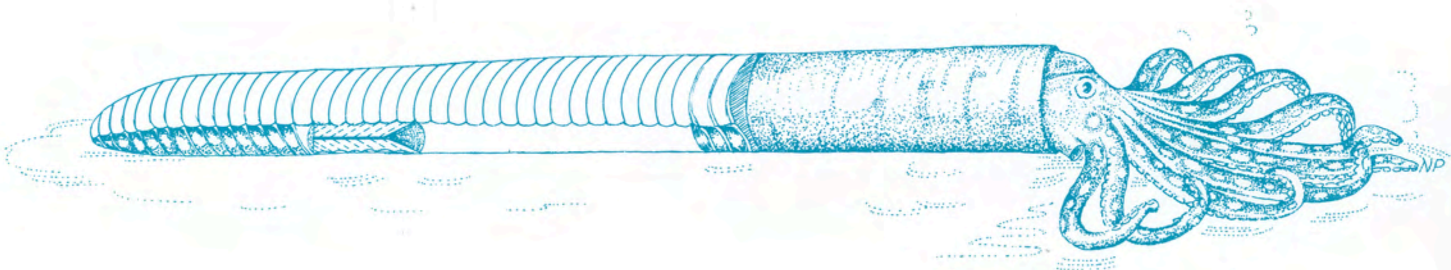
Part I —New American Wutinoceratidae with Review of Actinoceroid Occurrences in Eastern Hemisphere

and

Part II—Some Whiterock and Chazy Endoceroids

by ROUSSEAU H. FLOWER



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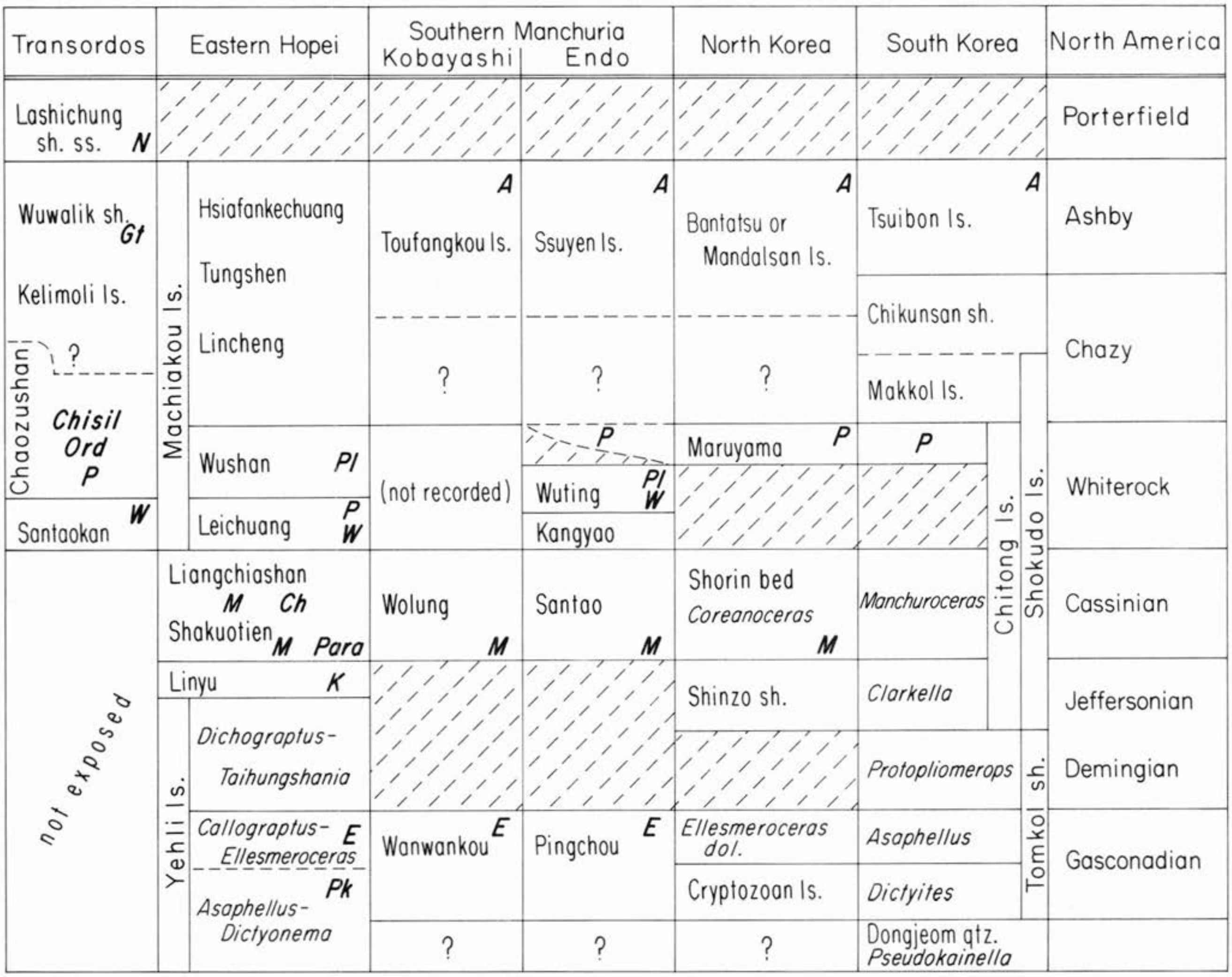

FIGURE 1—CORRELATIONS OF ORDOVICIAN WITHIN THE NORTH CHINA PLATE.

A.	*Aremoceras*	N.	*Nemagraptus*
Ch.	*Chihlioceras*	Ord.	*Ordosoceras*
Chisil.	*Chisiloceras*	P.	*Polydesmia*
E.	*Ellesmeroceras*	Para.	*Parapiloceras*
Gt.	*Glossograptus teretiusculus*	Pk.	*Protokaipingoceras*
K.	*Kaipingoceras*	Pl.	*Plectolites*
M.	*Manchuroceras*	W.	*Wutinoceras*

Part I—New American Wutinoceratidae with Review of Actinoceroid Occurrences in Eastern Hemisphere

ABSTRACT

New species of the Wutinoceratidae are described from upper Whiterock beds of Nevada, Oklahoma and Newfoundland. In North America the family is found only in late Whiterock beds. Occurrences in Asia, particularly eastern Asia are discussed. Some new reports seemingly conflict with the proposed sequence of 1) Polydesmia, 2) the Wutinoceratidae, and 3) more advanced actinoceroids including the Ormoceratidae, Armenoceratidae and Actinoceratidae. Some suggestions are made to the vexing problem of intercontinental correlation of Ordovician beds and cephalopod faunas.

INTRODUCTION

In a previous work the writer (Flower, 1968a) summarized the Wutinoceratidae then known, described some new forms, suggested that the Whiterock Stage is marked by the development of this family, and that it is in this interval that the Wutinoceratidae, the only Actinoceratida then developed, became nearly worldwide in distribution. Involved with this concept was the recognition of Whiterock equivalents in the Baltic region, in eastern Asia, and in Tasmania. No such occurrences are yet known in South America, but the Ordovician faunas known there are restricted.

The present work combines descriptions of some new Wutinoceratidae from North America, with some remarks on probable correlations of the strata from which they came, and an attempt to summarize some recent work elsewhere, mainly in eastern Asia.

ACKNOWLEDGMENTS

For some of the material described here I am indebted to Karl Waage and the Yale Peabody Museum of Natural History. The Geological Survey of Canada, through the kindness of Thomas Bolton loaned other material, notably the type of *Adamsoceras billingsi.* Reuben Ross of the U.S. Geological Survey submitted other material, including the type of *Wutinoceras reubeni.*

For discussion of stratigraphic and faunal problems, I am indebted to so many colleagues that I fear I may have omitted some, but I am particularly indebted to Teiichi Kobayashi of the Imperial University of Tokyo, Harry Whittington of the Sedgwick Museum of Cambridge, G. A. Cooper, Reuben Ross and Lehi Hintze of this country.

The investigation was supported by National Science Foundation Grant CB 6809. One result was an opportunity to examine a collection from "near fishing villages in Newfoundland" made in 1851 by the captain of the Frigate Cloud, and described by Barrande (1865-1877) in his monumental Système Silurien du Centre de la Bohéme, and preserved in the Musée National d'Histoire Naturel in Paris. The material was cited by Barrande as belonging to the collection of the Jardin des Plantes, to which the museum is adjacent. The collection contains several Wutinoceratidae and represents material completely of the Table Head Limestone. As this limestone is exposed only on the west coast of the Great Northern Peninsula, its geographic origin can be narrowed down to Table Point, Point Riche or exposures near Cook's Harbour. Probably it came from Point Riche, which lies just west of a good harbour at Port-au-Choix. A number of Barrande's species are junior synonyms of cephalopods described by Billings (1865) but not illustrated.

Walter Sweet read the manuscript and made many valuable suggestions; great help was supplied by Stephen Hook in making final corrections.

RANGES

NORTH AMERICA

Occurrences of the Wutinoceratidae in North America may be summarized as follows: Nevada—Wutinoceratidae are not uncommon in the Antelope Valley Limestone, but are known exclusively from the *Palliseria-Maclurites-Girvanella* zone, which seems from later observations to be a significant temporal unit rather than a magnafacies representing different parts of the Antelope Valley Limestone at different regions. The species now known are as follows: 1) from Ikes Canyon and the Toquima Range: *Wutinoceras lobiferum*, *W. planiseptatum*, *W. margaretae*, *W. huygenae*, *W. lowelli*, *Cyrtonybyoceras adamsi*, *Adamsoceras isabelae*, *A. gracile*, *A. attenuatum*, *A. toquimense;* 2) from the Hot Creek Range, *Wutinoceras reubeni;* and 3) from Meikeljohn Peak, *Adamsoceras leonardi.*

Western Utah has yielded only two described forms, *Adamsoceras lehmanense* from the Lehman limestone and *Wutinoceras davisi* from black shales, low zone N, high in the Kanosh Shale, or a black limestone in the Lehman limestone. Only fragments have been found subsequently; one consists of only two camerae of a fairly large form, apparently a *Wutinoceras* from the Lehman limstone.

Oklahoma had formerly yielded one Whiterock actinoceroid; two more are added. All are from the Oil Creek limestone:

Wutinoceras ulrichi (Foerste and Teichert)
Wutinoceras curviseptatum nov.
Cyrtonybyoceras oklahomae nov.

The Table Head Limestone of Newfoundland has yielded the following:

Wutinoceras logani Flower
W. *geronticum* nov.
W. *giganteum* nov.
Cyrtonybyoceras haesitans (Billings)
Cyrtonybyoceras barrandei (Teichert)
Cyrtonybyoceras curviseptatum Flower
Adamsoceras billingsi Flower
Adamsoceras transversum nov.

Interestingly, the actinoceroids in Utah and Nevada are confined to the upper part of the Whiterock Stage. In Nevada they are found in the *Palliseria* zone, in Utah in zone N, high Kanosh (?) and Lehman formations. In Oklahoma the known specimens are from the Oil Creek limestone and not from the underlying Joins Formation.

In Newfoundland the actinoceroids appear in the earliest cephalopod associations in the Table Head Limestone, only a few feet above its base, extend through the lower thick division L, of light-gray-weathering massive limestones, and continue on into the thinner bedded black limestones low in division M, and more sparingly into upper M, where trilobite-rich limestones alternate with black shale. Division N, consisting of black shales and siltstones, has yielded only graptolites and inarticulate brachiopods among its megafossils. It may be that the actinoceroids appear earlier in Newfoundland than in the Great Basin or in Oklahoma, but it may also be that the Table Head deposition began later than did the Whiterock in the Great Basin or in Oklahoma.

Two bits of evidence support this second interpretation. 1) Fâhraeus (1970) finds from the conodonts that the lower Table Head Limestone belongs in the zone of *Didymograptus bifidus.* This zone occurs in western Utah in the lower Kanosh shale, in zone M, and the earliest Whiterock is found in the underlying zone L, which contains a large fauna, but one largely undescribed. Recent field work has increased greatly the fauna as listed and described by Ross (1951) and Hintze (1951), and only part of the cephalopod fauna has been described (Flower, 1968b). 2) The St. George Group of Newfoundland embraces the entire Canadian system, beginning with the *Diphragmoceras* beds, containing a variety of early Canadian ellesmeroceroids, then vermicular dolomites with *Bassleroceras,* regarded as Middle Canadian, then a *Cryptozoan* reef and a gastropod-cephalopod fauna of Jeffersonian aspect, and next a Cassinian fauna with *Cassinoceras wortheni* which is further subdivisible into a lower *Teiichispira* horizon, then beds with the typical *Cassinoceras wortheni* fauna, and then limestones above with particularly large *Ceratopea.* Above are beds, mostly but not completely dolomites, Division I of Logan and Billings (see Schuchert and Dunbar, 1934). High in this sequence was found a small fauna with *Buttsoceras,* a genus indicative of latest Canadian age. We may thus conclude that the St. George deposition continued to the close of Canadian time. Subsequent uplift and erosion beveled the St. George surface to varying depths in various parts of Newfoundland. Near Lower Cove most if not all of division I is preserved as a dolomite. At The Gravels, the surface is eroded to the lower *Teiichisprira* zone below the main *Cassinoceras wortheni* fauna. Northeast of The Gravels, the top of the St. George is even lower, showing only the Jeffersonian fauna. For such uplift, warping and erosion, an appreciable time interval is required, and this interval is reasonably placed in early Whiterock time, zone L of Utah, rather than in the latest Canadian.

Recent field work (July 1971) has resulted in much more material of the Wutinoceratidae from the Table Head Limestone, but from field observations, no startlingly new forms have been found. If the Table Head occurrences belong in the *Didymograptus bifidus* zone, zone M of Utah, the occurrences are slightly older than the Utah-Nevada occurrences, which are confined to zone N.

EUROPE

In the Baltic region only two Wutinoceratidae have so far been found, *Adamsoceras holmi* (Troedsson) of the Kunda formation (Vaginatumkalk), and *A. oelandicum* (Troedsson) in the Aseri *(Platyurus)* Limestone.

An attempt to continue eastward is not profitable; it involves recent Russian papers, some of which are so poorly illustrated that the generic assignments cannot be evaluated, and some reports involve either anomalous mixing of genera elsewhere characteristic of distinct horizons, or else mixing of collections.

TASMANIA

Ordovician beds at Railton, Tasmania yielded *Wutinoceras paucicubiculatum* (Teichert and Glenister, 1953) and *Wutinoceras multicubiculatum* (Teichert and Glenister, 1953) and *Adamsoceras johnstoni* (Teichert and Glenister, 1953) from King Extended Hill, Zeehan, Tasmania. This is certainly distinct from the fauna described from Smelter's quarry at Zeehan, which has yielded *Hecatoceras, Tasmanoceras,* and *A naspyroceras* (Teichert and Glenister, 1953), and is probably late Mohawkian (Trenton, Barnevelt, and late Caradoc) in age.

EASTERN ASIA

Sections in eastern Asia are particularly important in relation to the development of the Actinoceratida, for it is only that region which has so far yielded *Polydesmia,* regarded as the oldest and most primitive of the Actinoceratida (Kobayashi, 1940). (See fig. 1)

Kobayashi (1931a, p. 152) summarized the cephalopod succession in eastern Asia as 1) the Wanwanian, the age of ellesmeroceroids equating with the Lower Canadian of North America, 2) the Wolungian, the age of piloceroids, equating with the Upper Canadian of North America, 3) the Toufangian, the age of actinoceroids, equating broadly with the Chazy through the Wilderness stages of North America.

Kobayashi (1931b) recognized two horizons in north Korea as Wolungian, the Shoiin bed, and the Maruyama bed, overlain by the Bantatsu bed. He subsequently (1940) concluded that the Maruyama bed, lying above the Shorn bed, which alone yielded piloceroids, notably *Coreanoceras* and *Manchuroceras,* should be better placed with the Toufangian.

Endo (1932) recognized a sequence in southern Manchuria of 1) the Santayo formation, of late Canadian age yielding *Manchuroceras, Penhsioceras* and *"Cameroceras,"* 2) the Kangyao formation which yielded a fauna largely of gastropods, mainly of the genus *Lophospira,* 3) the Wuting limestone, which yielded a small fauna largely of actinoceroids subsequently recognized as belonging to the Wutinoceratidae (Flower 1968a) and 4) the Ssuyen limestone, which yielded a cephalopod fauna with *Armenoceras, Ormoceras, "Cycloceras"* and *"Sactoceras"* which is reasonably equated with the Toufangian and Chazy to Black River faunas in North America.

In a subsequent work Endo (1935) added to the knowledge of these faunas and suggested that *Nybyoceras foerstei* might have come from the Ssuyen rather than from the Wuting limestone, inasmuch as the Ssuyen had yielded other species of *Nybyoceras.* It is now apparent that *Wutinoceras,* based on *Nybyoceras foerstei,* is a valid genus, distinct from *Nybyoceras,* and that this genus with *Adamsoceras* and *Cyrtonybyoceras,* the three constituting the Wutinoceratidae as emended by Flower (1968a), constitute a family characteristic of the Whiterock Stage.

Kobayashi (1940) in a study of *Polydesmia,* concluded that *Armenoceras elegans* Endo of the Ssuyen limestone belonged to that genus and that beds recognized as the basal Ssuyen limestone by Endo in 1932 may be equivalents of the Maruyama bed of Korea.

Kobayashi (1969, p. 176) notes that he and Endo had agreed that the Kangyao belongs above rather than below the Wuting, a conclusion which seems astonishing in view of the published sections of Endo (1932). The conclusion was partly influenced by similarity of gastropods of the Kangyao with those of the Ssuyen, as well as with faunas fairly high in the American Ordovician; Endo regarded the Kangyao as equivalent to the "Stones River beds, about Mosheim." Today this conclusion seems suspect. The writer has found similar gastropods, and *Lophospira* in particular, in the lowermost beds of the lower Table Head Limestone, and has observed some not dissimilar forms in the Whiterock beds in Utah and Nevada. Flower (1968a) has noted that two cephalopods of the Kangyao are somewhat anomalous; *Armenoceras nakaoi* and *A. nanum takayamai,* being anomalously small for actinoceroids, but showing siphuncles well filled with deposits. The Proteoceratidae may have siphuncles containing somewhat similar deposits, but we have no other indication of this family in beds older than the Chazy. *Spyroceras orientate* is, however, reasonably assigned to *Aethiosolen,* a Whiterock genus.

In the Wuting limestone *Cycloceras marginate* Endo (1932) is anomalous as an annulated shell showing subspherical siphuncle segments, but not showing cameral or siphonal deposits. No similar forms are known from beds of Whiterock age, but remotely similar siphuncle segments may be found in *Stereospyroceras* of the Chazy limestone. It has been pointed out earlier (Flower 1968a) that *Nybyoceras foerstei* is a *Wutinoceras,* being the type of the genus, and that *Armenoceras numatai* is reasonably a *Wutinoceras* allied to W. *minore*, and *Ormoceras manchuriense* is an *Adamsoceras. Plectoceras ohtakai* Endo belongs to the Whiterock genus *Plectolites.*

It is the belief of the writer that both the Kangyao and Wuting limestones belong in the Whiterock interval, as suggested further by the presence of an *Orthambonites (Orthis calligrama orthambonites)* in both formations. Endo (1932, 1935) has described *Hystricurus convexus* from the Kangyao formation and *H. granosus* from the Wuting formation. These appear to be hystricurids, though their precise generic position seems doubtful in view of later refinements of the genus (mainly Ross 1951, 1953) but it may be noted that the presence of such forms would suggest a Canadian rather than a Whiterock age.

It was hoped that the literature would present evidence of a sequence of 1) *Polydesmia,* in beds of Maruyama equivalence, 2) Wutinoceratidae in beds of Wuting and possibly upper Whiterock equivalence and 3) the more advanced and varied actinoceroid faunas of the Ssuyen limestone of Manchuria, the Makkol-Chikunsan-Tsuibon sequence of south Korea and the Bantatsu beds of north Korea, of probable Chazy-Wilderness equivalence.

Kobayashi (1969) has summarized some recent work in eastern Asia, involving some papers which I have been unable to obtain in this country, but it is essential to note that such work fails to support this expected sequence. True, error in generic identification may be involved, as well as errors in labeling, but without specimens or adequate illustrations, it is only possible to report the apparent anomalies, which are not confined to the actinoceroid faunas by any means.

Chang (1965) described two anomalous cephalopod faunas, one from Tatouyanggou and Shihuigou of the Qilianshan region, and another from Dongdayao, southwestern Yumen, Gansu Province. The former association yields from the upper part of the Tochuanshan (= Tuochuanshan or Duoquanshan) limestone *Wutinoceras shihuigouense, Ormoceras(?)* sp., *A rmenoceras* sp., *Pararmenoceras sp. 1, Pararmenoceras* sp. 2, *Cameroceras* sp., *Yehlioceras* sp. and *Manchuroceras tochuanshanense.* This is a seemingly mixed fauna containing Canadian (Wolungian) elements with *Wutinoceras* of Whiterock age and genera belonging in the Ssuyen-Makkol-Chikunsan-Tsuibon faunas, reasonably in the Chazy-Wilderness interval. However, the *Manchuroceras* is certainly not typical of that genus, the cross section of the endosiphuncle is subcircular rather than depressed. The *Yehlioceras* is based on a specimen insufficient to show the generic position. Illustrations are quite good, but all that can be said is that the generic assignments to *Wutinoceras, Ormoceras* and *Armenoceras* are reasonable. We regard *Pararmenoceras* as a synonym of *Armenoceras.* A second fauna from the Yingou Group of Gansu Province yields *Wutinoceras foerstei yensis, W. lui, W. lui dongdayaoensis, Polydesmia(?)* sp., *Armenoceras richthofeni* and *Linormoceras centrale var. minor.* Here are apparently in association forms of the Maruyama bed, the Wuting and the overlying faunas with more advanced actinoceroids. The *Polydesmia* is not, however, typical. From the illustrations, the assignment of the species to *Wutinoceras* is reasonable, and unquestionably there are also forms in this association with simple horizontal canals more typical of post-Wuting faunas.

Kobayashi, (1969, p. 190-192) reports further descriptions mainly by Chang, of discoveries in the Trans-Ordos region in which an even greater anomaly appears. Here, the basal unit, the Santaokan sandstone and limestone yields *Wutinoceras lui*. The overlying Chaotsushan limestone contains three zones, of which the lower one yields three new species of *Polydesmia*. The second yields six new species of *Ordosoceras*, and the third yields species attributed to *Chisiloceras*, *Vaginoceras*, *Polygrammoceras* and *Michelinoceras*.

The uppermost of these three faunas is of interest inasmuch as its fauna suggests that of the Orthoceras limestone faunas of central China described by Yu (1930). In modern terminology the fauna is that of the Kuniutan limestone, the *Sinoceras rude* zone. The correlation of the central China faunas is more thoroughly discussed in the paper following this one in the present volume.

In view of recent work summarized by Kobayashi (1969) we may venture the opinions that 1) *Wutinoceras* precedes *Polydesmia* in the Trans-Ordos region, 2) in eastern Hopei, in the Leichuang formation, there is a lower *Wutinoceras* zone, succeeded by a zone containing both *Wutinoceras* and *Polydesmia*, and that the succeeding Wushan limestone contains *Plectolites ohtakai*, originally described from the Wuting limestone.

The evidence suggests that *Polydesmia* may follow rather than precede *Wutinoceras* in terms of the first appearances of the respective genera. If this is true, it is reasonable that *Polydesmia elegans* (Endo) may represent a remnant of the Maruyama bed which lies between the Wuting limestone and the Ssuyen limestone proper, from which at the time it had not been distinguished in southern Manchuria.

NOTES ON POLYDESMIA

Polydesmia has been regarded as the oldest and quite possibly the most primitive of the actinoceroids (Kobayashi 1940, Flower 1957, 1968a). Kobayashi (1940) regarded its siphuncle as holochoanitic; we would claim instead that it had a thick connecting ring that was easily mistaken for a continuation of the septal neck. Its siphuncle is large, the segments short. Annuli develop but instead of growing as symmetrical doughnut-like rings, they form lobes extending forward for the length of one to one and a half siphuncle segments. Flower (1968a) regarded the radial canals as dendritic, dividing many times as they are traced from the center to the margin, and showing as continuous dark lines in every cross section. A contrary interpretation has claimed that the canals slope strongly apicad from the central canal to the siphuncle periphery; such bands mark the juncture of the annular deposits of the siphuncle; were they the sole course of the radial canals the canals would necessarily show in cross section only as dots or small circles arranged in a circle, as in Kobayashi 1940, pl. 5, fig. 18. There the canals do form such a pattern, but continuous canals are shown in numerous other sections, notably Kobayashi 1940, pl. 4, figs. 21, 22, 25, 27, 29, 30 and pl. 5, fig. 19.

Flower (1968a) suggested that *Polydesmia* was primitive in the thick connecting rings and the dendritic radial canals. He further suggested that if the ring of *Bathmoceras* were to be so altered as to produce first a marginal initial part, and later the growth forward of thickened lobes largely filling the siphuncle cavity, that the pattern of *Polydesmia* could be produced. Further, the sinuate outline of the siphuncle segments of *Bathmoceras* could be construed as the beginning of the expanded segments of *Polydesmia*. It now seems necessary to abandon this concept without being able to propose any other theoretical ancestor of the actinoceroids. As outlined above, new stratigraphic evidence indicates that while *Polydesmia* and Wutinoceratidae may occur together, as in eastern Hopei, *Polydesmia* follows the Wutinoceratidae in the Trans-Ordos section. In Manchuria or Korea *Polydesmia* does not precede the Wutinoceratidae, but Endo's *Polydesmia elegans* from the lower Ssuyen limestone may indicate that a thinning edge of the Maruyama bed may have been included in the Ssuyen, lying above the Wuting limestone.

Reports of *Bathmoceras* as from beds of "Arenig" age have been interpreted as meaning Canadian by various writers including the author. The main European occurrences are in beds of Whiterock age, the Kunda of the Baltic and the Sarka beds of Bohemia. The Kunda is also the source of an *Adamsoceras*. While the Kunda has been placed in the "Lower Ordovician" Ontikan stage, it is equivalent to the British Llanvirn, long considered the base of the Middle Ordovician. Considerable evidence now exists indicating that the Kunda and Sarka are equivalent to the lower Table Head, the Joins of Oklahoma and zone M in the lower Kanosh Shale of western Utah and to the lower part of the Swan Peak Quartzite in northern Utah. *B. norvegicum* Sweet (1958) in the cephalopod shale of Norway is younger than the Kunda-Sarka occurrences, in beds possibly as young as the Chazyan; it is exogastric, not straight as are the other forms, and taxonomy might be simplified by the erection of a separate genus for it. Teichert (1939) described a species from the Arenig of Australia harder to evaluate in the absence of knowledge of associated faunas. Reports of *Bathmoceras* from the Tremadoc of South America rest upon specimens which are not true *Bathmoceras*, but a new genus. *Bathmoceras* has also been listed from the *Yangtzeella poloi* beds of central China, a fauna difficult to evaluate from the extant published evidence. The dominant cephalopods are endoceroids, with michelinoceroids and Baltoceratidae, containing a mixture of genera of late Canadian aspect *(as Thylacoceras* and *Manchuroceras)* with others more suggestive of the fauna of the Volkhov of the Baltic, which the writer would place in the lower Whiterock. However, this *Bathmoceras* cannot be evaluated until it is illustrated and described.

Morphologically, *Bathmoceras* presents two anomalies when it is considered an ancestor of the actinoceroids. First, its siphuncle is in broad contact with the venter; in *Polydesmia* the siphuncle is sub-central; in the Wutinoceratidae it is ventrad of the center but, more commonly than not, well removed from the venter. Second, a feature generally overlooked in *Bathmoceras* (described by Holm 1885) is the presence of fine thin diaphragms between the forward-projecting lobes of the connecting rings, such diaphragms are confined to the dorsal side of the siphuncle. Such diaphragms are unknown in the actinoceroids or, for that matter, in any other group of the cephalopods.

Vexingly, in spite of the subcentral siphuncle and our failure to recognize any *Polydesmia* older than the supposedly more advanced Wutinoceratidae, the thick rings and dendritic canals are certainly primitive actinoceroid features, which are not found in younger forms.

Ordosoceras Chang is a somewhat puzzling genus, known only from the Trans-Ordos region. Like *Polydesmia* it shows dark bands in the siphuncle extending obliquely forward from the margin to the central canal, but it is not evident whether these oblique dark bands are junctures of forward-projecting annuli or radial canals. However, it does suggest the intriguing possibility that it may be a descendant of *Polydesmia* and also the ancestor of *Actinoceras,* in which relatively simple radial canals form oblique lines extending slightly forward from the perispatium to the central canal, but in which annuli have become simpler in form.

FAMILY WUTINOCERATIDAE

Shimizu and Obata 1936, emend
Flower 1968

The revised concept of this family (Flower, 1968a) has nothing in common with the original definition; the family name, however, has priority over any possible later proposal. As revised, the Wutinoceratidae are recognized by the combination of thick rings within which there is textural differentiation of the ends from the middle, and the reticular canal system. Siphuncle segments vary in outline from those resembling *Nybyoceras* to those resembling *Ormoceras.* It has been found that there is variation in outline of siphuncle segments in short intervals in one individual, making impossible generic refinements based on details of the form of the siphuncle segments. To Shimizu and Obata (1936) the family was characterized by "armenoceroid siphuncular segments," with "ormoceratoid septal necks" and septa contacted asymmetrically with "both dorsal and ventral segments." Aside from *Wutinoceras,* Shimizu and Obata placed in this family two new genera. Of these, *Shantungoceras,* based upon *Armenoceras tateiwai* Kobayashi, shows brims largely free, but joining the septa at their tips. Dorsoventral differentiation in the form of the segments is not clear. The species is distinctive in that the septa appear straight rather than curved in section, and must have been essentially conical rather than sections of spheres or ellipsoids. *Pararmenoceras,* based on *Armenoceras penhsiense* Endo, is a somewhat ambiguous form, as the radial canal system is not clearly shown. Teichert (in Teichert and others, 1964) placed both genera as synonyms of *Nybyoceras.* We regard this as essentially correct.

DESCRIPTIONS OF SPECIES

Genera are not discussed here; the new material requires no revision of the generic discussion supplied in Flower 1968a.

Wutinoceras curviseptatum, n. sp.

Pl. 1, figs. 7-11

This species is known from a fragment 65 mm long, containing six camerae. The septum at the base is bent strongly forward on the venter, with a depth of curvature of 21 mm, while on the dorsum the depth is 17 mm, and 15 mm laterally. The section increases from 90 and 51 mm to 100 and 65 mm. At the base the siphuncle is 21 mm across, 7 mm from the venter, 30 mm from the dorsum; adorally it is 22 mm across, 8 mm from the venter, 35 mm from the dorsum. The dorsum is broad, gently convex, curvature increases around the sides, curvature diminishing on ventrolateral faces, and strongly convex over the midventer. Sutures are transverse over most of the dorsum, then slope markedly forward laterally, and are again transverse, but only farther orad, on the venter.

A section was made which is slightly inclined from the vertical plane through the siphuncle. It shows a septal formula (see Flower 1968a, p. 6) of 16/7/14: 10/19/33; 9. The camerae, 9 mm in length are subequal throughout the species. Septal necks are recumbent dorsally, narrowly free ventrally, but the tips touch the septa ventrally; dorsally the necks are broadly adnate. The area of adnation is long ventrally, vestigial dorsally.

DISCUSSION—The proportions of the species are characteristic; particularly the subtriangular cross section, with a narrowly rounded venter and faintly convex ventrolateral faces, and also the remarkable forward extension of the septa on the venter. Other species of *Wutinoceras* show a more evenly rounded cross section, and a similar marked extension of the septa forward on the venter is not known. There is a superficial similarity between the cross section of this form and that attained at late maturity in *Cyrtobynoceras haesitans,* in the narrow rounding of the venter, but the cross section of our form is broader, and the departure from an evenly rounded section is more extreme.

TYPE AND OCCURRENCE—Holotype, USNM no. 166171 from 500 feet above the base of the Oil Creek Limestone, on highway 77, in the Arbuckle Mountains, SE1/4SE1/4 sec. 24, T. 23 N., R. 1 E., Carter Co., Oklahoma.

Wutinoceras reubeni, n. sp.

Pl. 3, figs. 1-11

Wutinoceras huygenae Flower (determination) in Ross, 1970, U.S. Geol. Surv. Prof. Paper 639, p. 18, 20.

