. Comparing other features at a diameter of 250 mm.:

	U	No. of ribs
D. bispinosum **(pl. 12)**	50.0	28±
D. amsburyi **(holotype)**	49.5	36±

Costation is alike in the two species except that it is more dense in *D. amsburyi.* The maximum diameter of *D. amsburyi* (holotype) with apertural margin intact is about 256 mm. The maximum diameter of *D. bispinosum* (Van Hoepen's pl. 12) with apertural margin intact is about 290 mm. in *D. bispinosum* the section is wider at the umbilicus than at the venter, and at a diameter of about 290 mm. H/W = 1.0 costally.

Horizon and locality.—See above, under Holotype. The biostratigraphy of the Washita rocks is as yet incomplete in this area, but *D. amsburyi* is known to occupy a level above the zone of *Craginites serratescens* (Cragin). It is suspected to occupy a level about the zone of *Pervinquieria kiliani* (Lasswitz).

Genus PROHYSTEROCERAS Spath, 1922

Type species: Prohysteroceras wordiei Spath, 1922.

Generic characters.—Evolute ammoniticones with ribs flexiradiate or concave orad in the adult; dipolocerine juvenile costation. Adult costation may be of two or three grades, or of only one grade as in the type species. Forms with ribs intercalating at or ventrad of mid flank should probably go into the genus *Neoharpoceras* Spath, 1921. The whorl sections of species of *Prohysteroceras* are oval or elliptical.

Remarks.—Few typical members of this genus have so far been described from Texas. There are forms in the boundary area with *Goodhallites* Spath, 1932, and undescribed forms in the boundary area with *Neoharpoceras* Spath, 1921. Most of the species included in *Prohysteroceras* by Adkins (1928) are now assigned to *Goohdallites* Spath; these are *Goodhallites whitei* (Böse), *G. burckhardti* (Böse), and questionably *G. austinensis* (Römer). "*Schloenbachia*" *wenoensis* (Adkins, 1920) has been assigned to *Spathiceras* Whitehouse, 1926. The species assigned to *Prohysteroceras* by Haas (1942) include *P. wordiei* Spath and other species which appear closer to some of the Texas species now assigned to *Goodhallites* [e.g., Haas reports "*P.*" *decipiens* Spath, "*P.*" cf. *dubium* Spath, and "*P.*" *hanhaense* Haas (1942)].

Described below is a species which is more closely related to the type species of *Prohysteroceras* than are most Texas species previously ascribed to this genus.

PROHYSTEROCERAS ATCHISONI n. sp.

Pl. 2, fig. 1; Text–fig. 11

Holotype.—UT 10529, from the Georgetown limestone, *Eopachydiscus brazoense* zone, on Lake Creek, Round Rock, Williamson County, Texas.

EXPLANATION OF PLATE 4

FIG. *1*—*Drakeoceras drakei,* n. gen., n. sp. Lateral view, ×1; UT 1460. (p. 26)

2—*Craginites,* n. gen., n. sp. Lateral view, ×1; UT 1340, questionably from the zone of *Craginites serratescens,* from the "Kiamichi" formation, Indio Mountains, SW ¼ NE ¼ sec. 67, Blk 3, G. C. & S. F. RR Co., Hudspeth Co. Texas; collector: Bostwick, 1952. (p. 18)

3—*Craginites serratescens* (Cragin, 1893), n. gen. Ventral view ×1; BEG 2402, from the *Craginites serratescens* zone, type locality of the Duck Creek formation, 2½ mi. N of Denison in Duck Creek (east branch), just below Frisco RR tracks, Grayson Co.; collector: W. S. Adkins, 1927. The individual is a topotype. (p. 15)

4—*Deiradoceras amsburyi,* n. sp. Lateral view of holotype, ×½; UT 1341, from near the base of the Espy formation, Ocotillo Quadrangle, Trans Pecos Texas. (p. 12)

Specific characters.—Oligogyral, concentrumbilicate, sublatumbilicate, subgradumbilicate, carinate, convexifastigate; whorl section oval, higher than wide, with convex flanks, the flanks tapering ventrad, resulting in the widest part of the shell being just ventrad of the umbilicus. The shell is moderately densicostate with about 38 ribs per volution at a diameter of 150 mm.; costae rectiradiate. Adult costae alternate primary and secondary with very low bullate umbilical tubercles on the primary ribs. No shoulder tubercles or flank tubercles are discernible. The costae were beaded with spirally arranged papillae on the last whorl, at least, but the preservation is so poor that these do not show in the illustration. The shell is evolute and the overlap barely extends past the rounded shoulder. Preservation is so poor it is difficult to determine the septate portion, but the shell may have been septate past a diameter of 150 mm.

Measurements of holotype

150	46.5	30.5	22.5	1.35	38	20	18	0
100	42.0	33.5	24.5	1.37				
75	38.5	37.5						

Observations.—*Prohysteroceras atchisoni,* n. sp., is the first species from Texas which can be referred to this genus in a restricted sense, although it may be older than the type species from Angola. Haas (1942) states only that *Prohysteroceras* is younger than *Hysteroceras.* The juvenile costation is similar to that of *Craginites,* n. gen. The whorl section compares very favorably with that of *P. wordiei.*

Horizon and locality.—See above, under Holotype.

Genus CRAGINITES n. gen.
Type species: *Craginites serratescens* (Cragin, 1893) [=*Schloenbachia leonensis* var. *serratescens* Cragin, 1893].

Generic characters.—Coiling is oligogyral, concentrumbilicate, subangustumbilicate, gradumbilicate, alticarinate; U = 32–44; these ammonites appear to be marked by spiral ornamentation throughout the more adult whorls; the ribs are alternating in the adult, being primary and secondary, with bullate umbilical tubercles on the primary ribs. The bullate ventrolateral (shoulder) tubercles seem always to bear two large clavate nodes in the adult. The whorl height is equal to or greater than the whorl width both intercostally and costally. Juvenile ribbing is dipolocerine. The young whorls are flat-flanked, with height greater than width whereas the young whorls of *Dipoloceras* and its allies are tumid with rounded flanks.

Observations.— Species of this group have been included under such varied genera as *Pervinquieria* Böhm, *Elobiceras* Spath, and *Prohysteroceras* Spath. The genus is quite distinct in ribbing and whorl section from *Prohysteroceras* if *P. wordiei,* the type species, is any indication. *Craginites,* n. gen., does not have the coarse, bifurcating costation of *Mortoniceras* nor the bifurcating, trinodose ribbing so characteristic of *Pervinquieria.* If the forms without club-shaped ribs be removed from the geologically younger(?) and otherwise homogeneous *Elobiceras,* which is more involute, the latter group then appears to encompass a tight, distinct genus which is more involute than *Craginites* (U = 25 plus or minus in such an interpretation of *Elobiceras),* and in which the ribs are club-shaped, expanding regularly in width from the umbilicus ventrad. If Spath's (1942) reading of *Elobiceras* is correct, *Craginites* is somewhat older.

Craginites has been separated from *Rusoceras* Van Hoepen (1946a) because the latter has a trinodose (pervinquieriine) stage where the former does not; *Rusoceras* lacks the double shoulder tubercle. *"Elobiceras" browni* Haas (1942) which Van Hoepen (1951a) says is a *Rusoceras* has also only the single shoulder tubercle, but lacks the pervinquieriine juvenile costation.

Localities and horizons.— In Texas *Craginites* occupies a zone at the base of the Georgetown formation from McLennan County north (lower Duck Creek), and occurs rather sporadically in Bell County (Adkins & Arick, 1930). It occurs in the Fort Stockton region at the same stratigraphic level and also farther west in Texas, exampies coming from the southern Eagle (Indio) Mountains, Sierra del Prieta, the Shafter area, and Pinto Canyon. In the area west of Fort Stockton the genus occurs in what is mapped as "Kiamichi," except at Sierra del Prieta, where it occurs in the basal "Duck Creek sandstone" of Adkins (1933) and at Pinto Canyon where it occurs in the formation overlying the "Kiamichi" (Amsbury, 1957).

The Texas representatives appear to occupy a definite zone in the Upper Albian at about the lower *varicosum* zone level; this zone in Texas is the zone of *Craginites serratescens* (Cragin).

is nontuberculate at the umbilicus and bears a shoulder tubercle identical with that of each primary rib. Overlap is just dorsad of the dorsal element of the shoulder tubercle, so that neither element of this tubercle is visible except on the outer whorl. BEG 17433 is septate throughout its 137 mm. diameter, but BEG 18726 is septate only to a diameter of 85 mm. BEG 2402 is a fragment of a large individual, the fragment being non-septate. The aperture of the species is as yet unknown.

The suture is mortoniceratine, but not sufficiently preserved on any specimen for good reproduction.

Measurements

BEG 19515; the holotype, is a crushed outer whorl on which measurements can not be trusted

				BEG 17433				
137	43.5	37.0	28.0	1.31	41	21	20	0
100	34.0	37.5	25.0	1.50	40	20	20	0
75	37.5							
60	32.5							
				BEG 2402				
150±		35.5	26.0	1.37				
				BEG 18726				
115	37.0	35.0	25.5	1.48	40±	20±	20±	0

CRAGINITES SERRATESCENS (Cragin, 1893)

