Scaphitoid cephalopods of the Colorado group

By W. A. COBBAN

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Evolution of Scaphites *and related genera, with descriptions and illustrations of new species and a new genus from Western Interior United States*

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By W. A. Cobban

ABSTRACT

Scaphitoid ammonites are locally abundant in rocks of middle and late Colorado age in the Western Interior. These scaphites may be divided into two groups on the basis of evolute or involute septate coil in the adult. Evolute scaphites, which are known in the Western Interior only from the Greenhorn limestone, are not treated in this report. Involute scaphites are common throughout much of the Colorado rocks and fall within the genera *Scaphites*, *Clioscaphites*, and *Desmoscaphites*. *Scaphites* is represented by 39 species and varieties, of which 27 are described as new. The new genus *Clioscaphites* is represented by nine species and varieties, of which six are new. *Desmoscaphites* is known by only a single new species.

The adult scaphite is defined as an individual with partly unrolled living chamber, a distinctive sculpture, and a constricted aperture. The adults range in length from 7.7 mm. to over 100 mm. At most localities the smallest adult of a species is about one-half as long as the largest, but this ratio may be as much as 1:3 or even 1:4.

The scaphites have a considerable range in form. The adults of each species grade from small, slender individuals to large, stout ones. The large shell is more involute than the small one, and its living chamber is less extended. Several species have umbilical swellings, and one species has a lateral swelling at the base of the living chamber. The aperture, which is moderately constricted, has a small dorsal lappet. In addition, a few species have lateral and ventral lappets.

The sculpture consists of primary and secondary ribs, and, in many species, ventrolateral nodes. Generally, the primary ribs are strong and, at the ventrolateral margin, split into two or three weaker secondaries. One species has flat-crested and uncommonly high ribs that are curved back in cross section.

The external suture has four or five well-defined lobes and saddles that decrease in size away from the venter. The saddles are bifid, the first being asymmetric. The first lateral lobe is bifid in *Scaphites*, but asymmetrically bifid or trifid in *Clioscaphites* and *Desmoscaphites*. The internal suture consists of three or four lobes and saddles decreasing in size away from the dorsum.

The scaphites of the Colorado group fall into 15 faunal zones, 1 in the Greenhorn limestone, 7 in the Carlile shale, and 7 in rocks of Niobrara age. The most completely fossiliferous sections known are on the north flank of the Black Hills in South Dakota, and on the Sweetgrass arch of north-central Montana. The Black Hills section is best for the Greenhorn and Carlile formations, whereas the Sweetgrass arch is most fossiliferous for rocks of Niobrara age.

These species seem to have descended from some form like *Scaphites aequalis* Sowerby of the European Cenomanian. The earliest scaphites of the Colorado group, represented by *S. delicatulus* Warren, are part of a cosmopolitan fauna. Subsequent development in the Western Interior is distinctly provincial. Several lineages are indicated. The main line of scaphites shows, in the Greenhorn and lower part of the Carlile, trends toward increase in size, decrease in density of ribbing, and simplification of suture. At the beginning of middle Carlile time these scaphites suddenly decrease in size, and the maximum simplification of the suture is attained. The trend after that is toward increase in size of the adult and toward complexity in the suture. This line of scaphites reaches maximum size and complexity of suture by middle and late Niobrara time. By latest Niobrara time a definite trend toward decrease in size and simplification of suture is seen. By the beginning of Niobrara time these scaphites show a tendency to become less unrolled, and by late Niobrara time, the dorsum of the adult living chamber is completely in contact with the outer septate coil. This tendency to become tightly enrolled is accompanied by a great reduction in the size of the umbilicus. The first lateral lobe of the suture is more or less symmetrically bifid in the Greenhorn, Carlile, and lower Niobrara species, but in the upper Niobrara species this lobe passes through an asymmetric phase and becomes trifid.

In the late Carlile a split from the main scaphite line gave rise to a new line of species characterized by ventrolateral nodes. These scaphites closely parallel the main line of species by becoming larger, less unrolled, and by developing a suture with trifid lobes.

A third lineage is represented by several tiny species. The oldest species, of earliest Carlile age, has a nearly normal aperture. Each younger species shows progressive forward extension of the lateral margins of the aperture, and by early Niobrara time, prominent lateral lappets developed. By late Niobrara time the suture developed trifid lobes.

At the close of Colorado time the native Western Interior species were largely replaced by an entirely different type of scaphites which had migrated into the area from Europe by way of the Atlantic and Gulf Coasts of America.

INTRODUCTION

The scaphites are one of the most abundant and easily recognized groups of ammonites in the Upper Cretaceous of the Western Interior. They are especially abundant in marine rocks of Colorado age, and serve as the best guides for subdividing those beds into faunal zones. The scaphites are most abundant in dark-gray noncalcareous to somewhat calcareous shale, but their presence also in sandy and chalky beds makes them particularly useful in correlating diverse lithologic units. The earliest scaphites of Colorado age belong to an early Turonian cosmopolitan fauna, but their development thereafter is distinctly provincial. This makes it possible to study lineages without the disturbing influence of periodic migrations of foreign elements into the local populations.

This study is based on a collection consisting of about 300 lots of fossils obtained largely by members of the United States Geological Survey from Montana, South Dakota, Wyoming, Utah, Colorado, Kansas, and New Mexico. Of the 3,300 specimens examined, about 1,500 were collected by the writer from measured stratigraphic sections.

The writer is deeply indebted to Dr. John B. Reeside, Jr., of the U. S. Geological Survey, whose broad experience in this field has been of great assistance and encouragement. Dr. Ralph W. Imlay and Dr. Roland W. Brown, of the U. S. Geological Survey, have offered much valuable advise. Thanks are also due Dr. Harold E. Vokes, of The Johns Hopkins University, for his guidance and many helpful suggestions in completing most of this work as part of a doctor's dissertation. Mr. Nelson W. Shupe, of the U. S. Geological Survey, photographed the fossils.

CHARACTERISTICS OF SCAPHITES OF THE COLORADO GROUP

SCOPE OF THE GROUP

The genus *Scaphites* and closely related genera have been discussed fully by Reeside (1927a, pp. 5, 6; 1927b; 1927c, pp. 20, 21). He summarizes the characters of the genus *Scaphites* as follows (1927a, pp. 5, 6):

> * * * a normal coil of septate whorls and the last living chamber partly unrolled; whorls stout, umbilicus small, sculpture of straight ribs beginning in the umbilicus and passing with increasing height to the margin of the venter, where they split into two or more ventral ribs; there are also intercalated ventral ribs, and there may be definite nodes at the ventrolateral ends of the primary ribs; the suture consists of moderately incised elements, decreasing gradually in size from the median plane to the line of involution; lobes trifid in the earliest stages but usually bifid in the adult. Nowak called this group *Holcoscaphites*, but Parkinson's name [*Scaphites*] should be retained in a restricted sense.

The writer accepts this definition and is applying it in a broad sense. However, it is possible to subdivide the scaphites of the Colorado group into several groups of species as follows:

A. Adult septate coil subevolute to evolute. (Not treated in this work.)

B. Adult septate coil involute.

a. Small forms with living chamber moderately to considerably freed from the septate coil. Suture simple, symmetrically bifid first lateral lobe. *Scaphites.*

tetonensis
sagensis
frontierensis
uintensis
corvensis
nigricollensis
whitfieldi
ferronensis
warreni
veterinovus
carlilensis
morrowi
arcadiensis
larvaeformis
patulus
praecoquus
delicatulus

b. Large forms with living chamber moderately to slightly freed from the septate coil. Suture moderately complex, first lateral lobe either symmetrically or asymmetrically bifid. *Scaphites.*

binneyi
interjectus
depressus
ventricosus
preventricosus

c. Large forms with living chamber not freed from the septate coil. Suture typically complex, first lateral lobe trifid or asymmetrically bifid. *Clioscaphites.*

novimexicanus
choteauensis
vermiformis
platygastrus
montanensis
saxitonianus

d. Moderate sized forms with living chamber not freed from septate coil. Constrictions on early whorls. Suture typically complex, first lateral lobe trifid. *Desmoscaphites.*

erdmanni

e. Moderate sized forms with living chamber freed from septate coil. Ribs strongly recumbent and may have flat crests. Suture simple, symmetrically bifid first lateral lobe. *Scaphites.*

impendicostatus
mariasensis

f. Small forms with living chamber considerably freed from septate coil. Aperture of adult with prominent lateral lappets. Suture simple, first lateral lobe bifid or trifid. *Scaphites.*

coloradensis
auriculatus

DEFINITION OF THE ADULT

The most characteristic feature of the scaphites is that the last living chamber is partly unrolled. The sculpture on this last living chamber is entirely different from that of the septate whorls. It is this sculpture that readily distinguishes a species, whereas the sculptural features of the internal whorls of many species are almost identical. The last living chamber commonly has strong primary ribs that may end in ventrolateral tubercles, the ventral ribs may be uniformly spaced or widely spaced on one part and closely spaced on another, and the aperture is always constricted. Lateral lappets may be present. The adult scaphites are here defined as those individuals with partly unrolled living chamber bearing a distinctive sculpture and ending with a constricted aperture. Immature specimens that have the living chamber preserved do not differ

in shape and sculpture from the internal septate whorls at comparable diameters of adult specimens.

SIZE

The scaphites of the Colorado group show a great range in size. The smallest known adult is a specimen of *Scaphites coloradensis*, 7.7 mm. long, from rocks of late Niobrara age. *S. ventricosus*, *S. depressus*, and *Clioscaphites montanensis*, of middle and late Niobrara age, attain lengths as great as 100 mm. The average length of 550 adults from all the scaphite zones of the Colorado group is 39.2 mm. (1.5 inches).

In any collection from any one locality a considerable range in size of the adults is noteworthy. The smallest individual is commonly about one half as long as the largest (pl. 18, figs. 7, 23, 24), and in some instances (compare pl. 18, fig. 23 with pl. 19, fig. 9), this ratio may be 1:3 or 1:4.

FORM

In all the scaphites of the Colorado group the umbilicus is wide in the first few whorls and narrow in the later ones. The umbilical shoulder rounds evenly into the narrow, steeply inclined umbilical wall and into the flattened or broadly rounded flanks. The whorl cross sections are normally wider than high, but the youngest whorls of the scaphites of late Carlile age may be as high as wide, or occasionally higher than wide (pl. 5, fig. 2). The venter of most species is well rounded to broadly rounded, but the last septate whorl of *Clioscaphites vermiformis* (Meek and Hayden) may have a flattened venter, and the new variety *C. v. toolensis* may even have a broadly depressed venter near the orad end of the septate coil. The venter rounds evenly into the flanks, and in many species it is difficult to determine where one passes into the other. Because of this difficulty and to maintain a uniform scheme of description, the point where the primary ribs fork is taken as the margin of the venter in most specimens. This is the point where the primaries commonly attain their greatest height or where tubercles may develop. Using this as a guide the scaphites have a much greater area in the venter than most other ammonites have.

On the third or fourth whorls succeeding the protoconch the ventrolateral margin is subangular to sharply rounded and, on many individuals, it is raised into a thickened ridge. On earlier and later whorls the ventrolateral margin is considerably more rounded.

The body chamber is large, making up one-half to three-fourths of a whorl. In *Scaphites* the adult living chamber is slightly to almost wholly freed from the septate coil. Where only slightly freed from the septate coil, it is the younger part of the living chamber that is not in contact with the coil. In *Desmoscaphites* and *Clioscaphites*, n. gen., the living chamber is wholly or nearly entirely in contact with the outer septate whorl. All specimens have a persistent dorsal furrow on the freed body chamber. The aperture is reniform in cross section and moderately constricted. A small, broad dorsal lappet is present in all adults. It is most conspicuous in *Scaphites*, especially in some of the species of Carlile age (pl. 5, fig. 25; pl. 6, fig. 5). *Scaphites tetonensis* and *S. impendicostatus*, n. spp. have the ventral margin of the aperture bent away from the septate coil. In the latter species the shell is thickened along the ventral margin (pl. 11, fig. 8). Two tiny species of Niobrara age, *S. auriculatus* and *S. coloradensis*, n. spp., have dorsal, ventral, and lateral lappets; the last is narrow, pointed, and directed laterally.

An umbical swelling occurs at the base of the adult living chamber of *S. delicatulus* Warren and *S. impendicostatus*, and in a few specimens of *S. larvaeformis* Meek and Hayden, *S. patulus*, n. sp., *Clioscaphites montanensis*, n. sp., and *C. novimexicanus* (Reeside). Many specimens of *S. nigricollensis*, n. sp. have a lateral swelling at the base of the living chamber.

SCULPTURE

The sculpture consists of numerous primary (umbilical) and secondary (ventral) ribs, and in addition, many species have a row of ventrolateral tubercles which may be round or radially elongate. The primary ribs are inclined backward as they cross the umbilical wall, and on reaching the umbilical shoulder, bend forward and cross the flank with a forward inclination of 15° to 45°. At the ventrolateral margin (about half way from the umbilical seam to the middle of the venter) the primaries attain their greatest height and then split into two or three weaker secondaries. These may (1) extend straight across the venter, as on the living chamber of *Scaphites ventricosus* Meek and Hayden (pl. 12), (2) cross the venter with a backward bending, as on the last septate whorl of *S. patulus*, n. sp. (pl. 1, fig. 27), (3) cross the venter with a forward arching, as on *S. whitfieldi*, n. sp. (pl. 4, fig. 37), or (4) curve back from the ventrolateral margin and then cross the middle of the venter with a forward arching, as on the immature stages of *Clioscaphites vermiformis* (Meek and Hayden) (pl. 18, figs. 12–18). Intercalated ribs are common between the paired secondaries and begin at the point of furcation or below it on the flanks. The ribs are either sharp or rounded, but one species, *Scaphites impendicostatus*, n. sp. (pl. 11), possesses flat-crested as well as unusually high ribs that are curved backward in cross section. Pointed, round tubercles are present in *S. delicatulus*, *S. larvaeformis*, *S. patulus*, *S. praecoquus*, n. sp., *S. arcadiensis* Moreman, *S. uintensis*, n. sp., *S. frontierensis*, n. sp., *S. sagensis*, n. sp., *S. binneyi* Reeside, *Clioscaphites vermiformis*, *C.*

platygastrus, n. sp., *C.? choteauensis*, n. sp., and *Desmoscaphites erdmanni*, n. sp.

SUTURE

The suture ranges in complexity from the simple pseudoceratitic type characteristic of the middle Carlile species to the highly incised form of the late Niobrara species. The external suture has four or five clearly defined lobes and saddles progressively decreasing in height away from the venter. The saddles are bifid, and the first is asymmetric with the widest part on the ventral side. The first lateral saddle is always wider than the second, but the second may or may not be broader than the third. The first lateral lobe is bifid in *Scaphites* and trifid or asymmetrically bifid in *Clioscaphites* and *Desmoscaphites*. The second lateral lobe is typically bifid in the early Carlile species, but commonly trifid in those from the late Carlile and Niobrara. The rest of the external lobes are trifid, bifid, or undivided. The internal suture consists of three or four lobes and saddles decreasing in size away from the middle of the dorsum. The dorsal lobe is long, slender, and trifid. The first internal lobe is bifid or trifid and may be nearly as large as the dorsal lobe. The remaining lobes are small and commonly bifid. The internal saddles are small and bifid.

VARIATION

The scaphites are a highly varied group. The adults of each species grade from small, slender forms to large, stout forms. Because of the more slender whorls, the small adults are less involute and the living chamber is more freed from the septate coil (compare pl. 1, figs. 8, 16; pl. 15, figs. 1, 7). In many species the ribs tend to be denser and weaker on the living chambers of the larger adults (pl. 7, figs. 6, 12). In some species the large and small adults differ considerably in shape and sculpture, and perhaps only the use of large collections that show the intergradations prevents mistaking the large and small forms for different species. For example, the internal molds of the living chambers of the large, stout form of *Scaphites nigricollensis*, n. sp. tend to be smooth and commonly are inflated laterally near the base (pl. 6). In contrast the internal molds of the small, slender form are strongly ribbed and show no trace of lateral swellings (pl. 5, figs. 11–25). In dealing with such varied species, varietal names are useful.

SCAPHITE ZONES

The most completely fossiliferous sections containing scaphites are on the flanks of the Black Hills and on the Sweetgrass arch of north-central Montana. The Black Hills section includes nearly all the zones of the Greenhorn and Carlile formations, and the Colorado shale of the Sweetgrass arch demonstrates nearly all the zones of Niobrara age. Collections from other localities in the Western Interior indicate that the Black Hills and Sweetgrass arch sequences each lack a scaphite zone, which may indicate hiatuses or that the particular ages may be represented by poorly fossiliferous or unfossiliferous beds. Scaphites have not been found in the Western Interior in pre-Greenhorn strata.

NORTHERN BLACK HILLS

The Niobrara formation of the Black Hills contains few fossils other than *Inoceramus* fragments, *Ostrea congesta* Conrad, Foraminifera, and fish bones. Scaphites have not been found in the Niobrara formation but the Carlile shale contains a rich scaphite fauna, and the underlying Greenhorn formation has yielded some specimens.

The following generalized section shows the major lithologic units that compose the Greenhorn, Carlile, and Niobrara formations and the scaphite species found in each. This section was measured 4 to 9 miles north of Belle Fourche, S. Dak.

	Feet
Niobrara formation (200 feet)	
16. Chalk marl, weathers white; interbedded with many thin layers of bentonite	200
Carlile shale (546 feet)	
Sage Breaks member (194 feet)	
15. Shale, dark-gray; weathers dark; contains abundant gray-weathering calcareous concretions that are septarian, with thick seams of brown, yellow, and white calcite. *Scaphites corvensis*, n. sp	194
Turner sandy member (258 feet)	
14. Shale, gray, finely sandy; weathers buff gray; contains tan- and yellow-weathering calcareous concretions. *Scaphites corvensis*, n. sp., near top, *S. nigricollensis*, n. sp., in middle, and *S. whitfieldi*, n. sp., at base	89
13. Shale, dark-gray; weathers dark; contains some sandy beds and numerous rusty- and reddish-weathering ferruginous concretions. *Scaphites whitfieldi*, n. sp., and *S. pisinnus*, n. sp	82
12. Shale, dark-gray; weathers medium gray; contains large yellow-weathering calcareous concretions and small gray-weathering calcareous concretions. *Scaphites warreni* Meek and Hayden in lower half	47
11. Shale, gray, very sandy; weathers medium-gray; contains large yellow-weathering sandy calcareous concretions at top and in middle; chert pebbles and coarse sandstone at base. *Scaphites warreni* Meek and Hayden and *S. veterinovus*, n. sp	40
Unnamed shale member (94 feet)	
10. Shale, dark-gray	13
9. Shale, dark-gray; weathers medium-gray; contains numerous ferruginous concretions weathering orange tan, rusty, and dark-maroon. *Scaphites carlilensis* Morrow and *S. arcadiensis* Moreman	24

Carlile shale—Continued	Feet
Unnamed shale member—Continued	
8. Shale, dark-gray, slightly sandy	26
7. Shale, black-gray, hard	18
6. Shale, dark-gray, slightly calcareous, weathers bluish gray; contains light-gray limestone concretions at top. *Scaphites larvaeformis* Meek and Hayden, *S. patulus*, n. sp., and *S. praecoquus*, n. sp	13
Greenhorn formation (312 feet)	
5. Shale, gray, calcareous; weathers white; contains thin lenses and shaly layers of limestone	37
4. Shale, gray, calcareous; weathers white; contains white-weathering limestone concretions	26
3. Shale, black-gray, noncalcareous; contains small yellow limonite nodules	22
2. Shale, gray, calcareous; weathers gray; contains ferruginous concretions and ferruginous shaly layers weathering rusty. *Scaphites delicatulus* Warren	70
1. Shale, gray, slightly calcareous, weathers gray	157

In the Black Hills section the scaphites occur in the following sequence:

Carlile shale
- Zone of *Scaphites corvensis*, n. sp.
- Zone of *Scaphites nigricollensis*, n. sp.
- Zone of *Scaphites whitfieldi*, n. sp.
- Zone of *Scaphites warreni* Meek and Hayden
- Zone of *Scaphites carlilensis* Morrow
- Zone of *Scaphites larvaeformis* Meek and Hayden

Greenhorn formation
- Zone of *Scaphites delicatulus* Warren

The beds from which the scaphites of the lower four zones of the Carlile shale were collected are separated by unfossiliferous shale. This may explain the fact that the ranges of the species do not overlap. In contrast, the Turner sandy member containing *S. whitfieldi*, *S. nigricollensis*, and *S. corvensis* is fossiliferous throughout and, apparently, there are no breaks in sedimentation. The result is that transitional forms occur between the species of each of these zones.

Collections from the top of the Frontier formation of the Laramie Basin of southeastern Wyoming and from the Mancos shale of central Utah and northwestern New Mexico contain a scaphite species intermediate between *S. warreni* and *S. whitfieldi* that occurs between the zones of these species. This species, *S. ferronensis*, n. sp., may eventually be found in the upper part of unit 12 of the northern Black Hills section.

SWEETGRASS ARCH

The Colorado shale of the Sweetgrass arch contains equivalents of the Colorado group of the Black Hills. The beds equivalent to the Greenhorn and Carlile formations are lithologically similar to those of the Black Hills but considerably thinner. In contrast the beds equivalent to the Niobrara formation are several times as thick and, unlike the Niobrara formation, are composed almost entirely of dark-gray noncalcareous shale. Scaphites have not been found in the Greenhorn equivalent, and only two zones can be recognized in the rocks of Carlile age. The overlying shale, however, contains the richest known scaphite faunas of Niobrara age.

The following generalized section shows the major lithologic units of that part of the Colorado shale equivalent to the Greenhorn, Carlile, and Niobrara formations of the Black Hills. The beds of Greenhorn and Carlile age were measured along Sun River valley west of Great Falls, and the Niobrara rocks were measured on the west and south flanks of the Kevin-Sunburst dome.

Colorado shale	Feet
Beds equivalent to the Niobrara formation (620 feet)	
12. Shale, dark-gray; contains gray-weathering calcareous concretions and about 10 thin layers of bentonite *Clioscaphites novimexicanus* (Reeside), *Desmoscaphites erdmanni*, n. sp., and *Scaphites leei* Reeside in upper part; *Clioscaphites? choteauensis*, n. sp., in middle part; *Clioscaphites montanensis*, n. sp., *C. vermiformis* (Meek and Hayden), *C. saxitonianus* (McLearn), and *Scaphites coloradensis*, n. sp., in lower part	200
11. Shale, dark-gray; contains ferruginous concretions weathering rusty and reddish brown and calcareous concretions weathering gray, buff, and yellow. Very few bentonite beds. *Scaphites ventricosus* Meek and Hayden and *S. tetonensis*, n. sp. in lower half	180
10. Shale, dark-gray, contains abundant gray-weathering calcareous concretions and about 40 layers of bentonite. *Scaphites preventricosus*, n. sp., *S. impendicostatus*, n. sp., and *S. auriculatus*, n. sp., in upper two-thirds. *S. mariasensis*, n. sp., in lower third	240
Beds equivalent to the Carlile shale (155 feet)	
9. Shale, dark-gray, sandy, hard; weathers bluish gray; contains gray- to yellow-weathering calcareous concretions and rarely a chert-pebble layer. *Scaphites nigricollensis*, n. sp.	100
8. Shale, dark-gray, finely sandy; contains numerous ferruginous concretions weathering rusty to reddish brown. *Scaphites carlilensis* Morrow	25
7. Shale, dark-gray, finely sandy, hard	30
Beds equivalent to the Greenhorn limestone (55 feet)	
6. Chalk marl, dark-gray; weathers buff; contains thin gray limestone lenses and thin layers of bentonite	12
5. Shale, gray, calcareous	19
4. Chalk marl, dark-gray; weathers light blue	8
3. Bentonite, creamy white	3
2. Shale, brownish, soft, papery, noncalcareous	12
1. Chalk marl, gray; weathers buff; contains small ferruginous concretions and larger gray-weathering calcareous concretions	1

The rarity and poor preservation of fossils in the beds of Carlile age may account for the recognition of only two of the six scaphite zones known in the Carlile shale of the Black Hills. However, *Scaphites nigricollensis* occurs so close above the beds containing *S. carlilensis* that probably the zones of *S. warreni*, *S. ferronensis*, and *S. whitfieldi* are absent or they are represented by very thin, unfossiliferous zones.

The shale of Niobrara age shows the following scaphite zones.

Zone of *Clioscaphites novimexicanus* (Reeside)
Zone of *Clioscaphites? choteauensis*, n. sp.
Zone of *Clioscaphites montanensis*, n. sp.
Zone of *Scaphites ventricosus* Meek and Hayden
Zone of *Scaphites preventricosus*, n. sp.
Zone of *Scaphites mariasensis*, n. sp.

This is the most complete record known for beds of Niobrara age. However, collections from the Cody shale of the Bighorn Basin, Wyoming, reveal a species, *Scaphites depressus* Reeside, intermediate in form between *S. ventricosus* and *Clioscaphites montanensis* and occurring between those zones. On the Sweetgrass arch *S. ventricosus* and *C. montanensis* are found in such close stratigraphic proximity that probably the *S. depressus* zone is absent. Phosphatic nodule layers present in the shale just above the highest occurrence of *S. ventricosus* also suggest hiatuses in this part of the sequence.

EVOLUTION OF THE SCAPHITES OF THE COLORADO GROUP

Spath (1934, p. 498) has pointed out that the family Scaphitidae may have had its origin in the Lytoceratidae of the Mediterranean-Equatorial region, and that the earliest known scaphites occur in the upper Albian. These early scaphites are tiny and have either evolute or involute septate whorls in the adult stage. The sutures are moderately incised and consist of but few elements. The suture of *Scaphites circularis* Spath (1937, p. 501, text fig. 175d) from the English Gault has only six lobes and six saddles. These little scaphites are comparatively rare in the Albian, but in the Cenomanian they are more abundant, especially *S. aequalis* Sowerby. The sutures of the Cenomanian forms seem to be less incised than those of their Albian ancestors.

In America the oldest described scaphite is *Worthoceras worthense* (Adkins and Winton) (1920, p. 36, pl. 7, figs. 1, 2), a slightly evolute form from the Duck Creek limestone of the basal upper Albian of Texas. *Scaphites hilli* Adkins and Winton (p. 37, pl. 7, figs. 3–6) of the Pawpaw formation of the uppermost Albian of Texas is an involute form. The lower Cenomanian Grayson shale of Texas has yielded a tiny involute scaphite, *S. bosquensis* Böse (1928, pl. 224, pl. 7, figs. 1–6), and a larger evolute form, *S. subevolutus* Böse (p. 225, pl. 7, figs. 7–30; pl. 18, fig. 8). Several small involute and evolute scaphites have been described from the Cenomanian of Oregon and California by Anderson (1902).

Scaphites have not been found in the Cenomanian Woodbine group of Texas (L. W. Stephenson, personal communication), or in the equivalent beds of the Western Interior.

The lower Turonian zone of *Sciponoceras gracile* (Shumard) marks the first widespread occurrence of scaphites in North America. *Scaphites delicatulus* Warren (1930, p. 66, pl. 3, fig. 3; pl. 4, figs. 7, 8) is known from the Alaskan arctic slope, from basal Turonian rocks of the Mackenzie River valley of northwestern Canada, from the lower part of the Smoky River shale of the Grande Prairie district of north central Alberta, from the Greenhorn formation of the Black Hills, and from equivalent beds in the Cody shale on the northeast flank of the Bighorn Mountains. *S. brittonensis* Moreman (1942, p. 215, pl. 34, figs. 1, 2; text fig. 2r), from the Eagle Ford group of Texas, very closely resembles *S. delicatulus* and is also associated with *Sciponoceras gracile* (Shumard). The resemblance of these scaphites to *S. aequalis* Sowerby of the European Cenomanian is striking. This close similarity, and the absence of scaphites in the post-Grayson Cenomanian rocks of the Gulf Coast and Western Interior, suggest that *S. aequalis* gave rise to *S. delicatulus* through some transitional form that migrated to America during the early Turonian.

Scaphites delicatulus var. *greenhornensis*, n. var., from the Greenhorn formation differs from the typical form of the species chiefly in possessing coarse ribbing on the curved part of the living chamber and in having proportionally more primary ribs and fewer secondaries on the living chamber. From this type of ancestor *S. larvaeformis* Meek and Hayden of the basal Carlile shale was probably derived. This species differs from *S. d. greenhornensis* in having fewer ribs and a smaller umbilical swelling. About one-half of the specimens of *S. larvaeformis* at hand have coarse ribbing on the last half of the living chamber although not as coarse as on the Greenhorn variety. *S. praecoquus*, n. sp., can be interpreted either as a split from *S. larvaeformis* or as a tiny variant that developed an uncoiled living chamber before other adult features were fully developed. It appears to mark the beginning of a line of small scaphites that by Niobrara time had developed prominent lateral lappets. *S. patulus*, n. sp., also of the basal Carlile, is either a split from *S. larvaeformis* or a descendent of *S. delicatulus* that developed a more curved and strongly sculptured living chamber considerably depressed in cross section.

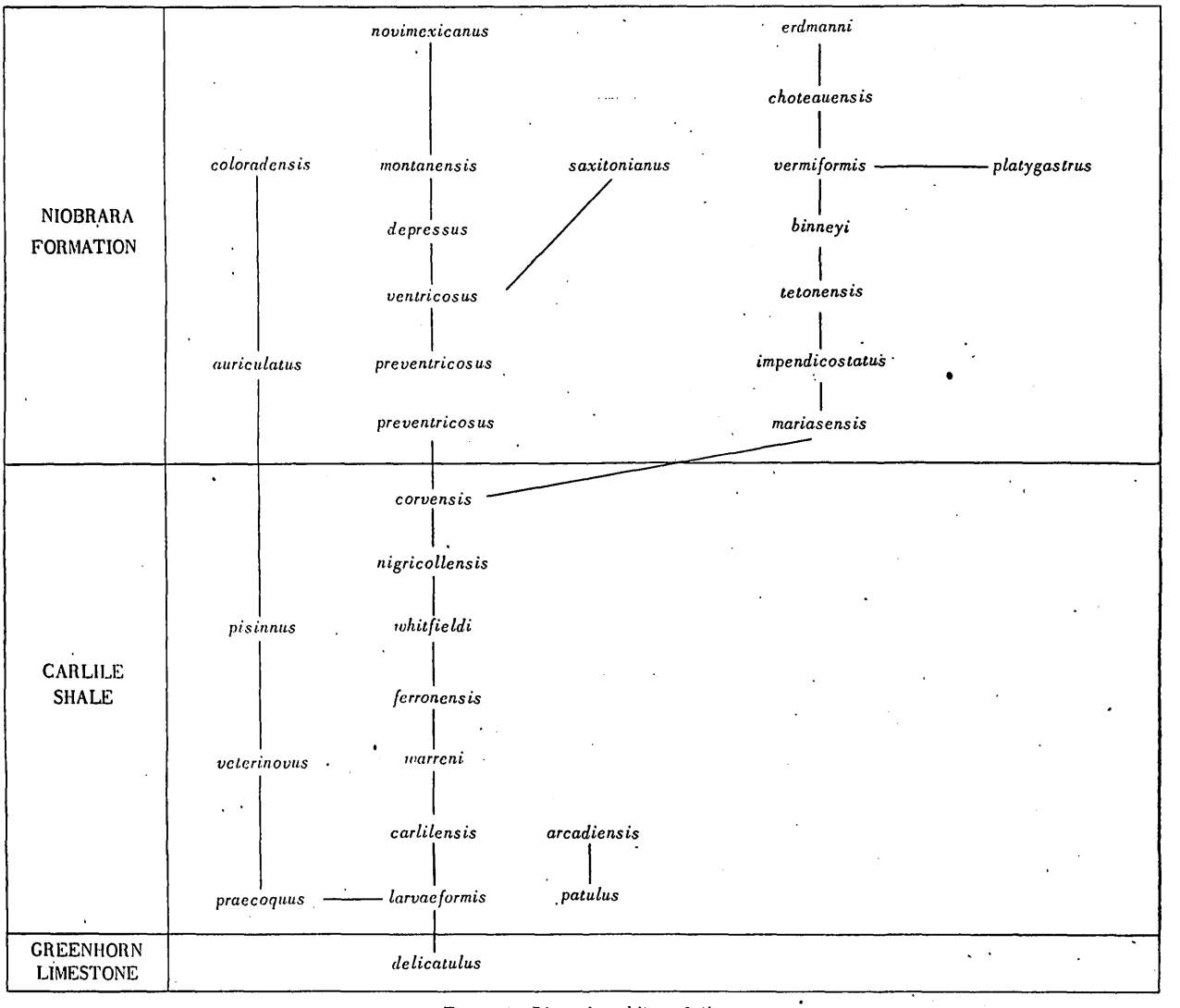

FIGURE 1.—Lines of scaphite evolution.