This is a straight *Wutinoceras,* in which the width increases more rapidly orad than the height. In vertical section the rather small siphuncle and septa, quite flat dorsad of the siphuncle until they slope suddenly forward on the dorsal fifth or sixth of the shell, give it very much the aspect of *Wutinoceras huygenae,* with which I had, as noted in the synonomy above, identified it, but the species differs from W. *huygenae* particularly in that the septa are here shallowly instead of deeply curved laterally, and while there is a low ventral lobe, there is no prominent dorsal lobe as in W. *huygenae.*

The type is a portion of a phragmocone 105 mm long, expanding from 24 and 28 mm to 32 and 42 mm. The ends were retained to show the cross sections, and a middle interval with a length of 80 mm was sectioned vertically. Camerae are spaced six in a length equal to the adoral width apically, and a little more than seven occur in similar adoral length. About five camerae occur in a length equal to the adoral height. The exterior, weathered to such an extent as to suggest etching, shows a shallow ventral lobe, apparent in the ventral half of the shell in lateral view, but sutures are straight and transverse dorsally.

The venter is incomplete from weathering but the section shows a siphonal formula of 7(e)/3.5/19:4(e)/10.5/16; 6 apically, and 6/4.5/19:3/10.5/22 adorally. Necks are free ventrally, varying from narrowly free to recumbent dorsally. There is a large central canal, and reticular tubes leave each segment at two regions, one anterior, one posterior. Hyposeptal deposits are thicker, more advanced in growth, and more prominent than episeptal deposits. Adorally the shell is 42 mm wide, 31 mm high, with the siphuncle 4 mm from the venter, 6 mm across the septal foramen and 22 mm from the dorsum.

DISCUSSION—As noted above the shallow septa, the absence of strong horizontal curvature or of a dorsal lobe, distinguish this from W. *huygenae* with which I had at first misidentified it. Both species show siphuncles of somewhat similar size and proportions and vertical sections quite similar in aspect, particularly in the flattening of the septa for some distance dorsad of the siphuncle.

TYPE AND OCCURRENCE—Holotype, US National Museum, no. 166172 from 251 feet below the top of the Antelope Valley Limestone and 139 feet above a lower sandstone layer within it, associated with *Girvanella* and *Anomalorthis*, from the Hot Creek Range, Nevada, USGS locality D1855-CO. Collected by Dr. Reuben Ross. I have what appears to be this species at the top of the *Palliseria*-*Girvanella* beds of the Antelope Valley Limestone from Frenchman's Flats, Nevada.

Wutinoceras giganteum, n. sp.

Pl. 2, fig. 4, Pl. 3, fig. 12;
Pl. 4, figs. 1-2, Pl. 5, fig. 6

This is a large *Wutinoceras* of the Table Head Limestone, similar in gross aspect to W. *logani*, but where the siphuncle is consistently close to the venter in that species, in this one it is only slightly ventrad of the center. The holotype (Pl. 5, fig. 6) is a phragmocone 482 mm long, rather rapidly expanding initially, then slender. The anterior part is crushed. The basal part consists of five camerae expanding from a width of 35 mm and a height of 30 mm to 40 and 45 mm, 45 mm in length. The next part, with a maximum length of 100 mm, and with one dorsolateral side lost by weathering, expands to a width of 60 mm and an estimated height of 55 mm. Adorally the siphonal formula is 15/15/24(e): 12/36/28(e); 9. The siphuncle is of the *Nybyoceras* type; ventrally brims are free and there is a long area of adnation; on the dorsum, brims vary from recumbent to hooked, touching the septa only at their tip, or free. A large central canal and complex reticular radial canals are evident. At the adoral end a septum shows a siphuncle 12 mm high at the septal foramen, 17 mm from the venter and 30 mm from the dorsum. The septum is evenly curved, and the sutures are evidently straight and transverse or nearly so. The adoral part, 350 mm long, expands from 55 and 65 mm at the base to a crushed width of 140 mm. Adoral camerae shorten from 14 to 9 mm, suggesting that the specimen ap proaches and perhaps attains the anterior end of a mature phragmocone. Reasonably, the living chamber would have occupied another 150 to 300 mm of shell length.

A paratype (Pl. 4, figs. 1, 2) is a portion of a phragmocone 200 mm in length, expanding from a width of 50 and an estimated height of 48 mm to a width of 86 mm. Eighteen camerae are preserved, increasing in length from 10 to 14 mm; adorally four camerae occupy a length equal to the adoral shell width. Siphuncle segments are similar to those of the holotype. Basally the septal foramen is 12 mm across, 25 mm from one side, the dorsum, and 15 mm from the other. Adorally the siphuncle becomes more central, but weathering of the venter makes accurate measurement impossible. The septal surface is quite evenly curved; the dorsal side shows sutures which are nearly transverse; broad indistinct saddles are quite possibly a result of distortion. The internal mold shows faint low longitudinal ridges, 4 mm wide, with concave spaces 2-3 mm wide between, of such faint relief as to almost defy photography.

DISCUSSION—This large *Wutinoceras* could be confused with the associated W. *logani,* but is distinguished by the much more nearly central position of the siphuncle.

TYPES AND OCCURRENCES—Holotype Yale Peabody Museum no. 28351, paratype, no. 28352, both from the lower part of the Table Head Limestone, the holotype from Table Head, the paratype from Point Riche, along the shore north and east from the Lighthouse there.

Wutinoceras geronticum, n. sp.

Pl. 3, fig. 13; Pl. 5, fig. 1

This is *a Wutinoceras* in which a series of camerae of moderate length is followed by a long series of markedly shorter ones. The type is a shell weathered from the ventral side, and weathered below the level of the siphuncle in the apical two thirds of its length. Initial expansion is exaggerated in the type, as apically the shell is weathered below the middle, thus increasing the apparent rate of expansion. The shell increases in width from 30 mm to 40 mm in the basal 30 mm, to 45 mm in the next 50 mm, and to 65 in the adoral 100 mm; a rate of expansion of 10 mm in 50 mm is reasonable. The specimen does not suggest that the apical end represents a part close to a blunt apex. The first nine camerae increase in length from 9 to 11 mm; beyond this point there are 12 more camerae that are markedly shorter, averaging 6 mm in length but varying from 5 to 7 mm in length. The horizontal weathered surface shows episeptal and hyposeptal deposits which thin only slightly in the anterior five camerae; orad of this part there is a short length of living chamber. The dorsal surface shows sutures which are nearly transverse and laterally only slightly inclined dorsorad. The weathered surface shows the siphuncle in only the anterior seven camerae, with part of the deposit extending forward in the last segment, indicating that the adoral aseptate part is not a true living chamber, but suffers from the destruction of anterior septa. A segment expands horizontally from 6 to 16 mm and is 5 mm long. Necks develop long brims; some are adnate, others are hookshaped, enclosing small cameral areas before their tips join the septa. The area of adnation is marked.

DISCUSSION—The type of this species does not permit detailed analysis of the proportions of the siphuncle segments; there is not enough of the siphuncle that a vertical section would produce significant measurements. The species is set apart from all others by the development of camerae first of moderate length, and then, at a shell width of 45 mm, a series of much shorter camerae. Adorally nine to ten camerae occur in a length equal to the adoral shell width; apically five to five and a half occupy a similar interval. The shell is obviously depressed in section, but it is unknown *whether* the venter is flattened or narrowly rounded. The siphuncle is well ventrad of the center, but its proximity to the venter cannot be determined. The shell shows a cross section which is obviously depressed, the dorsum broadly convex, the sides more strongly rounded.

TYPE AND OCCURRENCE—Holotype, Yale Peabody Museum no. 28354 from the lower Table Head Limestone, Table Head, Newfoundland locality 3100/12.

Cyrtonybyoceras oklahomae, n. sp.
Pl. 1, figs. 1-6

Of this form the only known specimen consists of 71 mm of phragmocone, expanding from 40 and 33 mm to 50 and 45 mm and showing a section higher than wide, and more narrowly rounded ventrally than dorsally. At the anterior end the septal foramen is small, 5 mm in diameter, and only 5 mm from the venter. The shell shows a profile which, in spite of irregularities from weathering, indicates that the venter is faintly convex and the dorsum faintly concave. Siphuncle segments are broad and broadly expanded, with a broad area of adnation on the ventral side; the necks are free ventrally, but on the dorsum they are recumbent apically, somewhat irregular from segment to segment, a few are hooked, the tip of the neck joining the septum and enclosing a small space, but adorally they are free. The siphonal formula is 4/5/32:1/13/30; 8 apically and 1/15/32:5/6/36; 10 adorally. Sutures are straight and transverse. The fragment contains nine camerae ranging rather irregularly in length from 7 to 9 mm, with the last 7 mm, which may represent the adoral shortening of camerae near the base of the mature living chamber. Septa are shallow, the curvature generally $^{3}/4$ the length of a camera, slightly irregular in the vertical plane, and turning forward rather abruptly in the dorsal third of the shell.

Canals are imperfectly shown in the siphuncle, but it is evident that two series extend out from the central canal, one set anterior, the other posterior. Clear evidence of the usual reticular structure is wanting.

DISCUSSION—This species is distinctive in a very slender form and a siphuncle with a rather small septal foramen very close to the venter. *C. haesitans is* a much more rapidly expanding species in which the siphuncle is very close to the venter only in the early stages, and *C. curviseptatum* has a siphuncle more removed from the venter and deeply curved septa. *C. adamsi* has septa rather abruptly bent forward in the dorsal third, but otherwise relatively slightly curved, but its siphuncle is more removed from the venter and the shell is more rapidly expanding.

TYPE AND OCCURRENCE—Holotype, Geology Department, Univ. of Oklahoma, no. 64, from the upper part of the Oil Creek formation, 80 rods north of Fall Creek, southwest of Davis, Oklahoma.

Adamsoceras billingsi Flower, 1957
Pl. 2, figs. 1-3; Pl. 5, *fig.* 4

Ormoceras cf. allumettense Teichert, 1933, Palaeontographica, Bd. 78, Abt. A., pl. 9, fig. 6.
Adamsoceras billingsi Flower, 1957, New Mexico Bureau Mines and Mineral Resources, Mem. 2, p. 25.
(not *Adamsoceras billingsi* Flower 1968, New Mexico Bureau Mines and Mineral Resources, Mem. 10, pl. 14, figs. 1-7)

The type of this species (Pl. 2, fig. 1) is a phragmocone 255 mm long, straight over most of its length, though with the venter faintly convex in the first 40 mm, expanding from an estimated 34 mm with a width which is slightly greater, to 45 and 48 mm in the first 110 mm, and to an ultimate adoral width of 60 mm, with a height, not preserved, but evidently slightly less. Sutures slope gently orad from venter to dorsum; the septum, gently and evenly curved, has the siphuncle at the point of its greatest depth. Owing to the obliquity of the septum, its depth is a little more than twice as great on the dorsum as on the venter. The siphuncle is small, like that of *Ormoceras* in outline of segments, and is appreciably removed from the venter. Camerae vary somewhat irregularly in length, averaging 7 mm apically, where there are five camerae in a length equal to the adoral shell height, to a maximum of 14 mm, where the shell width is 51 mm, decreasing adorally to a length of 10 mm in at least the adoral eight camerae of the type; there is no such marked adoral shortening of the camerae shown as is normally associated with maturity, and the mature phragmocone must have extended some further distance forward.

The apical part of the phragmocone has been sectioned vertically, and one sectioned surface is sagittal, judging from the clarity of the central canal. Apically the siphonal formula is 12/6/22e: 10/11/17e; 7 and adorally it is 14/6/25: 8/13/23; 9-10. The sectional surface shows segments subspherical, but with the adoral segments attaining a diameter of 14 mm with a length of only 9-10 mm, but with necks free on both dorsum and venter, and with no area of adnation on the dorsum, with the apical end of the ring in contact with or narrowly free from the septum for a length equal to the extent of the ventral brim. Cameral deposits are somewhat obscured by adventitious calcite, but are plainly wanting dorsad of the siphuncle. On the venter, curiously, hyposeptal deposits, though thin over the considerable series of camerae, extend farther forward in the phragmocone than do the episeptal deposits, which, as usual, extend along the free part of the septa and over the mural parts as well. Our sectioned surface shows only faint adapical increase in thickness of these deposits. Within the siphuncle there is a large central canal; radial canals are reticular. Siphonal deposits leave the siphuncle segments filled not only in the early sectioned part, but also, as nearly as can be judged, to the anterior limit of the specimen. Near the adoral end a break on the ventral side of the shell exposes some such segments of the siphuncle, but the broken surface is not clear enough to show details of the shape of the segments. They appear to be somewhat less broadly expanded than those of the earlier part of the shell.

DISCUSSION—This is an *Adamsoceras* in which the siphuncle is quite well removed from the venter throughout the known portion, the septa are more distant than those of *A. isabelae,* somewhat more widely spaced, and the siphuncle is more removed from the venter. The specimen described by me (Flower, 1968, p. 14, pl. 14, figs. 1-7) as *A. billingsi* proves, when the type of *A. billingsi* was studied, to be a distinct species, one in which the siphuncle is closer to the venter, its segments somewhat more elongate and less expanded in parts of commensurate shell diameters, and in which the septa are not strongly inclined forward from venter to dorsum, and the sutures are essentially transverse. It is here renamed *A damsoceras transversum.*

A. lehmanense is a small form, with a small rather broadly expanded siphuncle close to the venter. *A. toquimense* has transverse sutures like *A. transversum,* but a much larger siphuncle closer to the venter. *A. gracile is* a nearly tubular shell in which septa are closer; their greatest depth lies at the center of the shell rather than at the location of the siphuncle: the siphuncle segments are well removed from the venter in the young and rather broad; anteriorly the siphuncle is more ventrally located and the segments are less expanded. *A. billingsi* agrees in having adoral siphuncle segments less expanded than is usual, but the siphuncle is well removed from the venter anteriorly. *A. attenuatum,* known only from a relatively late growth stage of a phragmocone, has long camerae like those of ***A.*** *billingsi,* but is faintly exogastric, segments are more slender, and the forward slope of sutures on the dorsum is relatively slight. *A. leonardi* has closer septa, and broader siphuncle segments closer to the venter. Few matters present greater perplexities or more tiresome measurements than specific comparison among the cephalopods, and more particularly, the actinoceroids, where it has been demonstrated that proportions supply the essential criteria, but that proportions may vary markedly in the length of the phragmocone, a matter most difficult to apply in species particularly when so much comparison must be based upon fragmentary materials. The ever-present temptation to base species upon associations has, of course, much validity, but my assumption that the Table Head yields only one *Adamsoceras,* and my subsequent redefinition of *A. billingsi* must be rejected.

It may be noted here also that the Yale Peabody Museum material from the Table Head includes one *Adamsoceras* that is apparently different from both *A. billingsi* and *A. transversum.* It is not adequately known from the one specimen available, but has a small siphuncle very close to the venter.

HOLOTYPE—Geological Survey of Canada, no. 620a, b, from the Table Head Limestone, Point Riche, Newfoundland.

Adamsoceras transversum, n. sp.
Pl. 5, figs. 2, 3, 5

Adamsoceras billingsi Flower, 1968, New Mexico **Bureau** Mines and Mineral Resources, Mem. 19, p. 14, pl. 14, figs. 1-7.

The holotype of this species was figured and ***described*** by the writer as *Adamsoceras billingsi.* Examination of the type of that species shows some differences, and our specimen cannot be conspecific. Most notable of the differences are 1) in true *A. billingsi* the siphuncle is well removed from the venter, 2) sutures of *A. billingsi* slope forward from venter to dorsum, 3) septa in ***A.*** *billingsi* have their greatest depth of curvature at the siphuncle; in the present form the siphuncle lies ventrad of the greatest depth of the septum which, in vertical section, seems almost symmetrical in curvature.

The description of the holotype need not be repeated here. The septa are transverse, the depth of the septum may exceed the length of a camera slightly, though there is wide variation in the length of the camerae, from 6 mm near the apical end where the shell width is 38 mm, to 13 mm adorally where the shell width is 46 mm; the adoral increase in length of the camerae is, however, rather irregular.

PARATYPE—This is a fragment of a phragmocone 216 mm long, showing a surface weathered from the ventral side, and with one side incomplete over the adoral 60 mm. The base is somewhat obscure, but suggests fairly rapid shell expansion in the first 30 mm from a shell width of 30 mm to one of 37 mm. In the next 130 mm the width becomes 50 mm. Septa are moderately well curved. Camerae, 11 mm long at the base, increase adorally to 13-14 mm, with little erratic variation in length. A longitudinal horizontal section (pl. 5, fig. 3) was cut through the siphuncle at the base of the specimen, showing segments of the *Ormoceras* type, 12.5 mm long expanding from 6 to 12 mm, and similar in aspect to those of the holotype as seen in vertical section in outline. A cross section was cut slightly farther orad (pl. 5, fig. 5) showing a shell 37 mm wide, 32 mm high, with the venter incomplete; the height is reasonably restored as 34 mm. Anterior of the apical part the shell is slender, and the restored anterior width is only 55 mm.

TYPE AND OCCURRENCE—Holotype, Museum of Comparative Zoology, Harvard University; paratype Yale Peabody Museum no. 28353, from the lower Table Head Limestone at Point Riche, Newfoundland.

Part II—Some Whiterock and Chazy Endoceroids

ABSTRACT

The abundant orthocones of the Whiterock, and some in the later Canadian and Chazyan, show ventral siphuncles, depressed sections and ventral lobes; such forms include genera of the Endoceratida and also some assigned to the Baltoceratidae.

Endoceroid phylogeny and classification are discussed; noting the probable derivation of the Thy-Iacoceratidae from the Proterocameroceratidae, the problem of the origin and homogeneity of the Manch uroceratidae. *Intejoceras* and *Bajkaloceras,* having thin homogeneous rings and cameral deposits are removed from the Endoceratida. Baltic Whiterock genera are summarized; they are largely distinct from the American forms, but part of Holm's *Endoceras gladius* is *Williamsoceras* and part seems to belong to *Rossoceras.* Of the genera described, *Kiotoceras, Najaceras, Rossoceras*, *Trinitoceras* and *Ignoceras* are characteristic of the Whiterock Stage; *Perkinsoceras* is characteristic of the Chazy. The new family Najaceratidae is proposed.

INTRODUCTION

Here are described some endoceroids from the Whiterock and Chazy Stages of North America, to which are added notes on the equivalents of the Whiterock on other continents and something of their cephalopod faunas. Many endoceroids are large shells and occur in a fragmentary condition. Such fragmentary specimens commonly fail to supply all of the morphological information needed to trace evolution and to prepare an appropriate taxonomy. The problems and some solutions to them have been presented by Flower (1941, 1947, 1955a, 1958) and the morphology was summarized by Flower 1964b. Some Whiterock endoceroids were previously described (Flower 1968b) and a later paper (Flower 1971) included brief descriptions of *Kiotoceras* and *Najaceras;* indeed, much of that work was a condensation of descriptions from the present work. Here the genera are more fully described and illustrated, and new species are added. It must be emphasized that the present work is to be regarded as a report of progress rather than a definitive summary of the Whiterock endoceroids. A considerable bulk of material still remains unstudied and unpublished. Various views have been presented regarding the classification and evolution of the group of which the most valuable are those of Teichert (in Teichert and others, 1964) and Balashov (notably 1962 and 1968).

Some minor corrections are required in "Cephalopods of the Whiterock Stage" (Flower, 1971). Page 101, column 2, line 2, should read "post-Canadian" not "post-Ordovician." Page 103, column 1, line 19 requires emendation. *Oelandoceras* is not late Canadian in age, but is (according to Jaanusson) from the Kunda, which is equivalent to a part of the Whiterock Stage; considerable evidence suggests that it is equivalent to zone M of western Utah and to the lower Table Head Limestone of Newfoundland.

Genera and species described here are listed in the index.

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Some of the material here described was loaned from the collections of the U.S. National Museum and the U.S. Geological Survey through the kindness of several colleagues there, in particular, G. A. Cooper, Porter Kier, Norman Sohl and Reuben Ross. Material was loaned by the University of Oklahoma through the kindness of E. A. Frederickson and later Patrick Sutherland. Mary Louise Davis (Mrs. Richard Davis) supplied a translation of parts of Balashov's Russian papers, which forms the basis of our present analysis of the Baltic endoceroid genera.

A National Science Foundation grant to Lehi Hintze and Brigham Young University made possible the rather extensive collection of cephalopods from the Ibex area of western Utah, which includes some of the forms described here. Under National Science Foundation grant no. B7-1297R it was possible for the writer to make several important collections, notably in Nevada, Oklahoma, Newfoundland and Sweden, and to visit various institutions which house a number of important collections, including the Geological Survey of Canada, the Naturhistoriska Riksmuseum of Stockholm, the University of Oslo and the Narodni Muzeum of Prague, Czechoslovakia.

MORPHOLOGY AND EVOLUTION

The idea that *Orthoceras,* a straight shell of circular section and a central tubular siphuncle, was primitive has long been abandoned. From Hyatt's (1900) classification it was believed that a simple endoceroid with holochoanitic necks and endocones might be primitive. This too has been dispelled. The primitive cephalopods are to be found in the Ellesmeroceratida, and are endogastric to straight shells with a ventral siphuncle containing diaphragms (Flower, 1964a); the endoceroids came later. In an interval beginning in the Middle Canadian and extending through the Whiterock Stage, a generalized shell form is that shown in A and B of fig. 2, a straight slender shell, depressed in section, with a rather large ventral tubular siphuncle and with septa that form prominent lobes on the venter. This pattern is shown in several of the endoceroid genera described here, notably *Najaceras, Kiotoceras, Trinitoceras* and *Ignoceras.* It is also found in some annulated endoceroids, which are particularly prevalent in the Baltic faunas. It is not confined to the endoceroids, but is found again in rather specialized Ellesmeroceratida. notably in the smooth *Cyptendoceras* of the Whiterock and *Murrayoceras* and *Cartersoceras* of the Wilderness stage; all belong to the Baltoceratidae of the Elles-

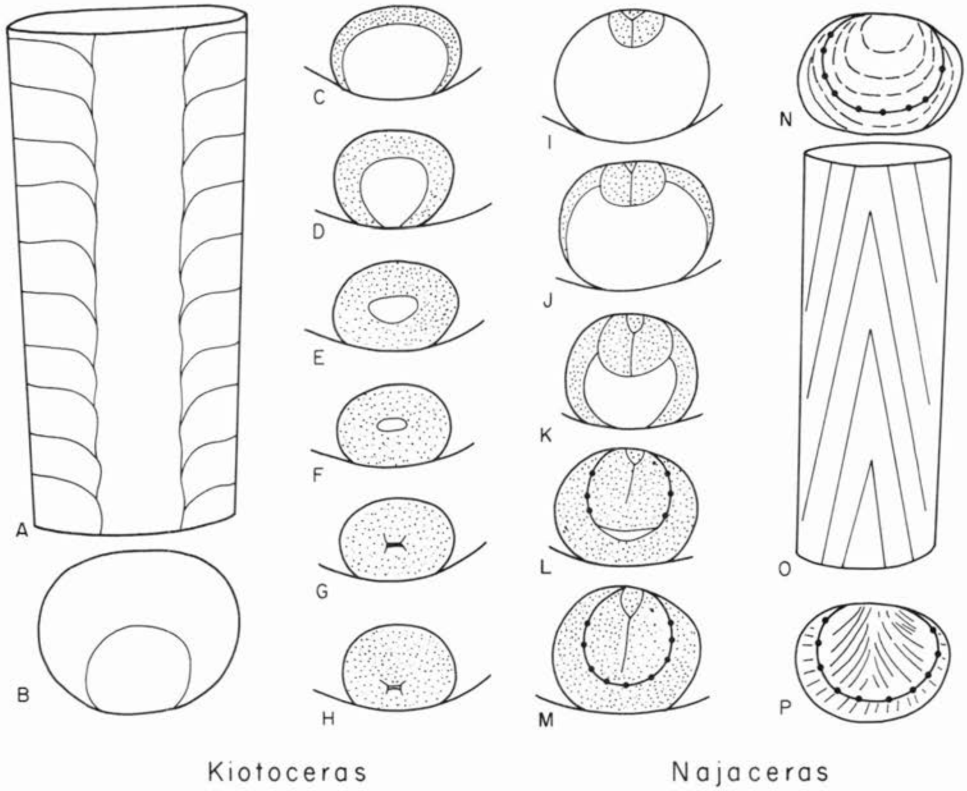

FIGURE 2—SECTIONS THROUGH SIPHUNCLES OF *Kiotoceras* AND *Najaceras*.

A Generalized ventral view of phragmocone. Common to both genera.
B Generalized cross section of the same.
C-H Progressively adapical cross sections of *Kiotoceras* siphuncle.
- C, anterior, endosiphuncle present only dorsally
- D, farther apicad; the endosiphuncle is nearly closed ventrally
- E, farther apicad, the endosipuncle is subtriangular
- F, endosiphuncle transverse, near its tip
- G, endosiphotube transverse quadrangular, with bases of four blades
- H, section near apex; the tube is similar to the section shown in G, but has moved close to the venter

I-M Progressively adapical cross sections of the siphuncle of *Najaceras.*
- I, anterior end of endosiphuncle, showing only the dorsal process with a Y-shaped blade
- J, farther apicad, the process is larger, two limbs of endosiphuncle extending along the sides
- K, endosiphuncle nearly closed ventrally
- L, cone reduced to a small rescentic cavity
- M, apicad of the cone the infula connects an arc of small tubes

N-P *Najaceras chevroniferun.*
- N, cross section showing theoretical growth lines and infula
- O, dorsum of a weathered siphuncle; chevrons reflect growth lines of the dorsal process
- P, cross section, showing fibres in endosiphuncle

meroceratida. A similar pattern is found in *Catoraphiceras* of the Protocycloceratidae, a shell with prominent annuli. Distinction between Ellesmeroceratida with such patterns and Endoceratida is not easy, and all species may not be sorted between these orders properly. Interestingly, Ulrich, Foerste, Miller and Unklesbay (1944, p. 75, pl. 34, figs. 1, 2) figured as *Catoraphiceras vaginatum* (Schlotheim)? a specimen from the Kunda limestone of the Baltic, and Flower (1964a, p. 134, pl. 29, figs. 8-10) figured and described a similar and perhaps identical species. Teichert (oral communication) suggested to the writer that possibly these Baltic forms with long necks were homeomorphs, a suggestion which has since been demonstrated by Balashov (1968, particularly his pl. 24, figs. 1-5). Balashov has concluded that Schlotheim's species *Orthoceras vaginatum* cannot be recognized; the type is lost, the description was rather vague. However, he has recognized a goodly number of annulated endoceroids in the Baltic region, which are discussed more fully below. The writer believes that the specimens figured by Ulrich, Foerste, Miller and Unklesbay and by Flower to be *Lobocyclendoceras kundense* Balashov.

Two smooth endoceroid genera here described have the gross aspect of A and B of fig. 2, but are so different internally that they cannot be closely related. *Kiotoceras* (fig. 2A-H) has an endosiphocone which extends forward dorsally far beyond its closure on the venter, leaving an endosiphocone cavity that is at first broadly rounded (fig. 2C). As the endosiphuncle is traced farther apicad and is nearly or completely closed ventrally, the cavity becomes subtriangular, broadly rounded and slightly flattened above, the ventrolateral sides nearly straight (fig. 2D, E). Toward its tip the cone becomes a depressed ellipse, and terminates in a small transverse tube (fig. 2G) with blades, only the bases of which are preserved, extending from its four corners. Farther apicad the tube assumes a position half way between the center and the venter (fig. 2H).

Najaceras is similar in gross aspect, but its endosiphuncle is radically different. It begins with a dorsal process, the free surface of which is convex, showing a

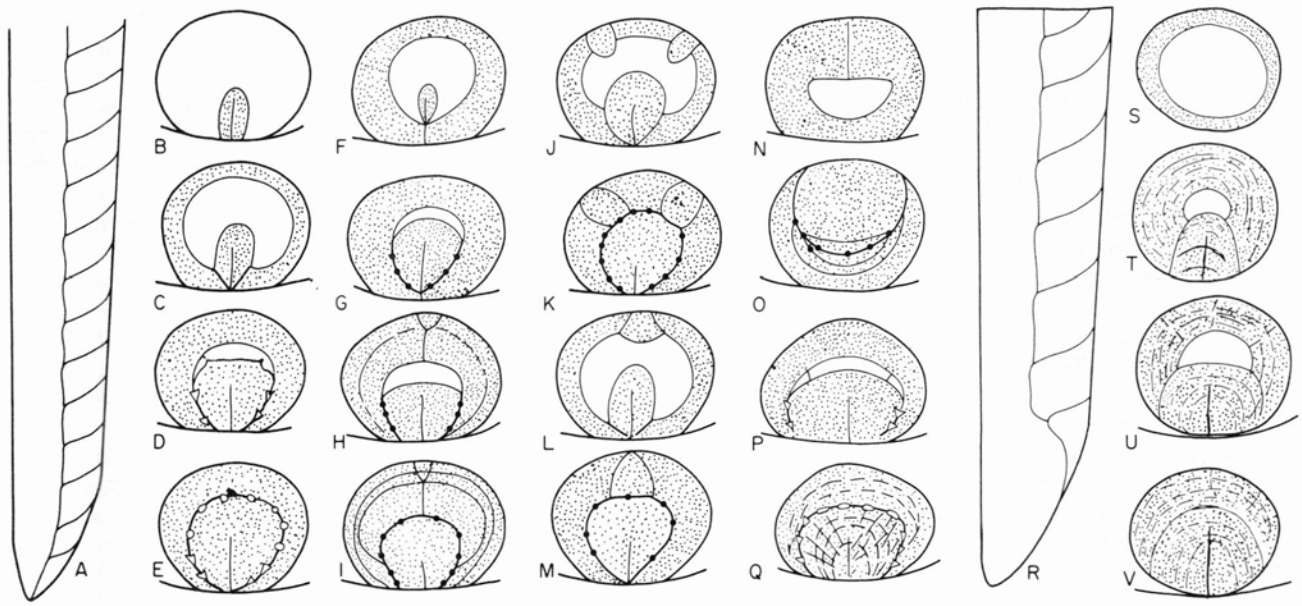

FIGURE 3—DIAGRAMMATIC CROSS SECTIONS OF THE SIPHUNCLES OF *Williamsoceras, Cacheoceras, Meniscoceras, Perkinsoceras, Juaboceras* AND *Emmonsoceras.*

A-E *Williamsoceras adnatum.*
- A, vertical section of apical end of phragmocone, showing the *Cameroceras*-type of apex
- B, anterior cross section of siphuncle, showing only the ventral process developed with a vertical blade
- C, section farther apicad, showing the endosiphuncle complete dorsally and draped around the process, also the beginning of the infula
- D, section at midlength of endosiphocone, showing infula connecting tubes, and a crescentic section of the cone
- E, section apicad of the cone, showing the infula connecting a series of small tubes

F-G Cross sections of the siphuncle of *Williamsoceras pedunculatum.*
- F, anterior, showing the cones and the ventral process
- G, section farther apicad, showing the cones nearly closed, the ventral process and the infula connecting several small tubes. Limbs of the infula join the blade of the ventral process before joining the ventral surface.

H-I Cross sections of the siphuncle of *Williamsoceras ankhiferum.*
- H, section at midlength of the cone, showing the limbs of the infula widely separated below, a dorsal blade bifuracted above and the median blade of the ventral process
- I, section apicad of the cone, showing the infula connecting an arc of tubes

J-K Cross sections of the siphuncle of *Cacheoceras trifidum.*
- J, section near midlength of cone, showing ventral process and two dorsolateral processes
- K, section apicad of the cone, showing the infula completed

L-M Sections of the siphuncle of *Cacheoceras uninodum.*
- L, anterior section, near midlength of cone
- M, section apicad of cone showing infula and tubes

N-O Cross sections of siphuncle of *Meniscoceras.*
- N, section near midlength of cone, showing senocircular cone cross section and dorsal blade
- O, section apicad of cone, showing growth lines for the cone of the preceding section and a later one where the cone is crescentic

P-R *Perkinsoceras inflatum.*
- P, cross section in apical third of endosiphocone
- Q, cross section apicad of the cone, showing infula and small tubes
- R, diagrammatic vertical section of apical end, showing siphuncle and phragmocone

S-T *Juaboceas brathwaitei.*
- S, cross section at anterior end of endosiphuncle
- T, cross section at apical end of the type, showing a crescentic endosiphocone, ventral process and lateral curved blades, possibly an infula

U-V *Emmonsoceras aristos.*
- U, cross section near midlength of endosiphocone, showing crescentic cone, blades and growth lines in endosiphuncle
- V, cross section apicad of the cone, showing an infula but only a single tube

Y-shaped blade within it. Farther apicad the process is enlarged (fig. 2J) and from its sides narrow bands extend laterally, finally joining ventrally (fig. 2K). With further growth the endosiphocone, which is by now a crescent with the concave side uppermost, diminishes, (fig. 2L) and finally all that is left is a curved infula connecting an arc of small rather obscure tubes (fig. 2M). An abraded siphuncle showing sheaths (growth lines within the endosiphuncle) presents the appearance of fig. 20 when viewed from the dorsum, with the anterior and apical cross sections as shown in fig. 2N and P.

