California Carboniferous Cephalopods

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California Carboniferous Cephalopods

By MACKENZIE GORDON, Jr.

CONTRIBUTIONS TO PALEONTOLOGY

GEOLOGICAL SURVEY PROFESSIONAL PAPER 483-A

Descriptions and illustrations of 17 Late Mississippian and 3 Middle Pennsylvanian species and their distribution

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CONTRIBUTIONS TO PALEONTOLOGY

CALIFORNIA CARBONIFEROUS CEPHALOPODS

By Mackenzie Gordon, Jr.

ABSTRACT

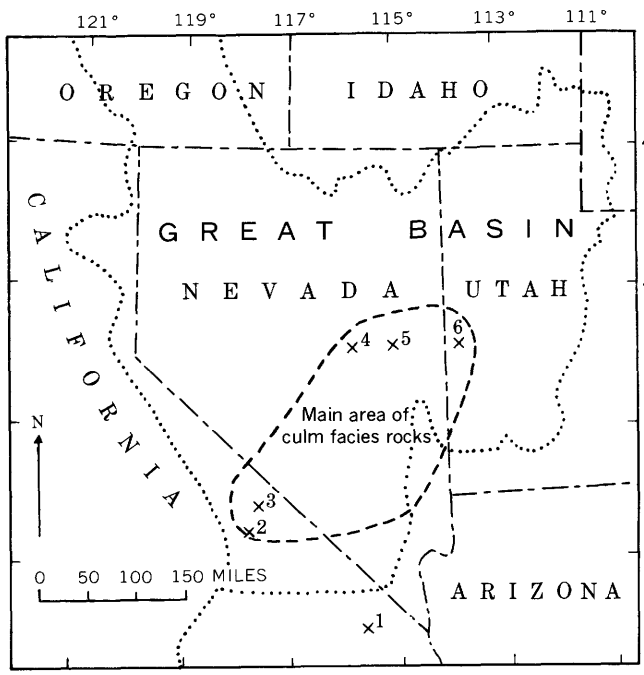
Cephalopods are abundant locally in a late Mississippian limestone bed in the Panamint Range, where the nautiloids *Rayonnoceras*, *Bactrites*?, *Mitorthoceras*, *Scyphoceras*, *Liroceras*?, and a possible belemnite fragment referred to *Hematites*? are associated with the goniatites *Cravenoceras*, *Eumorphoceras*, *Anthracoceras*, *Delepinoceras*, and *Prolecanites*?. The cephalopod species in this bed and another species of *Cravenoceras* that occurs a few feet higher stratigraphically are characteristic of the widespread *Eumorphoceras bisulcatum* zone in the Great Basin region of the western United States. In the Inyo Range, *Bactrites*?, *Cravenoceras*, *Cravenoceratoides*, *Eumorphoceras*, and *Dombarocanites* apparently represent a higher part of the same zone. Middle Pennsylvanian ammonoids *Bisatoceras* and *Stenopronorites* occur also in the Panamint Range and an ammonoid referred to *Paralegoceras*? has been found in the Providence Mountains. All these localities are in southeastern California.

New species described herein are *Mitorthoceras clinatum*, *Cravenoceras inyoense*, *Eumorphoceras paucinodum*, *Anthracoceras macallisteri*, *Delepinoceras californicum*, and *Dombarocanites masoni*. The genera *Cravenoceratoides*, *Delepinoceras*, and *Dombarocanites* are described for the first time from the Western Hemisphere.

INTRODUCTION

The fossil cephalopods upon which this report is based came from three southern California mountain ranges and were collected by several geologists during the course of their mapping and other field studies in those areas. The location of the areas is shown in figure 1. Most of the fossils are from a single bed at the top of the Mississippian Perdido Formation in the Quartz Spring area at the northern end of the Panamint Range, Inyo County. A few came from three nearby localities in higher beds of Late Mississippian and Middle Pennsylvanian age in the Quartz Spring area.

With a single exception, the rest came from the Mississippian Chainman Shale near the Cerro Gordo mine in the southern part of the Inyo Range, Inyo County. The exception is a mold of a large paralegocerid ammonoid in a block of limestone that was collected in the Providence Mountains, San Bernardino County.



1 Providence Mountains, Calif.
2 Cerro Gordo area, Inyo Range, Calif.
3 Quartz Spring area, Panamint Range, Calif.
4 Diamond Range, Nev.
5 Egan Range, Nev.
6 Confusion Range, Utah

Figure 1.—Map showing the Great Basin, main area of Chainman Shale culm-facies rocks, and locations of sections discussed.

ACKNOWLEDGMENTS

The writer wishes to thank Prof. S. W. Muller and A. M. Keen of Stanford University for making available the fossil material upon which a large part of this report is based. J. F. McAllister, J. C. Hazzard, and C. W. Merriam were most helpful in providing information as to the collecting localities and stratigraphy in the areas where they mapped.

GEOLOGIC SETTING

In late Mississippian time a moderately shallow epeiric sea occupied much of the west-central and southwestern parts of what we now know as the Great Basin (fig. 1). A culm facies of grayish-black shale having limestone interbeds was deposited in this area, and its remnants, broken and deformed by subsequent diastrophism, stretch today from the Confusion Range in west-central Utah to the Inyo Range in southeastern California. Like similar Late Mississippian black-shale facies in other parts of the world, this habitat was particularly suited to the development of cephalopods, and at some scattered localities their fossil remains are found in considerable numbers. This paper is concerned with the description of the cephalopod fauna that inhabited the southwestern part of the area of deposition of the culm-facies rocks, the part that extends into the State of California. It also records the occurrence of three cephalopods of Middle Pennsylvanian age in the same region.

In much of the depositional basin here discussed, it has long been customary to refer the culm-facies rocks to the White Pine Shale. The White Pine Shale, however, was originally defined by Hague (1883, p. 253, 266, 267) to include an underlying limestone unit of Early Mississippian age and a lower shale of Late Devonian age, now known as the Joana Limestone and Pilot Shale, respectively. The White Pine Shale also was originally defined to underlie the Diamond Peak "Quartzite" now called "Formation" (Nolan and others, 1956, p. 60), which, at its type locality in the Diamond Range near Eureka, Nev., represents rapid deposition of clastic rocks during Late Mississippian time. The Diamond Peak Formation fingers eastward into the cephalopod-bearing culm-facies rocks, and to this date, all cephalopods described from the "White Pine Shale" in eastern Nevada and western Utah by various authors (that is, Hall and Whitfield, 1877; Miller and Furnish, 1940; Miller and others, 1952; and Youngquist, 1949a, b) are from beds that are temporal equivalents of the Diamond Peak Formation at its type locality.

In recent years, use of the name Chainman Shale to refer to the Late Mississippian predominantly pelitic rocks discussed here has become rather widespread. The Chainman Shale was originally defined by Spencer (1917, p. 27, 28) from exposures in the Egan Range near Ely, Nev., to include the rocks that lie between the Joana Limestone of Early Mississippian age and the Ely Limestone of Early Pennsylvanian age. Subsequent investigations have shown that in much of east-central Nevada and west-central Utah the Chainman Shale represents roughly the entire span of Late Mississippian time.

The relation of Upper Mississippian rocks and the units that underline and overlie them in selected Carboniferous sections in Utah and Nevada are shown in the correlation chart (fig. 2), together with those of the California sections that were previously discussed. California cephalopod horizons are marked with an asterisk (*). The approximate locations of the sections in figure 2 are shown in figure 1.

PANAMINT RANGE

The Panamint Range stands at the west side of Death Valley in Inyo County. Cephalopod-bearing beds of Late Mississippian age crop out in the Quartz Spring area in the Cottonwood Mountains at the north end of the range. The Quartz Spring area was mapped by J. F. McAllister and most of the collections under study are those that he made. The presence of *Cravenoceras* in this area was pointed out by McAllister (1952, p. 24) in his report.

In the Quartz Spring area the Early Mississippian Tin Mountain Limestone is overlain by a sequence of varied beds that consists of calcareous siltstone, sandstone, conglomerate and interbedded chert, limestone, silty limestone, and siltstone having some shale. These constitute the Perdido Formation of McAllister (1952, p. 22–25), approximately 610 feet thick in its composite type section south of Perdido Canyon and south of Rest Spring. The topmost bed of this formation, a dark-gray fine-grained limestone, 6 to 12 inches thick, is crowded with fossils, mostly *Cravenoceras hesperium* Miller and Furnish. Four to five feet of very soft shale, grayish red to purplish gray, separate it from the gray locally sandy limestone below that carries productids, spirifers, and other brachiopods. The lower part of the Perdido Formation contains an Early Mississippian coral fauna.

The Perdido Formation is overlain by the Rest Spring Shale (McAllister, 1952, p. 25, 26), which consists mainly of olive-gray to olive-brown siltstone and shale but include some thin interbeds of light-gray quartzite and poorly sorted intraformational conglomerate. Incompetent, structurally contorted, and poorly exposed, the shale is nearly impossible to measure for thickness, but McAllister recorded 310 feet at one locality in the nearby Ubehebe Peak quadrangle. The shale rests with apparent conformity on the Perdido Formation. Concretions from the basal part yielded *Cravenoceras merriami* Youngquist, which is supporting evidence for the absence of a hiatus of any consequence at its base.

The Upper Mississippian, therefore, is represented in the northern part of the Panamint Range by the Perdido Formation and Rest Spring Shale. The lower part of the Perdido, however, is Early Mississippian in age and the upper part of the Rest Spring Shale may be Pennsylvanian in age (McAllister, 1952, p. 24–26).

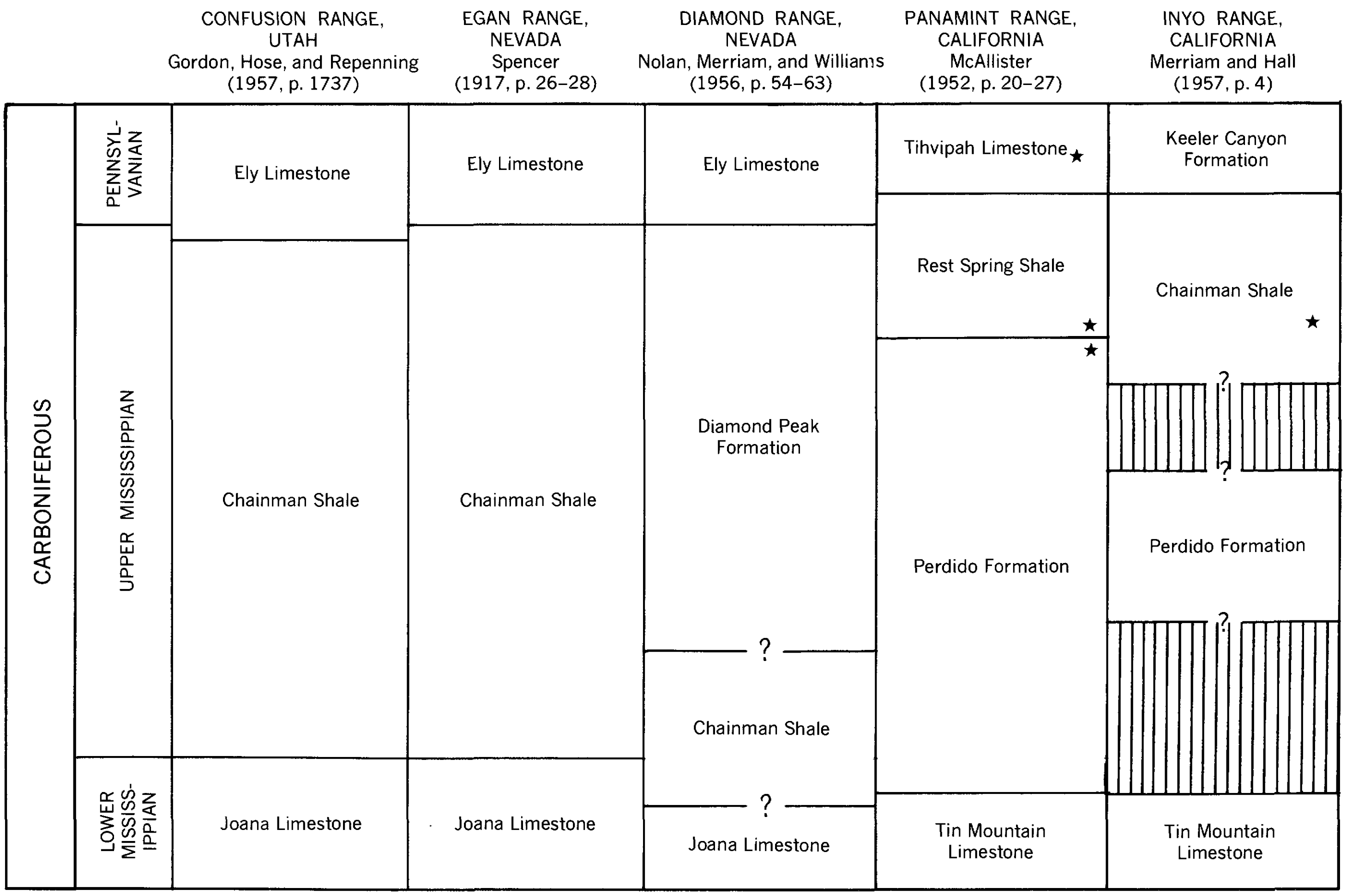


FIGURE 2.—Correlation chart of Upper Mississippian rocks in the Great Basin.

The cephalopods in the following table are from 12 collections made at 6 localities in the vicinity of Rest Spring. The collecting localities are shown on a generalized geologic map of part of the Quartz Spring area (fig. 3). With the exception of FL 36C, which is from a few feet above the base of the Rest Spring Shale, all the collections are from the limestone bed that McAllister took as the top of the Perdido Formation. Twelve species are recorded from this bed. The only species in the list not found in this bed is *Cravenoceras merriami* Youngquist, which occurs in calcareous to ferruginous claystone concretions in the basal several feet of the overlying Rest Spring Shale. The collection from USGS locality 15783–PC represents approximately a 15-foot sequence of beds, as it includes blocks of the *Cravenoceras hesperium*-rich bed, slabs of brachiopod-bearing medium-grained gray limestone from another bed about 5 feet lower stratigraphically, and weathered-out specimens of *C. merriami* from the overlying Rest Spring Shale.

In addition to these collections, an unusually well preserved specimen of *Rayonnoceras* aff. *R. solidiforme* Croneis was provided by C. W. Merriam (USGS loc. 19806–PC). It had been collected by Mr. Lawrence Dietz, a prospector, and came from an unknown locality in the Cottonwood Mountains, Panamint Range, probably from the vicinity of Rest Spring.

Two specimens of ammonoids also were collected from the Pennsylvanian Tihvipah Limestone near Rest Spring. McAllister (1952, p. 26, 27) proposed this name for a unit of platy light-gray limestone interbedded with shaly limestone and calcareous shale and some beds, 1 to 3 feet thick, of fine-grained medium-gray limestone, aggregating about 200 feet in thickness. Characteristic spherical concretionary chert nodules, 0.1 inch to 2 inches in diameter, are scattered through the limestone and fusulinids occur in scattered lenses. The Tihvipah unconformably overlies the Rest Spring Shale at its type locality and fossils indicate that beds corresponding to parts of the Lower and Middle Pennsylvanian are represented by the hiatus.

One collection of fusulinids from about a thousand feet due east of Rest Spring and 100 feet stratigraphically above the base of the formation was determined by Henbest (in McAllister, 1952, p. 26, 27) as representing either late Atoka or early Des Moines age, although

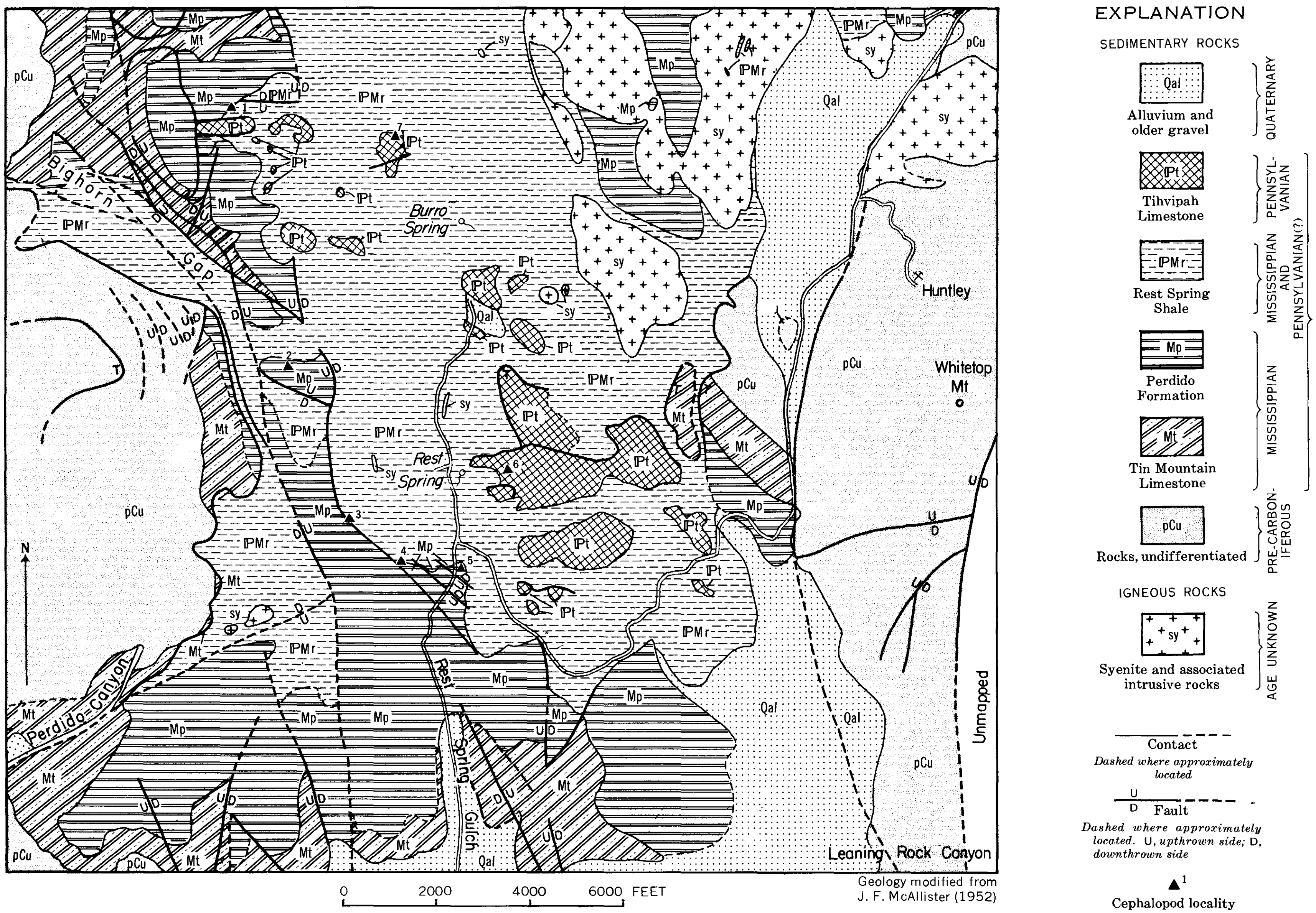


FIGURE 3.—Geologic map showing Carboniferous cephalopod collecting localities in the Quartz Spring area, Panamint Range, Calif.