S. patulus and *S. larvaeformis* show backward bending of the ribs crossing the venter on the last septate whorl, a character found in many early scaphites throughout the world.

Scaphites carlilensis Morrow, which marks the zone next above that of *S. larvaeformis*, is most abundant in the Blue Hill shale member of the Carlile shale of Kansas, and in lithologically similar beds that form most of the unnamed shale member of the lower part of the Carlile shale of the northern Black Hills. *S. carlilensis* attains a larger size than *S. larvaeformis* and the suture is less incised. There is further reduction in the number of ribs, and these are now uniformly spaced on the venter of the living chamber. Tubercles and umbilical swelling are lacking. The associated species, *S. arcadiensis* Moreman, still maintains ventrolateral tubercles and a depressed cross section of the living chamber, suggesting derivation from *S. patulus*. The tubercles, however, are much less conspicuous and tend to become high primary ribs. Both *S. carlilensis* and *S. arcadiensis* have lost the rursiradiate ribbing of the ventral ribs on the last septate whorl.

Scaphites warreni Meek and Hayden characterizes the lower third of the Turner sandy member of the Carlile shale of the Black Hills and equivalent sandy beds in eastern Wyoming, Colorado, and New Mexico. This species is smaller than its ancestor, *S. carlilensis*, possibly because of an unfavorable environment. The sediments containing *S. warreni* are sandy and, in central Utah, pass into cobble beds and variegated clays of nonmarine origin reflecting contemporary orogenic movements west of the region. The scaphite suture became progressively simpler after Cenomanian time and reached its simplest state attaining a pseudoceratitic stage in this species (pl. 3, figs. 8, 20, 22). The trend for ribbing to become dense on the curved part

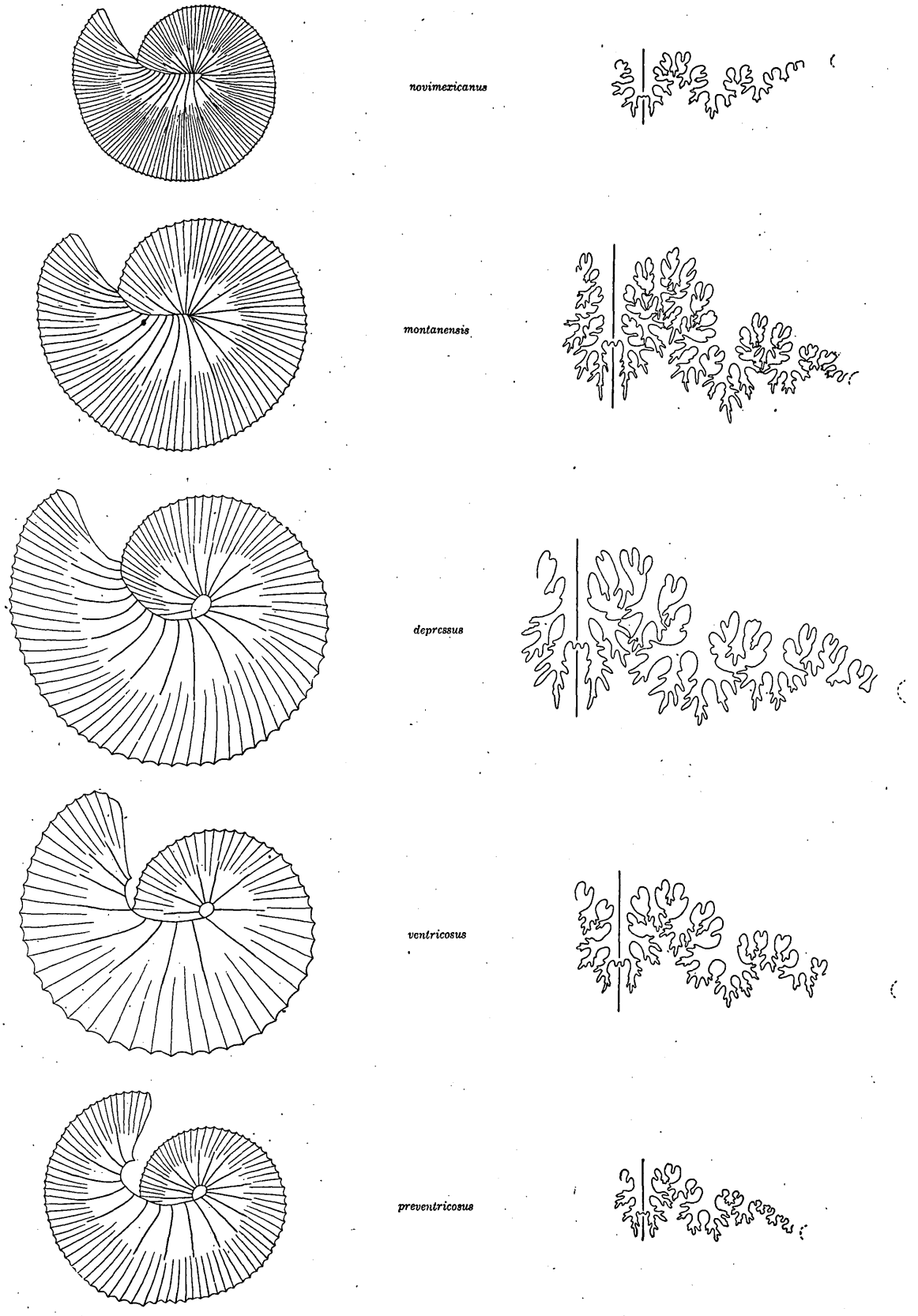

FIGURE 2.—Sketches illustrating changes in size, form, sculpture, and suture of one lineage of scaphites of Niobrara age.

of the living chamber continued, and in this species, the ribbing is more closely spaced than on the straight part. The tiny species, *S. veterinovus*, n. sp., continued the line of small species initiated with *S. praecoquus* of the basal Carlile. The ventrolateral edges of the aperture are produced outward faintly, foreshadowing the development of lateral lappets by Niobrara time.

Scaphites ferronensis, n. sp., which developed out of *S. warreni*, continued the trend toward denser ribbing. Many individuals are fairly quadrangular in side view.

Scaphites whitfieldi, n. sp., was derived from *S. ferronensis* by assuming a more quadrangular shape, and the dense ribbing that characterizes the younger part of the older species spread over the entire living chamber and made *S. whitfieldi* the most densely ribbed scaphite of the Carlile. This ribbing is evenly spaced. The suture, which was simplest in *S. warreni* and *S. ferronensis*, developed slightly longer elements, initiating a trend toward complexity. *S. pisinnus*, n. sp., which occurs with *S. whitfieldi*, is similar in size to *S. veterinovus* but has a greater lateral extension of the aperture.

Scaphites nigricollensis, n. sp., of the upper part of the Turner sandy member of the Carlile shale descended from *S. whitfieldi*, but is larger and stouter. The density of ventral ribs decreased and the number of primaries increased. The sutures of the two species are similar.

Scaphites corvensis, n. sp., of the Sage Breaks member and uppermost part of the Turner sandy member, continued the trend toward stoutness and increase in size that was initiated with *S. nigricollensis*. The suture of the younger species has proportionally longer lobes and saddles.

The scaphites of Niobrara age show four lineages. The tiny forms with abnormal apertures produced the new species *S. auriculatus* and *S. coloradensis*. The main line of scaphite development (*S. delicatulus* through *S. corvensis*) flourished to the end of Niobrara time. A split from this line probably in the uppermost part of the Carlile, gave rise to a very prominent group of scaphites that ranged through the Niobrara and into the basal Montana group (as *Desmoscaphites bassleri* Reeside). The new species, *Scaphites uintensis*, *S. frontierensis*, and *S. sagensis*, of early Niobrara age, represent a fourth line of scaphites, but these species are rare and their relationsip to the other scaphites is unknown.

Scaphites auriculatus is the earliest of the Niobrara species of the *praecoquus-veterinovus-pisinnus* line of scaphites. The lateral extensions of the aperture developed into prominent lappets directed outward and forward. The suture is simple and shows a bifid first lateral lobe. *S. coloradensis* of late Niobrara age has a trifid first lateral lobe.

Scaphites corvensis gave rise to *S. preventricosus*, n. sp., by further increase in size, stoutness, and complexity of suture. The living chamber of *S. preventricosus* is less extended from the septate coil. *S. ventricosus* Meek and Hayden, from the next younger zone, shows till further increase in size, stoutness, and suture complexity. The living chamber is less unrolled and, conversely, more curved. From *S. ventricosus* came *S. depressus* Reeside, which attains a very large size and great stoutness. The living chamber is so little unrolled that only in the more slender forms (*S. depressus* vars. *stantoni* Reeside and *oregonensis* Reeside) is the younger part freed from the septate coil (pl. 15, figs. 1, 7).

Clioscaphites montanensis, n. gen. and sp., descended from *S. depressus* and shows the following trends away from that species: (1) decreased size, (2) less unrolled living chamber, in contact with the septate coil, (3) reduction in size of umbilicus, (4) flattening of flanks, (5) increasing number of ventral ribs on the living chamber in comparison to the primaries, and (6) suture with first lateral lobe transitional from bifid to trifid. The scaphite suture attains its greatest degree of complexity in this species.

Clioscaphites novimexicanus (Reeside) of the youngest Colorado beds was derived from *C. montanensis* by further decrease in size, greater flattening of the flanks, increase in density of ribbing, and perfection of the trifid first lateral lobe. The suture became simplified, thus reversing the trend toward complexity that prevailed since middle Carlile time.

Clioscaphites saxitonianus (McLearn) may represent an evolutionary line that split off from *Scaphites ventricosus*.

Scaphites mariasensis, n. sp., from beds of early Niobrara age, is the oldest known species of a new line of scaphites that split off from the main line in the late Carlile. The characteristic features of this species are its high, sharp ribs and its fairly simple suture with broad first lateral lobe.

Scaphites impendicostatus, n. sp., descended from *S. mariasensis* by acquiring stronger sculpture with the ribs curving backward in cross section, and on the more stout individuals, becoming flat-crested (pl. 11, figs. 1, 2, 4, 5, 7). The ventral margin of the aperture is bent outward slightly. A prominent umbilical swelling is present on the large, stout specimens. The suture is as simple as that of its ancestor from the basal Niobrara. The two main branches that make up the first lateral lobe are deeply bifid, making the bifurcating saddles almost as high as the main saddle of the lobe.

This initiates a new type of suture that persisted through several faunal zones.

Scaphites tetonensis, n. sp., which occurs in the zone next above that of *S. impendicostatus*, shows the following trends away from that species: (1) reduction in stoutness with loss of the umbilical swelling, (2) reduction in density and strength of ribbing, with the ventral ribs on the older or straight part of the living chamber sparser than on the younger or curved part, and (3) elevation of the ventral extremities of the primary ribs into elongate incipient nodes. Trends initiated with *S. impendicostatus* that persisted through *S. tetonensis* are the outward-bent ventral lip of the aperture and the form of the suture. The suture is a little more incised and continued to have high lateral saddles on the first lateral lobe. These are as high as, or even higher than, the main saddle of the lobe.

Scaphites binneyi Reeside occurs in the zone next above that of *S. tetonensis*. This younger species has ventrolateral tubercles that developed out of the elevated ventral extremities of the primary ribs of *S. tetonensis*. The suture became slightly more incised and continued to have high lateral saddles on the first lateral lobe. These may be considerable higher than the central saddle of the lobe (pl. 14, fig. 16). *S. interjectus* Reeside, which occurs with *S. binneyi*, is actually a more advanced form judging by the less unrolled living chamber. The ribbing is denser than on *S. binneyi* but the sutures are similar.

Clioscaphites vermiformis (Meek and Hayden) descended from *Scaphites binneyi* or *S. interjectus*. It became so little unrolled that the dorsum of the living chamber was completely in contact with the last septate whorl. The sculpture became considerably stronger, and the ribbing on the internal whorls developed a pronounced forward arching on crossing the venter. The suture is fairly simple and characterized by trifid lobes. The development of trifid lobes out of symmetrically bifid lobes is not clear in this group of scaphites for the change appears to have taken place suddenly. However, if transition faunas are found between the zones of *Scaphites binneyi* and *Clioscaphites vermiformis*, the sutures may have asymmetrically bifid first lateral lobes, such as those of *Clioscaphites montanensis*. An alternate possibility is that the trifid lobe developed directly out of a symmetrically bifid lobe by the lateral saddles of the lobe having become so high and large as to reduce the inner or apicad prongs of the lobe to a single branch (pl. 14, fig. 16).

An interesting split from *C. vermiformis* is seen in *C. platygastrus*, n. sp., in which the ribs became high and sharp, the primaries lengthened, and the venter flattened. A sharp-ribbed variety of *C. vermiformis* (pl. 18, figs. 20, 21) is transitional to this species. This new line of scaphites continued into the Telegraph Creek formation of earliest Montana age, where it is represented by an undescribed species with a more compressed form and finer sculpture.

Clioscaphites? *choteauensis*, n. sp., marks the zone next above that of *C. vermiformis* and shows the following trends away from that species: (1) more rounded venter, (2) denser ribbing, (3) smaller ventrolateral nodes, and (4) more complex suture.

Desmoscaphites erdmanni, n. sp., occurs at the top of the Colorado shale. It was derived from *Clioscaphites*? *choteauensis* by further reduction in the size of the tubercles and by developing nearly uniform spacing of the ventral ribs on the living chamber. The internal whorls have the ribs crossing the venter bent forward as in *Clioscaphites vermiformis*, but about five constrictions are present on each complete whorl. *Clioscaphites*? *choteauensis*, which occurs in the zone between *C. vermiformis* and *Desmoscaphites erdmanni*, should be transitional between these genera. Unfortunately, the inner whorls have not been seen and the generic assignment of *C.*? *choteauensis* is only tentative. *Desmoscaphites erdmanni* gave rise to *D. bassleri* (Reeside, 1927c, p. 16, pl. 21, figs. 17-21; pl. 22, figs, 8-12) of the Telegraph Creek formation by further increasing the density of ribbing and developing uniform spacing of the ventral ribs.

Associated with *Clioscaphites novimexicanus* and *Desmoscaphites erdmanni* in the latest Colorado beds is a small species, *Scaphites leei* Reeside, which is completely foreign to the native Western Interior fauna. This species is characterized by its stout whorls, swollen living chamber, smooth flanks, umbilical and ventrolateral nodes, and simple suture with symmetrically bifid first lateral lobe. *Scaphites leei* marks the first appearance in the Interior fauna of a prominent group of scaphites (Reeside, 1927c) characterized by *S. hippocrepis* (DeKay) and *S. aquilaensis* Reeside that migrated to America from Europe in Santonian time. These species, rare at first, rapidly dominated the fauna and replaced the Interior scaphites. Only *Desmoscaphites bassleri* and an undescribed descendent of *Clioscaphites platygastrus* are known of the native stock in Telegraph Creek time, and by Eagle time, all the scaphites known are of the *S. hippocrepis-S. aquilaensis* group.

The first lateral lobe of the external suture reveals an interesting line of development (fig. 3). In *Scaphites warreni* and *S. whitfieldi* this lobe is bifid, with each branch consisting of a lower, broadly pointed prong and a lateral bifid prong. This basic pattern is seen in pre-*S. warreni* species, but in general, it is not as perfectly developed and commonly lacks bilateral symmetry. The next step in the development of this

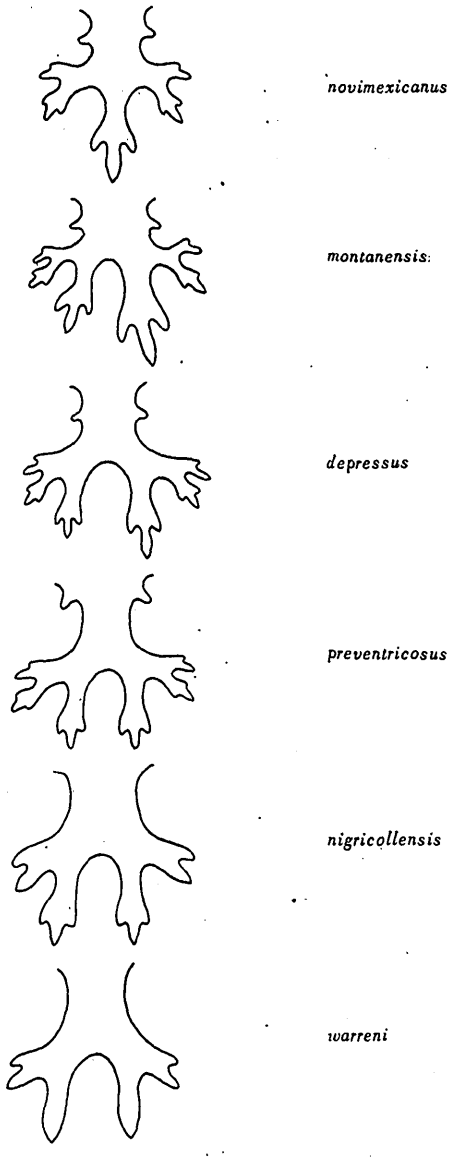

FIGURE 3.—Evolution of the trifid first lateral lobe. The venter would be to the left.

lobe is shown by *S. nigricollensis* in which the apicad prongs became trifid. The next stage was perfected in *S. preventricosus*. The lateral prongs became asymmetrically bifid, with the lower part of each trifid and the upper part smaller and bifid. In general, the lobe was still symmetrical, with a large central saddle and two smaller equidimensional lateral saddles. In *S. depressus* and varieties the symmetry was largely lost by a slight dwarfing of the ventrad branch of the lobe. This was carried to a great extreme in *Clioscaphites montanensis*, which had the dorsad branch of the lobe much longer than the ventrad branch. The dorsad saddle became almost as large as the central saddle, and the ventrad saddle was greatly reduced. In the overlying *C. novimexicanus* zone the trifid lobe was perfected by the migration of the trifid prong of the dorsad branch to a central position. The ventrad branch was reduced to the size of the dorsad prong and became symmetrical with it, having its prongs simplified to such an extent that the upper prong was reduced from five points to two.

In summary, the scaphites of the Colorado group reveal several trends in their development that persisted through many faunal zones. The main line of scaphites show, in the Greenhorn and early Carlile, trends toward increase in size, decrease in density of ribbing, and simplification of suture. *Scaphites warreni* of the basal part of the middle Carlile, marks the maximum simplification of the suture, and initiates a trend toward dense ribbing. This species shows a sudden decrease in size that possibly reflects adverse environmental conditions of that time. After that time, the trend was toward gradual increase in size and in complexity of suture. The maximum size was attained in the zones of *Scaphites ventricosus*, *S. depressus*, and *Clioscaphites montanensis*, of the middle and late Niobrara, and the greatest complexity of suture was reached in *Clioscaphites montanensis*. After the time of *C. montanensis*, the scaphites decreased in size and the suture became simpler. In the late Carlile the scaphites tended to become less unrolled in the adult stage, and by late Niobrara the whole dorsum of the living chamber was in contact with the outer septate whorl. This accompanied a reduction in the size of the umbilicus and a tendency for the umbilical wall of the adult living chamber to be extended over the umbilicus of the septate whorls.

In the late Carlile a split from the main scaphite line gave rise to a group of species at first characterized by peculiar, high, sharp ribs, and later by the development of a row of ventrolateral tubercles. These species paralleled the main line of scaphites in becoming larger, less unrolled, and in developing a suture with trifid lobes. However, the suture never reached the degree of complexity seen in *Clioscaphites montanensis*.

A group of tiny species represents another line of development beginning with *Scaphites praecoquus* of the basal Carlile. This species, which is very closely related to *S. larvaeformis*, has a nearly normal aperture, but the later species showed progressively greater forward extension of the lateral margins of the aperture. By early Niobrara time, conspicuous pointed lateral lappets were developed and, by the late Niobrara, the suture developed trifid lobes.

GEOGRAPHIC DISTRIBUTION

The occurrence of the scaphites of the Colorado group by state and locality is indicated in the insert (facing p. 12), and the localities are indicated on figure 4.

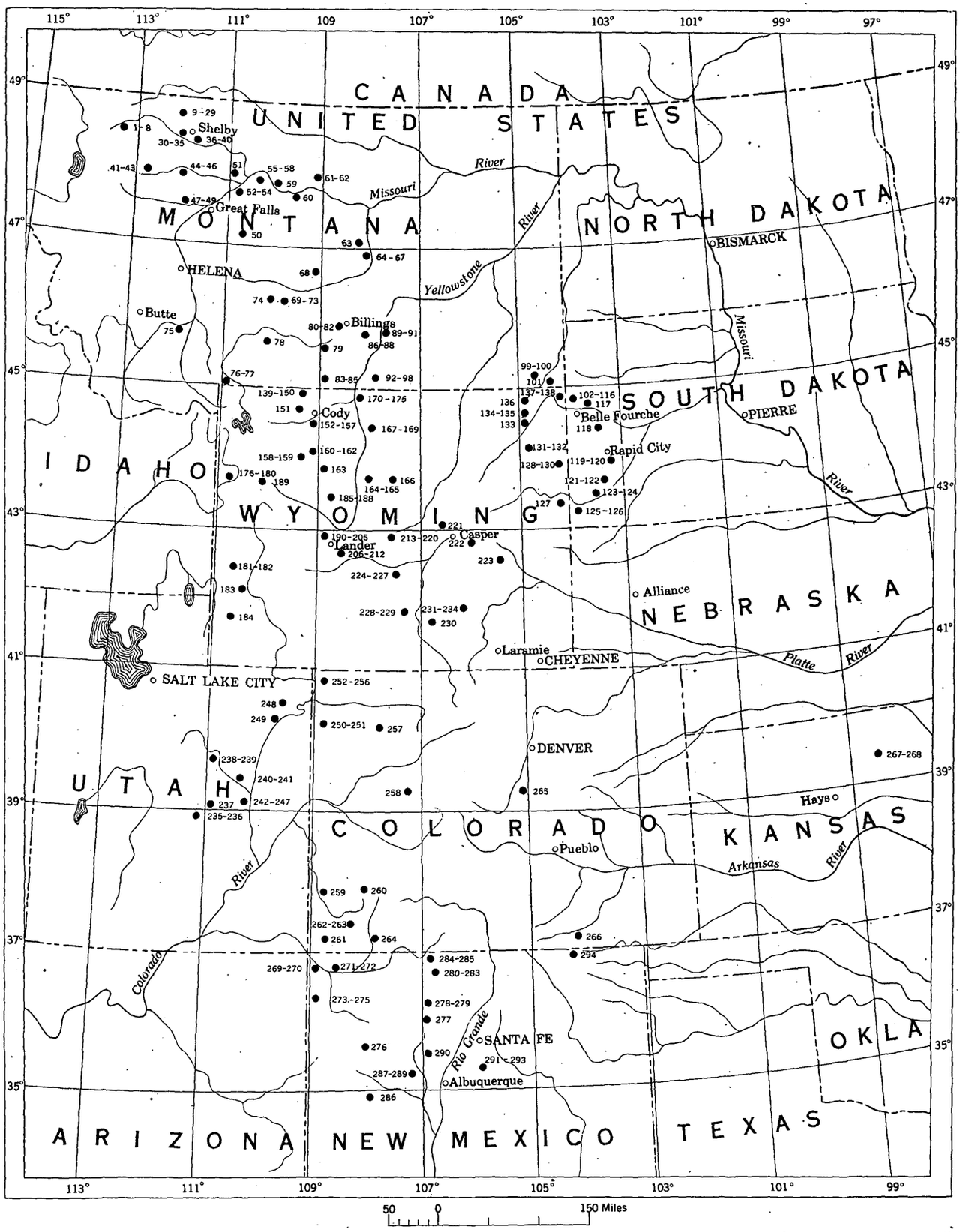

FIGURE 4.—Index map showing localities of collections from rocks of Colorado age. Numbers refer to the table of distribution and to the detailed description of localities on pages 13–18.

Distribution of scaphitoid cephalopods of the Colorado group and equivalent rocks, by localities

[T, Type locality; ×, occurrence; ?, doubtful identification]

State	Montana																																																
Region	Glacier Park								Marias River—Sweetgrass area																																Sun River-Birch Creek area			Sun River-Choteau area					
U. S. G. S. Mesozoic locality No.	7127	7128	7129	6551	7131	7162	7137	7142	9303	9301	8048	20299	21667	8605	20291	20292	20295	21483	11995	11974	20296	20298	20297	20289	20911	21429	21807	22130	11987	21419	11989	21412	21425	21421	21422	11979	22166	22149	22161	22164	9853	9856	9890	4023	11971	21806	21372	21373	21375
Map No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49
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larvaeformis Meek and Hayden																																																	
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patulus Cobban, n. sp.																																																	
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carlilensis Morrow																										×																							
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State	Montana																																																			
Region	Northcentral													Mussellshell Valley												Three Forks	Yellowstone Park		Yellowstone Valley					Northern Bighorn Basin			Crow Indian Reservation													Northern rim of Black Hills		
U. S. G. S. Mesozoic locality No.	3956	16201	1400	152	1403		154	1404	8968	2852	1407	2839	2847a	7904	21399	21401	21402	21403	8828	2894	2895	2896	4655	4656	4588	1663		22131	5608	9642	5230	5235	9420	9632	9651	5051	10897	20954	21805	20952	20953	20946	20935	20937	20938	20939	10888	10912	10909	12632	12637	21796
Map No.	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101
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sagensis Cobban, n. sp.																																																				
auriculatus Cobban, n. sp.																																																				
ventricosus Meek and Hayden					×	T				×															×																											
tetonensis Cobban, n. sp.																																																				
binneyi Reeside																																																				
interjectus Reeside																																																				
depressus Reeside																						×		×	×	×		×			×	×		×	×																	
depressus var. *oregonensis* Reeside																													×																							
depressus var. *stantoni* Reeside																						×			×		T	×				×				×																
coloradensis Cobban, n. sp.																																																				
leei Reeside																																																				
Clioscaphites montanensis Cobban, n. gen. and sp.		×										×								×	×		×																													
montanensis var. *hesperius* Cobban, n. var.																																																				
vermiformis (Meek and Hayden)						T			×		×		×	×			×	×	×	×									×	×			×				×			×	×						×		×			
vermiformis var. *tooleensis* Cobban, n. var.							×																														×										×		×			
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choteauensis Cobban, n. sp.																													×																							
platygastrus Cobban, n. sp.																																																				
novimexicanus (Reeside)																																																				
Desmoscaphites erdmanni Cobban, n. sp.								×																																												

State	South Dakota																																				
Region	Eastern rim of Black Hills																									Western rim of Black Hills											
U. S. G. S. Mesozoic locality No.	21181	21182	21183	21184	21185	21186	21187	21188	21189	21190	21194	21195	21198	21199	12734	21428	12170	21765	21953	18872	12642	10383	10382		13610	10281	12691	11190	21792	10334	11200	10410	8644	12630	21424	21591	21798
Map No.	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138
Scaphites delicatulus Warren var. *greenhornensis* Cobban, n. var.																																					?
larvaeformis Meek and Hayden	×																		×									×	×							×	
larvaeformis var. *obesus* Cobban, n. var.	×																				×		T						×	×						×	
patulus Cobban, n. sp.	×																		×	T	×		×													×	
praecoquus Cobban, n. sp.																																				T	
arcadiensis Moreman		×	×												×	×																					
carlilensis Morrow		×	×	×	×	×									×	×	×																				
morrowi Jeletzky																																					
warreni Meek and Hayden							×	×																T			×										
warreni var. *haydeni* Cobban, n. var.							×																														
warreni var. *ubiquitosus* Cobban, n. var.							×		×																		×										
veterinovus Cobban, n. sp.							T																														
ferronensis Cobban, n. sp.																																					
whitfieldi Cobban, n. sp.										×	T	×					×					×			×	×								×	×		
pisinnus Cobban, n. sp.											T																										
nigricollensis Cobban, n. sp.												×	T																			×					
nigricollensis var. *meeki* Cobban, n. var.													T																								
corvensis Cobban, n. sp.														×				×													×		×				
corvensis var. *bighornensis* Cobban, n. var.														×				×																			
mariasensis Cobban, n. sp.																																					
mariasensis var. *gracillistriatus* Cobban, n. var.																																					
preventricosus Cobban, n. sp.																																					
preventricosus var. *artilobus* Cobban, n. var.																																					
preventricosus var. *sweetgrassensis* Cobban, n. var.																																					
impendicostatus Cobban, n. sp.																																					
impendicostatus var. *erucoides* Cobban, n. var.																																					
uintensis Cobban, n. sp.																																					
frontierensis Cobban, n. sp.																																					
sagensis Cobban, n. sp.																																					
auriculatus Cobban, n. sp.																																					
ventricosus Meek and Hayden																																					
tetonensis Cobban, n. sp.																																					
binneyi Reeside																																					
interjectus Reeside																																					
depressus Reeside																																					
depressus var. *oregonensis* Reeside																																					
depressus var. *stantoni* Reeside																																					
coloradensis Cobban, n. sp.																																					
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Clioscaphites montanensis Cobban, n. gen. and sp.																																					
montanensis var. *hesperius* Cobban, n. var.																																					
vermiformis (Meek and Hayden)																																					
vermiformis var. *tooleensis* Cobban, n. var.																																					
saxitonianus (McLearn)																																					
saxitonianus var. *keytei* Cobban, n. var.																																					
choteauensis Cobban, n. sp.																																					
platygastrus Cobban, n. sp.																																					
novimexicanus (Reeside)																																					
Desmoscaphites erdmanni Cobban, n. sp.																																					