Najaceras of the Whiterock Stage is comparable in pattern to *Meniscoceras* (Flower 1941) of the Chazyan, but in *Meniscoceras* the endosiphocone is straight rather than concave dorsally, only becoming concave near its apical extremity (N and 0 in fig. 3). These two genera seem to be relatives. *Najaceras* is the older of the two, and its siphuncle wall is holochoanitic. From what could be ascertained of *Meniscoceras,* its siphuncle seemed to have short necks, but observation on more clearly preserved specimens is desirable.

Oddly, some endoceroids have endosiphuncles superficially like those of *Najaceras* and *Meniscoceras* but with the pattern inverted, the cavity of the cone being concave ventrally instead of dorsally. In the Canadian there are two such genera, *Coreanoceras* and *Manchuroceras,* known mainly from the Upper Canadian of Manchuria and Korea. Their cones terminate in simple tubes which, in at least *Manchuroceras, may* contain diaphragms. *Manchuroceras* is breviconic, piloceroid in aspect, but differs from the true Piloceratidae in the broad rather than compressed cross section; *Coreanoceras* has a siphuncle which is also broader than high, but the rate of expansion is more moderate. The Whiterock has yielded longiconic endoceroids with slender siphuncles, as *Juaboceras,* the endosiphocone of which is circular adorally but crescentic and concave ventrally apically (fig. 3 S, T.) It is slightly endogastric but slender. *Emmonsoceras* (fig. 3 U, V) is a large orthocone of the Chazyan which has a similar endosiphuncle. Both show a prominent pair of blades downcurved at the sides, or an infula, but in neither is there evidence of multiple tubes. *Emmonsoceras* is macrochoanitic. The siphuncle wall of *Juaboceras* is not known.

Williamsoceras Flower (1968b) is a characteristic Whiterock genus developing a crescentic cone as in the genera just discussed. Insofar as our information indicates, it has a siphuncle which is enclosed by camerae from its beginning, as is true of *Cameroceras* and also many, perhaps all of the simpler Proterocameroceratidae, as in fig. 3A. In *Williamsoceras adnatum* the endosiphuncle begins with the secretion of a narrow vertical process extending upward from the ventral wall of the siphuncle; its center is marked by a single vertical blade (fig. 3B). Cones are then secreted, simple except that they are draped over the process, and oblique dark bands, the incipient infula, converge from the sides of the cone to the base of the ventral process, as in fig. 3C. As growth progresses, (fig. 3D) the infula is seen to join an arc of tubes, and eventually the tip of the cone is reached and the infula is a complete arc joining tubes of which the ventral ones are triangular, the dorsal ones circular. In W. *pedunculatum* the pattern differs in that the ventral process is extremely narrow at its base, appearing stalked (fig. 3F), and in later growth stages (fig. 3G) the limbs of the infula join each other and do not reach the siphuncle wall. A further variation on this pattern is shown by W. *ankhiferum* (fig. 3H and I), in which the limbs of the infula are still widely separated where they reach the edge of the siphuncle, and in addition to the blade forming the axis of the ventral process, a Y-shaped blade appears in the dorsal part of the siphuncle.

A further variation on this pattern is shown by *Cacheoceras trifidum* (fig. 3J, K), in which the cones are modified by two dorsolateral processes in addition to the ventral process. The genus is redefined to include also *Cacheoceras uninodum* (fig. 3L, M), in which there is a single dorsal process in addition to the ventral one.

Some Chazyan endoceroids which I had at first thought to belong to *Meniscoceras* prove to have the internal pattern of *Williamsoceras,* but the limbs of the infula are wider apart and the siphuncle is of the *Nanno* type, swollen apically and not at first surrounded by camerae dorsally and laterally, as in fig. 3P, Q, and R. This is set aside as the genus *Perkinsoceras.*

Clearly, *Williamsoceras, Cacheoceras, Perkinsoceras, Allotrioceras* and *Mirabiloceras* belong to the family Allotrioceratidae, characterized by an infula and multiple tubes. Some problem surrounds the position of the Canadian Manchuroceratidae. *Coreanoceras* has short necks, and a reasonable case could be made for deriving it from the Proterocameroceratidae, and for regarding *Manchuroceras,* which is reputedly holochoanitic, as a specialization stemming from *Coreanoceras.* However, undescribed El Paso piloceroids supply material from which it could be argued that *Manchuroceras* may be derived from the true Piloceratidae by broadening of the cross section and the development of a thickening of the endosiphuncle ventrally. Either of these genera could be the source of *Juaboceras,* for which the siphuncle wall is unknown, and of *Emmonsoceras* in which the necks have become macrochoanitic.

Two remaining genera have simpler endosiphuncles. *Trinitoceras is* an endoceroid like *Kiotoceras* and *Najaceras* in gross aspect, but its endosiphuncle leaves a transverse elliptical endosiphocone which is ventrad of the center and is slightly more flattened dorsally than ventrally (see P1. 10, figs. 1-3, 8-10).

The remarkable Chazy genus *Allotrioceras* (Flower, 1955b, see particularly text fig. 6) is like *Williamsoceras* in the young except that the process is longer and its tip is forked. Adorally, however, the process divides the cavity of the siphuncle into two parts, in each of which there is a single cone. There was no criterion of orientation when *Allotrioceras* was described; its close similarities with *Williamsoceras* now show that the process springs from the ventral, not from the dorsal wall of the siphuncle. *Mirabiloceras* (Flower 1955b, see figs. 5, 6) has instead a central pillar around which the endocone forms a continuous moat or pit, at the apex of which there is a circle of small tubes. Our suggestion at the time (1955b) was that this pillar represents the tip of a process, like that of *Allotrioceras,* which is immensely prolonged forward beyond its base, but the base has not been observed. No better suggestion and no more material have come to light.

Holm's *Endoceras gladius,* which is one of the first endoceroids the endosiphuncle of which was investigated, shows in part endosiphocones with oblique annuli on the dorsal side, (Holm, 1885, Pl. 2, Mutvei, 1964, pl. 8, figs. 1-3 and pl. 10) and with a concavity on the ventral side representing the impression of the ventral process of *a Williamsoceras.* However, other material (notably Holm's (1885) pl. 3) represents an endoceroid endosiphuncle with a trifid blade pattern. The writer had at first thought that this might be *a Rossoceras* in which alteration had reduced the distal part of the blade pattern, but Balashov (1968) has shown that the pattern here is essentially original, and is consistent with that of *Proterovaginoceras.* Apparently the endosiphuncle figured by Holm (1885) on pl. 2, fig. 3, belongs to this form; a similar endosiphocone with the dorsal side bearing low oblique annuli but without a ventral process, has been figured by Balashov (1968, pl. 29, fig. 3).

Two Chazyan endoceroids showing a curved infula were at first thought to pertain to *Meniscoceras.* Closer study showed that the infula joins the siphuncle margin on the venter, multiple tubes are clearly developed, and the genus differs from *Williamsoceras* primarily in the greater distance between the tips of the two limbs of the infula, and by the apical swelling of the siphuncle of the *Nanno* type. They constitute our genus *Perkinsoceras.*

It is quite clear that the Whiterock genera *Williamsoceras* and *Cacheoceras,* and the Chazyan genera *Perkinsoceras, Allotrioceras* and *Mirabiloceras,* may be included in the Allotrioceratidae.

Two other Whiterock endoceroid genera have the generalized shells shown in figure 2A and B. One, *Trinitoceras* (see Pl. 10, figs. 1-3, 8-10) shows an endosiphocone ventrad of the center, and more flattened dorsally than ventrally. The other, *Ignoceras*, shows instead an endosiphocone transverse ventrally and rounded dorsally, and lying dorsad of the center of the siphuncle.

The present descriptions do not by any means exhaust the available endoceroid material from either the Whiterock or the Chazy stages. At the completion of this contribution new material of *Rossoceras* was received which will add to the knowledge of that genus, together with a large collection of endoceroids from the Table Head Limestone of Newfoundland. These forms, to which the name *Endoceras piscator* Billings has been broadly applied in the past, seem to represent a genus allied to but probably distinct from *Kiotoceras*. It may be noted that while early literature (Billings, 1865) identifies this species both from the St. George Group and from the Table Head Limestone, the types in the collection of the Geological Survey of Canada are exclusively Table Head specimens. The Table Head contains some curved cephalopods. My suggestion (Flower, 1968a, p. 20) that one pertained to *Oderoceras* is probably incorrect; it seems allied instead to *Endoceras piscator*. Also similar slightly curved slender endoceroid siphuncles have been observed in the uppermost Volkhov beds of northern Oland, and in the upper part of the Antelope Valley Limestone at Frenchman's Flat, Nevada, but specimens adequate for study are yet to be obtained.

BALTIC ENDOCEROIDS

The endoceroids of the Baltic region were surveyed in order to determine what genera there characterize the Whiterock Stage, and whether any of the genera are identical with those of North America. These observations were based in part upon collections made by the writer with the support of NSF grant no. B7 1297R, but were based more extensively on Balashov (1968) which involved descriptions of endoceroids primarily from the Baltic Platform. The work is one which makes commendable use of the features of the endosiphuncles in the recognition of genera. Balashov's table of distribution (p. 88) shows one species assigned to *Dideroceras* from the Leztsskii stage, five species of the same genus from the Volkhovskii stage (Volkhov), but the Kundskii (Kunda) and the Tallinskii (Tallin-Aseri, Lasnamag and probably the Uhaku, embracing the zones of *Didymograptus murchisoni* and *Glyptograptus teretiusculus)* contain in addition *Chisiloceras, Lobocyclendoceras, Paracyclendoceras, Proterovaginoceras, Proterocyclendoceras, Schmidtoceras* and *Suecoceras,* which do not extend into younger beds with one doubtful exception. Starting in the Tallin and extending to the top of the Ordovician are species referred to *Cameroceras* and *Rossicoceras,* essentially a *Cameroceras* with a siphuncle well removed from the venter.

As nearly as we can determine, the Volkhov, Kunda, Aseri and Lasnamag represent the Whiterock Stage, and the Uhaku is reasonably Chazy, placing the Kukers (Kukruse, zone of *Nemagraptus gracilis,)* in the Chazy-Black River hiatus in North America. It is of interest to note that the Baltic succession shows the diversity of the endoceroids to be spent beyond the Tallin stage. The writer would differ from Balashov's conclusions only in one particular: Holm's *Endoceras gladius* is based upon two species which are not congeneric. One shows a spiess, the impression of the endosiphocone, annulated above, and with a deep groove below; this form is a *Williamsoceras.* Another form shows a semicircular endosiphocone with a dorsal and two downcurved lateral blades. This I had at first thought to be a *Williamsoceras,* but Balashov (1968) has shown good evidence for assigning it to *Proterovaginoceras.*

The following summary of the Baltic endoceroid genera rests most heavily upon a translation provided by Mrs. Mary Davis, to which are added some observations of the writer based upon the illustrations of Balashov (1968).

PARACYCLENDOCERAS Balashov, 1968

GENOTYPE: *Orthoceras cancellatum* Eichwald

Shells straight, slender, with low rounded annuli, fine transverse markings and finer, more closely spaced longitudinal markings. Sutures are straight and transverse dorsally and laterally, with faint lobes on the venter. Siphuncle scarcely in contact with the venter, with holochoanitic necks and thick rings; endosiphuncle with the endosiphocone subcircular in cross section anteriorly, then flattened ventrally, terminating in a small subcentral tube rounded dorsally and flattened ventrally. Blades form a trifid pattern, reportedly with a ventral blade and two dorso-lateral blades. The illustrations would suggest a dorsal blade and two ventrolateral blades.

P. cancellatum, of the Kunda is subcircular in section, very slightly depressed. *P. compressum,* of the same interval is compressed in section. *P. aluverense* of the much younger Khrevitskii stage seems of doubtful assignment.

PROTOCYCLENDOCERAS Balashov, 1968

GENOTYPE: *Protocyclendoceras balticum* Balashov

Slender orthoconic shells, surface with low annuli, and fine transverse markings. Sutures transverse, without obvious ventral lobes. Siphuncle in contact with venter, less than half the shell height. Siphuncle wall holochoanitic. The spiess is strongly compressed and is open to the venter until near its termination in a tube; is simply compressed in *P. iruense* and dumbbell-shaped, as in *Lobosiphon,* in *P. balticum.* The blade pattern is unknown. Balashov records two species, *P. iruense* and *P. balticum;* both are from the Kunda. The spiess shows prominent longitudinal ridges and fainter transverse markings.

LOBOCYCLENDOCERAS Balashov, 1968

GENOTYPE: *Lobocyclendoceras kundense* Balashov, 1968

Slender endoceroids with low annuli and transverse lirae, both sloping slightly apicad on the venter. Sutures transverse except for a narrow very deep ventral lobe. Section subcircular, siphuncle ventral, about half the shell height. Necks holochoantic, rings thick. The endosiphocone is subcircular, the tube central. The blade pattern is not known. The apex is reported as of the *Nanno* type.

Species attributed to *Endoceras vaginatum* Schlotheim undoubtedly belong in these three genera, but that species cannot be recognized with certainty. Clearly, *E. vaginatum* as misidentified by Ulrich, Foerste, Miller and Unklesbay (1944) and by Flower (1964a) as *Cyptendoceras*, rest upon *L. kundense.* Balashov recognized only this one species of *Lobocyclendoceras;* it is from the Kunda of Estonia.

PROTEROVAGINOCERAS Ruedemann, 1905

GENOTYPE: *Endoceras belmnitiforme* Holm

This is a smooth slender endoceroid with macrochoanitic necks, differing from *Dideroceras,* according to Balashov, in having the siphuncle swollen apically and occupying the whole of the shell, as in *Nanno.*

Balashov has provided additional information on the endosiphuncle. The cone becomes flattened ventrally, the tube is central, concave or flat ventrally, arched dorsally. It has a middorsal blade and two downcurved lateral blades. A similar pattern is found in the base of the blades of *Rossoceras,* and I had thought that these genera might be related, a view it is necessary to abandon.

Holm's *Endoceras gladius* is based upon types embracing two species and genera. One shows an annulated endosiphocone with a ventral ridge, an excavation of the spiess. This is clearly a *Williamsoceras.* Other specimens, showing trifid blades with the lateral ones downcurved, I had thought might represent *Rossoceras.* Balashov has shown figures showing this conclusion to be incorrect, and supporting the assignment to *Proterovaginoceras.* Oddly, the writer suggested tentatively that *E. belmnitiforme* might belong to *Dideroceras.* Teichert *(in* Teichert and others, 1964) accepted this view as a fact, and made *Dideroceras* a synonym of *Proterovaginoceras.* Balashov, from a closer study of the endoceroids involved, has come to the opposite conclusion.

SCHMIDTOCERAS Balashov, 1968

GENOTYPE: *Schmidtoceras kundense* Balashov

This genus contains slender smooth endoceroids with rather long camerae. The siphuncle is ventral, its wall holochoanitic; septa are transverse. The endosiphocone is rounded dorsally, pointed ventrally. The spiess shows a prominent ventral ridge. The tube is subcentral, pointed below, rounded above. The best evidence suggests a midventral blade and two dorsolateral blades. Balashov recognized *S. estonicum* from Tallin beds and *S. kundense* from the Kunda beds. Oddly, we have no comparable forms in the American Whiterock, but old collections from the Cincinnati Society of Natural History show similar spicula from the Cincinnatian. Origin of these specimens and their orientation are both uncertain. The ridge there might as easily be dorsal as ventral.

VAGINOCERAS Hyatt, 1883

GENOTYPE: *Endoceras multitubulatum* Hall, 1847

Hyatt based *Vaginoceras* on a Black River species with a smooth exterior, transverse sutures, a ventral siphuncle, with a compressed cuneate cone terminating in a narrow compressed tube pointed above, rounded below, with two vertical blades. Such forms I had considered as confined to the Black River beds, and present in the Black River equivalent in the Cape Calhoun section. However, there are Chazyan forms which are certainly allied, as Ruedemann's *Vaginoceras oppletum.* The form that Balashov named *Vaginoceras grandiense* is at least credible as a member of the genus; it is from the Tallin beds, which we believe to contain forms of late Whiterock and of Chazy age.

VENTROLOBENDOCERAS Balashov, 1968

GENOTYPE: *Ventrolobendoceras grandiense* Balashov, 1968

This genus contains large smooth endoceroids depressed in section. The sutures are transverse dorsally, but show broad lobes on the entire ventral surface. The neck is macrochoanitic, the siphuncle is ventral, but not in contact with the ventral shell wall. A *Nanno-like* apex is assumed. The endosiphuncle has not been observed. The one known species is from the Tallin stage.

Cincinnatian endoceroids are known to yield spicula ridged on one side or actually subtriangular in section near their apices. Such forms are probably not closely related to *Ventrolobendoceras.*

TALLINOCERAS Balashov, 1960

GENOTYPE: *Tallinoceras lasnamense* Balashov

A new species *Tallinoceras nechatuense* is figured and described. The necks are slightly macrochoanitic, the siphuncle contains simple cones of circular section terminating in a tube occupied by very close diaphragms. In T *lasnamense* the tube is elongate (vertically?); in *T. nechatuense* it is more nearly circular. A pair of dorsolateral blades and a single ventral blade are developed. Both of the known species are from the Tallin stage, including the Lasnamag and the Uhaku.

DIDEROCERAS Flower, 1950

GENOTYPE: *Endoceras wahlenbergi* Foord

This genus was erected for smooth rather slender endoceroids, with straight transverse sutures, a ventral siphuncle with macrochoanitic necks. Features of the endosiphuncle were at first unknown. Flower (1964b) described three additional species. 1) *D. magnum,* a large form with quite distant septa, showing only the anterior end of the endosiphuncle, with cones circular and regular in cross section; this species is, from its locality and Jaanusson's map (1960, p. 253) probably from the Lasnamagian, though origin in the Aserian is not impossible if the location was rather approximate. 2) D. gracile is indicated as only from the Orthoceras limestone of Oland, and could have come from any part of the interval including the Volkhov at the base through the Folkeslunda limestone at the top. 3) The type of D. ventrale is from red limestones at Kinnekulle. The same is true for the type material of D. wahlenbergi. At Kinnekulle a wide section is exposed but only two intervals are a red limestone, the Volkhov and the K unda.

These specimens show some variation in the features of the endosiphuncle. In *D. magnum* only the anterior extremity of the spiess is known, it is circular in section surrounded by thin regular endosiphuncle, circular in section also. *D. wahlenbergi* is represented by a specimen from Westergotha, showing the spiess flat dorsally rounded and obscurely pointed ventrally. *D. gracile* shows an endosiphocone circular in section, terminating in a tube just dorsad of the center. *D. holmi* from Kinnekulle, shows a cone terminating centrally but with a tube which swings toward the venter apically. *D. gracile* shows a cone terminating in a tube close to the venter, from which the cone extends about five times as far forward on the dorsum as on the venter. It was at that time uncertain as to how rigidly morphological definition should be drawn on features of the endosiphuncle.

Balashov (1968) has recognized the following species in the Baltic region:

D. leetsense, from the Leztsskii beds, is, from the one illustration of the one specimen, not very well known, but can be distinguished by proportions, in particular the rather slight curvature of the septa and their rather close spacing. Its assignment to *Dideroceras* seems questionable.

D. frisense, from the Volkhov, shows a thin siphuncle wall which may be macrochoanitic, but seems anomalously thin. The endosiphuncle is unknown.

D. glauconiticum, from the Volkhov, also shows an anomalously thin siphuncle wall, and no endosiphuncle. *D. laxiseptatum* again shows a rather thin siphuncle wall and a spiess which is obscurely angled midventrally near its *tip*.

D. popovkense, also from the Volkhov, shows typical macrochoanitic necks, but no endosiphuncle.

D. amplum, from the Kunda, is a large species with rather short camerae, showing the typical macrochoanitic siphuncle wall, but the endosiphuncle is unknown.

D. incognitum, from the Kunda, is known from material showing the typical macrochoanitic siphuncle wall, with one specimen showing a central cone which is slightly depressed in section, with blades obscure, and another shows a small subcentral tube with at least four assymmetrically arranged faint radial blades.

D. longispiculum, of the Kunda, has a slender endosiphocone, terminating in a tube slightly dorsad of the center with no clear blades.

D. pribalticum, also from the Kunda, shows typical siphuncle wall but the endosiphuncle is unknown.

D. purtsense, also from the Kunda, shows a macrochoanitic siphuncle wall, a cone subcircular in section terminating in a tube ventrad of the center.

D. brevispiculum, of the Tallin Stage (= Aseri Lasnamag and probably Uhaku), has a short cone terminating in a tube dorsad of the center showing one clear dorsal blade, a faint trace of a ventral blade, and a suggestion of at least a pair of ventrolateral blades.

D. magnisiphonatum, from the Tallin Stage, has a siphuncle of exceptionally large cross section, typical macrochoanitic necks, but no endosiphuncle is known.

D. rectistrigatum shows the typical macrochoanitic siphuncle with slender endocones terminating in a circular subcentral tube.

D. wahlenbergi as recognized by Balashov is from the Tallin Stage also; the macrochoanitic necks are a reasonable interpretation, the septa are singularly flat and transverse across the center of the vertical section, with a low forward inclination dorsally. The endosiphuncle shows cones extending forward for a short distance on the venter, much farther on the dorsum, and terminating in a tube close to the venter as in *D. gracile*, but the spacing and inclination of the septa are unlike those of that species. From the stratigraphic information, this species is probably not true *D. wahlenbergi*, but is nevertheless a significant species. As noted above, *D. wahlenbergi* must, from the locality and the nature of the lithological succession there, have come either from the Volkhov or from the Kunda.

It is evident that as at present interpreted, *Dideroceras* is recognized as showing some variation in the features of the endosiphuncle.

SUECOCERAS Holm, 1896

GENOTYPE: *Endoceras barrandei* Dewitz, 1880

Suecoceras was originally differentiated by the gentle apical swelling of both the siphuncle and of the shell. The original material shows an endosiphuncle of calcite, with structures rather indistinct, but apparently a central tube. Balashov has added to the genus *Endoceras schlieffeni* Rudiger and *E. angelini* Rudiger and three new species, *Suecoceras mishinagorense*, *S. aseriense* and *S. magnicameratum*. His illustrations fail to show the expected apical swelling, but the species are reasonably assigned to *Suecoceras* on the basis of 1) the very long slender almost tubular shells, 2) the size of the siphuncle which is about half the shell height, and 3) the very long camerae. Sutures are simple, the siphuncle holochoanitic, the tube central; the blade pattern is not clearly shown, but some illustrations (notably his pl. 51, fig. 2) suggest a possible five blades, one ventral, the others paired.

CHAZY ENDOCEROIDS

The Chazy contains a mixture of simple and some highly specialized Proterocameroceratina, together with a number of true Endoceratidae. Some of these genera have obvious relatives and probable ancestors in the Whiterock Stage. Genera of this group are not known above the top of the Chazyan. With them are some true Endoceratida, slender shells with long necks and in general, rather simple endosiphuncles. The Proterocameroceratidae are represented by *Lamottoceras* and *Vaningenoceras*, in which endosiphuncles are relatively simple. *Emmonsoceras*, which has a crescentic cone and an infula and long necks, is obviously related to *Juaboceras* of the Whiterock and hearkens back to

Coreanoceras or *Manchuroceras* or both in the Canadian. The Allotrioceratidae, which probably stem from the same source in the Canadian, are represented by *Williamsoceras* and *Cacheroceras* in the Whiterock stage, and by *Allotrioceras, Mirabiloceras* and *Perkinsoceras* in the Chazyan. One *Cyrtovaginoceras*, an endosiphuncle slender initially, then becoming rapidly expanding, was collected by the writer from the Middle Chazy at its type section, and is in the New York State Museum.

Endoceratidae are represented by *Vaginoceras oppleturn*, which may eventually be separated from *Vaginoceras,* but is probably allied to the genus. *Nanno noveboracum* Ruedemann, is the apical part of this same species. Ruedemann (1906) described also *Endoceras hudsoni* and *E. magister,* and assigned endoceroids to *Cameroceras tenuiseptum,* though it is doubtful whether the type of that species is an endoceroid. Other Endoceratidae of the Chazy are assigned to the genera *Chazyoceras,* and *Triendoceras.* See Flower (1941, 1955a, 1955b, and 1958) for the descriptions of these genera.

ENDOCEROID PHYLOGENY AND CLASSIFICATION

Attempts to trace relationships within the Endoceratida are hampered because many genera are known from fragmentary material that fails to show some critical morphological features, in particular the nature of the siphuncle wall. Flower (1941, 1956) found that slender Canadian endoceroids showing siphuncle wall structure had short necks, thick rings and straight to faintly concave segments, in contrast to the long necks found in the Piloceratidae and Endoceratidae. Later (1958) he proposed dividing the endoceroids into two groups. 1) The Proterocameroceratina, primitively with short necks, and with endosiphuncles ranging from simple to quite complex; in some forms with comparably complex endosiphuncles, it was found that the necks lengthened, but relationships with more advanced Proterocameroceratidae were shown by the patterns of the endosiphuncles. 2) In contrast, the Endoceratina were regarded as endoceroids with holochoanitic or macrochoanitic necks, but retaining relatively simple endosiphuncles.

The Russian and American treatises adopted the procedure of removing the endoceroids and actinoceroids from the Nautilida, and treating them as groups equal to it in rank. The writer (Flower 1968b, p. 24) opposed this procedure. The claim that the endoceroids and actinoceroids are morphologically distinctive is belied by genera included in those groups that do not belong. Such endoceroid genera noted at that time *are Cyptendoceras,* which belongs to the Baltoceratidae, and *Boreoceras,* which belongs to the Ellesmeroceratidae (Flower 1964a). Subsequent finds depleted the Endoceratida further. As discussed more fully below it was found that the Nathecoceratidae are homeomorphs of the Endoceratida and are Michelinoceratida derived from the Troedssonellidae (Flower 1968c). This removed *Narthecoceras* and *Tasmanoceras* from the Endoceratida. As noted more fully below, cameral deposits and central siphuncles indicate that *Intejoceras* and *Bajkaloceras* are not endoceroids, but are derivatives of the Baltoceratidae, or, less probably, of the Troedssonellidae.

Teichert (1967) while accepting the elevation in rank of the endoceroids, expressed the belief that the Endoceratida and Intejoceratida had independent origins, leaving the "Endoceratoidea" polphyletic. The virtue in recognizing elevation in rank of a group that is polyphyletic is not immediately evident. We offer a very different solution to the problem of the Intejoceratina or Intejoceratida, below. It is neither necessary nor desirable to recognize it as a major group of the endoceroids.

Teichert (1967, p. 168) states "I now also consider it likely that the Early Ordovician Troedssonellidae are true endoceroids rather than endoceroid homeomorphs among the Orthocerida as postulated in the *Treatise of Invertebrate Paleontology*. It is difficult to conceive of the Troedssonellidae as an ancestral or archaic group of the Orthocerida, and their stratigraphic occurrence suggests that they are more probably a branch of the Early Ordovician endoceroid radiation." Some misconceptions are involved. *Buttsoceras is* a genus characteristic of the very latest Canadian in western and northern Utah, zones J and K, in the Florida Mountains Formation of the El Paso Group, in association with the last of the *Ceratopea* zones in Oklahoma, that of *C. unguis*, in the Odenville of Alabama, the highest Canadian of Oxford Township Ontario, the Corey limestone of the Phillipsburg region of Quebec, and in the highest known fauna of the St. George Group of Newfoundland. One occurrence of the genus in Nevada may be of equivalent age, or may be slightly younger. Teichert overlooked the fact that both in Alabama and in western Utah, Michelinoceratidae with small annuli in the siphuncle occur also. Further, the oldest of the Michelinoceratidae known internally is *M. primum* Flower, from the basal beds of the limestone member of the Scenic Drive Formation, 220 feet below the base of the Florida Mountains Formation, to which *Buttsoceras* is confined. Small silicified Michelinoceratida are found some 70 feet still lower in a four-foot bed of dolomite associated with *Ceratopea ankylosa*, a species indicative of Cotter age. These specimens have failed to show whether the siphuncles contain small annuli, but there is no indication of continuous linings. However, our present stratigraphic evidence indicates Michelinoceratida with annuli to precede those with linings. While *Buttsoceras is* a genus of the latest Canadian, two other genera of the Troedssonellidae are of Whiterock age. *Troedssonella* is known only from the Lasnamagian of the Baltic region; a new genus of the family awaiting publication is a shell with low annuli on the surface; it is from the Juab limestone.

No Canadian Endoceratida are known in which the siphuncles are central; no true endoceroids are known possessing cameral deposits or thin homogeneous rings. The Michelinoceratida are regarded as derived from the higher Baltoceratidae. Although rings are thick in the Baltoceratidae as far as they are known, cameral deposits are developed and *Wolungoceras* has a subcentral siphuncle and is a likely ancestor of the Michelinoceratida.

Thylacoceras has a curious history of investigation. Teichert and Glenister (1952) described *Thylacoceras* as a slender endoceroid with a small ventral siphuncle, sharp ventral lobes, and long, subholochoanitic necks. No endosiphuncle was known. Teichert and Glenister (1954) proposed the family Thylacoceratidae, regarded as a family of the Ellesmeroceratida, circular or depressed in section, the siphuncles small, ventral, tubular, subholochoanitic, and added to it the new genera *Ventroloboceras, Lebetoceras* and *Notocycloceras.* It was later reported orally about ten years ago, that an endoceroid endosiphuncle has been found in *Thylacoceras,* but it has not been described or illustrated. Meanwhile Balashov (1960) added to the family the genus *Talassoceras,* regarded as related to *Lebetoceras,* but this genus possesses, from the description and illustration, a good endoceroid endosiphuncle. Teichert (in Teichert and others 1964) treated the Thylacoceratidae as the first family of the endoceroids, and placed in it only the genera *Thylacoceras* and *Talassoceras.* He further expresses the belief that the Thylacoceratidae may have sprung directly from the ancestral Ellesmeroceratidae. The writer would regard the Thylacoceratidae as a modification of the Proterocameroceratidae because 1) that family precedes the Thylacoceratidae in appearance in the Emanuel Limestone of Australia, 2) long necks are not a common characteristic of the Ellesmeroceratidae, and where they occur *(Metallesmeroceras* and *Clarkeoceras)* they are not associated with small siphuncles.

Teichert's (1964) treatment of supposed Proterocameroceratidae as "genera known from more or less fragmentary conchs, but including siphuncles, but mostly with missing apical end and body chamber" (we prefer the older and more familiar "living chamber," which has cognates in at least French and German) as distinguished from "genera known from fragmentary siphuncles only, represented by parts filled with endocones, believed to belong to the Proterocameroceratidae" is a good factual treatment of the perplexities, but division of the Endoceratidae into forms known primarily from gross parts of conchs and genera based upon apical ends has the danger of including some apical ends which might belong to the Proterocameroceratidae in particular *Vaningenoceras,* while the holochoanitic siphuncle wall of ***Allocotoceras*** and the validity of its consequent assignment to the Endoceratidae has not been demonstrated. *Lamottoceras,* assigned to the Endoceratidae belongs to the Proterocameroceratidae. The family Humeoceratidae must be abandoned. Additional material (Flower 1968b) shows *Humeoceras* to be a piloceroid, distinguished from true *Piloceras* only by the fact that the dorsal and ventral blades do not bifurcate. In view of Mutvei's (1964) claim that the blades are adventitious, this is interesting. Subsequently *new* calcareous material of *Humeoceras* has been collected by the writer from the Thornloe Limestone of the Lake Timiskaming *area.*

Emmonsoceras Flower, 1958 (formerly *Hudsonoceras* Flower, 1956) is a slender endoceroid with a ventral siphuncle combining macrochoanitic necks with an endosiphuncle of crescentic cones like those of the Manchuroceratidae and *Juaboceras.* In all these forms an infula, a pair of curved blades passing from the lower corners of the cone or tube to the ventral margin of the siphuncle, is found; in the Allotrioceratidae an infula of a similar pattern connects an arc of small tubes; the infula is adnate to or tangent to the siphuncle margin, and is removed from it only in *Mirabiloceras.*

Balashov (1960) placed his genus *Tallinoceras* in the Emmonsoceratidae, apparently because it also has macrochoanitic necks, but its siphuncle reportedly contains three or four tubes closely appressed containing diaphragms and located centrally. Balashov indicates that assignment to the Emmonsoceratidae rests upon the long necks and the presence of diaphragms within the tubes. From other material the reported several small tubes here rests upon a misinterpretation, and instead this genus has a single tube containing diaphragms. When a cross section intersects diaphragms, the illusion of several tubes may result. Balashov (1968, p. 137, pl. 34) has added a second species to the genus for which only a single central tube is illustrated, from which a trifid blade pattern extends. The affinities of *Tallinoceras* remain obscure, but a relationship to *Emmonsoceras* with its crescenric cones seems most unlikely.