Pl. 4, fig. 3; Pl. 5, fig. 1,2,4; Text–fig. 2a,d,e,p

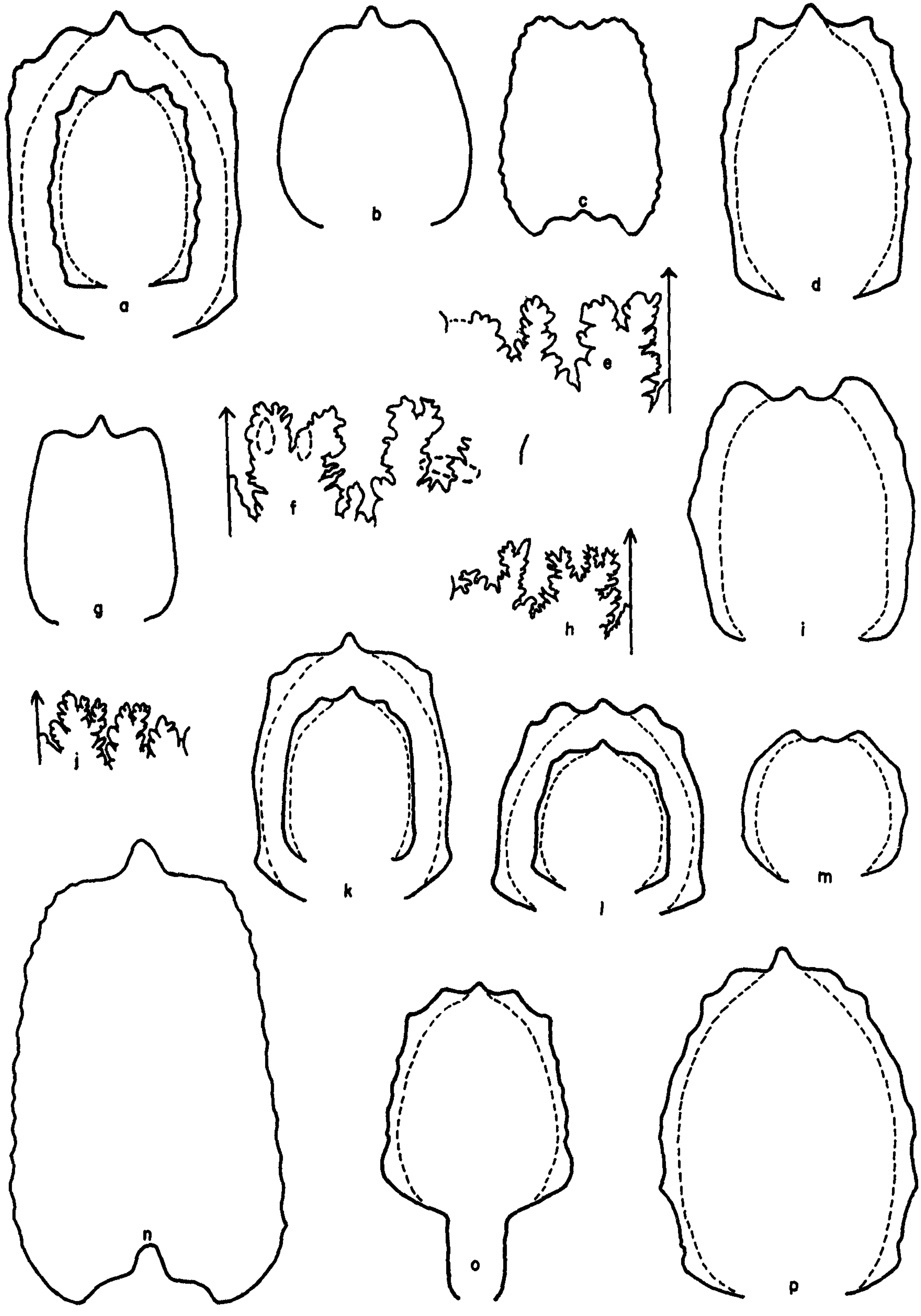
Schloenbachia leonensis var. *serratescens* CRAGIN, 1893, Geol. Surv. Texas, 4th Ann. Rpt., p. 241.
Elobiceras serratescens (Cragin). ADKINS, 1927, Univ. Texas Bull. 2738, p. 41, 43, 44, 51, 55, 63; ADKINS, 1928, Univ. Texas Bull. 2838, p. 234.
?*Elobiceras serratescens* (Cragin); ADKINS & ARICK, 1930, Univ. Texas Bull. 3016, p. 43.
Elobiceras serratescens (Cragin). ADKINS, 1933, Univ. Texas Bull. 3232, p. 355.
?*Elobiceras* sp. BRAND, 1953, Univ. Texas, Bur. Econ. Geol., Rpt. Invest, no. 20, p. 11.

Holotype.—BEG 19515, from the lower Duck Creek formation, Duck Creek, north of Denison, Grayson County, Texas.

Specific characters.—This species has all of the characters of the genus. In addition it has flexiradiate costae in the adult; the costae alternate almost regularly primary and secondary, each primary rib bearing a bullate umbilical tubercle and a bullate shoulder tubercle which in turn has two large clavate nodes. Each secondary costa

Observations.—*Craginites serratescens* was named by Cragin (1893) as a variety of "*Schloenbachia*" *leonensis* (Conrad, 1857). The variety was not mentioned as new, but his writing is the first mention of "*serratescens*" in conjunction with mortoniceratine ammonites in Texas. Since that publication the species has been mentioned in the literature by Adkins (1927, 1928, 1933) as *Elobiceras serratescens* (Cragin) and, insofar as the writer can determine, correctly interpreted paleontologically and stratigraphically; but the species has never been adequately described. Cragin's only description of the species as a variety under "*Ammonites*" *leonensis*, to which it is obviously unrelated, consists of the following sentence: "In a third phase, *serratescens*, the form is strongly compressed and the outer part more lentoid than usual, the ribs low and presenting a centripetally diminishing series of seven to nine compressed tubercles." Cragin did not illustrate his "variety" and subsequent authors have not illustrated the species.

The holotype of *Craginites serratescens*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(Cragin), BEG 19515, is still extant and in the collection of the Bureau of Economic Geology. It consists of slightly less than one-half volution of a peni-adult whorl, containing fragments of sutures; thus the body chamber, at least, is absent, and how much more cannot be ascertained. There are no juvenile whorls present on the holotype. The individual has been crushed, but not as much in the central part as at the ends. The ribs are flexiradiate, but not as much as in the species of *Rhytidoceras* described by Van Hoepen (1931, 1941). The holotype can be duplicated by a large amount of material in North Texas, in the Pan Handle of Texas, and in Trans Pecos Texas.

Except for the flexuosity of the ribbing and the double shoulder tubercle *C. serratescens* (Cragin) would appear to be closely related to the group of "*Pervinquieria*" *irregulare* (Spath), which Spath (1922) leaves in *Pervinquieria* and which Haas (1942) places in *Elobiceras,* Van Hoepen (1946b) agreeing with Spath. Cragin's species is more fastigate than "*P.*" *irregulare,* and looks somewhat like some species of *Rhytidoceras* Van Hoepen (1941), except that species of Van Hoepen's genus have tumid whorls, even in the juveniles, with well rounded flanks, and lack the double shoulder turbercle. Since Haas's (1942) objections to *Rhytidoceras* and *Drepanoceras* (Van Hoepen, 1931), Van Hoepen (1951a) has pointed out that these two genera occur below the zone of *Dipoloceras cristatum.* Haas's (1942) Angola material is younger, being in part, at least, from the *dispar* zone (Spath, 1922, 1942,) ranging down to include the *varicosum* zone. *Craginites serratescens* is from the lower part of this range (probably the *varicosum* zone), occurring above any of the *Dipoloceras* spp. described from Texas (Fredericksburg group) (Scott, 1928), and occurring between the zones of *Oxytropidoceras bravoense* and *Eopachydiscus brazoense.* If Spath's (1942) interpretation of the range of *Elobiceras* is correct, *C. serratescens* is older, but might provide an ancestor.

C. serratescens (Cragin) differs from Haas's group of "*Elobiceras*" *irregulare* (Haas, 1942, non Spath, 1922) in possessing slightly flexuous ribs, whereas the ribs of *E. irregulare* Haas and related species are arcuate (concave orad) [e.g., *Pervinquieria arietiforme* (Spath) var. *elegans,* Haas, 1942, pl. 20, fig. 4a], as are the ribs of other species of *Craginites* from Texas. Other Angola species have slightly flexuous ribs [e.g., *P. arietiformis* (Spath) in Haas, 1942] or straight ribs. The venter of *Pervinquieria irregulare* (Spath) is not broad, with ventral sulcae is in that of *P. inflata* (Sowerby), and unlike the adult of the latter the costae of *P. irregulare* project orad on the venter, as do those of *Craginites serratescens* (Cragin).

Neither "*Elobiceras*" *irregulare* Haas nor "*Pervinquieria*" *irregulare* (Spath) fit easily into *Elobiceras, Prohysteroceras,* or *Pervinquieria.* In attempting to make such "fits" Haas (1942) ended with *Elobiceras elobiense* (Szajnocha), the type species of the genus, as atypical of *Elobiceras* and with

TEXT–FIG. *2*

a,d,ep—*Craginites serratescens* (Cragin, 1893), n. gen. *a,* whorl sections, ×1, at 100 and 150 mm. diam.; BEG 17433. *d,e,* whorl section and suture, ×1; BEG 18726, 2 feet above the Kiamichi-Duck Creek boundary, zone of *Craginites serratescens,* 1½ miles south of Blum, Hill Co., Texas, Bur. Econ. Geol. loc. 109-T-6; collector: B. J. Kummel. *p,* whorl section, ×1; BEG 2402.

b—"*Pervinquieria*" sp. aff. "*P.*" *inflatiforme* (Szajnocha). From Spath (1922, pl. 4, fig. 8b).

c—*Elobiceras lobitoense* Spath, 1922. After Spath's fig. 2c.

f,o—*Craginites,* n. gen., n. sp. Suture and whorl section (slightly crushed), ×1; UT 1340.

g—"*Pervinquieria*" *striatum* (Spath, 1922). From Spath's pl. 3, fig. 3b.

h,l—*Drakeoceras gabrielense,* n. gen., n. sp. Suture and whorl sections, at 50 and 87 mm. diam., ×1; BEG 186.

i—*Elobiceras lenzi* (Szajnocha). From Szajnocha, 1885.

j—*Drakeoceras dellense,* n. gen., n. sp. Suture, ×1; unnumbered specimen from the top of the zone of *Drakeoceras drakei* at Pease Park, Georgetown formation, Shoal Creek, Austin, Texas.

k—*Drakeoceras lasswitzi,* n. gen., n. sp. Whorl sections of holotype, ×1, at 60 and 100 mm. diam.; BEG 18679.

m—*Angolaites gracilis* (Haas, 1942). After Haas's pl. 13, fig. 4c.

n—"*Elobiceras*" *arietiforme* Spath, 1922. From Spath's pl. 2, fig. 6b.

Prohysteroceras wordiei Spath, the type species of that genus, atypical of *Prohysteroceras.* The species of the group of *"Pervinquieria" irregulare* Spath are similar to the fossils herein described under *Craginites,* n. gen., except that the Texas species all have the pronounced double shoulder tubercles, a character not present in the Angola species. Neither does Van Hoepen's South African material contain any *"Elobiceras*-like" ammonites with double shoulder tubercles. Whether these African species will eventually be determined to fit into the *Craginites* lineage, into something like *Rusoceras* Van Hoepen (1946a), or require a new genus, must be determined by a revision of that material.

Horizon and localities.—Craginites serratescens (Cragin) occurs between the zones of *Oxytropidoceras bravoense* (Böse) and *Eopachydiscus brazoense* (Shumard). It occurs in the lower Duck Creek formation from Bell County north in Texas, in the "Kiamichi" of the Pan Handle of Texas, and in the "Kaimichi" of Trans Pecos Texas; only one poorly preserved individual referable to this species has been found south of Bell County in central Texas. *C. serratescens* is associated with *Idiohamites fremonti* (Marcou), species of ammonites of the group of *"Pervinquieria" barbouri* Haas (1942), and some small, undescribed, keeled ammonites.

CRAGINITES n. sp.

Pl. 4, fig. 2; Pl. 6, fig. 5; Text–fig. 2f,o

Fragments of ammonites of a species congeneric with *Craginites serratescens* (Cragin) were collected by Adams (1953) and Allday (1953) in the summer of 1952 in the Indio Mountains, Trans Pecos Texas.

This species is more flattened across the venter and H/W is not as great as in *C. serratescens.* The ribs are not as flexuous as in *C. serratescens,* and the secondary ribs do not extend as close to the umbilicus. The costal sections of the two species are quite different, that of *Craginites* n. sp., being widest at the shoulder.

Observations.—The whorl section of *Craginites* n. sp., is strikingly similar to that of *Angolaites vicina* (Haas, 1942) (see Spath, 1922, pl. III, fig. 2c, non Haas, 1942; Haas's form has only the single shoulder tubercle whereas Spath's either has a high lateral tubercle or a double shoulder tubercle; it appears to be the latter. Haas made Spath's individual the holotype of the species. Haas's illustration cannot represent a crushed form. Text–fig, le this paper shows how the double shoulder tubercle appears when crushed); the geologic ages and derivations of *Angolaites vicina* (Haas) and *Craginites* n. sp., are quite unrelated. Certainly the Texas species must remain in a separate genus until a reevaluation of the Angola material is completed.