State	Wyoming																																																		
Region	Western rim of Bighorn Basin																									Eastern rim of Bighorn Basin												Jackson Hole area					Western rim of Green River Basin				Northern rim of Wind River Basin				
U. S. G. S. Mesozoic locality No.	17953	17954	17955	17956	17957	17958	17959	18152	18156	18160	17942	17952	17928	4091	4060	7369	3079			17175	17176	17168	17164	17110	17115	10422	10421	8915	4538	4958	8278	9615	4539	9770	4540	9675	9669	20701	21109	21173	21110	21179	17301	17302	17315	6880	19532	20920	20921	21751	21748
Map No.	139	140	141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	177	178	179	180	181	182	183	184	185	186	187	188	189
Scaphites delicatulus Warren var. *greenhornensis* Cobban, n. var.																																																			
larvaeformis Meek and Hayden																																																			
larvaeformis var. *obesus* Cobban, n. var.																																																			
patulus Cobban, n. sp.																																																			
praecoquus Cobban, n. sp.																																																			
arcadiensis Moreman																																																			
carlilensis Morrow																																																			
morrowi Jeletzky																																																			
warreni Meek and Hayden																																																			
warreni var. *haydeni* Cobban, n. var.																																																			
warreni var. *ubiquitosus* Cobban, n. var.																																																			
veterinovus Cobban, n. sp.																																																			
ferronensis Cobban, n. sp.																																																			
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corvensis Cobban, n. sp.																																																			
corvensis var. *bighornensis* Cobban, n. var.																																																			
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mariasensis var. *gracillistriatus* Cobban, n. var.																																																			
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ventricosus Meek and Hayden											×							×																					×												
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binneyi Reeside														×					T																																×
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depressus Reeside	×		×				×					×			×	×	×		T				×			×	×		×	×	×		×																		
depressus var. *oregonensis* Reeside		×		×	×														T	×						×																									
depressus var. *stantoni* Reeside	×	×		×	×				×	×					×		×		×			×	×				×		×			×		×	×		×											×			
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Clioscaphites montanensis Cobban, n. gen. and sp.																																																			
montanensis var. *hesperius* Cobban, n. var.																																																			
vermiformis (Meek and Hayden)						×		×					×												×			×								×									×						
vermiformis var. *tooleensis* Cobban, n. var.								×																																											
saxitonianus (McLearn)																																																			
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novimexicanus (Reeside)																																																		×	
Desmoscaphites erdmanni Cobban, n. sp.																																																			

State	Wyoming																																												
Region	Western rim of Wind River Basin																							Southern rim of Wind River Basin								Platte River Valley			Sweetwater River Valley				Rawlins area			Medicine Bow area			
U. S. G. S. Mesozoic locality No.	10032	10033	21093	21087	20611	20612	20610	21083a	20614	20773	21547	21548	19542	21099	21100	21549	6011	6012	14308	14310	18945	18946	18941	8984	8985	21538	21757	20613	9008	21102	8524	8511	4448	20917	4872	9029	10464	10456	4066	4069	3712	22125	530	533	399
Map No.	190	191	192	193	194	195	196	197	198	199	200	201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220	221	222	223	224	225	226	227	228	229	230	231	232	233	234
Scaphites delicatulus Warren var. *greenhornensis* Cobban, n. var.																																		?											
larvaeformis Meek and Hayden																																													
larvaeformis var. *obesus* Cobban, n. var.																																													
patulus Cobban, n. sp.																																													
praecoquus Cobban, n. sp.																																													
arcadiensis Moreman																																													
carlilensis Morrow																																													
morrowi Jeletzky																																													
warreni Meek and Hayden																																										×			
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warreni var. *ubiquitosus* Cobban, n. var.																																										×	×		
veterinovus Cobban, n. sp.																																													
ferronensis Cobban, n. sp.																																									×				
whitfieldi Cobban, n. sp.																																	?						×	×				×	×
pisinnus Cobban, n. sp.																																													
nigricollensis Cobban, n. sp.																																													
nigricollensis var. *meeki* Cobban, n. var.																																													
corvensis Cobban, n. sp.																																													
corvensis var. *bighornensis* Cobban, n. var.																																													
mariasensis Cobban, n. sp.																																													
mariasensis var. *gracillistriatus* Cobban, n. var.																																													
preventricosus Cobban, n. sp.				×	×		×	×											×							×										×	×								
preventricosus var. *artilobus* Cobban, n. var.																																													
preventricosus var. *sweetgrassensis* Cobban, n. var.			×	×	×	×											×	×	×						×	×		×		×					×										
impendicostatus Cobban, n. sp.									×				×				×	×		×		×										×													
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Clioscaphites montanensis Cobban, n. gen. and sp.																×																													
montanensis var. *hesperius* Cobban, n. var.																																													
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vermiformis var. *tooleensis* Cobban, n. var.														×	×																×														
saxitonianus (McLearn)																																													
saxitonianus var. *keytei* Cobban, n. var.																																													
choteauensis Cobban, n. sp.																																													
platygastrus Cobban, n. sp.																																													
novimexicanus (Reeside)																																													
Desmoscaphites erdmanni Cobban, n. sp.																																													

State	Utah															Colorado																	Kansas		New Mexico																									
Region	Central													Northeast		Northwest									Southwest						East		Northwest		San Juan Basin																	Rio Grande Valley								Northeast
U. S. G. S. Mesozoic locality No.	6270	12583	22129	6945	11956	13319	934	13240	13243	13261	13262	13263	13331	21426	21427	4363	21764	11670	11678	11685	11699	11705	13699	6252	6950	2007	7389	17431	4012	10506	7360	14305		21838	11591	18874	12008	12006	10368	11593	11594	15580	13283	16818	515	17628	17633	17635	17637	16784	17638		15590	15600	15601	16115	7180	7165	3532	5596
Map No.	235	236	237	238	239	240	241	242	243	244	245	246	247	248	249	250	251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270	271	272	273	274	275	276	277	278	279	280	281	282	283	284	285	286	287	288	289	290	291	292	293	294
Scaphites delicatulus Warren var. *greenhornensis* Cobban, n. var.																																																												
larvaeformis Meek and Hayden																																																												
larvaeformis var. *obesus* Cobban, n. var.																																																												
patulus Cobban, n. sp.																																																												
praecoquus Cobban, n. sp.																																																												
arcadiensis Moreman																																																												
carlilensis Morrow																																	T	×																										
morrowi Jeletzky																																	T	×																										
warreni Meek and Hayden		×	×				×																				×	×							×	×			×	×		×	×	×	×	×		×	×				×							
warreni var. *haydeni* Cobban, n. var.																																							×																					
warreni var. *ubiquitosus* Cobban, n. var.							×									×									×		×	×							×				×	T		×	×	×	×			×	×	×			×	×						
veterinovus Cobban, n. sp.																																																												
ferronensis Cobban, n. sp.		T	×					×									×																										×									×								
whitfieldi Cobban, n. sp.								×								×		×						×		×			×	×	×										×						×				×				×	×				
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novimexicanus (Reeside)																																																											T	
Desmoscaphites erdmanni Cobban, n. sp.																																																												

The individual localities are described in the following list.

Localities at which scaphite cephalopods were collected from rocks of the Colorado group

No. on fig. 4	U.S.G.S. Mesozoic locality number	Collector, year of collection, description of locality, and stratigraphic assignment
1	7127	M. R. Campbell and T. W. Stanton, 1911. About 2.5 miles west-northwest of Summit, Glacier National Park, Mont. Colorado shale.
2	7128	M. R. Campbell, J. Hoats, and T. W. Stanton, 1911. On southwest slope of Summit Mountain, Glacier National Park, Mont. Colorado shale.
3	7129	T. W. Stanton, 1911. Great Northern Railroad cut three-fourths mile northeast of Summit, Glacier National Park, Mont. Colorado shale.
4	6551	M. R. Campbell, 1910. Railroad cut 2.5 miles west of Lubec, Glacier National Park, Mont. Colorado shale.
5	7131	T. W. Stanton, 1911. East slope of Squaw Mountain north of Lubec, Glacier National Park, Mont. Colorado shale.
6	7162	M. R. Campbell and J. Hoats, 1911. Ridge south of North Fork of Cut Bank Creek, Glacier National Park, Mont. Colorado shale.
7	7137	M. R. Campbell, J. Hoats, and T. W. Stanton, 1911. North side of Two Medicine River, 9 miles south of Browning, in the NW¼ sec. 27, T. 31 N., R. 11 W., Glacier County, Mont. Colorado shale.
8	7142	M. R. Campbell and T. W. Stanton, 1911. South side of Two Medicine River, in the NW¼ sec. 26. T. 31 N., R. 11 W., Glacier County, Mont. Colorado shale.
9	9303	L. S. Kempher, 1915. Four miles west of Sunburst, in sec. 9, T. 36 N., R. 3 W., Toole County, Mont. Colorado shale, upper part.
10	9301	L. S. Kempher, 1915.. Four miles west of Sunburst, in sec. 16, T. 36 N., R. 3 W., Toole County, Mont. Colorado shale, near top.
11	8048	T. W. Stanton, 1912. Nine miles west of Kevin, in sec. 29, T. 35 N., R. 4 W., Toole County, Mont. Colorado shale, near top.
12	20299	C. E. Erdmann and J. T. Gist, 1944. Five miles northwest of Kevin, in the NE¼NW¼ sec. 24, T. 35 N., R. 4 W., Toole County, Mont. Colorado shale, 101 feet below top.
13	21667	C. E. Erdmann, R. W. Imlay, and J. B. Reeside, Jr., 1944. Five miles northwest of Kevin, in the NE. corner NW¼ sec. 24, T. 35 N., R. 4 W., Toole County, Mont. Colorado shale, 23 feet below top.
14	8605	Eugene Stebinger, 1913. Five miles northwest of Kevin, in the NW¼ sec. 24, T. 35 N., R. 4 W., Toole County, Mont. Colorado shale, upper part.
15	20291	C. E. Erdmann and J. T. Gist, 1944. Four miles north of Kevin, in the SW¼ sec. 3, T. 35 N., R. 3 W., Toole County, Mont. Colorado shale, 379 to 381 feet below top.
16	20292	C. E. Erdmann and J. T. Gist, 1944. Same locality as 20291. Colorado shale, 381 to 388 feet below top.
17	20295	C. E. Erdmann and J. T. Gist, 1944. Same locality as 20291. Colorado shale, 364 feet below top.
18	21483	B. R. Alto, W. A. Cobban, and C. T. Moore, 1949. Five miles northwest of Kevin, in the SE¼NE¼ sec. 4, T. 35 N., R. 3 W., Toole County, Mont. Colorado shale, in ferruginous concretions 306 to 392 feet below top.
19	11995	A. J. Collier, 1923. Three miles northwest of Kevin, in sec. 17, T. 35 N., R. 3 W., Toole County, Mont. Colorado shale, 20 feet below top.
20	11974	A. J. Collier, 1923. Three miles north of Kevin, in the NE¼ sec. 15, T. 35 N., R. 3 W., Toole County, Mont. Colorado shale, 500 to 580 feet below top.
21	20296	C. E. Erdmann and J. T. Gist, 1944. Three miles north of Kevin, in the SW¼NW¼NE¼ sec. 15, T. 35N., R. 3 W., Toole County, Mont. Colorado shale, 513 to 517 feet below top.
22	20298	C. E. Erdmann and J. T. Gist, 1944. Same locality as 20296. Colorado shale, 527 to 531 feet below top.
23	20297	C. E. Erdmann and J. T. Gist, 1944. Three miles north of Kevin, in the NW¼ sec. 15, T. 35 N., R. 3 W., Toole County, Mont. Colorado shale, 528 to 532 feet below top.
24	20289	C. E. Erdmann and J. T. Gist, 1944. Three miles north of Kevin, in the SW¼NE¼NW¼ sec. 15, T. 35 N., R. 3 W., Toole County, Mont. Colorado shale, about 600 feet below top.
25	20911	C. E. Erdmann, 1947. Five miles north-northwest of Oilmont, in the NW¼NW¼NW¼ sec. 12, T. 35 N., R. 2 W., Toole County, Mont. Colorado shale, pebbly sandstone 651 feet below top.
26	21429	W. A. Cobban, 1943. One mile west of Oilmont, in the NW¼NW¼ sec. 3, T. 34 N., R. 2 W., Toole County, Mont. Colorado shale, in ferruginous concretions about 800 feet below top of Colorado.
27	21807	W. A. Cobban, 1949. Ten miles east of Oilmont in the SE¼SE¼SE¼ sec. 32, T. 35 N., R. 1 E., Toole County, Mont. Colorado shale, about 675 feet below top.
28	22130	M. E. Porter, 1948. About 2 miles north of Ethridge, Toole County, Mont. Colorado shale near top.
29	11987	A. J. Collier, 1923. Three miles northwest of Shelby, in sec. 8, T. 32 N., R. 2 W., Toole County, Mont.
30	21419	W. A. Cobban, 1948. Eight miles west of Shelby, at head of ravine 3 miles north of Marias River, in the NE¼ sec. 31, T. 32 N., R. 3 W., Toole County, Mont. Colorado shale, 10 feet below top.
31	11989	A. J. Collier, 1923. North side of Marias River, sec. 3, T. 31 N., R. 4 W., Toole County, Mont. Colorado shale.
32	21412	B. R. Alto and K. Holmes, 1948. About 11.5 miles southwest of Shelby, in the SW¼SW¼ sec. 14, T. 31 N., R. 4 W., Pondera County, Mont. Colorado shale, about 250 feet below top.
33	21425	W. A. Cobban, 1940. East bank of Marias River, 11 miles southwest of Shelby, in the W½NE¼SE¼ sec. 14, T. 31 N., R. 4 W., Toole County, Mont. Colorado shale, 234 to 252 feet below top.
34	21421	W. A. Cobban, 1935. North bank of Marias River, 5.5 miles south of Shelby, in the NE¼ sec. 20, T. 31 N., R. 2 W., Toole County, Mont. Colorado shale, 617 to 634 feet below top.
35	21422	W. A. Cobban, 1935. Same locality as 21421. Colorado shale, 514 to 525 feet below top.
36	11979	A. C. Collier, 1923. One mile below railroad bridge across Marias River, in sec. 4, T. 30 N., R. 1 W., Toole County, Mont. Colorado shale.
37	22166	K. H. Holmes, 1949. Nine miles southwest of Devon, in the SE¼SW¼ sec. 16, T. 30 N., R. 1 E., Toole County, Mont. Colorado shale, 468 feet below top.
38	22149	K. H. Holmes, 1949. Eleven miles south of Devon, in the SE¼SW¼ sec. 34, T. 30 N., R. 2 E., Toole County, Mont. Colorado shale, 165 feet below top.
39	22161	K. H. Holmes, 1949. Marias River, 9 miles south of Devon, in the NE¼SW¼ sec. 22, T. 30 N., R. 2 E., Toole County, Mont. Colorado shale, 330 feet below top.
40	22164	K. H. Holmes, 1949. Eight miles south-southwest of Devon, in the NW¼SW¼ sec. 18, T. 30 N., R. 2 E., Toole County, Mont. Colorado shale, 484 feet below top.
41	9853	M. I. Goldman, 1916. Sheep Creek, in sec. 34, T. 28 N., R. 8 W., Pondera County, Mont. Colorado shale.
42	9856	M. I. Goldman and E. Stebinger, 1916. Southeast slope of Antelope Butte, in sec. 28, T. 26 N., R. 8 W., Teton County, Mont. Colorado Shale.
43	9890	Eugene Stebinger, 1916. On Willow Creek, in the NW¼ sec. 19, T. 24 N., R. 7 W., Teton County, Mont. Colorado shale, near top.
44	4023	W. R. Calvert, 1906. About half a mile northeast of Choteau, in sec. 19, T. 24 N., R. 4 W., Teton County, Mont. Colorado shale, upper part.
45	11971	A. J. Collier, 1923. North side of Teton River above Dent bridge, in sec. 34, T. 25 N., R. 3 W., Teton County, Mont. Colorado shale, about 500 feet below top.
46	21806	W. A. Cobban and C. T. Moore, 1949. Two miles southeast of Power, in the W½ sec. 34, T. 23 N., R. 1 W., Teton County, Mont. Colorado shale, about 900 feet above base.
47	21372	W. A. Cobban and R. W. Imlay, 1946. Two miles north of Fort Shaw, in the S½ secs. 35 and 36, T. 21 N., R. 2 W., Cascade County, Mont. Colorado shale, 184 to 208 feet above top of calcareous shale of Greenhorn age.

Localities at which scaphite cephalopods were collected from rocks of the Colorado group—Continued

No. on fig. 4	U.S.G.S. Mesozoic locality number	Collector, year of collection, description of locality, and stratigraphic assignment
48	21373	W. A. Cobban, 1942. Same locality as 21372. Colorado shale, 202 to 207 feet above calcareous shale of Greenhorn age.
49	21375	W. A. Cobban, 1942. Same locality as 21372. Colorado shale, 238 to 255 feet above calcareous shale of Greenhorn age.
50	3956	C. A. Fisher, 1906. Six miles northwest of Geyser, Judith Basin County, Mont. Colorado shale.
51	16201	C. B. Hunt, 1932. T. 26 N., R. 7 E., Chouteau County, Mont. Colorado shale, 270 feet below base of Virgelle sandstone.
52	1400	T. W. Stanton, 1894. Fort Benton, Mont. Colorado shale.
53	152	J. B. Marcou, 1883. Fort Benton, Mont. Colorado shale.
54	1403	T. W. Stanton and W. H. Weed, 1894. Missouri River, about 10 miles below Fort Benton. Colorado shale.
55	-----	John Pearsall, 1862. Chippewa Point, on the Missouri River 20 miles [presumably river miles] below Fort Benton, Mont. Colorado shale, upper part.
56	154	J. B. Marcou, 1883. Missouri River 3 miles below mouth of Marias River. Colorado shale.
57	1404	T. W. Stanton and W. H. Weed, 1894. Missouri River 4 or 5 miles below mouth of Marias River, Mont. Colorado shale, upper part.
58	8968	E. R. Lloyd, W. T. Thom, Jr., and W. B. Wilson, 1914. One mile south of Virgelle, in the NE¼ sec. 24, T. 26 N., R. 11 E. Chouteau County, Mont. Colorado shale.
59	2852	J. B. Hatcher, and T. W. Stanton, 1903. Missouri River near Eagle Butte, Chouteau County, Mont. Colorado shale.
60	1407	T. W. Stanton and W. H. Weed, 1894. On Missouri River 5 or 6 miles below mouth of Arrow Creek, Fergus County, Mont. Colorado shale, upper part.
61	2839	J. B. Hatcher and T. W. Stanton, 1903. Thirteen miles above mouth of Cow Creek, Blaine County, Mont. Colorado shale, upper part.
62	2847a	J. B. Hatcher, and T. W. Stanton, 1903. Thirteen miles above mouth of Cow Creek [probably the W½ sec. 4, T. 25 N., R. 21 E., Blaine County], Mont. Colorado shale.
63	7904	C. F. Bowen, 1912. Southwest flank of West dome of Cat Creek anticline, in sec. 17, T. 15 N., R. 29 E., Petroleum County, Mont. Colorado shale, near top.
64	21399	W. A. Cobban, 1948. Half a mile west of bridge over Musselshell River near Mosby, in the SE¼ sec. 10, T. 14 N., R. 30 E., Petroleum County, Mont. Colorado shale, in ferruginous concretions, 99 to 115 feet above top of Mosby sandstone member.
65	21401	W. A. Cobban, 1948. Three miles east of Mosby, in the SW¼ sec. 8, T. 14 N., R. 31 E., Garfield County, Mont. Colorado shale, 5 feet above so-called Sage Hen limestone member.
66	21402	W. A. Cobban, 1948. Three miles east of Mosby, in the N½ sec. 8, T. 14 N., R. 31 E., Garfield County, Mont. Colorado shale, 300 feet below top of calcareous shale of Niobrara age.
67	21403	W. A. Cobban, 1948. Same locality as 21402. Colorado shale, 251 to 280 feet below top of calcareous shale of Niobrara age.
68	8828	C. E. Lesher, 1914. Sec. 19, T. 9 N., R. 22 E., Golden Valley County, Mont. Colorado shale.
69	2894	M. S. Farr, J. B. Hatcher, A. C. Silberling, and T. W. Stanton, 1903. Near Crawford's Ranch, in the NW¼ T. 6 N., R. 16 E., Wheatland County, Mont. Colorado shale, upper part.
70	2895	M. S. Farr, J. B. Hatcher, A. C. Silberling, and T. W. Stanton, 1903. Near Crawford's Rranch on Mud Creek, Wheatland County, Mont. Colorado shale, near top.
71	2896	M. S. Farr, J. B. Hatcher, A. C. Silberling, and T. W. Stanton, 1903. Mud Creek about one mile northeast of Crawford's Ranch, Wheatland County, Mont. Colorado shale.
72	4655	R. W. Stone, 1907. East bank of American Fork, in sec. 23, T. 7 N., 15 E., Wheatland County, Mont. Colorado shale.
73	4656	R. W. Stone, 1907. Ten miles south of Harlowton, in sec. 12, T. 6 N., R. 15 E., Wheatland County, Mont. Colorado shale.
74	4588	R. W. Stone, 1907. Big Elk Creek near bridge, in the NE¼ sec. 36, T. 7 N., R. 13 E., Wheatland County, Mont. Colorado shale.
75	1663	A. C. Peale, 1891. Opposite Jefferson Canyon. [Probably about 5 miles west of Sappington, Madison County, Mont.] Colorado shale.
76	-----	F. V. Hayden, 1871. Cinnabar Mountain, near Gardiner, Park County, Mont. Colorado shale, upper part.
77	22131	W. A. Cobban, 1937. Cinnabar Mountain, 4.5 miles west-northwest of Gardiner, Park County, Mont. Colorado shale, near top.
78	5608	W. R. Calvert and T. W. Stanton, 1908. North side of Boulder Creek near old McLeod P. O., Sweet Grass County, Mont. Colorado shale, near top.
79	9642	C. J. Hares, 1916. South bank of Yellowstone River, sec. 6, T. 3 S., R. 23 E., Carbon County, Mont. Colorado shale.
80	5230	T. E. Williard, 1907. South side of Yellowstone River, 1.5 miles east of Billings, Yellowstone County, Mont. Colorado shale.
81	5235	T. E. Williard, 1907. South side of Yellowstone River, 1.5 miles southeast of Billings, Yellowstone County, Mont. Colorado shale.
82	9420	C. J. Hares, 1915. Billings, Mont. Colorado shale, upper part.
83	9632	C. J. Hares, 1916. Five miles southeast of Bridger, in sec. 15, T. 7 S., R. 23 E., Carbon County, Mont. Colorado shale.
84	9651	C. J. Hares, 1916. Southeast of Bridger, in T. 7 S., R. 24 E., Carbon County, Mont. Colorado shale.
85	5051	E. F. Schramm, 1907. Southwest of Bowler, in T. 8 S., R. 24 E., Carbon County, Mont. Colorado shale.
86	10897	W. T. Thom, Jr., 1921. Thirteen miles west of Hardin, in the NE¼ sec. 4, T. 2 S., R. 31 E., Big Horn County, Mont. Cody shale, Niobrara member.
87	20954	Paul Richards, 1947. North side of Woody Creek, 16 miles southwest of Hardin, in center of sec. 4, T. 3 S., R. 31 E., Big Horn County, Mont. Cody shale, Carlile member.
88	21805	W. A. Cobban, 1947. Cut on Two Leggin Creek, in T. 2 S., R. 32 E., Big Horn County, Mont. Cody shale, Carlile member.
89	20952	W. A. Cobban, 1947. East bank of Bighorn River 2 miles southeast of Hardin, in the E½ sec. 36, T. 1 S., R. 34 E., Big Horn County, Mont. Cody shale, 154 to 160 feet below top of Niobrara member.
90	20953	W. A. Cobban, 1947. East bank of Bighorn River 1 mile southeast of Hardin, in the NE¼NE¼ sec. 25, T. 1 S., R. 34 E., Big Horn County, Mont. Cody shale, upper 32 feet of Niobrara member.
91	20946	W. A. Cobban, 1947. Seven miles south of Hardin, in the SW¼ sec. 26, T. 2 S., R. 33 E., Big Horn County, Mont. Cody shale, 280 feet above the top of the Greenhorn calcareous member.
92	20935	W. A. Cobban, 1947. East flank of Soap Creek dome, in the NW¼SW¼ sec. 36, T. 6 S., R. 32 E., Big Horn County, Mont. Cody shale, 58 feet below top of Greenhorn calcareous member.
93	20937	W. A. Cobban, 1947. East flank of Soap Creek dome, in the NW¼SW¼ sec. 36, T. 6 S., R. 32 E., Big Horn County, Mont. Cody shale, 152 to 164 feet above top of Greenhorn calcareous member.
94	20938	W. A. Cobban, 1947. Same locality as 20937. Cody shale, 165 to 180 feet above top of Greenhorn calcareous member.
95	20939	W. A. Cobban, 1947. East flank of Soap Creek dome, in the NW¼SW¼ sec. 36, T. 6 S., R. 32 E., Big Horn County, Mont. Cody shale, 181 feet above top of Greenhorn calcareous member.
96	10888	G. F. Moulton, 1921. Seventeen miles southwest of Lodge Grass, near center of sec. 21, T. 7 S., R. 33 E., Big Horn County, Mont. Cody shale, Niobrara member.
97	10912	G. F. Moulton and W. T. Thom, Jr., 1921. Northeast flank of Rotten Grass dome, in sec. 21, T. 7 S., R. 33 E., Big Horn County, Mont. Cody shale, Carlile member.
98	10909	G. F. Moulton, 1921. Seven miles west of Wyola, at north bend of dry creek entering Lodge Grass Creek from the west above Miller's Ranch, near east quarter corner of sec. 16, T. 8 S., R. 34 E., Big Horn County, Mont. Cody shale, near middle.
99	12632	W. W. Rubey, 1924. Sec. 4, T. 8 S., R. 57 E., Carter County Mont. Carlile shale, Sage Breaks member, about middle.
100	12637	W. W. Rubey, 1924. Fourteen miles northwest of Alzada, in the N½ sec. 5, T. 8 S., R. 58 E., Carter County, Mont. Carlile shale, 20 feet above base of Sage Breaks member.
101	21796	W. A. Cobban, 1941. Northeast side of Five Mile Creek valley, in the W½ sec. 14, T. 9 S., R. 60 E., Carter County, Mont. Greenhorn formation, about 10 feet below top.
102	21181	W. A. Cobban, 1947. Five miles north of Belle Fourche, in the NE¼NW¼NW¼ sec. 14 and NW¼NE¼NE¼ sec. 16, T. 9 N., R. 2 E., Butte County, S. Dak. Carlile shale, light-gray limestone concretions 12 feet above base.

Localities at which scaphite cephalopods were collected from rocks of the Colorado group—Continued

No. on fig. 4	U.S.G.S. Mesozoic locality number	Collector, year of collection, description of locality, and stratigraphic assignment
103	21182	W. A. Cobban. 1947. Five miles north of Belle Fourche. in the SW¼SE¼SW¼ sec. 11, T. 9 N., R. 2 E., Butte County, S. Dak. Carlile shale, in ferruginous concretions 57 to 81 feet above base.
104	21183	W. A. Cobban, 1947. Same locality as 21182. Carlile shale, 58 to 65 feet above base.
105	21184	W. A. Cobban, 1947. Same locality as 21182. Carlile shale, 65 feet above base.
106	21185	W. A. Cobban, 1947. Same locality as 21182. Carlile shale, 66 to 78 feet above base.
107	21186	W. A. Cobban, 1947. Same locality as 21182. Carlile shale, 81 feet above base.
108	21187	W. A. Cobban, 1947. Five miles north of Belle Fourche, in the SW¼SE¼SW¼ sec. 11, T. 9 N., R. 2 E., Butte County, S. Dak. Carlile shale, from large calcareous concretions 14.5 feet above base of Turner sandy member.
109	21188	W. A. Cobban, 1947. Same locality as 21187. Carlile shale, from calcareous concretions 36 feet above base of Turner sandy member.
110	21189	W. A. Cobban, 1947. Six miles north of Belle Fourche, in the N½ sec. 10, T. 9 N., R. 2 E., Butte County, S. Dak. Carlile shale, 164 feet above base.
111	21190	W. A. Cobban, 1947. Same locality as 21189. Carlile shale, 194 to 202 feet above base.
112	21194	W. A. Cobban, 1947. Same locality as 21189. Carlile shale, 251 to 264 feet above base.
113	21195	W. A. Cobban, 1947. Six miles north of Belle Fourche, in the NE¼NE¼NW¼ sec. 10, T. 9 N., R. 2 E., Butte County, S. Dak. Carlile shale, 272 to 274 feet above base.
114	21198	W. A. Cobban, 1947. Same locality as 21195. Carlile shale, 293 feet above base.
115	21199	W. A. Cobban, 1947. Same locality as 21195. Carlile shale, 333 to 336 feet above base.
116	12734	W. W. Rubey, 1924. Five miles north of Belle Fourche, S. Dak. Carlile shale, lower part.
117	21428	W. A. Cobban, 1946. Three miles northeast of Fruitdale, in center of sec. 33, T. 9 N., R. 4 E., Butte County, S. Dak. Carlile shale, about 60–70 feet above base.
118	12176	Mrs. C. J. Haas, 1923. Near Whitewood, Lawrence County, S. Dak. Carlile shale.
119	21765	W. A. Cobban, 1948. Nine miles south-southeast of Rapid City, in the NE¼ sec. 22, T. 1 S., R. 8 W., Pennington County, S. Dak. Sage Breaks member of Carlile shale, 42 to 46 feet above base.
120	21953	W. A. Cobban, 1946. Nine miles south-southeast of Rapid City, in the NW¼ sec. 21, T. 1 S., R. 8 E., Pennington County, S. Dak. Carlile shale, near base.
121	18872	N. H. Darton, 1898. Two miles southeast of Fairburn, Custer County, S. Dak. Carlile shale, lower part.
122	12642	J. B. Reeside, Jr. and W. W. Rubey, 1924. Two miles south of Fairburn, in sec. 31, T. 4 S., R. 8 E., Custer County, S. Dak. Carlile shale, calcareous concretions 90 feet below top of lower member.
123	10383	T. W. Stanton, 1920. Half a mile southwest of Buffalo Gap, Custer County, S. Dak. Carlile shale, Turner sandy member.
124	10382	T. W. Stanton, 1920. About 5 miles southeast of Hot Springs Fall River County, S. Dak. Carlile shale, near base.
125	-----	F. V. Hayden, 1857. Southern base of Black Hills, S. Dak. Carlile shale.
126	13610	W. W. Rubey, 1926. Five miles south of Edgemont, in the NW¼ sec. 30, T. 9 S., R. 3 E., Fall River County, S. Dak. Carlile shale, sandstone 43 feet above shark-tooth conglomerate.
127	10281	E. T. Hancock, 1919. Mule Creek oil field, in sec. 18, T. 39 N., R. 60 W., Niobrara County, Wyo. Carlile shale, in a sandstone 200 feet above base.
128	12691	W. W. Rubey, 1924. One mile south of Newcastle, in sec. 2, T. 44 N., R. 61 W., Weston County, Wyo. Carlile shale, 20 feet above shark-tooth conglomerate of Turner sandy member.
129	11190	C. R. Longwell and W. W. Rubey, 1922. About 2.5 miles south of Newcastle, Weston County, Wyo. Carlile shale, near base.
130	21792	W. A. Cobban, 1948, One mile west of Newcastle, Weston County, Wyo. Carlile shale, light-gray limestone concretions 62.to 70 feet above base.
131	10334	Mrs. W. O. George, 1920. Near Pedro, Weston County, Wyo. Carlile shale.
132	11200	W. W. Rubey, 1922. About a mile east of Pedro, Wyo. Carlile shale.
133	10410	A. J. Collier, K. C. Heald, and M. G. Gulley, 1920. Railroad cut in sec. 3, T. 48 N., R. 66 W., Weston County, Wyo. Carlile shale.
134	8644	V. H. Barnett, 1913. About 15 miles north of Moorcroft, in the NE¼SE¼ sec. 33, T. 52 N., R. 67 W., Crook County, Wyo. Carlile shale.
135	12630	W. W. Rubey, 1924. Three miles north of Oshoto, in the NE¼ sec. 32, T. 54 N., R. 67 W., Crook County, Wyo. Carlile shale, middle of Turner sandy member.
136	21424	M. M. Knechtel, 1947. Eleven miles southeast of Rockypoint, in sec. 30, T. 56 N. R. 67 W., Crook County, Wyo. Carlile shale, Turner sandy member.
137	21591	W. A. Cobban, 1948. Southwest flank of Bull Creek anticline, in the NE¼ sec. 15, T. 57 N., R. 62 W., Crook County, Wyo. Carlile shale, light-gray limestone concretions near base.
138	21798	W. A. Cobban, 1941. Northeast side of Crow Creek valley, in the E½ sec. 9, T. 57 N., R. 61 W., Crook County, Wyo. Ferruginous concretions 76 to 101 feet below top of the Greenhorn formation.
139	17933	R. P. Bryson and W. G. Pierce, 1938. Line Creek, in the NW¼NW¼ sec. 35, T. 58 N., R. 103 W., Park County, Wyo. Cody shale.
140	17954	W. G. Pierce and J. B. Reeside, Jr., 1938. Line Creek, in the SE¼SW¼ sec. 26, T. 58 N., R. 103 W., Park County, Wyo. Cody shale, 690 to 720 feet above base.
141	17955	W. G. Pierce and J. B. Reeside, Jr., 1938. In the SE¼SW¼ sec. 26, T. 58 N., R. 103 W., Park County, Wyo. Cody shale, 630 feet above base.
142	17956	W. G. Pierce and J. B. Reeside, Jr., 1938. In the SW¼SW¼ sec. 26, T. 58 N., R. 103 W., Park County, Wyo. Cody shale, 590 feet above base.
143	17957	W. G. Pierce and J. B. Reeside, Jr., 1938. Line Creek, in the SE¼SW¼ sec. 26, T. 58 N., R. 103 W., Park County, Wyo. Cody shale, 760 to 810 feet above base.
144	17958	W. G. Pierce, 1938. Line Creek, in the SE¼SW¼ sec. 26, T. 58 N., T. 103 W., Park County, Wyo. Cody shale, 1,110 feet above base.
145	17959	W. G. Pierce, 1938. Line Creek, in the NW¼NW¼ sec. 35, T. 58 N., R. 103 W., Prk County, Wyo. Cody shale, about 700 feet above base.
146	18152	W. G. Pierce, 1938. Line Creek, in the SE¼SW¼ sec. 26, T. 58 N., R. 103 W., Park County, Wyo. Cody shale, 1,215 feet above base.
147	18156	W. G. Pierce, 1938. In the SW¼SW¼ sec. 26, T. 58 N., R. 103 W., Park County, Wyo. Cody shale, 620 feet above base.
148	18160	W. G. Pierce, 1938. In the SW¼SW¼ sec. 26, T. 58 N., R. 103 W., Park County, Wyo. Cody shale, 370 feet above base.
149	17942	W. G. Pierce, 1938. South of Bennett Creek, in the SW¼SE¼ sec. 10, T. 57 N., R. 103 W., Park County, Wyo. Cody shale, 375 feet above base.
150	17952	W. G. Pierce and J. B. Reeside, Jr., 1938. South of Bennett Creek, in the SW¼SE¼ sec. 10, T. 57 N., R. 103 W., Park County, Wyo. Cody shale, 375 feet above base.
151	17928	W. G. Pierce, 1937. In the SW¼NW¼ sec. 23, T. 55 N., R. 103 W., Park County, Wyo. Cody shale about middle.
152	4991	T. E. Williard, 1907. South side of Shoshone River about 2 miles east of Cody bridge, Park County, Wyo. Cody shale.
153	4960	C. A. Fisher and E. G. Woodruff, 1907. Shoshone River, two miles east of Cody, Wyo. Cody shale.
154	7369	D. F. Hewett, 1911. South side of Shoshone River 3 miles northeast of Cody, Park County, Wyo. Cody shale.
155	3079	C. A. Fisher, 1904. Near Cody, Wyoming. Cody shale.
156	-----	Edwin Binney, Jr., 1924. Oregon Basin, in sec. 6, T. 51 N., R. 100 W., Park County, Wyo. Cody shale, 600 feet above base.
157	-----	Edwin Binney, Jr., 1924. Oregon Basin, in sec. 6, T. 51 N., R. 100 W., Park County, Wyo. Cody shale, 800 feet above base.
158	17175	W. G. Pierce, 1935. West flank of Fourbear anticline, half a mile northwest of Palette Ranch No. 2, 9.5 miles west of Pitchfork, in sec. 18, T. 48 N., R. 103 W., Park County, Wyo. Cody shale.