Upper Mississippian cephalopod collecting localities and their fauna in the Quartz Spring area

Cephalopod species	Collection No. and locality No. on fig. 3											
	FL 15	FL 15A	FL 23	FL 27	FL 36A	FL 36B	FL 36C	FL 38	10 E8	SU 2776	15782-PC	15783-PC
	2	2	1	3	4	4	4	5	5	5	2	5
Rayonnoceras aff. *R. solidiforme* Croneis	--	--	--	--	--	--	--	--	--	--	X	X
Bactrites? cf. *B.*? *carbonarius* Smith	X	--	--	--	--	--	--	X	X	X	--	--
Mitorthoceras cf. *M. perfilosum* Gordon	--	--	--	--	--	--	--	--	--	X	X	X
clinatum n. sp	--	--	--	--	--	--	--	X	--	X	--	--
Scyphoceras cf. *S. cessator* (Hall and Whitfield)	--	--	--	--	--	--	--	X	--	X	--	--
Liroceras? sp	--	--	--	--	--	--	--	X	--	--	--	--
Hematites? sp	--	--	--	--	--	--	--	--	--	X	--	--
Cravenoceras hesperium Miller and Furnish	X	X	X	X	X	X	--	X	X	X	X	X
inyoense n. sp	--	--	--	--	--	X	--	X	X	X	--	X
merriami Youngquist	--	--	--	--	--	--	X	--	--	--	--	X
Eumorphoceras paucinodum n. sp	--	--	--	--	--	--	--	X	--	--	--	--
Anthracoceras macallisteri n. sp	--	--	--	--	--	--	--	X	--	--	--	--
Delepinoceras californicum n. sp	--	--	--	X	--	--	--	--	X	--	X	--

early Missouri age must be regarded as a possibility. The ammonoid *Bisatoceras* cf. *B. greenei* Miller and Owen presently identified from USGS locality 19804–PC, about 1,500 feet due east of Rest Spring and a few feet higher stratigraphically than the fusulinids, is very close to if not identical with a Des Moines species. The two determinations thus suggest a Middle Pennsylvanian age for the Tihvipah Limestone.

The other ammonoid from the Tihvipah Limestone is an incomplete fragment of a phragmocone of *Stenopronorites* sp.; part of the external suture is preserved (McAllister loc. FL 5). It was collected in an outlier of the limestone about 7,200 feet north by west of Rest Spring.

INYO RANGE

The section in the southern part of the Inyo Range has yielded cephalopods in the Cerro Gordo area in Inyo County about 20 miles west-southwest of the Quartz Spring area. This section, roughly a thousand feet of dark-gray silty shale and phyllite, including some limestone interbeds, is at least in part Late Mississippian in age; it was called "White Pine shale" in an early report by Kirk (1918, p. 38, 39) and was described briefly by Merriam and Hall (1957, p. 4) who referred it to the Chainman Shale. It overlies the Perdido Formation, which in the Cerro Gordo area is only 50 to 200 feet thick.

Because the Chainman Shale is much thicker than the Perdido Formation in this area, the Chainman might appear to represent a considerable part of Late Mississippian time, as the Chainman Shale does in eastern Nevada and western Utah. The present study, however, shows that the cephalopods that occur in the lower part of the Chainman Shale in the Inyo Range are very Late Mississippian in age and are probably younger than those at the top of the Perdido Formation in the Quartz Spring area. The "Chainman Shale" of the Inyo Range appears therefore to be approximately equivalent to the Rest Spring Shale of the Panamint Range (fig. 2) and represents only a small part of the Chainman Shale of eastern Nevada. It also might be in part Pennsylvanian in age, like the Rest Spring. Whether the Perdido Formation of the Inyo Range is equivalent in total to that of the Panamint Range is not known at present. This uncertainty is indicated by questioned hiatuses on the correlation chart (fig. 2).

Cephalopods were first noted in the "White Pine Shale" of the Inyo Range by Kirk (1918, p. 39) along the Cerro Gordo Spring trail, about 1½ miles north of the Cerro Gordo mine (USGS loc. 10403–PC). The fossils occur in grayish-black slightly altered shale, some of them flattened, some as molds, and some as partly distorted partly limonitic casts. They were identified by Girty for Kirk, who listed the following cephalopods.

Orthoceras, several species
Gastrioceras aff. *G. richardsonianum* Girty
Goniatites sp.
Eumorphoceras bisulcatum Girty?

The cephalopods in this collection have been reexamined, along with additional specimens from the same locality collected by Merriam and his party (USGS locs. 15334–PC, 15335–PC) and are now identified as follows:

Orthoceracone indet.
Bactrites? cf. *B.*? *carbonarius* Smith?
Cravenoceratoides cf. *C. nititoides* Bisat
Eumorphoceras bisulcatum Girty

Merriam (oral communication, 1960) stated that the cephalopod-bearing beds at this locality are in a stratigraphic position about one-quarter of the way from the bottom to the top of the Chainman Shale, which at this locality is a little more than 800 feet thick.

Three small lots of fossil cehalopods collected by J. F. Mason and now in the Stanford University collection also came from near the Cerro Gordo mine. Two lots (23137 and 23145, SU fossil register) are labeled as coming from the Cerro Gordo Spring trail.

These are the species *Cravenoceras merriami* Youngquist and *Eumorphoceras bisulcatum* Girty, respectively. The *Eumorphoceras* occur in matrix similar to that of Kirk's and Merriam's collections and presumably came from approximately the same locality as the others. The *Cravenoceras* specimens appear to have come from a concretion.

One other fossil lot of three specimens is labeled as coming from the trail, 2¼ miles north of the Cerro Gordo mine. Three specimens, apparently from a dark-gray calcareous concretion, constitute the type lot of *Dombarocanites masoni* n. sp.

The fauna of the Chainman Shale of the Inyo Range, including *Cravenoceras merriami* Youngquist and *Cravenoceratoides* cf. *C. nititoides* (Bisat), probably represents a slightly higher horizon than the fauna that has abundant *Cravenoceras hesperium* Miller and Furnish at the top of the Perdido formation in the Panamint Range. *Cravenoceras merriami*, as noted earlier occurs in the Great Basin normally at a higher stratigraphic level than *C. hesperium*, though locally the two species have been found together in the same bed. The occurrence of *C. merriami* near the base of the Rest Spring Shale in the Panamint Range as well as in the goniatite-bearing beds of the Chainman Shale along the Cerro Gordo Spring trail suggests a rough stratigraphical equivalence of the two localities. And as these goniatite-bearing beds in the Inyo Range are at a relatively low horizon in the Chainman Shale, the correlation of most of this unit with the Rest Spring Shale appears warranted (fig. 2).

Cravenoceratoides, described for the first time from the Western Hemisphere and illustrated here, has been identified by the writer from the upper part of the Diamond Peak Formation near Eureka, Nev., as noted by Nolan, Merriam, and Williams (1956, p. 61). In Great Britain, *C. nititoides* (Bisat), to which the California species appears to be referrable or is at least very closely related, is a very late form occurring in the *Nuculoceras nuculum* subzone at the top of the *Eumorphoceras bisulcatum* zone of the Lower Namurian. Thus the Inyo Range cephalopods appear to be late representatives of the *E. bisulcatum* assemblage.

PROVIDENCE MOUNTAINS

The Providence Mountains is the name of a small north-northeast-trending range in the eastern part of the Mojave Desert in San Bernardino County, Calif., a few miles southeast of Kelso, a settlement on the Union Pacific Railroad. Hazzard (1938, 1954) mapped the geology of the northern part of the range. In an abstract (1938, p. 240) he listed, but did not describe, the units of a 10,000-foot measured section of well-exposed Paleozoic rocks in this range. For the 825 feet of rocks that is Pennsylvanian in age, he introduced the name Providence Mountains Limestone but did not elaborate on it. Later Hazzard (1954, p. 28) referred the same rocks to the lower part of the Bird Spring Formation.

A loose block of moderately dark gray limestone in the collection of Stanford University was collected in the Providence Mountains by Hazzard and is presumably from the Bird Spring Formation, as it contains the imprint of a large ammonoid of Pennslyvanian age (SU fossil register 23147). This fossil was listed by Hazzard (1954, p. 28) in a table as *Gastrioceras cf. G. cancellatum*. Additional locality data that he has kindly provided the writer show that this specimen came from the west slope of the Providence Mountains about 1,800 feet southeast of the bottom of Long Canyon, 5,500 feet west of Sheep Spring and 6,700 feet north by east of a point where Vulcan Mine Canyon joins the road from Kelso to Essex.

This specimen is referred with question to *Paralegoceras texanum* (Shumard), the closest species with regard to superficial ornament, an ammonoid that occurs in rocks of Middle Pennsylvanian (Atoka) age in the American midcontinent.

REGISTER OF LOCALITIES

The material studied in preparing this paper came from the collections of Stanford University, California, and of the U.S. Geological Survey in Washington, D.C. The types have been deposited in the Stanford University paleontological type collection and the type collection of the U.S. National Museum. Most of the Stanford University collecting localities in the Quartz Spring area, Panamint Range, are recorded under McAllister's field numbers. Abbreviations used in the text are SU for Stanford University, USGS for U.S. Geological Survey, and USNM for U.S. National Museum.

STANFORD UNIVERSITY COLLECTIONS

FL 5. Tihvipah Limestone, outlier capping hill, 2,300 ft N. 31° W. of Burro Spring and 7,200 ft N. 9° W. of Rest Spring, Cottonwood Mountains, Panamint Range, Inyo County, Calif. Collector, J. F. McAllister, July 15, 1937.

FL 15. Perdido Formation, top 10 feet, on top of round hill with cliff, forming south side of Bighorn Gap, 4,200 ft N. 58° W. of Rest Spring, Cottonwood Mountains, Panamint Range, Inyo County, Calif. Collector, J. F. McAllister, Aug. 26, 1937.

FL 15A. Same locality and horizon as FL 15. Collector, J. F. McAllister, Sept. 26, 1938.

FL 23. Perdido Formation, top limestone bed. Poor fossils from east slope of West Crest, north of Bighorn Gap, about 5,300 ft N. 61° W. of Burro Spring and 9,000 ft N. 29° W. of

Rest Spring, Cottonwood Mountains, Panamint Range, Inyo County, Calif. Collector, J. F. McAllister, Oct. 7, 1938.

FL 27. Perdido Formation, top limestone bed. Blocks of fossiliferous limestone in gully on east side of low ridge, 2,300 ft S. 53° W. of Rest Spring, Cottonwood Mountains, Panamint Range, Inyo County, Calif. Collector, J. F. McAllister, Nov. 23, 1938.

FL 36A. Perdido Formation, platy limestone just below top limestone bed, 2,200 ft S. 29° W. of Rest Spring, Cottonwood Mountains, Panamint Range, Inyo County, Calif. Collector, J. F. McAllister, Nov. 23, 1938.

FL 36B. Perdido Formation, float block from top limestone bed. Same locality as FL 36A.

FL 36C. Rest Spring Shale, concretion from basal few feet. Same approximate locality as FL 36A.

FL 38. Perdido Formation, top limestone bed, float blocks with goniatites on east side of road, a short distance north of upper end of narrow gorge through which road passes, about 2,100 ft S. 3° E. of Rest Spring, Cottonwood Mountains, Panamint Range, Inyo County, Calif. Collector, J. F. McAllister, Oct. 29, 1938.

10 ES. Perdido Formation, top limestone bed. Float block from same approximate locality as FL 38. Collector, J. F. McAllister, Sept. 8, 1938.

SU 2776 (Stanford University locality register). Same locality and horizon as FL 38. Float blocks. Collectors, J. F. McAllister and S. W. Muller, July 18, 1947.

SU 23137 and 23145 (Stanford University fossil register). White Pine Shale (Chainman Shale), Spring Trail, Cerro Gordo, Inyo Range, Calif. Collector, J. F. Mason.

SU 23146 (Stanford University fossil register). White Pine Shale, 2¼ miles north of Cerro Gordo mine, Inyo Range, Calif. Collector, J. F. Mason.

SU 23147 (Hazzard loc. P–1767) Bird Spring Formation. Providence Mountains, Mojave desert, San Bernardino County, Calif. Collector, J. C. Hazzard.

U.S. GEOLOGICAL SURVEY COLLECTIONS

10403–PC (field No. C6). White Pine Shale (Chainman Shale), Cerro Gordo Spring trail, 1½ miles north of Cerro Gordo mine, Inyo Range, Calif. Collector, E. Kirk.

15334–PC (field No. I–136). Chainman Shale, 250–300 ft above base. On pipeline trail to Cerro Gordo Spring, 1½ miles north of Cerro Gordo mine. Presumably the same locality as 10403–PC. Collector, C. W. Merriam, Oct. 11, 1946.

15335–PC (field No. 118–G). Same locality and bed as 15334–PC. Collector, M. W. Ellis, Oct. 10, 1948.

15782–PC (field No. U643). Same locality and horizon as FL 15. Collector, R. F. Johnson, Aug. 16, 1949.

15783–PC (field No. U644). Perdido Formation, uppermost 10 ft and probably lower 5 ft of Rest Spring Shale; 9,000 ft N. 83½° E. of bench mark 5257 at Quartz Spring, near long 117°29′ W., lat 36°47′ N., Cottonwood Mountains, Panamint Range, Inyo County, Calif. Collector, J. F. McAllister, 1946.

19804–PC (field No. U377). Tihvipah Formation, upper part, above fusulinid bed of collection F–7078. On hill about 1,500 ft due east of Rest Spring, Cottonwood Mountains, Panamint Range, Inyo County, Calif. Collector, E. M. Mac Kevett, Nov. 5, 1944.

19806–PC (Merriam loc. 2001). Large orthoconic cephalopod from unknown locality and horizon in the Cottonwood Mountains; camped at Gold Belt Spring. Presumably from the uppermost Perdido Formation, near Rest Spring, Quartz Spring area, Panamint Range, Inyo County, Calif. Collector, Lawrence Dietz, March 1950.

LATE MISSISSIPPIAN SPECIES

Genus RAYONNOCERAS Croneis, 1926

Rayonnoceras aff. R. solidiforme Croneis

Plate 1, figures 1, 5

Rayonnoceras solidiforme Croneis, 1926, p. 343–350, pl. 1, figs. 1–4, 6; pl. 2, figs. 4, 5.

Two specimens of *Rayonnoceras* are considered under this taxon. Both are illustrated on plate 1. They are believed to represent a species, probably new, but closely related to the type species of the genus. Study of further material will be necessary to determine the limits of this species.

The smaller specimen exposes a natural transverse section (pl. 1, fig. 1). It is approximately 30 mm long and expands to a width of 27.5 mm at the broad end, at a rate of 1 in 9 mm. The siphuncle is subcentral and its center is a little more than 14 mm from the slightly flattened presumed dorsal margin of the shell. At the narrow end, the connecting rings measure 8.9 mm wide and 5 mm long, giving a length/width ratio of 0.59. The sutures are straight and appear to be inclined shallowly dorsorad. The connecting rings are inclined more strongly ventrorad. As seen on the exposed cross section, rather thin episeptal and hyposeptal deposits coat the septa.

The large specimen is 148 mm long and reaches a width of about 124 mm at the wide end. It has been sawed longitudinally to expose the ventrodorsal section (pl. 1, fig. 5). The camerae are 21 to 22 mm long, about 5½ occurring in the space of one diameter of the conch. The depth of the septa, from where they curve into the shell margin, is about 40 mm. The shell and septa are crushed on one side, presumably the ventral, owing to lack of strength due to thinness of the cameral deposits. The shell is constricted at right angles to the siphuncle at one place, but this may have occurred after burial. The shell material adheres to the phragmocone in some places and averages about 1.2 mm thick. The surface is smooth.