The Intejoceratina Balashov, 1960, later raised in rank to the Intejoceratida, are supposedly a group of cephalopods with straight shells and large tubular siphuncles, like those of the previously known endoceroids, but with a filling of the siphuncle composed not of cones, but of radial lamellae extending from the siphuncle margin to close to its center. *Rossoceras* Flower, 1964 is an endoceroid so like *Padunoceras* and *Evencoceras* that Teichert (personal communication), suggested from photographs I sent him, that it might belong to one of those genera. *Rossoceras* has a normal endosiphocone, but the mass of the endosiphuncle does not show sheaths, possibly an indication that endosiphuncle growth is continuous rather than intermittent, but has numerous branching blades. Irregularities or departures from a simple smooth rounded cross section of the endosiphocone or tube (Balashov, 1960, pl. 29, fig. 4b, which is trifid, and pl. 32, fig. 3b which is polygonal) are paralleled by piloceroids and endoceroids in manuscript by the writer, some of which have elaborately fluted cones. *Evencoceras* has short necks and an endosiphuncle in which the central cavity is extended outward along the bases of the blades, it is from the middle Mamyr' suite of the Angara River basin, and assigned to the Chun' stage. *Padunoceras is* similar, but has holochoanitic necks, is depressed rather than compressed in section, and the cavity in the siphuncle is well dorsad of the center. This genus, from the upper part of the Mamyr' suite, is regarded by Balashov as belonging to the Krivolutski Stage, Middle Ordovician. *Rossoceras, Evencoceras* and *Padunoceras* are reasonably allied as endoceroids in which blades are strongly developed and sheaths are not evident. It must remain for future work to establish their grouping; a reasonable course would be placing all of these in the family Padunoceratidae, recognized on the basis of the multiple prominent blades and the absence of sheaths; in *Evencoceras* the septal necks are very short, in *Rossoceras* the necks are hemichoanitic but rings extend beyond the tips of the next adapical necks; in *Padunoceras* the necks are reported as holochoanitic. Such a family is reasonably derived from the Proterocameroceratidae.

No such simple explanation can be offered for *Intejoceras.* This is a genus from the lower Mamyr' suite of the Angara River basin of Siberia, which Balashov assigned to the Chun' Stage. With reservations noted elsewhere, the Chun' Stage lies within the limits of the Middle and Upper Canadian of North America. *Intejoceras* is a moderately slender, rather small conical shell, gently curved, though whether exogastrically or endogastrically is not known. The siphuncle is subcentral, composed of concave segments involving aneuchoanitic necks and rings of moderate thickness, but failing to show either layering or the eyelet which characterize the endoceroids. The siphuncle is occupied by calcareous material, which Balashov interpreted as longitudinal lamellae springing from the periphery, and leaving a small eccentric cavity; whether this is dorsal or ventral is not clear. Sections (Balashov 1960, pl. 27, fig. 2b, v, 3b) show an obscurity of radial or longitudinal elements highly suggestive of various deposits (rods in *Cyptendoceras* and a lining in *Buttsoceras)* that have suffered from slight dolomitization with perhaps some silicification. However, the weathered surfaces of *Iinejoceras* show the longitudinal lamellae so clearly that they must be accepted as original. The section (fig. 2b) also shows calcite in the camerae suggesting cameral deposits, which are more strongly suggested by the weathered sections showing thickening of the septa.

Intejoceras is anomalous as a Canadian endoceroid. First, no Canadian endoceroids are known in which the siphuncle is far removed from the venter; the first such endoceroids are *Chisiloceras,* which makes its appearance in strata that are of Whiterock or younger age. Cameral deposits are unknown in the Endoceratida. Concave and aneuchoanitic siphuncle walls characterize the greater part of the Proterocameroceratidae, but rings are layered or else may develop eyelets. The resulting conclusion is that *Intejoceras* is not an endoceroid. That it might be a derivative of the Troedssonellidae in which a previously simple lining was scalloped, received serious consideration. This interpretation is however opposed by the nature of the siphuncle wall, which in the Troedssonellidae and indeed, throughout the older Michelinoceratida, is composed of tubular segments in which necks parallel the siphuncle axis, but are not abbreviated. However, the higher Baltoceratidae constitute a stock in which concave segments very like those of *Intejoceras* are found, in which cameral deposits are developed, and the siphuncle varies from a ventral to a subcentral position. The scalloped lining may be a coenogenetic feature of *Intejoceras*, or it may be a form-modification of the ventral rods which extend around the sides of the siphuncle cavity, and finally close on the dorsum, rather like the endosiphuncles of *Kiotoceras* and *Najaceras.*

Bajkaloceras Balashov, based upon *B. angarense* Balashov 1962, was given a family by itself and referred to the Intejoceratina. It is a slender straight shell with simple sutures, the siphuncle well removed from the venter, subcentral in some forms, composed of faintly to moderately concave segments including very short septal necks and apparently thin homogeneous rings. The siphuncle contains a lining of light calcite, broken up into prismatic bodies, the bases of some quadrangular, those of others triangular; there are two to a segment, one longer than the other, but grouped longitudinally into consistent pairs. The illustration of *B. angarense* shows cameral deposits. The genus is known from the Chun' Stage of the Angara River basin. The subcentral siphuncle makes this unique among the endoceroids of Canadian age, but other features suggest that it is not an endoceroid, notably the thin homogeneous rings and the cameral deposits. The concave segments would suggest affinities with the Baltoceratidae, but here again the thin rings are anomalous, and accepting such affinities, *Bajkaloceras* and the Bajkaloceratidae would be considered as a family derived from the Baltoceratidae, but the peculiar filling of the siphuncle must be considered as a coenogenetic structure. An alternative possibility is an origin in the Troedssonellidae, as was considered for *Intejoceras,* in which the lining of the Troedssonellidae is broken up into prismatic units by thin dark bands or planes. The dark lines cannot represent tubes, for they are seen in all cross sections, and all segments of longitudinal sections, and thus cannot be considered as analogous to the radial canals of the actinoceroids. Here again the concave siphuncle segments are alien to the pattern known in the Michelinoceratida. We may suggest yet another interpretation, that rods may extend laterally producing a lining like that of the Troedssonellidae, and that such forms are the ancestors of the Troedssonellidae, while perhaps the michelinoceroids with annuli are derived, though our present evidence suggests that they precede forms with linings. Happily, some material being prepared while a final revision of this discussion was being completed, promises to contribute to the problem.

In summary, *Intejoceras* and *Bajkaloceras* of the Intejoceratina cannot be endoceroids; *Evencoeras* and *Padunoceras* are endoceroids allied to *Rossoceras.*

The varied features of endoceroid endosiphuncles were first suggested by Holm (1896) and more fully by Ruedemann (1905). They have been used in recognition of genera by Kobayshi (1935, 1936), notably in *Coreanoceras,* and *Manchuroceras,* and earlier the remarkable *Chihlioceras* was thus recognized by Grabau (1922). Features of the endosiphuncle have been considered as among the characters by which genera can be distinguished (Teichert and Glenister 1952, 1953, 1954), and they have come to be the main basis for the recognition of some genera (Flower 1955a, 1955b, 1956, 1958) and have subsequently been given serious consideration by Balashov (1960, 1962, 1968). In a considerable monograph of the Canadian endoceroids, still incomplete, it has been found as was indicated by previous studies, that the form of the endosiphocone, section and position of the tube, presence or absence of diaphragms and the pattern of the blades, all contribute features by which genera can be distinguished. Were this not true, isolated endoceroid endosiphuncles would yield only to a very broad and general classification, and we would be denied the use of generic groups that have been found to be significant stratigraphically and faunally.

Mutvei (1964) has claimed that endoceroid endosiphuncles are erratic in pattern and vary widely within a species. This remarkable conclusion was reached on the basis of material from the Ontikan Raniceps limestone, which he regards as *Dideroceras wahlenbergi*, and material from the younger Aseri Stage which he identifies as *Nanno belemnitiforme*. Many of the siphuncles are small fragments and are not really identifiable. Mutvei has apparently acted on the premise that there was only one endoceroid in each of the two horizons from which his material had been obtained. Mutvei also claimed that the blades were adventitious structures. His conclusions are at variance with extensive observations by the writer, and have been ignored also by Balashov (1968). Were Mutvei correct, endoceroid taxonomy would be much simpler than it is, but we would be denied the use of a number of genera which have proved to be valuable faunally and stratigraphically.

Collins (1967) has produced some valuable observations on endosiphuncles of *Lobendoceras* Teichert and Glenister, and of his new genus *Loxendoceras*, on the basis of material from the Emanuel Limestone of Australia. Unfortuntely he does not provide information on the surface or cross section of the endosiphocone, the cross section of the tube, or the pattern of the blades. Quite possibly limited material prohibited the sections necessary, but such genera cannot be compared with those based upon endosiphuncles in which these features are known, and in which these features have contributed to the recognition of the genera. It may be further suggested that the separation of diaphragms into simple and complex types may have another interpretation. In some endoceroids the tube is empty until a late growth stage, when diaphragms are secreted rapidly throughout its length. Such diaphragms appear as "simple," having no relevance to the spacing of the endocones. Others, the "complex diaphragms," are parts of the endocones themselves. These are diaphragms formed contemporaneously with the surrounding endocones. Oddly, simple endocones are found in the early part of *Loxendoceras*, while later ones are complex; all are considered simple in *Lobendoceras*.

Flower (1968c) revised the Narthecoceratidae, placing in it *Narthecoceras, Farroceras, Tasmanoceras* and *Donacoceras*. Cameral deposits and thin homogeneous rings suggest that this group belongs to the Michelinoceratida, probably stemming from the Troedssonellidae. The large heavy endosiphuncle or *Narthecoceras* resembles that of the Endoceratida, but proved to be distinctive in habit as well as some fine structures; plainly these endosiphuncles are very different in texture and composition from those of the Endoceratida. The same work showed from additional material that *Humeoceras* can be distinguished from *Piloceras* only by the fact that its dorsal and ventral blades fail to bifurcate.

Flower (1964b) in connection with a discussion of cephalopod morphology illustrated and described the genera *Bisonoceras, Dartonoceras* and *Disphenoceras*, all of which belong to the Piloceratidae. Flower (1968d) described as *Botryceras enigma* an anomalous endoceroid siphuncle unusually rich in carbonaceous material, with simple endocones which terminate in a subcentral group of tubes; apically the tubes are in one group, adorally there are two narrowly separated groups of tubes. The family Botryceratidae was proposed for this genus; no close relatives are known, and it is unknown where in the Endoceratida it should be placed. *Botryceras* is known only from the second Value Formation of Red River age, in New Mexico.

Some remarkable endoceroids were described (Flower 1968e) from a fauna apparently of Upper Candian age, from the Seward Peninsula of Alaska. *Kugeloceras* is based upon short bullet-shaped endosiphuncles with blunt apices. Three other genera constitute the family Yorkoceratidae; they are endoceroids known mainly from siphuncles remarkable in that their surfaces are strongly annular, so much so that some of them suggest shells of the aspect of *"Cycloceras,"* and annuli and septal markings are so nearly transverse that it was difficult to identify dorsal and ventral sides. Either such siphuncles were subcentral in position, a remarkable feature in endoceroids and one not otherwise known in those of Canadian age, or septa and sutures were strongly inclined orad from venter to dorsum. A specimen associated with this endoceroid fauna tentatively assigned to *Sewardoceras* shows a siphuncle wall of short necks and thick rings, indicating affinities with the Proterocameroceratidae. *Yorkoceras* has a simple endosiphuncle, the sheaths straight in longitudinal section. In *Sewardoceras* at least the anterior cones and sheaths are sinuate in longitudinal section. In *Telleroceras* the cones are again sinuate, but vary rhythmically, being alternately extended strongly forward marginally and then recurved; some resorption of material is involved.

Flower (1968b) described some Whiterock endoceroid genera, including the cyrtoconic *Juaboceras*, a genus with crescentic cones as in the Manchuroceratidae and Emmonsoceratidae, described more fully *Williamsoceras*, a genus in which multiple branching blades supply the explanation in part for the supposed radial lamellae of part of the Intejoceratina, and new genera of the Allotrioceratidae, which supplied also the first real basis for the orientation of the siphuncle of *Allotrioceras*. Flower (1971) briefly described *Kiotoceras* and *Najaceras*, more fully described here.

Our long-delayed and still-growing study of El Paso and related endoceroids includes some genera which pose more problems than they answer. The problem as to whether the Manchuroceratidae came through *Coreanoceras* from the Proterocameroceratidae, or from some undescribed piloceroids showing broadening of the section and development of wedges of the Piloceratidae, has already been noted. New finds have made it necessary to question many older concepts. *Perkinsoceras*, described here, shows a *Nanno-like* apex in a genus certainly belonging to the Allotrioceratidae. My previous suggestion that the *Nanno-type* of apex was confined to the Endoceratida and suggested an origin in the Piloceratidae must be questioned. When the writer suggested that all slender Canadian endoceroids had short necks, he hoped that if this were not true, someone would demonstrate the fact. The closest to such demonstration was the recognition of genera now referred to the Thylacoceratidae having hemichoanitic necks. *Allocotoceras* Teichert and Glenister, a later Canadian slender endoceroid known only from a faintly exogastric siphuncle, reputedly has holochoanitic necks, but they have not been illustrated. The writer has in manuscript, however, two slender Canadian endoceroids with holochoanitic or macrochoanitic necks.

One has a fairly simple endosiphuncle, the cone nearly semicircular, the other, with macrochoanitic necks has a siphuncle with a regular cone and tube, but branching blades show a remarkable pattern, the branches being curved as in the stipes of *Clonograptus.*

It seems pertinent to note the questions raised by some recent discoveries in the hope that someone will have a better solution than is now evident. A few matters, however, are clear. There can be little doubt of derivation of the endoceroids from the Ellesmerocera-tida, and quite possibly from the Ellesmeroceratidae; origin in the simpler Baltoceratidae is morphologically possible, but as yet we have only one Lower Canadian genus doubtfully assigned to that family, *Microbal-toceras* which, if more material should show that it has diaphragms, would be better assigned to the Elles-meroceratidae. The lower Canadian *Pachendoceras is* an ellesmeroceratid, large for othocones of the family and depressed in section. Gross shell features are very close to those of *Proendoceras;* we do not know its siphuncle wall in detail, but there is no apparent consistent difference between the siphuncle walls of *Proendoceras* and those known from well preserved material of the Ellesmeroceratidae in general. The one essential change required is the development of endo-cones instead of diaphragms. Ellesmeroceroid dia-phragms are modifications of the rings. The endoceroid endocones are new structures, unlike the rings in habit. Whether the oldest endoceroids possess diaphragms in the tube and cone is yet uncertain, but such diaphragms are consistent in structure and texture with the endo-cones or where such a structure exists, a differentiated wall of the tube. To put it more simply, where diaphragms develop they are composed of material similar or identical with that bounding the cavity in which they ax developed.

Among the older endoceroids the genus *Clitendoceras* is faintly endogastric. In that genus there is ontogenetic progression in the lengthening of the necks; let such lengthening extend back to the early stages and let the siphuncle be shortened, and we have essentially the simplest of our piloceroids. As yet the oldest and simplest of the piloceroids has yielded no evidence as to the siphuncle wall, but holochoanitic necks are known for all of the genera for which they can be observed, including *Piloceras, Bisonoceras* and *Cassinoceras,* and shorter necks have yet to be found in the true Piloceratidae.

The first endoceroids involve some anomalous ques-tions. We have none in the Lower Canadian of North America. The earliest Middle Canadian faunas yield sparse Protocycloceratidae and Baltoceratidae, the first endoceroids consisting of the genera *Proendoceras* and *Clitendoceras,* and a rare small piloceroid, a new genus. Tarphyceratidae are represented by *Bassleroceras* of the Bassleroceratidae, rare *Aphetoceras* and a costate shell of the aspect of *Campbelloceras.* While both the En-doceratida and Tarphyceratida are represented by forms of some diversity, combining the ancestral Proter-ocameroceratidae and the descendant Piloceratidae in the endoceroids, and the ancestral Bassleroceratidae and the descendant Tarphyceratidae of the Tarphyceratida, we know of no earlier faunas in North America in which perhaps only the Proterocameroceratidae and Bassleroceratidae occur without Piloceratidae and Tar-phyceratidae.

In Siberia (Nikarova 1955, Balashov 1962) some endoceroids have been reported from the Lower Cana-dian Ust'kutsk' Stage as well as from the Chun' Stage of Middle-Upper Candian age, but the same species are reported in some cases from both horizons and Elles-meroceratidae, of Lower Canadian aspect are reported from the Chun' Stage. Mixing of collections or misas-signment of certain beds may be the explanation, as was suggested by Sokolov (1967) from other evidence. Likewise, reports of endoceroids anomalously low, below ellesmeroceroid faunas in eastern Asia (see Kobayashi 1969) without description or illustration, must be viewed with doubt.

As already noted, there remains much uncertainty concerning the taxonomy of the Endoceratida. The dominantly Canadian Proterocameroceratidae extend into the Chazyan where they are represented by *Lamottoceras* and *Vaningenoceras;* no Whiterock forms are yet known, but a large amount of material remains to be processed. Though there is ambiguity as to the evolution and even the homogeneity of the Manchuroceratidae, two families sprang from one of its two genera, the Emmonsoceratidae, containing the Whiterock *Juaboceras* and the Chazy *Emmonsoceras* and *Perkinsoceras,* and the Allotrioceratidae, containing the Whiterock *Williamsoceras* and *Cacheoceras* and the Chazy *Allotrioceras* and *Mirabiloceras.* Tentatively, the family Padunoceratidae is used as containing *Rossoceras, Padunoceras* and *Evencoceras.* Slender White-rock endoceroids with relatively simple endosiphuncles and holochoanitic necks, including *Trinitoceras* and *Ignoceras,* are assigned to the Endoceratidae; Chazy Endoceratidae are discussed above. Forms with crescen-tic or semicircular endosiphocones are placed in a new family.

SYSTEMATIC DESCRIPTIONS

FAMILY NAJACERATIDAE, n. fam.

This family contains slender endoceroids in which the endosiphuncle forms a pattern inverted from that of the Manchuroceratidae, Emmonsoceratidae and Allo-trioceratidae. The endosiphocone is convex ventrally and flat or concave dorsally. I had thought the necks of *Meniscoceras* to be short, and assigned it to the Protero-cameroceratidae. The necks are long *in Najaceras,* and better material to confirm the length of the necks in *Meniscoceras* is desirable.

GENUS *NAJACERAS* Flower, 1971

GENOTYPE: *Najaceras triangulatum* Flower, 1971

Text fig. 2 L-P

Najaceras Flower, 1971, Smithsonian Contrib. to Paleobiology, no. 3 p. 104.

This is a smooth slender endoceroid, with simple sutures, transverse except for a deep lobe formed close to the siphuncle. The siphuncle wall is holochoanitic, the siphuncle apex blunt, straight ventrally, expanded rapidly on the sides and dorsum for a short distance and then slender, as in *Cameroceras.* The endosiphuncle (text fig. 2 I-M) begins with a mass secreted against the dorsal wall, having a ventral surface convex in cross section, rounded, but commonly developing a median emargination. The endosiphuncle grows laterally and finally closes on the venter, extending down from sharp angles on either side of the dorsal mass. An infula develops that, when complete, terminates in a small transverse tube, though the lateral parts of the infula separate into discrete bodies which in cross section resemble and quite probably are homologous to the multiple tubes of the Allotrioceratidae. The dorsal mass of the siphuncle shows a median dark blade as an axis, which bifurcates once or twice upon approaching the dorsal margin.

DISCUSSION—This genus is similar to *Meniscoceras* and I at first considered that as a receptacle for these species. It differs, however, in that the endosiphocone is concave dorsally rather than flat at first, the dorsal mass being rounded, and there is no point in the length of the cone at which its dorsal margin is straight and transverse.

Najaceras is as yet known definitely only from the Oil Creek limestone of Oklahoma. It is of particular interest as a forerunner and the apparent ancestor of the Chazya n *Meniscoceras.*

Najaceras triangulatum Flower, 1971
Pl. 15, figs. 1-13

Najaceras triangulatum Flower, 1971, Smithsonian Contrib. to Paleobiology, no. 3, p. 104, pl. 2, figs. 1-3. 8. 9.

The holotype is a part of a phragmocone 100 mm long, showing the wall and cross section for a length of 86 mm, in which the shell expands from 30 and 46 mm to 37 and 50 mm, and in which the siphuncle expands from 20 and 24 mm to 27 mm and an estimated height of 22 mm. Sutures are close, septa slope apicad as they approach the siphuncle, but are elsewhere straight and transverse. Apically, camerae average 5 mm in length, adorally they vary erratically from 4 to 6 mm. The siphuncle wall is holochoanitic, but replacement leaves the condition of the rings somewhat ambiguous from our one sectioned specimen. The endosiphuncle appears first as a dorsal process in cross section, its free surface rounded (Pl. 15, fig. 8). Sections farther apicad show increase in size of the process, and extension of thin bands from either of its sides, within the margin of the siphuncle (Pl. 15, figs. 9, 10) while the process itself increases in girth. Eventually the lateral bands of the endosiphuncle join on the venter, leaving the endosiphocone as a transverse cavity, triangular, the base (above) concave, the two sides faintly sinuate. The endosiphuncle is somewhat recrystallized and fails to show the infula clearly, a dark band marking the margins of the dorsal mass, but there are traces of a median blade in the dorsal process.

A paratype, an isolated part of a siphuncle evidently close to its apex, for the early part is quite rapidly enlarging while the anterior part is quite slender (Pl. 15, figs. I-6) and is 86 mm long. In the first 20 mm the siphuncle expands from 9 and 13 to 19 and 23 mm, the ventral profile straight, the lateral and dorsal profiles diverging from the axis of the siphuncle. The remainder of the siphuncle is nearly tubular, expanding in 66 mm from 19 and 23 mm to 23 and 28 mm. The height throughout is scarcely three fourths the width. The siphuncle exterior shows traces of septal ridges, but they are so obscure that their spacing cannot be determined. The cross sections show some interesting and puzzling features, notably the blade which forms the axis of the dorsal mass, which bifurcates once or twice as it approaches the dorsum and an incomplete band, preserved on one side but not on the other in the dorsal mass, curving like the infula, which is called here a "secondary infula." The anterior section, the smoothed anterior end of the specimen, has the dorsal region obscured by limonite, but shows the main infula forming an arc which brings its lower extremities quite close to the venter. There is no apparent median tube, but instead the infula is beaded; under high magnification the beading is seen to consist of small triangular bodies, their narrow apices pointing laterad and dorsad, their broad bases facing the center and the venter. One side of the dorsal mass shows a secondary infula to the upper right of Pl. 15, fig. 3, and a faint trace of a comparable band extending for a shorter distance on the opposite side. A section 40 mm farther apicad, a cut, both sides of which are shown, shows the infula, bifurcating near the dorsum, and with one limb bifurcating again. The secondary infula terminates touching one of these limbs at the margin of the siphuncle, while the main infula, though somewhat obscured by replacement, shows one end joining the siphuncle margin a little distance from the bases of the blade. In the section near the base, 20 mm farther apicad, the infula passes very close to the venter (P1. 15, fig. 6). The blade of the infula is divided dorsally as before, the secondary infula terminates close to one limb of the blade; the main infula has its dorsal part somewhat obscured by replacement, but clearly its one limb bifurcates a little above mid-height of the siphuncle, but its tip can be traced close to the beginning of the one limb of the axial blade. The very base of the specimen was ground for another transverse section, but replacement is so advanced that no original organic structures are evident.

DISCUSSION—The holotype supplies the main features of the siphuncle wall and the anterior part of the endosiphuncle. The paratype, assigned to this species mainly on the basis of proportions, shows some puzzling features, notably bifurcation of the axial blade, the secondary infula, and the beading of the infula without any clear central tube being developed. The exterior shows faint discontinuous longitudinal lines which mark the juncture of the base of the blade and of the infula with the surface of the siphuncle. The feature is brought out by weathering. The surface is quite poor.

HOLOTYPE AND PARATYPE—Holotype, no. 162062, paratype, no. 162063, USNM, from the upper fourth of the Oil Creek limestone, West Spring Creek, 3 miles east of Pooleville, Oklahoma.

Najaceras cf. *triangulatum* Flower, 1971
Pl. 14, figs. 1-4

The type is a specimen consisting of a part of a siphuncle lying apicad of the spiess. A basal part 25 mm long expands from 19 and 24 mm to 19 and 26 mm; an adoral part, with not more than 2 mm lost in smoothing the ends of a break, increases from 19 and 27 mm to 19 and 29 mm in a length of 31 mm. The venter shows flattening, moderate for the genus basally, but increasing adorally to nearly the width of the siphuncle; the ventral surface is rough and shows no septal markings. The dorsal and lateral surfaces are smooth, but show on the dorsum a groove to the left of the center, which marks the contact of a short incompletely preserved dorsolateral blade.

Cross sections are somewhat recrystallized, and show some features typical of *Najaceras,* but show in addition some structures of blades and infula which differ from those observed elsewhere and are of sufficient interest for special illustration and discussion.

The cross section at the base of the specimen (Pl. 14, fig. 4) shows a faint infula, a band scarcely darker than the rest of the siphuncle, connecting a string of bodies, each with a dark border and center, but light between; some are rounded, as seen best on the right side of the figure; those in the lower center tend to be elongated, triangular, in general with the narrow apex of the triangle directed laterally, the broad short base directed centrad.

The dorsal mass shows an axis which, as in *N. triangulatum,* is bifurcated above, but one of its limbs shows a second bifurcation. It ventral tip ends abruptly where it joins three erratic asymmetric bands, apparently blades.

A section at the apical end of the anterior part shows somewhat better contrast (Pl. 14, fig. 3). Here again the infula connects light bodies with dark margins and centers, which are short and rounded laterally, longer and subtriangular ventrally; here some are markedly more elongate than in the preceding section. The axis of the dorsal mass is seemingly composed of similar light bodies with dark margins, elongate and generally rectilinear in section, but without dark centers. The axis is bifurcated above as in the preceding section, but does not show secondary branching; below it terminates in dark blades, again somewhat askew, and showing no regularity of pattern. The dark band at the upper left which does not extend far from the siphuncle margin, terminates at the narrow longitudinal groove seen on the dorsal exterior (Pl. 14, fig. 1).

The anterior end (Pl. 14, fig. 2) shows the infula again as a band of light bodies with darker margins and centers. The blade extending down a short distance from the groove of the exterior is seen here in the upper right; the axis of the dorsal mass shows a first bifurcation below, and a secondary bifurcation of the limb on the right of the figure. The lower part of the axis is a thin dark line without apparent light colored bodies, and terminates in two similar bands definitely askew.

DISCUSSION—The specimen here described is remarkable in the marked adoral broadening of the ventral flattened zone on the ventral side, which progresses without any corresponding increase in height. It is probably a distinct species, but we have so little of the complete shell that giving it a new name would only increase the problems of others trying to identify specimens showing nonhomologous parts with it; it is not beyond the range of possibility that this form might prove conspecific with *N. triangulatum.* The part that we have compares favorably with the adoral section observed on the holotype of that species in cross section. The specimen is particularly significant in that while its structure is related to that shown in the paratype of *N. triangulatum,* from which it differs slightly in proportions, the two very different looking series of cross sections are almost certainly two different expressions of homologous endosiphonal patterns under different conditions of preservation.

FIGURED SPECIMEN—USNM 162064, from the Oil Creek limestone, 60 ft below the base of the Bergen Sandstone, Dan's Road, Ardmore, Oklahoma (USGS loc. 198c).

Najaceras bilobatum Flower, 1971
Pl. 8, figs. 1-6;
Pl. 12, figs. 12-15; Pl. 13, figs. 1-15

Najaceras bilobatum Flower. 1971, Smithsonian Contrib. to Paleobiology. No. 3, p. 105. pl. 2, figs. 4-5; pl. 8, figs. I-6.

This is a large *Najaceras,* readily distinguished from the preceding form by the appreciably longer camerae. The endosiphuncle differs somewhat in pattern, the endosiphocone shows a slight middorsal ridge, from an emargination in the dorsal process the endocones enclose the venter apically, producing a cone which is more transverse than in the preceding form and terminates in a small (apparent) transverse tube.

The holotype (Pl. 13, figs. I-15) is a part of a phragmocone expanding from 48 mm high and 64 mm wide to 56 and 72 mm, with a siphuncle 28 mm high and 32 mm wide expanding to 30 and 37 mm, in a length of wall of 100 mm, extended, by the curvature of the basal septum and apical extension of the siphuncle, to 120 mm. The basal septum shows a depth to the dorsal wall of the siphuncle of 17 mm, more than half the shell width. Sutures are obscure, but a camera near the base is 8 mm long.

At the anterior end (Pl. 13, fig. 2) the siphuncle bears a mass of the endosiphuncle lying against the dorsal wall, extending down centrally, the tip emarginate and bilobed, sloping up to the sides, and then slightly outward and down; the endosiphuncle is beginning to enclose the endosiphocone laterally. The anterior surface is somewhat rough; a section taken about 15 mm apicad (Pl. 13, fig. 3) shows a Y-shaped axis in the dorsal process; traced apicad, the median process grows, the bilobed nature of its tip becomes fainter, the limbs extend downward, and at length enclose the cone on the ventral side, 75 mm from the anterior end of the specimen. The apical end (Pl. 13, figs. 14, 15) shows the siphuncle filled to the tube; in its calcite can be seen a small transverse tube in a curving infula, which cannot be traced to the siphuncle margin; above the tube there is a trace of a Y-shaped axis of the dorsal mass, and some growth lines.

A paratype (Pl. 12, figs. 12-15) shows a length of 70 mm of phragmocone, expanding from 54 and 49 mm at the base to 60 and 50 mm. The siphuncle at the base is 30 mm wide, 24 mm high, slightly flattened where in broad contact with the venter. In the length of the phragmocone, 70 mm, there are parts of seven camerae; five occupy a length of 15 mm.

A section at the base (Pl. 12, fig. 15) shows a

Y-shaped axis of the dorsal mass, the two limbs of the infula convex and converging gently; the condition is strikingly similar to that of *Bisonoceras*. The endosiphuncle is preserved for a length of 50 mm; its condition anteriorly is obscured by weathering, but apparently all of this part of the siphuncle lies apicad of the endosiphocone.

A large specimen (Pl. 8, figs. I-4), consisting of an anterior part of the phragmocone is 70 mm in length, and contains camerae measuring 18, 17, 15, 15, 15, 15, 13, 11 and 9 mm in adoral succession. The shortening of the anterior camerae indicates that the adoral 20 mm is a base of an essentially mature living chamber. The fragment shows at the base a section 70 mm high, 104 mm wide, with a siphuncle 38 mm high, 45 mm wide, with 35 mm of its width in broad contact with the venter. The cross section shows the anterior part of an endosiphuncle forming a dorsal process 30 mm wide and 18 mm high, with short lateral thin extensions dorsolaterally. Adorally the specimen is 115 mm wide and shows an incomplete height—the venter is weathered—of 65 mm. The weathered venter shows septal necks, some incomplete, but others clearly extending at least the length of one siphuncle segment.

Hypotype, Univ. of Oklahoma, Geology Dept., no. 61, is from the upper part of the Oil Creek Formation, 80 rods north of Fall Creek, southwest of Davis, Oklahoma.