Localities at which scaphite cephalopods were collected from rocks of the Colorado group—Continued

No. on fig. 4	U.S.G.S. Mesozoic locality number	Collector, year of collection, description of locality, and stratigraphic assignment
159	17176	D. A. Andrews and W. G. Pierce, 1935. Eight miles west-northwest of Pitchfork, in the NW¼ sec. 21, T. 48 N., R. 103 W., Park County, Wyo. Cody shale, 200 feet above base.
160	17168	D. A. Andrews, 1935. South side of Spring Creek, near Meeteetse, Wyo. Cody shale.
161	17164	W. G. Pierce, 1935. Pitchfork anticline, in the SE¼SE¼ sec. 2, T. 48 N., R. 102 W., Park County, Wyo. Cody shale, 1,400 feet above base.
162	17110	W. G. Pierce, 1935. In the NE¼NW¼ sec. 24, T. 48 N., R. 102 W., Park County, Wyo. Cody shale.
163	17115	W. G. Pierce, 1935. In the NE¼ sec. 10, T. 46 N., R. 101 W., Park County, Wyo. Cody shale.
164	10422	M. G. Gulley and K. C. Heald, 1920. South of Kirby Creek, in the NE¼ sec. 20, T. 43 N., R. 92 W., Hot Springs County, Wyo. Cody shale.
165	10421	M. G. Gulley and K. C. Heald, 1920. South Branch of Kirby Creek, about 15 miles east of Lucerne, in sec. 22, T. 43 N., R. 92 W., Hot Springs County, Wyo. Cody shale.
166	8915	W. P. Woodring, 1914. Nine miles northwest of Nowood, in the NW¼NE¼ sec. 30, T. 43 N., R. 89 W., Washakie County, Wyo. Cody shale.
167	4538	M. A. Pishel, 1907. Four miles southeast of Greybull, in the NW¼SW¼ sec. 25, T. 52 N., R. 93 W., Big Horn County, Wyo. Cody shale.
168	4958	M. A. Pishel, 1907. Four miles northeast of Basin, in the SW¼NE¼ sec. 30, T. 52 N., R. 92 W., Big Horn County, Wyo. Cody shale.
169	8278	J. Henderson, 1913. Twelve miles east of Basin, Big Horn County, Wyo. Cody shale.
170	9615	C. J. Hares, 1916. Garland anticline, one mile west of Byron, in sec. 33, T. 56 N., R. 97 W., Big Horn County, Wyo. Cody shale.
171	4539	C. W. Washburne, 1907. Garland coal field, Park County, Wyo. Cody shale.
172	9770	C. J. Hares, 1916. Eight miles southeast of Lovell, Big Horn County, Wyo. Cody shale, lower part.
173	4540	H. P. Little, 1907. Two miles east of Cowley, Big Horn County, Wyo. Cody shale.
174	9675	C. J. Hares, 1916. Southeast of Frannie, in sec. 23, T. 57 N., R. 97 W., Big Horn County, Wyo. Cody shale.
175	9669	C. J. Hares, 1916. About 1.5 miles south of Frannie, in sec. 24, T. 58 N., R. 98 W., Park County, Wyo. Cody shale.
176	20701	J. D. Love, 1945. Gros Ventre area. Teton County, Wyo. Frontier formation.
177	21109	H. R. Bergquist, D. C. Duncan, R. K. Hose, and J. D. Love, 1947. In the NE¼NW¼ sec. 20, T. 42 N., R. 112 W., Teton County, Wyo. Cody shale, 500 feet above base.
178	21173	D. C. Duncan, R. K. Hose, and J. D. Love, 1947. Same locality as 21109. Cody shale, sandstone unit 607 to 614 feet above base.
179	21110	H. R. Bergquist, 1947. One mile northwest of Upper Slide Lake, in the NW¼NE¼ sec. 19, T. 42 N., R. 112 W., Teton County, Wyo. Cody shale, 1,283 feet above base.
180	21179	H. R. Berquist, D. C. Duncan, R. K. Hose, and J. D. Love, 1947. North side of bend on Bacon Creek north of Bar Y Creek, in the NE¼NE¼ sec. 22, T. 41 N., T. 111 W., Teton County, Wyo. Frontier formation, 180 feet below top.
181	17301	W. W. Rubey, 1936. South Piney Creek, in the NE¼NW¼ sec. 15, T. 29 N., R. 115 W., Sublette County, Wyo. Frontier formation.
182	17302	W. W. Rubey, 1936. In the NW¼ sec. 22, T. 29 N., R. 115 W., Sublette County, Wyo. Frontier formation.
183	17315	W. W. Rubey, 1936. Afton quadrangle, in the NW¼NW¼ sec. 9, T. 26 N., R. 113 W., Lincoln County, Wyo. Hilliard shale.
184	6286	Robert Forrester, 1909. Glencoe, Lincoln County, Wyo. Frontier formation, just above Kemmerer coal bed.
185	19532	J. D. Love, 1944. East Fork of Sheep Creek, 35 miles north of Riverton, in sec. 15, T. 6 N., R. 2 E., Fremont County, Wyo. Frontier formation, top sandstone unit.
186	20920	H. H. R. Sharkey, 1945. Bargee area, in the NE¼NE¼ sec. 27, T. 7 N., R. 1 W., Fremont County, Wyo. Cody shale, about 1,000 feet above base.
187	20921	H. H. R. Sharkey and M. D. Williams, 1945. Five miles southwest of Bargee, in center of sec. 5, T. 6 N., R. 1 W., Fremont County, Wyo. Cody shale, in conspicuous rusty sandstone 50 to 75 feet above top of Frontier.
188	21751	W. R. Keefer, J. D. Love, J. B. Reeside, Jr., and M. L. Troyer, 1949. Northeast flank of Maverick Springs anticline, in the NE¼NE¼ sec. 28, T. 6 N., R. 1 W., Teton County, Wyo. Cody shale, 1,508 feet above base.
189	21748	J. D. Love and G. N. Pipiringos, 1949. Near Horse Creek, 10 miles north of Dubois, in the SE¼SW¼SE¼ sec. 23, T. 43 N., R. 107 W., Fremont County, Wyo. Cody shale, about 1,500 feet above base.
190	10032	C. J. Hares, 1917. Pilot Butte oil field, in sec. 28, T. 3 N., R. 1 W., Fremont County, Wyo. Cody shale.
191	10033	C. J. Hares, 1917. Pilot Butte oil field, sec. 34, T. 3 N., R. 1 W., Fremont County, Wyo. Cody shale.
192	21093	G. N. Pipiringos, 1948. Twelve miles northwest of Fort Washakie in the SW¼NE¼SW¼ sec. 21, T. 2 N., R. 2 W., Fremont County, Wyo. Frontier formation, 140 to 196 feet below top.
193	21087	G. N. Pipiringos, R. M. Thompson, Max Troyer, and V. White, 1948. Sage Creek anticline, in the SE¼ sec. 30, T. 2 N., R. 1 W., Fremont County, Wyo. Frontier formation, upper part.
194	20611	J. D. Love and J. B. Reeside, Jr., 1944. Same locality as 21087. Frontier formation, near top.
195	20612	J. D. Love and J. B. Reeside, Jr., 1944. Same locality as 21087. Frontier formation, upper part.
196	20610	J. D. Love and J. B. Reeside, Jr., 1944. Norkok Creek, Fremont County, Wyo. Frontier formation, near top.
197	21083a	G. N. Pipiringos and R. M. Thompson, 1948. Sage Creek anticline, in the NW¼ sec. 20, T. 2 N., R. 1 W., Fremont County, Wyo. Frontier formation, at top.
198	20614	J. D. Love, 1944. Sage Creek, in the NE¼SE¼NE¼ sec. 18, T. 1 S., R. 1 E., Fremont County, Wyo. Frontier formation, near top.
199	20773	J. D. Love, 1944. Sage Creek, in sec. 18, T. 1 S., R. 1 E., Fremont County, Wyo. Frontier formation, at top.
200	21547	J. D. Love, J. B. Reeside, Jr., R. M. Thompson, and M. L. Troyer, 1949. Eight miles north of Lander, in the NE¼SW¼ sec. 25, T. 1 S., R. 1 E., Fremont County, Wyo. Cody shale, 450 to 574 feet above base.
201	21548	J. D. Love, J. B. Reeside, Jr., R. M. Thompson, and M. L. Troyer, 1949. Ray Lake, 8 miles north of Lander, in the SW¼NE¼ sec. 25, T. 1 S., R. 1 E., Fremont County, Wyo. Cody shale, 574 to 774 feet above base.
202	19542	J. D. Love, 1944. Ray Lake, first low ridge on west side, 8 miles north of Lander, Wyo. Frontier formation.
203	21099	Max Troyer, 1948. In bluff half a mile north of old Fort Washakie road, 1 mile north and northwest of bridge over North Fork, in the NW¼SW¼SE¼ sec. 10, T. 2 S., R. 1 E., Fremont County, Wyo. Cody shale, about 3,000 feet above base.
204	21100	Max Troyer, 1948. One-eighth mile northeast of bridge over North Fork on 2nd Street Road, 4 miles north of Lander, in the NE¼SW¼SE¼ sec. 14, T. 2 S., R. 1 E., Fremont County, Wyo. Cody shale, about 3,000 feet above base.
205	21549	J. D. Love, J. B. Reeside, Jr., R. M. Thompson, and M. L. Troyer, 1949. Six miles northeast of Lander, in the NE¼NW¼ sec. 8, T. 2 S., R. 2 E., Fremont County, Wyo. Cody shale, 2,040 feet above base.
206	6011	N. H. Brown, T. W. Stanton, and E. G. Woodruff, 1909. Southeast of Lander, in T. 33 N., R. 99 W., Fremont County, Wyo. Frontier formation.
207	6012	N. H. Brown, T. W. Stanton, and E. G. Woodruff, 1909. Southeast of Lander, in T. 33 N., R. 99 W., Fremont County, Wyo. Frontier formation, 200 feet below collection 6011.
208	14308	I. A. Keyte, 1928. Two miles southeast of Lander, Fremont County, Wyo. Frontier formation, top sandstone unit.
209	14310	I. A. Keyte, 1928. Taylor ditch, near Lander, Fremont County, Wyo. Frontier formation.
210	18945	R. M. Thompson, 1944. Dallas dome, in sec. 9, T. 32 N., R. 98 W., Fremont County, Wyo. Frontier formation.

Localities at which scaphite cephalopods were collected from rocks of the Colorado group—Continued

No. on fig. 4	U.S.G.S. Mesozoic locality number	Collector, year of collection, description of locality, and stratigraphic assignment
211	18946	H. H. R. Sharkey, 1944. Dallas dome, in sec. 16, T. 32 N., R. 98 W., Fremont County, Wyo. Frontier formation.
212	18941	H. A. Tourtelot, 1944. Derby dome, in sec. 26, T. 32 N., R. 98 W., Fremont County, Wyo. Frontier formation.
213	8984	C. J. Hares, 1914. About 30 miles east of Lander, Fremont County, Wyo. Frontier formation.
214	8985	C. J. Hares, 1914. About 30 miles east of Lander, Fremont County, Wyo. Frontier formation, 50 feet lower than Loc. 8984.
215	21538	G. N. Pipiringos and K. Yenne, 1949. Conant Creek, 35 miles east of Lander, in the NW¼SW¼ sec. 13, T. 33 N., R. 94 W., Fremont County, Wyo. Frontier formation, 53 feet below top.
216	21757	G. N. Pipiringos, 1948. Same locality as 21538. Frontier formation, near top.
217	20613	J. D. Love, 1944. Conant Creek, Fremont County, Wyo. Frontier formation.
218	9008	J. B. Reeside, Jr., 1914. Muskrat Creek, T. 32 N., R. 91 W., Fremont County, Wyo. Cody shale.
219	21102	R. M. Thompson, 1948. Ten miles southwest of Raderville, in the NW¼ sec. 12, T. 33 N., R. 90 W., Fremont County, Wyo. Cody shale, 50 to 100 feet above top sandstone of Frontier.
220	8524	C. J. Hares, 1913. Sec. 9, T. 32 N., R. 86 W., Natrona County, Wyo. Cody shale.
221	8511	C. J. Hares, 1913. Twenty-seven miles northwest of Casper, in sec. 36, T. 37 N., R. 82 W., Natrona County, Wyo. Frontier formation.
222	4448	C. T. Lupton, 1907. About 4.5 miles southeast of Big Muddy station, in T. 33 N., R. 76 W., Converse County, Wyo.
223	20917	J. D. Love, 1946. Eleven miles south of Douglas, in the NW¼ NW¼ sec. 5, T. 30 N., R. 71 W., Converse County, Wyo. Frontier formation.
224	4872	E. B. Hopkins, 1907. Six miles east of Crooks Gap oil field, in the NW¼ sec. 19, T. 28 N., R. 91 W., Fremont County, Wyo.
225	9029	C. J. Hares and J. B. Reeside, Jr., 1914. One mile east of Jack Grelvo's Ranch near Whiskey Peak, in sec. 26, T. 28 N., R. 90 W., Fremont County, Wyo. Cody shale.
226	10464	N. W. Bass, 1920. Lost Soldier oil field, Sweetwater County, Wyo. Frontier formation, shale beneath top sandstone.
227	10456	A. E. Fath and C. Y. Hsieh, 1920. Thirty-two miles north-northwest of Rawlins, in sec. 7, T. 26 N., R. 88 W., Carbon County, Wyo. Steele shale, 1,728 feet above base.
228	4066	A. C. Veatch, 1906. Three miles southeast of Rawlins, in the NE¼ sec. 27, T. 21 N., R. 87 W., Carbon County, Wyo. Frontier formation, 570 feet above Dakota sandstone.
229	4069	A. C. Veatch, 1906. Three miles southeast of Rawlins, in the NW¼ sec. 26, T. 21 N., R. 87 W., Carbon County, Wyo. Frontier formation.
230	3712	A. C. Veatch, 1906. Fifteen miles south-southwest of Hanna, in the SE¼NE¼ sec. 30, T. 20 N., R. 82 W., Carbon County, Wyo. Frontier formation, 680 feet above Dakota sandstone.
231	22125	F. V. Hayden, 1870. Medicine Bow River, southeastern Wyo. (Frontier formation.)
232	530	A. Hyatt, and Russell, 1888. Railroad cut half a mile east of Aurora, Carbon County, Wyo.
233	533	A. Hyatt, and Russell, 1888. Railroad cut 1 mile north of Aurora, Carbon County, Wyo.
234	399	L. F. Ward. One mile north of Rock Creek, in sec. 30, T. 22 N., R. 75 W., Albany County, Wyo. Carlile shale.
235	6270	Robert Forrester, 1909. Four miles east of Oak Springs, Sevier County, Utah, Mancos shale.
236	12583	E. M. Spieker, 1924. Near Emery, Emery County, Utah. Mancos shale, Ferron sandstone member.
237	22129	Philip Katich, 1949. Six miles east of Clawson, in sec. 26, T. 19 S., R. 8 E., Emery County, Utah. Blue Gate shale, near base.
238	6945	Robert Forrester, 1910. Irrigated Lands Company tunnel between Price and Spring Glen, Carbon County, Utah. Mancos shale.
239	11956	J. B. Reeside, Jr., and E. M. Spieker, 1923. 300 feet north of Carbon County High School, Price, Utah. Mancos shale.
240	13319	H. F. Moses, 1925. Three miles north of Woodside, in the SE¼ SW¼ sec. 28, T. 17 S., R. 14 E., Emery County, Utah. Mancos shale.
241	934	T. W. Stanton, 1892. Four miles northwest of Woodside, Emery County, Utah. Mancos shale.
242	13240	J. B. Reeside, Jr., and E. M. Spieker, 1925. One mile west of Desert, Emery County, Utah. Mancos shale, 20 feet above Ferron sandstone member.
243	13243	J. B. Reeside, Jr., and E. M. Spieker, 1925. One mile east of Desert, Emery County, Utah. Mancos shale, 970 feet above base.
244	13261	J. B. Reeside, Jr., 1925. Near Desert, Emery County, Utah. Mancos shale, 1,250 feet above base.
245	13262	J. B. Reeside, Jr., 1925. Near Desert, Emery County, Utah. Mancos shale, 1,340 feet above base.
246	13263	J. B. Reeside, Jr., 1925. Near Desert, Emery County, Utah. Mancos shale, 1,400 feet above base.
247	13331	J. D. Fisher, 1925. Sec. 3, T. 20 S., R. 16 E., Emery County, Utah. Mancos shale.
248	21426	W. A. Cobban, 1944. Brush Creek, 9.5 miles northeast of Vernal, in center of sec. 11, T. 3 S., R 22 E., Uintah County, Utah. Mancos shale, 180 feet above top of Frontier sandstone member.
249	21427	W. A. Cobban, 1945. Northeast side of Ashley Creek, 2.5 miles west of Jensen, in the SW¼SE¼ sec. 24, T. 5 S., R. 22 E., Uintah County, Utah. Mancos shale, about 800 feet above base.
250	4363	H. S. Gale, 1907. Eleven miles north of Rangely, in sec. 12, T. 3 N., R. 102 W., Moffat County, Colo. Mancos shale.
251	21764	W. A. Cobban, 1945. Three miles west of Skull Creek, in the SE¼SE¼ sec. 4, T. 3 N., R. 101 W., Moffat County, Colo. Mancos shale, top of Frontier sandstone member.
252	11670	W. H. Bradley, J. B. Reeside, Jr., and J. D. Sears, 1923. Vermilion Creek, in the SW¼NW¼ sec. 11, T. 10 N., R. 101 W., Moffat County, Colo. Mancos shale, 20 feet above top of Frontier sandstone member.
253	11678	W. H. Bradley, J. B. Reeside, Jr., and J. D. Sears, 1923. Vermilion Creek, in the NE¼NW¼ sec. 11, T. 10 N., R. 101 W., Moffat County, Colo. Mancos shale, 1,002 feet above base.
254	11685	W. H. Bradley, J. B. Reeside, Jr., and J. D. Sears, 1923. Vermilion Creek, in the SE¼SW¼ sec. 2, T. 10 N., R. 101 W., Moffat County, Colo. Mancos shale, 1,222 feet above base.
255	11699	W. H. Bradley, J. B. Reeside, Jr., and J. D. Sears, 1923. Vermilion Creek, in the NW¼NE¼ sec. 11, T. 10 N., R. 101 W., Moffat County, Colo. Mancos shale, 1,642 feet above base.
256	11705	W. H. Bradley, J. B. Reeside, Jr., and J. D. Sears, 1923. Same locality as 11699. Mancos shale, 1,767 feet above base.
257	13699	J. B. Reeside, Jr., 1926. Fourteen miles northwest of Craig, in the SW¼SE¼SE¼ sec. 27, T. 9 N., R. 29 W., Moffat County, Colo. Mancos shale.
258	6252	A. S. Beekly, 1909. Edgerton Creek Gap, 10 miles south of Glenwood Springs, in sec. 1, T. 8 S., R. 89 W., Garfield County, Colo. Mancos shale.
259	6950	C. W. Washburne, 1910. At Cedar, San Miguel County, Colo Mancos shale.
260	2007	C. W. Purington, 1896. Near Rico, Colorado. Mancos shale within 100 feet of Dakota sandstone.
261	7389	M. A. Pishel and H. F. Wright, 1911. Twelve miles southwest of Cortez, in sec. 3, T. 34 N., R. 17 W., Montezuma County, Colo.
262	17431	J. D. Northrop, 1934. Center of NW¼ sec. 21, T. 36 N., R. 14 W., Montezuma County, Colo. Mancos shale, 475 feet above base.
263	4012	C. D. Smith, 1906. North side of Mancos-Thompson Park road, one mile southeast of Menefee ranch house, Durango coal field, Colo. Mancos shale, in limestone ledges.
264	10506	J. B. Reeside, Jr., 1920. A mile and a half west of Durango, in the NW¼SE¼ sec. 18, T. 35 N., R. 9 W., La Plata County, Colo. Mancos shale, about 300 feet above Dakota sandstone.
265	7360	C. W. Cooke, 1911. At base of mountain a quarter of a mile north of head of Deadman's Creek, 10 miles southwest of Castle Rock, Douglas County, Colo. Benton shale.
266	14305	A. E. Brainerd and I. A. Keyte, 1928. Sixteen miles east of Trinidad, in sec. 1, T. 32 S., R. 62 W., Las Animas County, Colo. Apishapa shale, near top.
267	------	A. L. Morrow. Three miles south-southeast of Tipton, in the SE¼ sec. 4, T. 9 S., R. 10 W., Mitchell County, Kans. Carlile shale, in upper part of Blue Hill shale member.
268	21838	W. A. Cobban, 1948. Three miles south-southeast of Tipton, in the SE¼ sec. 4, T. 9 S., R. 10 W., Mitchell County, Kans. Carlile shale, in upper part of Blue Hill shale member.

Localities at which scaphite cephalopods were collected from rocks of the Colorado group—Continued

No. on fig. 4	U.S.G.S. Mesozoic locality number	Collector, year of collection, description of locality, and stratigraphic assignment
269	†1591	W. B. Emery, 1923. Top of the "Black Hill" on Shiprock-Biltabito road about 14 miles west of Shiprock Agency, Navajo Indian Reservation, San Juan County, N. Mex. Mancos shale, 150 feet below base of Tocito sandstone lentil.
270	18874	N. W. Bass, 1943. On Biltabito road 15 miles west of Shiprock bridge, San Juan County, N. Mex. Mancos shale, in sandstone ledges.
271	12008	J. B. Reeside, Jr., 1923. Center of the NW¼SW¼ sec. 25, T. 30 N., R. 17 W., San Juan County, N. Mex. Mancos shale, 698 feet below base of Mesaverde formation.
272	12006	J. B. Reeside, Jr., 1923. In the SW¼NE¼ sec. 20, T. 30 N., R. 16 W., San Juan County, N. Mex. Mancos shale, 115 feet below top.
273	10368	W. E. Brysant, C. E. Dobbin, and J. B. Reeside, Jr., 1920. Fourteen miles southwest from Shiprock Mtn. (Wilson Peak), in sec. 5 or 8, T. 9 N., R. 4 W., San Juan County, N. Mex. Mancos shale.
274	11593	W. B. Emery, 1923. Two miles west of Tsenosti Trading Post, Navajo Indian Reservation, San Juan County, N. Mex. Mancos shale, from thin sandstone about 150 feet below base of Tocito sandstone lentil.
275	11594	W. B. Emery, 1923. Two miles west of Tsenosti Trading Post, Navajo Indian Reservation, San Juan County, N. Mex. Mancos shale, in banded calcareous concretions 120 feet below Tocito sandstone lentil.
276	15580	C. B. Hunt, 1930. Sixteen miles northwest of San Mateo, in the NE¼ sec. 2, T. 14 N., R. 10 W., McKinley County, N. Mex. Mancos shale, 200 feet below base of Gallup sandstone member of Mesaverde formation.
277	13283	B. C. Renick, 1925. Senorita Canyon, Sandoval County, N. Mex. Mancos shale.
278	16818	C. B. Hunt, 1933. Three miles west of Gallina, in the SW¼NW¼ sec. 13, T. 23 N., R. 1 W., Rio Arriba County, N. Mex. Mancos shale.
279	515	J. W. Powell, 1887. Near Lagoon, 5 miles from Gallina, Rio Arriba County, N. Mex. Mancos shale.
280	17628	R. P. Bryson, 1937. About 7.5 miles north-northeast of north end of El Vado Reservoir, Rio Arriba County, N. Mex.
281	17633	R. P. Bryson, 1937. About 7.5 miles north-northeast of El Vado Reservoir, Rio Arriba County, N. Mex. Mancos shale.
282	17635	R. P. Bryson, 1937. Near El Vado, Rio Arriba County, N. Mex. Mancos shale.
283	17637	R. P. Bryson, 1937. Upper Lagunas Creek, Rio Arriba County, N. Mex. Mancos shale.
284	16784	C. H. Dane, 1933. East of Monero and north of Denver Rio Grande Western R. R., in northeast part of T. 31 N., R. 1 E., Rio Arriba County, N. Mex. Mancos shale, 1,000 feet below base of upper part of the Hosta sandstone member of the Mesaverde formation.
285	17638	C. H. Dane, 1937. Near Chama-Monero road, Rio Arriba County, N. Mex. Mancos shale.
286	------	W. S. Pike, Jr., 1931. West side of Cebolleta Mesa, in sec. 17, T. 8 N., R. 9 W., Valencia County, N. Mex. Mancos shale, 275 feet below top.
287	15590	C. B. Hunt, 1930. Six miles east of Seboyeta, Valencia County, N. Mex. Mancos shale, 679 feet above base, and 250 feet below base of Gallup sandstone member of Mesaverde formation.
288	15600	C. B. Hunt, 1930. About 5.5 miles north of Evan's Park, Cebolleta Grant, Sandoval County, N. Mex. Mancos shale, 200 feet below Gallup sandstone member of the Mesaverde formation.
289	15601	C. B. Hunt, 1930. About 2.5 miles north-northeast of Evan's Ranch, Nuestra Senora de la Luz de las Lagunitas Grant, Sandoval County, N. Mex. Mancos shale, 400 feet below Gallup sandstone member of the Mesaverde formation.
290	16115	C. B. Hunt, 1931. Nineteen miles southeast of Dominguez, in the SW¼NW¼ sec. 5, T. 14 N., R. 1 E., Sandoval County, N. Mex. Mancos shale, top of Carlile shale member.
291	7180	W. T. Lee, 1911. Omera mine, east flank of Ortiz Mountains, Santa Fe County, N. Mex. Mancos shale, uppermost part.
292	7165	W. T. Lee, 1911. One mile southwest of Waldo, Santa Fe County, N. Mex. Mancos shale, upper 200 feet, and Mesaverde formation, basal part.
293	3532	W. T. Lee, 1905. One mile north of Galisteo Creek and 1 mile east of head of Canyon del Yeso, Santa Fe County, N. Mex. Mancos shale, uppermost part.
294	5596	W. T. Lee, 1908. Outlet of Johnson Park, Raton coal field, northeastern Colfax County. N. Mex. Niobrara formation.

SYSTEMATIC DESCRIPTIONS

Scaphites delicatulus Warren var. greenhornensis Cobban, n. var.

Plate 1, figures 1–3

This variety is represented in the collections by only two individuals, the smaller of which has been selected as the type. It is 28 mm. long, 23 mm. high, and 14.2 mm. wide, and has about 85 ventral ribs on the exposed whorls of which 40 are on the living chamber. Primary ribs number 15 on the living chamber and about 16 or 17 on the last septate whorl. Neither the internal whorls nor the suture were seen.

The variety differs from the holotype of *Scaphites delicatulus* Warren (1930, p. 66, pl. 3, fig. 3; pl. 4, figs. 7, 8) in its coarse ribbing near the aperture and greater number of primaries in proportion to the number of secondaries on the living chamber, the straight part having two or three secondaries to each primary whereas Warren's specimen shows four to six secondaries to each primary. The tubercles are not as conspicuous or pointed as on Warren's type. The variety more closely resembles a specimen of *S. delicatulus* more recently figured by Warren (1947, p. 123, pl. 29, fig. 5), differing from it chiefly in the presence of coarse ribbing near the aperture and lack of pointed tubercles.

Scaphites brittonensis Moreman (1942, p. 215, pl. 34, figs. 1, 2; text fig. 2) from the Britton formation of Texas is related to the variety *greenhornensis* but differs by its smaller size, pointed tubercles, and uniform spacing of the ventral ribs over the entire living chamber. Of the European species *S. d. greenhornensis* closely resembles *S. aequalis* Sowerby although that species may lack terminal coarse ribbing. One of the specimens figured as *S. geinitzi* d'Orbigny by Geinitz (1874, p. 191, pl. 35, fig. 3) is coarsely ribbed at the end of the living chamber and appears to differ from the Greenhorn form only in its high, rounded tubercles.

Holotype, U.S.N.M. 106766.

The holotype is from a calcareous concretion about 10 feet below the top of the Greenhorn formation on the north flank of the Black Hills uplift, in the W½ sec. 14, T. 9 S., R. 60 E., Carter County, Mont. The

external mold of part of a large specimen was found in the living chamber of a *Vascoceras thomi* Reeside in the Greenhorn calcareous member of the Cody shale on the Crow Indian Reservation in south-central Montana.