The siphuncle is nummuloidal as in other species of this genus, and the rather widely expanded connecting rings are vertically grooved on the outside. The siphuncle is partly filled with thick annular deposits and between them are rayonettes (Croneis, 1926) and an irregular endosiphuncle that ranges in width generally from 9 to 15 mm but possesses scattered apophyses. It is filled with recrystallized light-gray calcite that locally extends into and around the dark siphuncular deposits and even penetrates the rayonnettes at some points. The dimensions, in mm, of the siphuncle and septal necks are as follows:

Width of septal aperture	21.0
Length of connecting ring	20.8
Width of connecting ring	44.5
Length of septal neck	3.0
Width of septal brim	3.2

The length/width ratio of the connecting rings in this specimen is 0.46.

Fibrous episeptal and hyposeptal deposits fill most of the camerae on the dorsal side, normally being deposited on the septa to depths of 7 mm. The spaces between them have been filled with dark-gray calcareous mud. On the ventral side the cameral deposits have a maximum thickness of about 3 mm but most are about 2 mm thick.

This species appears to be intermediate between *R. solidiforme* Croneis and *R. vaughanianum* (Girty). It resembles the former in depth of the camerae, proportions of the mature connecting rings, and the sparseness of the cameral deposits on what is presumed to be the ventral side. It resembles the latter in its subcentral siphuncle. *R. solidforme* has a rather strongly eccentric siphuncle.

Figured specimens: USNM 120614, 120615.

Occurrence: Perdido Foundation and basal Rest Spring Shale, USGS locs. 15783–PC, 9000 ft. north of Bench Mark 5257 at Quartz Spring: Perdido Formation, (?) 19806–PC, unknown locality, probably near Rest Spring; Cottonwood Mountains, Panamint Range, Inyo County, Calif.

Genus BACTRITES Sandberger, 1843

Bactrites? cf. B. carbonarius Smith

Plate 1, figures 10–12

Bactrites carbonarius Smith, 1903, p. 31, 32, pl. 6, figs. 9–11.

Bactrites? is represented by several fragments from two localities in the Panamint Range. The one figured consists of three camerae broken from the narrow end of a longer imperfectly preserved slightly compressed incomplete phragmocone, which is 70 mm long and consists of 11 camerae. At the apicad end of this fragment a single camera is 8.5 mm high, 7.9 mm wide, and 9.0 mm long (6.1 mm between sutures). The phragmocone expands to diameters of 9.1 by 8.6 mm in the space of two camerae, a distance of 12.2 mm, or 1 in 24 mm. There are 1.5 camerae in a space equal to the dorsoventral diameter, but this proportion varies somewhat as some camerae are longer than others. The sutures are straight and normal to the shell axis. The siphuncle is marginal, tubular, and 0.7 mm wide.

A fragment of a body chamber from locality SU 2776 shows on one side the poorly preserved smooth shell surface and on the other the imprint of wavy transverse lirae that ornament the interior of this part of the shell. These are approximately at right angles to the shell axis at one end but curve diagonally about 20° at the other. They appear to form an orad bow, but as the taper of the shell is so slight and the preservation leaves something to be desired, it is difficult to distinguish the orad from the apicad end of this fragment. One cannot be certain, therefore, if the transverse internal lirae form a bow or a sinus. A patch of shell adhering to the side of another piece of a phragmocone from the same locality shows faint wavy striae. The striated surface apparently represents a layer within the shell itself. The striae are inclined dorsorad about 72° to the shell axis.

The proportions of the phragmocone of these shells agree in general with those of *B.? carbonarius* Smith. Only two species are known to the writer to possess wavy lirae on the inner surface of the body chamber. These are *B.? carbonarius* Smith and *B.? quadrilineatus* Girty. Those of *B.? carbonarius* are approximately normal to the shell axis, whereas those of *B.? quadrilineatus* are strongly inclined. Our specimens are intermediate in this respect but resemble more strongly those of *B.? carbonarius.* Diagonal incised striae are also preserved in some specimens of *B.? quadrilineatus* on the surface of the internal mold of the phragmocone. Nothing precisely like these can be seen in the California specimens.

Figured specimen: SU 9150.

Occurrence: Perdido Formation, top limestone bed, locs. FL 38, 10 E8, and SU 2776, 2,100 ft S. 3° E. of Rest Spring; FL 15, 4,200 ft N. 58° W. of Rest Spring, Cottonwood Mountains, Panamint Range, Inyo County, Calif.

Genus MITORTHOCERAS Gordon, 1960

Mitorthoceras cf. M. perfilosum Gordon

Plate 1, figures 2–4

Mitorthoceras perfilosum Gordon, 1960, p. 136, 137, pl. 27, figs. 1–4, 8.

A small orthoconic cephalopod that resembles *Mitorthoceras perfilosum* is represented by four specimens from three localities in the Panamint Range. The shells are similar to the type lot of *M. perfilosum* but expand a little more rapidly with growth. The slightly distorted fragmental phragmocone figured on plate 1, figures 2 and 3, expands about 1 in 8 mm, and the shorter one shown in figure 4 on the same plate expands 1 in 7 mm. The conch is subcircular in section and 1.9 to 2.2 camerae occur in a space equal to one diameter of the conch. The septa are concave orad and shallowly bowl shaped.

The siphuncle is slightly eccentric. Where the diameter of the conch is 5.3 mm the siphuncle is 0.7 mm in diameter, and its center is 1.9 mm from what is presumed to be the dorsal margin of the shell (by anology with *M. clinatum* n. sp.). The shell surface is ornamented by prominent raised slightly recurved transverse lirae that have subequal interspaces, of which 12 to 13 occur in the space of 2 mm. Hyposeptal and episeptal cameral deposits are present and can be seen at the weathered orad end of one of the specimens (USGS loc. 15783). The paucity and partial distortion of the specimens precludes their being sectioned, so description and comparison of the internal characters is not presently possible.

Figured specimens: SU 9151, 9151A.

Occurrence: Perdido Formation, top limestone bed, SU loc. 2776 (2 specimens) 2,100 ft S. 3° E. of Rest Spring; USGS locs. 15782–PC, 4,200 ft N. 58° W. of Rest Spring; 15783–PC, 9,000 ft. N. 83½° E. of bench mark 5257 at Quartz Spring; Cottonwood Mountains, Panamint Range, Inyo County, Calif.

Mitorthoceras clinatum Gordon, n. sp.

Plate 1, figures 13–18, 22, 23

Diagnosis.—*Mitorthoceras* with conch expanding at moderate rate; sutures inclined moderately ventrorad; siphuncle rather strongly eccentric dorsad; six to nine gently sinuous transverse lirae in the space of 1 mm.

Description.—This species is represented by several fragments of phragmocones from two localities in the Panamint Range. The holotype, however, is an exceptionally well preserved fragment of an internal mold of two camerae, from the Burbank Hills, Utah. The holotype is circular in cross section, has a diameter of 9.2 mm at the apicad suture, and expands 1 in 9 mm. The first camera is 9.3 mm long (6.5 mm between sutures) and 1.5 camerae occur in a space equal to the diameter of the conch. The sutures are straight and inclined ventrorad 83° to the axis of the conch. The surface of the internal mold is polished and shows both the ventral furrow (*conchial furrow* of Flower, 1939) as a slightly raised rectilinear thread along the venter (pl. 1, fig. 18), and the dorsal furrow (*septal furrow* of Flower, 1939) as an interrupted pair of striae along the dorsum (pl. 1, fig. 15). The siphuncle is 1.0 mm in diameter in the plane of the apicad septum and its center is 3.3 mm from the dorsal margin of the conch, or two-sevenths of the way from the center to the dorsum of the conch. The shell is recrystallized internally and does not show internal characters. Two small patches of shell material adhere to the internal mold and bear raised transverse lirae with subequal or slightly narrower interspaces, of which 14 occur in the space of 2 mm.

The best preserved California paratype is a moderately large specimen of three camerae, 40 mm long, that expands at a rate of 1 in 9.3 mm. The inclination of the sutures is the same as in the holotype and the cameral length proportionally the same. The dorsal furrow can be seen, but the ventral one is not preserved.

Other California specimens, mostly of a single camera, show variation in surface sculpture from 12 to 18 lirae in the space of 2 mm. On one of these (SU 9152A), enough shell material is preserved on the dorsal side to show that the transverse lirae are shallowly sinuous and form a gentle orad bow over the dorsum.

Comparisons and affinities.—*Mitorthoceras clinatum* can be distinguished from all other known species of the genus principally by its moderately inclined sutures and relatively long camerae, as well as by the rather markedly eccentric siphuncle. The common preservation of the dorsal furrow also appears to be characteristic. The dorsal furrow has not been seen on *M. perfilosum*, from which the surface shell material is much less prone to peel. The holotype was found in a bed with *Cravenoceras merriami* Youngquist and the California paratypes in association with *Cravenoceras hesperium* Miller and Furnish and thus belong in the same broad goniatite zone, the *Eumorphoceras bisulcatum* zone.

Holotype: USNM 120616. Paratypes SU 9152, 9152A.

Occurrence: Chainman Shale, upper part, USGS loc. 17024–PC (holotype), 5 miles east and 1 mile north of the Foote Ranch, Confusion Range, Millard County, Utah. Perdido Formation, top limestone bed locs. SU 2776 (paratypes) and FL 38, 2,100 ft. S. 3° E. of Rest Spring, Cottonwood Mountains, Panamint Range, Inyo County, Calif.

Genus SCYPHOCERAS Ruzhentsev and Shimansky, 1954

Scyphoceras cf. S. cessator (Hall and Whitfield)

Plate 1, figures 6–9

Cyrtoceras cessator Hall and Whitfield, 1877, p. 278, pl. 6, fig. 15.

A rapidly expanding annular nautiloid, which appears to be very slightly cyrtoconic and is represented by four fragmental specimens from two Panamint Range localities, is referred to *Scyphoceras*. The figured specimen, an incomplete phragmocone of four camerae about 16 mm long, is the most rapidly expanding one, averaging 1 in 2.3 mm; other specimens (one from the same locality as the figured one) average approximately 1 in 4 mm. The conch is rounded trapezoidal in cross section, becoming squarish with growth; the ventral side is a little wider than the dorsal. The figured specimen is 13.4 mm high and 13.6 mm wide at the annulation near the orad end. Annulations are spaced 3.5 mm apart and are inclined very slightly dorsorad; they are slightly sinuous. Septa are bowl shaped, of moderate concavity, and spaced 3.1 mm apart. The sutures are nearly straight and approximately at right angles to the shell axis. About 3½ camerae occur in a space equal to the mean dorsoventral diameter of the conch. The shell surface is covered with fine threadlike lirae that are irregularly spaced but tend to be bunched over the annuli; 18 to 20 occur normally between crests of annuli, but locally there are more. The transverse lirae have approximately the same configuration as the annuli.

The siphuncle is located close to the margin. In the plane of the apicad septum, where the dorsoventral diameter is 9.2 mm, the siphuncle is 0.7 mm wide and its center is 2.1 mm from the margin. On the septum at the wide end, it is 1.1 mm wide and its center is 2.7 mm from the margin. The shape of the connecting rings and the nature of the siphuncular and cameral deposits have not been determined.

This shell is closely related to and perhaps identical with *Cyrtoceras cessator* Hall and Whitfield described from the White Pine Shale (Chainman Shale) in central Nevada, and appears to belong in *Scyphoceras*. The rate of expansion of the conch of *S. cessator* is 1 in 3 mm, which falls well within the range of the California specimens, and the spacing of the annuli is the same. The septa are reportedly a little more widely spaced in the holotype of *S. cessator* than in the California shells, but for the present it seems best to consider that the range of variation in *S. cessator* includes these California specimens.

Figured specimen: SU 9153.
Occurrence: Perdido Formation, top limestone bed, locs. SU 2776 and FL 38, 2,100 ft S. 3° E. of Rest Spring, Cottonwood Mountains, Panamint Range, Inyo County, Calif.

Genus LIROCERAS Teichert, 1940

Liroceras? sp.

Plate 2, figures 1–4

A single coiled nautiloid consisting only of the first volution of the phragmocone with parts of the shell of the second volution adhering to it is referred here questionably to *Liroceras*. It expands rapidly about 1 in 3.5 mm measured along the lateral zones and by the end of the first volution is depressed elliptical in cross section; the greatest diameter is near the middle of the whorl. The conch is perforate, the perforation with a diameter of 3 mm. Surface ornament consists of strong raised longitudinal subequally spaced cords with wider interspaces, of which about 15 occur over the venter between the rounded lateral zones. They are crossed by somewhat wavy transverse lirae that swing apicad on the umbilical slope to cross the lateral zones. Where the shell is missing, the cords can be seen faintly expressed on the surface of the internal mold. The center of the venter in the initial part of the phragmocone is occupied by a faint shallow longitudinal depression in which two additional cords are intercalated between the others at either side of the central one. This depression and the subsidiary cords die out within three-quarters of the beginning of the volution.

Part of the umbilical wall of the succeeding volution can be seen at one side and bears four longitudinal cords crossed by nearly straight transverse lirae. The cords die out at the end of the first third of the second volution, indicating that the shell is nearly smooth in its mature stages. The sutures are nearly straight across the venter. Nineteen camerae compose the first volution.

The dimensions of the shell, in mm, are as follows: diameter (D) 16.0; height of last whorl (H) 7.0; width of last whorl (W) 10.8; and width of umbilicus (U) 7.8. These give the following proportions: $U/D=0.49$, $W/D=0.68$, and $W/H=1.55$.

It is difficult to determine what an adolescent specimen like this will become with growth, but the most mature part appears to resemble *Liroceras* more closely than any other genus.

Figured specimen: SU 9154.
Occurrence: Perdido Formation, top limestone bed, loc. FL 38, 2,100 ft S. 3° E. of Rest Spring, Cottonwood Mountains, Panamint Range, Inyo County, Calif.

Genus HEMATITES Flower and Gordon, 1959

Hematites? sp.

Plate 1, figures 19–21

A small fragment of a phragmocone of bactritid aspect is considered under this taxon. It was mentioned by Flower and Gordon (1959, p. 835) in their discussion of Mississippian belemnoid phragmocones. It is 7 mm long and exposes four septa. The cross section is subcircular, slightly compressed, measuring 6 by 7 mm at the adoral end and expanding 1 in 4.9 mm. The septa are shallowly bowl shaped, 1.7 mm deep, and are spaced 1.4 mm apart; 4⅝ camerae occur in the space of one dorsoventral diameter of the conch. The sutures appear to lack lateral lobes but slope gently dorsorad. The siphuncle is marginal but cannot be clearly discerned on the specimen.

This fragment is somewhat similar to *Bactrites? nevadensis* Youngquist but is a little more broadly rounded in cross section, has very slightly more closely spaced septa, and is slightly more rapidly expanding. As Flower and Gordon pointed out, its phragmocone has most of the features typical of their belemnoid genus *Hematites*. It is devoid of rostral material, and though some shell material is found on the phragmocone wall, this has a smooth faintly granular surface. One cannot tell, therefore, whether this shell belongs with the bactritids or the belemnoids, though its closely spaced gently sloping sutures indicate that it is not part of the normal Late Paleozoic bactritid line typified by *Bactrites? carbonarius* Smith.

Figured specimen: SU 9155.

Occurrence: Perdido Formation, top limestone bed, loc. SU 2776, 2,100 ft S. 3° E. at Rest Spring, Cottonwood Mountains, Panamint Range, Inyo County, Calif.

Genus CRAVENOCERAS Bisat, 1928

Cravenoceras hesperium Miller and Furnish

Plate 3, figures 3–5, 14–17, 21–33; text figures 4*A*, *D*, *E*

Cravenoceras hesperium Miller and Furnish, 1940, p. 374, 375, pl. 49 figs. 1–8, text figs. 15B, 16B.

[part] Youngquist, 1949a, p. 291, pl. 59, figs. 4–11, 14–16; pl. 60, figs. 1, 2, 8–15; pl. 61, figs. 1–3; pl. 62, figs. 1–6, 16–18 [not pl. 59, figs. 12, 13; pl. 61, figs. 10–12]; text fig. 1B; 1949b, p. 613, 614, pl. 100, figs. 1–7.

Cravenoceras nevadense [part] Youngquist, 1949a, p. 295, 296, pl. 58, figs. 7–11; pl. 59, figs. 1, 17, 18; pl. 60, figs. 3, 4(?); pl. 62, figs 11–15; pl. 64, figs. 13–16 [not pl. 59, figs. 2, 3].

This species is by far the most common fossil in the limestone bed that marks the top of the Perdido Formation in the Panamint Range. It exhibits a considerable range of variation in shape, shown in the scatter diagrams (figs. 5 and 6) along with variation in *C. inyoense* n. sp. Two forms are recognizable, a typical rather involute relatively narrow form and a broader less involute one. These two forms are recognized also in other parts of the Great Basin region, in Nevada and Utah. Although there is a tendency toward intergradation, they do not appear to merge completely. Although only one or the other form is represented in some of our collections, this may be due to the accident of haphazard collecting, incomplete exposure of the containing beds, or of thanatocoenosis. The reason for the presence of two distinct forms is not certain at present, but the most obvious explanation that comes to mind is sexual dimorphism. These forms do not appear to represent distinct species, as the pattern of ornament is the same and they occur together at many localities.