Horizon and locality.—Craginites n. sp., questionably occurs in the zone of *Craginites serratescens* (Cragin). It was collected from fault blocks in the Indio Mountains (Southern Eagle Mountains) in Trans Pecos Texas. Fragments of 40 or 50 individuals are in the collection, but no individuals are complete.

Genus GOODHALLITES Spath, 1932

(=*Cainoceras* Van Hoepen, 1942; =*Letheceras* Van Hoepen, 1942; =*Lethargoceras* Van Hoepen, 1942; =*Aidocems* Van Hoepen, 1946.)

Type species: *Goodhallites goodhalli* (Sowerby).

Generic characters.—Goodhallites Spath can best be described as a keeled form with

EXPLANATION OF PLATE 5

FIG. *1,2—Craginites serratescens* (*Cragin,* 1893), n. gen. Ventral and lateral views of holotype, ×1; BEG 19515, zone of *Craginites serratescens,* lower Duck Creek formation, 2½ mi. N of Denison in Duck Creek (east branch), Grayson Co., Texas; collectors: Taff and Leverett, 1892. (p. 15)

3—Deiradoceras amsburyi, n. sp. Ventral view of holotype, ×½; UT 1341. (p. 12)

4—Craginites serratescens (Cragin, 1893), n. gen. Lateral view, ×1; BEG 17433, 2 feet above the Kiamichi Duck Creek contact, zone of *Craginites serratescens,* 1½ mi. S of Blum, Hill Co., Texas, Bur. Econ. Geol. loc. 109-T-6; collector: B. J. Kummel. (p. 15)

5—Drakeoceras lasswitzi, n. gen., n. sp. Lateral view, ×1; BEG 2391, zone of *Drakeoceras lasswitzi,* Georgetown limestone, 1 mi. N of Georgetown. Williamson Co., Texas. (p. 28)


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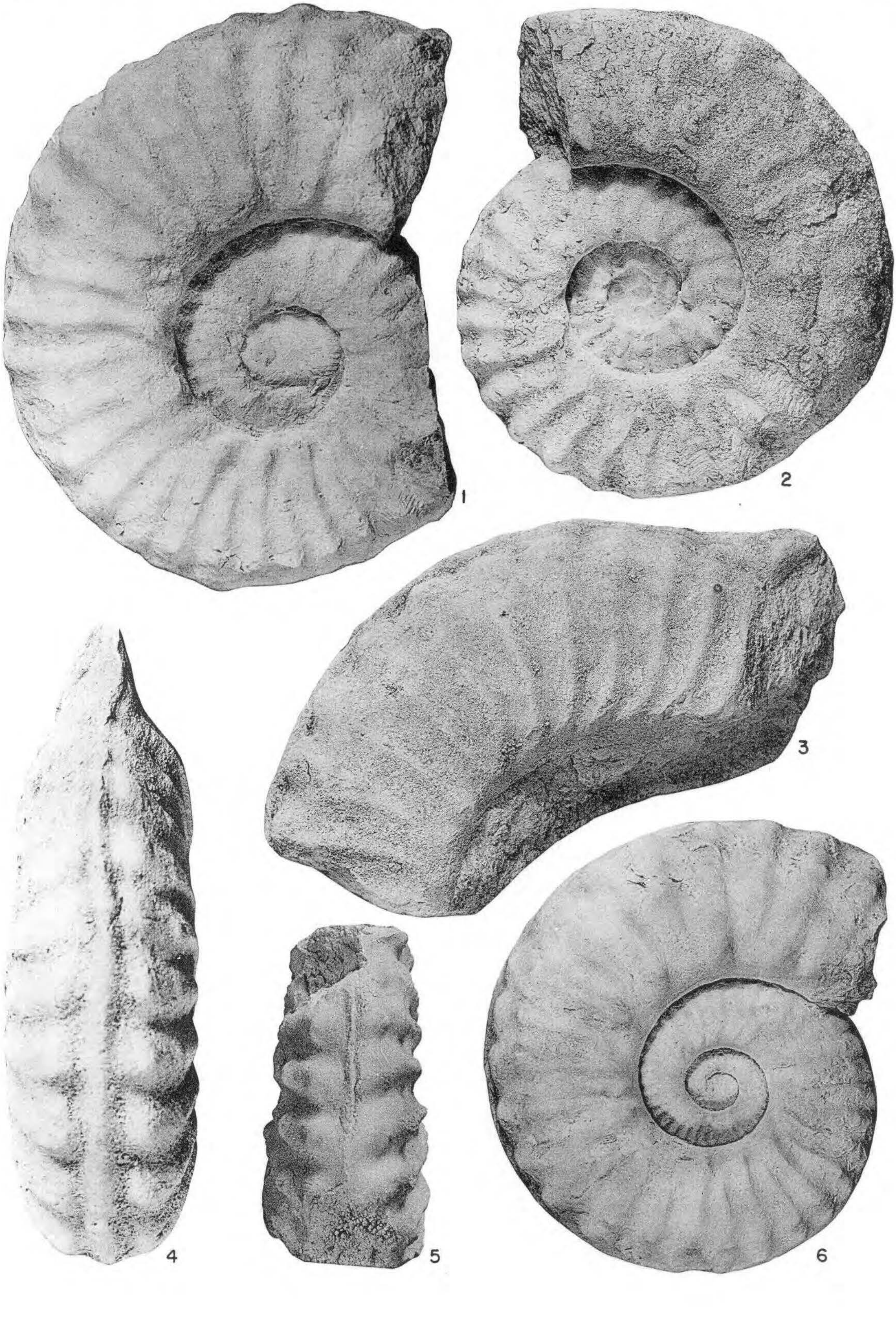
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fine costation in both adult and juvenile, tuberculation reduced, but with umbilical tubercles present, nodate or bullate. In some forms the juvenile costation may tend toward a mortonicerine aspect, but usually remains flexiradiate. U = 21–36; H/W = greater than 1.0.

Observations.—The genus *Goodhallites* was first described by Spath (1932), but he included it as a subgenus of *Prohysteroceras* Spath (1922). The latter genus has been little understood and relatively few species assigned to it, perhaps as Haas (1942) suggests, this is because it is an end member of a lineage. Considering only Texas material one would think *Goodhallites* to constitute a distinct group, descended from some form with juvenile dipolocerine costation, and separate from *P. wordiei* Spath, the type species of *Prohysteroceras.* However, Angola species of *Goodhallites* such as G. *decipiens* (Spath) and G. *hanhaense* (Haas) appear closer to *P. wordiei.* Even though the transition were complete I would prefer not to use *Goodhallites* as a subgeneric unit because in number of species and individuals it is a much larger taxon than is *Prohysteroceras* s. s.

In addition to the group of *Goodhallites goodhalli* (Sowerby), there are four other groups of this genus: (1) the group of "*Schloenbachia*" *gracillima* Kossmat (1898) in which the costae are coarser, only slightly sigmoid, and in which the whorl-section is peculiarly trapezoidal. Van Hoepen (1942) described forms belonging to this group under his genus *Cainoceras.* (2) Another group, with much finer ribbing than the type species of *Goodhallites,* is typified by "*Schloenbachia*" *whitei* Böse (1910). (3) A group with straight ribs in the adult is typified by *Aidoceras jubatum* Van Hoepen (1946a), but not all of the forms described by Van Hoepen under *Aidoceras* have these straight ribs. (4) A group described under *Letheceras* Van Hoepen (1942) contains typical goodhallitids except that the costation tends to be effaced in the adults. This group includes "*Ammonites*" *propinquus* Stoliczka (1865) for which species Spath (1934) suggested generic separation might be warranted.

Texas species of *Goodhallites* include G. *burckhardti* (Böse), G. *whitei* (Böse), G. *aguilerae* (Böse), and questionably G. *austinensis* (Römer).

Genus DRAKEOCERAS, n. gen.

Type species: *Drakeoceras drakei,* n. sp.

Generic characters.—Oligogyral, concentrumbilicate, sublatumbilicate, gradumbilicate, carinate, intercostal section arched; subquadrate in adult whorl section, H/W ratio decreasing with age. Moderately densicostate in young forms, becoming almost paucicostate in adult. Juvenile costation is usually prosiradiate and always goodhallitine up to a diameter of from 60 to 90 mm. or more, depending on the species. Beyond that diameter the costation changes, rather rapidly (usually within 1/3 volution) to a bituberculate costation with mortonicerine bifurcation or with single bituberculate ribs, or with alternation of these two with each other and/or with secondary ribs tuberculate only at the ventral end. In most species the shoulder tubercle is double, even in juvenile individuals, whereas it is usually

EXPLANATION OF PLATE 6

FIG. *1–4*—*Drakeoceras drakei,* n. sp., n. gen., *1,* Lateral view, ×1; BEG 2451, Weno formation, Lampasas River, at N end of Horseshoe Bend, 3 mi. SE of Belton and 1 mi. E of the Dallas highway, Bell Co., Texas. 2, lateral view, ×1; UT 14446A, upper part of *Drakeoceras drakei* zone, Georgetown limestone, Smith's Branch, 1 mi. E of Georgetown, Williamson Co., Texas; collector: Billy Walls, 1950. *3,4,* lateral and ventral views of apertural half of body chamber, ×1; the periphery has been abnormally compressed by sedimentary processes; UT 14446, horizon, locality, collector as for UT 14446A. (p. 26)

5—*Craginites,* n. gen., n. sp., ventral view, ×1; UT 1340. (p. 18)

6—*Drakeoceras arringtoni* n. gen., n. sp. Lateral view of holotype, ×1; UT 10523, from the *Drakeoceras lasswitzi* zone, Georgetown limestone, abandoned road material pit on the Dedear Ranch, 0.3 mi. E of U. S. highway 81 and 3.0 mi. N of the Brushy Creek bridge at Round Rock, Williamson Co., Texas; collector: D. E. Atchison, 1954. (p. 30) absent in *Goodhallites,* or when present, long, drawn out, and reduced as in *G. candollianum* (Pictet).

Observations.— I can find no species of this development previously described from other parts of the world. Van Hoepen's *Mimeloceras* species all go through a trituberculate (pervinquieriine) stage of costation and the costation and tuberculation is much more robust; juvenile *Deiradoceras* possess mortonicerine costation and the ornamentation on this genus is also much more robust than on *Drakeoceras,* n. gen. None of the groups of species discussed under the genus *Goodhallites* possesses the adult development herin described. The subquadrate whorl section in the adult with H/W ratio about equal to unity separate this group from *"Cainoceras"* Van Hoepen with trapezoidal section and flexiradiate ribs which definitely bifurcate, and the goodhallitine juvenile costation and subquadrate adult whorl section separate it from forms Van Hoepen (1951b) described under *"Pagoceras,"* which has mortonicerine juvenile costation, usually a higher whorl section, and a fastigate venter. *Drakeoceras* is the only one of all of these groups with the double shoulder tubercle. Furthermore, in the species groups of *Goodhallites,* the H/W ratio increases with age (or more rarely remains about constant), whereas in *Drakeoceras* the H/W ratio usually decreases with age, quite a different ontogenetic development.