Scaphites larvaeformis Meek and Hayden

Plate 1, figures 4–15

1859. *Scaphites larvaeformis* Meek and Hayden, Acad. Nat. Sci. Philadelphia Proc., vol. 10, p. 58.
1876. *Scaphites larvaeformis* Meek and Hayden. Meek, U. S. Geol. Survey Terr. Rept., vol. 9, p. 418, pl. 6, figs. 6a-c.
1893. *Scaphites larvaeformis* Meek and Hayden. Stanton, U. S. Geol. Survey Bull. 106, p. 182, pl. 44, fig. 2.
1898. *Scaphites larvaeformis* Meek and Hayden. Logan, Kansas Univ. Geol. Survey, vol. 4, p. 473, pl. 104, fig. 2.
1915. *Scaphites larvaeformis* Meek [and Hayden]. Frech, Centralbl. Mineralogie, Jahrg. 1915, no. 21, p. 556, fig. 1.
1916. *Holcoscaphites larvaeformis* (Meek and Hayden). Nowak, K.-k. Geol. Reichsanstalt Verh., Jahrg. 1916, no. 3, p. 66.
1927. *Scaphites larvaeformis* Meek and Hayden. Reeside, U. S. Geol. Survey Prof. Paper 150–B, p. 31.

The description by Meek (1876, p. 418) is as follows:

Shell small, transversely subovate, compressed, evenly rounded on the periphery; volutions slender, nearly round, the inner or coiled ones forming only a very small part of the entire shell, and so closely involuted as to leave only a very small umbilical pit; extended body portion rather long, slender, and straight to the recurvature, thence continued backward until it comes nearly in contact with coiled inner volutions; aperture apparently circular; surface ornamented by small costae, which pass from the inner side of the volutions to about half way across their lateral surfaces, where they swell into small, obscure, transversely elongated nodes, and then branch each into two or three smaller linear ribs, all of which pass straight over the periphery.

Length, 0.87 inch; height, 0.63 inch; convexity, 0.33 inch.

The septa of this species are comparatively rather simple, being each provided with but two principal lateral lobes on each side, none of which are deeply divided. The siphonal lobe is longer than wide, and has two very small, short, nearly parallel, obscurely bifid, terminal divisions, with a more oblique, somewhat similar branch on each of the sides above. The first lateral sinus is wider than the siphonal lobe, and nearly as long, with its extremity deeply divided by a slender, obscurely trifid, auxiliary lobe, into two very unequal, more or less sinuous, and obtusely digitate branches. First lateral lobe about half as wide as the siphonal, but somewhat shorter, and bearing two very small terminal divisions, similar to those of the siphonal lobe. Second lateral sinus not larger than the outer division of the first, and merely obscurely divided into two very short, simple, obtusely rounded, terminal subdivisions. Second lateral lobe very small, and obscurely trifid at the end. Whether this last is what is usually called a ventral lobe, or whether there is another still smaller one beyond it, the specimen is scarcely in a condition to show.

To this the writer adds the following observations of the type specimen: Ribs on youngest part of living chamber coarser and more widely spaced toward the aperture; ventral ribs on youngest part of last septate whorl faintly curved back forming a broad sinus on the venter; total number of ventral ribs on exposed whorls about 65, of which 29 are on the living chamber; total number of primary ribs 24, of which 10 are on the living chamber; length, 22.2 mm.; height, 16.1 mm.; width, 8.4 mm.

The writer has at hand 11 adult specimens of *Scaphites larvaeformis* and fragments of several times that number, all from a bed of limestone concretions in the basal part of the Carlile shale of the Black Hills. The adults range uniformly in length from 13 to 26.5 mm., averaging 21.2 mm. The living chambers have 6 to 9 primary ribs, averaging 7.5, and 19 to 40 secondaries, averaging 26.9. Most are coarsely ribbed near the aperture and nearly all display backward bending of the ribs crossing the venter on the younger part of the last septate whorl. The young stages have a smooth subevolute shell for the first three or three and a half whorls. The whorl succeeding the protoconch is wide and depressed. In the next whorl the cross section is much more rounded. Beginning with the third whorl, the ventrolateral margin becomes subangular and is raised into a faint ridge which is broadly undulating, forming poorly defined blunt nodes. On the fourth whorl, at a diameter of between 4.5 and 5 mm., broad weak ribs appear, trending straight across the venter. They are not of uniform strength or spacing for the next one-half whorl, but following that they become very high and uniform. Each pair of ribs unites in a ventrolateral node from which extends a single primary rib. At a diameter of about 6 mm. a few intercalated secondaries appear on the venter. As the whorls enlarge the intercalated ribs increase in abundance, the primaries become stronger, but the ventrolateral nodes are reduced to radially elongate swellings. Four or five whorls comprise the septate part of an adult. Many specimens have a very small swelling on the umbilical shoulder at the base of the straight part of the shell.

Scaphites larvaeformis is characterized by its small size, quadrangular shape with markedly straight living chamber, row of small, pointed ventrolateral tubercles, and apicad bending of the ventral ribs on the younger part of the last septate whorl. In addition, many specimens show a small umbilical swelling and, near the aperture, coarser ribbing than on the older part of the living chamber.

A specimen figured as *S. geinitzi* D'Orbigny by Geinitz (1874, p. 191, pl. 12, fig. 23) resembles *S. larvaeformis* in its form and in the arrangement of ribs and nodes, including the wide spacing of the ribs near the aperture, but apparently differs by possessing a large umbilical swelling. Schlüter (1872, p. 75, pl.

23, figs. 12–22; pl. 27, fig. 5) figured a number of examples of *S. geinitzi*, all differing from *S. larvaeformis* by their larger size, more numerous nodes and primary ribs, and the tendency toward bigger umbilical swellings. A specimen figured by Schlüter (pl. 23, figs. 23–25) as *Scaphites* sp. closely resembles *S. larvaeformis* in its sculpture and wide spacing of the ribs near the aperture, but differs in its more rounded outline and larger size. Yabe's *S. yonekurai* (1910, p. 165, pl. 15, figs. 4–7) shows a backward bending of the ribs over the venter as in *S. larvaeformis*, but the living chamber is much more depressed and does not have the row of nodes. *S. meriani* Pictet and Campiche (1861, p. 16, pl. 44) closely resembles *S. larvaeformis* in shape and general sculptural features including the apicad inclined ribs on the last septate whorl, but differs in the more depressed whorls and denser costation. The specimen figured by Collignon (1928, p. 54, pl. 5, figs. 15, 15a, 15b) as *Scaphites* cf. *S. meriani* and later referred tentatively to *S. hugardianus* D'Orbigny by Spath (1937, p. 503) also shows rursiradiate ribbing on the septate whorl.

Holotype, U.S.N.M. 229; plesiotypes, U.S.N.M. 106743–106745.

The species occurs in limestone concretions in the lowest part of the Carlile shale of the Black Hills, associated with *Collignoniceras woollgari* (Mantell) and *Inoceramus fragilis* Hall and Meek.

Scaphites larvaeformis Meek and Hayden var. obesus Cobban, n. var.

Plate 1, figures 16–22

This variety differs from the typical form in its decidedly stouter shell, greater size, and tendency toward denser costation. Because of the stoutness, the space between the curved part of the living chamber and the septate coil is proportionally smaller than in the typical form. The holotype is 31.5 mm. long, 25.9 mm. high, and 16.2 mm. wide. It has 16 primary and 60 ventral ribs on the exposed whorls, with 8 primaries and 29 secondaries on the living chamber. Thirteen adults from the Black Hills range in length from 21 to 37 mm., averaging 29.8 mm. These have on their living chambers 6 to 10 primary ribs, averaging 8, and 24 to 45 secondaries, averaging 32.2.

Holotype, U.S.N.M. 106767; paratype, U.S.N.M. 106768.

The holotype is from a limestone concretion in the lowest part of the Carlile shale, 5 miles southeast of Hot Springs, Fall River County, S. Dak.

Scaphites patulus Cobban, n. sp.

Plate 1, figures 23–32

This species is closely related to *Scaphites larvaeformis* from which it differs by its more rounded outline, fewer ribs, equal spacing of the ventral ribs on the living chamber, stronger tubercles, and much more depressed cross section of the living chamber. The general sculptural features, including rursiradiate ribbing on the last septate whorl, are similar to those of *S. larvaeformis*. The holotype is 31.5 mm. long, 27.5 mm. high, and 19.5 mm. wide. It has 18 primary ribs and 55 secondaries on the exposed whorls, with 6 or 7 primaries and 27 secondaries on the living chamber. The 10 other adults at hand range in length from 23 to 43 mm. and show 5 to 8 primaries and 21 to 27 secondaries on the living chambers.

The suture is similar to that of *S. larvaeformis*.

Holotype, U.S.N.M. 106769; paratypes, U.S.N.M. 106770, 106771.

The species occurs with *S. larvaeformis*, *Collignoniceras woollgari* (Mantell), and *Inoceramus fragilis* Hall and Meek, in the lowest part of the Carlile shale of the Black Hills. The holotype is from a limestone concretion found two miles southeast of Fairburn, Custer County, S. Dak.

Scaphites praecoquus Cobban, n. sp.

Plate 1, figures 33–36

The holotype of this tiny species is only 10.4 mm. long, 8.2 mm. high, and 4.8 mm. wide. It is quadrangular in side view, and moderately stout. The septate coil is not ribbed, but the subangular ventrolateral margin is undulated into large, blunt nodes. The umbilicus is wider than in most scaphites from the Carlile shale. The living chamber, which comprises most of the specimen, is uniform in size and has a very small umbilical swelling at its base. The straight part is smooth except for a few faint irregularly spaced ventral ribs. A row of small ventrolateral tubercles appears on the curved part, and the ventral ribs become progressively larger toward the aperture, with those on the last half of the whorl relatively coarse. Primary ribs are absent. The aperture is broadly ovate and slightly constricted.

The suture was not seen.

This species could be considered a variant of *Scaphites larvaeformis* that developed an uncoiled living chamber before other adult features were fully developed. The septate coil is comparable to the third inner whorl of *S. larvaeformis*, and the sculpture of the curved part of the living chamber suggests the larger species. However, in the younger Carlile beds, similar tiny adult scaphites occur that are related to contemporary larger species, but are distinctly different from the smallest adult forms of those species. By Niobrara time descendants of the small species are unlike associated species. It seems best to consider *S. praecoquus* as a

split from *S. larvaeformis* and the initial member of a new line of scaphite development.

Holotype, U.S.N.M. 106758.

The holotype is from a limestone concretion near the base of the Carlile shale, in the NE¼ sec. 15, T. 57 N., R. 62 W., Crook County, Wyo.

Scaphites arcadiensis Moreman

Plate 2, figures 1–8

1942. *Scaphites arcadiensis* Moreman, Jour. Paleontology, vol. 16, no. 2, p. 216, pl. 34, fig. 3.

This species is characterized by its small size, simple suture, relatively few but coarse ribs, and living chamber with depressed cross section, with widely spaced ventral ribs on the older part, and with about five primaries raised into strong elongate nodes. The type specimen has 17 primary ribs on the exposed whorls and only 5 on the living chamber, and 48 ventral ribs on the exposed whorls and 18 on the living chamber. It is 26 mm. long and 21 mm. high.

Scaphites arcadiensis is distinguished from *S. patulus* by its fewer ribs, wide spacing of the ventral ribs toward the base of the living chamber, lack of pointed tubercles, and lack of rursiradiate ribbing on the septate coil.

Plesiotypes, U.S.N.M. 106765a-c.

The holotype is from the Arcadia Park formation, 1 mile south of Arcadia Park, Texas. In the Western Interior the species has been collected from the ferruginous concretions in the lower part of the Carlile shale of the northern Black Hills associated with *Scaphites carlilensis* Morrow and *Collignoniceras hyatti* (Stanton).

Scaphites carlilensis Morrow

Plate 2, figures 9–23

1935. *Scaphites carlilensis* Morrow, Jour. Paleontology, vol. 9, no. 6, p. 466, pl. 50, figs. 4a-d.

Shell of average size for the genus, oval in outline, stout, and ornamented by equispaced, straight primary and secondary ribs. Morrow gives the following dimensions and rib counts on the holotype: Length, 55 mm.; width, 27 mm.; total number of ventral ribs on exposed whorls, 58; ventral ribs on living chamber, 27

In the northern Black Hills this species occurs abundantly in ferruginous concretions in the lower part of the Carlile shale above the zone of *Scaphites larvaeformis*. A collection consisting largely of the living chambers of 43 adults from one locality shows a range in height from 27 to 55 mm., averaging 39 mm. The living chambers have 8 to 16 primary ribs, averaging 10.3, and 24 to 38 secondaries, averaging 27.7. These specimens show normal variation for a scaphite species with the larger individuals stouter and more densely costate than the smaller.

The suture is simple and has a broad, shallow first lateral saddle and fairly short bifid lobes.

Plesiotypes, U.S.N.M. 106740, 106741, 106742a-c.

The holotype is from the Blue Hill shale member of the Carlile shale three miles southeast of Tipton, in the SE¼ sec. 4, T. 9 S., R. 10 W., Mitchell County, Kansas, associated with *Collignoniceras hyatti* (Stanton). The species is known also from a widespread ferruginous concretion unit in the lower part of the Carlile shale on the north flank of the Black Hills, on the Cat Creek anticline of central Montana, and on the Sweetgrass arch of north-central Montana.

Scaphites morrowi Jeletzky

1935. *Scaphites pygmaeus* Morrow, Jour. Paleontology, vol. 9, no. 6, p. 465, pl. 50, figs. 2a-e, 3.

1942. *Scaphites pygmaeus* Morrow. Moreman, Jour. Paleontology, vol. 16, no. 2, p. 216, pl. 34, figs. 5, 6.

1949. *Scaphites morrowi* Jeletzky, Jour. Paleontology, vol. 23, no. 3, p. 330.

It is possible that this form is a small, slender variant of *Scaphites carlilensis* Morrow. Regarding a comparison of his species, Morrow (1935, p. 466) states:

> *Scaphites pygmaeus* and *S. carlilensis* are very much alike in many details, the principal difference being in the size. The former is consistently smaller, all specimens being very nearly the size of the figured specimens. Another constant difference is in the number of ribs crossing the venter. *S. carlilensis* having from six to ten more.

A large collection of *S. carlilensis* from the Black Hills shows a fairly uniform gradation in size from specimens as small as Morrow's *S. pygmaeus* to those even larger than his holotype of *S. carlilensis*. The smaller specimens have fewer ribs. However, the Black Hills specimens have uniformly spaced ventral ribs whereas Morrow's *S. pygmaeus* has the ribs more widely spaced on the straight part of the living chamber than on the curved part. The importance and constancy of this feature has not been determined.

Scaphites warreni Meek and Hayden

Plate 3, figures 8–21

1860. *Scaphites warreni* Meek and Hayden, Acad. Nat. Sci. Philadelphia Proc., vol. 12, p. 177.

1876. *Scaphites warreni* Meek and Hayden. Meek, U. S. Geol. Survey Terr. Rept., vol. 9, p. 420, pl. 6, fig. 5.

1876. *Scaphites warreni* Meek and Hayden var. *wyomingensis* Meek, U. S. Geol. Survey Terr. Rept., vol. 9, p. 421, text figs. 61–63.

1877. *Scaphites warreni* Meek and Hayden. White, U. S. Geog. and Geol. Surveys W. 100th Mer. Rept., vol. 4, pt. 1, p. 200 [not pl. 19, fig. 3a].

1893. *Scaphites warreni* Meek and Hayden. Stanton, U. S. Geol. Survey Bull. 106, p. 185, pl. 40, fig. 4 [not figures 5–7].

1898. *Scaphites warreni* Meek and Hayden. Logan, Kansas Univ. Geol. Survey, vol. 4, p. 475, pl. 104, fig. 4 [not figs. 5–7].

1899. *Scaphites warreni* Meek and Hayden. Logan, Field Mus. Nat. History Pub., Geol. ser., vol. 1, no. 6, p. 210 [not pl. 22, fig. 1; pl. 23, fig. 5].
1916. *Holcoscaphites warreni* (Meek and Hayden). Nowak, K.-k. Geol. Reichsanstalt Verh., Jahrg. 1916, no. 3, p. 66.
1927. *Scaphites warreni* Meek and Hayden. Reeside, U. S. Geol. Survey Prof. Paper 150–B, p. 36.

Meek's description (1876, p. 420) is as follows:

Shell small, transversely subovate, moderately compressed; inner volutions nearly circular, closely involute, and composing a comparatively rather large part of the entire bulk; deflected body-portion short and (perhaps accidentally) rather more compressed proportionally than the inner turns; surface costate, and without proper nodes; costae small on the inner volutions, where they do not differ materially in size, but on the body part about every fourth or fifth one becomes more prominent than the others, and extends entirely across from the inner side to and over the periphery, in passing upon which they bifurcate, or give off lateral branches, so that the whole, with some intercalated ones, assume there a uniform size; aperture and septa unknown.

Length, 1.45 inches; height, about 1.22 inches; convexity, about 0.57 inch.

The foregoing description is made out from the original type specimen of *S. warreni*, which is unfortunately not in an entirely satisfactory condition, either as to form or ornamentation, while it shows no traces of the septa.

* * * I should remark that the specimen from which our figure 5, on plate 6 was drawn, seems to have had its body-part accidentally compressed laterally, while its mouth or lip probably does not end where it would seem to in the figure, but may pass under the rock, and curve farther back toward the involuted part. It is also a little doubtful whether the latter has been worked out correctly, the enveloping rock adhering so firmly to the shell, that in cutting it away, the inner part of the whorl is made to appear smooth instead of costate, and it is not quite clear that this part is so broad as represented. The same difficulty of having to cut away the enveloping rock has prevented the bifurcations of the costae, particularly the larger ones, from being clearly seen.

The holotype is from the southern edge of the Black Hills. Associated with it, and preserved in the same hard calcareous siltstone, is the greater part of the living chamber of a small, slender scaphite with ventral ribs more widely spaced on the straight part than on the curved part. The holotype is not sufficiently complete to demonstrate the presence of a similar type of rib-spacing. Scaphites identical with the small specimen occur widespread in the Western Interior at one horizon in the Carlile shale. These grade into specimens as large or larger than the holotype. The larger individuals are stouter and more densely ribbed than the smaller, a condition normal for a scaphite species. The small, slender form is herein set aside as *S. warreni* var. *ubiquitosus*. The abundant material from the Black Hills now at hand permits a more detailed description of the species and its variations.

The form typical of the species is stout, about medium size, subovate in outline, with small umbilicus and living chamber considerably freed from the septate coil. The living chamber increases in size toward the bend, then tapers toward the aperture. Venter on last septate whorl well rounded and, on living chamber, broadly rounded. Living chamber slightly depressed in cross section; venter rounded in side view; umbilical wall nearly straight on older half. Aperture reniform and only very faintly constricted; dorsal lappet broad and slightly extended. Ten adults from one locality in the Black Hills range in length from 29 to 47 mm., averaging 35.2 mm.

The early whorls are broad and depressed. Up to a diameter of 4 or 5 mm. they have a subangular ventrolateral margin which, in some individuals, is raised into a faint ridge as in *Scaphites larvaeformis*. Later whorls are higher and more rounded.

The early whorls are smooth. At a diameter of about 3 mm. faint ribs appear that pass straight across the venter. These increase in height as the whorls enlarge, and at a diameter of about 5 mm., primary ribs appear. The latter are inclined slightly forward on crossing the flank and, at the ventrolateral margin, they swell slightly and then divide into two ribs that trend straight across the venter. Intercalated secondary ribs are rare at first but become more numerous as the whorls enlarge, and on the last septate whorl there are as many as 6 secondaries for each primary rib. The sculpture of the living chamber consists of strong primary ribs and numerous weaker secondary ribs, and all are more closely spaced on the curved part. The primary ribs range from straight to somewhat sigmoid, and extend from the umbilical shoulder half way to the middle of the venter where they split into two or three secondaries. Near the ventral extremity of the primaries, two or three intercalated secondaries appear and pass straight across the venter. In some specimens, particularly those that have a greater than average depression of the living chamber, the ventral extremity of the primary ribs is raised into an incipient elongate node. Rib counts on the living chambers of 13 adults from one locality in the Black Hills show 6 to 13 primaries, averaging 8.4, and 27 to 41 secondaries, averaging 34.2.

The suture is simplified to a pseudoceratitic stage with broad, slightly incised saddles, and short lobes.

Meek (1876, p. 241, text figs. 61–63) gave the name, *S. warreni* var. *wyomingensis*, to a specimen from the Medicine Bow River area of southeastern Wyoming. This specimen has been lost, but Meek's figures suggest an individual of average form and sculpture for the species.

Scaphites warreni resembles *S. arcadiensis* and *S. morrowi* in the wider spacing of the ventral ribs on the straight part of the living chamber than on the curved part, but it is easily distinguished by its weaker and

more numerous ribs and the more simplified suture. Frech's *S. warreni* var. *silesiaca* (1915, p. 557, figs. 3a, 3b) is much more densely costate, shows uniform rib spacing, and has an umbilical swelling; it should be regarded as a distinct species.

Holotype, U.S.N.M. 225; plesiotypes, U.S.N.M. 106746–106750.

This species occurs in the lower third of the Turner sandy member of the Carlile shale of the Black Hills associated with *Inoceramus dimidius* White and *Prionocyclus macombi* Meek. It is especially abundant in the Mancos shale of the San Juan Basin of northwestern New Mexico and southwestern Colorado.

Scaphites warreni Meek and Hayden var. ubiquitosus Cobban, n. var.

Plate 3, figures 26, 27; plate 4, figures 1–15

1877. *Scaphites warreni* Meek and Hayden. White, U. S. Geog. and Geol. Surveys W. 100th Mer. vol. 4, pt. 1, pl. 19, fig. 3a.

The small size and slender shell characterize this variety. The holotype is 24 mm. long, 18.7 mm. high, and 10.5 mm. wide. There are 21 primary ribs and 64 secondaries on the exposed whorls, with 7 primaries and 33 secondaries on the living chamber. The collection from the Mancos shale of New Mexico from which the holotype was selected consists of 12 adults ranging in length from 20 to 31 mm., averaging 25.8 mm., and having on their living chambers 5 to 9 primary ribs, averaging 7.4, and 27 to 44 secondaries, averaging 35. A collection of 26 individuals from one locality in the Black Hills shows a similar range in size and number of primaries, but the ventral ribs on the living chamber average only 32.2.

Holotype, U.S.N.M. 106751; paratypes, U.S.N.M. 106752–106754.

The types are from a thin sandstone in the Mancos shale about 150 feet below the base of the Tocito sandstone lentil.

Scaphites warreni Meek and Hayden var. haydeni Cobban, n. var.

Plate 3, figures 22–25

Relatively few but exceptionally strong primary ribs characterize this variety. The holotype is of about average size and stoutness for the typical form of the species. It is 38.8 mm. long, 33 mm. high, and 21.7 mm. wide. It shows 13 primary ribs and 64 secondaries on the exposed whorls, with 4 primaries and 30 secondaries on the living chamber.

The suture is simplified to a pseudoceratitic stage.

Holotype, U.S.N.M. 106761.

The type was collected by F. V. Hayden from the Medicine Bow River area in the Laramie Basin, southeastern Wyoming. This is a rare form that is known elsewhere only from central Wyoming, the Black Hills, and the San Juan Basin of northwestern New Mexico.

Scaphites veterinovus Cobban, n. sp.

Plate 3, figures 1–7

Adults of this tiny species are only 10 to 15 mm. in length. The holotype is 11.5 mm. long, 10 mm. high, and 6 mm. wide. The coiled part has a fairly wide umbilicus, rounded umbilical shoulder, narrow and slightly flattened flanks, subangular ventrolateral margin raised into a ridge, and well rounded venter. The older half of the living chamber is markedly straight, and shows broadly rounded flanks grading evenly into the rounded venter. The aperture has a small dorsal lappet and incipient lateral lappets.

Whorls less than 5 mm. in diameter are smooth. From that diameter to the base of the living chamber, the sculpture consists of straight ventral ribs. The living chamber is crossed by 30 to 45 evenly spaced ventral ribs that die out on the flanks. The holotype has about 7 faint primary ribs on the living chamber, but many specimens show none.

The suture is very simple.

In size and ornamentation this species resembles *Scaphites minutus* Moreman (1942, p. 216, pl. 34, figs. 9, 10) from the Britton formation of Texas, but that species has a wider umbilicus and is more densely ribbed.

Holotype, U.S.N.M. 106763; paratype, U.S.N.M. 106764.

This species is known only from the *S. warreni* zone in the lower part of the Turner sandy member of the Carlile shale of the Black Hills. The types are from calcareous concretions 14.5 feet above the chert pebble-shark tooth conglomerate in the Turner, five miles north of Belle Fourche, in the SW¼SE¼SW¼ sec. 11, T. 9 N., R. 2 E., Butte County, South Dakota.

Scaphites ferronensis Cobban, n. sp.

Plate 4, figures 16–29

This species is closely related to *Scaphites warreni* Meek and Hayden. In size and suture these species are almost identical, and the rib arrangement is similar in that the curved part of the living chamber has more closely spaced ribs that the straight part. However, there are important differences. The ventral ribs on the living chamber of *S. ferronensis* are much more dense than those of *S. warreni*, but the primaries are fewer. On internal molds the ribbing on the curved part of the living chamber is weak, and on many specimens, this part of the shell is smooth. The smaller and more slender individuals are commonly more nearly quadrangular in outline than similar-sized specimens of *S. warreni* var. *ubiquitosus*.

S. ferronensis is based largely on a collection (U.S.G.S. Mes. loc 12583) of 19 adults from the Ferron sandstone member of the Mancos shale near Emery, Utah. These range in length from 25 to 39.5 mm., averaging 33.1 mm., and in height from 19 to 35.5 mm. averaging 24.6 mm. The ventral ribs on the exposed whorls number 86 to 99, and the primaries 13 to 25. The living chambers have 35 to 56 ventral ribs, averaging 46, and 4 to 7 primaries, averaging 5.1. The holotype is 26 mm. long, 24 mm. high, and 13.6 mm. wide. It has 92 ventral ribs and 18 primaries, with 47 secondaries and 5 primaries on the living chamber.

Holotypes, U.S.N.M. 106759; paratypes, U.S.N.M. 106760a-b.

The holotype is from the Ferron sandstone member near Emery, Utah. The species also occurs in the Mancos shale 275 feet below the top on the west side of the Cebolleta Mesa, Valencia County, central western New Mexico; in the top of the Frontier sandstone member of the Mancos shale of northwestern Colorado and northeastern Utah; and in the top of the Frontier formation of the Laramie Basin, southeastern Wyoming.

Scaphites whitfieldi Cobban, n. sp.

Plate 4, figures 30–40; plate 5, figures 1–4

1880. *Scaphites warreni* Meek and Hayden. Whitfield, U. S. Geog. and Geol. Survey Rocky Mtn. Region Rept. on Black Hills, p. 444, pl. 13, figs. 1–4.
1880. *Scaphites wyomingensis* Meek. Whitfield, U. S. Geog. and Geol. Survey Rocky Mtn. Region Rept. on Black Hills, p. 446, pl. 13, figs. 5–7.
1893. *Scaphites warreni* Meek and Hayden. Stanton, U. S. Geol. Survey Bull. 106, pl. 40, figs. 5–7.
1898. *Scaphites warreni* Meek and Hayden. Logan, Kansas Univ. Geol. Survey, vol. 4, pl. 104, figs. 5–7.
1899. *Scaphites warreni* Meek and Hayden. Logan, Field Mus. Nat. History Pub., Geol. ser., vol. 1, no. 6, pl. 23, fig. 5.
1910. *Scaphites warreni* Meek and Hayden. Grabau and Shimer, North American index fossils, p. 176, fig. 1427a, b.
1915. *Scaphites warreni* Meek [and Hayden]. Frech, Centralbl. Mineralogie, Jahrg. 1915, no. 21, p. 557, figs. 4a, 4b.
1944. *Scaphites warreni* Meek and Hayden. Shimer and Shrock, Index fossils of North America, p. 591, pl. 244, fig. 6.

Adult shell of average size for the genus, quadrangular in outline, and slender to moderately stout. Sculpture consists of dense, evenly spaced ribs.

The cross section of the whorl succeeding the protoconch is wide and depressed. The second whorl is much higher and more rounded, and the next two are almost circular or, in many individuals, distinctly compressed with slightly flattened flanks. The umbilicus is wide in the first whorl and narrow in the rest. Up to a diameter of 4 mm. the ventrolateral margin is subangular and raised into a faint ridge. Between whorl diameters of 4 and 6 mm. this ridge becomes fainter, gradually disappearing. The living chamber, which begins after the fifth whorl succeeding the protoconch, is of nearly uniform size, with only a very small and gradual expansion toward the aperture. The umbilical area of the living chamber is broad and gently sloping on the straight part but is steeply inclined on the curved part. The aperture is reniform, slightly constricted, and has a small dorsal lappet. A collection of 12 adults from the type locality on the north flank of the Black Hills shows lengths ranging from 28 to 47 mm., averaging 37.2 mm., although fragments of larger individuals are known (pl. 5, fig. 1). The holotype is 35 mm. long, 28 mm. high, and 13.5 mm. wide.

The inner whorls are smooth to a diameter of 4.5 mm., where ventral ribs appear. Primary ribs appear between diameters of 7 and 8 mm. On the first half of the last septate whorl the primaries trend straight from the umbilicus to a point a third of the distance to the middle of the venter. There they split into two ribs, with one or two intercalated secondaries. On the last half of the septate whorl and on the living chamber, the primaries are decidedly sigmoidal and strongly inclined forward. Each primary splits into 2 or 3 secondaries, and each group of secondaries is separated by 2 to 6 intercalaries. The ribs are equally strong and evenly spaced as they cross the venter. The holotype has 24 primary ribs and 115 secondary ribs on the exposed whorls, with 8 primaries and 63 secondaries on the living chamber. As many as 133 secondary ribs are visible on an adult shell. Twelve specimens from the type locality have living chambers with 6 to 9 primaries, averaging 7.6, and 37 to 75 secondaries, averaging 52.

The suture is simple and resembles that of *Scaphites warreni*, but the elements tend to be more elongate.

Scaphites whitfieldi is easily distinguished by its slender, quadrangular shape and the dense, evenly spaced ribbing. Some specimens of *S. ferronensis* are as quadrangular and densely costate as *S. whitfieldi* but differ by their unequal spacing of ribs on the venter of the living chamber. The form described by Frech (1915, p. 557, figs. 3a, b) as *S. warreni* var. *silesiaca* has ribbing comparable to that of *S. whitfieldi* but is oval in shape and has an umbilical swelling.

The species is named for R. P. Whitfield.

Holotype, U.S.N.M. 106735; paratypes, U.S.N.M. 12258a, 106736, 106737, 106738a–b.

The types are from calcareous and ferruginous concretions in the Turner sandy member, 251 to 264 feet above the base of the Carlile shale, six miles north of Belle Fourche, in the N½ sec. 10, T. 9 N., R. 2 E., Butte County, South Dakota, associated with *Inoceramus perplexus* Whitfield and *Prionocyclus wyomingensis* Meek. The species has been collected from many localities

around the Black Hills in the middle third of the Turner sandy member of the Carlile shale. It is known also from the Carlile member of the Cody shale in the Crow Indian Reservation in south-central Montana, from the top of the Frontier formation of the Laramie Basin of southeastern Wyoming, and from the Mancos shale at many localities in Colorado, Utah, and New Mexico.

Scaphites pisinnus Cobban, n. sp.