The typical form is shown on plate 3, figures 21–33. This agrees in general shape and degree of involution with the type lot from the Chairman Shale in the Egan Range, Nev. (Miller and Furnish, 1940, p. 374, pl. 49, figs. 1–8). The original lot consists of 6 figured (USNM 98935) and 22 unfigured (USNM 98934) syntypes. The large specimen illustrated by Miller and Furnish (1940) on plate 49, figure 1, is hereby designated the lectotype (USNM 120617) and the rest paralectotypes. Cross sections of a paralectotype (USNM 98934) are shown in figure 4*A*, *D*.

The specimen shown on plate 3, figures 24–26, belongs with the typical form but is more loosely coiled than normal so that the width of its umbilicus is equal to a little more than one-third the diameter of the conch. Looser coiling is a common character in late mature and gerontic shells of *Cravenoceras*. It is particularly characteristic of *Cravenoceras kingi* (Hall and Whitfield), which is probably an ancestor of *C. hesperium*. Some shells at the same diameter as the one shown on plate 3, figures 24–26, however, still retain the tighter coiling of the typical early mature conch.

The characteristic transverse sculpture of *Cravenoceras* is particularly well developed on some of the California specimens, as for example those illustrated on plate 3, figures 21–23, 30–33. In early maturity, the shinglelike transverse lamellae form a prominent broad arch across the venter, bowing markedly orad. Over the ventrolateral shoulders is a correspondingly prominent though narrower sinus and on the flanks near the umbilical area a small gentle orad bow. The umbilical shoulder is marked by a single raised spiral cord on top of the transverse lamellae. Internal varices are developed, generally about four to a volution and have approximately the same configuration as the transverse lamellae. At maturity the ventral orad bow of the transverse sculpture becomes flattened in the center, and in some specimens a faint ventral sinus is developed.

The suture of the typical form of *C. hesperium*, as illustrated by Miller and Furnish (1940, text fig. 15B) and by Youngquist (1949a, text fig. 1B), needs a very slight modification. It has a relatively narrow ventral lobe shallowly divided by a subtriangular median saddle into two narrow pointed prongs. The sides of the ventral lobe are shown as straight and subparallel in the illustrations cited. Actually they are gently sigmoidal, bulged slightly apicad, and pinched in orad. This part of the suture is difficult to see in the specimen used for its illustration by Miller and Furnish, but the slightly sigmodial shape of the side of the ventral lobe can be made out on close inspection. This character is well shown on many of the California specimens and the suture of one of them is illustrated in figure 4*E*. The first lateral lobe is fairly broad, with convex sides, and is pointed.

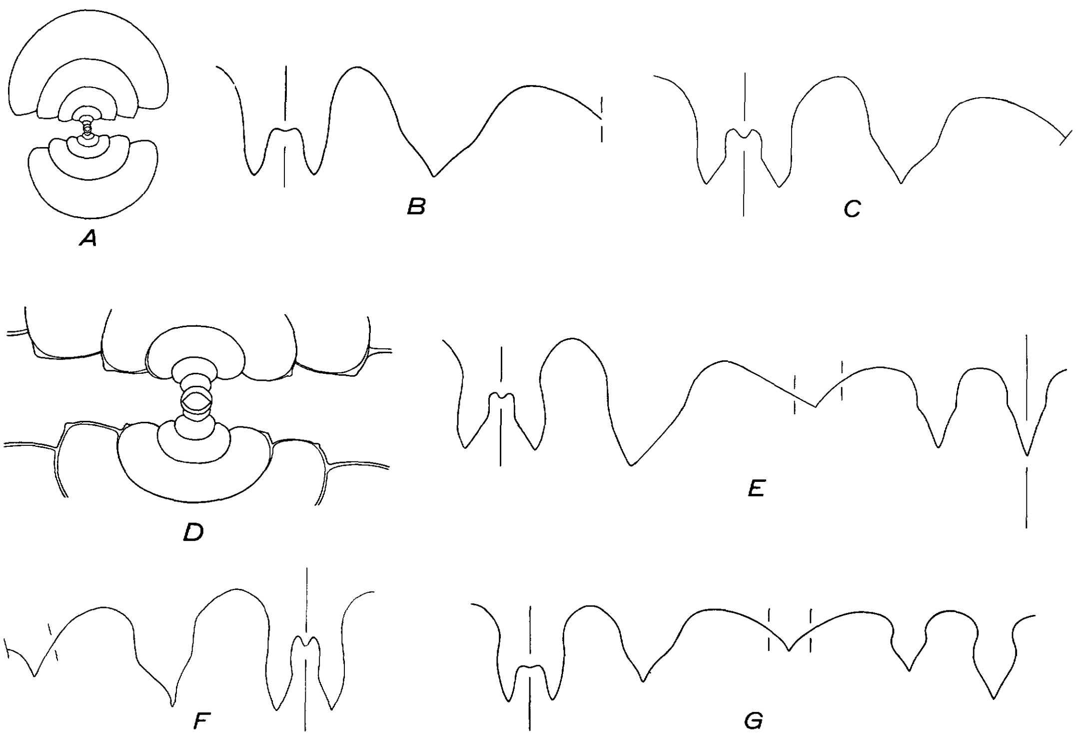


FIGURE 4.—*Cravenoceras* cross sections and sutures. *A, D, E, Cravenoceras hesperium* Miller and Furnish, cross section of a paralectotype (USNM 98934) × 1½ and × 5, respectively; suture of a California specimen (SU 9156) × 3 at a whorl height of 9.5 mm. *B, C, Cravenoceras merriami* Youngquist, external sutures of an Inyo Range specimen (SU 9161) × 3, at a whorl height of approximately 10 mm; of a Panamint Range specimen (USNM 120619) × 3, at a diameter of 18.5 mm and whorl height of 10 mm. *F, G, Cravenoceras inyoense* n. sp., external suture of the holotype, × 2, at a diameter of 33 mm and whorl height of 13.5 mm; suture of a paratype (SU 9158) at a whorl height of 4.2 mm.

The dimensions and proportions of the typical form are given in the following table. All come from SU locality 2776.

Dimensions and proportions

	A	B	C	D	E
Diameter (D)____________mm__	38. 7	29. 2	19. 7	13. 0	3. 3
Height of last whorl (H)___do____	14. 7	13. 7	9. 0	5. 4	1. 2
Width of last whorl (W)___do____	26. 0	20. 4	14. 4	10. 8	2. 2
Width of umbilicus (U)___do____	13. 4	6. 4	5. 3	3. 4	2. 0
U/D________________________	. 35	. 22	. 27	. 26	. 60
W/D________________________	. 67	. 70	. 73	. 83	. 67
W/H________________________	1. 77	1. 49	1. 60	2. 00	1. 83

The wide form is illustrated on plate 3, figures 3–5. Other individuals have been described and illustrated as *Cravenoceras nevadense* Miller and Furnish by Youngquist (1949a, p. 295, 296, pl. 58, figs. 7–11; pl. 59, figs. 1, 17, 18; pl. 60, figs. 3, 4?; pl. 62, figs. 11–15; pl. 64, figs. 13–16) and also as *C. hesperium* (Youngquist, 1949b, p. 613, 614, pl. 100, figs. 4–7).

The dimensions and proportions of several specimens of the wider form are given in the following table. Data from these and other specimens are plotted in the scatter diagrams (figs. 5, 6) where they are compared with those of the typical form and of *C. inyoense* n. sp.

Dimensions and proportions

	A	B	C	D	E
Diameter (D)__________mm__	29. 8	17. 5	11. 4	10. 8	9. 6
Height of last whorl (H)__do____	11. 3	5. 5	4. 2	4. 0	3. 6
Width of last whorl (W)__do____	23. 7	[1] 14. 4	9. 6	8. 9	[2] 8. 6
Width of umbilicus (U)__do____	11. 0	8. 3	5. 7	4. 5	3. 7
U/D______________________	. 37	. 47	. 50	. 41	. 40
W/D______________________	. 80	. 82	. 84	. 82	. 91
W/H______________________	2. 10	2. 62	2. 29	2. 23	2. 29

[1] Twice the half width.
[2] Adjusted for slight distortion.

The wide form has a broader venter and less elevated whorl than the typical form, remaining broadly subspherical throughout much of its growth. The umbilicus is wider than in the typical form, averaging about two-fifths of the diameter of the conch in early maturity. The transverse striae and internal varices bow orad across the venter as in the typical form, but the arching is shallower and the sinuosity more subdued. The spiral cord along the umbilical shoulder is present in these shells but is easily lost when the shell is broken free from the enclosing rock. The suture shows no appreciable difference from that of the typical form.

Comparisons and affinities.—*C. hesperium* is probably most closely related to the earlier species *C. kingi*

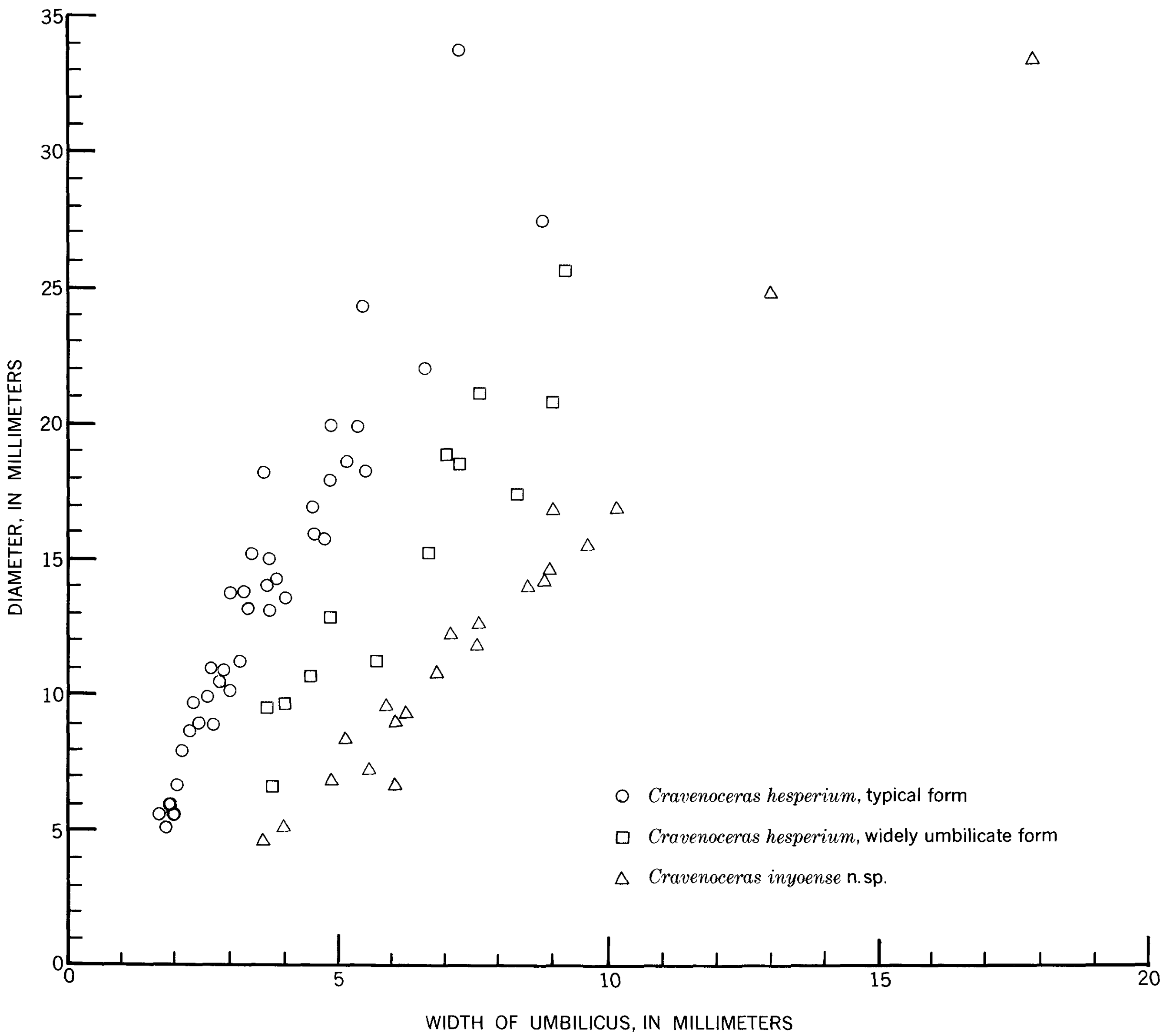


FIGURE 5.—Scatter diagram showing relative involution of the conch (diameter/width of umbilicus ratio) for California specimens of *Cravenoceras* from a single bed.

(Hall and Whitfield), which is similarly ornamented by a single cord along the umbilical shoulder and which differs principally in the much greater evolution of the mature conch. Young shells of *C. kingi* resemble those of the broader, more evolute form of *C. hesperium*, but well preserved ones possess fine longitudinal lirae over the surface of the shell that die out in early maturity; these are absent in *C. hesperium*.

C. nevadense Miller and Furnish, as was noted earlier, has been confused by some authors with the wider, more evolute form of *C. hesperium*. It is, however, a distinct species. Its early mature shell is narrower than that of *C. hesperium* and the umbilical shoulder is ornamented by four or five fine spiral lirae, instead of a single cord as in *C. hesperium*. The writer has not seen any shells other than the type lot that he would identify as *C. nevadense*.

C. merriami Youngquist likewise is a distinct species and occurs generally a little higher stratigraphically than *C. hesperium*, although the two species are associated at the type locality of the former. Though strongly involute and thus resembling extreme examples of the typical form of *C. hesperium*, it lacks any sort of spiral ornament in the region of the umbilical shoulder and its suture has a slightly wider ventral lobe that becomes more deeply divided at maturity than that of *C. hesperium*. Differences of *C. hesperium* from *C. inyoense* n. sp. are given in the discussion of that species.

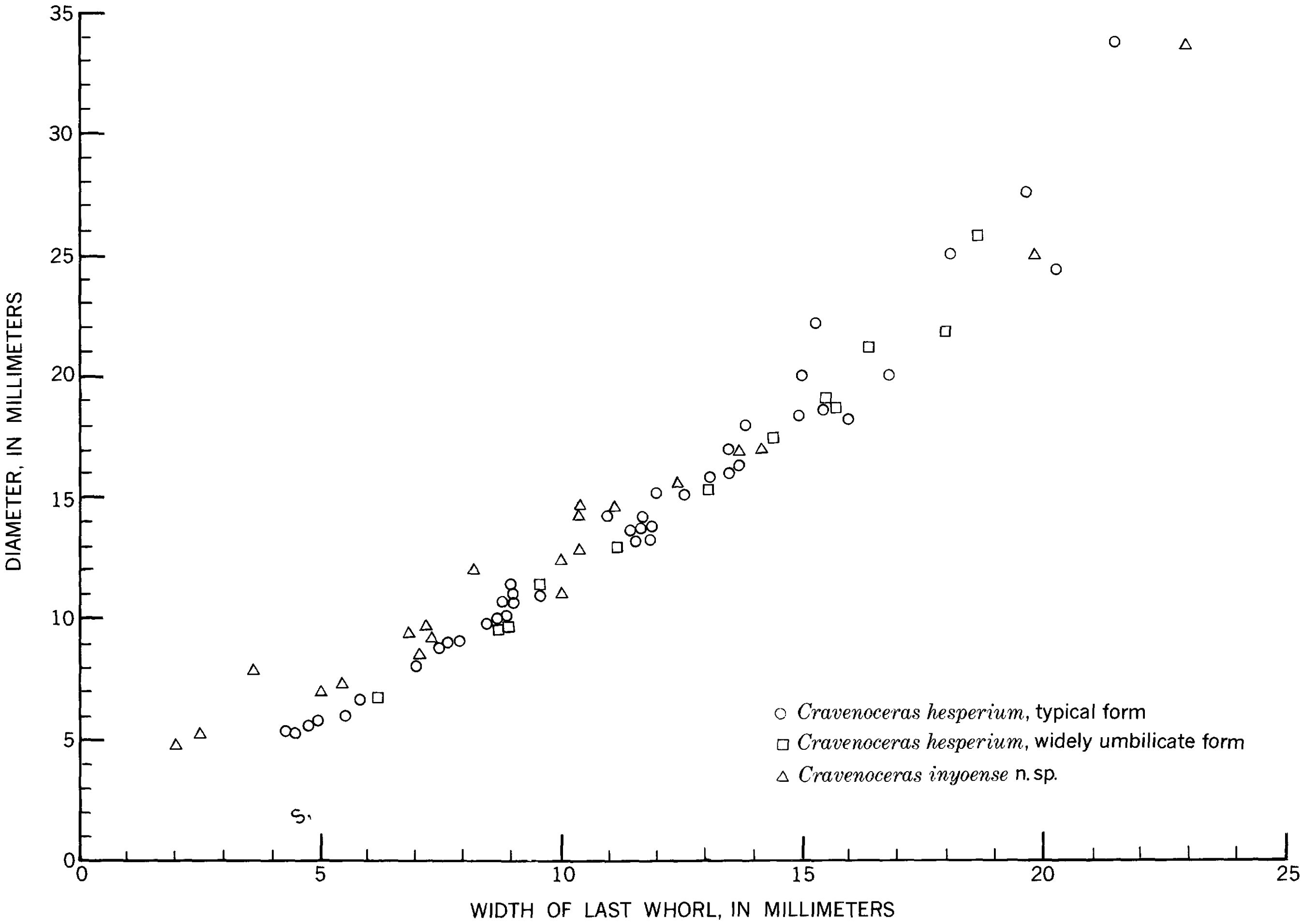


FIGURE 6.—Scatter diagram showing relative width of conch (diameter/width ratio) for California specimens of *Cravenoceras* from a single bed.

Hypotypes: SU 9156, USNM 120617.