A second specimen (Pl. 8, figs. 5, 6) from the University of Oklahoma collections is here figured; it is a portion of a phragmocone increasing from a width of 58 mm and an estimated height—the dorsum is crushed —of 45 mm, in a length of 130 mm, to a width of 72 mm and a height of 60 mm; anteriorly a siphuncle is shown 28 mm wide, 25 mm high, in contact with the venter over a little more than half of its width, and showing an infula; the anterior end lies apicad of the endosiphocone. Sutures are exposed only laterally, where they are straight and transverse, the midventral region is covered by the shell. Six camerae occupy a length equal to the adoral shell width, they vary rather erratically in length from 9 to 11 mm.

Hypotype, no. 78a, University of Oklahoma, is from the top of the Oil Creek Formation, from the west branch of Sycamore Creek, about 8 miles northwest of Ravia, Oklahoma.

TYPES—Holotype and Paratype, USNM no. 162065, 162066, from the upper fourth of the Oil Creek Formation, bed no. 8, West Spring Creek section, 3 miles east of Elk or Pooleville, Oklahoma; hypotypes no. 61, and 78a Univ. of Oklahoma, occurrences noted above.

Najaceras cf. *bilobatum* Flower, 1971
Pl. 6, figs. 11, 12

Under this designation are figured opposing sides of a transverse section through a small piece of a siphuncle; the fragment is 65 mm long, slender, failing to show septal ridges. A transverse section is taken where the siphuncle is 18 mm high and 22 mm wide. It lies apicad of the endosiphocone and shows an infula, as in other forms, describing a broad arc tangent to the edge of the endosiphuncle on the dorsum. The endosiphuncle shows a fine aphanitic texture, suggesting at a glance a filling of yellow mud rather than of organic material, but shows within the dorsal mass numerous fine lines radiating from the top to the infula. On the venter, there are similar lines. On both sides of the infula the lines may be irregular. Comparable structures, found in other specimens, are more obscurely preserved in material which is more obviously calcitic, and white, rather than yellow.

FIGURED SPECIMEN—USNM No. 165714, from bed 8, in the upper third of the Oil Creek limestone, from West Spring Creek, 3 miles east of Pooleville, Oklahoma. The same locality and horizon has yielded *N. bilobatum*, *N. triangulatum* and *N. chevroniferum.*

cf. *Najaceras bilobatum* Flower, 1971
Pl. 6, figs. 1-4

We have here a part of a phragmocone orad of the endosiphuncle, 135 mm long. At the base it is 50 mm high, 55 mm wide, with a siphuncle 27 mm high and 29 mm wide, well rounded above, but in broad contact with the venter for a width of 22 mm, over which the curvature of the cross section is reduced.

Adorally the shell is weathered and slightly distorted, but the section of the shell is 70 mm wide, 65 mm high, with a siphuncle 42 mm wide and 38 mm high. Sutures transverse, but sloping apicad on the venter as they approach the siphuncle. The specimen shows 16 camerae in its length; 9 in a length equal to the adoral shell width; four and a half in a length equal to the adoral siphuncle width.

FIGURED SPECIMEN-165 71 5 U.S. National Museum, from the upper third of the Oil Creek limestone, West Spring Creek, 3 miles east of Pooleville, Oklahoma.

Najaceras chevroniferum Flower, 1971 Pl. 16, figs. 11-14
Text fig. 2 N-P

Najaceras chevroniferum Flower, 1971, Smithsonian Contrib. to Paleobiology, no. 3, p. 106, pl. I, fig. 9; pl. 2. fig. 10.

This species is known from a very slender portion of an endosiphuncle 173 mm long expanding uniformly from 14 and 18 mm to a width of 21 mm and a height slightly in excess of 14 mm. The dorsal side is exposed, and shows a chevron-like pattern. The apices of the chevrons represent the anterior limits of the dorsal mass. Cross sections show the exposed part to be dorsal, with a broad infula across the venter. Replacement of the endosiphuncle is advanced; it consists of amorphous yellowish material, rather than the usual light calcitic structure.

DISCUSSION—This specimen was a puzzle to me for some years, showing as it does chevron-like alternating dark and light bands on a weathered surface of a partly exposed siphuncle. Sections show an infula, typical of *Najaceras* (Text fig. 2 N-P) and indicate that the forward-pointing chevrons of the dorsum represent cones and sheaths, and the pattern they form in relation to the forward-projecting dorsal mass of this genus. Advanced replacement left the interpretation of morphology uncertain from this specimen alone, and without the better preserved specimens of *Najaceras*, it would still remain a puzzle. That the siphuncle is slender down to a relatively small diameter distinguishes it from *N. triangulatum*, of which an early rapidly expanding part of a siphuncle is known.

TYPE AND OCCURRENCE—Holotype, USNM no. 162067, from "greenish shale below the third sandstone," Simpson Group, Henryhouse Creek section, Oklahoma. This is in the Oil Creek Formation.

Najaceras? sp.
Pl. 6, fig. 8; Pl. 9, fig. 9

The Oil Creek limestone has yielded a rather long piece of an endoceroid showing no trace of the endosiphuncle. It retains 180 mm of phragmocone and 125 mm of living chamber. At the base, evidently slightly weathered on the venter, the shell is about 60 mm wide and 52 mm high, with a siphuncle 28 mm wide and seemingly 17 mm high, evidently in broad flattened contact with the venter over a good part of its width. Early camerae occur five in a length of 40 mm. Such spacing continues for a length of 90 mm, and in the next 60 mm the camerae become suddenly shorter, five occupying lengths varying from 30 to 20 mm. This condition begins where the shell is 70 mm wide and 62 mm high. At the anterior end of the phragmocone the shell is 72 mm wide and 74 mm high; at the anterior end of the living chamber the shell is 88 mm wide and 80 mm high.

DISCUSSION—This specimen I had at first considered an anterior end of *Najaceras bilobatum*, until another larger specimen showed that species to continue to maturity at a much larger shell diameter and a later growth stage. *N. triangulatum* has much closer septa, and proportions of the several species of *Najaceras* are not closely comparable. *N. quadratum* has much closer septa. *N. depressum attains* a larger size with the septa still rather more widely spaced, and there is no such anterior narrowing of the siphuncle anteriorly as in *Kiotoceras contractum*. While this species is tentatively assigned to *Najaceras*, without the endosiphuncle one cannot prove that it belongs there rather than in *Kiotoceras*.

FIGURED SPECIMEN—U.S. National Museum, no. 165716, from the upper third of the Oil Creek limestone, West Spring Creek 3 miles east of Pooleville, Oklahoma.

FAMILY ENDOCERATIDAE Hyatt, 1883

GENUS KIOTOCERAS Flower, 1971
GENOTYPE: *Kiotoceras quadratum* Flower, 1971
Text fig. 2 A-H

Kiotoceras Flower, 1971, Smithsonian Contrib. to Paleobiology, no. 3, p. 103.

Shell a slender endoceroid of depressed section, sutures slope apicad close to the ventral siphuncle, but are otherwise straight. Siphuncle wall holochoanitic. Siphuncle in broad contact with the venter, its ventral side considerably flattened by this contact over most of its width. The siphuncle exterior shows septal ridges forming steep lobes on the dorsum, strongly inclined laterally, with broadly rounded ventral saddles. Siphuncles of *Rossoceras* and *Najaceras* may be quite similar in external aspect, but are distinctive internally. The endosiphuncle is strongly extended forward dorsally, extending gradually around the sides, and finally completed ventrally (Text fig. 2 C-H). The cross section of the spiess is rounded anteriorly, becomes quadrangular at about midlength, rarely slightly hexagonal at the anterior end of middle, more strongly rectangular toward its tip, and terminates in a small transverse rectangular tube which may be central anteriorly, but is ventral apically. The apical end of the siphuncle is not definitely known, but appears to be of the *Cameroceras* type from relatively small early stages.

Endosiphuncles, when not strongly recrystallized, tend to show a structure of radial fibers. Sheaths are not well displayed; growth of the endosiphuncle may have been essentially continuous.

DISCUSSION—This genus appears to be one of the earliest members of the true Endoceratidae. It shares with *Najaceras* the broad cross section, sutures transverse except where they slope apicad close to the large siphuncle, which is in broad contact with the venter, and its ventral side is somewhat flattened. The endosiphuncle is quite unlike that of *Najaceras*, being greatly extended forward dorsally, the material later growing around the sides and closing ventrally some distance apicad of its anterior extremity. The endosiphocone is simple in section, broad, elliptical, conforming with the siphuncle cross section, and terminating in a small tube as described above. Oddly, silicified endosiphuncles, which we have not found, would be in aspect much like those of *Mcqueenoceras* except that they are inverted; in *Mcqueenoceras* the endosiphuncle extends strongly forward on the venter.

The species described here probably do not exhaust the true limits of the genus. Small poorly preserved endosiphuncles of *Najaceras* are particularly abundant in ferruginous calcarenites lying low in zone N, in the upper part of the Kanosh Shale of western Utah. Newfoundland has yielded some material, not yet fully worked, from the Table Head Limestone. Billings' *Endoceras piscator* and Barrande's *Orthoceras insulare*, which are perhaps the same species, are allied to this genus though perhaps not strictly members of it.

European or Asiatic forms which are comparable to this genus are not close. Balashov's (1968) genus *Ventrolobendoceras* has the suture pattern of *Kiotoceras* and of *Najaceras*, but its camerae are exceptionally long, the endosiphuncle is not known, and illustrations present inconclusive evidence as to the nature of the siphuncle wall.

Kiotoceras quadratum Flower, 1971
Pl. 12, figs. 1-11; Pl. 16, figs. 15, 16

Kiotoceras quadratum Flower, 1971, Smithsonian Contrib. to Paleobiology, no. 3, p. 104, pl. 1, figs. 1-8, 10.

This is a large straight endoceroid. The type is somewhat crushed, but expands from a width of 36 mm and a height (crushed) of 24 mm, with a ventral siphuncle 14 mm high and 21 mm wide, to a shell 63 mm wide, with a height estimated as between 55 and 60 mm, and a siphuncle 34 mm wide and 24 mm high in a length of 170 mm; the maximum length of the holotype is 200 mm, and consists completely of a part of a phragmocone.

Sutures are straight and transverse except close to the siphuncle, where they slope strongly apicad. Septa are somewhat obscure, but camerae are very short, 4 mm apically and 6 mm adorally, with about ten in a length equal to the adoral shell width.

Breaks and cuts expose the siphuncle at several points in cross section, and near the apical end, a horizontal longitudinal section was taken; part of one side was sacrificed to make a thin section to see the siphuncle wall, which, in spite of some evident replacement, proves to be holochoanitic (Pl. 12, figs. 10, 11).

A break near the anterior end (Pl. 12, figs. 2, 3) shows the siphuncle 25 mm high, 34 mm wide. The ventral side of the siphuncle shows only slight convexity over three fourths of its width, where it is evidently in contact with the ventral wall of the shell. Here the anterior end of the endosiphuncle is a band of calcitic material only 3 mm thick over the dorsal and lateral regions, and is wanting ventrally.

A break 42 mm farther apicad (Pl. 12, fig. 4) shows the siphuncle 23 mm high, 29 mm wide; the endosiphocone is closed below, is 12 mm high, 14 mm wide, and shows four sharp angles at the four corners of its rectangular section, but dorsal and ventral walls are convex, obscurely angled centrally, so that the cone is obscurely hexagonal.

A section 15 mm farther apicad (Pl. 12, fig. 5) shows the siphuncle 22 by 28 mm, the spiess 7 by 9 mm, subrectangular, dorsum and venter slightly curved but no longer angled.

A section 26 mm farther apicad (Pl. 12, fig. 6) shows the siphuncle 20 by 24 mm, completely filled except for a small obscure tube 12 mm from the dorsum and 8 from the venter, scarcely 1 mm high, transverse, rectangular, with bases of four blades radiating from its four corners.

A section 13 mm farther apicad shows in a siphuncle 19 mm high and 24 mm across, a similar small tube, which is here 1 mm high, 4 mm from the venter, 14 mm from the dorsum, being closer to the venter.

A paratype (Pl. 16, figs. 15, 16) consists of part of an exfoliated siphuncle 100 mm long expanding from 15 and 20 mm at the base to 19 and 25 mm at midlength, and to a height of 20 mm and an estimated width of 28 mm anteriorly.

The venter is broadly flattened, scarcely convex, over two thirds of its width, and shows septal ridges forming broad gently rounded crests; siphuncle segments are somewhat erratic in length, but average five and a half in a length equal to the adoral width of the siphuncle.

Anteriorly the broken end shows a thin lining of the endosiphuncle present only dorsally. Apically the endosiphuncle is scarcely thicker dorsally, but extends farther down along the lateral regions.

This siphuncle has essentially the proportions shown in the holotype. It shows in addition the septal ridges on the venter and on the sides; the dorsal surface is partly obscured by matrix and partly exfoliated. Laterally the septal ridges are inclined at an angle 35° from the horizontal.

DISCUSSION—The siphuncle rather than the shell shows the characteristic specific features, apparently the anterior end of the endosiphuncle is long and slender, where it is developed only against the dorsal and lateral walls; once the endosiphuncle encloses the spiess ventrally, it thickens more rapidly, resulting in a spiess first obscurely hexagonal, or at least with the dorsum and venter strongly convex, with four more sharply angled corners, then becoming transversely rectangular, terminating in a small transverse tube with four blades extending from its four corners; the tube being at first about twice as far from the dorsum as from the venter, but apically it moves so much closer to the venter that its distance from the dorsum is five times that from the venter.

Anterior parts of phragmocones have much the aspect and proportions of the associated *Najaceras* but endosiphuncles are very different.

TYPES AND OCCURRENCE—Holotype and paratype, U.S. National Museum nos. 162058 and 162059. Both are from the Oil Creek limestone. The holotype is from the upper fourth of the Oil Creek limestone, (USGS 200f) from West Spring Creek, 3 miles east of Pooleville, Oklahoma; the paratype is from "basal Simpson, horizon, 4-5 miles southeast of Dougherty, Oklahoma." This could possibly be the Joins rather than the Oil Creek Formation.

Kiotoceras depressum, n. sp.
P1. 16, figs. 1-5

This form is known from a part of a broadly depressed siphuncle. The specimen is 100 mm long, increasing from 40 and 26 mm at the base to 41 and 28 mm in the basal 60 mm, and to a width of 42 mm and a height of 26 mm; the height is incomplete, and is estimated at 30 mm, in the remaining 40 mm.

The surface is badly weathered, and shows no septal markings. The cross section shows a marked decrease in curvature over two thirds of its width on the venter, suggesting broad contact with the ventral shell wall, but greatest width is attained at or slightly above midheight.

The endosiphuncle is, in its present form, composed of radial fibers, whether original, or a mode of alteration particularly characteristic of this genus is not certain; at the anterior end (Pl. 16, fig. 3) the endosiphocone is rounded above, sides are nearly straight, approaching below, but the endosiphuncle is incomplete ventrally. A second section shown by a break (Pl. 16, fig. 4) shows similar features, with the endosiphocone smaller. At the apical end the cone is still smaller (Pl. 16, fig. 5) the rounded upper surface showing some flattening, the sides converging below, but with the venter narrowly rounded. We have no specimens certainly showing the transition of the cone into the tube.

DISCUSSION—This is a larger species than *K quadraturn*, and it has a considerably broader siphuncle. The species differs from *K. contractum* in that the siphuncle is not narrowed anteriorly, though our known parts of the two species are essentially commensurate, and in that the ventrolateral margins of the endosiphocone are markedly flattened, gently converging below, rather than evenly rounded.

TYPE AND OCCURRENCE—Holotype USNM no. 162060, from the upper fourth of the Oil Creek limestone, from West Spring Creek, 3 miles east of Pooleville, Oklahoma. The same locality and horizon has yielded additional fragmentary material undeter. minable specifically, which may belong here.

Kiotoceras contractum, n. sp.

Pl. 16, figs. 6-10

This is based upon a siphuncle fragment 122 mm long, enclosing most of the length of a spiess. In the basal 70 mm the siphuncle expands from 32 and 34 mm to 29 and 37 mm, being broadly depressed, the venter rather well rounded apically, but progressively flattened adorally. In the remaining 52 mm the siphuncle contracts markedly laterally, and less strongly vertically, attaining a width of 32 mm and a height of 27 mm. The surface is somewhat worn. Septal ridges form broad lobes on the dorsum, showing camerae averaging 7 mm in length over the known part.

Anteriorly the endosiphuncle averages 5 mm thick around the dorsum and sides of the spiess, which is in contact with the siphuncle wall on the venter; 52 mm farther apicad a break (Pl. 16, fig. 8) shows the spiess rounded above, sides slightly flattened as they converge gently ventrad, the cone 18 mm wide and 20 mm high, still open to the siphuncle wall below. Another break 40 mm farther apicad (Pl. 16, fig. 9) shows the cone near its tip, 9 mm high, 7 mm wide, rounded above, obliquely pointed below, with calcite in its upper part. Apically, (Pl. 16, fig. 10) there is seen either the tube or the cone very near its tip; 3.0 mm high, 3.5 mm wide, and 6 mm from the venter, 12 mm from the dorsum. The two lower corners are angled, the two upper corners rounded; two ventrolateral blades are clear, there is a trace of one dorsolateral blade.

DISCUSSION—Though I name this species with some reluctance, owing to difficulty in distinguishing earlier stages from those of *K. quadratum* or *K. depressum,* the species is clearly distinctive in the anterior contraction of the siphuncle in width and, more slightly, in height. Also, the spiess is narrower and less transverse than that of *K quadratum.*

HOLOTYPE—USNM no. 162061, from the upper fourth of the Oil Creek limestone, West Spring Creek, 3 miles east of Pooleville, Oklahoma.

Kiotoceras gilesae, n. sp.

P1. 7, figs. 1, 2

This species is known from a mature living chamber and an anterior part of a phragmocone showing the last septa crowded. At the base, the shell is 55 mm wide, and 44 mm high. The siphuncle, flattened over two-thirds of its width where it is in contact with the ventral wall of the shell, is 22 mm wide and 18 mm high, showing on the weathered ventral surface concave segments which narrow from 17 to 14 mm in width. The first five camerae in a length of 32 mm, range from 6 to 7 mm in length. Five anterior camerae shorten to about 3 mm, and occupy a length of 17 mm. Sutures are transverse dorsally and laterally, describe broad lobes on the ventral surface, bending apicade increasingly as they approach the siphuncle. The ventral surface of the siphuncle shows the usual broad saddles of the septa ridges.

The phragmocone increases from 55 to 58 mm ir, width; from 40 to 44 mm in height. The length is 6(mm. The living chamber is 100 mm in length laterally and attains a width of 65 mm, an estimated height of 46 mm. Beyond the basal third, there is a marked reduc• tion in lateral (and also possibly vertical) rate of expansion, giving the shell a faintly fusiform aspect.

DISCUSSION—The species is named for Mrs. Vera Giles, who found and gave me the holotype. Its position as from the Lehman Limestone, supported by the lithology, was confirmed by study of conodonts from matrix.

TYPE AND OCCURRENCE—Holotype, collection of the writer no. 1538, from the south end of the Ibex Hills, western Utah, from a horizon determined as the Lehman Limestone by conodonts in the matrix (Dr. R. L. Ethington, personal communication).

Kiotoceras ibexense, n. sp.

Pl. 7, figs. 4, 5

The holotype is a shell with a maximum length of 205 mm, expanding from 39 and 43 mm near the base to an estimated height of 52 mm and a width of 56 mm in a length of 100 mm; there is a faint suggestion of a reduction in lateral expansion adorally. At the base, the siphuncle is 18 mm high, 22 mm wide, is markedly flattened where it is in broad contact with the venter, and shows an endosiphocone which is not closed on the ventral side. At the base there are 6 camerae in a length of 53 mm; they vary in length from 7 to 11 mm in length, rather erratically. Anterior septa are incomplete, and we are uncertain that the adoral absence of septa may not be simply due to their destruction; ordinarily the anterior end of the endosiphuncle would not be expected so close to the base of a living chamber.

Camerae are rather long for the genus; six occur in a length equal to the adoral shell width; there are about three in a length equal to the adoral width of the sigh uncle.

DISCUSSION—This species has relatively long camerae, and siphuncle segments. Here there are two segments in a length of siphuncle where, in *K gilesae* three segments occupy an equivalent length in parts where the shells are essentially commensurate. The siphuncle is somewhat larger in proportion to the cross section of the shell, and sutures slope more steeply apicad as they approach the siphuncle on the venter than in that species.

TYPE AND OCCURRENCE—The holotype, to be deposited in the U.S. National Museum, USNM no. 166172, is from the Lehman Limestone, from the Desert Range section (Hintze 1951) Ibex region, western Utah.

Kiotoceras piochense, n. sp.

P1. 7, fig. 3

This is an exceptionally closely septate *Kiotoceras.* The type is a portion of phragmocone 140 mm long, exposed in a nearly horizontal section, weathered from the dorsal side. The shell width, probably not quite the maximum width, shows an expansion from 19 to 29 mm in 120 mm with the siphuncle expanding in width from 11 to 19 mm. Adorally, the weathered surface illustrated passes down toward the venter, and cuts the siphuncle near the anterior end of the endosiphocone; it shows the endosiphuncle here developed on the dorsum, but open to the siphuncle wall ventrally. Adorally the septa are spaced so that there are 8 camerae in a length equal to the shell width, and 5 camerae in a length equal to the width of the siphuncle. Apically the same proportions are maintained. The siphuncle is clearly in broad contact with the venter, and is conspicuously flattened there. Septal necks, are, from the weathered surface, holochoanitic.

DISCUSSION—The extremely close septa characterize this species. The siphuncle is typical of the genus. Isolated siphuncles should be recognizable from the closeness of the septal ridges.

It is not known whether the type represents a mature individual. Associated larger siphuncles of this genus are described as *Kiotoceras sp.*, as they fail to show septal ridges and are thus not comparable with this or other species at the specific level.

HOLOTYPE—Collection of the writer, no. 1407, from the lower beds exposed not far from the road at the southernmost extent of the outcrop at the south end of the Ely Springs Range, west of Pioche, Nevada. The associated fauna is reminiscent in content, and also lithology, of this same zone as developed in the upper part of the Lehman Limestone in the Ibex region of western Utah.

Kiotoceras sp.

Pl. 6, figs. 5-7, 9, 10

The beds of the Ely Springs range carrying the fauna of zone N have yielded some endosiphuncles of this genus which, from lack of specimens separable from the matrix, are needed for specific comparison and cannot be identified specifically from the material now available. *Kiotoceras piochense* is from this association, but is known only from specimens showing parts of siphuncles of materially smaller size. From such indications as exist, it seems unlikely that these larger fragments have comparably closely spaced septa.

One fragment, no. 1408 (Pl. 6, fig. 9) shows only the anterior end of an endosiphuncle, roughly 25 mm across and 20 mm high. The figured section is inclined vertically to the axis, and thus shows an exaggeration of height in relation to width. It shows an endosiphocone thick dorsally and laterally, and barely shut off from the siphuncle wall ventrally. The fragment has a maximum length of only 25 mm.

A second fragment, no. 1409 (P1. 6, fig. 10) shows an oblique weathered cross section in which the endosiphocone is incomplete ventrally. This section is roughly 17 mm high and 20 mm wide, showing marked flattening of the venter in cross section. The fragment is 45 mm long. The apical end shows the cone closed, evidently giving way to the tube, but is filled with orange calcite and the tube is not evident.

A third fragment, no. 1410 (P1. 6, figs. 5-7), is a bit of a weathered endosiphuncle 100 mm long, expanding in height 23-25 mm in 80 mm. Anteriorly part of the endosiphocone is seen, but it is closed ventrally; a cross section made farther apicad shows the cone smaller, pointed ventrally, rounded dorsally and laterally. An apical section shows a small tube ventrad of the center, elliptical, broader than high. There is a strong suggestion of a middorsal blade, but ventrally the blade pattern is obscure.

FIGURED SPECIMENS—Nos. 1408, 1409, 1410, collection of the writer (to be deposited in the U.S. National Museum) from the south end of the Ely Springs Range, in limestone of Lehman lithology and the fauna of high zone N.

Kiotoceras? multiseptatum, n. sp.

Pl. 9, figs. 6-8

This is an endoceroid from the Lehman Limestone, known from a portion expanding from a base 46 mm wide with an estimated height, the dorsum being weathered, of 40 mm, to a width of 62 mm and an estimated height of 52 mm; one side extends forward for another 50 mm where the estimated width is 70 mm, the height estimated at 60 mm.

At the base the siphuncle is 20 mm high, 28 mm wide, in broad contact with the venter, where it is slightly flattened, for a width of 26 mm. Septa are close, with five in 20 mm and 11 in 50 mm apically, and 5-6 in 20 mm adorally; at midlength fifteen camerae occupy a length equal to the adoral shell height. In lateral view sutures slope ventrorad. In ventral view they are nearly transverse, sloping only faintly apicad for a width of 5 mm on either side of the siphuncle. On the siphuncle septal ridges should show between seven and eight segments in a length equal to the adoral width of the siphuncle. The endosiphuncle is not known; the type represents a phragmocone, but anterior septa are lost and some sutures are obscure. The anterior 20 mm show no septa and may possibly represent the base of a living chamber. Adoral septa show no crowding or other variation in spacing.

DISCUSSION—This form differs from described species of *Kiotoceras* or *Najaceras* in the slope of the sutures forward from dorsum to near the venter, where there is a very slight apical slope of the septa near the siphuncle; in both of those genera sutures are typically transverse, and the apical slope of the septa near the siphuncle is much more extreme. This species differs from known members of both of these genera in the very close septa. We are as yet without material showing the nature of the siphuncle wall or of the endosiphuncle. The large siphuncle in broad flattened contact with the venter is similar to that of both *Najaceras* and of *Kiotoceras*.

TYPE—Holotype, no. 1583, to be deposited in the U.S. National Museum, is from the Lehman Limestone, from 450 ft above the base of section K north, Ibex region, western Utah.

GENUS *TRINITOCERAS*, n. gen.

GENOTYPE: *Trinitoceras lobiferum*, n. sp.

This is an endoceroid, apparently smooth externally, with a slightly depressed section, a ventral siphuncle, and sutures which describe prominent ventral lobes.

The siphuncle wall is holochoanitic, and the siphuncle contains endocones. As yet, only the anterior part of the endosiphuncle is known; it shows the endosiphocone more depressed than the exterior of the siphuncle, the endocone material thicker dorsally than ventrally, producing a cone of transverse oval section more flattened dorsally than ventrally, and located slightly below the center of the siphuncle.

DISCUSSION—Oddly enough, while study of the Pogonip *Cyptendoceras* led to the suspicion that that genus was not an endoceroid, which was confirmed by a study of additional material, here is a form in the Whiterock portion of the Pogonip, internal molds of which have the general section and suture pattern on the basis of which *Cyptendoceras* was originally differentiated. Yet this form differs from *Cyptendoceras* not only in having endocones instead of a rod in the siphuncle, but in having apparently holochoanitic septal necks. As yet apical portions of the endosiphuncle of this genus and species have not been identified. A number of siphuncles are available from Ikes Canyon, but show loss of structure by extensive recrystalization, and they are inadequate for proper study of the exacting morphological details which are unfortunately a requirement for proper endoceroid classification.

Trinitoceras lobiferum, n. sp.

P1. 10, figs. 1-3, 8-10

Two fragments represent this species. The larger, the holotype (Pl. 10, figs. 8-10) consists of a ventral portion of a phragmocone retaining the siphuncle, but lacking the endosiphuncle. The specimen shows a siphuncle at the base 42 mm wide and 36 mm high, in flattened contact with the venter of the shell. The shell here is preserved for a width of 110 mm; the cross section of the shell was depressed, and the present specimen approaches closely to the total width if it does not attain it. The specimen is a fragment with a length of 85 mm, showing parts of nine camerae of 10 to 11 mm in length. Sutures form broad ventral lobes interrupted by the siphuncle. The ventral surface suggests septal necks which are considerably recurved and holochoanitic. A thinsection was made of one side of the siphuncle (Pl. 10, fig. 10). Though there is considerable recrystallization of material, it is evident that the septal necks are holochoanitic, and rather thick connecting rings lie within the necks. The siphuncle wall pattern is that of the Endoceratidae, but reference to that family is not automatically certain, for lengthening of the necks also occurs in some specialized Proterocameroceratina.

A paratype (Pl. 10, figs. I-3) represents a considerably earlier portion of a shell; again only the ventral part is preserved, but the fragment, 60 mm long, expands from 36 to 47 mm in width, and shows parts of seven camerae. The camerae are only slightly shorter than those of the larger specimen; they range from 9 to 10 mm in length; evidently, as is common in the larger endoceroids, cameral length increases much more slowly than does the diameter of the shell, if an elliptical shell can be assumed to have a diameter.

At the base of this specimen is seen natural weathered section through the endosiphocone, showing the cone slightly below the center, broader than the siphuncle, its top slightly flattened, the venter more rounded. Blades are not evident.

TYPES—Holotype and paratype, Columbia Univ. No. 28785, and 28786. Both specimens are from the sponge beds, zone N of Hintze, and within the Antelope Valley Limestone of Cooper, from Yellow Gulch, a half mile above its mouth, and half a mile north of Ikes Canyon, Toquima Range, Nevada.

GENUS *IGNOCERAS,* n. gen.

GENOTYPE: *Ignoceras obliquum,* n. sp.

This is a genus of slender endoceroid in which the sutures slope obliquely apicad from dorsum to the venter, though the slope is negligible on the dorsal surface. There is a large ventral siphuncle depressed in section in contact with the ventral part of the shell. Its wall structure is not yet definitely known, but it appears to be holochoanitic. The endosiphuncle shows an endosiphocone which in cross section lies in the dorsal half of the siphuncle, is a transverse oval, but more nearly flat on the ventral side.

DISCUSSION—This genus resembles *Trinitoceras,* except that here the cone lies in the dorsal half of the siphuncle and is strongly flattened ventrally; in *Trinitoceras* the endosiphocone is flattened dorsally and rounded ventrally.

Ignoceras obliquum, n. sp.

P1. 11, figs. 1 1-1 3

The type is a part of large phragmocone 125 mm long increasing in width from 64 mm to 82 mm, depressed in section, and showing septa which slope apicad from the dorsum to the venter. The endosiphuncle thickens ventrally rather than dorsally, and at the apical end shows a section in the apical third of the endosiphocone which is elliptical, depressed, and closer to the dorsum than to the venter (Pl. 11, fig. 13).

At the base the shell is 64 mm wide and 55 mm high, with a siphuncle 33 mm wide and 26 mm high, showing an elliptical section of the endosiphocone 7 mm high, 17 mm wide, 17 from the venter and 2 mm from the dorsum. Adorally the shell is crushed, showing a width of 82 mm, a height estimated as between 65 and 70 mm, a siphuncle 44 mm wide, somewhat crushed, with an estimated height of 30 mm; the anterior end shows a section through the anterior end of the endosiphocone, with endocone material averaging 4 mm thick dorsally and laterally, but thicker ventrally, but not forming a ventral boss or process. The specimen shows in its length ten complete camerae and parts of two more, which vary slightly in length from 10 mm basally to 13 mm adorally. Sutures form broad lobes on the venter, but are nearly transverse laterally and presumably also dorsally.

DISCUSSION—This is another endoceroid of depressed section showing ventral lobes. Its siphuncle wall appears to be holochoanitic, but has not been sectioned. The endosiphuncle is unlike that of either *Kiotoceras* or *Trinitoceras,* the cone becomes depressed, flattened ventrally rather than dorsally, and comes to lie in the dorsal rather than the ventral half of the siphuncle.

TYPE AND OCCURRENCES—The holotype, no. 1539 was collected by the writer from the Kanosh Shale; lithology suggests the upper Kanosh, zone N, rather than zone M, but this was from an early collection made before the writer was completely familiar with the faunal succession in the Kanosh Shale. It is from near section K of the Ibex area, southern end of the Confusion Range, western Utah.

Family PADUNOCERATIDAE Balashov, 1960

GENUS *ROSSOCERAS* Flower, 1964

GENOTYPE: *Rossoceras lamelliferum* Flower, 1964

Rossoceras Flower, 1964, New Mexico Bureau Mines Mineral Resources, Mem. 13. p. 59; Flower 1968, New Mexico Bureau Mines Mineral Resources, Mem. 19. p. 32.

No additional material of this genus is described at this time. Several species, in manuscript for some years, are delayed in publication, because they were based upon fragmentary material, and some doubt existed as to the precise stratigraphic origin of some of the specimens. It is possible to define them from much more complete material, and from material of precisely recorded horizons, particularly in the sections in western Utah. Some notes on the range of the genus are, however, relevent.