Angolaites gregoryi (Spath, 1922), with double shoulder tubercles, in the adult has single, evenly spaced costae, all extending to the umbilicus, whereas in *Drakeoceras,* n. gen., only the last few ribs on the body chamber are of this type. In addition *Angolaites* possesses a good flank tubercle, never present in *Drakeoceras*. "*A.*" *montroynaudensis* (Haas) [=*Schloenbachia (Mortoniceras) inflata* Boule, Lemoine & Thevenin, 1907, forme typique] compares with the Texas trinodosa with notched shoulder tubercle and mortonicerine juvenile costation. The variety *gracilis* Haas (1942) gave to this species does not belong in it. Both of these possess the flank tubercle and are more evolute than species of *Drakeoceras*.

Drakeoceras, n. gen., appears to have no relation to species of *Durnovarites* Spath (1932), but species of *Drakeoceras* do have the peculiar double shoulder tubercle of many species assigned to *Durnovarites* by Spath. The species of *Drakeoceras,* excepting perhaps *D. georgetownensis,* in which the inner whorls have not been observed, all start with goodhallitine juvenile costation, whereas *Durnovarites subquadratum* Spath, *D. quadratum* Spath, *D. postinflatum* Spath, *D. adkinsi,* n. sp., and probably *D. perinflatum* (Spath) all have juvenile mortonicerine costation followed by a neanic and ephebic flank tubercle.

The young of *Drakeoceras,* n. gen., have typical goodhallitine costation and the species differ largely in how early or late in the ontogeny the goodhallitine costation is replaced by adult costation. Even at the earliest diameters (e.g., 20 mm.) of *D. gabrielense,* n. sp., the notched shoulder tubercle is forshadowed by two papillae. Some juvenile forms even develop a neoharpoceran aspect with new costae intercalating at mid flank (UT 10103, Pl. 10, fig. 4). Juveniles of this genus can be separated from the juveniles of *Goodhallites* most easily on the possession of the two shoulder papillae. Nothing in Spath's *Goodhallites* or Van Hoepen's *Aidoceras, Letheceras,* or *Cainoceras* resembles the adults of *Drakeoceras,* nor do any of, these genera show a notched shoulder tubercle at any stage. Species attributed to *Leonites* by Spath (1932), including *"Amm." maximus* Lasswitz, have a notched shoulder tubercle as do some species of *Poikiloceras* Van Hoepen and *Pagoceras* Van Hoepen (1951b), some of the latter two genera having the notched tubercle becoming single in the adult (e.g., *P. adjacens* Van Hoepen, 1951b). However, all species of the above mentioned groups [except *Drakeoceras maximum* (Lasswitz)] have coarse mortonicerine costation in the young forms. Van Hoepen (1944) also attributes such forms with notched shoulder tubercles as *"Pervinquieria" ornata* and *"Pervinquieria" referta* to the genus *Pervinquieria* (Böhm). Other species described more properly under the genus *Pervinquieria* also have notched shoulder tubercles [e.g., *P. amplicostata* Van Hoepen, *P. cognata,* etc. Van Hoepen (1951b)], but the rest of the ontogenies of these species is quite different from the Texas species of *Drakeoceras.* Notice particularly *Pervinquieria geniculatum* Van Hoepen, 1942, and *P. scobina* Van Hoepen, 1942.

Except for quadrituberculate forms belonging to *Angolaites* and *Durnovarites* the Mortoniceratinae with notched or double shoulder tubercles seem to be almost exclusively South African and North American (Texas, New Mexico, Mexico). The only exception known to the writer is *Peninquieria ? nanum* Spath, 1933, which is a juvenile and probably belongs to some group of *Mortoniceras* s.s.

The South African and North American species with double shoulder tubercles, mentioned above, belong to the following groups: (1) The South African species, some mentioned above, with mid flank tubercles appearing very early in the ontogeny and with pervinquieriine juvenile costation; (2) there are the Texas species with juvenile mortonicerine costation and with mid flank tubercles appearing extremely late in the ontogeny, usually on the last volution as in *"Pervinquieria"* n. sp. Adkins (1928, pl. 10, fig. 2); (3) there are Texas species without flank tubercles, or virtually without them, and with juvenile mortonicerine costation as in *Mortoniceras wintoni* (Adkins, 1920); (4) the group with goodhallitine juvenile costation as in *Drakeoceras maximum* (Lasswitz); and (5) a more distant group, described above under the genus *Craginites,* which seems to be the double shoulder tubercle counterpart of *"Elobiceras" arietiformis* Spath (1922). As indicated earlier, however, by the approval of Van Hoepen's assignment of certain species with double shoulder tubercles to *Pervinquieria,* the presence of the double shoulder tubercle alone, or of any other tubercle for that matter, does not indicate any certain generic affinity unless it is a part of a discrete ontogeny that makes a complete picture.

Horizons and localities.—Various species of *Drakeoceras,* n. gen., occur in Texas, Upper Albian, ranging in age from the zone of *Pervinquieria kiliani,* upper Duck Creek formation, to the lower part of the zone of *Turrilites brazosenis,* Main Street formation. Species have been collected from north, central and Trans Pecos Texas.

DRAKEOCERAS KUMMELI, n. sp.

Pl. 8, fig. 2,4; Pl. 9, fig. 5

Prohysteroceras sp. aff. *austinensis* (Roemer); ADKINS, 1928, Univ. Texas Bull. 2838, pl. 11, fig. 2.

Holotype.—*BEG* 18727, collected by B. J. Kummel above the *Epoachydiscus brazoensis* zone, probably from the zone of Pervinquieria Kiliani, on the Brazos River near Steiner Bend, bed d, Bur. Econ. Geol., locality 109–T–11, Hill County, Texas.

Specific characters.—Oligogyral, concentrumbilicate, gradumbilicate, sublatumbilicate, carinate, flanks almost flat, costation goodhallitine, but with double shoulder tubercles. Costation becomes coarser at about 80 mm. diameter; appears to bifurcate to about 100 mm. diameter, although bifurcation is uneven; ribs, single, primary and secondary beyond a 100 mm. diameter. Adult costae slightly convex adorad.

The shoulder tubercle is low and double, bearing two large papillae, the ventral of which is faintly clavate and the dorsal of which is clavate up to about 80 mm. diameter and thereafter is nodate or slightly inclined. The holotype is septate to at least the 100 mm. diameter. Costae and intercostae are about the same width. The umbilical tubercle is bullate and pronounced; costae are prosiradiate, but not markedly. The keel is high, extending ventrad beyond the shoulder tubercles. The overlap of each whorl just conceals the dorsal element of the ventral shoulder tubercle of the preceding whorl. The H/W ratio is about 1.4, the whorl section being high throughout.

Measurements of holotype

113 (maximum)	33	2	3	14pr
100 31.5				

Observations.—*Drakeoceras,* n. gen., is apparently derived from some form of *Goodhallites* Spath, and *D. kummeli,* n. sp., occurs with species of *Goodhallites.* Were it not for the continuity of the group herein described under the genus *Drakeoceras,* with *D. kummeli* the beginning member, *D. kummeli* could as well be placed in the genus *Goodhallites* Spath. However, *D. kummeli* does have the double shoulder tubercle which can not be observed in the illustrations of species of *Goodhallites* described by Spath. An example of *Goodhallites goodhalli* var. *tuberculata* Spath, kindly furnished me by R. Casey, has no evidence of double shoulder tuberculation, but its further resemblance to *D. kummeli* is remarkable. Since *D. kummeli* is the first of a continuous Upper Albian sequence which in Texas at least forms a coherent group, I have placed it in this new genus.

D. kummeli differs from other species of *Drakeoceras* in being more goodhallitid throughout, successively younger species, with few exceptions, successively losing their goodhallitid resemblance at earlier ontogenetic stages. *D. kummeli* more closely resembles *D. lasswitzi*, n. sp., than other Texas forms, but differs from the latter in its more flexiradiate costation, with the ribs less pronounced, especially at mid flank; *D. kummeli* also has a higher whorl section.

Horizon and localities.—See above, under Holotype. Adkins (1928, pl. 11, fig. 2) has recorded the species from the Duck Creek equivalents at University Mesa, Pecos County, Texas.

DRAKEOCERAS GABRIELENSE, n. sp.

Pl. 3, fig. 3; Pl. 7, fig. 2,3,5,6; Pl. 10, fig. 3,7; Text–fig. 2h, 3b,c,e,n

?*Schloenbachia austinensis* (Römer) var. *minima* LASSWITZ, 1904, p. 25 (pro parte), not pl. VI, fig. 1.

Schloenbachia sp. M. ADKINS & WINTON, 1920, pl. 5, fig. 1,4.

Holotype.—UT–10121, from the Georgetown limestone, lower part of the zone of *Turrilites brazosensis,* 1 mile north of the junction of U. S. highway 81 and Texas highway 195, on a branch of Dry Berry Creek; Williamson County, Texas; collected by R. T. Arrington, 1953.

Specific characters.—Oligogyral, concentrumbilicate, gradumbilicate, carinate; intercostal section arched; costation as in genus, changing from goodhallitine to coarser costation at about a diameter of 60 mm. At the same diameter the typical goodhallitine whorl section becomes subquadrate and H/W approaches unity. Adult costation is single, primary and secondary, with costae slightly concave aborad. The shoulder tubercle is bullate and bears two large clavate nodes (notched shoulder tubercle of Winton, 1925); the umbilical tubercle is nodate. BEG 34–2 is septate to 90 mm. and UT 10122 is septate to 108 mm. Other specimens do not have any of the living chamber preserved and all are septate, UT 10121 being septate through all of a 116 mm. diameter. Each whorl overlaps the shoulder tubercles and a few millimeters of the flank dorsad to the shoulder tubercle.

The suture is typically mortoniceratine with the secondary elements reduced. The first and second lateral saddles are well developed.