Occurrence: Perdido Formation, top limestone bed, locs. FL 38, 10 E8, and SU 2776, 2,100 ft S. 3° E. of Rest Spring; FL 15 and USGS loc. 15782–PC, 4,200 ft N. 58° W. of Rest Spring; FL 27, 2,300 ft S. 53° W. of Rest Spring; FL 36A, B, 2,200 ft S. 29° W. of Rest Spring; and USGS loc. 15783–PC, 9,000 ft N. 83° E. of bench mark 5257 at Quartz Spring; Cottonwood Mountains, Panamint Range, Inyo County, Calif.

Cravenoceras inyoense Gordon, n. sp.

Plate 2, figures 5, 6; plate 3, figures 1, 2, 6–13, 18–20; text figures 4 *F*, *G*

Diagnosis.—Exceedingly evolute *Cravenoceras* lacking longitudinal ornament on umbilical shoulder.

Description.—This species is based on 38 specimens from 2 localities in the same general area. The holotype is an internal mold of a phragmocone nearly 34 mm in diameter. Only small patches of the shell are preserved, but surface sculpture is well preserved on several of the paratypes, which also show characters of the adolescent conch. These features are particularly well exhibited on the specimens figured on plate 3, figures 6–13. The conch is subglobose to broadly thick discoidal; the venter is broadly rounded and merges imperceptibly with the flanks. The umbilical shoulder is subangular.

The protoconch and the early part of the first postnuclear whorl, as seen in the best preserved paratype, are broader than the second postnuclear whorl; the whorl narrows markedly in the latter half of the first volution. The conch is coiled planorbitally for four to five volutions, remaining subdiscoidal in shape, and then the whorl begins to broaden more rapidly, and the sides of the umbilicus begin to steepen. By the eighth volution the conch is barrel shaped and subspherical. The surface sculpture at this stage consists of transverse striae that form a very shallow moderately narrow ventral sinus, flanked by faint, shallow broad rounded orad bows. Outside of these, near the lateral zone are slightly more prominent lateral sinuses. The transverse striae swing rather strongly orad to cross the subangular lateral zone that can be said also to constitute the umbilical shoulder. They continue on to the umbilical wall, where they are approximately radial. The umbilical wall and shoulder in these immature shells is also ornamented by a few small scattered rounded nodelike swellings, 3 to 10 to a whorl but difficult to count owing to nonuniformity of their development. Some of the more prominent ones are adjacent to transverse constrictions of growth.

The growth constrictions are generally more strongly developed in shells more than 10 mm in diameter and are roughly parallel to the transverse striae. They are weak or absent on the umbilical shoulder. On the holotype they are spaced three to four to a volution.

In shells more than 15 mm in diameter, the umbilicus becomes stepped; this occurs in the last 4½ volutions of the holotype. The typical straplike transverse lamellae of *Cravenoceras*, each bounded by a stria on the adoral edge, are well developed in the adult phragmocone and preserve in a subdued manner the ventral and lateral sinuses and intervening bows of the adolescent conch. In some specimens the ventral sinus is not apparent.

The suture (fig. 4*F*, *G*) is like that of *Cravenoceras hesperium*, having a moderately narrow ventral lobe with gently convex sides, divided to almost half its length into two hastate prongs by an inverted goblet-shaped median saddle. The first lateral saddle is slightly narrower than the ventral lobe, asymmetrically rounded-spatulate in shape. The first lateral lobe is about the same width as the first lateral saddle, acuminate, slightly constricted orad. The second lateral saddle arches asymmetrically across the umbilical shoulder to the moderately short narrowly pointed umbilical lobe. The internal suture consists of three hastate, sharply pointed lobes separated from each other by fairly narrow rounded saddles and from the umbilical lobes by broader asymmetrically rounded saddles. Twenty sutures occur on the final volution of the holotype, which does not appear to represent a complete phragmocone, as there is no tendency for the last several sutures to be spaced closer together. Another paratype (USNM 120618), a phragmocone partly distorted by crushing, which probably reaches a diameter about 5 mm greater than the holotype, does show crowding of the septa at the orad end and represents a nearly complete phragmocone.

Comparisons and affinities.—*Cravenoceras inyoense* is the most evolute species of this genus found in the American Carboniferous. It recalls the earlier species *C. scotti* Miller and Youngquist, but that species has fine spiral lirae ornamenting the umbilical region, a character shared with *C. nevadense* Miller and Furnish and is less evolute than *C. inyoense*. It also recalls *C. kingi* (Hall), another earlier evolute form, but that

Dimensions and proportions

[Holotype A and paratypes B, C, E, and F are from SU loc. 2776. Paratype D is from McAllister loc. FL 38]

	A	B	C	D	E	F
Diameter (D) mm	33. 7	25. 0	14. 8	10. 8	9. 7	5. 2
Height of last whorl (H) do	10. 6	9. 3	4. 7	3. 2	3. 0	1. 3
Width of last whorl (W) do	23. 0	19. 8	10. 2	8. 0	7. 2	2. 5
Width of umbilicus (U) do	17. 8	13. 0	8. 9	6. 4	5. 9	4. 0
U/D	. 53	. 52	. 60	. 60	. 61	. 77
W/D	. 68	. 79	. 69	. 74	. 74	. 48
W/H	2. 17	2. 11	2. 17	2. 50	2. 40	1. 92

species differs in its much less evolute early stages, its strong spiral cord along the umbilical shoulder, and its having fine longitudinal lirae in young shells, a character it shares with *C. leion* Bisat.

C. inyoense is easily distinguished from *C. hesperium* with which it occurs by its much wider umbilicus and lack of a spiral cord along the umbilical shoulder and, in young stages, by the absence of a strong orad bow of the transveres sculpture over the venter, as well as by its planorbital coiling and subdiscoidal shape (on pl. 3 compare figs. 18–20 with 27–29). Comparison of the shape of the conch and width of the umbilicus of the two species is shown graphically in figures 5 and 6.

Primary types: Holotype SU 9157. Paratypes SU 9158–9158D, 9159, 9160, USNM 120618, 143889.

Occurrence: Perdido Formation, top limestone bed, locs. FL 38 (10 specimens), 10 E8 (7 specimens), and SU 2776 (20 specimens), 2,100 ft S. 3° E. of Rest Spring; loc. FL 36B (1 specimen) 2,200 ft S. 29° W. of Rest Spring; USGS loc. 15783–PC (3 specimens) 9,000 ft N. 83° E. of bench mark 5257 at Quartz Spring; Cottonwood Mountains, Panamint Range, Inyo County, Calif.

Cravenoceras merriami Youngquist

Plate 2, figures 11, 12; text figure 4 *B*, *C*

Cravenoceras hesperium [part] Youngquist, 1949, Jour. Paleontology, v. 23, no. 3, p. 291, pl. 59, figs. 12, 13; pl. 61, figs. 10–12 [not pl. 59, figs. 4–11, 14–16; pl. 60, figs. 1, 2, 8–15; pl. 61, figs. 1–3; pl. 62, figs. 1–6, 16–18; text fig. 1 B].

Cravenoceras merriami Youngquist, 1949, Jour. Paleontology, v. 23, no. 3, p. 291–295, pl. 61, figs. 4–7; pl. 63, figs. 9–12; text figs. 1 C, D.

This species commonly has a subglobose shape in early maturity and becomes thick discoidal with growth. Characteristic features are: strong involution, lack of longitudinal sculpture in the umbilical region, and transverse cravenoceratid lamellae that are fairly straight across adolescent and immature shells and gradually deepen with growth to form a shallow sinus over the venter in mature shells. On the largest of three shells from the Rest Spring Shale (loc. FL 38C), a constriction on the outer volution shows such a sinus well developed over the venter.

Characteristic also of this species is the external suture, which has been figured by Youngquist, (1949, text figs. 1C, D). Sutures, two of which are illustrated here (figs. 4*B*, *C*), are exposed in some of the California specimens. The ventral lobe is rather broad and its prongs are more inflated, that is, wider than in *C. hesperium*. The ventral lobe of *C. hesperium* normally has the sides slightly convex apicad and pinched in orad. The ventral lobe of *C. merriami* has rather straight sides, never pinched in orad. This results in the first lateral saddle of *C. merriami* having a more open appearance than that of *C. hesperium*. The width of the first lateral lobe has about the same range of variation in both species and cannot be used to distinguish them.

Dimensions and proportions of four California specimens from the Quartz Spring area, Panamint Range, are given as follows:

Dimensions and proportions

	A	B	C	D
Diameter (D)----------------mm--	37. 4	32. 6	22. 2	21. 8
Height of last whorl (H)------do----	21. 0	16. 4	10. 0	10. 0
Width of last whorl (W)-------do----	[1] 24. 5	21. 6	16. 9	16. 8
Width of umbilicus (U)--------do----	5. 2	4. 7	[2] 3. 0	3. 0
U/D-------------------------------	. 14	. 14	. 14	. 14
W/D-------------------------------	. 66	. 66	. 76	. 77
W/H-------------------------------	1. 17	1. 32	1. 69	1. 68

[1] Estimated.
[2] Approximate.

Comparisons and affinities.—In general shape of the conch and in the lack of spiral ornament on the umbilical region, *C. merriami* is close to *C. richardsonianum* (Girty), an American midcontinent species. Its main differences from *C. richardsonianum* are the spherical to subspherical shape of young shells of three or four volutions in contrast to the discoidal to subsidcoidal shape of shells of this size of *C. richardsonianum* and the ventral lobe of the adult suture that develops much longer prongs than that of *C. richardsonianum*.

C. merriami can be confused with involute specimens of *C. hesperium*. How the two are distinguished by suture characters has already been discussed. In addition, the shell of *C. hesperium* is less involute, its transverse elements of ornament do not form a well-defined ventral sinus but bow strongly orad in immaturity and early maturity and also form lateral sinuses; and, most important, a spiral cord is present at the umbilical shoulder in *C. hesperium*.

Both species occur in the same bed at the type locality of *C. merriami*, but studies by the writer and by R. K. Hose in the Confusion Range of western Utah have shown that they commonly occupy separate parts of the section, and *C. merriami* is stratigraphically above *C. hesperium*. This relation is borne out by the specimens of *C. merriami* from McAllister locality FL 36C that occur slightly higher stratigraphically than the beds having abundant *C. hesperium*. Whether the two species occur in the same bed at USGS locality 15783–PC is open to question as all of the specimens of *C. merriami* show areas of caliche indicating that they were picked up loose and thus could have come from the Rest Spring Shale. Moreover, they do not have chunks of dark-gray limestone matrix adhering to them as do most of the specimens of *C. hesperium* in the same collection.

Figured specimens: SU 9161, USNM 120619.

Occurrence: Base of Rest Spring Shale or top of Perdido Formation USGS loc. 15783–PC (4 specimens) 9,000 ft N. 83½° E. of bench mark 5257 at Quartz Spring; Cottonwood Mountains, Panamint Range. Rest Spring Shale, concretions in the lower few feet, loc. FL 36C (3 specimens) about 2,200 ft S. 29° W. of Rest Spring, Cottonwood Mountains, Panamint Range, Inyo County, Calif. Chainman Shale, SU 23137 (Stanford University fossil register) (2 specimens) Spring Trail, Cerro Gordo, Inyo Range, Calif.

Genus CRAVENOCERATOIDES Hudson, 1941

Cravenoceratoides cf. C. nititoides (Bisat)

Plate 4, figures 18–23

Cravenoceras nititoides Bisat, 1932, p. 35, pl. 2, fig. 2.
Cravenoceratoides nititoides Hudson, 1941, p. 282.

The most common cephalopod in the Chainman Shale in the Cerro Gordo area of the Inyo Range is a form originally identified by Girty in a fossil list published by Kirk (1918, p. 39) as *Gastrioceras* aff. *G. richardsonianum* Girty. It is represented largely by fragmental remains of shells flattened on surfaces of the grayish-black slightly altered shale. Young individuals, however, occur fairly commonly as partly distorted party limonitic casts in the shale, locally weathered out in part to leave molds. This form is extremely close to, if not identical with, *Cravenoceratoides nititoides* (Bisat) originally described from the Arnsbergian (Lower Sabdenian) stage of Pace Gate Beck, Blubberhouse Moore, Yorkshire, England. Enough specimens are preserved to permit the following description of the California form.

The conch is subspherical and moderately evolute in young shells, rapidly becoming involute and developing somewhat wide flanks with growth. In early maturity the conch has a rather well rounded venter that merges into the more gently rounded flanks and rather sharply rounded umbilical shoulders. The diameter of the umbilicus of a specimen with a conch diameter of a little more than 4 mm (pl. 4, figs. 18–20) is nearly two-fifths that of the conch. In another specimen at a conch diameter of 13 mm (pl. 4, figs. 22, 23) it is between one-sixth and one-seventh that of the conch. A crushed and distorted example, flattened to a diameter of 39 mm is shown on plate 4, figure 21. Fragments of other shells show that the diameter of some specimens exceeds 60 mm.

The surface of the conch bears rather strong transverse lirae, most of which bifurcate on the flanks near the umbilical shoulders, though locally a single cord crosses without bifurcation. These lirae in young and immature shells form a broad orad bow across the whorl over the venter, but in more mature specimens the forward swing of the transverse lirae near the umbilical shoulder is taken up in a lateral bow orad outside of which the lirae extend across the venter in a nearly straight line. In young shells the lirae are moderately sharp and elevated, with slightly wider interspaces. In mature shells the lirae are flattened into gently canted lamellae, slightly raised along the orad edge and separated by narrow grooves.

The suture is not known. The specimens are too crushed for specimens to be determined, except for those less than 5 mm in diameter.

The holotype of *Cravenoceratoides nititoides*, a specimen likewise crushed in shale, has been figured by Bisat (1932, pl. 2, fig. 2) and by Hudson (1946, pl. 21, fig. 8). It agrees with the California shells in its small umbilicus and asymmetrical (canted) lirae in the adult, which are protractive at the umbilical shoulder but curve back gently and cross the venter in a nearly straight line. In the absence of English specimens for comparison, as well as of better preserved California material, it seems best for the present merely to point out the general agreement of the California shells with the British species.

Figured specimens: USNM 120620, 120621.

Occurrence: Chainman Shale, USGS locs. 10403–PC, 15334–PC, 15335–PC, Cerro Gordo Spring trail, about 1½ miles north of Cerro Gordo mine, Inyo Range, Inyo County, Calif.

Genus EUMORPHOCERAS Girty, 1909

Eumorphoceras bisulcatum Girty

Plate 2, figures 13, 14

Eumorphoceras bisulcatum Girty [part], 1909, p. 68–70, pl. 11, figs. 15, 17–19a [not figs. 16–16b].
Bisat [part], 1924, p. 97, 98, pl. 6, fig. 5 [? not pl. 6, figs. 1–4, pl. 10, fig. 12].
Schmidt, 1925, p. 584, 585, pl. 22, fig. 5, pl. 25, figs. 2, 3.
[part], 1929, in Gürich, p. 70, 71, pl. 19, fig. 5 [not fig. 6].
Delépine, 1930, in Dorlodot and Delépine, p. 57, 58, pl. 1. figs. 1–5.
Mailleux, 1933, pl. 10, fig. 139.
Schmidt, 1933, p. 455, text fig. 12.
Delépine, 1935, p. 184, 185, pl. 8, figs. 5, 6.
Demanet, 1936, pl. 2 fig. 5.
Plummer and Scott [part], 1937, p. 175, 176 [not pl. 38, figs. 4–7, text fig. 37].
Demanet and Van Straelen, 1938, in Renier and others, p. 175, pl. 130, figs. 6–9.
Demanet, 1941, p. 137, 138, pl. 5, fig. 15.
Delépine, 1941, p. 79.
Shimer and Shrock [part], 1944, p. 571, [not pl. 233, figs. 16–18].
E. W. J. Moore [part], 1946, p. 430, 431, 433, pl. 22, fig. 3, pl. 23 fig. 7, pl. 25, figs. 5a–d, text fig. 29 [not pl. 27, figs. 1, 2, text fig. 5].
R. C. Moore, 1948, p. 399, fig. 17.
Miller and Youngquist [part?], 1948, p. 622–225 [not p. 100, figs. 9–17, text fig. 2B].
Youngquist, 1949a, p. 299–301, pl. 58, figs. 4, 5.
Elias, 1956, pl. 6, fig. 6.
?*Pericyclus impressus* Koninck [part] Hind, 1918, p. 449, pl. 16, fig. 10, [not figs. 8, 9, 12].
Eumorphoceras bisulcatum var. *varicata* Schmidt, 1933, p. 455, text fig. 29.
Eumorphoceras bisulcatum mut. β Schmidt, 1933, p. 455, text fig. 50.
Van Lechwijck, Stockmans, and Willière, 1955, pl. A, fig. 24, pl. D, fig. 7.
?*Sagittoceras* sp. Delépine, 1937, in Delépine and Menchikoff, p. 82, 83, pl. 5, fig. 10, text figs. 9, 10.
Eumorphoceras bisulcatum varicatum [Schmidt] Demanet, 1941, p. 138, 139, pl. 5, figs. 16, 17.
Schmidt, 1952, p. 215, pl. 13, fig. 14.
Eumorphoceras bisulcatum mut. *grassingtonensis* Dunham and Stubblefield, 1945, p. 258, 260, pl. 11, figs. 4a–c.
Eumorphoceras bisulcatum aff. *grassingtonensis* Currie, 1954, p. 582, 583, pl. 4, fig. 6.
Eumorphoceras bisulcatum aff. *varicatum* Currie, 1954, p. 583, pl. 4, fig. 7.
Eumorphoceras bisulcatum s. l. (tending to *varicatum*) Currie, 1954, p. 583.