Plate 5, figures 5–8

Adult shell tiny, oval in outline, with relatively large living chamber and small septate coil. The latter has a fairly wide umbilicus, narrow flanks, subangular ventrolateral margin raised into a faint ridge, and well-rounded venter. The living chamber increases uniformly in size to the aperture. The venter and dorsum are almost evenly curved in side view. The flanks and venter are well rounded. The aperture is incomplete, but weakly developed lateral lappets are indicated. The holotype is 8.6 mm. long, 7 mm. high, and 4 mm. wide.

The septate coil is smooth. The sculpture of the living chamber consists of about 25 equispaced ventral ribs that are arched slightly forward. About 6 primary ribs are present but scarcely discernible.

The suture is one of the simplest known for any of the adult scaphites of the Colorado group. The ventral lobe is as broad as high, with a wide siphonal saddle. The first lateral saddle is broader than the ventral lobe and asymmetrically bifid. The first lateral lobe is bifid and half as large as the ventral lobe. The second lateral saddle is bifid and as wide as the first lateral lobe. The second lateral lobe is very small and undivided. The third lateral saddle is bifid and a little larger than the second lateral saddle. The internal suture was not seen.

This species differs from *Scaphites veterinovus* in its oval outline, smooth septate coil, fewer ribs on the living chamber, and larger incipient lateral lappets.

Holotype, U.S.N.M. 106762.

The species occurs with *S. whitfieldi* in the middle part of the Turner sandy member of the Carlile shale of the northern Black Hills. The holotype is from a bed of ferruginous concretions 251 to 264 feet above the base of the Carlile shale, six miles north of Belle Fourche, in the N½ sec. 10, T. 9 N., R. 2 E., Butte County, S. Dak.

Scaphites nigricollensis Cobban, n. sp.

Plate 6, figures 1–17; plate 7, figures 1–5

Shell elliptical in outline, moderately stout, with small umbilicus, and living chamber considerably freed from the septate coil and commonly laterally inflated at its base. The internal whorls are circular to slightly wider than high in cross section; the last whorl is usually laterally compressed. The umbilicus is wide only up to a diameter of 4 or 5 mm. The living chamber is almost uniform in size, and has slightly flattened flanks and well-rounded venter. The aperture is faintly constricted, about as high as wide, and has small dorsal lappet. Adults are slightly larger than average for the genus. Seventeen specimens from the type locality in the Black Hills range in length from 37 to 63 mm., averaging 51.6 mm. The holotype is 54 mm. long, 43 mm. high, and 21 mm. wide.

The first three and a half whorls are smooth. Weak ventral ribs first appear at a diameter of 5 mm. Primary ribs appear at a diameter of about 10 mm. On the last septate whorl about two secondary ribs are present to each primary, whereas on the living chamber the ratio of secondaries to primaries is about four to one. The ribs are fairly straight and, on the venter, evenly spaced. On internal molds the ribbing is weak on the older half of the living chamber, and on many individuals the venters are smooth (pl. 6, figs. 9, 11). The secondaries extend well down between the primaries. The holotype has 30 primaries and 111 secondaries on the exposed whorls, with 14 primaries and 52 secondaries on the living chamber. Rib counts on the living chambers of 18 adults from the type locality show 9 to 15 primaries, averaging 11.4, and 38 to 58 secondaries, averaging 49.

The suture, although fairly simple, is slightly more complex than that of *Scaphites whitfieldi*.

The diagnostic features of *S. nigricollensis* are the swelling at the base of the living chamber, numerous primary and secondary ribs, and the tendency toward loss of ribbing on the older half of the living chamber of internal casts. This loss of ribbing is similar to that of *S. ferronensis*, but *S. nigricollensis* differs in its larger size, uniform spacing of ventral ribs, and the greater number of primary ribs. Of European species *S. nigricollensis* is nearest to the form described by Frech (1915, p. 557, figs. 3a, 3b) as *S. warreni* var. *silesiaca* from the upper Turonian.

Holotype, U.S.N.M. 106730; paratypes, U.S.N.M. 106731a-d, 106732.

The types are from calcareous concretions 59 feet below the top of the Turner sandy member (and 294 feet above the base of the Carlile shale), six miles north of Belle Fourche, in the NE¼NE¼NW¼ sec. 10, T. 9 N., R. 2 E., Butte County, S. Dak. Outside the Black Hills region, the species occurs in the Carlile member of the Cody shale in the Crow Indian Reservation of south-central Montana, and in the Colorado shale about 650 to 750 feet below the top in north-central Montana.

Scaphites nigricollensis Cobban var. meeki Cobban, n. var.

Plate 5, figures 9–26

This variety is smaller and more slender than the typical form and the living chamber is proportionally more extended. The ribs, which are fewer and stronger, are retained on all internal molds of living chambers. The flanks of the living chamber are more rounded, and no specimen has a lateral swelling at the base. The abundant specimens show intergradation with the typical form.

The holotype is 31 mm. long, 24.5 mm. high, and 12.3 mm. wide. It has 25 primary ribs and 71 secondaries on the exposed whorls, with 10 primaries and 36 secondaries on the living chamber. Thirty-two adults from the type locality range in length from 26 to 50 mm., averaging 34.4 mm., and have on their living chambers 7 to 14 primary ribs, averaging 10, and 29 to 50 secondaries, averaging 40.

The suture has narrower lobes than those of the typical form.

This variety resembles *Scaphites whitfieldi* in size, suture, and general sculpture, but differs in its oval shape, coarser ribbing, and living chamber with fewer ventral ribs and more primary ribs.

Holotype, U.S.N.M. 106733; paratypes, U.S.N.M. 106734a-d.

The types are from calcareous concretions 59 feet below the top of the Turner sandy member (and 294 feet above the base of the Carlile shale), six miles north of Belle Fourche, in the NE¼NE¼NW¼ sec. 10, T. 9 N., R. 2 E., Butte County, S. Dak.

Scaphites corvensis Cobban, n. sp.

Plate 7, figures 6–10

This species is characterized by its moderately large size, stout form, slightly inflated living chamber, and suture with narrow lobes. It was derived from *Scaphites nigricollensis* and differs from that species in its slightly larger size, more rounded flanks, retention of the ventral ribbing on internal molds of living chambers, and in its more deeply incised suture with narrower elements. In contrast to the lateral swelling at the base of the living chamber of *S. nigricollensis*, the entire living chamber of *S. corvensis* is swollen.

The holotype is 63.5 mm. long, 53.5 mm. high, and 27 mm. wide. It has 28 primary ribs and 92 evenly spaced ventral ribs on the exposed whorls, with 15 primaries and 52 secondaries on the living chamber.

Holotype, U.S.N.M. 106755.

The holotype is from a calcareous concretion 180 feet above the base of the Carlile shale member of the Cody shale, 33 miles south of Hardin, on the Crow Indian Reservation, in the E½NW¼SW¼ sec. 36, T. 6 S., R. 32 E., Big Horn County, Mont. The species is known also from the Sage Breaks member and the uppermost part of the Turner sandy member of the Carlile shale of the Black Hills.

Scaphites corvensis Cobban var. bighornensis Cobban, n. var.

Plate 7, figures 11–17

This variety differs from the typical form in its smaller size, more slender whorls, more depressed cross section of living chamber, and stronger sculpture with fewer ribs. The internal whorls have not been seen, but the outer whorls are well rounded in cross section and have a relatively wide and deep umbilicus. The living chamber is long, almost uniform in size, and considerably extended beyond the septate coil. The flanks and venter are rounded and intergrade evenly. The aperture is almost as high as wide, with small dorsal lappet. The holotype is 44.5 mm. long, 36.5 mm. high, and 20 mm. wide.

The sculpture on the coiled part of the holotype consists of 14 primary ribs that pass straight out from the umbilicus and commonly cross the venter without forking. Well out on the flank these ribs are separated by one or two secondaries. The sculpture on the living chamber of the holotype consists of 10 primary ribs and 33 ventral ribs. The primaries are arched forward. A third of the way out from the umbilicus to the middle of the venter they become higher and branch into two or three high sharp ribs that cross the venter with a slight forward swing.

This variety is distinguished from *Scaphites nigricollensis* var. *meeki* by its stronger sculpture with fewer ribs and its more incised suture with narrower lobes.

Holotype, U.S.N.M. 106756.

The holotype is from a calcareous concretion 180 feet above the base of the Carlile shale member of the Cody shale, 33 miles south of Hardin, in the E½NW¼ SW¼ sec. 36, T. 6 S., R. 32 E., Big Horn County, Mont. The variety is known also from the Sage Breaks member and the uppermost part of the Turner sandy member of the Carlile shale of the Black Hills.

Scaphites preventricosus Cobban, n. sp.

Plate 9, figures 1–16

Adult shell, large, stout, oval in outline, and ornamented by fairly straight primary and secondary ribs that are uniformly spaced on the living chamber. Although most of the living chamber is freed from the septate coil, it is curved so that very little space exists between the aperture and the septate coil.

The first whorl succeeding the protoconch is wide and depressed in cross section. The second whorl is much higher proportionally than the first, and the third whorl is almost circular. Later whorls are broader than high with depressed cross sections.

About six whorls make up the coiled part. The umbilicus is wide in the early whorls and narrow in the later. The living chamber is stout, with rounded venter and broadly rounded to slightly flattened flanks. The venter of the living chamber is curved in side view, whereas the umbilical shoulder of the older part is straight. The living chamber is almost uniform in size from its base to a point a short distance beyond the place where the umbilical shoulder begins to curve, and there it becomes depressed in cross section and gradually tapers to the aperture. The aperture is slightly constricted, a little wider than high, and with small dorsal lappet. The adult shell is larger than average for the genus. The holotype is 75 mm. long, 68 mm. high, and 39.5 mm. wide. Eleven adults from Montana and Wyoming sufficiently complete for measurement range in length from 68 to 77 mm., averaging 74 mm.

The coiled part is smooth up to a diameter of 3 mm. where faint ventral ribs appear. These quickly increase in strength and become coarse about a quarter of a whorl beyond the point of first appearance. At a diameter of 8 mm. there are about 25 of these ribs per whorl. Primary ribs appear at this diameter. They are inclined backward on crossing the umbilical wall, but on reaching the umbilical shoulder, bend forward and cross the flank with a forward inclination. The ventral ribs have a lesser forward inclination. All ribs are less curved on the younger whorls, and on the last septate whorl, they pass almost straight out from the umbilicus. The early whorls have about two secondary ribs to each primary rib, whereas the last septate whorl has 3 or 4 secondaries to each primary. The sculpture on the living chambers of ten adults consists of 36 to 49 secondaries and 6 to 15 primaries. These ribs are straight or slightly flexuous, and are evenly spaced on the venter. The holotype has 90 secondaries and 23 primaries on the exposed whorls, with 45 secondaries and 10 primaries on the living chamber.

The suture is complex and has bifid lobes. The first lateral lobe is commonly asymmetric with the dorsal branches larger than the ventral.

This species is easily distinguished from older scaphites by its larger size and more complex suture. Of the younger scaphites, *Scaphites preventricosus* is most closely related to *S. ventricosus* Meek and Hayden (Meek and Hayden 1862, p. 22), from which it can be distinguished by its smaller size, more extended living chamber, denser costation, and uniformly spaced ventral ribs.

Holotype, U.S.N.M. 106675; paratypes, U.S.N.M. 106676 a-d, 106679.

The holotype is from a bed of calcareous concretions in the Colorado shale, 514 to 525 feet below the top, in the north bank of the Marias River, 5.5 miles south of Shelby, in the NE¼ sec. 20, T. 31 N., R. 2 W., Toole County, Mont. The species is known also from many other localities in central, north-central, and northwestern Montana, in the Colorado shale 400 to 580 feet below the top. In central and western Wyoming it occurs in the upper part of the Frontier formation.

Scaphites preventricosus Cobban var. sweetgrassensis Cobban n. var.

Plate 10, figures 18-25

This variety differs from the typical form of the species in its smaller size, more slender form, and more extended living chamber. The holotype is 60 mm. long, 52 mm. high, and 28.5 mm. wide. It has 109 secondaries and 28 primaries on the exposed whorls, with 50 secondaries and 11 primaries on the living chamber. Nine adults from the type locality range in length from 51 to 67 mm., averaging 59.7 mm., and have 34 to 58 secondaries on the living chambers.

This variety can be readily distinguished from all earlier scaphites by its larger size and more complex suture. It can be differentiated from the slender variants of later species by the more extended living chamber.

Holotype, U.S.N.M. 106677; paratype, U.S.N.M. 106678.

It occurs with the typical form of the species in Montana and Wyoming. The holotype is from a bed of calcareous concretions 514 to 525 feet below the top of the Colorado shale, in the north bank of the Marias River, 5.5 miles south of Shelby, in the NE¼ sec. 20, T. 31 N., R. 2 W., Toole County, Mont.

Scaphites preventricosus Cobban var. artilobus Cobban, n. var.

Plate 8, figures 1–6

This variety is based on a small collection from one locality in north-central Montana. It differs from the typical form of the species by its compressed form, flexuous ribbing, and suture with narrow lobes. The living chamber is fairly short, almost uniform in size, and considerably extended beyond the septate coil. The venter is rounded and the flanks are flattened on both the living chamber and the septate coil. The type specimen is 60 mm. long, 50 mm. high, and 24 mm. wide.

The sculpture consists of numerous thin, flexuous primary and secondary ribs, with more than 100 visible on the adult. The holotype has 23 primaries and 63 secondaries on the septate coil, and 16 primaries and 49 secondaries on the living chamber.

The suture is characterized by narrow lobes. The siphonal lobe is as high as wide, with long, slender branches and narrow saddles. The first lateral saddle

is very broad and divided asymmetrically by a long, narrow bifid lobe, and the saddles are dissected by long, narrow lobes. The first lateral lobe is bifid and a little smaller than the siphonal lobe. The second lateral saddle is bifid and as large as the first lateral lobe. The second lateral lobe is small, bifid, and with very narrow stem and branches. Remaining elements are small and show narrow lobes.

This variety differs from *Scaphites preventricosus* var. *sweetgrassensis* by its compressed form and suture with narrower lobes. It is known only from the base of the *S. preventricosus* zone whereas the var. *sweetgrassensis* ranges throughout the zone. The narrow-lobed suture is much like that of *S. corvensis* and *S. c. bighornensis*, but is more incised.

Holotype, U.S.N.M. 106680.

Known only from the Colorado shale 617 to 634 feet below the top, on the north bank of the Marias River, 5.5 miles south of Shelby, in the NE¼ sec. 20, T. 31 N., R. 2 W., Toole County, Mont.

Scaphites mariasensis Cobban, n. sp.

Plate 8, figures 14–17

Shell large and stout with living chamber but slightly extended beyond the septate coil. Umbilicus of average size. Umbilical wall of older half of living chamber straight for half its length and then directed outward almost at right angles. The holotype is 75.0 mm. long, 67.5 mm. high, and 41.0 mm. wide.

The sculpture consists of numerous high, sharp ribs, the holotype showing 28 primaries and 81 ventral ribs on the exposed whorls, with 15 primaries and 49 ventral ribs on the living chamber. The ventral ribs on the living chamber are equispaced and extend well down on the flanks between the primaries.

The suture is relatively simple in comparison with that of the associated species, *Scaphites preventricosus*. The short, wide first lateral lobe has a broad supporting stem.

This species closely resembles *S. preventricocsus* in size, shape, and stoutness. The sculpture of *S. mariasensis*, however, is much stronger and the primaries are more numerous.

Holotype, U.S.N.M. 106681.

The species is known only from the Colorado shale, 620 to 636 feet below the top, on the north bank of the Marias River, 5.5 miles south of Shelby, in the NE¼ sec. 20, T. 31 N., R. 2 W., Toole County, Mont.

Scaphites mariasensis Cobban var. gracillistriatus Cobban, n. var.

Plate 8, figures 7–13

The holotype is an internal mold that does not preserve the inner whorls. The shell is oval in outline, slender, and of average size. It is 46 mm. long, 36 mm. high, and 19 mm. wide. The septate part is crushed and incomplete. The living chamber is large in proportion to the rest of the shell and considerably extended beyond the septate coil. It is nearly uniform in size and has slightly flattened flanks and rounded venter. The aperture is about as high as wide and has a very small dorsal lappet.

The septate coil is densely costate with thin, flexuous ribs. The sculpture on the living chamber consists of 54 ventral ribs and 17 primary ribs, all narrow and sharp. The primaries are markedly flexuous, and turn sharply forward on crossing the flanks. The secondaries begin well down on the flanks.

The suture is simple, with lobes and saddles progressively decreasing in size away from the venter.

Holotype, U.S.N.M. 106682; paratype, U.S.N.M. 106683.

The holotype is from the Colorado shale 620 to 636 feet below the top, on the north bank of the Marias River, 5.5 miles south of Shelby, in the NE¼ sec. 20, T. 31 N., R. 2 W., Toole County, Mont.

Scaphites impendicostatus Cobban, n. sp.

Plate 11, figures 1–14

This species is characterized by its stout form, conspicuous umbilical swelling, aperture with outward-turned ventral margin, and peculiar ribs that are either flat-crested or curved back.

The first whorl succeeding the protoconch is broad and depressed in cross section. The subsequent whorls are proportionately higher, but all are broader than high. The umbilicus is wide in the early whorls and narrow in the later. The venter of the living chamber is broadly rounded and grades evenly into the flattened flanks. There is a prominent umbilical swelling at the base of the living chamber. The aperture is wider than high, slightly constricted, and has a normal dorsal lappet. The ventral margin of the aperture, however, shows an unusual feature. It is extended slightly and bent away from the rest of the shell, and, in the holotype, there is some thickening of the shell here (pl. 11, fig. 8). The adult shell is stout, quadrangular in outline, and of about average size for the genus. The holotype is 50 mm. long, 42 mm. high, and 27 mm. wide. Other specimens range in length from 37 to 55 mm.

Ventral ribs first appear at a diameter between 3 and 4 mm., and primary ribs appear at a diameter of about 6 mm. These ribs are curved and spaced like the early ribs of *Scaphites preventricosus*. The ribs on the last septate whorl and on the straight part of the living chamber assume a form unique among the scaphites of Colorado age. As shown on plate 11, figure 7, each

rib is strongly flattened on the distal end and produced into a flange on the aboral side. In contrast the ribs on the curved part of the living chamber are sharp and curved backwards. On the holotype the primaries on the coiled part are flat as they leave the umbilicus, and at a point a quarter of the way to the middle of the venter, they are twisted so that one of the edges becomes nearly or quite vertical. The ribs abruptly flatten again and remain so on crossing the venter where they are separated by one or two flat secondaries. On the living chamber the primaries bifurcate about a quarter of the distance from the umbilicus to the middle of the venter. The ribs of the adult shell are slightly flexuous. They are of equal strength and spacing on the venter. There are 93 secondary ribs and 29 primary ribs visible on the holotype. The living chamber has 59 secondaries and 17 primaries.

The suture is simple. The siphonal lobe is longer than wide, with a high saddle. The first lateral saddle is asymmetrically bifid and broader than the siphonal lobe. The first lateral lobe is bifid and as wide as the siphonal lobe, but only half as long. The second lateral saddle is bifid and about half as large as the first lateral saddle. The second lateral lobe is small and trifid. The third lateral saddle is bifid and slightly smaller than the second lateral saddle. The third lateral lobe is very small and bifid or trifid. The internal suture was not seen.

This species is easily distinguished from other scaphites by its form and sculpture. In size, umbilical swelling, and density of ribs it somewhat resembles the European Turonian forms figured by Leonard (1897, p. 61, pl. 6, figs. 7, 8a–b) as *Scaphites lamberti* Grossouvre and later referred by Frech (1915, p. 557) to his *S. warreni* var. *silesiaca*. *Scaphites impendicostatus* differs, however, in its flat ribs, stout form, and marked quadrangular shape. Several scaphite species have umbilical swellings and outward bending of the ventral margin of the aperture, and thus resemble *S. impendicostatus*, but all are much smaller and lack the flattened ribs. Typical examples of these scaphites are *S. condoni* Anderson (1902, p. 111, pl. 2, figs. 58–63) from the Cretaceous of Oregon, and the following species from the Coniacian of Japan: *S.? pseudoaequalis* Yabe (1910, p. 163, pl. 15, figs. 1–3), *S.? yonekurai* Yabe (1910, p. 165, pl. 15, figs. 4–7), *Yezoites planus* Yabe (1910, p. 167, pl. 15, figs. 12–15), and *Yezoites ainuanus* Shimizu (Yabe, pl. 15, fig. 16).

Holotype, U.S.N.M. 106686; paratypes, U.S.N.M. 106687–106689.

The holotype is from a calcareous concretion in the Colorado shale 195 feet above the top of a calcareous shale of Greenhorn age, 1.5 miles north of Fort Shaw, in the SE¼ sec. 35, T. 21 N., R. 2 W., Cascade County, Mont. The species is moderately abundant in the Colorado shale 500 to 550 feet below the top, on the Sweetgrass arch of north-central Montana, associated with *Scaphites preventricosus*. It occurs also in the upper part of the Frontier formation of the Wind River and Laramie basins of Wyoming, and in the Mancos shale of central Utah.

Scaphites impendicostatus Cobban var. erucoides Cobban, n. var.

Plate 11, figures 15–28

This variety departs considerably from the typical form of the species. It is smaller, more slender, lacks an umbilical swelling and upturned ventral apertural margin, and has fewer ribs.

The adult shell is small, ranging in length from 20 to 42 mm. The holotype is 35.5 mm. long, 30 mm. high, and 18.5 mm. wide. The shell is stout, quadrangular in side view, and with umbilicus of normal size. The living chamber is long, stout, uniform in size, and with the older half straight.

The sculpture consists of numerous high sharp primary and secondary ribs. On the living chamber the ribs are exceptionally high and the crest of each rib tends to be curved slightly back. Some large individuals have flattened ribs. The holotype has 86 ventral ribs and 33 primary ribs on the exposed whorls, of which 41 secondaries and 16 primaries are on the living chamber.

The suture is that of the species.

Holotype, U.S.N.M. 106690; paratypes, U.S.N.M. 106691, 106692 a–b.

The holotype is from the top of the Frontier formation at Sage Creek, in sec. 18, T. 1 S., R. 1 E., Fremont County, Wyo.

Scaphites uintensis Cobban, n. sp.

Plate 10, figures 5, 6

The collection from which the type was selected consists of crushed specimens in shale. The holotype is an impression in the shale, and an artificial cast of it is figured.

The shell is small subovate in outline, and with narrow umbilicus. The older half of the living chamber is straight. The holotype is 26 mm. long and 20 mm. high.

The sculpture of the coiled part consists of numerous fairly straight primary ribs each forking at the mid-flank into two secondaries. On the living chamber the primaries consists of about 10 or 11 straight ribs which begin as prominent elongate swellings on the umbilical shoulder and terminate in a row of tubercles on the ventrolateral margin. Numerous fine ribs cross the venter of the straight part, whereas coarse distantly spaced ribs occur on the venter and flank of the curved

part. The ratio of secondaries to primaries on the straight part is about six to one.

The suture is rather simple.

This species closely resembles *Scaphites delicatulus* var. *greenhornensis* in size, shape, and ornamentation, but can be distinguished by the incipient umbilical nodes and the higher ratio of secondary to primary ribs on the living chamber.

Holotype, U.S.N.M. 106702; paratype, U.S.N.M. 106703.

The species is known only from the Mancos shale 172 to 192 feet above the top of the Frontier sandstone member, on the south flank of the Uinta Mountains, 9.5 miles northeast of Vernal, in the W½ sec. 11, T. 3. S., R. 21 E., Uintah County, Utah.

Scaphites frontierensis Cobban, n. sp.

Plate 10, figures 1–4

This species is based on a small, somewhat distorted specimen. The septate coil is normal and very densely ribbed. The living chamber is straight for half its length and largely freed from the septate coil. The sculpture on the venter of the living chamber consists of fine, closely spaced ribs on the straight part and coarse, widely spaced ribs on the curved part. Along the ventrolateral margin are six round nodes, largest on the curved part. Several subequal nodes are evenly spaced along the umbilical margin of the straight part. Obscure ribs connect these with the ventrolateral tubercles, but otherwise the flanks are smooth.

The suture is not discernible.

This species is close to *Scaphites uintensis* but it has fewer tubercles, and they are strongest on the curved part of the living chamber, whereas, in *S. uintensis*, the ventrolateral nodes are weakest on the curved part.

Holotype, U.S.N.M. 106704.

The holotype is from a sandstone bed in the Frontier formation 180 feet below the top, on Bacon Creek, in the NE¼NE¼ sec. 22, T. 41 N., R. 111 W., Teton County, Wyo.

Scaphites sagensis Cobban, n. sp.

Plate 10, figures 7–10

Shell of average size and shape for the genus with the living chamber largely freed from the septate coil. The holotype, a distorted specimen, is 33± mm. long, 27± mm. high, and 23± mm. wide.

The sculpture of the septate coil consists of relatively few, coarse, straight primary and secondary ribs. The living chamber likewise has relatively few ribs; there are only 6 primaries and 30 secondaries on the holotype. The ventral ribs are equispaced on both the straight and curved parts. Six ventrolateral tubercles are present on the living chamber of the holotype. The primary ribs are straight and rise into high, elongate nodes about in the middle of the flank on the older part of the living chamber.

The suture has not been seen.

The ventrolateral tubercles and elongate flank nodes ally this species to *Scaphites uintensis* and *S. frontierensis*, but it has fewer and more uniformly spaced ventral ribs.

Holotype, U.S.N.M. 106696; paratype, U.S.N.M. 106697.

This species is known only from the upper part of the Frontier formation of the Wind River Basin, Wyo. The holotype is from a sandstone concretion in the upper part of the Frontier formation 1.3 miles north of Sage Creek, in the SE¼ sec. 30, T. 2 N., R. 1. W., Fremont County, Wyo.

Scaphites auriculatus Cobban, n. sp.

Plate 10, figures 11–17

This tiny species is represented in the collections by twelve specimens ranging in length from 7.8 to 11.5 mm. The holotype is 9.7 mm. long and 8.8 mm. high.

The first and second whorls are wide and depressed in cross section. The third whorl is proportionally higher than the earlier whorls, and the fourth whorl is slightly more depressed. The umbilicus is wide in the first two whorls and narrow in the next two. The living chamber, which begins after the fourth complete whorl, is long, curved, and almost entirely freed from the septate coil. In cross section the living chamber is wider than high with broadly rounded venter and more sharply rounded flanks. The aperture is much wider than high and has dorsal, ventral, and lateral lappets. The dorsal lappet is broad and extended very little but the ventral lappet is narrower and more extended. The lateral lappets are long, narrow, and pointed, directed laterally and a little forward.

The coiled part is completely smooth or the last whorl may have weak ribs crossing the venter. This weak ribbing extends to the living chamber, but on some individuals the ribbing there is much stronger. The living chamber shows 6 to 9 large blunt primary ribs, which are the only ornamentation on some specimens. The living chamber of the holotype has 8 primaries and 31 secondaries.

The suture is simple. The siphonal lobe is a little longer than wide. The first lateral saddle is broader than the siphonal lobe and asymmetrically bifid. The first lateral lobe is bifid and half as large as the siphonal lobe. The second lateral saddle is bifid and a little wider than the first lateral lobe but only half as long. The second lateral lobe is bifid and very small. The third lateral saddle is bifid and as large as the second lateral lobe. The third lateral lobe is undivided and

half as large as the second lateral lobe. The internal suture was not seen.

This species is easily distinguished by its very small size and narrow, pointed lateral lappets. It resembles *Scaphites pisinnus* in size and shape but can be distinguished by its weaker sculpture and more extended lateral lappets. *S. auritus* Schlüter (1872, p. 77, pl. 23, figs. 5–9), *S. puerculus* var. *teshioensis* Yabe (1910, p. 171, pl. 15, figs. 23–27), and *S. perrini* Anderson (1902, p. 114, pl. 2, figs. 71–73) bear lateral lappets but of an entirely different shape from those of *S. auriculatus*.

Holotype, U.S.N.M. 106684; paratype, U.S.N.M. 106685.

The species occurs in the Colorado shale 500 to 550 feet below the top, on the Sweetgrass arch, north-central Montana, associated with *S. preventricosus* and *S. impendicostatus*. The holotype was collected from a calcareous concretion 521 to 527 feet below the top of the Colorado shale, on the north bank of the Marias River, 5.5 miles south of Shelby, in sec. 20, T. 31 N., R. 2 W., Toole County, Mont.

Scaphites ventricosus Meek and Hayden

Plate 12, figures 1–10; plate 13, figures 11–13

1862. *Scaphites ventricosus* Meek and Hayden, Acad. Nat. Sci. Philadelphia Proc., vol. 14, p. 22.
1876. *Scaphites ventricosus* Meek and Hayden. Meek, U. S. Geol. Survey Terr. Rept., vol. 9, p. 425, pl. 6, figs. 7, 8.
1893. *Scaphites ventricosus* Meek and Hayden. Stanton, U. S. Geol. Survey Bull. 106, p. 186, pl. 44, figs. 8, 9; pl. 45, fig. 1 [not pl. 44, fig. 10].
1898. *Scaphites ventricosus* Meek and Hayden. Logan, Kansas Univ. Geol. Survey, vol. 4, p. 476, pl. 104, figs. 8, 9; pl. 105, fig. 1 [not pl. 104, fig. 10].
1899. *Scaphites ventricosus* Meek and Hayden. Stanton, U. S. Geol. Survey Mon. 32, p. 636.
1903. *Scaphites ventricosus* Meek and Hayden. Douglass, Carnegie Mus. Annals, vol 2, no. 1, p. 8.
1927. *Scaphites ventricosus* Meek and Hayden. Reeside, U. S. Geol. Survey Prof. Paper 150-A, p. 6, pl. 3, figs. 11–18; pl. 4, figs. 1–4.
1927. *Scaphites ventricosus* Meek and Hayden. Reeside, U. S. Geol. Survey Prof. Paper 150–B, p. 35, pl. 10, figs. 1, 2.
1944. *Scahpites ventricosus* Meek and Hayden. Shimer and Shrock, Index fossils of North America, p. 591, pl. 244, fig. 10.

The holotype is large and stout, and the umbilicus is of average size for the genus. The outer septate whorl is much wider than high, and has a broadly rounded venter and sharply rounded flanks. The living chamber is nearly circular in cross section, and in side view, the umbilical wall of the older half is nearly straight whereas the entire venter is evenly curved. The younger part of the living chamber is missing but evidently it was not in contact with the septate coil. The holotype is 79 mm. long and 47.6 wide.

The sculpture of the holotype consists of coarse, fairly straight primary and secondary ribs. The ventral ribs are more widely spaced on the middle of the living chamber than on the extremities. The complete specimen probably had 16 or 17 primaries and about 65 secondaries on the exposed whorls and possibly 9 or 10 primaries and 34 or 35 secondaries on the living chamber. On the middle of the living chamber 4 or 5 secondaries are present to each primary.

The suture of the holotype is not preserved and Meek figured the suture of a specimen that may have been associated with the type. The suture is complex and has symmetrically bifid lobes.

Scaphites ventricosus was derived from *S. preventricosus* and differs from that species in many respects. *S. ventricosus* is larger; some individuals are more than 100 mm. in length. As the living chamber is less freed from the septate coil, the aperture lies at an angle different from that on *S. preventricosus*. Commonly the lateral margin of the aperture forms a right angle with the straight part of the umbilical wall of the living chamber, whereas in *S. preventricosus*, owing to the greater enrolling of the living chamber, this angle averages about 70 degrees. The ribbing of *S. ventricosus* is less uniformly spaced and considerably coarser than that of *S. preventricosus*.

Holotype, U.S.N.M. 1903; plesiotypes, U.S.N.M. 106698–106700, 106757.

The holotype is from the upper part of the Colorado shale about twenty miles northeast of Fort Benton, Mont. On the Kevin-Sunburst dome in north-central Montana, the species occurs sparingly in the Colorado shale 300 to 400 feet below the top, associated with the coiled *Inoceramus* species *I. exogyroides* Meek and Hayden, *I. umbonatus* Meek and Hayden, and *I. undabundus* Meek and Hayden. In northwestern Wyoming *Scaphites ventricosus* is present in the lower part of the Cody shale.