Rossoceras was first made known from material from zone L in the upper part of the Garden City limestone in northern Utah. Material from the Ibex region of western Utah has shown that *Rossoceras*, possibly represented by *R. lamelliferum*, is the most abundant endoceroid in zone L there also. In the Juab Limestone, a different and a larger species is the commonest endoceroid in the overlying zone M, in the Kanosh Shale. Comparable and possibly conspecific material occurs in zone M in the lower Swan Peak Formation of northern Utah, but the specimens are crushed and considerably replaced, and are not actually determinable; specific and even generic assignments are inferrential. No *Rossoceras* has yet been recognized in zone N, comprising the upper Kanosh Shale and the overlying Lehman limestone.

As yet, *Rossoceras* has not been recognized in beds of Whiterock age in Oklahoma or in Newfoundland. It is not impossible that the genus is difficult to recognize there because of gross recrystallization of siphuncles, though from examination of considerable material, this appears unlikely.

Some of the types of Holm's (1885) *Endoceras gladius* suggest *Rossoceras* (notably his pl. 3, fig. 1) particularly in the trifid blade pattern, which is one found where finer branching blades are lost by recrystallization, but Balashov (1968, p. 3, pl. 29) has instead referred this material to *Proterovaginoceras*. Some of the material, however, belongs to *Williamsoceras* (Holm's pl. 2, fig. 2a-h).

Hill, Playford and Woods (1969, pl. 0 4, fig. 8a-g) illustrate cross sections of siphuncles that are reasonably *Rossoceras*, though somewhat recrystallized, with some blades destroyed, others accentuated by recrystallization as in some material from Ikes Canyon (Flower 1964b, pl. 4, figs. 18, 19). The material, figured as *Proterocameroceras* sp. nov., is from the Nora Formation, head of Wheelaman Creek, Toko Range, Queensland. The same generic assignment is reasonable for *Proterocameroceras* sp. (Hill, Playford and Woods, 1969, pl. 0 4, fig. 2a-b) from the Nora Formation, base of Neeyamba Hill, Toko Range.

Siphuncles of *Rossoceras* were collected by the writer with Dr. Lehi Hintze and Dr. Swenson from the north end of the Ely Springs Range, west of Pioche, Nevada, in a massive limestone determined by Dr. Hintze and Dr. Swenson as representing zone M. Shales believed to represent this same zone in the section near Sunnyside, Nevada, (the section, described in Hintze, 1951, 1952) possibly yield the same genus and species as that of the lower Kanosh Shale.

The section at Ikes Canyon, Nevada, has failed to yield *Rossoceras* in the lower *Nileus* beds. The overlying sponge beds have yielded some large endoceroids, but they are crushed and somewhat recrystallized, and neither generic nor specific identifications are certain. *Rossoceras* siphuncles reported as coming from the sponge beds are, from lithology and subsequent collecting, from the overlying *Palliseria* beds, which are there somewhat atypical in lithology. Instead of being massive dark weathering beds, they are gray limestones, weathering light gray with tan stringers, and with variable replacement by orange-weathering silica. At Meikeljohn Peak no *Rossoceras* has been found in the lower reef beds, nor in non-reefy fairly soft and nonresistant dark beds above, which are reasonably the equivalent of the sponge beds of Ikes Canyon, but large siphuncles have been found in the dark massive *Palliseria* beds above. It is interesting to note that *Rossoceras* appears in later beds of zones N and 0 in Utah, but in Nevada it is wanting in the lower beds, and appears in the *Palliseria* zone.

The anomaly of *Rossoceras* appearing early in the Whiterock in Utah, and only late in the Whiterock of central Nevada, is not unique, but similar though different anomalies exist in other cephalopod groups. In Nevada *Litoceras* is known from the lower *Nileus* beds and from the reefs at Meikeljohn Peak, and more abundantly from the sponge beds of Ikes Canyon, but has not been encountered in the *Palliseria* beds. In western Utah *Plectolites* is common in zone L, rarer in zone M, but true *Litoceras* and the closely allied *Jasperoceras* are known only in zone N. In Oklahoma a somewhat doubtful *Litoceras* appears in the Joins limestone, but *Jasperoceras* is known only in the Jasper Limestone of Arkansas, which is reasonably zone N. In the sponge beds of Ikes Canyon, *Jasperoceras* and *Litoceras* are very difficult to distinguish; material consists largely of internal molds, and it is difficult to tell whether such shells were externally smooth as is true of *Litoceras*, or whether they are costate. Both types of shells are present there, largely in the sponge beds. In Newfoundland *Litoceras*, as of the sense of Flower 1968b, is the dominant coiled genus of the lower Table Head, but persists into the black limestones of Logan's (1863) zone M and possibly in the higher beds with shaly partings and abundant trilobites, which continue to the base of Logan's (1863) zone N. *Plectolites* we have found rare there, only in the middle part of the lower gray massive beds of the lower Table Head Limestone.

Family ALLOTRIOCERATIDAE Flower, 1955

GENUS *WILLIAMSOCERAS* Flower, 1968
GENOTYPE: *Williamsoceras adnatum* Flower, 1968

Text fig. 2A-H

Williamsoceras Flower, 1968, New Mexico Bureau Mines Mineral Resources, Mem. 19, p. 19.

This is a genus of slender endoceroids, the siphuncle ventral, its wall holochoanitic to macrochoanitic. Such endosiphuncles as approach the apex show it to be small and slender, and not inflated as in *Nanno* or even rapidly expanding apically as in *Cameroceras* and *Foerstellites.* The endosiphocone develops first as a ventral process, a pilar extending perhaps half way from the venter to the dorsum of the siphuncle (Text fig. 3 B-E). Cones are then draped around this, and the endosiphocone terminates in a dark band, as seen in cross section, the infula, connecting an arc of small tubes. The endosiphocone reaches its termination first ventrally, and extends backward toward the dorsum.

This genus was first known only from the Whiterock Stage of northern Utah, in zone L. Some more material has since been collected from the same zone as represented in the Juab Limestone of Western Utah. In spite of extensive collecting, only a few fragmentary specimens have been obtained; endoceroids of the Juab Limestone of the genus *Rossoceras* are far commoner. It should be noted that in Hill, Playford and Woods (1969) some sections pertaining to this genus have been illustrated, but while the species *adnatum* Flower is recognized, it is treated as a species of the genus *Manchuroceras.* Amazing.

Clearly, *Williamsoceras,* with its long slender siphuncle and multiple tubes connected by an infula, is quite distinct from *Manchuroceras,* which is breviconic, and contains only a single endosiphotube. The associated *Proterocameroceras* (pl. 0 4) is clearly *a Rossoceras,* and the two together suggest that the source of these forms, the Nora limestone, mainly from the Toko range, represents yet another occurrence of beds of Whiterock age; this is in Queensland, Australia.

While *Williamsoceras* is a distinctive genus, problems remain at the specific level which can be solved only with more and better material. Reasonably, one might expect the specimens here described from the Juab Limestone of western Utah to be conspecific with those from the same zone in the upper Garden City limestone of northern Utah. The material shows slight differences, which seem to be largely original, though specimens are complicated by varying degrees of recrystallization, and the Garden City material, being in an area of extensive faulting and thrusting, may be somewhat distorted in section. No evidence of such distortion has been found in the endoceroids of the Juab Limestone of western Utah. Specimens are largely assigned tentatively to the Garden City species, but it must be noted that there are differences, which may, with more and better material, require the recognition of the Juab specimens as specifically distinct.

Although there is extensive material at hand, *Williamsoceras* has not been found yet in the Antelope Valley Limestone of Nevada, and material which at first glance seemed to represent *Williamsoceras* in Oklanoma proves to have a siphuncle similar in aspect, but inverted in pattern, a large process developing on the dorsum and not on the venter; this is the genus *Najaceras.*

As noted in the introduction, part of the material on which Holm (1885) based *Endoceras gladius* pertains to *Williamsoceras.* The annuli on the endosiphocone are shown in P1. 2, fig. 3; a ventral process is shown in Pl. 2, fig. 2. On the other hand, the section shown in Holm's pl. 3, fig. 1, suggests *Rossoceras* but is probably *Proterovaginoceras* instead, as Balashov (1968) concluded. Annuli on the endosiphocone of *Williamsoceras are* shown here for W. cf. *adnatum*, on Pl. 11, figs. I-4 and 6.

Williamsoceras cf. *adnatum* Flower, 1968
Pl. 11, figs. 1-8

Williamsoceras adnatum Flower, 1968, New Mexico Bureau Mines Mineral Resources, Mem. 19, p. 28, pl. 17, figs. 1-15, pl. 18, figs. 8-16, 24-26. pl. 19, figs. 1-8, text figs. 2-4.

This species was described from a series of specimens from zone L, of lower Whiterock age, from the upper part of the Garden City limestone of northern Utah. The Juab Limestone of the Ibex region, in western Utah at the southern end of the Confusion Range, has yielded a number of specimens which seem very similar. They are here described as W. cf. *adnatum,* and the individual specimens are discussed separately below. With such fragmentary remains, it is almost impossible to reach a certain decision at the specific level.

No. 1538, pl. 11, figs. I-4, is an endosiphuncle 150 mm long, the apical end broken obliquely. Adorally the specimen split in such a way as to show the surface of the endosiphocone which bears low rounded annuli slightly oblique, and also slightly oblique to the apparent plane of symmetry. Six such annuli occur in 30 mm, and adorally two more are seen which are incomplete. Near the anterior end the siphuncle is 17 mm in diameter, the cone 15 mm; 40 mm farther apicad the siphuncle is still 16 mm across, but the cone is reduced to 10 mm. The surface exposed is a right dorsolateral view.

Apicad from the internal mold of the cone, two dark lines extend apicad, marking the intersection of the broken surface with the infula; 42 mm from the apical end of the exposed cone surface the siphuncle is 14 mm across, showing an infula 10 mm high and 60 mm wide tangent to the siphuncle margin ventrally. The siphuncle extends incompletely apicad for another 60 mm, but there is not enough left to show its diameter at the base of the apical end of specimen.

This is a rather small siphuncle, of particular interest in showing an annulated surface of the endosiphocone, which has not been observed in other forms. It is of interest to note that *Endoceras gladius* Holm 1885, pl. 2, fig. 3a-c, shows somewhat similar annuli on the surface of the endosiphocone, and the cross sections shown on his pl. 2, figs. 2a and 2b suggest *Williamsoceras.* Other cross sections do not, and it is feared that Holm included two, possibly three different species under this name. His pl. 2, fig. I shows no annuli on the endosiphocone, which are present in figs. 2d and 3. His pl. 3, fig. la-c show the exterior of a siphuncle with oblique coarse annuli. The cross sections taken from this specimen show a semicircular endosiphocone and a trifid blade pattern, reminiscent of *Proterocameroceras;* there is certainly no such ventral process here as is characteristic of *Williamsoceras.*

No. 1536, Pl. 11, fig. 5 consists of the ventral part of a phragmocone incomplete adorally, notable mainly for a cross section at its base showing an endosiphuncle with a crescentic endosiphocone, a large round ventral process, and an infula which is tangent to the venter, its lower converging limbs nearly straight and clearly divided into a series of small triangular tubes. The siphuncle in cross section is 22 mm high and 19 mm wide, showing a ventral mass 11 mm high and 7 mm wide, and an endosiphocone 13 mm wide with a median height of 4 mm. The shell here is 38 mm wide; the height is slightly less than the width, but the dorsum is not preserved. An anterior length of phragmocone of 80 mm is preserved, but it fails to show spacing or pattern of the septa. The lower limbs of the infula show clearly small tubes, triangular in cross section.

No. 1539, Pl. 11, fig. 6 is a part of a siphuncle 84 mm in length expanding from 9 to 15 mm. It is exfoliated partly from the rock and shows a dorsal surface marked by low broad rounded annuli. Six segments occur in the apical 30 mm. Juncture of septa with the siphuncle is not clearly shown, the anterior end shows an infula which is only most narrowly adnate to the siphuncle margin on the venter.

DISCUSSION—This material is illustrated to show the annular surface of the siphuncle. Some anterior fragments, not illustrated, suggest that the siphuncle becomes much more slender anteriorly; such fragments are broken longitudinally and show the intersection of the surface with the infula as dark longitudinal lines, like those of no. 1538, Pl. 11, figs. I-4.

No. 1540, Pl. 11, figs. 7, 8, a part of an endosciphuncle, expands from a diameter of 18 mm with an infula 15 mm high and 10 mm wide, to a section of 22 mm, with the infula 11 mm wide and 16 mm high in a length of 80 mm. The infula is barely adnate, essentially tangent to the ventral margin of the siphuncle; the axis of the ventral mass is variously preserved, and tubes are seen obscurely in the adoral section, apically a few tubes are visible laterally.

FIGURED SPECIMENS-110S. 1537-1540 are all from the Juab Limestone of the Ibex region, southern end of the Confusion Range, western Utah.

Williamsoceras compressum, n. sp.
Pl. 10, figs. 11-14

Of this form we have only an endosiphuncle 155 mm in length; basally and adorally the section is faintly compressed, but is subcircular at midlength; it expands from 11 mm to 20.5 mm in height. A section 6 mm from the extreme anterior end (Pl. 10, fig. 11) shows the siphuncle 20.5 mm high and 19 mm wide. The section cuts the endosiphocone which is crescentic, 4 mm high centrally, with a maximum height of 7 mm and a width of 8 mm. From its lower angles extend dark bands of the infula, slightly curved, convexity directed laterad. The ventral mass is 8 mm high, shows a maximum width, near the venter, of 9 mm, and is adnate to the venter for a width of 7 mm.

A section 44 mm farther apicad (Pl. 10, fig. 12) shows a siphuncle 17 mm high and 16 mm wide, with an infula bounding a ventral mass 10 mm high, and with a maximum width of 9 mm in the lower third. Tubes along the infula are not evident, but its dorsal extremity is widened, and the widening shows partitions dividing it into a number of tubes with sharply angled boundaries.

A section 36 mm farther apicad (Pl. 10, fig. 13) shows a siphuncle 14 mm wide and 14 mm high, with the infula a sharp line, bounding a ventral mass 8 mm high with a maximum width of 6 mm, and adnate for a width of 5 mm. Here again the infula is widened at its dorsal extremity. Laterally, tubes are tiny and narrow.

A section close to the apical end of the specimen, 46 mm farther apicad, shows a siphuncle 11 mm high and very slightly compressed, with an infula 7 mm high, 6 mm wide, the sides showing reduced curvature as they approach the venter, to which the ventral mass is broadly adnate, as before. Here again the infula is widened dorsally but it shows a widening also on the one ventrolateral limb.

DISCUSSION—This species shows endosiphonal features which are rather peculiar. The compressed cross section is believed to be real; the Juab shows no other endosiphuncles in which crushing has occurred. The ventral mass is extremely broadly adnate, and the infula shows consistently a widening of its middorsal area, while its lateral limbs show only few very fine tubes, which are evident only at high magnification; there is nothing here comparable to the large tubes of W. *adnaturn.* No median blade of the ventral mass is evident in any of the sections.

TYPE AND OCCURRENCE—Holotype, no. 1534, from the Juab Limestone, between sections J and K, Ibex region, southern end of the Confusion Range, western Utah.

Williamsoceras cf. **_ankhiferum_** Flower, 1968
Pl. 11, figs. 9, 10

Williamsoceras ankhiferum Flower, 1968, New Mexico Bureau Mines Mineral Resources, Mem. 19, p. 31, pl. 18, figs. 1-7.

This form is known only from a small piece of siphuncle 31 mm long expanding from 19 and 23.5 mm to 20 and 25 mm. The ventral mass is broadly adnate to the venter for a width of 5 mm at each end. The infula at the basal end shows the sides well rounded, slightly flattened dorsally, and with two straight dorsolatal blades diverging from it to the siphuncle margin; on the opposite side a single blade is seen. Between the dorsolateral blades, the infula is slightly flattened. Tubes are not clearly evident, but the infula consists of two dark walls, subparallel, with a light space between, in which obscure divisions can be seen. Apically the infula is 10 mm high and 95 mm wide, its sides well rounded. Adorally the infula is slightly narrowed and its ventral limbs show a reduction of curvature as they approach each other ventrally. Again traces of two dorsolateral blades are seen on one side, which join before reaching the infula. The weathered venter shows two prominent dark lines where the infula joins the ventral margin of the siphuncle.

DISCUSSION—This endosiphuncle bears a strong resemblance to that of *Williamsoceras ankhiferum* (Text fig. 3 H, I), but shows also some differences; instead of a middorsal blade, there are dorsolateral blades and oddly, apically that on the left is divided into two straight blades joining at the infula, while at the other end two such blades join before reaching the infula, and are on the right rather than on the left; at either end there is only a single blade seen in the corresponding position on the other side. Quite probably this is a species distinct from W. *ankhiferum*, but the one specimen seems too fragmentary to serve as an adequate basis for a species.

FIGURED SPECIMEN—No. 1537, from the upper 70 feet of the Juab Limestone, Ibex area, southern end of the Confusion Range, western Utah.

Williamsoceras ellipticum, n. sp.
P1. 9, figs. 1-5

This form is known from an endosiphuncle 174 mm long. It is enclosed in matrix, and its features are known from a series of cross sections. At the anterior end (Pl. 9, fig. 1) a large ventral process is seen, 15 mm high and 6 mm wide; the remainder of the siphuncle is incomplete, but a width of 30 mm is indicated, with a height, judging from other sections, slightly greater. In 34 mm the siphuncle (Pl. 9, fig. 2) is 28 mm high, 26 mm wide, has a ventral process 16 mm high 11 mm wide, and a lining of endocone material 4 mm thick. The prosess shows a clear axis and is tangent to the shell wall. The next adapical cross section (Pl. 9, figs. 3, 4), 38 mm farther apicad, shows a siphuncle 25 mm high and 24 mm wide, with an infula 17 mm high and 13 mm wide tangent to the ventral wall of the siphuncle. A section 84 mm farther apicad shows a siphuncle (Pl. 9, fig. 5) 18 mm high and 16 mm wide, slightly compressed in aspect, but with a slight flattening of the venter, containing an infula 18 mm high and 18 mm wide.

Tubes are generally small and obscure; the infula is marked by gray calcite; contrast is slightly exaggerated in the photographs.

DISCUSSION—The compressed cross section is ap• parently original, and serves to distinguish this species from W. *adnatum*, which it resembles in the infula being tangent to the ventral wall of the siphuncle. The tube; are smaller and more obscure.

TYPE AND OCCURRENCE—Holotype, no. 1535, from the basal beds of the Juab Limestone, between sections J and K, Ibex region, southern end of the Confusior. Range, western Utah.

GENUS *CACHEOCERAS* Flower, 1968
Text fig. 3 J-M

Cacheoceras Flower, 1968, New Mexico Bureau Mines Mineral Resources, Mem. 19, p. 3*i*.

Cacheoceras is essentially a *Williamsoceras* in which in addition to the infula two processes outlined by blades extend into the cavity of the endosiphocone. At closure of the cone, these blades join the infula. A second species here described, shows a pair of curved blades outlining only a single middorsal mass of this sort. At present, this species is retained in *Cacheoceras,* which is redefined as having one or more such invagina tions into the endosiphocone. Future work may show the advisability of making a separate genus for this species, but at present this single species shows no other anomalies, morphological or stratigraphic. Both *C. trifidum* and *C. uniondum* are from zone L, the former from the Garden City of northern Utah, the latter from the Juab Limestone of west-central Utah.

Cacheoceras uninodum, n.
sp. P1. 10, figs. 4-7
Text fig. 3 L-M

This species is known from an endosiphuncle with a maximum preserved length of 204 mm. At the adoral end the cross section (Pl. 10, fig. 4) is 30 mm wide, 29 mm high, showing a ventral process 16 mm high with a dark axis, a lining elsewhere 2 mm thick, interrupted by a small dorsal node, bounded by straight dark lines dorsolaterally and a rounded ventral surface, the whole 5 mm long and 5 mm wide.

A second cross section, 92 mm farther apicad (P1. 10, fig. 5) shows the siphuncle 24 mm high and 25 mm wide, with an infula narrowly adnate to the venter, 16 mm high and 14 mm wide, evenly curved, elliptical, but with a slight dorsal flattening where it joins the dorsal node. The dorsal node is 6 mm wide, widest where it joins the infula, 6 mm high, the dark bands marking its sides diverging from dorsum to venter, slightly curved, the convexity facing the sides.

A third cross section taken 75 mm farther apicad shows a cross section incomplete on one side, but the siphuncle is 17 mm high and apparently 17 mm wide, the infula is 12 mm high, 11 mm wide, the dorsal half more strongly rounded than the ventral half, and slightly flattened where it joins the dorsal node, which is 4 mm wide and 5 mm long, the sides slightly convex as before. All sections show a dark axis of the ventral process.

DISCUSSION—We know nothing of the siphuncle surface or of the gross parts of the shell or of the siphuncle wall structure. *Cacheoceras trifidum* has the infula and the endocones modified by two dorsolateral masses; our present form shows only one dorsal mass.

TYPE AND OCCURRENCE—No. 1533, collection of the writer, from the Juab Limestone, probably from the basal ledge, from the vicinity of sections J and K, Ibex region, southern Confusion Range, western Utah.

GENUS *PERKINSOCERAS*, n. gen.
GENOTYPE: *Perkinsoceras infiatum*, n. sp.

This is a member of the Allotrioceratidae, with an arc-like infula like that of *Williamsoceras,* containing an arc of small tubes. It differs from *Williamsoceras in* that the limbs of the infula are widely separated where they join the edge of the endosiphuncle, and that the apical part of the siphuncle is swollen as in the form-genus *Nanno.*

Included at present in the genus are two species from the Chazyan of the Champlain valley, both known as yet only from endosiphuncles. General features of the genus are shown in text fig. 3 P-R.

Perkinsoceras inflatum, n. sp.
Pl. 14, figs. 9-12 Text fig. 3 P-R

This form is known from a single specimen, an endosiphuncle 150 mm long, in matrix, weathered from the dorsal side the middorsum being just to the left of the center as oriented on our Pl. 14, figs. 9, 10. The apical 45 mm of the siphuncle is inflated as in the form-genus *Nanno*, widening to 25 mm in the first 25 mm, contracting to 19 mm in the remaining 20 mm. The dorsum is apparently inflated, the venter, presumably straight, is not exposed. Unfortunately the apical part of the inflated region is weathered below the middle. In the remaining length, the siphuncle is slender, enlarging to only 19 mm in the first 60 mm; farther orad the specimen is weathered below the middle, but the siphuncle is evidently very slender, nearly tubular. In cross section, the venter is strongly flattened, with the width 18 mm where the height is 14 mm. An infula forms a broad arc, its lower limbs terminating wide apart, a width nearly equal to that of the broad flattened ventral part of the cross section. Ventrolaterally it is narrow and dark; dorsally it widens and is divided into a series of tubes filled with light calcite in the section shown on P1. 14, fig. 11. A section 15 mm farther apicad (not figured) shows a very similar condition except that the infula is less widened dorsally, the tubes are smaller, and its margins are feathered, dark bands extending from it marking evident endosiphosheaths. The ventral region is grossly recrystallized, and fails to show evidence of an axis of the ventral process.

DISCUSSION—This form, from its position in the Chazy Limestone and the development of an arc-like infula, I expected to be *Meniscoceras*. However, the arc arches from ventral limbs up and across the dorsum, and the flattening of the ventral surface marks it plainly and supplies a good basis for interpreting this form as having a pattern almost upside down from that of *Meniscoceras*, but one agreeing with *Williamsoceras*.

The *Nanno-like* inflation of the apical end of the siphuncle is a surprising feature, and one not known in *Williamsoceras*. This form is regarded as a new but allied genus. It shows, however, the development of such an apex as is unknown in the other Allotrioceratidae. It must then be concluded that such apical inflation of the siphuncle is adaptive, is not confined, as I had previously believed, to the Endoceratidae, and clearly cannot be, in the Allotrioceratidae, a recapitulation of a piloceroid phase in evolution as I had suggested for the Endoceratidae.

TYPE AND OCCURRENCE—No. 1584, collection of the writer from the Crown Point Limestone, 0.5 miles south of Ferrisburg, Vermont.

Perkinsoceras foerstei, n. sp.
Pl. 14, figs. 5-8

This form is represented by a part of an endosiphuncle 164 mm long. At the base the cross section shows a height of 17 mm a width of 19 mm. It expands adorally to a width of 24 mm in a length of 100 mm, with an apparent height of 22 mm (we do not know how much was lost in making a horizontal section) while in the remaining 65 mm the width continues to increase gently, though the anterior width shown, 25 mm, is less than maximum, as the surface shown lies below the point of greatest width.

As in the preceding form, the infula joins the venter with its limbs rather far apart, arches across the dorsum, and shows a series of small tubes filled with light calcite, while its dark edges are feathered, extending as sheaths a little way into the main calcareous mass of the endosiphuncle. Two curved dark bands extend downward from the middle of the arc, but disappear about half way to the ventral side; they appear to represent the boundaries of the ventral mass.

In two respects this form differs from the preceding one enough that I consider it a different species. The siphuncle shows a more rapid rate of enlargement, and, probably more important, the cross section is quite different in that the venter is well rounded rather than flattened.

TYPE—USNM no. 307, from the Upper Chazyan, Isle La Motte, Vermont. This specimen was labeled *Lamottoceras*, a manuscript name of Foerste's, for which I have not been able to find any manuscript. I had formerly believed it to be identical with my genus *Meniscoceras*, based upon material from the Crown Point Limestone, Middle Chazy, at Crown Point, New York.

References for Parts I and II

Balashov, Z. G., 1960, Novye ordovikski nautiloidei SSSR: *in* Novye vidy drevnikh rasteniy bespoz vonochnyk SSSR, part 2, p. 123-136, pls. 26-31.

———, 1962, Nautiloidei Ordovika Sibirskoi platformi: Izadatelstvo Leningradskogo Univ., 204 p., 52 pls.

———, 1968, Endoceratoidei dei Ordovika, SSSR: Izdatelstvo Leningradskogo Univ., 277 p., 51 pls., 23 figs., 2 tables.

Barrande, J., 1865-1877, Système Silurien du centre de la Bohême, Pt. 2, Céphalopodes, texte: pt. 1, p. 1-712, 1867; pt. 2, 1-263, 1870; pt. 3, p. 1-804, 1874; pt. 4, p. 1-743, 1877; pt. 5, p. 1-743, 1877; supp., p. 1-297, 1877; pls. 1-107, 1865; pls. 108-244, 1866; pls. 245-350, 1868; pls. 351-460, 1870; supp. pls. 461-544, 1877. Prague (Praha).

Billings, E., 1865 (1861-65), Paleozoic fossils, containing descriptions of new or little known species of organic remains from the Silurian rocks: Canada Geol. Survey, v. 1, 426 p., 401 figs.

Chang, Jihtung, 1965, On some lower Ordovician nautiloids from Qilianshan, northwestern China: Acta Palaeontographica Sinica, v. 13, no. 2, p. 343-362, 4 pls. (Chinese, with English summary).

Collins, D. H., 1967, Endocone diaphragms and the "phragmocone of *Ecdyceras*" (Nautiloidea): Jour. Paleontology, v. 41, p. 1101-1112, 1 pl., 7 figs.

Endo, R., 1932, The Canadian and Ordovician of southern Manchuria: U.S. Natl. Mus., Bull. 164, 152 p., 40 pls., map.

———, 1935, Additional fossils from the Canadian and Ordovician rocks of the southern part of Manchuoko: Tohoku Imp. Univ., Sci. Repts., ser. 2, v. 16, no. 4, p. 191-223, 6 pls.

Fåhraeus, L. E., 1970, Conodont-based correlations of Lower and Middle Ordovician strata in western Newfoundland: Geol. Soc. America, Bull., v. 81, no. 7, p. 2061-2076, 4 figs., 2 tables.

Flower, R. H., 1941, Notes on structure and phylogeny of eurysiphonate cephalopods: Palaeontographica Americana, v. 3, no. 13, 56 p., 3 pls., 3 figs.

———, 1947, Holochoanites are endoceroids: Ohio Jour. Sci., v. 47, p. 155-172, 3 figs.

———, 1955a, Status of endoceroid classification: Jour. Paleontology, v. 29, p. 329-371, pls. 32-35, 6 figs.

———, 1955b, New Chazy orthocones: Jour. Paleontology, v. 29, p. 806-830, pls. 77-81, 1 fig.

———, 1956, Cephalopods from the Canadian of Maryland: Jour. Paleontology, v. 30, p. 75-96, pls. 19-21, 22 (pars), figs. 1-15.

———, 1957, Studies of the Actinoceratida, I, The Ordovician development of the Actinoceratida: New Mexico Bureau Mines Mineral Resources, Mem. 13, 79 p., 6 pls., 23 figs.

———, 1958, Some Chazyan and Mohawkian Endoceratida: Jour. Paleontology, v. 32, p. 433-458, 4 pls., 2 figs.

———, 1964a, The nautiloid order Ellesmeroceratida (Cephalopoda): New Mexico Bureau Mines Mineral Resources, Mem. 12, 234 p., 32 pls., 53 figs.

———, 1964b, Nautiloid shell morphology: New Mexico Bureau Mines Mineral Resources, Mem. 13, 79 p., 6 pls., 23 figs.

———, 1968a, The first great expansion of the Actinoceratida: New Mexico Bureau Mines Mineral Resources, Mem. 19, pt. 1, p. 1-16, pls. 1-30 (pars), 1 fig.

———, 1968b, Some additional Whiterock cephalopods: New Mexico Bureau Mines Mineral Resources, Mem. 19, pt. 2, p. 17-55, pls. 1-30 (pars), figs. 2-6.

———, 1968c, Silurian cephalopods of James Bay Lowland, with a revision of the Narthecoceratidae: Canada Geol. Survey, Bull. 164, 88 p., 34 pls.

———, 1968d, *Botryceras*, a remarkable nautiloid from the Second Value of New Mexico: New Mexico Bureau Mines Mineral Resources, Mem. 21, pt. 1, p. 3, 4, pl. 1.

———, 1968e, Endoceroids from the Canadian of Alaska: New Mexico Bureau Mines Mineral Resources, Mem. 21, pt. 3, p. 13-17, pls. 3, 4.

———, 1971, Cephalopods of the Whiterock stage, *in* Dutro, J. T., Jr., (ed), Paleozoic perspectives, a paleontological tribute to G. Arthur Cooper: Smithsonian Contrib. Paleobiology, no. 3, p. 101-111, 2 pls.

Grabau, A. W., 1922, Ordovician fossils from North China: Palaeontologica Sinica, Ser. B, v. 1, fasc. 1, 99 p., 9 pls., 19 figs.

Hill, D., Playford, G., and Woods, J. T., 1969, Ordovician and Silurian fossils of Queensland: Queensland Paleontographical Soc., 18 p., 16 pls.

Hintze, Lehi F., 1951, Lower Ordovician detailed sections for western Utah: Utah Geol. and Mineralog. Survey, Bull. 39, 99 p., 11 figs.

———, 1952, Lower Ordovician trilobites from western Utah: Utah Geol. and Mineralog. Survey, Bull. 48, 249 p., 28 pls., 2 figs.

Holm, G., 1885, Ueber die Innere Organization Einiger Silurischer Cephalopoden: Paleontologische Abhandlungen von Dames und Kayser, v. 3, 28 p., 5 pls.

———, 1896, Om apikalendan hos *Endoceras:* Geol. Foren. i Stockholm, Forh., v. 18, p. 394-426, 3 pls.

Hyatt, A., 1900, Cephalopoda: *in* Zittel-Eastmann Textbook of Paleontology, MacMillan, New York, v. 1, p. 502-604.

Jaanusson, Valdar, 1960, The Viruan (Middle Ordovician) of Öland: Uppsala Univ., Geol. Inst., Bull., v. 38, no. 28, p. 207-288, pls. 1-5, 26 figs., 8 tables.

Kobayashi, Teiichi, 1931a, Studies on the stratigraphy and paleontology of the Cambro-Ordovician formations of Hua-lien-chai and Niu-hsin-tai, south Manchuria: Japanese Jour. Geology and Geography, v. 8, p. 131-189, pls. 16-22, 2 figs.

———, 1931b, Studies on the Ordovician stratigraphy and paleontology of North Korea, with notes on the Ordovician fossils of Shantung and Liaotung: Geol. Surv. Chosen (Korea), v. 11, no. 1, p. 1-60, 9 pls. figs. and tables (unnumbered).

———, 1935, Restudy of *Manchuroceras,* with a brief note on the classification of the endoceroids: Geol. Soc. Japan, Jour., v. 42, p. 736-752, 2 pls., 1 fig.