(See Measurements on page 23)

Observations.—*Drakeoceras gabrielense,* n. sp., differs from other known species of the genus in its aborad concavity of the adult costae and in the greater clavateness of the two elements of the double shoulder tubercle. The sharp flexiradiate costation of the adult is also distinctive. Lasswitz (1904) reported "*Schloenbachia*" *minima* from Pease Park in Austin where about 17 feet of uppermost Georgetown limestone is exposed below the Del Rio clay. He also described *Goodhallites minima* from the Missouri Pacific (I. G. N.) railroad cut at West Sixth Street in Austin. The figured specimen (1904, pl. VI, fig. 1) must be from the railroad cut because it

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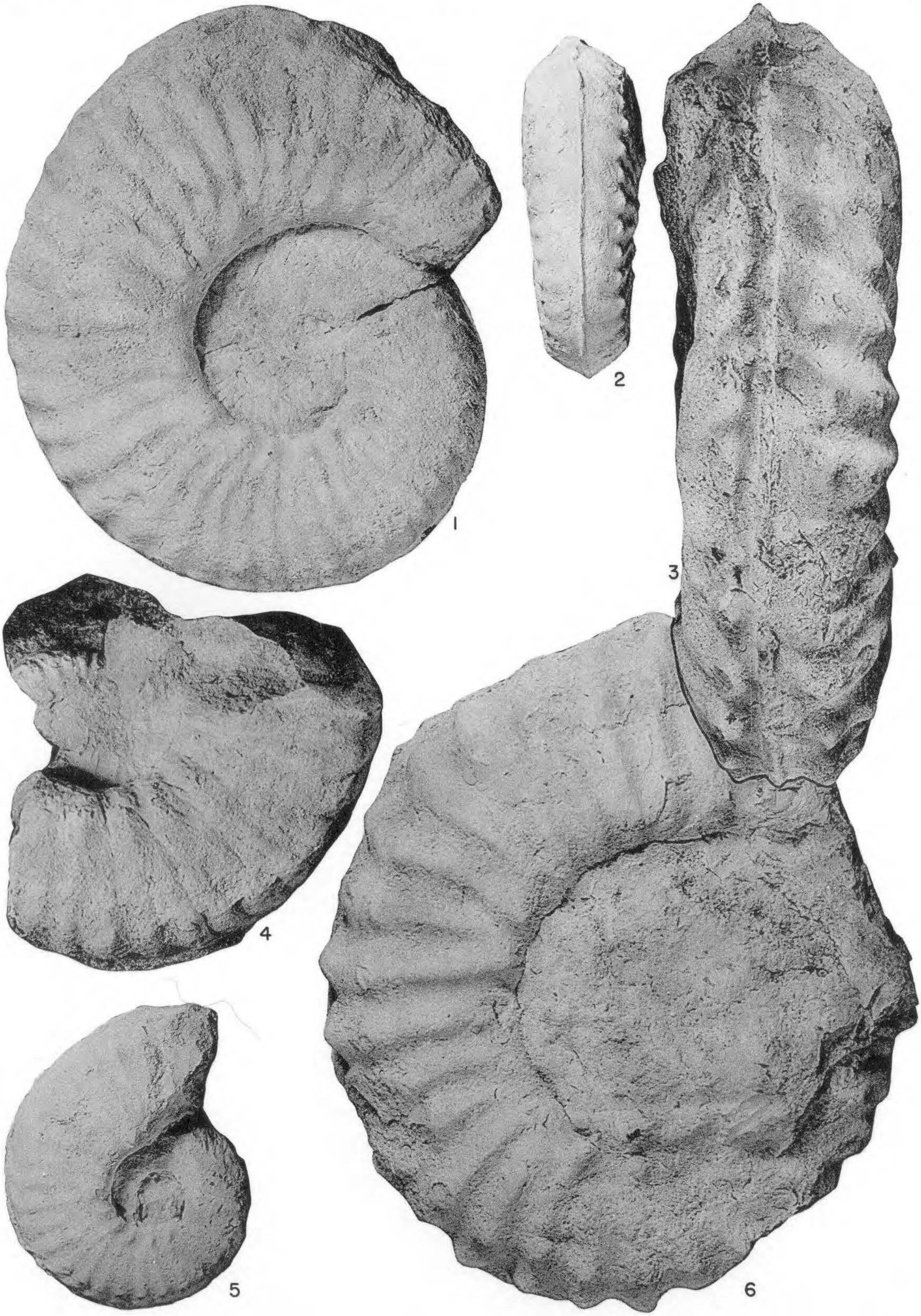
EXPLANATION OF PLATE 7

FIG. *1*—*Drakeoceras dellense*, n. gen., n. sp. Lateral view of holotype, ×1; BEG 2445A, Main Street formation, i mi. S of Prairie Dell, Bell Co., Texas; collector: W. S. Adkins. (p. 25)

2,3,5,6—*Drakeoceras gabtielense,* n. gen., n. sp. *2,* ventral view of juvenile specimen, ×1; BEG 3043A, from Bell Co., horizon not designated. *3,6*—lateral and ventral views of holotype, ×1; UT 10121, lower part of *Turrilites brazosensis* zone, Georgetown limestone, 1 mi. N of the junction of U. S. highway 81 and Texas highway 195, on a branch of Dry Berry Creek, Williamson Co. Texas; collector: R. T. Arrington, 1953. *5,* lateral view of juvenile specimen ×1; UT 10127; locality, horizon and collector as for UT 10121. (p. 22)

4—*Durnovarites adkinsi,* n. sp. Lateral view, ×1; UT 10824. (p. 6)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Measurements

				BEG 3043A				
60	30.0	39.0	31.5	1.27	30	0	4	13pr
50	28.0	40.0	36.0	1.11	27	0	3	12pr
40	27.5	42.5	37.5	1.30	26	0	4	11pr
30	25.0	41.5			22?	0	0	11pr
25	24.0							
20	25.0							
				BEG 186				
90	35.0	32.0	30.0	1.06	29?	9?	10?	5?pr
75	27.5	29.0	28.5	1.02				
60		22.5						
				BEG 34-2				
108					36			
				UT 10127				
55								
50	30.0	42.0	37.0	1.14	29	0	1	14pr
40	29.0	40.0	34.0	1.19				
30	26.5	38.0	30.0	1.22				
20	35.0	45.0	35.0	1.20				
				UT 10122				
117					31	13	11	4pr
100	36.5	33.5	27.0	1.24				
75	34.5	39.0						
60	35.0	45.0	33.5	1.35				

appears to be a true, but densicostate, *Goodhallites,* without shoulder tubercles, whereas the Pease Park locality exposes rocks of only the *Turrilites brazosensis* and *Drakeoceras drakei* zones, and is too high in the section for the occurrence of *Goodhallites.* The specimen reported from this Shoal Creek (Pease Park) locality was, thus, not figured by Lasswitz (1904) and is probably a *Drakeoceras gabrielense* as the writer has found examples of this species at this locality and horizon.

"Schloenbachia" wintoni Winton (1925, non Adkins, 1920) appears to be very closely related to *D. gabrielense* and might be conspecific with it. I've not seen the specimen, only the illustration (Winton, 1925, pl. 5, fig. 4). Winton's individual may be older than most individuals of *D. gabrielense,* and is slightly more densicostate at equivalent diameters.

Schloenbachia sp. M (Adkins & Winton, 1920) has been assigned to this species although it appears to be transitional to *Drakeoceras drakei.,* n. sp. Although the whorl section of the juvenile is similar to that of *Drakeoceras drakei,* the adult section and the flexiradiate adult costation is similar to that of *D. gabrielense.*

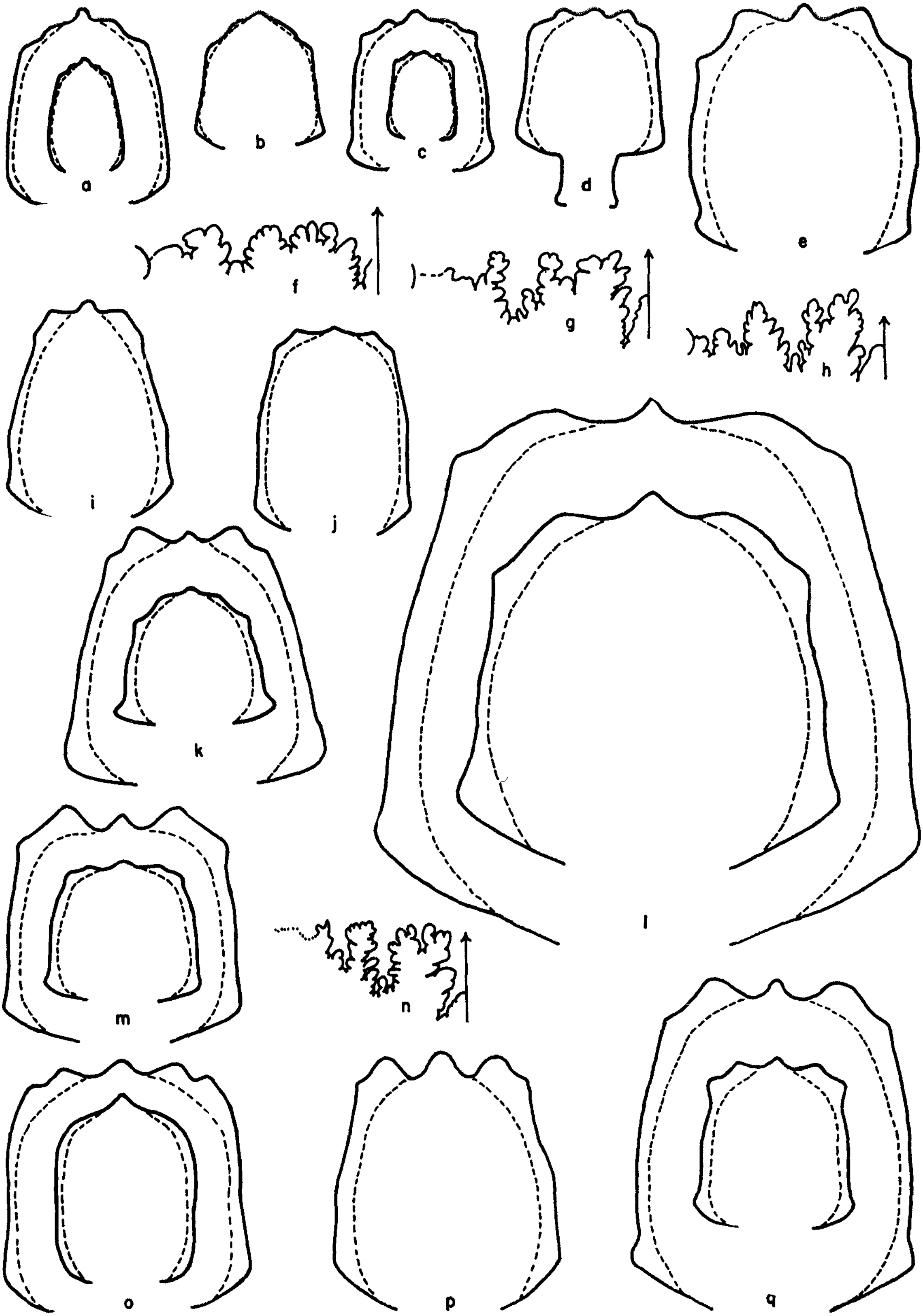
Horizon and localities.—Drakeoceras gabrielense, n. sp., is one of the two youngest species so far assigned to the genus, and with *Drakeoceras dellense,* n. sp., and *Durnovarites adkinsi,* n. *sp.,* is one of the three youngest Mortoniceratinae in the Texas Cretaceous. *D. gabrielense* occurs in the lower

EXPLANATION OF PLATE 8

FIG. *1—Drakeoceras georgetownense,* n. gen., n. sp. Ventral view of holotype, ×1; UT 863, Georgetown formation, Smith's Branch, 1 mi. E of Georgetown, Williamson Co., Texas. (p. 27)

2,4—Drakeoceras kummeli, n. gen., n. sp. Ventral and lateral views of holotype, ×1; BEG 18727, probably from the zone of *Pervinquieria kiliani,* Duck Creek formation, bed d, Bur. Econ. Geol. loc. 109–T–11, Brazos River, near Steiner Bend, Hill Co., Texas; collector: B. J. Kummel. (p. 21)

3—Drakeoceras lasswitzi, n. gen., n. sp. Lateral view of holotype, ×1; BEG 18679, zone of *Drakeoceras lasswitzi,* top of Fort Worth formation, bed 109, Bur. Econ. Geol. loc. 109–T–6, Rock Creek, E of Blum, Hill Co., Texas; collector: B. J. Kummel. (p. 28)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part of the zone of *Turrilites brazosensis* in central Texas, along with the two species mentioned above, *Turrilites brasosensis* Römer, and a new species of *Stoliczkaia,* occurring in the upper part of the Georgetown limestone. It also occurs in the underlying *Drakeoceras drakei* zone. The species has been collected from Travis County to North Texas.