Scaphites tetonensis Cobban, n. sp.

Plate 14, figures 1-10

This species, of about average size for the genus, is characterized by its strong, coarse ribbing, high primary ribs on the living chamber, and widely spaced ventral ribs on the older part of the living chamber. The holotype is 42.5 mm. long, 37 mm. high, and 25 mm. wide.

Whorls less than 6 mm. in diameter have not been seen. The early whorls are broad and depressed in cross section and ornamented by straight, fairly coarse ventral ribs and curved primary ribs that are inclined forward. About 30 ventral ribs are on a complete whorl 12 mm. in diameter. The last septate whorl has a depressed cross section due to the broadly rounded venter and more sharply rounded flanks. The umbil-

icus is fairly small and has an indistinct rounded shoulder. This whorl is much more densely ribbed than the internal whorls. The living chamber is straight for half its length, wider than high, and has rounded flanks and venter. It is crossed by 26 to 43 straight secondary ribs and 7 to 9 flexuous primary ribs. The ventral ribs are widely spaced on the straight part and closely spaced on the curved part. The primaries are strong and attain their maximum height at the ventrolateral margin.

The holotype shows 71 ventral ribs and 23 primaries on the exposed whorls, of which 37 ventral ribs and 9 primaries are on the living chamber. The aperture is wider than high and has a very short dorsal lappet. The ventral lappet is bent outward a little.

The suture is fairly simple. The most distinctive feature is the first lateral lobe, which has a saddle for each of the two main branches about as large and as high as or higher than the central saddle.

Scaphites tetonensis was derived from *S. impendicostatus* by becoming less unrolled and developing fewer ribs, which are widely spaced on the straight part of the living chamber. It is associated with *S. ventricosus* but is much smaller, more slender, has stronger primaries raised into incipient nodes on the living chamber, and a much simpler suture.

Holotype, U.S.N.M. 106707; paratype, U.S.N.M. 106708.

The holotype is from a sandstone bed in the Cody shale 538 feet above the base, in the NE¼NW¼ sec. 20, T. 42 N., R. 112 W., Teton County, Wyo., where it is associated with *S. ventricosus* and *Inoceramus umbonatus* Meek and Hayden. The species is known also from the lower part of the Cody shale of the west side of the Bighorn Basin of northwestern Wyoming, and from the Mancos shale of east-central Utah.

Scaphites binneyi Reeside

Plate 14, figures 11–16

1927. *Scaphites vermiformis* Meek and Hayden var. *binneyi* Reeside, U. S. Geol. Survey Prof. Paper 150–A, p. 8, pl. 6, figs. 1–8.

Shell about average size for the genus, moderately stout, with living chamber partly straightened and considerably freed from the septate coil. The lateral margin of the aperture forms an angle of 90 degrees or less with the straight umbilical wall of the older part of the living chamber. The holotype is 39 mm. long, 35 mm. high, and 24 mm. wide.

The inner whorls are not visible in the specimens at hand. The last septate whorl is densely ribbed. The spacing of the ribs widens greatly on the older or straightened part of the adult living chamber and then gradually becomes closely spaced again on the younger or curved part. On the living chamber the primary ribs end in ventrolateral tubercles that are strongest where the ribs are most widely spaced.

The suture is fairly simple and closely resembles that of *Scaphites tetonensis*. The first lateral lobe is characterized by high lateral saddles.

Holotype, Yale Peabody Mus. 6417; plesiotypes, U.S.N.M. 106705, 106706.

This is a very rare species known only from the Cody shale of central and northwestern Wyoming. The holotype is from the Cody shale, 800 feet above the base, on the Oregon Basin anticline, in sec. 6, T. 51 N., R. 100 W., Park County, Wyo.

Scaphites interjectus Reeside

Plate 14, figures 17–21

1927. *Scaphites ventricosus* Meek and Hayden var. *interjectus* Reeside, U. S. Geol. Survey Prof. Paper 150–A, p. 7, pl. 5, figs. 1–4 [not fig. 5].

This is a stout species whose living chamber is largely in contact with the outer septate whorl. The lateral edge of the aperture forms an obtuse angle with the umbilical wall of the living chamber. Sculpture of the living chamber consists of straight ventral ribs more widely spaced on the older part, and slightly curved primary ribs ending in ventrolateral tubercles. The suture, which is moderately incised, has large, high lateral saddles on the first lateral lobe, a characteristic feature of the scaphites of the *S. tetonensis-S. binneyi* group.

Holotype, Yale Peabody Mus. 6416; plesiotype, U.S.N.M. 106701.

The species is rare. The holotype is from the Cody shale 800 feet above the base, in Oregon Basin, sec. 6, T. 51 N., R. 100 W., Park County, Wyo. Reeside records it also from the Garland anticline, 31 miles northeast of Oregon Basin. One specimen (pl. 14, figs. 17–21) was collected from the Cody shale of the Lander area in the Wind River Basin, Wyo.

Scaphites depressus Reeside

Plate 15, figures 6–8

1927. *Scaphites ventricosus* Meek and Hayden var. *depressus* Reeside, U. S. Geol. Survey Prof. Paper 150–A, p. 7, pl. 5, figs. 6–10.

This is one of the biggest scaphites of Colorado age. The adults range in length from 73 to 94 mm. All specimens are exceptionally stout and have the last septate whorl very deressed. In the largest individuals the entire adult living chamber is in contact with the septate coil. The umbilicus is of average size for the genus. The adult living chamber attains its greatest width in the older half, then tapers evenly to the aperture. The venter of the living chamber is uniformly curved; the umbilical wall is gently curved for

half its length and is then straightened and directed outward forming an obtuse angle with the older part. The aperture is wider than high and has a very small dorsal lappet. The inner whorls are stout; the last septate whorl is so depressed that the width of the shell is as great as or greater than the height.

The early whorls are somewhat coarsely ribbed, but the last septate whorl is finely ribbed. From the beginning of the living chamber, the ribbing gradually becomes more widely spaced to a point about midway to the aperture, then gradually becomes denser toward the aperture. On the older part of the living chamber there are five or six secondaries for each primary.

The suture is complex. The first lateral lobe is bifid, with the dorsal branch commonly a little longer than the ventral branch.

This species is most closely related to *Scaphites ventricosus* and *Clioscaphites montanensis* var. *hesperius*, n. gen. and sp. It differs from *S. ventricosus* in its greatly depressed outer septate whorl, denser costation, more tightly coiled shell, and lateral margin of the aperture directed outward at an obtuse angle to the umbilical wall of the older part of the living chamber. It differs from *Clioscaphites montanensis* var. *hesperius* mainly in having a larger umbilicus and in lacking uniform spacing of the ventral ribs.

Holotype, Yale Peabody Mus. 6417; plesiotype, U.S.N.M. 106693.

The holotype is from the Cody shale, 800 feet above the base, in sec. 6, T. 51 N., R. 100 W., Park County, Wyo. It is known also from other localities in the Bighorn Basin of northern Wyoming and southern Montana, where it is associated with *Inoceramus umbonatus* Meek and Hayden, *Baculites asper* Morton, *B. codyensis* Reeside, and *Texanites shoshonensis* (Meek).

Scaphites depressus Reeside var. stantoni Reeside

Plate 15, figures 1–5

1893. *Scaphites ventricosus* Meek and Hayden. Stanton, U. S. Geol. Survey Bull. 106, p. 186, pl. 44, fig. 10 [not pl. 44, figs. 8, 9; pl. 45, fig. 1].

1898. *Scaphites ventricosus* Meek and Hayden. Logan, Kansas Univ. Geol. Survey, vol. 4, p. 476, pl. 104, fig. 10 [not pl. 104, figs. 8, 9; pl. 105, fig. 1].

1927. *Scaphites ventricosus* Meek and Hayden var. *stantoni* Reeside, U. S. Geol. Survey Prof. Paper 150–A, p. 7, pl. 3, figs. 19, 20; pl. 4, figs. 5–10.

This variety differs from the typical form of the species in its smaller size, more slender shape, and in having the younger part of the living chamber slightly separated from the septate coil. The holotype is 59.2 mm. long, 49 mm. high, and 34.6 mm. wide. Other specimens from Wyoming range from 48 to 70 mm. in length.

The sculpture on the adult consists of numerous fine and fairly straight primary and secondary ribs. the ribbing is dense on the last septate whorl and on the younger part of the living chamber. The holotype has 97 ventral ribs and 31 primary ribs on the exposed whorls of which 55 ventral ribs and 16 primaries are on the living chamber. Other specimens from Wyoming have 75 to 103 ventral ribs on the adult shell with 11 to 16 primaries and 45 to 56 secondaries on the living chamber. On the middle part of the living chamber there are 4 or 5 ventral ribs for each primary.

The suture is moderately complex.

Holotype, U.S.N.M. 18817; plesiotype, U.S.N.M. 106695.

The holotype is from the upper part of the Colorado shale on Cinnabar Mountain near Gardiner, Park County, Mont. The variety is common in the lower half of the Cody shale of the Bighorn Basin, Wyo., and in the Colorado shale of southern and southwestern Montana.

Scaphites depressus Reeside var. oregonensis Reeside

1927. *Scaphites ventricosus* Meek and Hayden var. *oregonensis* Reeside, U. S. Geol. Survey Prof. Paper 150–A, p. 7, pl. 6, figs. 11–15.

This form is much like *Scaphites depressus* var. *stantoni* in size and shape but has higher, thin, sharp ribs and higher primaries.

Holotype, Yale Peabody Mus. 6411.

The variety occurs with the typical form of the species and with *S. depressus* var. *stantoni* in northern Wyoming and southern Montana. The holotype is from the Cody shale, 800 feet above the base, in sec. 6, T. 51 N., R. 100 W., Park County, Wyo.

Scaphites coloradensis Cobban, n. sp.

Plate 18, figures 1–6

This species closely resembles *Scaphites auriculatus* in size, shape, and in the details of the aperture, but the first lateral lobe of the suture is trifid rather than bifid. The living chamber is broader and more depressed than that of *S. auriculatus*, and the sculpture tends to be more pronounced. The holotype is 9.8 mm. long, 8 mm. high, and 5 mm. wide. On the living chamber are 22 coarse ventral ribs and 6 or 7 scarcely discernible primary ribs. Three other specimens from the type locality range in length from 7.7 to 12.3 mm.

Holotype, U.S.N.M. 106715; paratype, U.S.N.M. 106714.

This species is known only from the Colorado shale 234 to 252 feet below the top, on the Kevin-Sunburst dome of north-central Montana. The holotype is from a calcareous concretion on the east bank of the Marias River, in the NE¼SE¼ sec. 14, T. 31 N., R. 4 W., Toole County, Mont. Associated fossils

include *Clioscaphites vermiformis* (Meek and Hayden) and *C. montanensis*, n. sp.

Scaphites leei Reeside

Plate 21, figures 24–26

1927. *Scaphites leei* Reeside, U. S. Geol. Survey Prof. Paper 151, p. 26, pl. 20, figs. 17–22; pl. 21, figs. 1–7.

This small species is characterized by its stout form, simple suture, and living chamber with four umbilical nodes, smooth flanks, and row of ventrolateral nodes. It is distinctly different from its associates, *Clioscaphites novimexicanus* (Reeside), and *Desmoscaphites erdmanni* n. sp., of the uppermost part of the Colorado shale, and represents the first appearance of the *S. hippocrepis*-like scaphites that dominate the Telegraph Creek and Eagle faunas.

Holotype, U.S.N.M. 73354; plesiotypes, U.S.N.M. 106720 a-b.

The holotype is from the uppermost part of the Mancos shale, one mile southwest of Waldo, Santa Fe County, New Mexico. The species is known also from the uppermost part of the Mancos shale of east-central Utah, from the Steele shale of central Wyoming, and from the Colorado shale 10 feet below the top, on the Sweetgrass arch of north central Montana.

Genus CLIOSCAPHITES Cobban, n. gen.

Type species.—*Clioscaphites montanensis* Cobban.

Etymology.—From the Greek *kleio*, close. A closed or tightly enrolled scaphite in contrast to the typical open forms with living chambers freed from the septate coil.

The distinguishing generic characters are the closely coiled shell, the dorsum of the adult living chamber entirely in contact with the septate coil, and the suture with the trifid or asymmetrically bifid first lateral lobe.

Clioscaphites montanensis Cobban, n. sp.

Plate 16, figures 1–11; plate 17, figures 1–3; plate 20, figures 1–4

Flattened flanks, small umbilicus, rather dense evenly spaced ribs, and complex suture characterize this species. The adults are large, attaining lengths as great as 105 mm. Sixteen adults from the type locality average 69.2 mm. in length; the smallest is 46.5 mm. long. The holotype is 61 mm. long, 52.5 mm. high, and 32.5 mm. wide.

The shell is tightly coiled and only a few small, slender specimens have a little of the oral end of the living chamber free from the septate whorl. In side view the venter of the living chamber is nearly evenly curved; the umbilical wall is straight for half its length and then directed outward, forming a large obtuse angle. An unusual feature is the migration of the flank upon the umbilicus. In some specimens, such as the holotype (pl. 16, fig. 1), the umbilicus is largely covered. The aperture is nearly circular and almost lacks a dorsal lappet.

The sculpture consists of numerous straight evenly spaced primary and secondary ribs, the holotype having 32 primaries and 96 secondaries on the exposed whorls with 20 primaries and 66 secondaries on the living chambers. The living chambers of thirteen adults from the type locality show 13 to 20 primaries, averaging 17.3, and 51 to 69 secondaries, averaging 61.5. On the living chamber 4 or 5 secondaries are present for each primary. The secondaries extend well down between the primaries. There is a tendency, particularly in the larger individuals, for the primaries to attain their greatest height at the margin of the venter.

The suture is deeply incised and reaches the highest degree of complexity of the scaphites of the Colorado group. The first lateral lobe is in a transitional stage from bifid to trifid owing to elongation of the dorsal terminal branch and atrophy of the ventral branches.

Large individuals approach *Scaphites interjectus* in size, general form, and in having the primaries highest at the margin of the venter. However, *Clioscaphites montanensis* has more flattened and extended flanks, more tightly enrolled shell, denser costation, and differs in sutural details. A few smaller and more slender specimens with fewer ribs having the living chamber near the aperture slightly freed from the septate coil, and thus resemble the varieties *stantoni* and *oregonensis* of *Scaphites depressus*. These small specimens can be distinguished by the more flattened flanks of the living chamber, smaller umbilicus, and complex suture with a highly asymmetrical first lateral lobe.

Holotype, U.S.N.M. 106716; paratypes, U.S.N.M. 106717 a-d, 106726 a-d.

The types are from calcareous concretions in the Colorado shale, 234 to 252 feet below the top, on the east bank of the Marias River, 11 miles southwest of Shelby, in the W½NE¼SE¼ sec. 14, T. 31 N., R. 4 W., Toole County, Mont., where they are associated with *Clioscaphites vermiformis* (Meek and Hayden), *Scaphites coloradensis*, n. sp., and *Baculites codyensis* Reeside. Other specimens have been collected from the upper part of the Colorado shale at several localities in northwestern, north-central, and central Montana, and a little above the middle of the Cody shale of the Bighorn and Wind River Basins of Wyoming.

Clioscaphites montanensis Cobban var. hesperius Cobban, n. var.

Plate 16, figures 12–14; plate 17, figures 4–7

This variety differs from the typical form of the species in its much more inflated form, less flattened flanks, which are little advanced over the umbilicus,

and fewer and coarser ribs. The type is 74.5 mm. long, 61 mm. high, and 43.5 mm. wide.

Some specimens of *Scaphites depressus* rather closely resemble this variety in shape and ribbing but are distinguishable by the larger umbilicus, the lack of equal-spaced ventral ribs, and by sutural details.

Holotype, U.S.N.M. 106718; paratype, U.S.N.M. 106719.

This variety is known only from the upper part of the Colorado shale of the Sweetgrass arch of north-central Montana. The holotype is from a bed of calcareous concretions 234 to 252 feet below the top of the Colorado shale, in the east bank of the Marias River, 11 miles southwest of Shelby, in the W½NE¼SE¼ sec. 14, T. 31 N., R. 4 W., Toole County, Mont.

Clioscaphites vermiformis (Meek and Hayden)

Plate 18, figures 7–27

1862. *Scaphites vermiformis* Meek and Hayden, Acad. Nat. Sci. Philadelphia, vol. 14, p. 22.
1876. *Scaphites vermiformis* Meek and Hayden. Meek, U. S. Geol. Survey Terr. Rept., vol. 9, p. 423, pl. 6, fig. 4.
1893. *Scaphites vermiformis* Meek and Hayden. Stanton, U. S. Geol. Survey Bull. 106, p. 183, pl. 44, fig. 3.
1898. *Scaphites vermiformis* Meek and Hayden. Logan, Kansas Univ. Geol. Survey, vol. 4, p. 474, pl. 104, fig. 3.
1910. *Scaphites vermiformis* Meek and Hayden. Grabau and Shimer, North American index fossils, p. 176, fig. 1427c.
1916. *Holcoscaphites vermiformis* (Meek and Hayden). Nowak, K.-k. Geol. Reichsanstalt Verh., Jahrg. 1916, no. 3, p. 66.
1927. *Scaphites vermiformis* Meek and Hayden. Reeside, U. S. Geol. Survey Prof. Paper 150–A, p. 7, pl. 6, figs. 9, 10.

Meek fully described the adult shell which came from the upper part of the Colorado shale of north-central Montana. He apparently saw only the single specimen for he does not mention the internal whorls, the growth stages, or variations of the adult. The writer has at hand more than a hundred specimens from north-central Montana, which makes possible a more detailed description of the species and variations.

All whorl sections are broader than high and very depressed. The venter is well rounded on the early whorls, broadly rounded to flattened on the last septate whorl, and broadly rounded on the living chamber. The flanks are rounded on the early whorls and flattened on the later whorls and body chamber. The ventrolateral margin is rounded on the first two whorls out to a diameter of about 1.5 mm. It is subangular between whorl diameters of 1.5 to 6 mm. and then becomes rounded on the remainder of the shell. The umbilicus is wide in the early whorls and narrow in the later ones; umbilical shoulder rounded. The living chamber is curved and not freed from the septate coil; its flanks are nearly flat and inclined inward. The aperture is constricted, subcircular, and has a very small dorsal lappet. The adult shell is subcircular in side view, slender to moderately stout, and a little larger than average size for the genus. The holotype is 53.8 mm. long, 45.1 mm. high, and 32 mm. wide (from extremities of nodes). Nineteen adults from one locality in north-central Montana range in length from 25 to 57 mm., averaging 50.7 mm.

The early whorls are smooth to a diameter of about 4 mm., where coarse, rounded ventral ribs appear. These are sigmoid, curving back from the ventrolateral margin and then forward on crossing the venter. There are 23 to 29 ribs on the first completely ribbed whorl. Primary ribs first appear between diameters of 5 and 6 mm. and curve forward on crossing the narrow flank. The coarse ventral ribbing continues to the beginning of the last septate whorl where the ribs suddenly become sharp, dense, and straight. This dense ribbing continues nearly to the younger end of this whorl where the ribs gradually become more widely separated. The ribbing is sparse on the older half of the living chamber, but on the younger half it again becomes dense. The primary ribs on the living chamber are high, sharp, and nearly straight, and each terminates at the margin of the venter in a high sharp tubercle. These tubercles are largest in the middle third of the living chamber and become progressively smaller toward the extremities, disappearing near the aperture and on the youngest part of the last septate whorl. On the holotype the nodes are arranged on each side of the venter in alternate positions, but in most individuals the nodes are paired. The holotype has 23 primary ribs and 74 secondary ribs on the exposed whorls, with 14 primaries and 45 secondaries on the living chamber. The living chambers of 19 specimens from one locality in northern Montana have 10 to 16 primaries, averaging 13, and 33 to 53 secondaries, averaging 40.7. On the middle part of the living chamber there are 3 ventral ribs to each primary.

The suture is fairly complex and characterized by trifid lobes. The siphonal lobe is almost as wide as high. The first lateral saddle is asymmetrically bifid and wider than the siphonal lobe. The first lateral lobe is trifid and as broad but not as high as the siphonal lobe. The second lateral saddle is bifid and about as wide as the first lateral saddle but only half as long. The second lateral lobe is trifid and about half as large as the first lateral lobe. The remaining lobes are small and trifid. The rest of the saddles are small and bifid.

The diagnostic features of this species are the closely coiled shell, completely curved living chamber, row of ventrolateral tubercles, and fairly complex suture with trifid lobes. Immature specimens can be distinguished from juveniles of the associated species, *Clioscaphites*

montanensis, by the forward bending of the ribs as they cross the venter. In addition, most young specimens of *C. vermiformis* are stouter.

A few individuals (pl. 18, figs. 20, 21) have sharp, knife-like ribs and nodes and, in this respect, exactly parallel the development of *Scaphites depressus* var. *oregonensis* Reeside.

Holotype, U.S.N.M. 1902; plesiotypes U.S.N.M. 106713a–f.

The species is present in the Mancos shale of northwestern New Mexico, western Colorado, and central and northeastern Utah; in the Hilliard shale of southwestern Wyoming; in the Cody shale of central and western Wyoming; and in the Colorado shale of Montana. The holotype is from the upper part of the Colorado shale at Chippewa Point on the Missouri River about 20 miles below Fort Benton in Chouteau County, Mont.

Clioscaphites vermiformis (Meek and Hayden) var. toolensis Cobban, n. var.

Plate 19, figures 1-10

This variety differs from the typical form of the species in its larger size, stouter form, and greatly depressed whorls. In addition, the sculpture is not as pronounced and the ribbing is slightly more dense. The holotype has 26 primaries and 73 secondaries on the exposed whorls, with 14 primaries and 41 secondaries on the living chamber. Seven other specimens from the type locality have 13 to 19 primaries on the living chambers, averaging 15.6, and 38 to 57 secondaries, averaging 45. The holotype is 68.5 mm. long, 62 mm. high, and 44.5 mm. wide. Other specimens from the type locality range from 63 to 78 mm. in length. Probably, a few adults (pl. 19, fig. 9) attained the size of *Scaphites depressus*.

Many individuals (pl. 19, figs. 7, 8) from the Cody shale of southern Montana and northern Wyoming differ from the northern Montana specimens in possessing denser ribbing and more depressed whorls. The last septate whorl of some individuals is so depressed as to form a broad, shallow depression along part of the venter exactly as in the most depressed specimens of *Scaphites depressus*.

The variety resembles the form described by McLearn (1929, p. 77, pl. 18, figs. 1–3; pl. 19, figs. 1, 2) as *Scaphites ventricosus* Meek and Hayden var. *saxitonianus* in size, shape, stoutness, and arrangement of ribbing, but differs in possessing prominent tubercles and a suture with well-developed trifid lobes.

Holotype, U.S.N.M. 106709; paratypes, U.S.N.M. 106710–106712.

The holotype is from a bed of calcareous concretions 234 to 252 feet below the top of the Colorado shale, in the east bank of the Marias River, 11 miles southwest of Shelby, in the W½NE¼SE¼ sec. 14, T. 31 N., R. 4 W., Toole County, Mont. The variety occurs with the typical form of the species at many other localities in Montana and Wyoming.

Clioscaphites platygastrus Cobban, n. sp.

Plate 20, figures 12-16

The holotype is an adult shell 52.5 mm. long, 50 mm. high, and 28.6 mm. wide. It is tightly coiled, with very small umbilicus. The living chamber, of nearly uniform size, is entirely in contact with the septate coil. The venter is flattened and the flanks but slightly convex.

The sculpture consists of numerous strong, sharp ribs and a row of high, pointed ventrolateral tubercles. The holotype has 90 ventral ribs and 28 primaries on the exposed whorls, with 70 ventral ribs and 20 primaries on the living chamber. On the septate coil both primary and secondary ribs are straight. On the living chamber the primaries bend slightly forward on leaving the umbilical wall, then curve back a little and cross the flanks gradually bending forward again. Each primary rib terminates in a ventrolateral tubercle that is curved slightly back. The ventral ribs are numerous, strong, and straight. They are more sparse on the older part of the living chamber where the ventrolateral tubercles are largest.

The suture is moderately complex with the first lateral lobe transitional from bifid to trifid.

The species closely resembles *Clioscaphites vermiformis* in size, shape, and general sculptural features, but differs in the flattened venter and denser and stronger costation.

Holotype, U. S. N. M. 106729.

The holotype is from the upper part of the Colorado shale, four miles west of Sunburst, in sec. 16, T. 36 N., R. 3 W., Toole County, Mont.

Clioscaphites saxitonianus (McLearn)

Plate 13, figures 1-10

1929. *Scaphites ventricosus* Meek and Hayden var. *saxitonianus* McLearn, Canada Nat. Mus. Bull. 58, p. 77, pl. 18, figs. 1-3; pl. 19, figs. 1, 2.

Shell, large, stout, and tightly coiled. McLearn gives 59 mm. as the length of the holotype.

The sculpture of the septate coil consists of fine, dense, straight ribs. On the living chamber the ventral ribs are coarse and sparse on the older portion and progressively denser toward the aperture. The primary ribs on the living chamber are strong and attain their greatest height in incipient nodes at the ventrolateral margin.

The suture is only moderately complex. The first lateral lobe is typically asymmetrically bifid but on advanced individuals it may be trifid.

This species resembles *Clioscaphites vermiformis* va. *toolensis* in size, form, and general sculptural features, but differs in lacking pointed nodes and in rarely having the first lateral lobe of the suture trifid.

Holotype, Nat. Mus. Canada 9041; paratype, N. M. C. 9041a; plesiotypes, U.S.N.M. 106739a-b.

The holotype is from the Alberta shale of the Crowsnest River area of southwestern Alberta. In the United States the species is known only from the Apishapa shale of southeastern Colorado, and from the Colorado shale, 165 feet below the top, on the east flank of the Sweetgrass arch of north-central Montana.

Clioscaphites saxitonianus (McLearn) var. keytei Cobban, n. var.

Plate 20, figures 5-7

This variety differs from the typical form by its much smaller size and more slender shape. The holotype is 42.3 mm. long, 38 mm. high, and 27 mm. wide. It has 20 primary ribs and 66 ventral ribs on the exposed whorls with 9 primaries and 29 ventral ribs on the living chamber.

The suture is not discernible on the type specimen. Most specimens in the type lot have the first lateral lobe asymmetrically bifid, owing to elongation of the dorsal branch.

The variety closely resembles small adults of *Clioscaphites vermiformis*, but lacks pointed nodes and the perfectly trifid first lateral lobe.

The variety is named for I. A. Keyte, late professor of geology at Colorado College, who collected the type specimen.

Holotype, U.S.N.M. 106727.

The holotype is from a calcareous concretion in the Apishapa shale, 16 miles east of Trinidad, in sec. 1, T. 32 S., R. 62 W., Las Animas County, Colo. The variety occurs also in the Raton Park area of northeastern New Mexico, and in the Colorado shale, 165 feet below the top, on the east flank of the Sweetgrass arch of north-central Montana.

Clioscaphites novimexicanus (Reeside)

Plate 21, figures 1–9

1927. *Desmoscaphites novimexicanus* Reeside, U. S. Geol. Survey Prof. Paper 151, p. 17, pl. 11, figs. 1–4.

This species was based on a single specimen consisting chiefly of the septate coil. The sculpture of this specimen consists of forwardly inclined primary ribs which pass half way outward from the umbilicus to the middle of the venter and then split into two coarse secondary ribs that pass straight across the venter. Constrictions were doubtfully reported on this specimen, but Dr. Reeside and the writer on reexamining the type agree that their presence cannot be demonstrated. The upper 23 feet of the Colorado shale on the west flank of the Sweetgrass arch of north-central Montana has yielded scaphites that exactly fit Reeside's figures of this species. The Montana material includes some adults, permitting more complete description of the species.

Clioscaphites novimexicanus is characterized by its compressed, involute form with very narrow umbilicus, dense costation, and suture with trifid first lateral lobe. The adults at hand range in length from 38 mm. to 76 mm.

The first whorl is broad and depressed in cross section; succeeding whorls are proportionally higher than the first, but all are wider than high. The umbilicus is wide in the first two whorls and narrow in the later ones. The ventrolateral margin is subangular, beginning with the third whorl at a diameter of about 2 mm. and continuing into or through the fourth whorl to a diameter of 6 to 8 mm. It is rounded at larger diameters. The living chamber begins with or after the sixth whorl, is relatively compressed, and is wholly attached to the septate coil. The venter is evenly curved in its entire length, is rounded in cross section, and grades uniformly into the flattened flanks. The umbilicus of the adult is exceedingly narrow and straight because of the considerable overlap by the extended flanks. The aperture is constricted, almost circular, and has scarcely any dorsal lappet.

The earliest three whorls are smooth. At a diameter of 3.5 mm. straight, coarse ventral ribs appear, and there are about 22 ribs on the first complete whorl following their initial appearance. At a diameter of 5 mm. primary ribs appear. These are curved and inclined forward as they cross the flanks, and on reaching the margin of the venter, they become more elevated and commonly fork into two secondaries. On the last half of the outer septate whorl the sculpture changes rather suddenly from coarse rounded ribs to sharp narrow ribs that are more closely spaced. The ribbing is especially dense on the living chamber, which has 60 to 70 equispaced straight ventral ribs and 16 to 20 straight primary ribs. Six or seven secondaries are present to each primary on the middle part of the living chamber. The secondaries are exceptionally long, extending between the primaries almost to the umbilical wall.

The suture is moderately complex and characterized by a trifid first lateral lobe. The suture is considerably simplified from its *Clioscaphites montanensis* ancestor.

Clioscaphites novimexicanus can be distinguished from advanced specimens of *C. montanensis* by its more compressed form, denser costation, and simplified suture with a trifid first lateral lobe. A few fragments of a large, stout variety (pl. 21, fig. 9) are present in the

collections, but none are sufficiently complete to warrant description.

Holotype, U.S.N.M. 73312; plesiotypes, U.S.N.M. 106721a-b, 106722a-b, 106723.

The holotype is from the uppermost Mancos shale, one mile east of head of Canyon del Yeso, Santa Fe County, north-central New Mexico. The species is common in the upper 23 feet of the Colorado shale on the Sweetgrass arch, north-central Montana, associated with *Inoceramus lundbreckensis* McLearn and *Baculites thomi* Reeside.

Clioscaphites? choteauensis Cobban, n. sp.

Plate 20, figures 8–11

Shell moderately large, stout, and tightly coiled, with small umbilicus. Last septate whorl considerably depressed, with broadly rounded venter and more sharply rounded flanks. In side view both the venter and umbilical shoulder of the living chamber are evenly curved; in cross section the venter is well rounded, the flanks are flattened and round gradually into the convex, steeply sloping umbilical wall. The living chamber tapers slightly toward the nearly circular aperture. The holotype is 64.5 mm. long, 64 mm. high, and 35 mm. wide.

The innermost whorls were not seen. The early part of the last septate whorl is coarsely ribbed but changes abruptly to fine, dense ribbing. The ribbing widens on the proximal half of the living chamber and then gradually becomes denser toward the aperture. On most of the shell the primaries are fairly straight but near the aperture they become broadly curved and inclined forward. On the older three-fourths of the living chamber each primary ends as a conical ventrolateral tubercle. The ventral ribs on the living chamber are straight on the older part, but arch gently forward on the younger part. They extend well down between the primaries. Four or five are present for each primary on the middle part of the living chamber. On the exposed whorls, the holotype has 27 primaries and 104 secondaries with 17 primaries and 67 secondaries on the living chamber.

The suture is complex and characterized by trifid lobes.

The well-rounded venter, denser costation, and intercalation of secondary ribs between the primaries readily distinguishes this species from *Clioscaphites vermiformis* and *C. platygastrus*. It is a transition species between *C. vermiformis* and *Desmoscaphites erdmanni* Cobban, n. sp.