Ribbed involute goniatites from the Inyo Range, many of them juvenile, are referred to the type species of *Eumorphoceras*. They are preserved in slightly altered fissile to slaty grayish-black shale and tend to be compressed slightly more than is normal and otherwise distorted. Most are ornamented by 30, or slightly more, sickle-shaped ribs that curve orad near the prominent narrow sulcus that borders the outer edge of the flanks. The figured specimen is 15.5 mm in diameter and its umbilicus is 3.2 mm wide. It is imperfectly preserved and shows 21 ribs in approximately three-quarters of a volution. Another specimen, an external mold 11 mm in diameter collected at the same locality, has nearly 40 ribs. Shells in early maturity with 30 to 40 ribs per volution are typical of *E. bisulcatum*.

Figured specimen: SU 9162.

Occurrence: Chainman Shale, lower part, SU 23145 (2 specimens) Spring Trail, Cerro Gordo, Inyo Range; USGS locs. 10403–PC, 15334–PC, 15335–PC, Cerro Gordo Spring trail, 1½ miles north of Cerro Gordo mine, Inyo Range, Calif.

Eumorphoceras paucinodum Gordon, n. sp.

Plate 2, figures 7–9; text figure 7

Diagnosis.—Eumorphoceras ornamented in late adolescent phragmocone with a prominent sulcus bordering each flank and 11 to 12 broad weak sickle-shaped ribs, each terminating dorsad in a prominent umbilical node and dying out gradually ventrad.

Description.—This species is based on only two internal molds of incomplete phragmocones, but its distinctive sculpture separates it easily from other described species. The larger specimen, taken as the holotype, is slightly compressed by crushing along the venter anteriorly. Originally this part of the phragmocone would have had a diameter of slightly more than 20 mm. The conch at this stage is subdiscoidal and the venter well rounded. Marking the line where the flanks meet the ventrolateral shoulder is a prominent longitudinal sulcus 1 mm wide. The flanks are slightly convex though nearly flat and slope outward very slightly so that the greatest width is at the subrounded umbilical shoulders. The umbilical wall is convex and approximately perpendicular to the flank. The diameter of the umbilicus is roughly one-third that of the conch.

The sculpture consists of weak sickle-shaped ribs on the flanks, most of which terminate in a prominent rounded bluntly pointed node at the umbilical shoulder. The ribs do not encroach on the umbilical wall but extend radially or very slightly protractively across the inner part of the flanks, dying out rapidly ventrad. Some appear to curve orad on the outer part of the flanks near the sulcus and some appear to split in two, but they are so weak in this region that it is difficult to determine their shape. On both the holotype and paratype an occasional lone weak rib is intercalated between the others and fails to reach the umbilical shoulder and form a node. Twelve ribs terminating in nodes occur on the final volution of the holotype and 11 on the paratype. A few patches of shell material adhere to both specimens but show only a smooth granular surface.

The external suture (fig. 7) as seen in the holotype is typical of *Eumorphoceras*, having a broad ventral lobe that occupies the entire ventral region of the conch. The ventral lobe has straight sides sloping at

FIGURE 7.—*Eumorphoceras paucinodum* n. sp., external suture × 4 of the holotype at conch diameter of 16.5 mm.

angles of roughly 40° to the center of the venter and is divided to less than half its length into two broad pointed prongs by a subtriangular median saddle that in turn is notched adorally by a short lobelike protuberance over the siphuncle. The subtriangular first lateral saddle is rounded orad and centers on the outer part of the longitudinal sulcus. The first lateral lobe is less than half as wide as the ventral lobe and is pointed, with gently convex sides. The second lateral saddle curves asymmetrically across the umbilical shoulder. The umbilical lobe is short, broad, and rounded. The internal suture is not exposed.

Dimensions and proportions

	Holotype	Paratype
Diameter (D) mm	[1] 16. 7	15. 6
Height of last whorl (H) do	7. 5	7. 3
Width of last whorl (W) do	7. 8	7. 6
Width of umbilicus (U) do	5. 6	4. 6
U/D	. 33	. 29
W/D	. 47	. 49
W/H	1. 04	1. 04

[1] The holotype was measured at the widest diameter of no distortion.

Discussion.—Presumably, as in other species of *Eumorphoceras* and in the closely related genus *Girtyoceras*, the phragmocone of *E. paucinodum* becomes more discoidal with growth and acquires an acute to subacute venter, and the ribs and longitudinal sulci die out. Further collecting will have to determine whether this is so in this species. Meanwhile it should be emphasized that the present specimens show only the characters of the late adolescent phragmocone.

Comparisons and affinities.—This species is distinguished from all previously known species by its sparse evanescent ribs that are strengthened at the umbilical shoulder to form about a dozen prominent nodes, hence its trivial name. The form with the fewest ribs previously known from America is *Eumorphoceras girtyi* Elias from the Caney shale of Oklahoma. That species has 18 to 21 ribs per volution that are stronger and sharper than those of *E. paucinodum* and do not terminate in prominent nodes on the umbilical shoulder. *E. bisulcatum*, which gives its name to the stratigraphic zone in which *E. paucinodum* occurs, has 30 to 40 ribs. The two species have not yet been found together in the same bed.

Primary types: Holotype SU 9163. Paratype SU 9164.

Occurrence: Perdido Formation, top limestone bed, McAllister loc. FL 38, 2,100 ft S. 3° E. of Rest Spring, Cottonwood Mountains, Panamint Range, Inyo County, Calif.

Genus ANTHRACOCERAS Frech, 1899

Anthracoceras macallisteri Gordon, n. sp.

Plate 4, figures 1–3, 7–9; text figure 8

Diagnosis.—*Anthracoceras* with well-rounded venter and an external suture with broad pointed lobes; sides of ventral lobe concave dorsad.

Description.—This species is based on three incomplete phragmocones from the Panamint Range. The conch is subdiscoidal to discoidal, involute; the whorl sublenticular in cross section, with a well-rounded narrow venter and very slightly convex flanks. The umbilical shoulders round gently to the narrow umbilicus. Patches of shell adhering to one of the paratypes show that its surface is smooth; the growth-line pattern is not preserved.

The external suture (fig. 8) consists of a broad ventral lobe with sloping sides concave dorsad, more strongly rounding about a third of the distance orad, divided to a little less than half its length by a broad subtriangular median saddle into two pointed triangular prongs. The first lateral saddle is broad, a little less so than the ventral lobe, and very asymmetrically rounded orad. The first lateral lobe is rather narrow, roughly as wide as either prong of the ventral lobe, rather straight-sided ventrad with a shallow sigmoidal bend near the middle and convex dorsad. The second lateral saddle is broad, shallow, and asymmetrically rounded.

FIGURE 8.—*Anthracoceras macallisteri* n. sp., external suture × 4 of the holotype at whorl height of 9.5 mm.

Dimensions and proportions

[A is the holotype; B and C are paratypes]

	A	B	C
Diameter (D) mm	-------	14.9	12.2
Height of last whorl (H) do	10.6	7.3	6.7
Width of last whorl (W) do	7.2	5.7	5.7
Width of umbilicus (U) do	1.7	1.4(?)	1.2
U/D	-------	.09(?)	.10
W/D	-------	.49	.43
W/H	.68	.78	.78

Comparisons and affinities.—*Anthracoceras macallisteri* is distinguished from *A. paucilobum* (Phillips) of northwestern Europe by its well-developed pointed asymmetric first lateral lobe and from *A. glabrum* Bisat by its narrow well-rounded venter.

Primary types: Holotype SU 9165. Paratype SU 9166.

Occurrence: Perdido Formation, uppermost member, McAllister loc. FL 38, 2,100 ft. S. 30° E. of Rest Spring, Cottonwood Mountains, Panamint Range, Inyo County, Calif.

Genus DELEPINOCERAS Miller and Furnish, 1954

Delepinoceras californicum Gordon, n. sp.

Plate 2, figures 10, 15–22; text figures 9*A*–*C*

Diagnosis.—*Delepinoceras* with sutures less advanced than in type species; prongs of ventral lobe more strongly trifid than first lateral lobe. Surface of adolescent conch with about 70 longitudinal lirae.

Description.—Six incomplete specimens are available for study. The holotype is an internal mold, representing an incomplete phragmocone, with parts of the two outer volutions missing but with the inner volutions preserved. With the missing parts present, the phragmocone at this stage must have reached a diameter of slightly more than 60 mm. The conch is subdiscoidal, with a well-rounded venter and gently convex flanks sloping outward at an angle of about 25° to one another, the greatest width occurring at the rather abruptly rounded umbilical shoulders. The umbilicus is narrow, its diameter equal to $\frac{1}{8}$–$\frac{1}{10}$ that of the conch. It has rather straight inward-sloping sides. The shell surface is not preserved on the holotype and the large paratypes so one cannot tell if the surface is longitudinally lirate in the adult as it is in young specimens.

The mature suture (fig. 9*A*) has the ventral lobe divided to nearly its full length by an inverted long-stemmed goblet-shaped median saddle into two stout trifid prongs. The middle lobelet of each prong is long and narrowly acuminate; the ventrad one is extended but short, narrow, and blunt and the dorsad one merely an angulation. The first lateral saddle is narrower than either prong of the ventral lobe and is asymmetrically rounded spatulate orad. The first lateral lobe is about as wide as either prong of the ventral lobe but more weakly trifid; the middle extension narrowly acuminate, the ventrad one rather sharply angular and the dorsad one abruptly rounded. The second lateral saddle is broad and asymmetrically rounded. The um-

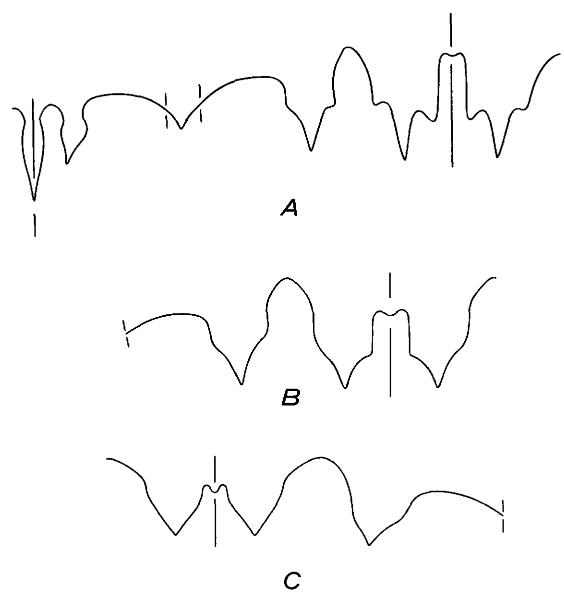


FIGURE 9.—*Delepinoceras californicum* n. sp. external suture. *A*, the holtotype × 1 at a whorl height of 30 mm; *B*, inner part of the holotype × 3 at a diameter of 19 mm and whorl height of 9 mm; and *C*, specimen illustrated on plate 2, figure 10, × 4, at a diameter of 13.4 mm and whorl height of 6.3 mm.

bilical lobe is moderately short, with an extended point. The internal suture consists of a long narrow dorsal lobe extended to a point and separated by narrow asymmetrically rounded saddles from a pair of shorter pointed hastate lateral lobes. These are joined to the umbilical lobes by a broad asymmetrically rounded second lateral saddle on either side.

Young stages are represented by a weathered specimen (pl. 2, fig. 10) with a narrowly subspherical conch at a diameter of 13 mm. The venter and the umbilical shoulders are well rounded. The surface of the shell where preserved is ornamented by fairly strong raised longitudinal lirae, separated by wider interspaces, of which roughly 70 occur over the flanks and venter between the umbilical shoulders. The lirae are crossed by faint growth lines and by internal varices, spaced about one-third of a volution apart on this specimen. These bow very slightly orad over the venter and are flanked by correspondingly shallow lateral sinuses on the ventrolateral areas.

The external suture at this stage (fig. 9*C*) is goniatitid, with the ventral lobe divided to only slightly more than half its length by a subtriangular median saddle. The first lateral saddle is asymmetrically bell shaped. The first lateral lobe is slightly less than half the width of the ventral lobe, with an acuminate tip and a subangulation at either side.

The inner part of the holotype represents the phragmocone up to a diameter of 23 mm and is thick discoidal. Longitudinal lirae are preserved on patches of shell material as well as on parts of the internal suture of the succeeding volution. The lobes of the external suture (fig. 9*B*) begin to assume a trifid aspect at diameters greater than 20 mm.

Dimensions and proportions

[B is the inner part of the holotype from USGS loc. 15782; A is a paratype from McAllister loc. FL 27 and C a paratype from McAllister loc. 10 E8]

	A	B	C
Diameter (D)..........mm..	[1] 67	22. 5	13. 2
Height of last whorl (H)..........do....	35	11. 5	6. 7
Width of last whorl (W)..........do....	28	14. 3	10. 1
Width of umbilicus (U)..........do....	8	3. 0	1. 5
U/D..........	. 12	. 13	. 11
W/D..........	. 42	. 64	. 76
W/H..........	. 80	1. 24	1. 51

[1] Estimated by extending curvature.

Comparisons and affinities.—Delepinoceras californicum is the third species of this genus to be described. It differs from the type species *D. thalassoide* (Delépine) from Haci-Diab on the Algeria-Morocco frontier principally in its somewhat less advanced suture. Delépine (in Delépine and Menchikoff, 1937, text fig. 12) illustrated the suture of the type species at a shell diameter of 18 mm where it already has a decidedly trifid aspect. In contrast is the figure of the holotype of *D. californicum* (fig. 9*B*) at a diameter of 19 mm.

The Russian species *D. bressoni* Ruzhentsev (1958, p. 490–492, text figs. 1, 2) is similar to *D. californicum* in shape and has a suture very slightly more advanced than that of *D. californicum* and less advanced than that of *D. thalassoide*. The principal difference is in the sculpture of the adolescent conch. Whereas that of *D. californicum* has about 70 strong lirae, the young shell of *D. bressoni* has approximately twice that number, judging from Ruzhentsev's figures, and the transverse sculpture is about as strong as the longitudinal, giving the surface of the conch a finely cancellate appearance.

The three species may not represent precisely the same stratigraphic horizon, judging from differences in the degree of development of the sutures, but all three are within the *Eumorphoceras bisulcatum* zone and therefore roughly equivalent in age.

Primary types: Holotype USNM 120622. Paratypes USNM 120623, SU 9167, 9168.

Occurrence: Perdido Formation, uppermost member, USGS loc. 15782–PC, 4,200 ft N. 58° W. of Rest Spring; McAllister loc. FL 27, 2,300 ft S. 53° W. of Rest Spring; Cottonwood Mountains, Panamint Range, Inyo County, Calif.

Genus DOMBAROCANITES Ruzhentsev, 1949

Dombarocanites Ruzhentsev, 1949, Akad. Nauk SSSR Doklady, tom 67, no. 4, p. 738.

Prolecanites [part] Miller, Furnish, and Schindewolf, 1957, in Moore, Treatise on Invertebrate Paleontology, p. L70.

Ruzhentsev gave the following diagnosis of the genus,

The conch is discoidal, evolute, with a somewhat wide umbilicus and with an elongate elliptical cross section of the whorls. The suture line consists of siphonal, antisiphonal and four lateral lobes on the exterior. One lateral lobe is present on the internal side of the conch. The siphonal lobe is short but with a long narrow extension. The first lateral lobe is considerably longer than the wide part of the siphonal lobe. (Free translation by S. W. Muller.)

Dombarocanites chancharensis Ruzhentsev, 1949, was designated the "typical species" and is the only species thus far referred to the genus. Its suture is shown in figure 10*B*.

Ruzhentsev pointed out that although *Dombarocanites* has the same number of lobes in its suture as *Prolecanites*, it is distinguished from that genus by the siphonal (ventral) lobe, the wide part of which is considerably higher than the base of the first lateral lobe. In *Prolecanites* the ventral lobe is as long as the first lateral (fig. 10*C*). Miller, Furnish, and Schindewolf (1957, p. L70), however, regarded *Dombarocanites* as a synonym of *Prolecanites*.

At first the writer believed it was necessary to erect a new genus for the new Californian species described below because of its distinctive trilobate ventral lobe.

Consideration of available names, however, has convinced him that its difference from *Dombarocanites chancharensis* is mainly one of degree in the width of the bulges of the ventral lobe. Considering also that such a distinctive ventral lobe occurs with lateral lobes of a slightly different shape than those in typical *Prolecanites*, that it is limited to Russian and Californian species that have an approximately equivalent stratigraphic position, and that this position is two major cephalopod zones higher than the highest known typical *Prolecanites*, it would appear reasonable and warranted to recognize Ruzhentsev's genus as distinct and assign to it the new species described below.

Dombarocanites masoni Gordon, n. sp.

Plate 4, figures 4–6, 14; text figure 10*A*

Diagnosis.—Dombarocanites with trilobate ventral lobe pinched in orad.

Description.—This species is based on three fragmental specimens from the Inyo Range. The holotype is the fragment of an internal mold of a phragmocone that shows the most complete suture. The mature whorl section in this species is elongate-elliptical, the height increasing with growth. The venter is strongly rounded, and the flanks are gently rounded. No trace of the shell material remains in any of the specimens.