———, 1936, *Coreanoceras,* one of the most specialized piloceroids, and its benthonic adaptation: Japanese Jour. Geology and Geography, v. 13, p. 187-197, 2 pls., 3 figs.

———, 1969, The Cambro-Ordovician formations and faunas of South Korea, Part X. Stratigraphy of the Chosen group in Korea and Manchuria, and its relationship to Cambro-Ordovician formations of other areas. Section D. The Ordovician of eastern Asia and other parts of the Continent: Tokyo Imperial Univ., Fac. Sci. Jour., sec. 2, (part 2), v. 17, p. 163-316, 18 fossil lists, 20 tables.

Logan, W. E., 1863, Geology of Canada: Canada Geol. Survey, Rept. Prog. to 1863, 983 p.

Mutvei, H., 1964, On the secondary internal calcareous lining of the wall of the siphonal tube in certain fossil nautiloid cephalopods: Ark. Zool., v. 16, p. 375-424, 29 pls., 23 figs.

Nikiforovoi, O. I., (ed.), 1955, Polevoi Atlas Ordovikskoi i Siluriiskoi fauny Siberskoi Platformy: Nsesoiuznvinauchno-Issledov-atel'skii Geologicheshii Institut (Rergei), Ministerstva geologii Iokhrang Nedr. Moscow (Moskva), 266 p., 62 pls., 18 figs.

Ross, R., 1951, Stratigraphy of the Garden City formation in northeastern Utah and its trilobite fauna: Yale Univ. Peabody Mus. Nat. History, Bull. 6, 101 p., 36 pls., 4 figs.

———, 1953, Additional Garden City (Early Ordovician) trilobites: Jour. Paleontology, v. 27, no. 5, p. 633-646, pls. 62-64, 1 fig.

———, 1970, Ordovician brachiopods, trilobites and stratigraphy in eastern and central Nevada: U.S. Geol. Survey Prof. Paper 639, 103 p., 22 pls.

Ruedemann, R., 1905, Structure of primitive cephalopods: New York State Museum, Bull. 162, 51 p., 10 pls., 26 figs.

———, 1906, Cephalopods of the Champlain Basin: New York State Museum, Bull. 90, p. 393-611, 38 pls., 57 figs.

Schuchert, C. and Dunbar, C. O., 1934, Stratigraphy of western Newfoundland: Geol. Soc. America, Mem. 1, 123 p., 11 pls., 4 figs.

Shimizu, S. and Obata, T., 1936, Three new genera of Ordovician nautiloids belonging to the Wutinoceratidae (nov.), from eastern Asia: Shanghai Sci. Inst., Jour., sec. 2, v. 2, p. 27-35.

Sokolov, 1967, Principal problems on stratigraphy of Ordovician and Silurian deposits of central Siberia: *in* The stratigraphy of the lower Paleozoic of central Siberia, p. 21-29, Novosibirsk (in Russian).

Sweet, W. C., 1958, The Middle Ordovician of the Oslo region, Norway: Norsk Geologisk Tidsskrift, bd. 38, h. 1, 178 p., 20 pls., 20 figs.

Teichert, Curt, 1939, The nautiloid genus *Bathmoceras* Barrande: Royal Society of South Australia, Trans., v. 62, part 2, p. 384-391, pl. 19.

———, 1967, Major features of cephalopod evolution: *in* Kansas

Univ. Dept. Geology Spec. Pub. 2, Essays in paleontology and stratigraphy, Raymond C. Moore commemorative volume, p. 162-210, 20 figs., 1 table.

Teichert, Curt, and Glenister, B. F., 1952, Fossil nautiloids from Australia: Jour. Paleontology, v. 26, p. 730-752, 5 pls., 2 figs.

———, 1953, Ordovician and Silurian cephalopods from Tasmania: Bull. Am. Paleontology, v. 34, no. 144, 11 p., 6 pls., 3 figs.

———, 1954, Early Ordovician cephalopod fauna from northwestern Australia: Bull. Am. Paleontology, v. 35, no. 150, 94 p., 10 pls., 18 figs.

Teichert, Curt, Kummel, B., Sweet, W. C., Stenzel, H. B., Furnish, W. M., Glenister, B. V., Erben, H. K., Moore, R. C., and Zeller, D. E., 1964, Treatise on invertebrate paleontology, Part K, Mollusca 3, Cephalopoda–general features, Endoceratoidea-Actinoceratoidea-Nautiloidea-Bactritoidea: Kansas Univ. and Geol. Soc. America, 520 p., 361 figs.

Ulrich, E. O., Foreste, A. F., Miller, A. K., and Unkelsbay, A. G., 1944, Ozarkian and Canadian cephalopods. Part III: Longicones and summary: Geol. Soc. America, Special Papers, no. 58, 226 p., 68 pls., 9 figs.

Yü, C. C., 1930, The Ordovician cephalopods of central China: Palaeontologica Sinica, ser. B., v. 1, fasc. 2, p. 5-71, pls. 1-9, 3 figs., Chinese summary 18 p.

Fossil Plates

PLATES 1-16

Where not otherwise indicated figures are natural size.

PLATE 1

Figures *Page*

1-6 *Cyrtonybyoceras oklahomae,* n. sp. 11

Holotype, Univ. of Oklahoma, no. 64.

1) dorsum. **2)** lateral, dorsum on left. **3)** ventral view; the right side is considerably weathered. **4)** adoral view venter below, showing cross section and position and size of siphuncle. **5)** longitudinal section, slightly off center, showing two series of tubes of the radial canal system in each segment. **6)** longitudinal section, essentially central, showing central tube at both ends and part of the radial canal system. From the upper Oil Creek limestone, 80 rods north of Fall Creek, southeast of Davis, Oklahoma.

7-11 *Wutinoceras curviseptatum,* n. sp. 9

Holotype, U.S. National Museum no. 166171.

7) lateral view, venter on left. **8)** ventral view; the left side of the specimen seen in this view is incomplete. **9)** dorsal view, the right side, as here oriented, is incomplete. **10)** basal view showing cross section and siphuncle proportions. **11)** longitudinal section, venter on right. The plane of the section is slightly oblique to the plane of symmetry, the venter being to the right of the center, the dorsum to the left; the section was cut with regard to the oblique weathered margin shown in figure 10.

Oil Creek limestone, from route 77, in the Arbuckle Mountains, SE¼ SE¼ of section 24, T. 23 N., R. 1 E. From the collections of the U.S. Geological Survey.

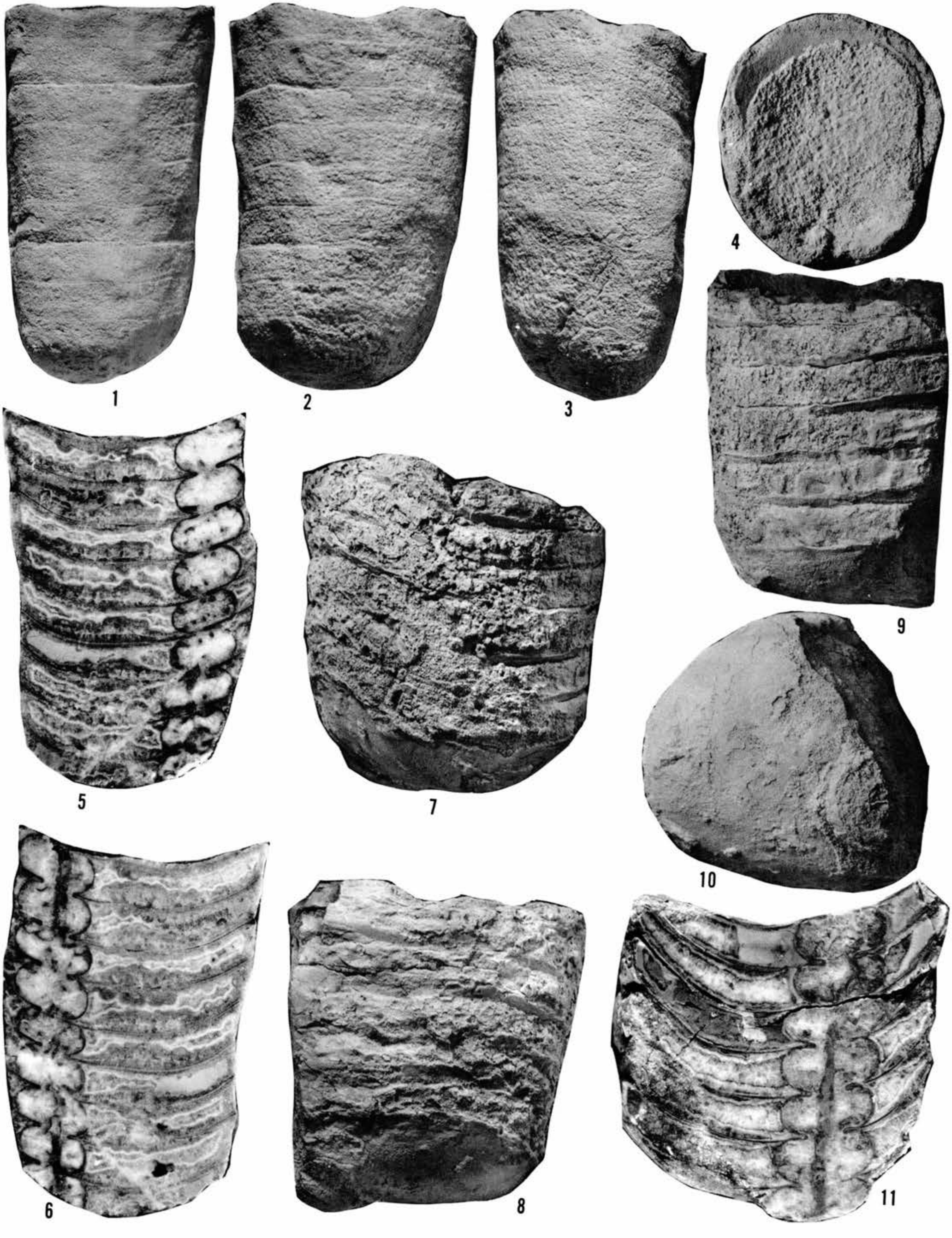
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PLATE 2

Figures		*Page*
1-3	*Adamsoceras billingsi* Flower	11
	Holotype. Geological Survey of Canada no. 620 a, b. **1)** entire specimen, 12/13 natural size, lateral view, venter on left. **2)** same, dorsal view. **3)** vertical section from the apical half of the type, dorsum on left. From the Table Head Limestone, Point Riche, Newfoundland.	
4	*Wutinoceras giganteum,* n. sp.	10
	Vertical section from the apical third of the holotype, shown entire on Pl. 4, figs. 1, 2; venter on right. See also Pl. 3, fig. 12, Pl. 5, fig. 6. Yale Peabody Museum, no. 28351 from the lower Table Head Limestone, Table Head, Newfoundland. See also Pl. 4 and 5, fig. 6.	

PLATE 2

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PLATE 3

Figures		*Page*
1-11	*Wutinoceras reubeni,* n. sp.	9
	1, 2) opposite sides of siphuncle, ×2, showing outline of segments and canal system; fig. 2 is central, showing much of the central canal; fig. 1 shows a surface intersected obliquely by the reticular radial canals. **3)** adoral view, a septal surface. **4)** cross section at the anterior end of the vertically sectioned surface shown in figs. 7 and 8. **5)** cross section at apical end of figs. 7 and 8. **6)** apical view, siphuncle retouched. **7, 8)** opposite sides of a vertical section through the greater length of the type; the siphonal side is the venter. **9)** dorsal view of entire specimen before sectioning. **10)** lateral view of the same, dorsum on left. **11)** ventral view. Holotype, USNM no. 166172, Antelope Valley Limestone, *Palliseria* zone, Hot Creek Range, USGS collection no. D1855-CO.	
12	*Wutinoceras giganteum,* n. sp.	10
	Septum at the base of the apical third of the holotype, oriented with the weathered dorsolateral surface above, Table Head Limestone, Table Head, Newfoundland, YPM 28351. Same specimen as Pl. 5, fig. 6. See also Pl. 4, figs. 1, 2.	
13	*Wutinoceras geronticum,* n. sp.	10
	Apical end of the holotype, a septal surface, venter below. See also Pl. 5, fig. 1. YPM 28352, from the Table Head Limestone, Point Riche, Newfoundland.	

PLATE 3

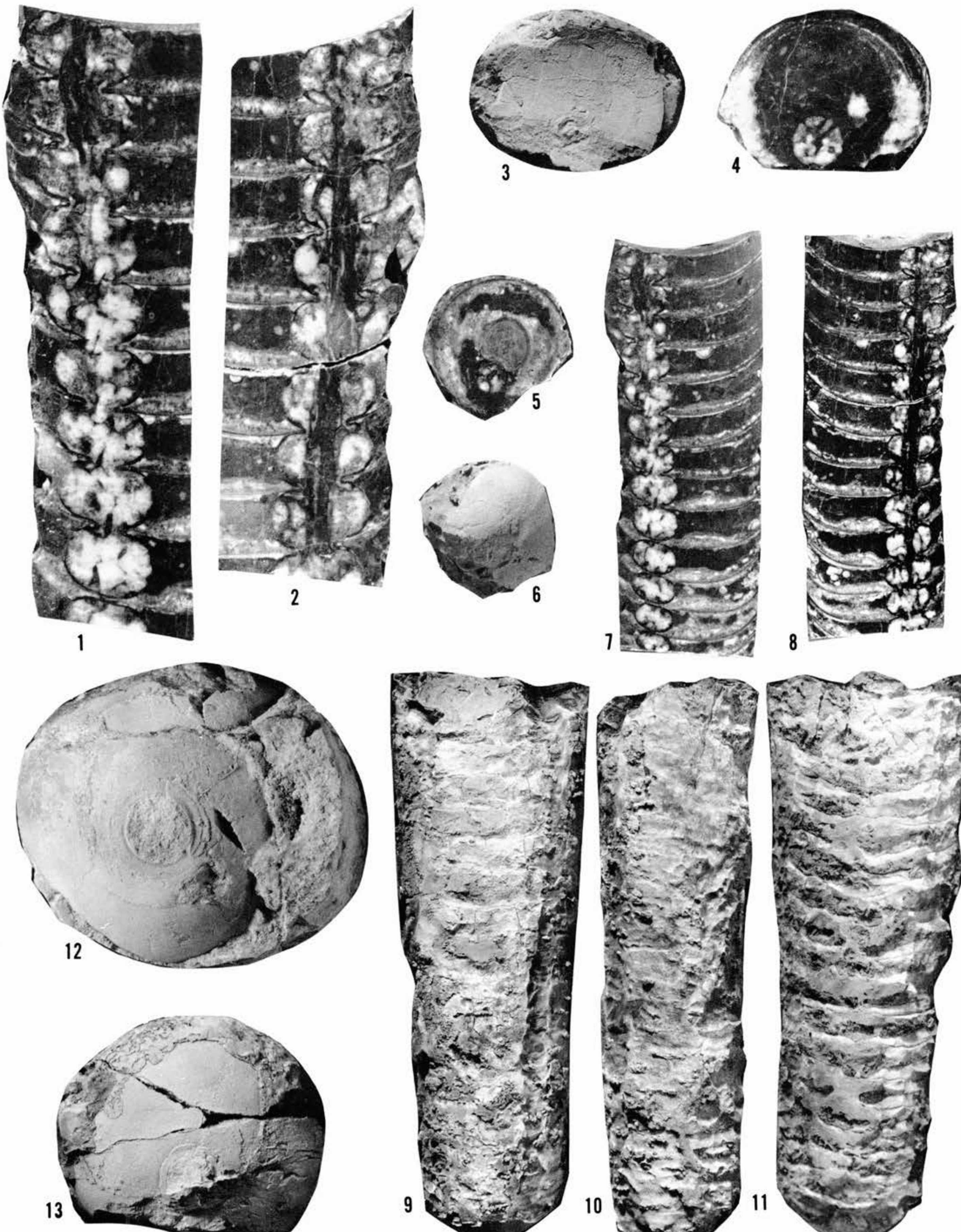

PLATE 4

Figures		*Page*
1-2	*Wutinoceras giganteum,* n. sp.	10

1) weathered surface, the venter. **2)** dorsum, the slightly forward-sloping septa may result from slight crushing; the internal mold shows coarse, broad, low longitudinal lirae, of only the faintest relief. Paratype, Yale Peabody Museum, no. 28352, from the lower Table Head Limestone, Point Riche, Newfoundland. See also Pl. 2, fig. 4 and Pl. 5, fig. 6.

PLATE 4

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PLATE 5

Figures		*Page*
1	*Wutinoceras geronticum*, n. sp. . . . . Holotype showing the weathered ventral surface. Yale Peabody Museum, no. 28354, from the lower Table Head Limestone, Table Head, Newfoundland.	10
2-3, 5	*Adamsoceras transversum*, n. sp. . . . . Paratype, Yale Peabody Museum, no. 28353. **2)** ventral weathered surface. **3)** longitudinal horizontal section from the apical part of the same specimen. **5)** cross section, taken 43 mm from the apical end of the specimen, at the anterior end of fig. 3.	12
4	*Adamsoceras billingsi* Flower . . . . Septum, at the base of the anterior half of the holotype; see Pl. 2, figs. 1-4.	11
6	*Wutinoceras giganteum*, n. sp. . . . . Entire holotype, about ×2.4, length 482 mm, ventrolateral surface; see Pl. 2, fig. 4, for vertical section in the apical part, Pl. 3, fig. 12, for septum at base of the anterior two thirds and Pl. 4. Yale Peabody Museum, no. 28351, from the lower Table Head Limestone, Table Head, Newfoundland.	10

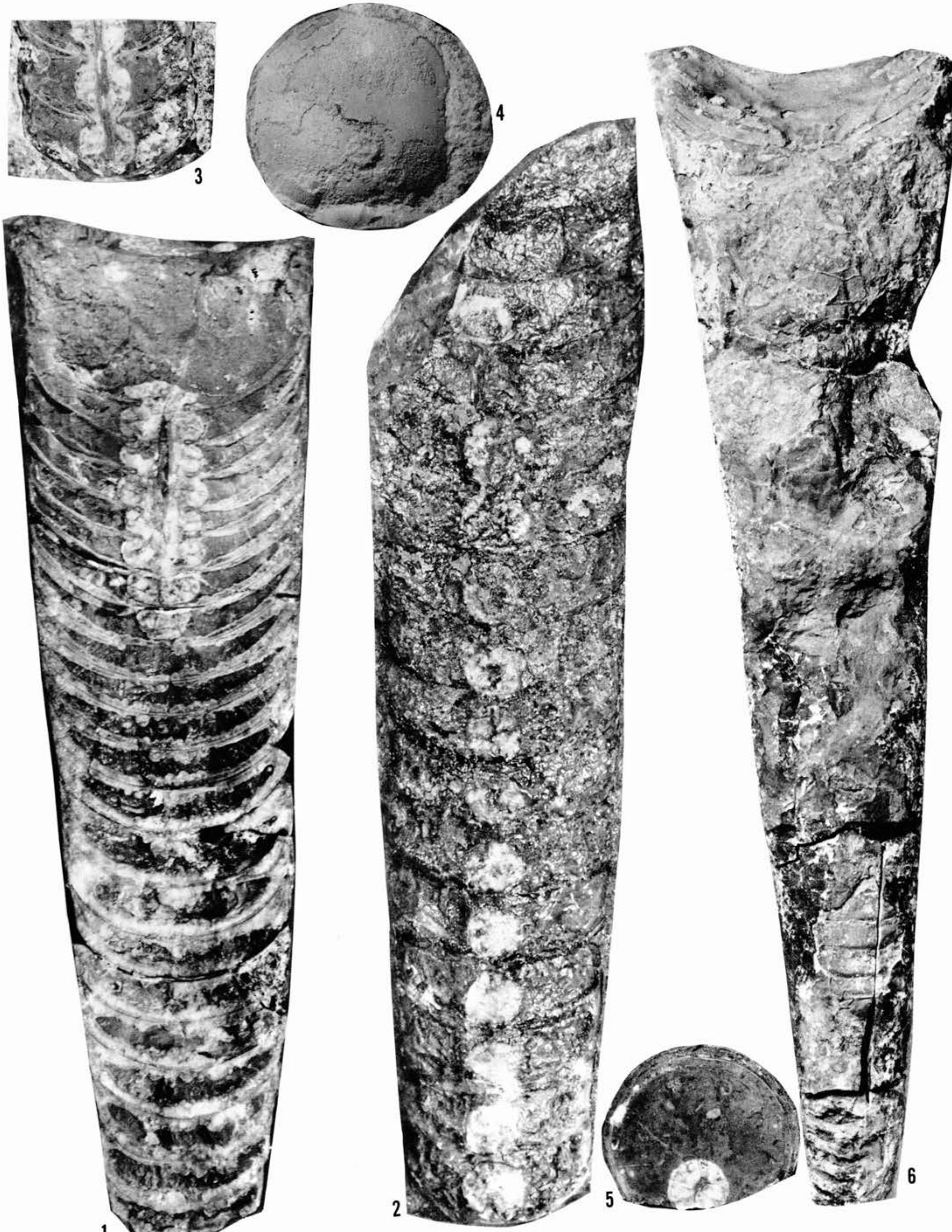
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PLATE 6

Figures *Page*

1-4 cf. *Najaceras bilobatum* Flower 27
USNM no. 165715; **1)** ventral view. **2)** apical view showing broad and slightly flattened contact of the siphuncle with the shell. **3)** lateral and **4)** dorsal views, about ×2/3. Apparent lobes on the dorsum are due to weathering. From the upper third of the Oil Creek Formation, West Spring Creek, 3 mi. east of Pooleville, Oklahoma.

5-7, 9-10 *Kiotoceras* sp. 31
5) side view of siphuncle, a weathered dorsolateral surface, (no. 1410). **6)** cross section at cut near the anterior end, (no. 1408) venter below. **7)** apical cross section. No. 1410, collection of the writer. **9)** obliquely weathered anterior end of another specimen, (no. 1408) showing the endosiphocone barely closed on the venter. **10)** oblique weathered cross section of another specimen, no. 1409, showing the endosiphuncle open below. From the south end of the Ely Springs Range, from zone N, Tank Hill Limestone, Pogonip Group.

8 *Najaceras*(?) sp. 28
Ventral view of a large specimen, USNM no. 165716, length 305 mm, about 1/3 natural size. From the same locality and horizon as figs. 1-4. See also Pl. 9, fig. 9.

11-12 *Najaceras* cf. *bilobatum* Flower 27
Cross section, ×2, of opposite sides of a cross section from a small portion of a siphuncle showing strands normal to the growth surface of the dorsal process of the siphuncle. Figured specimen, USNM no. 165714, from the upper third of the Oil Creek limestone, bed no. 8, West Spring Creek section, 3 miles east of Pooleville, Oklahoma.

PLATE 6

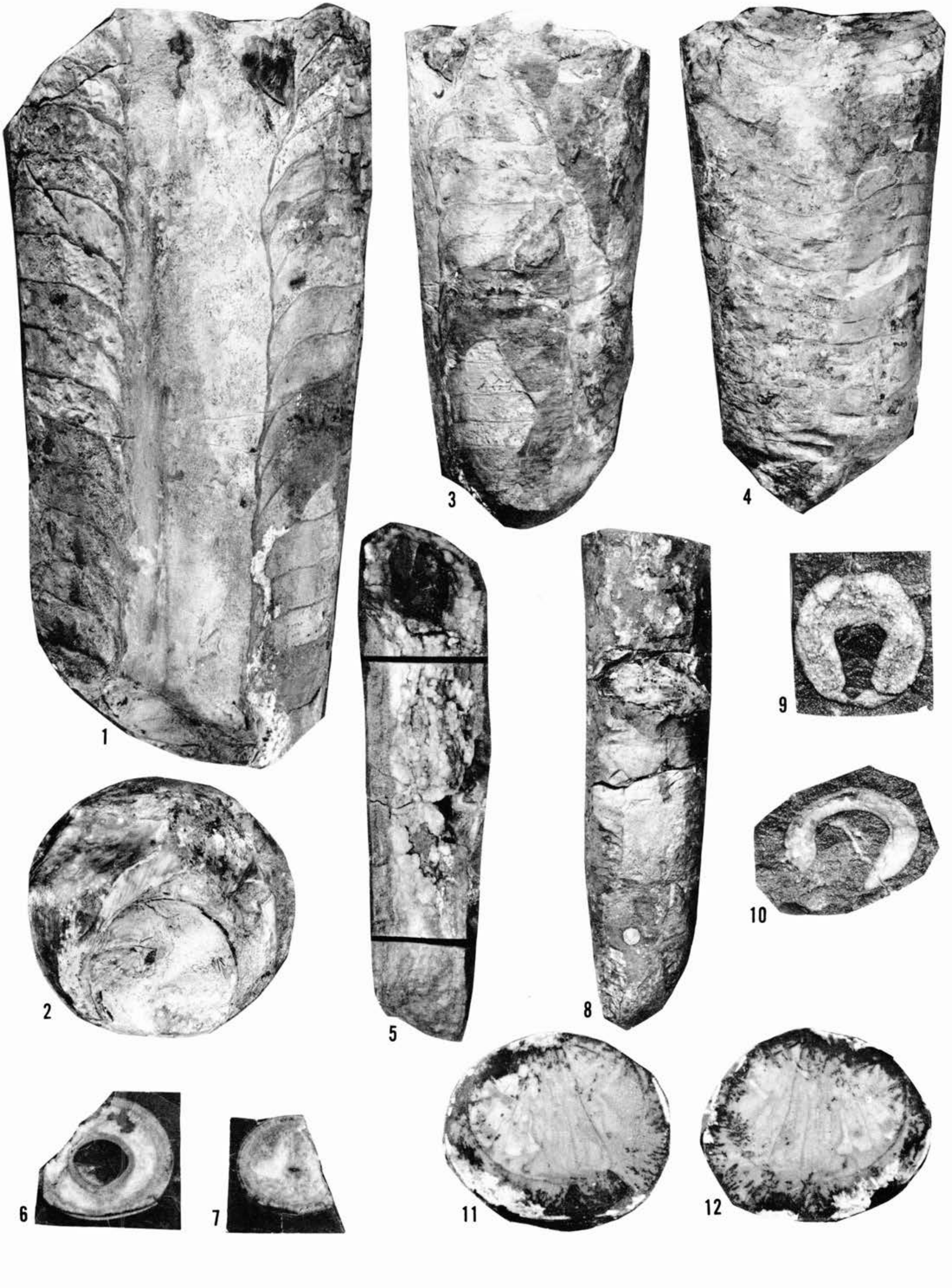

PLATE 7

Figures		*Page*
1-2	*Kiotoceras gilesae,* n. sp.	30

Holotype, 1538, collection of the writer. **1)** ventral view, showing a relatively complete living chamber, anterior mature short camerae, following somewhat longer ephebic camerae. **2)** cross section at the base; the outline of the siphuncle is slightly retouched and strengthened. From the Lehman Limestone, south Ibex Hills, Ibex area, western Utah. Collected and given by Mrs. Vera Giles.

3	*Kiotoceras piochense,* n. sp.	30

Holotype, no. 1407, collection of the writer, a portion of a phragmocone weathered from and viewed from the dorsal side. Anteriorly, the weathered surface slopes down toward the venter, and cuts the siphuncle where the endosiphuncle is only developed as thin dorsal band. Apically, the surface passes down through the siphuncle apicad of the tip of the endosiphocone. From zone N, Tank Hill Limestone, Pogonip Group, from the south end of the Ely Springs Range, west of Pioche, Nevada.

4-5	*Kiotoceras ibexense,* n. sp.	30

Holotype, collection of the writer, to be USNM no. 166172. **4)** ventral view, showing septa, siphuncle and a nearly complete living chamber. **5)** cross section at the base, showing the anterior end of the endosiphocone but with some extraneous calcite. Lehman Limestone, from 515 feet above the base of the Desert Range section of Hintze (1951, 1952).

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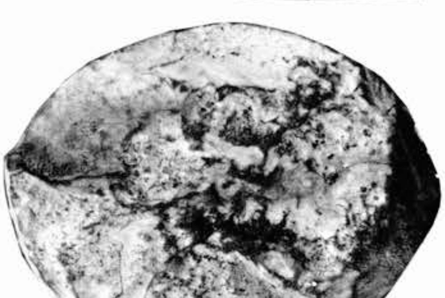

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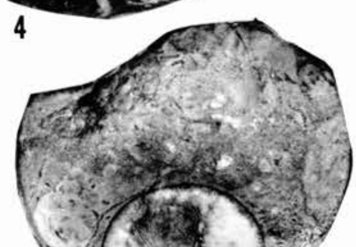

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PLATE 8

Figures		*Page*
1-6	*Najaceras bilobatum* Flower	26

Hypotype, Univ. of Oklahoma, no. 78a, top of the Oil Creek Formation, from the west branch of Sycamore Creek, about 8 miles northwest of Ravia, Oklahoma.

1) dorsal view, slightly more than ×0.5. **2)** weathered ventral surface. **3)** apical end, reduced, about ×2/3. **4)** cross section of siphuncle, showing the features of the genus, ×1, from basal section shown reduced in fig. 3. Hypotype, Univ. of Oklahoma, no. 61, from the Oil Creek limestone, 80 rods north of Fall Creek, southwest of Davis, Oklahoma. **5)** part of a phragmocone, ventral view, reduced. **6)** apical end of the same specimen, showing the endosiphuncle apicad of the endosiphocone.

PLATE 13

Figures		*Page*
1-15	*Najaceras bilobatum* Flower	26

Holotype, USNM No. 162065, from the upper fourth of the Oil Creek limestone, from West Spring Creek, 3 miles east of Pooleville, Oklahoma.

1) ventral view of holotype, about ×5/8. **2)** anterior end showing siphuncle containing only the dorsal process of the endosiphuncle. **3-4)** opposite sides of anterior transverse section of the siphuncle alone; showing beginning of growth of endosiphuncle downward along the sides. **5-6)** opposite sides of break apicad of anterior cut; showing further downward growth of the lateral processes. **7)** section showing in fig. 5, ×2, showing finer details. **8)** section shown in fig. 9, ×2, showing traces of blades and axis, bifurcated above. **9-10)** opposite sides of siphuncle at transverse cut near midlength. **11, 13)** opposite sides of transverse cut near apical end, with endosiphuncle completed and closed ventrally. **12)** section shown in fig. 11, ×2, showing traces of lateral blades and bifurcated dorsal axis. **14)** apical end of holotype. **15)** siphuncle only from fig. 14, ×2, showing infula, parts of blades and dorsal axis.