DRAKEOCERAS DELLENSE, n. sp.
Pl. 7, fig. 1; Pl. 10, fig. 4,5,9,10; Text-fig. 2j,3a,h–j

Holotype.—BEG 2445A, from the Main Street formation, ½ mile south of Prairie Dell, Bell County, collected by W. S. Adkins.

Specific characters.—Oligogyral, concentrumbilicate, sublatumbilicate, gradumbilicate, carinate; flanks slightly arched. Costation is densicostate, moderately goodhallitine to diameters of 100 mm. or more. Costae convex adorad, prosiradiate with some intercalated ribs as ventrad as mid flank. There are from 40 to 45 ribs per volution at a diameter of 75 mm., of which almost half form bifurcating pairs. The H/W ratio is from 1.3 to 1.5. The whorl section remains high throughout, having some resemblance to whorl sections of *Neoharpoceras.* A typical shoulder tubercle is non-existent, but there are two rows of papillae on the shoulder as in the juveniles of *D. gabrielense.* The dorsal of these two papillae is nodate, the ventral inclined with the forward inclination of the rib onto the venter. All individuals examined were septate, and adult forms may be larger than those of *D. gabrielense,* n. sp. Each whorl overlaps past the two shoulder papillae on the preceding whorl and onto a few mm. of the flank. Sutures are as in *D. gabrielense.*

Measurements

				BEG 3043B				
82 (maximum)								
75	31.5	41.5	30.0	1.38	38			
50	32.0	46.0	34.0	1.38				
				UT 10103				
75	28.5	38.5	30.0	1.29	46	1	1	22pr
60	29.5	41.5	31.5	1.31				
50	29.0	41.0	32.0	1.28				
40	27.5	41.5	27.5	1.50				
				UT 14413				
111 (maximum)					34	3	11	10pr
100	30.5	37.5	26.5	1.41	35			
75	29.5	40.0	28.0	1.43	38			
50	28.5	32.7	28.5	1.44				
				BEG 2445A (holotype)				
					44	3	7	17pr

TEXT–FIG. *3*

a,h-j—*Drakeoceras dellense,* n. gen., n. sp. *a,h,* whorl sections at 40 and 75 mm. diam., and suture; UT 10103. *i,* whorl section of holotype at 75 mm. diam.; BEG 2445A. *j,* whorl section at 75 mm. diam.; BEG 3043B. All ×1.

b,c,e,n—*Drakeoceras gabrielense,* n. gen., n. sp. *b,* whorl section at 50 mm. diam.; UT 10127. *c,n,* whorl sections at 25 and 50 mm. diam., and suture; BEG 3043A. *e,* whorl section of holotype at 100 mm. diam.; UT 10121. All ×1.

d,f,g,m,o—*Drakeoceras drakei,* n. gen., n. sp. *d,* whorl section at 55 mm. diam.; UT 14446A. *f,* suture; BEG 20250, from the Weno formation, Bell Co., Texas. *g,m,* holotype, suture and whorl sections at 50 and 90 mm. diam.; BEG 20249. *o,* whorl sections at 60 and 100 mm. diam.; UT 1460. All ×1

k,q—*Drakeoceras lasswitzi,* n. gen., n. sp. Whorl sections, ×1. *k,* at 50 and 95 mm. diam.; BEG 2391. *q,* at 60 and 125 mm. diam.; BEG 20251.

l—*Drakeoceras maximum* (Lasswitz, 1904), n. gen. Whorl sections of cast of holotype, ×1.

p—*Drakeoceras,* n. gen., n. sp. Whorl section, ×1, at 100 mm. diam.; BEG 2445B, Main Street formation, ½ mile S of Prairie Dell, Bell Co., Texas; collector: W. S. Adkins.

BEG 3043B appears to be transitional between *D. dellense,* n. sp., and *D. gabrielense,* n. sp.

Observations.—Drakeoceras dellense, n. sp., appears to have evolved from *D. gabrielense,* n. sp., perhaps by the caenogenetic development of the adult ornamentation of *D. dellense,* and these two species do occur together, although *D. gabrielense* appears earlier. Such forms as BEG 3043B (Text-fig. 3j and Pl. 10, fig. 10) seem to be transitional from *D. gabrielense* to *D. dellense. D. dellense* has a higher H/W ratio, the whorls remaining high to more advanced growth stages, and the species is more densicostate than any other Texas species of *Drakeoceras.* None of the other species of this genus possess intercalated ribs at or near mid flank.

Horizon and localities.—Drakeoceras dellense, n. sp., is known only from the lower part of the *Turrilites brazosensis* zone of the Georgetown formation and its equivalents. It occurs with *T. brazosensis* Römer, *Durnovarites adkinsi,* n. sp., *Drakeoceras gabrielense* n. sp., *D. drakei,* n. sp., and a new species of *Stoliczkaia. D. dellense* has been collected in Bell, Williamson, and Travis counties, Texas.

DRAKEOCERAS DRAKEI, n. sp.

Pl. 3, fig. 2; **Pl.** 4, fig. 1; Pl. 6, fig. 1–4; Pl. 10, fig. 1,2,6,8; Text–fig. 1e,3d,f,g,m,o

Holotype.—BEG 20249, deposited in the Bureau of Economic Geology, The University of Texas, Austin, Texas. It is from 10 to 15 feet below the top of the Georgetown limestone, 2 miles east of Belton, Bell County, Texas, and was collected by N. F. Drake, probably in 1892.

Specific characters.—Oligogyral, concentrumbilicate, sublatumbilicate, gradumbilicate, carinate. The whorl section is quadrate to subquadrate, and the H/W ratio is nearly always close to unity. Costae are relatively straight, appearing to turn adorad on the venter; rectiradiate, becoming markedly prosiradiate on the last third of the body whorl, as in most Mortoniceratinae (Pl. 6, fig. 3). Costation also becomes less robust on the orad part of the body whorl. Rib density in *D. drakei* ranges from 24 to 28 costae per volution at a diameter of 50 mm.; most of these are bifurcating. At a diameter of 100 mm. the rib density ranges from 28 to 31, and nearly all ribs are alternating, single, primary and secondary. One individual retains the aperture (Pl. 6, fig. 3,4). The rostrum is very short, and forms an angle of about 20 degrees with the periphery of the whorl. The diameter of this shell was about 120 mm. at the aperture.

BEG 20250 is septate to a shell diameter of about 67 mm., and the last two septa are closer together than are septa immediately preceding. The holotype (BEG 20249) is septate to 80 mm., with part of the body chamber present, and BEG 2445B is septate to 75 mm., with part of the body chamber present.

The sutures are not well preserved, as is usual in specimens preserved in carbonate rock, but the ventral lobe is narrow, the first lateral saddle is wide with the subsidiary lobe displaced asymmetrically dorsad; the first lateral lobe is well developed, and the second lateral lobe is reduced. In *D. dellense,* n. sp., in which the whorl section is much higher, the lateral saddles and lobes are not widened, if anything narrower, but the additional flank width results in a more complete development of the second lateral saddle.

UT 14446A has been included in *D. drakei,* n. sp., but it is atypical, apparently transitional to *D. georgetownense,* n. sp., and in UT 1460, although like *D. drakei* in the adult, the young appears to be transitional to the juvenile form of *D. gabrielensis,* n. sp.

Observations.—There is considerable variation in *Drakeoceras drakei,* n. sp., particularly in the elevation of the ventral element of the paired shoulder tubercle, as in UT 1460 and BEG 20249 (Text–fig. 3m,o; Pl. 10, fig. 2,6). UT 1460, as observed in whorl section at a diameter of 60 mm., seems to be evolving toward *D. gabrielense,* n. sp., and both this specimen and UT 14446A appear to have the ventral part of the outer whorl compressed. This is typical of both older and younger species of the genus, but not of the holotype of *D. drakei.* In these individuals the compression may be the result of compaction of sediments. There appear to be forms, such as UT 1460, transitional to *D. gabrielense,* n. sp., and forms, such as UT 14446A, transitional to *D. georgetownense,* n. sp. Consequently, al-

Measurements

				BEG 20249 (holotype)				
100	37.0	35.0	34.0	1.03	29	9	10	5pr
75	35.5	37.0	37.5	0.98	30	5	7	9pr
50	36.0	39.0	38.0	1.03	28	0	2	13pr
				UT 1460				
122	37.0	34.0			29	9	4	8pr
100	34.0	37.0	35.0	1.06	33	3	4	13pr
75	28.5	40.5	36.5	1.11				
60	30.0	42.5	36.5	1.16				
				BEG 20250				
100	35.5	35.0	34.0	1.03	26	10	6	5pr
75	36.0	38.5	38.0	1.04				
				BEG 2451				
100	36.5	34.0	33.0	1.03	31	12	13	3pr
75	36.0	37.5	37.5	1.00	30	6	6	9pr
50	32.0	40.0	38.0	1.05				
				UT 14446A				
86					28	7	9	6pr
75	40.5	33.5	34.5	0.96	27	1	4	11pr
60	38.5	35.0	35.0	1.00	26	1	3	11pr
50	39.0	37.0	38.0	0.97	24	0	4	10pr
40	42.5	40.0	44.0	0.92				

though UT 1460 has a whorl section and costation of *D. drakei,* the termination of the ribs on the venter and the juvenile whorl section more closely resemble those of *D. gabrielense.* Likewise UT 14446A has a slightly coarser costation, thus approaching *D. georgetownense,* but not sufficiently to be included in that species.

Horizon and localities.—*Drakeoceras drakei,* n. sp., is fairly abundant at some localities. The species ranges from somewhere in the *Mortoniceras wintoni* zone up into the lower part of the zone of *Turrilites brazosensis.* Probably that sequence of rocks between the zone of *Mortoniceras wintoni* (in abundance) and the zone of *Turrilites brazosensis* should be designated the *Drakeoceras drakei* zone. The specimens in the collections are mostly from Williamson and Bell Counties, Texas.

DRAKEOCERAS GEORGETOWNENSE, n. sp.
Pl. 8, fig. 1; Pl. 9, fig. 3; Text–fig, 1a

Holotype.—UT 863, from the middle part of the Georgetown limestone, on Smith's Branch, 1 mile east of Georgetown, Williamson County, zone of *Drakeoceras lasswitzi,* n. sp.

Specific characters.—Oligogyral, concentrumbilicate, gradumbilicate, sublatumbilicate, carinate. The whorl section is subquadrate, but the width is greater than the height at all diameters of more than 50 mm. H/W is 0.90 more or less at a diameter of 75 mm. UT 873 is septate to 90 mm. and the holotype is septate to 92 mm., the body chamber being small as the more adoral costae are swinging adorad on the apertural end of the shell, becoming extremely prosiradiate as is typical in the apertural parts of the body chambers of many Mortoniceratinae.

Costae are slightly rursiradiate on all visible whorls except the body chamber, and costae on the visible whorls of the holotype are coarse, paucicostate, ranging from 24 to 26 ribs per volution at diameters of 75 to 100 mm. Both shoulder elements are clavate, the dorsal element more so than the ventral element. The ventral element rises to an elevation at least equal to the elevation of the keel and maybe higher than the keel.