The suture consists of 12 lobes. The ventral lobe of the external suture (fig. 10*A*) is trilobate, pinched in orad, with a short rounded prong bulging at either side and a long narrow median prong extending apicad, a little farther in some sutures than in others. The lateral lobes are elongate spatulate, bluntly rounded apicad or terminating in weak points; all are slightly pinched in orad. The lateral saddles are well rounded orad and increase regularly in depth from the first to the third, the fourth being considerably shorter, and the fifth still shorter. The internal suture consists of three lobes, a simple dorsal one of moderate length, flanked by an internal lateral lobe at either side, each about the same size and shape as the fourth lateral lobe of the external suture, separated by narrow rounded saddles.

Dimensions and proportions

	A	B	C
Diameter (D) mm	------	------	-----
Height of last whorl (H) do	16.7	8.3	6.7
Width of last whorl (W) do	9.1	6.4	5.2
Width of umbilicus (U) do	------	------	-----
W/H	.55	.77	.78

Comparisons and affinities.—Dombarocanites masoni differs from the only other known species in the genus, *D. chancharensis* Ruzhentsev, principally in the ventral lobe of the suture, which is pinched in orad to give it a trilobate aspect. The ventral lobe of *D. chancharensis* (fig. 10*B*) has nearly straight sides along the thick part.

The only other American prolecanitid, *Prolecanites americanus* Miller and Garner, from beds of Meramec age in Indiana, differs by having a rounded subquadrate whorl section and by its suture (fig. 10*C*), which has a long narrow undivided ventral lobe, the first three lateral lobes pointed hastate and the fourth narrow, short, and pointed.

This species is named for the collector of the type lot, J. F. Mason.

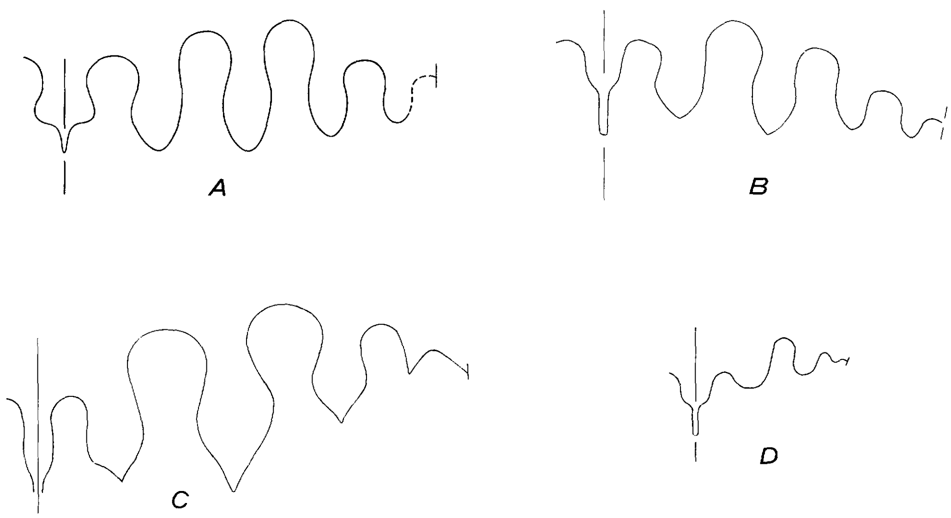


FIGURE 10.—External sutures of *Dombarocanites* and *Prolecanites*. *A*, *Dombarocanites masoni* n. sp. from the holotype × 5, at a whorl height of 8.4 mm. *B*. *Dombarocanites chancharensis* Ruzhentsev from the holotype × 5, at a whorl height of 8.5 mm, after Rozhentsev. *C*, *Prolecanites americanus* Miller and Garner from the holotype × 3, at whorl height of 16 mm, from Miller and Garner. *D*, *Proclecanites* (*Riphaecanites*)? sp., from the only specimen × 10, at a diameter of 4.6 mm and whorl height of 1.7 mm.

Primary types: Holotype SU 9168. Paratype SU 9169.
Occurrence: Chainman Shale, trail $2\frac{1}{4}$ miles north of the Cerro Gordo mine, Inyo Range, Inyo County, Calif.

Genus PROLECANITES Mojsisovics, 1882

Prolecanites (Rhipaecanites)? sp.

Plate 4, figures 15–17, text figure 10*D*

A juvenile specimen of a subdiscoidal goniatite with a primitive prolecanitid suture was found associated with *Cravenoceras hesperium* Miller and Furnish in the Quartz Spring area. Only a little more than 6 mm in diameter, the conch of this specimen has a compressed oval whorl section, with slightly flattened flanks. The umbilicus is not quite half the diameter of the conch.

The suture is exposed on the inner whorls and part of the outer volution. It has an undivided U-shaped ventral lobe with a moderately long protuberance apicad along the siphuncle. The ventral lobe is separated by a moderately well rounded first lateral saddle from the U-shaped first lateral lobe, about the same size as the main part of the ventral lobe but set a little farther orad. The very deep rounded second lateral saddle is followed by a shorter narrower second lateral lobe, bluntly rounded apicad. Narrower shallower third lateral saddle and lobe follow, then the suture line is fairly straight for the short distance to the umbilical seam.

The dimensions of this shell are as follows: diameter (D) 6.2; height of last whorl (H) 2.5; width of last whorl (W) 2.2; width of umbilicus (U) 2.8 mm. These give the following proportions: $U/D=0.47$, $W/D=0.35$, and $W/H=0.79$.

The suture is not maturely developed and although it possesses only three lateral lobes, possibly with growth at least one more lateral lobe would have been added. No fully mature prolecanitids with less than four lateral lobes are known this high up in the section. The shape of the ventral lobe does not appear trifid as in the genus *Epicanites* Schindewolf, 1926 or any of the daraelitid stock. The fact that the wider part of the ventral lobe extends further apicad than the first lateral lobe would appear to exclude the possibility of this shell being a *Dombarocanites;* however, it is such a young individual that one cannot be sure. The suture appears to be closest to that of *Rhipaecanites* Ruzhentsev (1949, p. 737), which has been put into synonymy with *Prolecanites* by Miller, Furnish, and Schindewolf (1957, p. L70).

Figured specimen: USNM 120624.
Occurrence: Perdido Formation, top limestone bed, USGS loc. 15783–PC, 9,000 ft N. $83\frac{1}{2}°$ E. of bench mark 5257 at Quartz Spring, Panamint Range, Inyo County, Calif.

MIDDLE PENNSYLVANIAN SPECIES

Genus PARALEGOCERAS Hyatt, 1884

?Paralegoceras texanum (Shumard)

Plate 4, figure 24

Goniatites texanus Shumard, 1863, p. 109.
Paralegoceras texanum, Smith, 1903, p. 104.

An external mold in a loose block of limestone from the Providence Mountains is that of a paralegocerid ammonoid that agrees in shape and in ornament with *Paralegoceras texanum* (Shumard). The conch has a diameter of 108 mm near the end, and here the whorl is 32 mm high and the umbilicus 62 mm in diameter. The umbilicus/diameter ratio is 0.57. The shell ornament consists of approximately 35 transversely elongate umbilical nodes per volution that split into transverse cords over the flanks and venter; about four cords emanate from a single node and one or two intercalated between. The cords are fairly straight across the flanks, swing forward slightly to form a broad bow over the ventrolateral shoulders and backward over the venter to form a broad rounded ventral sinus. Subequally spaced longitudinal cords of equal weight to the transverse ones give the shell surface a weakly cancellate appearance on the venter and ventrolateral shoulders.

The suture is not preserved on this specimen, so one cannot ascertain whether it was like that of *Paralegoceras texanum* or of the closely related *Diaboloceras varicostatum* Miller and Furnish, which is almost as evolute but generally lacks umbilical nodes on the outer volution. The strength of the umbilical nodes in this specimen suggests the former species, rather than the latter, but the fact that it was found several hundreds of miles farther west than any paralegocerid has heretofore been reported, demands caution in its identification. It is referred here to the species that agrees most closely in shape and surface sculpture and this identification is questioned in the absence of evidence as to the nature of its suture. An Atokan age for the containing beds is likely but a very late Morrow age is a remote possibility.

Figured specimen: SU 9170.
Occurrence: Bird Spring Formation, loose black limestone, west slope of Providence Mountains 5,500 ft west of Sheep Spring, a few miles southeast of Kelso, San Bernardino County, Calif.

Genus BISATOCERAS Miller and Owen, 1937

Bisatoceras cf. B. greenei Miller and Owen

Plate 4, figures 10–13; text figure 11

Bisatoceras greenei Miller and Owen, 1939, Jour. Paleontology, v. 13, no. 2, p. 155, 156, pl. 20, figs. 1–7, text fig. 6.

A silicified phragmocone from a gray sandy limestone bed in the Panamint Range is comparable to this species. The conch is subdiscoidal, has a strongly rounded venter, and gently rounded flanks. The umbilical shoulders are strongly rounded, nearly subangular, and the umbilicus appears to be closed. No traces of shell material or surface sculpture remain.

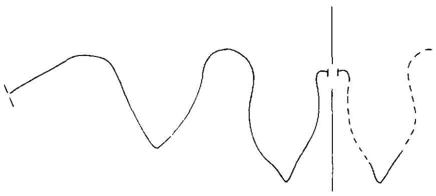


FIGURE 11.—*Bisatoceras* cf. *B. greenei* Miller and Owen, external suture × 4 from the unique California specimen, at a diameter of 18 mm and whorl height of 10.5 mm.

The eight-lobed suture has the ventral lobe divided to about three-quarters of its length into two large inflated pointed prongs. The first lateral saddle is somewhat asymmetrically rounded and spatulate. The first lateral lobe is not quite as wide as either prong of the ventral lobe, slightly more convex on the ventrad side than on the dorsad one and pointed apicad. The second lateral saddle is asymmetric and broad. The umbilical lobe is short and subrounded. The internal suture consists of three lobes, but their details cannot be ascertained in this specimen.

The dimensions of this shell, in mm, are as follows: diameter (D) 19.9; height of last whorl (H) 10.5; width of last whorl (W) 9.0; umbilicus closed. These give the following proportions: W/D=0.45, W/H=0.86.

This species agrees in its subdiscoidal shape and in the general configuration of its external suture with *Bisatoceras greenei* Miller and Owen. Only the lack of more and better preserved material precludes a positive identification. The stratigraphic position of this specimen is a few feet above fusulinids determined in the field by L. G. Henbest as very late Atoka or earliest Des Moines in age. The primary types of *B. greenei* were described from beds of Des Moines age in Missouri.

Figured specimen: USNM 120625.

Occurrence: Tihvipah Limestone, middle part, USGS loc. 19804–PC, about 1,500 ft due east Rest Spring, Cottonwood Mountains, Panamint Range, Inyo County, Calif.

Genus STENOPRONORITES Schindewolf, 1934

Stenopronorites sp.

Text figure 12

A fragment of light-gray fine-grained sandstone weathering light brownish gray preserves parts of eight slightly distorted sutures of a pronoritid. The most complete suture is reproduced in figure 9. It is that part of the external suture preserved on the flanks of the flat-sided pronoritid whorl between the ventrolateral and the umbilical shoulders. In the one figured, this distance is approximately 16 mm. The suture consists of a bifid first lateral lobe and four additional undivided lateral lobes. The number and shape of the lateral lobes suggest that this specimen should be referred to the genus *Stenopronorites*.

Figured specimen: SU 9171.

Occurrence: Tihvipah Limestone, McAllister loc. FL 5, in outlier, 7,200 ft N. 9° W. of Rest Spring, Cottonwood Mountains, Panamint Range, Inyo County, Calif.

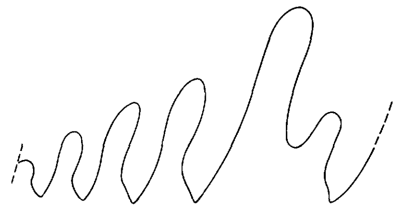


FIGURE 12.—*Stenopronorites* sp. Part of the external suture × 3 of the crushed specimen, at a whorl height of about 16 mm.

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INDEX

[Italic page numbers indicate descriptions]

PLATES 1–4

PLATE 1

[All figures natural size unless otherwise indicated on plate]

FIGURES 1, 5. *Rayonnoceras* aff. *R. solidiforme* Croneis (p. A7).

1. Fragment of the immature phragmocone broken laterally in longitudinal section to expose septa, cameral fillings, and fluted connecting rings, × 1, USNM 120615, from USGS loc. 15783–PC.

5. Longitudinal dorsoventral section × ⅔ of a specimen, USNM 120614, from Merriam loc. 2001.

2–4. *Mitorthoceras* cf. *M. perfilosum* Gordon (p. A8).

Side view × 2 and × 1 of an incomplete phragmocone (SU 9151) and view × 2 of the adoral end of another (SU 9151A), both specimens from SU loc. 2776.

6–9. *Scyphoceras* cf. *S. cessator* (Hall and Whitfield) (p. A9).

Ventral, adoral, and side views × 2 and ventral view × 1 of a specimen SU 9153, from SU loc. 2776.

10–12. *Bactrites*? cf. *B.*? *carbonarius* Smith (p. A8).

Side view × 1 and adpical and side views × 2 of part of a phragmocone, SU 9150, from McAllister loc. FL 38.

13–18, 22, 23. *Mitorthoceras clinatum* Gordon, n. sp. (p. A9).

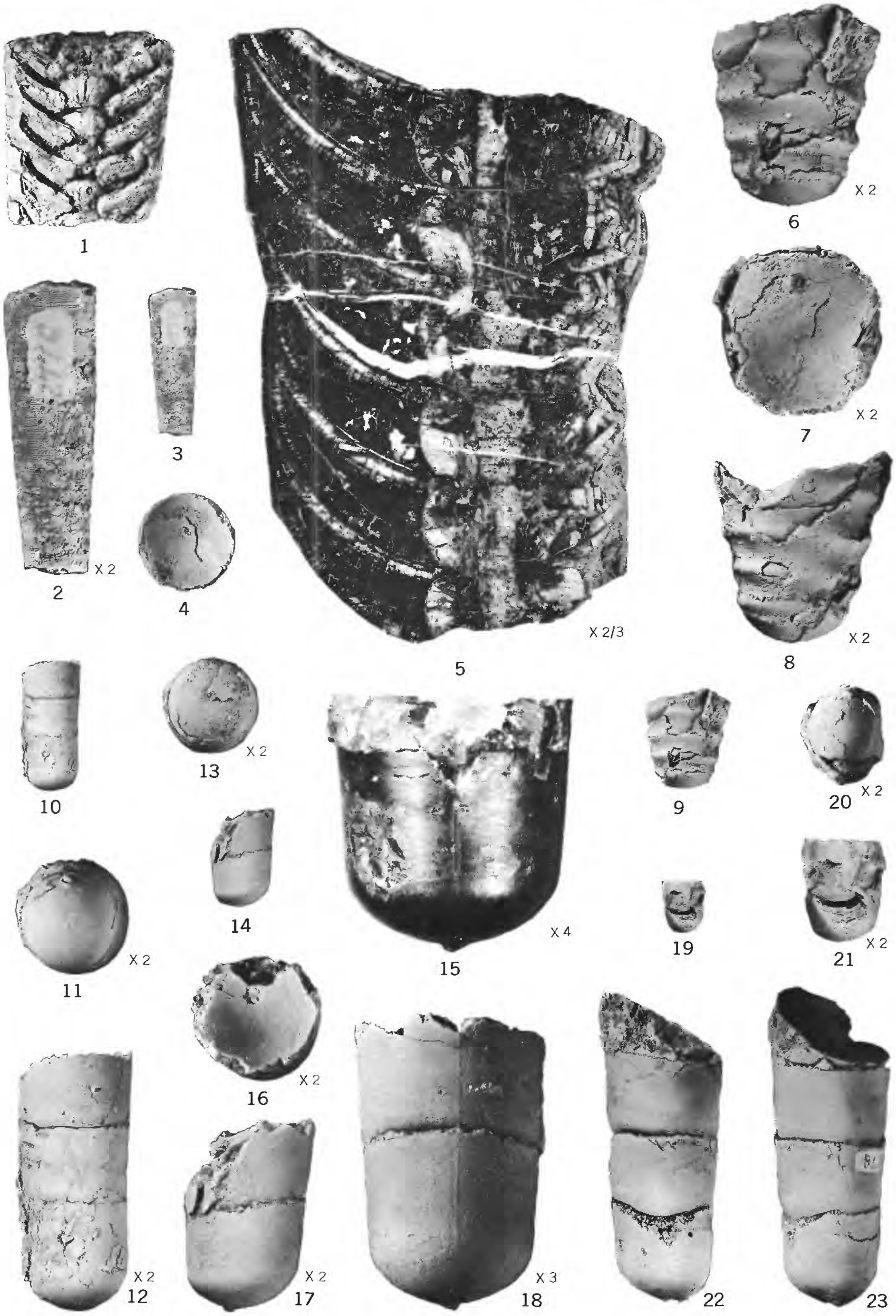
13–18. View of adapical end × 2, side view × 1, and views of adoral end and side × 2, view (uncoated) × 4, and ventral view × 3 of the holotype, USNM 120616 from USGS loc. 17024–PC.

22, 23. Side and ventral views × 1 of a hypotype, SU 9152, from SU loc. 2776.

19–21. *Hematites*? sp. (p. A10).

Side view × 1 and views of the adapical end and side × 2 of a small fragment of a phragmocone of a possible belemnite, SU 9155, from SU loc. 2776.

NOTE.—The specimen shown in figures 13–18 is from the Chainman Shale, Burbank Hills, Millard County, Utah. The rest are from the Perdido Formation, near Rest Spring, Panamint Range, Inyo County, Calif.