PLATE 12

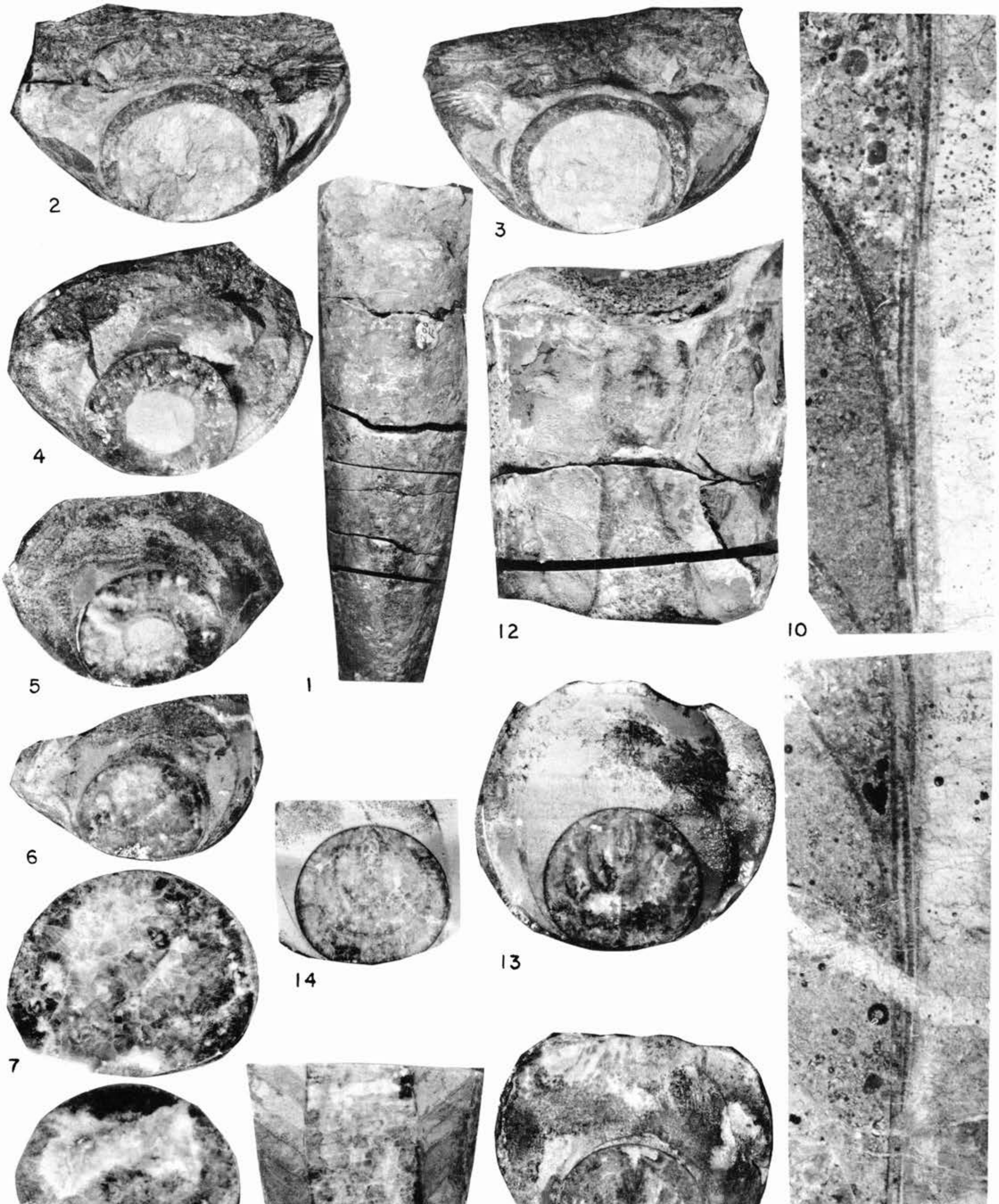

PLATE 12

Figures *Page*

1-11 *Kiotoceras quadratum,* n. sp. 28

Holotype, USNM No. 162058 from the upper fourth of the Oil Creek limestone, West Spring Creek section (bed 8) 3 miles east of Pooleville, Oklahoma.

1) ventral view of the holotype, about 1/3 natural size. **2-3)** natural break, across section, near the anterior end showing endosiphuncle developed only on the dorsum. **4)** break 45 mm farther apicad, showing spiess enclosed, quadrate, most faintly hexagonal in section. **5)** break 15 mm farther apicad, showing spiess more quadrate and smaller. **6)** cross section 42 mm farther apicad, showing the very small quadrate tube. **7)** same ×2, showing tube and bases of four blades more clearly. **8)** cross section, ×2, at extreme base, showing the tube ventral rather than subcentral in position. **9)** transverse longitudinal section between figs. 6 and 8. **10-11)** thin section prepared from surface opposing that in fig. 9.

12-15 *Najaceras bilobatum* Flower 26

12) paratype, ventral view showing the siphuncle in contact with the venter and the lobes of the sutures. **13)** cross section, shown at break near midlength; apicad of the spiess, showing infula and axis of dorsal mass. **14)** siphuncle from a cut 16 mm farther apicad. **15)** apical end, weathering has stained and accentuated endosiphonal structures. USNM no. 162066; same horizon and locality.

PLATE 11

PLATE 11

Figures *Page*

1-8 *Williamsoceras* cf. *adnatum* Flower 34

1) endosiphuncle, showing anteriorly the exfoliated surface of the endosiphocone (not the surface of the siphuncle), and apically, two dark bands marking the intersection of the infula with the broken surface, viewed from the dorsum. **2)** cross section, at base of fig. 1. **3)** anterior end, the obverse of fig. 1. **4)** anterior part of fig. 1, whitened. Ridges are askew from the symmetry of the shell. Collection of the writer, no. 1538. **5)** cross section, X2, of another specimen, showing a rather broad infula, its limbs becoming straighter below and joining at the siphuncle periphery; no. 1536. **6)** another specimen, no. 1539, showing the dorsal surface of an exfoliated endosiphocone, with the characteristic annular surface. **7, 8)** anterior and apical cross sections of another specimen, no. 1540, showing infula and median blade of the ventral process, X1.5.

9-10 *Williamsoceras* cf. *ankhiferum* Flower 35

9) ventral view of a small part of an endosiphuncle, the dark lines mark the juncture of the infula with the siphuncle margin, no. 1537. Figs. 1-10 are from the upper part of the Juab Limestone, between sections J and K, Ibex region, southern Confusion Range, western Utah.

11-13 *Ignoceras obliquum,* n. sp. 32

Holotype, collection of the writer, no. 1539, **11)** ventral view. **12)** lateral view, venter on left. **13)** apical view, showing siphuncle with endosiphocone round dorsally flat ventrally. From the Kanosh Shale, probably zone N, Ibex region, western Utah.

PLATE 10

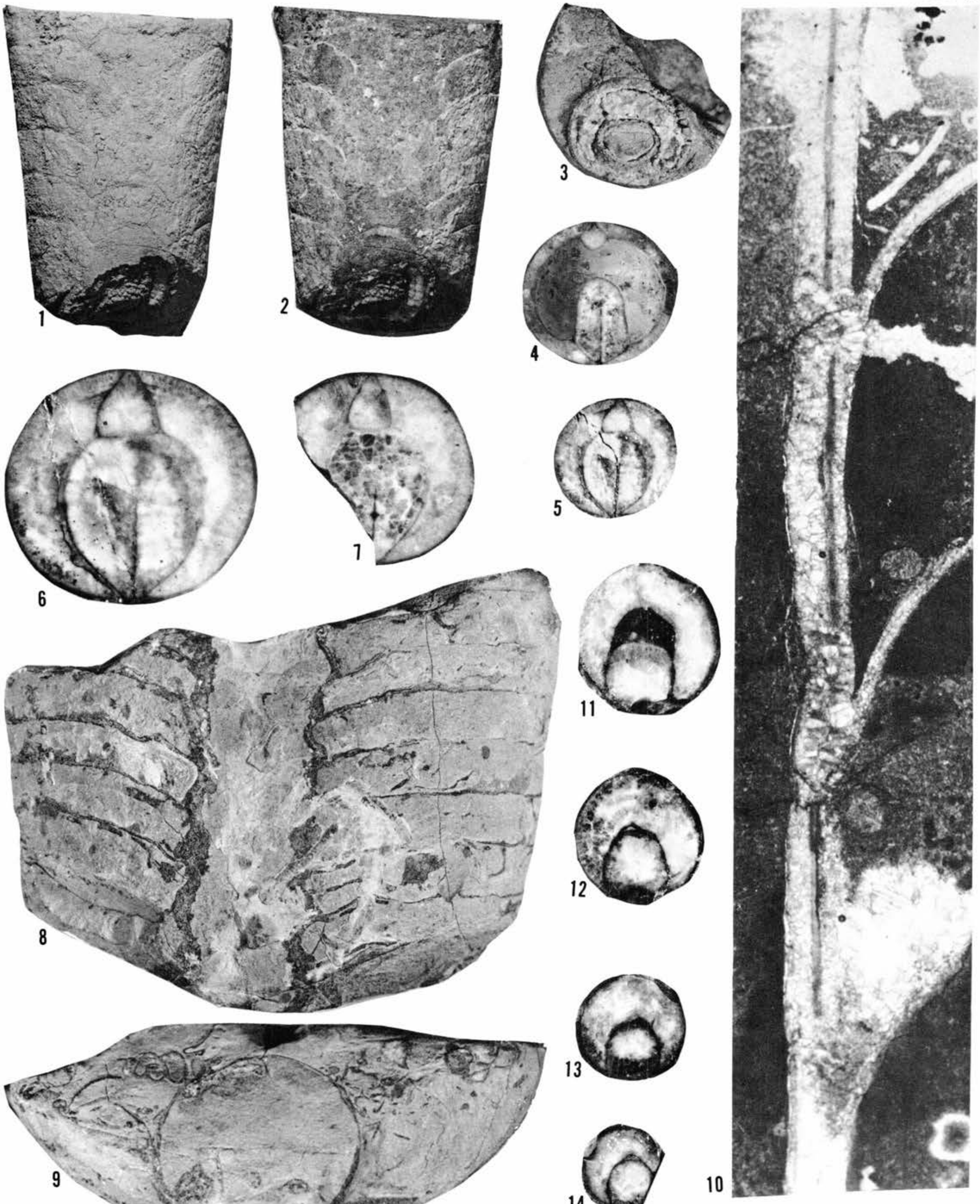

PLATE 10

Figures		*Page*
1-3	*Trinitoceras lobiferum,* n. sp. . . . . Paratype, Columbia University no. 28786, a portion of a phragmocone containing a siphuncle and retaining the anterior part of the endosiphocone. **1)** ventral view, whitened. **2)** same view, unwhitened. **3)** base, showing siphuncle with endosiphocone slightly flattened dorsally. From the sponge beds, Ikes Canyon, Toquima Range, Nevada.	32
4-7	*Cacheoceras uninodum,* n. sp. . . . . Holotype, no. 1533, collection of the writer. **4)** anterior cross section, showing ventral process with a median blade, to which some endocone material has been added, but is not separated from the material of the original process. Below, the infula separates the process and its supplements from the remainder of the endocone material. **5)** cross section 92 mm farther apicad. **6)** same section, ×2, showing more fully the single dorsal process, the infula, with some small tubes, and the axial blade of the ventral process. **7)** section 75 mm farther apicad, ×2, showing somewhat different outlines of the infula and of the dorsal wedge. From the Juab Limestone, Ibex area, western Utah.	36
8-10	*Trinitoceras lobiferum,* n. sp. . . . . Holotype, Columbia University, no. 28785, a small part of a phragmocone from a much later growth stage than the paratype. **8)** ventral view. **9)** apical view. **10)** thin section of siphuncle wall, ×9, showing holochoanitic necks, in spite of considerable recrystallization. From the Antelope Valley Limestone, Ikes Canyon, Nevada, reputedly from the Sponge Beds.	32
11-14	*Williamsoceras compressum,* n. sp. . . . . Holotype, no. 1534, a portion of an endosiphuncle. **11)** cross section near the anterior end, showing the crescentic endosiphocone, and below, parts of the infula. **12)** section 44 mm farther apicad, showing middorsal widening of the infula. **13)** section 36 mm farther apicad. **14)** section 46 mm apicad, near the apical end of the specimen. All ×2. From the Juab Limestone, between sections J and K of Hintze (1951, 1952), Ibex Area, western Utah.	35

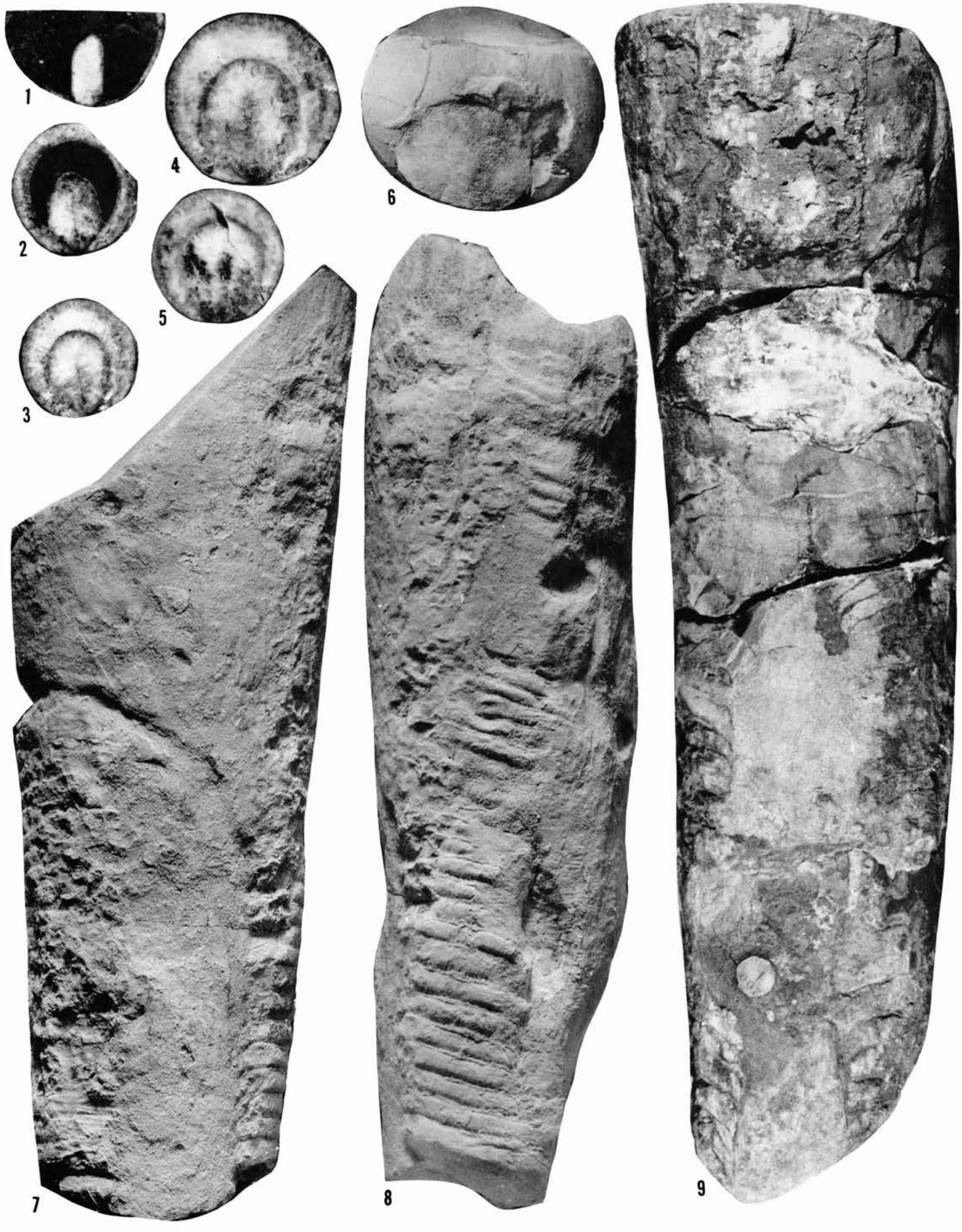
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PLATE 9

Figures		*Page*
1-5	*Williamsoceras ellipticum,* n. sp.	36

1) anterior cross section showing the ventral process. **2)** section 34 mm farther apicad, showing the ventral process enlarged, with a median blade, but with endocone material incorporated, and seemingly separated below from the remainder of the endocones by the infula. **3)** section 38 mm farther apicad, showing the infula apicad of the endosiphocone, and median blade of the ventral process. **4)** same section, ×1.5. **5)** section 84 mm farther apicad, ×1.5. All from the holotype, no. 1535, collection of the writer. From the Juab Limestone, Ibex region, western Utah, from between sections J and K.

6-8 *Kiotoceras? multiseptatum,* n. sp. 31

Holotype, no. 1583 collection of the writer, an imperfectly preserved part of a phragmocone, lacking any trace of the endosiphuncle. **6)** base, showing section of conch and siphuncle. **7)** ventral view. **8)** lateral view, venter on left. From the Lehman Limestone, Ibex area, western Utah.

9 *Najaceras?* sp. 27

Ventral view, about ×3/4. USNM 165716, see also Pl. 6, fig. 8. Oil Creek limestone, from West Spring Creek, 3 miles east of Pooleville, Oklahoma.


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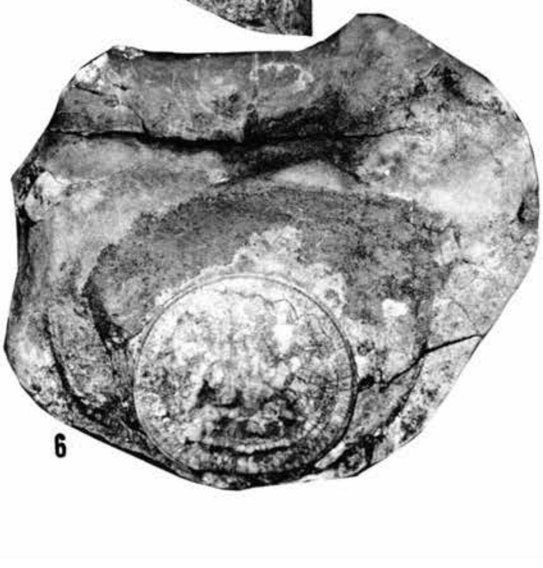
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PLATE 13

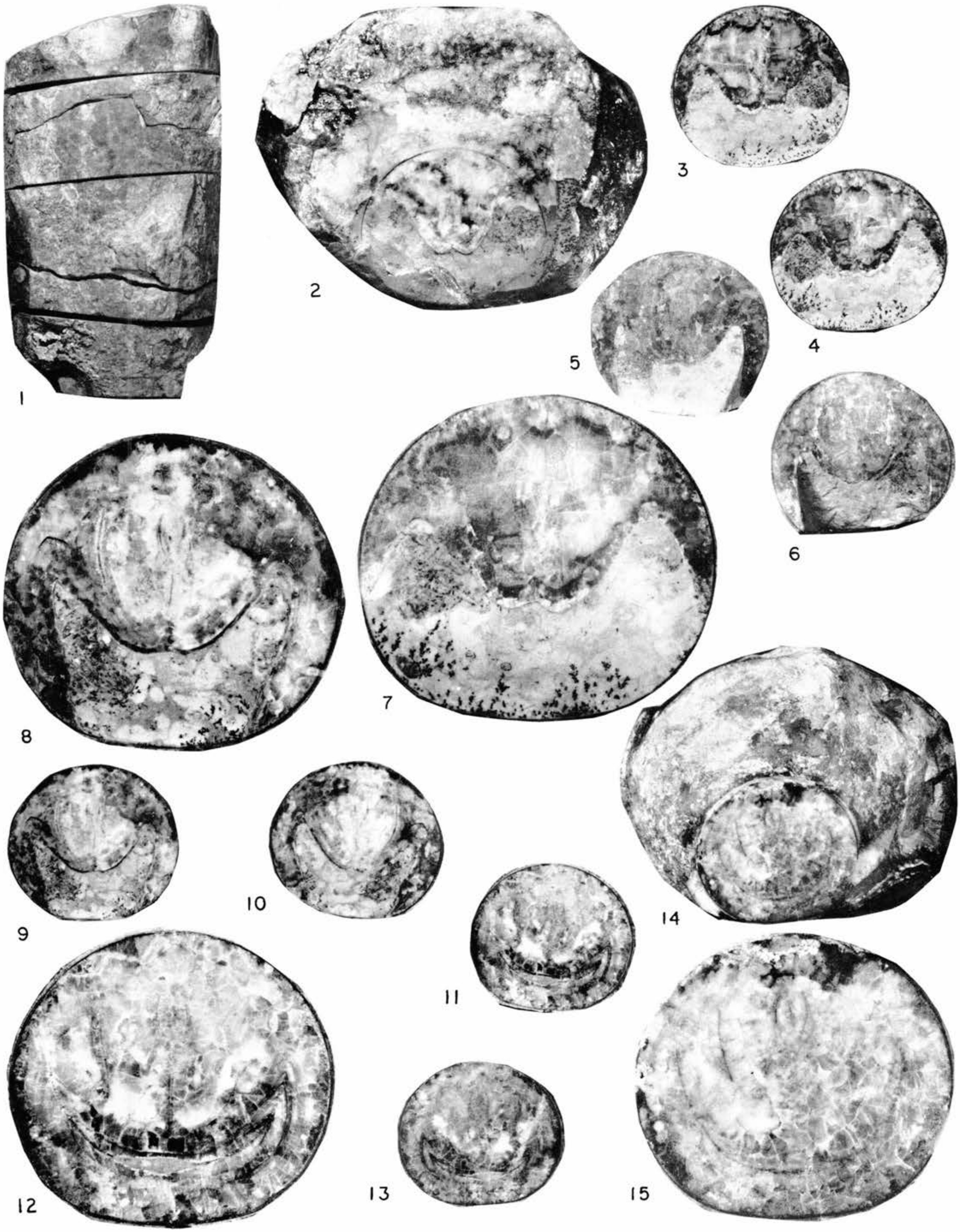

PLATE 14

Figures *Page*

1-4 *Najaceras* cf. *triangulatum* Flower 25

A part of the siphuncle, apicad of the spiess, USNM 162064 from 66 ft below the Bergen Sandstone, Dan's Road, Ardmore, Oklahoma. **1)** dorsal exterior, showing a narrow groove to the left of the center. **2)** anterior cross section, smoothed at anterior end, X3, showing discrete light bodies with dark borders marking the infula, with some similar bodies marking part of the axis of the dorsal mass; the axis shows bifurcation above, and a secondary bifurcation of one branch; the groove of the exterior is a dark band in the upper right, which extends only a short distance into the endosiphuncle; below, the axis of the dorsal mass ends in two strongly askew branches. **3)** section at mid-length; X3 apicad end of the anterior part of fig. 1. The infula is similar to that of fig. 2, the axis of the dorsal mass and its ventral termination anomalous. **4)** section at apical end, X3, showing infula as before, axis of dorsal mass with secondary bifurcation of the upper left limb, base of axis terminating in three askew blades.

5-8 *Perkinsoceras foerstei,* n. sp. 37

Holotype, USNM no. 307, Upper Chazy, (Valcour limestone) Isle la Motte, Vermont. **5)** dorsal view of type, part of an endosiphuncle embedded in matrix and partly exposed, essentially a dorsal view. The plane of the section descends forward into the body of the siphuncle, and intersects the infula. **6)** anterior cross section, X2, showing an upper part of the specimen not included in fig. 5 with allowance for missing part lost in cutting. **7)** an apical cross section, X2 showing infula, numerous tubes, triangular imperfectly preserved blades around the tubes, and axial structure of the ventral mass. **8)** the same section, X3, retouched to reduce contrast between very light and very dark parts.

9-12 *Perkinsoceras inflatum,* n. sp. 37

Holotype, a part of an endosiphuncle including a swollen *Nanno*-like tip, which is weathered apically below the middle, from the Chazy limestone (Crown Point?) 0.5 miles south of Grosse Point, Ferrisburg township, Vermont, no. 1584. **9)** lateral surface, weathered, unwhitened. **10)** apical part of the same, whitened. **11-12)** cross section, X2, showing flattened ventor; the infula with multiple tubes.

PLATE 14

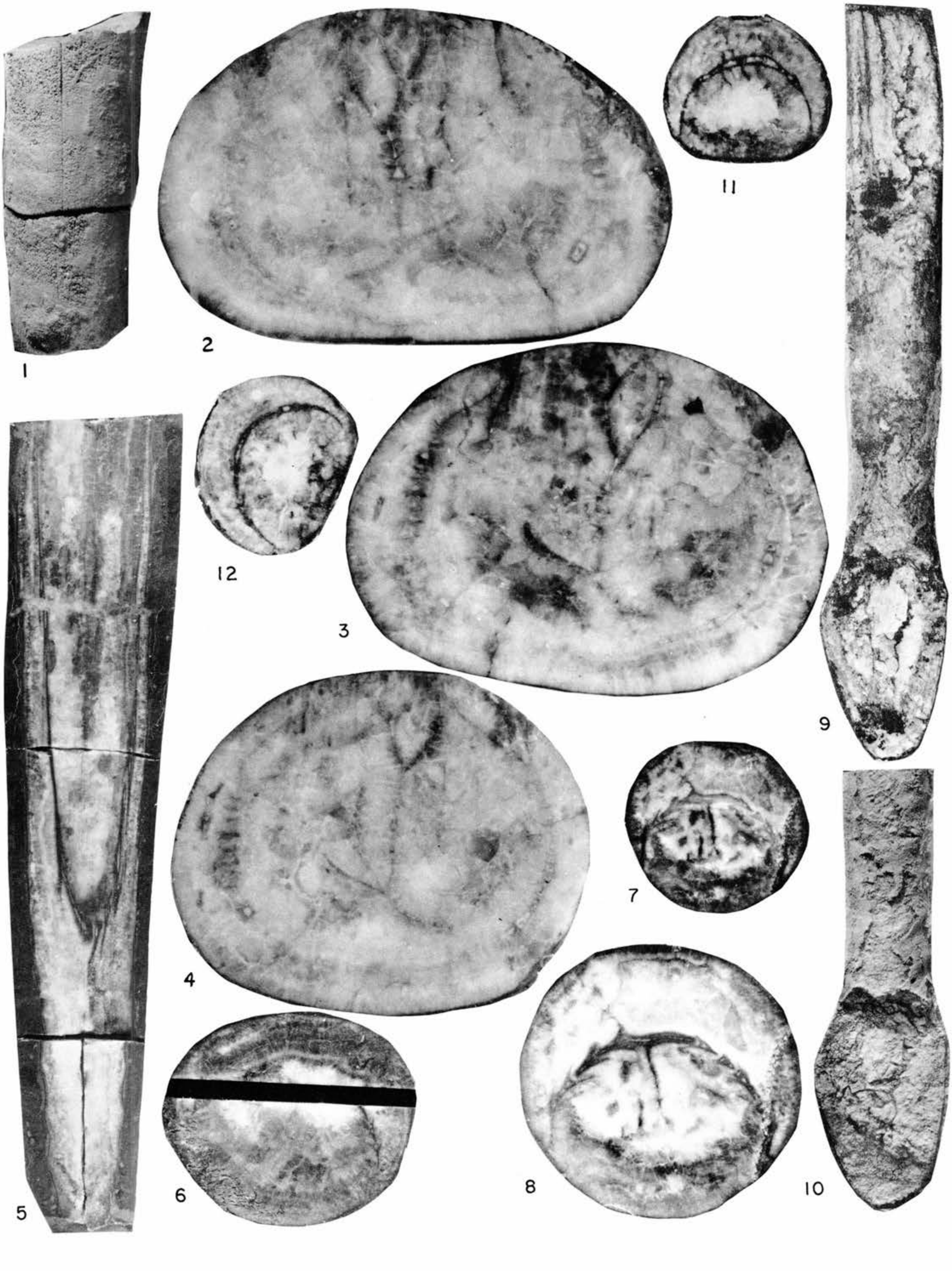

PLATE 15

Figures		*Page*
1-13	*Najaceras triangulatum* Flower	25

Paratype, USNM no. 162063, a part of a siphuncle close to a rapidly expanding blunt tip, and apicad of the endosiphocone.

1) lateral view, venter on left. **2)** dorsal view. **3)** anterior end ground smooth, X2, showing infula and axial blade of the dorsal mass, bifurcated above. **4-5)** opposite sides of cross section at midlength, showing infula and various accessory blades, X2. **6)** section at break near apex.

Holotype, USNM no. 162062

7) ventral exterior. **8)** cross section at transverse cut near anterior end showing the dorsal process alone. **9-10)** opposite sides of section at transverse break at midlength, showing narrow bands extending from the sides of the dorsal mass. **11)** cross section 30 mm farther apicad, showing endosiphocone triangular and barely closed below. **12)** section at apical end, showing transverse triangular section of endosiphocone. **13)** longitudinal section, X15, showing holochoanitic siphuncle wall somewhat replaced.

All specimens are from the upper fourth of the Oil Creek limestone, West Spring Creek section, 3 mi. east of Pooleville, Oklahoma.

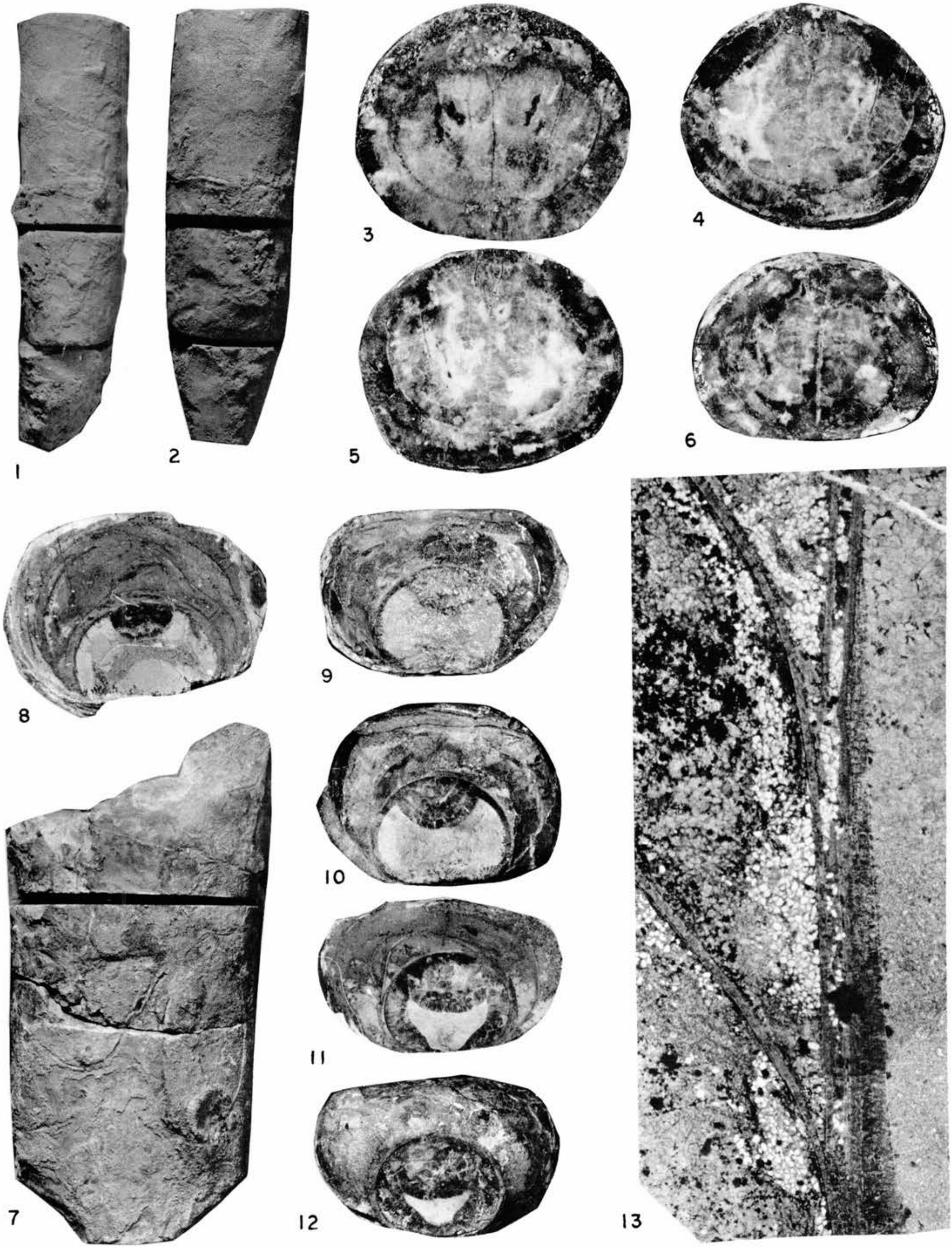
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PLATE 16

Figures *Page*

1-5 *Kiotoceras depressum*, n. sp. 29
Holotype, USNM no. 162060. **1)** ventral view, showing obscurely the opening of the endosiphuncle in the anterior third. **2)** lateral view, venter on right. **3)** anterior end, venter at right, the dorsum incomplete from weathering. **4)** cross section at break at midlength, venter on right. **5)** cross section at apical end, venter on right. From the upper fourth of the Oil Creek limestone, West Spring Creek, 3 mi. east of Pooleville, Oklahoma.

6-10 *Kiotoceras contractum*, n. sp. 30
Holotype, USNM no. 162061. **6)** dorsal view, showing septal ridges. **7)** lateral view, dorsum on left. **8)** cross section, at break at anterior third of the specimen, venter below. **9)** cross section, break at apical third of the type, venter below. **10)** cross section at apical end, venter below. Same horizon and locality as figs. 1-5.

11-14 *Najaceras chevroniferum* Flower 27
USNM no. 162067. **11)** dorsal view of holotype, an isolated endosiphuncle, showing sheaths and blades, which extend forward in sharp middorsal angles, marking the sides of the dorsal process. **12)** section near anterior end, X2.5 showing considerable replacement, but the infula is clearly shown. **13-14)** sections near the apical end, X2, showing infula and some radial structures in the dorsal mass. Oil Creek limestone, Henryhouse Creek station, Arbuckle Mts., Oklahoma.

15-16 *Kiotoceras quadratum* Flower 28
Paratype, USNM no. 162059. **15)** lateral view, venter on right. **16)** ventral view. Oil Creek limestone, West Spring Creek.


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