Measurements

				UT 873				
124	28.0	30.0			27	13	8	3pr
75	32.5	36.5						
				UT 863 (holotype)				
112 (maximum)								
100	40.0	35.0			26	8	8	5pr
75	36.5	36.0	39.5	0.92	25	1	4	10pr
60	34.0	36.0	38.0	0.98				

Observations.—The middle Georgetown limestone forms constituting *Drakeoceras georgetownense,* n. sp., are more paucicostate than the younger species of the genus such as *D. gabrielense,* n. sp., *D. dellense,* n. sp., and *D. drakei,* n. sp. The number of costae per volution may not be significantly different from that of *D. lasswitzi,* n. sp., but the costae are flexiradiate in the latter species and are prosiradiate rather than slightly rursiradiate. Also *D. georgetownense* has a smaller H/W ratio than any other recorded species of the genus, and it is more paucicostate at diameters of 50 mm and less.

Horizon and localities.—*Drakeoceras goergetownense,* n. sp., has been collected in the Georgetown limestone in Travis and Williamson Counties, Texas, from the zone of *Drakeoceras lasswitzi,* n. sp.

DRAKEOCERAS LASSWITZI, n. sp.
Pl. 5, fig. 5; Pl. 8, fig. 3; Pl. 9, fig. 7;
Text–fig. 2k,3k

Holotype.—BEG 1.8769, from the top of the Fort Worth formation, Rock Creek, east of Blum, Hill County, Texas, from the zone of *Drakeoceras lasswitzi,* n. sp.

Specific characters.—Oligogyral, concentrumbilicate, sublatumbilicate, gradumbilicate, carinate; whorl section slightly higher than wide in the adult, tapering very gently ventrad. Costae are not dense, ranging from 27 to 30 ribs per volution at a diameter of 100 mm. Costae are slightly prosiradiate and very slightly flexiradiate, recalling the ribbing of *Goodhallites.* Costae are bifurcating except on the body chamber, where they are single and alternating, primary and secondary, the primary costae bearing pronounced umbilical tubercles and all costae bearing the double shoulder tubercle. The mid flank of the rib may swell, but hardly becomes a tubercle. The umbilical tubercle is nodate to slightly bullate, and the elements of the shoulder tubercle are clavate.

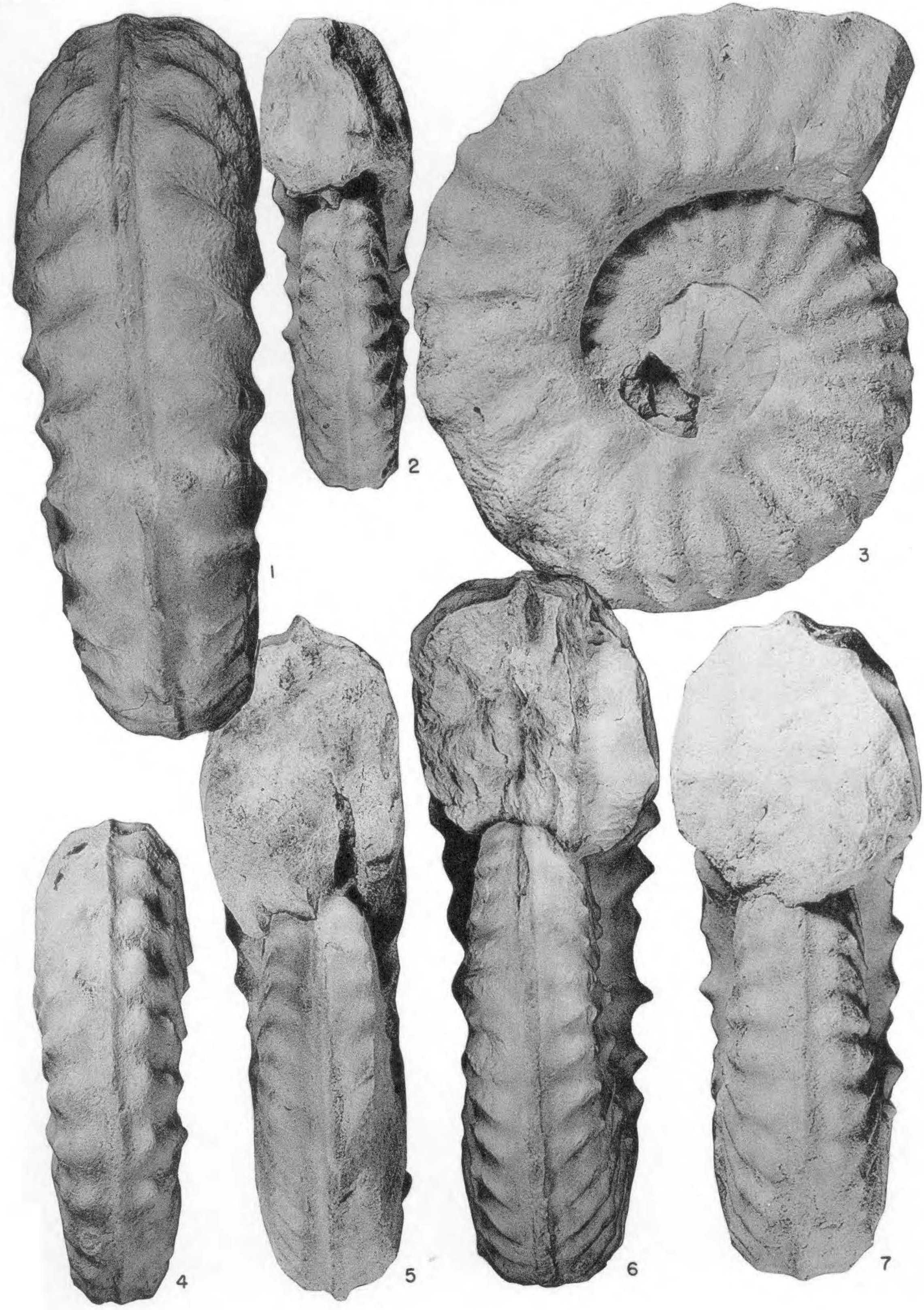
BEG 2391 is septate to 87 mm., which is the maximum diameter of the mold. BEG 18769 is septate to at least 86 mm., and BEG 20251 is septate to 92 mm. BEG 20251 is nearly complete, since the ribs become markedly prosiradiate at the apertural end. BEG 2391 has most of the body chamber destroyed. The overlap of one whorl over the preceding extends to just cover the dorsal element of the shoulder tubercle.

(See Measurements on page 29)

Observations.—*Drakeoceras lasswitzi,* n. sp., like *D. kummeli,* n. sp., differs from other species of the genus in retaining the goodhallitine appearance into the adult stages. In *D. kummeli* the ribs are more flexiradiate, less pronounced at mid flank, and the tubercles and papillae are a little sharper. *D. kummeli* is probably the direct progenitor of *D. lasswitzi.* The H/W ratio is greater in the former than in the latter. In both of these species the pronounced bifurcation at the umbilical tubercle does not continue

EXPLANATION OF PLATE 9

FIG. *1,6*—*Drakeoceras maximum* (Lasswitz, 1904), n. gen. Ventral views of cast of holotype, ×1. (p. 29)
2,4—*Drakeoceras arringtoni,* n. gen., n. sp. Ventral views of holotype, ×½; UT 10523. (p. 30)
3—*Drakeoceras georgetownense,* n. gen., n. sp. Ventral view of holotype, ×1; UT 863. (p. 27)
5—*Drakeoceras kummeli,* n. gen., n. sp. Ventral view of holotype, ×1; BEG 18727. (p. 21)
7—*Drakeoceras lasswitzi,* n. gen., n. sp. Ventral view, ×1; BEG 20251; collected from Bell Co., Texas, but horizon not designated. (p. 28)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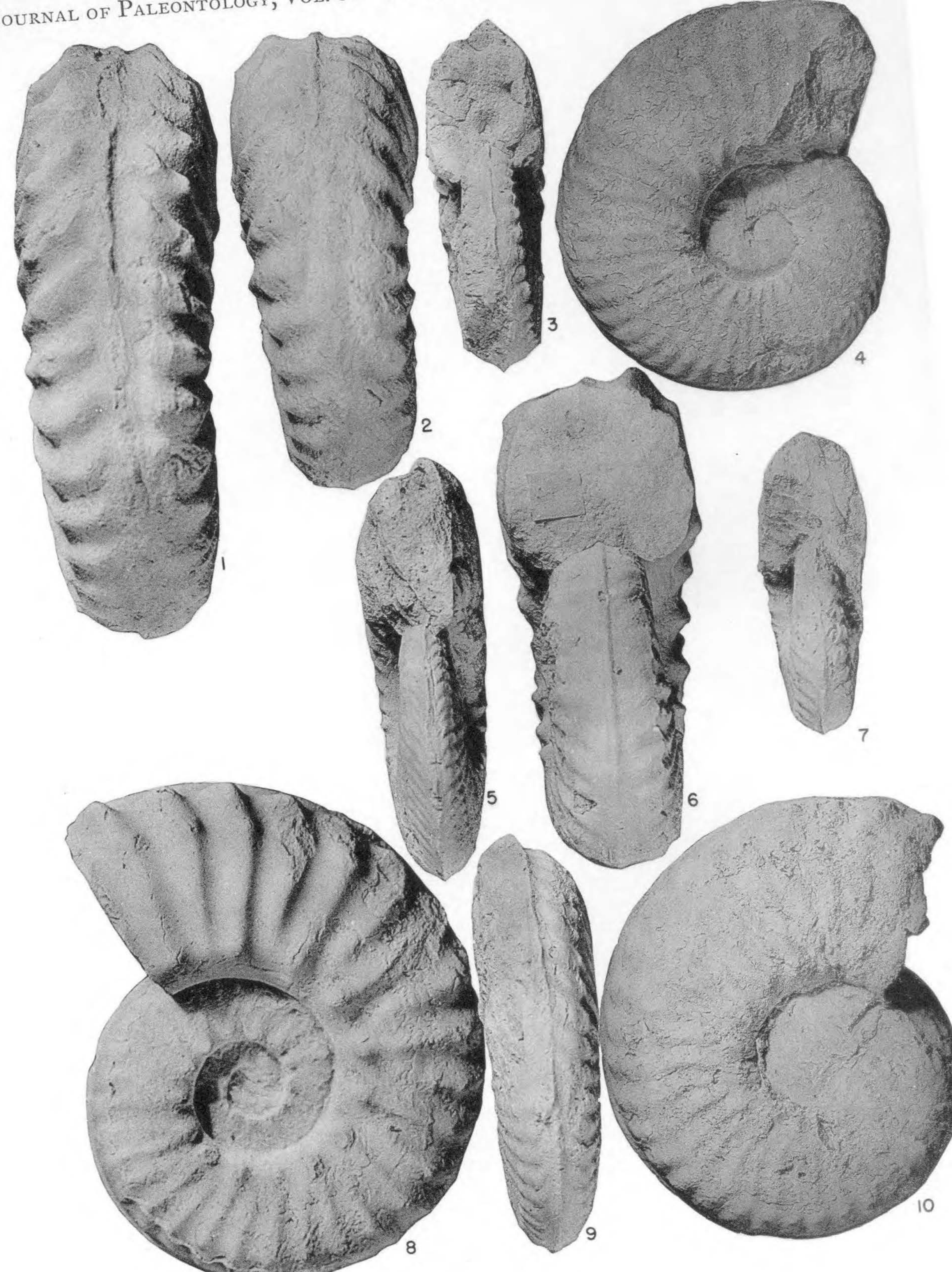
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Measurements

BEG 18769 (holotype)

100	35.0	38.5			27	2	3	11pr
75	32.0	38.5	35.5	1.09	29	1	2	13pr
50	32.0	38.0	36.0	1.06	27	1	2	12pr

BEG 2391

100	35.0	37.0	33.5	1.11	27	4	9	7pr
75	33.5	38.5	37.5	1.03				
50	35.0	42.0	42.0	1.00				

BEG 20251

134	35.5	33.5	31.5	1.06	29	12	11	3pr
100	34.0	38.0	35.0	1.08	30	5	7	9pr
75	33.5	41.5	37.5	1.10				

into the greater diameters (more than 100 mm) as in *D. maximum* (Lasswitz), and the costae do not have the marked prosiradiate flexure just ventrad of the umbilical tubercle that is so typical of *D. arringtoni,* n. sp. *D. arringtoni* and *D. maximum* are much larger species than any of the other species of the genus herein described.