ORTHOCONIC NAUTILOIDS OF THE GENERA *RAYONNOCERAS*, *MITORTHOCERAS*, AND *BACTRITES*?; CYRTOCONIC NAUTILOID OF THE GENUS *SCYPHOCERAS*; AND A POSSIBLE BELEMNOID, *HEMATITES*?

PLATE 2

[All figures natural size unless otherwise indicated on plate]

FIGURES 1–4. *Liroceras*? sp. (p. A10).
Front, side, and back views × 2 and side view × 1 of an adolescent specimen, SU 9154, from McAllister loc. FL 38, Perdido Formation, near Rest Spring, Panamint Range, Calif.

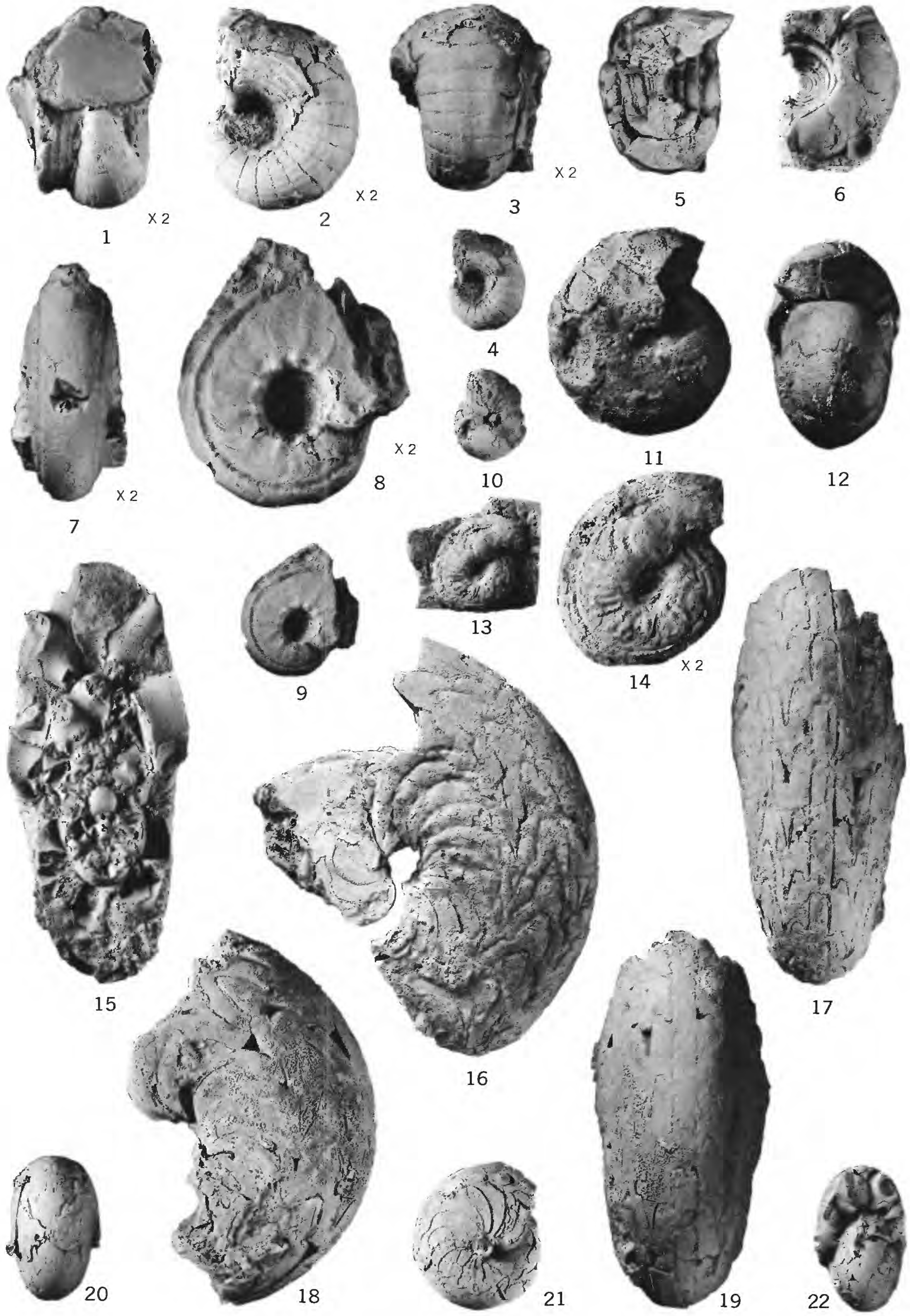
5, 6. *Cravenoceras inyoense* Gordon, n. sp. (p. A14).
Front and side views × 1 of a broken paratype, SU 9159, showing profile of umbilicus, from McAllister loc. FL 38, same as above.

7–9. *Eumorphoceras paucinodum* Gordon, n. sp. (p. A17).
Back and side views × 2 and side view × 1 of the holotype, SU 9163, from McAllister loc. FL 38, same as above.

10, 15–22. *Delepinoceras californicum* Gordon, n. sp. (p. A19).
10. Side view × 1 of a juvenile paratype, SU 9168, McAllister loc. 10 E8.
15–17. Front section, side, and back views × 1 another paratype, SU 9167 from McAllister loc. FL 27.
18–22. Side and ventral views × 1 of the outer volution of the holotype and back, side, and front views × 1 of the inner part of the same specimen, USNM 120622, from USGS loc. 15782–PC. Perdido Formation near Rest Spring, Panamint Range, Calif.

11, 12. *Cravenoceras merriami* Youngquist (p. A15).
Side and front views × 1 of a specimen, USNM 120619, from USGS loc. 15783–PC probably from the base of the Rest Spring Shale, Panamint Range, Calif.

13, 14. *Eumorphoceras bisulcatum* Girty (p. A17).
Side views × 1 and × 2 of a specimen, SU 9162, Chainman Shale near Cerro Gordo mine, Inyo Range, Calif.



COILED NAUTILOID OF THE GENUS *LIROCERAS*? AND AMMONOIDS OF THE GENERA *CRAVENOCERAS*, *EUMORPHOCERAS*, AND *DELEPINOCERAS*

PLATE 3

[All figures natural size unless otherwise indicated on plate]

FIGURES 1, 2, 6–13, 18–20. *Cravenoceras inyoense* Gordon, n. sp. (p. A14).

1, 2. Front and side views × 1 of the holotype, SU 9157, from SU loc. 2776, Perdido Formation, near Rest Spring, Panamint Range, Inyo County, Calif.

6–9. Front, view × 2, side view × 1, and side and back views × 2 of a paratype, SU 9158B, from the same locality as the holotype.

10–13. Front, side, and back views × 2 and side view × 1 of another paratype, SU 9158C, from the same locality.

18–20. Side view × 1 and side and front views × 4 of an adolescent paratype, SU 9158D, from the same locality.

3–5, 14–17, 21–33. *Cravenoceras hesperium* Miller and Furnish (p. A11).

3–5. Back, side, and front views × 1 of a broad variant more evolute than the typical form, USNM 120617, from USGS loc. 15782–PC, Perdido Formation, near Rest Spring, Panamint Range, Inyo County, Calif.

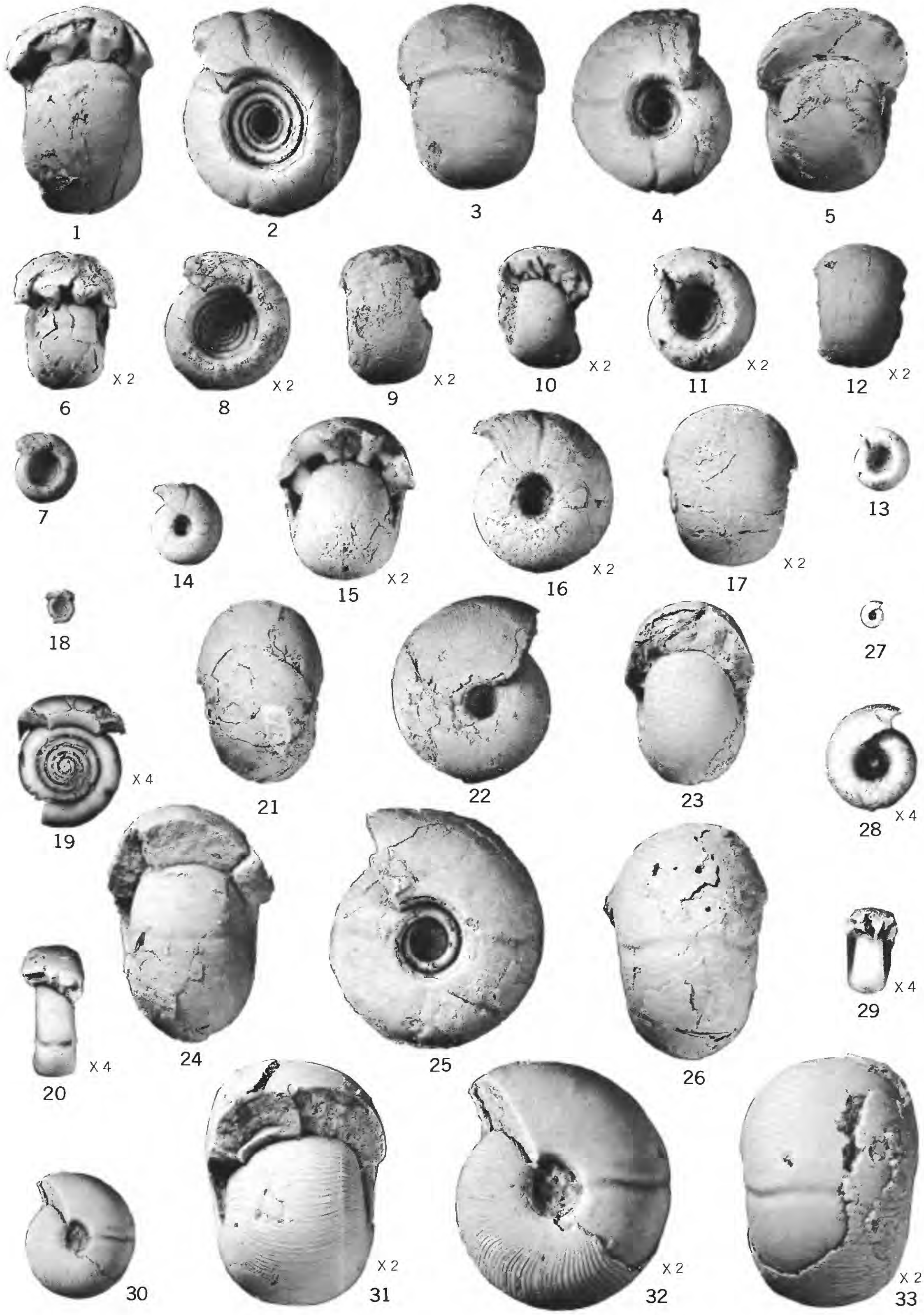
14–17. Side view × 1 and front, side, and back views × 2 of a small typical specimen, SU 9156 from SU loc. 2776, Perdido Formation, near Rest Spring.

21–23. Back, side, and front views × 1 of another specimen from the same locality as the last.

24–26. Front, side and back views × 1 of a mature example from the same locality.

27–29. Side view × 1 and side and front views × 4 of an adolescent specimen from the same locality.

30–33. Side view × 1 and front, side, and back views × 2 of a specimen from the same locality showing the typical cravenoceratid sculpture.



AMMONOIDS OF THE GENUS *CRAVENOCERAS*

PLATE 4

[All figures natural size unless otherwise indicated on plate]

FIGURES 1–3, 7–9. *Anthracoceras macallisteri* Gordon, n. sp. (p. A18).

1–3. Back and side views × 2 and side view × 1 of the holotype, SU 9165, from McAllister loc. FL 38, Perdido Formation, near Rest Spring, Panamint Range, Inyo County, Calif.

7–9. Back and side views × 2 and side view × 1 of a paratype, SU 9166 from the same locality.

4–6, 14. *Dombarocanites masoni* Gordon, n. sp. (p. A21).

4–6. Side view × 1 and side and ventral views × 2 of the holotype, SU 9168, a fragment of a whorl showing the suture, Chainman Shale, 2¼ miles north of Cerro Gordo mine, Inyo Range, Inyo County, Calif.

14. Side view × 1 of a larger paratype, a fragmental phragmocone, SU 9169, from the same locality.

10–13. *Bisatoceras* cf. *B. greenei* Miller and Owen (p. A22).

Side view × 2 and back, side, and front views × 1 of a silicified specimen, USNM 120625, from USGS loc. 19804–PC, Tihvipah Formation, about 1,500 feet due east of Rest Spring, Panamint Range, Inyo County, Calif.

15–17. *Prolecanites* (*Rhipaecanites*)? sp. (p. A22).

Back, side, and front views × 4 of a specimen, USNM 120624 from USGS loc. 15783–PC, Perdido Formation, top limestone bed (?), near Quartz Spring, Panamint Range, Inyo County, Calif.

18–23. *Cravenoceratoides* cf. *C. nititoides* (Bisat) (p. A16).

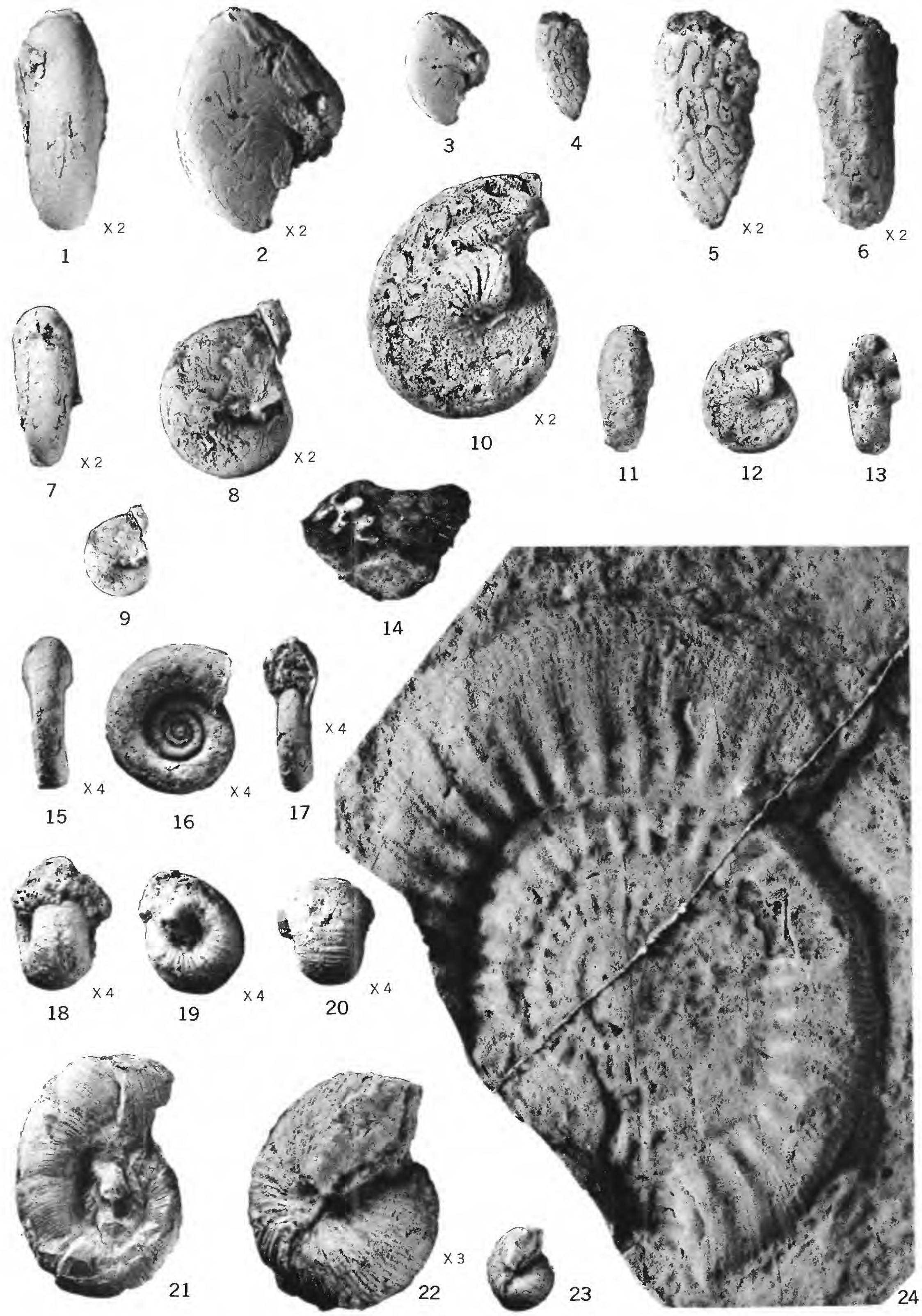
18–20. Front, side, and back views × 4 of a small limonitic specimen, USNM 120620, from USGS loc. 15335–PC.

21. Side view × 1 of a crushed specimen from the same locality.

22, 23. Oblique view × 3 and × 1 of a specimen, USNM 12062 from USGS loc. 15334–PC. All are from the Chainman Shale, about 1½ miles north of Cerro Gordo mine, Inyo Range, Inyo County, Calif.

24. ?*Paralegoceras texanum* (Shumard) (p. A22).

Rubber cast × 1 of an external mold in limestone, SU 9170, from J. Hazzard loc. P–1767, Providence Mountains, San Bernardino County, Calif.



AMMONOIDS OF THE GENERA *ANTHRACOCERAS, DOMBAROCANITES, BISATOCERAS, PROLECANITES (RHIPAECANITES)?, CRAVENOCERATOIDES,* AND *PARALEGOCERAS*?

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