Horizon and. localities.—Drakeoceras lasswitzi, n. sp., is known from Williamson, Bell, and Hill Counties, Texas. It ranges down a few feet into the zone of *Drakeoceras maximum* (Lasswitz) and ranges upward for some interval, which, as yet, is not known to overlap the range of *Mortoniceras wintoni.* At the present time it is proposed to call that interval between the zones of *Drakeoceras maximum* and *Mortoniceras wintoni* the zone of *Drakeoceras lasswitzi.*

DRAKEOCERAS MAXIMUM (Lasswitz, 1904)

Pl. 3, fig. 4; Pl. 9, fig. 1,6; Text–fig. 31

Schloenbachia konensis var. *maxima* LASSWITZ, 1904, Geol. and Pal. Abh., n. s. 6, pl. VI, fig. 2, text–fig. 5.

Pervinquieria maxima (Lasswitz). ADKINS, 1928, Univ. Texas Bull. 2838, p. 231 (pro parte), Pl. XIII, fig. 3.

Pervinquieria maxima (Lasswitz). ADKINS, 1933, Univ. Texas Bull. 3232, p. 363–371 (pro parte).

Holotype.—Adkins (1928) stated that the holotype was at the University of Breslau. A cast of the holotype is at the Bureau of Economic Geology, The University of Texas, Austin, Texas.

Specific characters.—Oligogyral, concentrumbilicate, gradumbilicate, sublatumbilicate, carinate; the whorl section is roughly subquadrate, tapering slightly ventrad, slightly higher than wide. The costation is moderately dense in the adult, with 32 ribs per volution at a diameter of 250 mm. in the holotype, increasing steadily and continually to 39 ribs per volution at a diameter of 100 mm. (rib density decreases with increasing diameter). Costae are very slightly prosiradiate to a diameter of 150 mm., rectiradiate on the body chamber, and the apertural part of the body whorl is absent on the holotype. The umbilical tubercle is pronounced and nodate to a diameter of 150 mm., becoming slightly bullate from that diameter on. The shoulder tubercles are more or less nodate at all diameters

EXPLANATION OF PLATE 10

FIG. *1,2,6,8,—Drakeoceras drakei,* n. gen., n. sp. *1,* ventral view, ×1; BEG 2451. *2,6,8,* lateral and ventral views of holotype ×1; BEG 20249, 10 to 15 feet below the top of the Main Street limestone, 2 mi. E of Belton, Bell Co.; collector: N. F. Drake, 1892. (p. 26)

3,7—Drakeoceras gabrielense, n. gen., n. sp. Ventral views of two juvenile specimens, ×1, *3,* BEG 3043A. *7,* UT 10127. (p. 22)

4,5,9,10—Drakeoceras dellense, n. gen., n. sp. *4,5,9,* lateral and ventral views, ×1; UT 10103, lower part of *Turrilites brazosensis* zone, Georgetown limestone, collected near Georgetown, Williamson Co., Texas, by Billy Walls, 1950. *10,* lateral view of individual transitional to *D. gabrielense,* n. sp., ×1; BEG 3043B, from Bell Co., horizon not designated. (p. 25) beyond 100 mm., and at a diameter of 200 mm. the ventral element of the shoulder tubercle becomes relatively less pronounced. The rectiradiate ribs thicken slightly and are convex laterad, but not sufficiently so to be termed tuberculate. On the body whorl the costae and intercostae are about the same width; prior to the body whorl the intersoctae slightly exceed the costae in width. The mid-flank laterad thickening of the ribs is easily visible on the costal whorl section, and this thickening seems only to be the result of the non-nodate part of the rib parallelling the rounded flank of the intercostal section. Costae bifurcate to a diameter of 200 mm. more or less. The keel is pronounced, higher than adjacent tubercles.

150 mm. the whorl section of *D. arringtoni* is higher, and bifurcation does not continue to as large a diameter. The ventral element of the shoulder tubercle becomes higher in the adult stage of *D. arringtoni,* whereas in *D. maximum* it becomes lower and more obscure; *D. arringtoni* also has a sharp flexure in the ribs just ventrad of the umbilical tubercle which is not present in *D. maximum.*

Horizon and locality.—According to Adkins (1933) the zone of *Drakeoceras maximum* (Lasswitz) occurs at a Fort Worth level above the zone of *Pervinquieria kiliani* (Lasswitz). Lasswitz's locality and age designation are in error as pointed out by Adkins (1928).

Measurements of holotype

237	38.0	35.0	31.0	1.12	32	10	6	8pr
200	40.0	36.5	31.0	1.17	34	5	5	12pr
150	38.0	37.5	33.5	1.12	36	0	6	15pr
100	33.0	34.0			39	0	9	15pr
75	32.5							
60	34.0							
50	33.0							

Observations.—Many separate forms have been assigned to this species and the synonomy given by Adkins (1928) lists some forms which have a coarse, mortonicerine juvenile stage not found in the genus *Drakeoceras* (e.g., Bullard, 1925, pl. 22, fig. 1). The data listed above under specific characters is taken largely from the cast of the holotype to augment Lasswitz's (1904) description and the further remarks by Adkins (1928).

Unlike most of Lasswitz's illustrations his flank view of *D. maximum* (1904, pl. 6, fig. 2) is extremely misleading, but shows the essential bifurcation at the umbilical tubercle to an advanced stage. Adkins's (1928, pl. 13, fig. 3) shows the double shoulder tubercle as only an oblique photograph can.

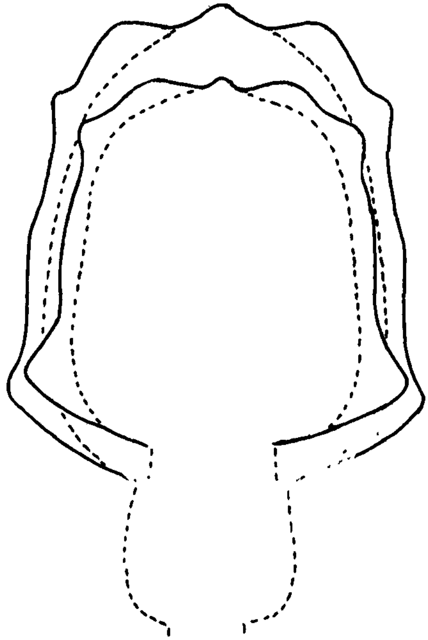
D. maximum (Lasswitz) is larger than *D. kummeli,* n. sp., *D. lasswitzi,* n. sp., and *D. drakei,* n. sp. The young forms of *D. maximum* show strong bifurcation at the umbilical tubercles to diameters greater than the adults of the above species ever attain. *D. arringtoni* is very close to *D. maximum* as is an undescribed species of the genus which occurs with *D. arringtoni.* At a diameter of

DRAKEOCERAS ARRINGTONI, n. sp.

Pl. 6, fig. 6; Pl. 9, fig. 2,4; Text–fig. 4

Holotype.—UT 10523, from low in the *Drakeoceras lasswitzi* zone, in an abandoned road metal pit on the Dedear Ranch, 0.3 mile east of U. S. highway 81, 3.0 miles north of the Brushy Creek bridge at Round Rock, Williamson County, Texas. Collector: D. E. Atchison, 1954.

Specific characters.—This species has all of the characters attributed to the genus. The whorl section is higher than wide, especially from a diameter of 100 mm. to greater diameters, and at a diameter of 150 mm. the H/W ratio is roughly 1.2. The flanks are slightly flattened, and the costal section shows a slight widening of the rib through mid flank, but not sufficiently to be called tuberculate. The flanks converge slightly ventrad. Gestation changes from goodhallitine to adult at a diameter of about 90 mm., and the change is more gradual than in other Texas species of the genus. Costae are narrower than intercostae; only on the last whorl do the costae lose all flexuosity and become rectiradiate. Costae are flex-



TEXT–FIG. 4—*Drakeoceras arringtoni,* n. gen., n. sp. Whorl sections, ×1, at 120 and 150 mm. diam.; UT 10523.

iradiate in earlier stages with a sharp prosiradiate flexure just ventrad of the umbilical tubercle. On the body chamber costae are single, alternating primary and secondary, rectiradiate.

The umbilical tubercles are nodate, to slightly bullate, the dorsal element of the shoulder tubercle is faintly clavate, and the ventral element is nodate. The ventral element is low and rounded up to a diameter of about 120 mm. whereafter it becomes more pronounced and higher until, at a diameter of 150 mm. it is elevated almost to the height of the keel. The species is evolute, the dorsal element of the shoulder tubercle being visible on the inner whorls.

Observations.—*Drakeoceras arringtoni,* n. sp., differs from *D. maximum* (Lasswitz) in its sharp prosiradiate flexure just ventrad of the umbilical tubercle, in its higher whorl section beyond diameters of 120 mm., in the greater development of the ventral element of the shoulder tubercle beyond a 120 mm. diameter, in the disappearance of bifurcation at an earlier diameter, and in the dorsal elements of the shoulder tubercles being visible on the inner whorls when the outer whorls are in place. It differs from *D. kummeli,* n. sp., and *D. lasswitzi,* n. sp., in the greater involution of these two species, and in the low rounded ventral elements of the shoulder tubercles prior to a diameter of 120 mm. in *D. arringtoni. D. kummeli* and *D. lasswitzi* do not have the sharp prosiradiate flexure just ventrad of the umbilical tubercle which is so typical of *D. arringtoni.*

Horizon and locality,—Drakeoceras arringtoni, n. sp., is known only from the zone of *Drakeoceras lasswitzi.* It probably does not extend upward into the zone of *Mortoniceras wintoni.* The species is known only from Williamson County, Texas.

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Measurements of holotype

160					28	10	10	4pr
150	35.5	36.0	30.5	1.19	32	8	8	8pr
100	33.0	40.5	32.0	1.26	36	3	5	15pr
75	35.0	45.5	37.5	1.22	36	0	0	18pr
60	34.0	36.0						
50	34.0	35.0						
40	32.5	37.5						
30	33.5	43.5						

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