Holotype, U.S.N.M. 106728.

The holotype is from near the top of the Colorado shale half a mile northeast of Choteau, in sec. 19, T. 24 N., R. 4 W., Teton County, Mont. The species occurs also in calcareous concretions 162 feet below the top of the Colorado shale on the west flank of the Kevin-Sunburst dome in north-central Montana. Outside of those areas it is known only from the upper part of the Colorado shale of southwestern Montana, from the Mancos shale of northwestern Colorado, and from the Apishapa shale of eastern Colorado.

Genus DESMOSCAPHITES Reeside

Reeside (1927c, p. 16) proposed this genus with *Desmoscaphites bassleri* as the genotype to include moderate-sized shells with abnormal living chambers, early whorls having constrictions and coarse, forward arching ventral ribs, later whorls finer ribbed, and suture with a trifid first lateral lobe. The genus was derived from *Clioscaphites vermiformis* through *Clioscaphites? choteauensis* by acquiring constrictions in the internal whorls.

Desmoscaphites erdmanni Cobban, n. sp.

Plate 21, figures 10–23

The external whorls of this species closely resemble those of *Clioscaphites? choteauensis* in size, shape, and general sculptural features. *Desmoscaphites erdmanni* has smaller nodes and more uniformly spaced ribs, and specimens comparable to *C.? choteauensis* in size are commonly more densely ribbed.

The first two whorls succeeding the protoconch are wide and depressed in cross section, but later whorls are proportionally higher and more nearly circular. The umbilicus is wide in the early whorls and narrow in the later, with rounded umbilical shoulder. The flanks and venter are well rounded in the early whorls, but on the last septate whorl the flanks become slightly flattened and the venter broadly rounded. The living chamber is shaped like that of *C.? choteauensis*. The holotype is a nearly complete but partly crushed living chamber that was probably 48 mm. in length.

The early whorls are smooth. Between diameters of 4 and 5.5 mm. constrictions appear on the venter and on the outer part of the flanks. These occur in pairs spaced first about four and a half per whorl but gradually increase to six per whorl. In the early whorls the orad constriction is weaker than the apicad constriction, but in the later whorls they are equal. The constrictions of a pair are closely spaced, but separated by a high rib. This rib and the constrictions bend forward on crossing the venter. At a whorl diameter of 8 to 10 mm. ribs first appear between the pairs of constrictions and cross the venter with the same forward swing. These ribs rapidly become coarse, attaining their greatest height on the venter. On the outer part of the flank each pair commonly unites into a primary rib that curves back across the

flank, describing an arc concave forward. These primaries disappear at the edge of the umbilicus. At the beginning of the last septate whorl the coarse ribbing suddenly becomes fine and dense, as it does in *C. vermiformis* and *C.? choteauensis*. On the middle third of the living chamber the ribbing is a little sparser. There the primaries are long and straight and terminate in conical tubercles on the margin of the venter. From each tubercle two or three secondaries and one or two intercalated ribs cross the venter with a forward arching. The holotype has four secondaries to each primary. Fragments of larger individuals have four to six secondaries for each primary.

The suture is moderately complex with trifid lobes.

Demoscaphites erdmanni differs from the later *D. bassleri* Reeside in possessing fewer ribs and in having those on the middle third of the living chamber sparser than on the extremities. *D. bassleri* has uniformly spaced ribs with 6 to 9 secondaries to each primary.

The species is named for Mr. Charles E. Erdmann.

Holotype, U.S.N.M. 106724; paratypes, U.S.N.M. 106725 a–d.

D. erdmanni is known only from the uppermost part of the Colorado shale in north central Montana and from the upper part of the Cody shale of the Wind River Basin of western Wyoming. The holotype is from a calcareous concretion 10 feet below the top of the Colorado shale, 8 miles west of Shelby, in the NE¼ sec. 31, T. 32 N., R. 3 W., Toole County, Mont., associated with *Clioscaphites novimexicanus*, *Baculites thomi* Reeside, and *Inoceramus lundbreckensis* McLearn.

REFERENCES

Adkins, W. S., and Winton, W. M., 1919, Paleontological correlations of the Fredericksburg and Washita formations in north Texas: Texas Univ. Bull. 1945, pp. 1–128, pls. 1–21, (issued 1920).

Anderson, F. M., 1902, Cretaceous deposits of the Pacific Coast: California Acad. Sci. Proc., 3d ser., Geology, vol. 2, pp. 1–154, pls. 1–12.

Böse, Emil, 1927, Cretaceous ammonites from Texas and northern Mexico: Texas Univ. Bull. 2748, pp. 143–350, pls. 1–19, (issued 1928).

Collignon, Maurice, 1928, 1929, Paléontologie de Madagasgar; 15, Les Céphalopodes du Cénomanien Pyriteux de Diégo-Suarez: Annales de paléontologie, tome 17, pp. 1–25 (137–161), pls. 1–5 (15–19), 1928; tome 18, pp. 25–80 (1–56), pls. 6, 7 (1, 2), 1929.

Frech, Fritz, Ueber Scaphites, 1915, I: Centralbl. Mineralogie, Jahrg. 1915, no. 21, pp. 553–568, 14 figs.

Geinitz, H. B., 1874, Das Elbthalgebirge in Sachsen; Theil 2, Der mittlere und obere Quader, 5, Gasteropoden und Cephalopoden: Palaeontographica, Band 20, pp. 120–199, pls. 31–36.

Leonard, R., 1897, Die Fauna der Kreideformation in Oberschlesien: Palaeontographica, Band 44, pp. 11–70, illus.

McLearn, F. L., 1929, Cretaceous invertebrates; Mesozoic paleontology of Blairmore region; Alberta: Canada Nat. Mus. Bull. 58, pp. 73–79, pls. 13–19.

Meek, F. B., 1876, Invertebrate Cretaceous and Tertiary fossils of the upper Missouri country: U. S. Geol. Survey Terr. Rept., vol. 9, pp. 1–629, illus.

Meek, F. B., and Hayden, F. V., 1862, Descriptions of new Cretaceous fossils from Nebraska Territory, collected by the expedition sent out by the Government under the command of Lieut. John Mullan, U. S. Topographical Engineers, for the location and construction of a wagon road from the sources of the Missouri to the Pacific Ocean: Acad. Nat. Sci. Philadelphia Proc. 1862, pp. 21–28.

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

Morrow, A. L., 1935, Cephalopods from the Upper Cretaceous of Kansas: Jour. Paleontology, vol. 9, no. 6, pp. 463–473, pls. 49–53, text figs. 1–8.

Pictet, F. J., and Campiche, G., 1861–1864, Description des fossiles du terrain crétacé des environs de Sainte Croix, pt. 2: Materiaux pour la paléontologie suisse, ser. 3, Mon. 2, pp. 1–752, pls. 44–98.

Reeside, J. B., Jr., 1927a, Cephalopods from the lower part of the Cody shale of Oregon Basin, Wyoming: U. S. Geol. Survey Prof. Paper 150–A, pp. 1–10, pls. 1–8.

———, 1927b, The scaphites, an Upper Cretaceous ammonite group: U. S. Geol. Survey Prof. Paper 150–B, pp. 21–40, pls. 9–11.

———, 1927c, The cephalopods of the Eagle sandstone and related formations in the western interior of the United States: U. S. Geol. Survey Prof. Paper 151, pp. 1–87, pls. 1–45.

Schlüter, Clemens, 1872, Cephalopoden der oberen deutschen Kreide: Palaeontographica, Band 21, pp. 1–120, pls. 1–35.

Spath, L. F., 1923–1943, A monograph of the Ammonoidea of the Gault: Palaeont. Soc. Mon., pp. 1–783, illus.

Warren, P. S., 1930, New species of fossils from Smoky River and Dunvegan formations, Alberta: Alberta Research Council Geol. Survey Rept. 21, pp. 57–68, pls. 3–7.

———, 1947, Cretaceous fossil horizons in the Mackenzie River valley: Jour. Paleontology, vol. 21, no. 2, pp. 118–123, pls. 29, 30.

Yabe, H., 1910, Die Scaphiten aus der Oberkreide von Hokkaido: Beitr. Paläontologie Oesterr.-Ungarns u. des Orients, vol. 23, pp. 159–174, pl. 15.

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[Italic numbers indicate descriptions.]

PLATES 1–21

PLATE 1

[All figures natural size except as indicated on plate]

FIGURES 1–3. *Scaphites delicatulus* Warren var. *greenhornensis* Cobban, n. var. Bottom, top, and side views of holotype, an internal mold, U.S.N.M. 106766. From a limestone concretion 10 feet below top of Greenhorn formation at map locality 101 (p. 18).

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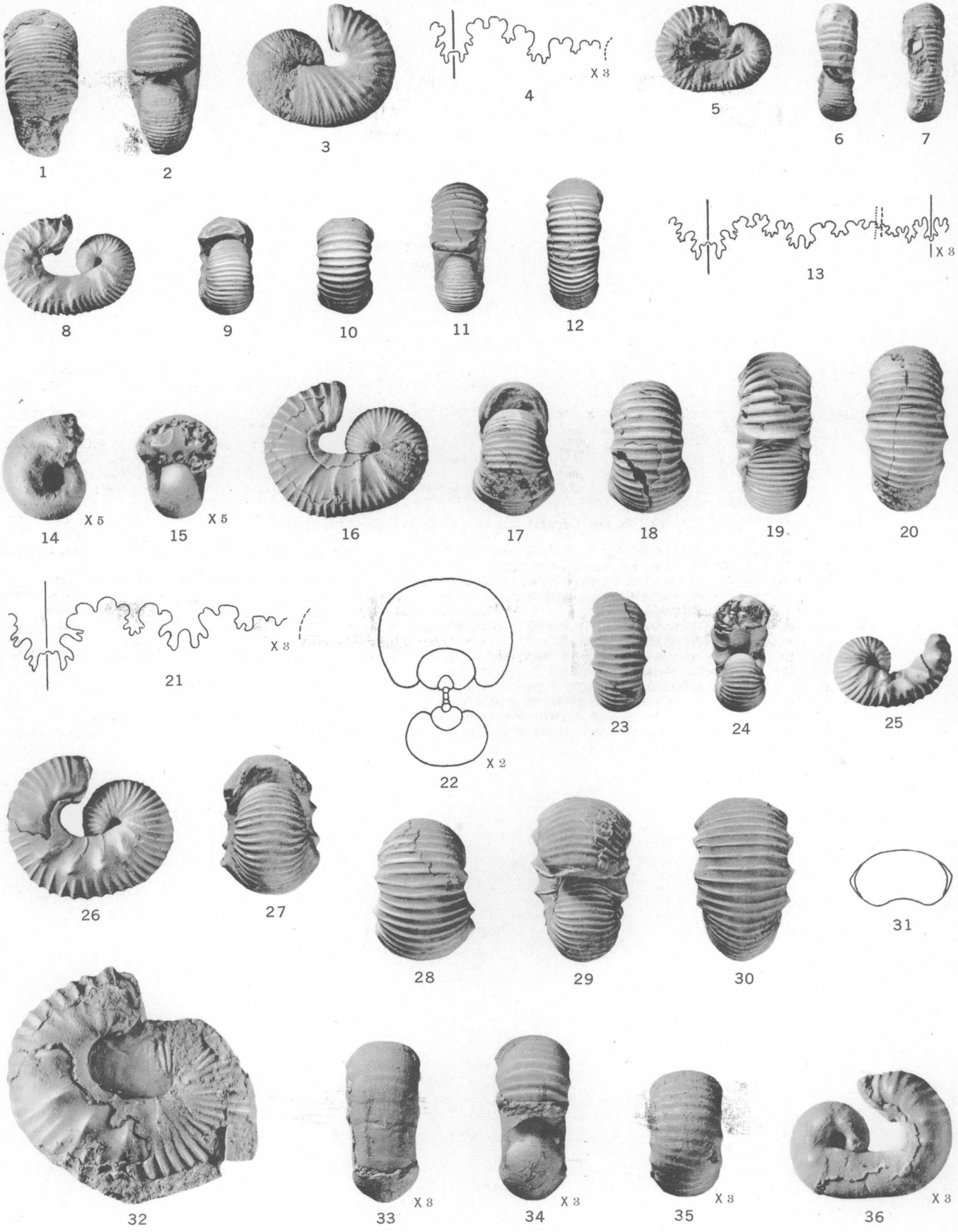

SCAPHITES OF THE COLORADO GROUP

PLATE 2

[All figures natural size except as indicated on plate]

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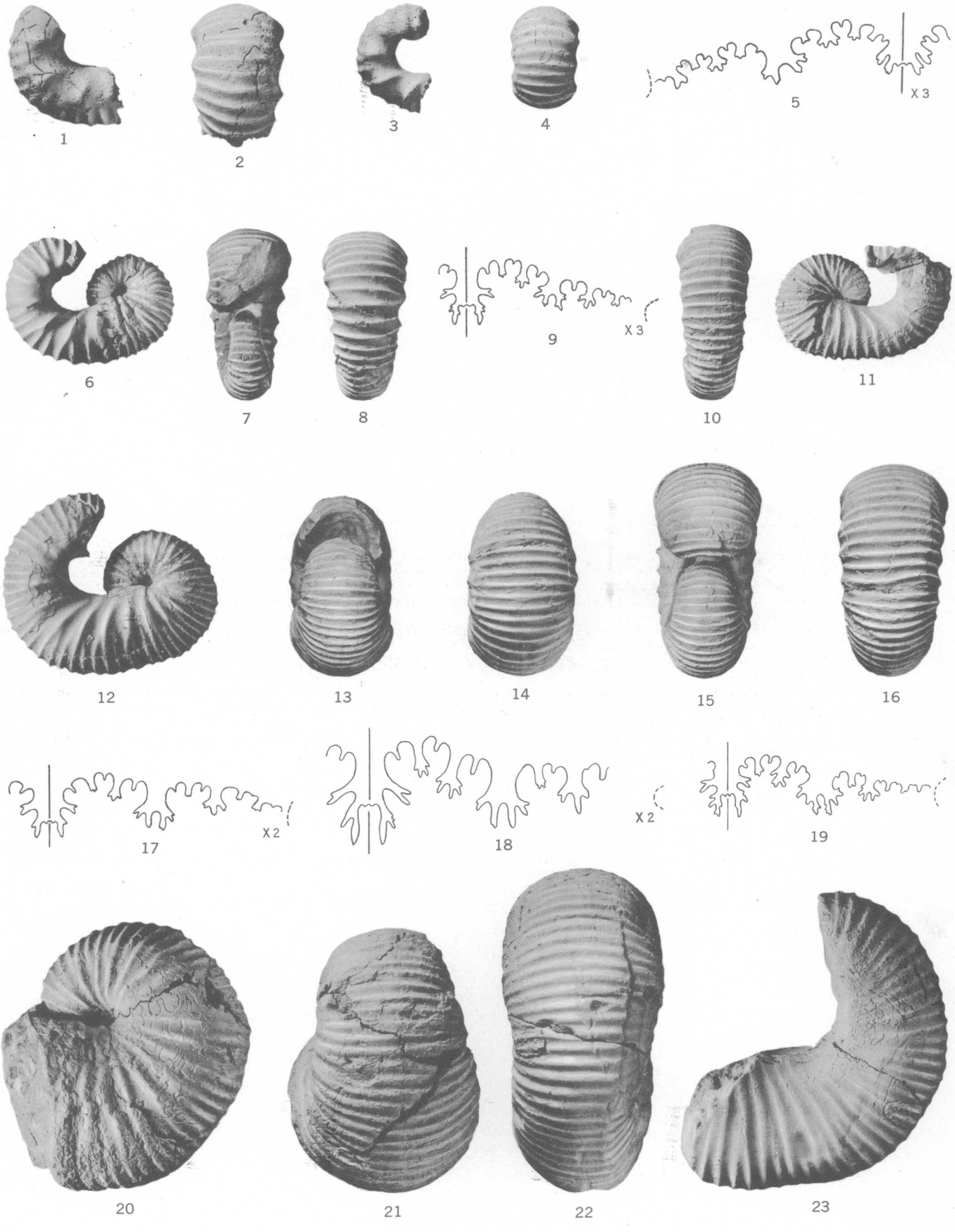

SCAPHITES OF THE COLORADO GROUP

PLATE 3

[All figures natural size except as indicated on plate]

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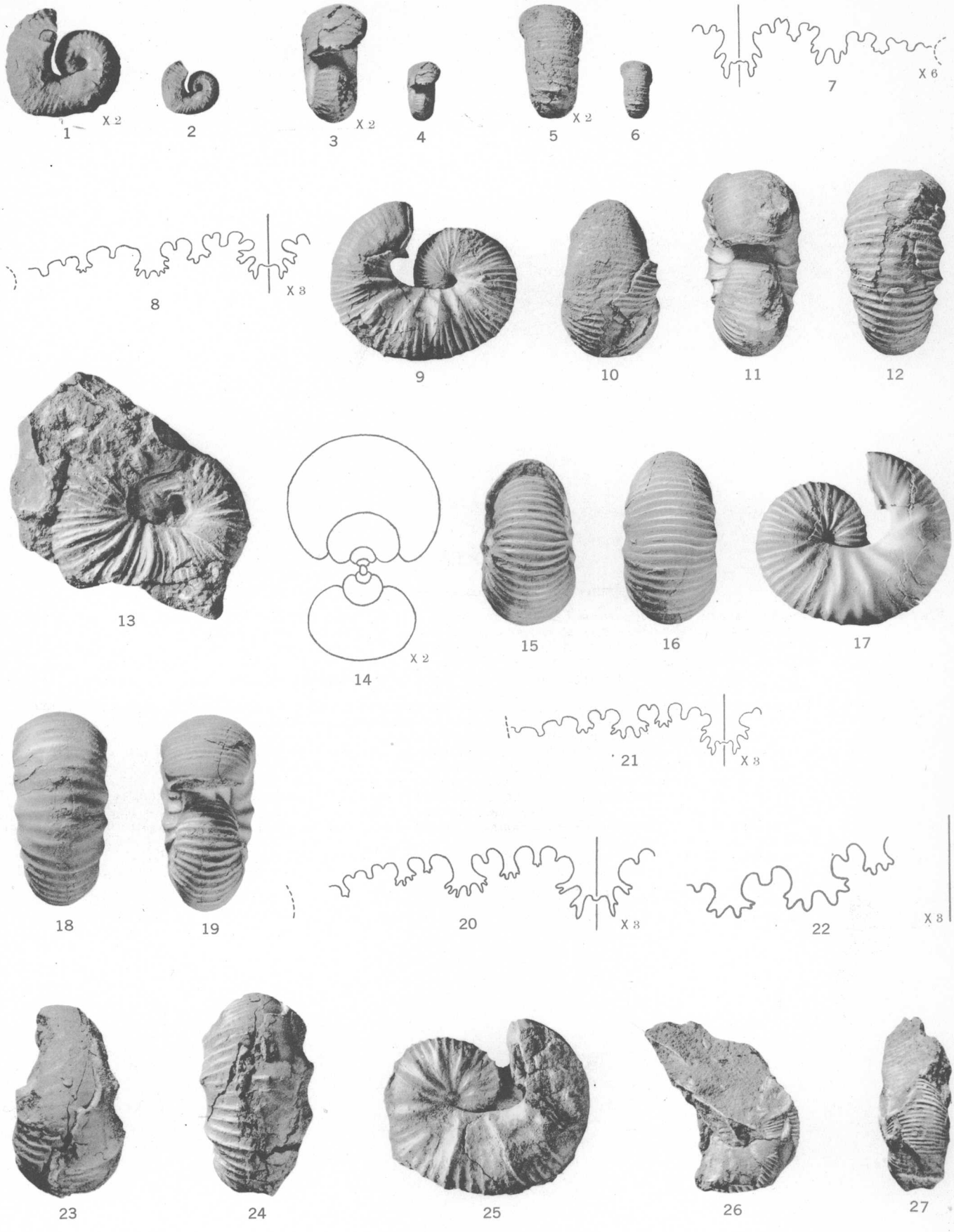

SCAPHITES OF THE COLORADO GROUP

PLATE 4

[All figures natural size except as indicated on plate]

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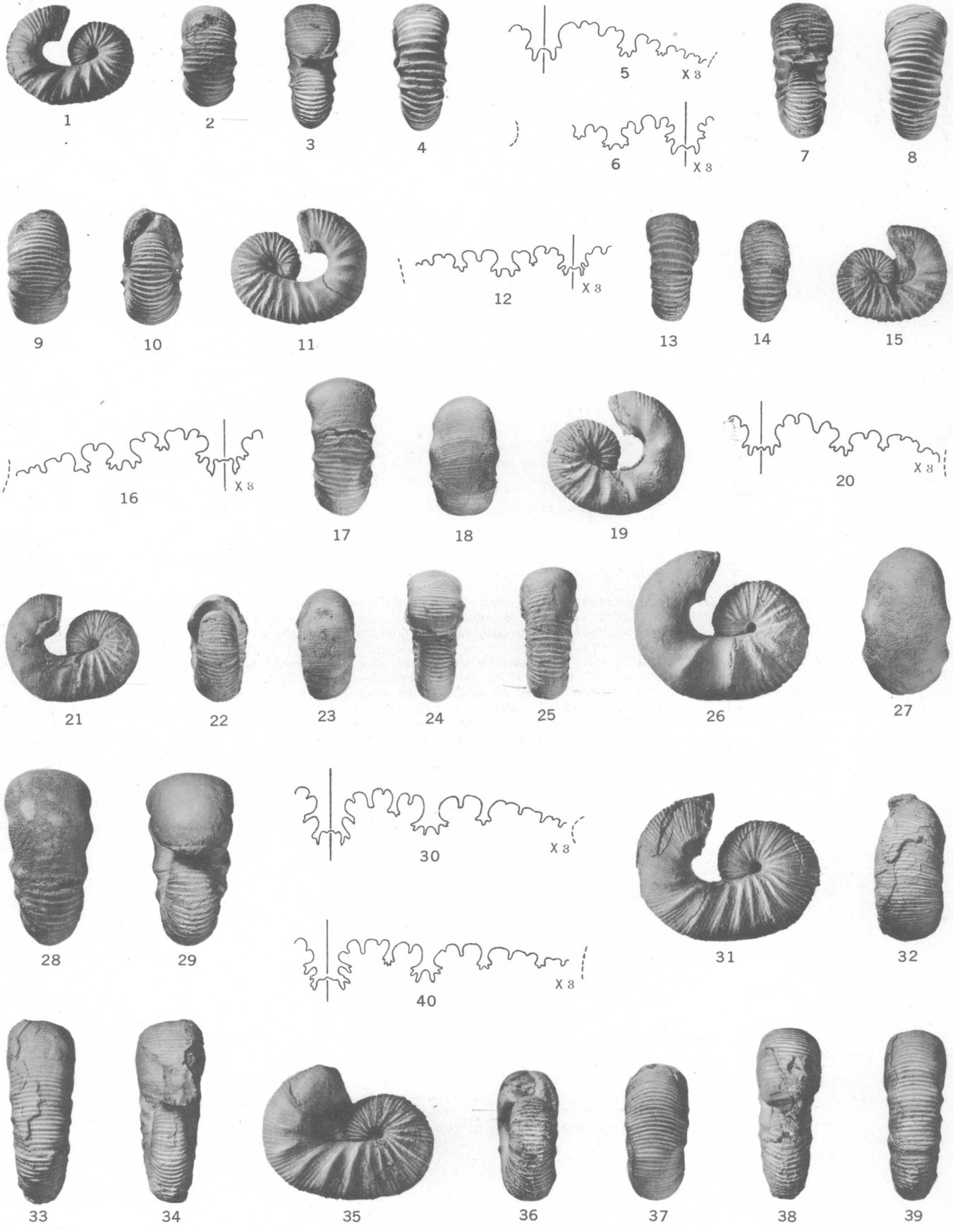

SCAPHITES OF THE COLORADO GROUP

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[All figures natural size except as indicated on plate]

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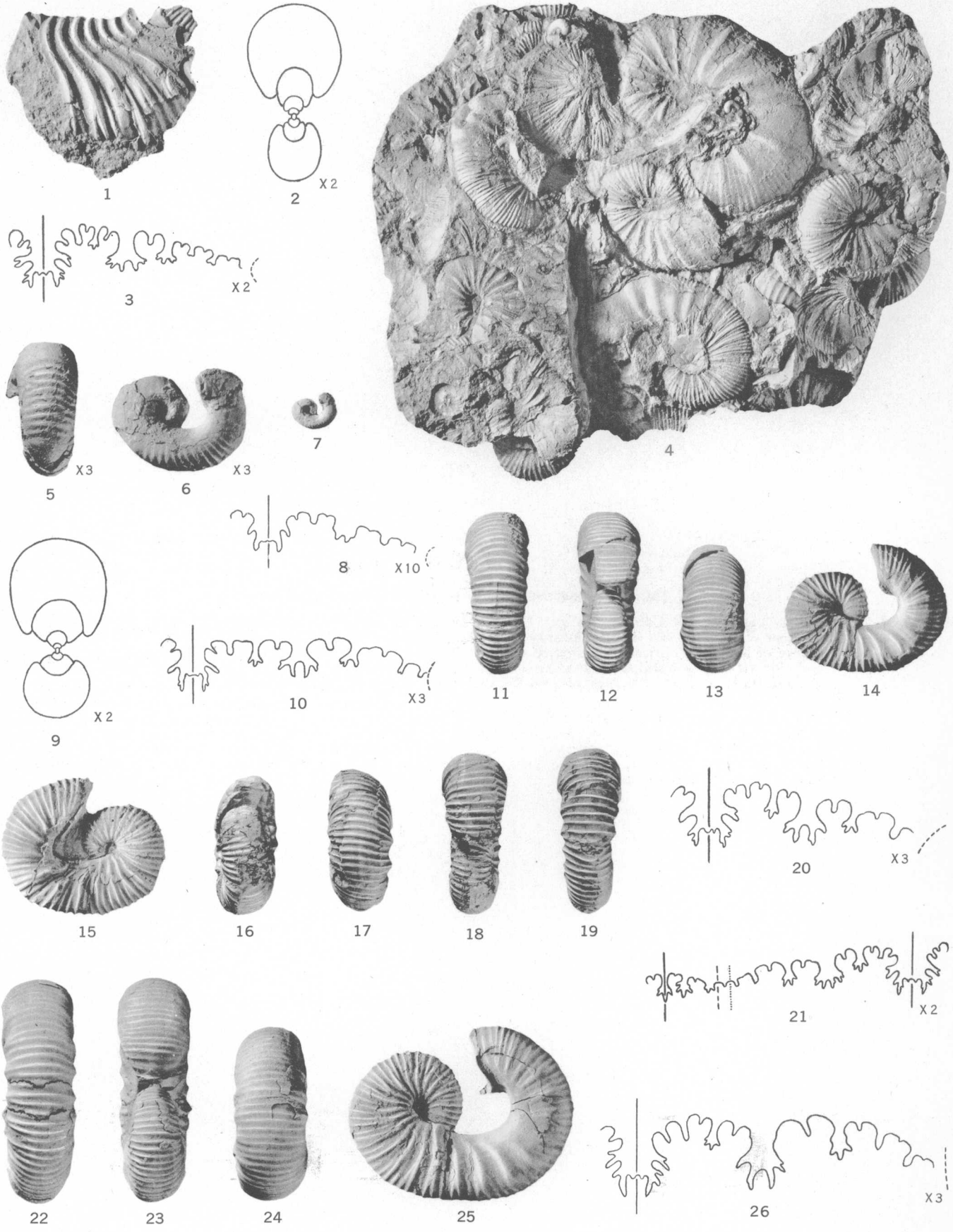
5–8. *Scaphites pisinnus* Cobban, n. sp. Bottom and side views, and sixth from last suture of holotype, an internal mold retaining part of the shell, U.S.N.M. 106762. From same locality as figure 1 (p. 25).

9–26. *Scaphites nigricollensis* var. *meeki* Cobban, n. var. From a calcareous concretion bed 59 feet below top of Turner sandy member of Carlile shale at map locality 114. 9, Cross section through septate whorls at diameter of 16.5 mm. of a complete specimen, U.S.N.M. 106734b. 10–14, Second from last suture, and bottom, top, rear, and side views of holotype, U.S.N.M. 106733. 15–20, Side, front, rear, top, and bottom views, and next to last suture of an internal mold, U.S.N.M. 106734a. 21, Second from last suture of an internal mold of an adult specimen, U.S.N.M. 106734d. 22–26, Bottom, top, rear, and side views, and next to last suture of a large specimen retaining some of the shell, U.S.N.M. 106734c (p. 26).



SCAPHITES OF THE COLORADO GROUP

PLATE 6

[All figures natural size except as indicated on plate]

FIGURES 1–17. *Scaphites nigricollensis* Cobban, n. sp. From a bed of calcareous concretions 59 feet below top of Turner sandy member of Carlile shale at map locality 114. 1–6, Bottom, top, rear, front, and side views, and second from last suture of holotype, an internal mold, U.S.N.M. 106730. 7–12, Next to last suture, and front, rear, top, bottom, and side views of a paratype, an internal mold, U.S.N.M. 106731b. 13–17, Fifth from last suture, and side, rear, top and bottom views of a paratype, an internal mold, U.S.N.M. 106731a (p. 25).

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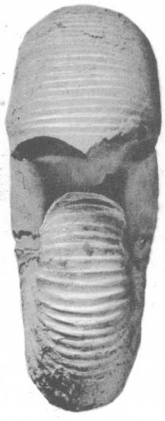

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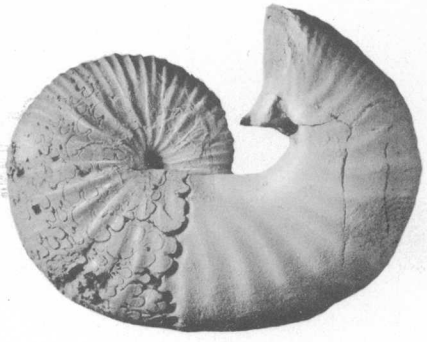

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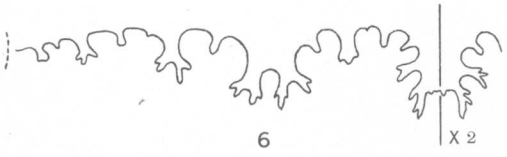

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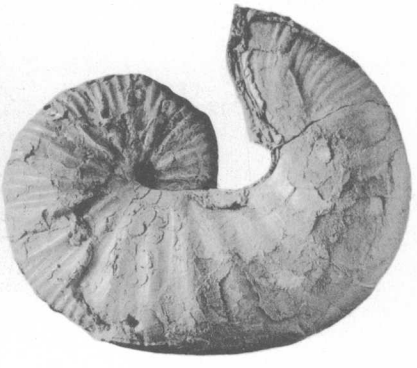

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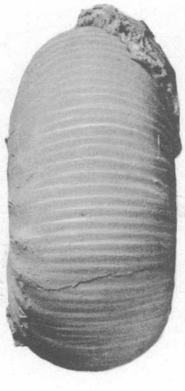

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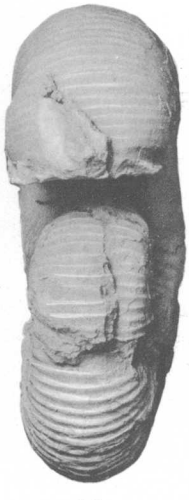

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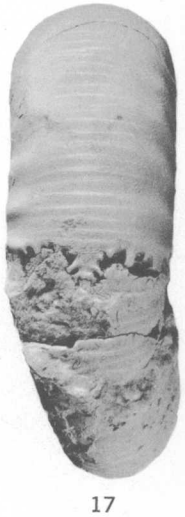

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SCAPHITES OF THE COLORADO GROUP

PLATE 7

[All figures natural size except as indicated on plate]

FIGURES 1–5. *Scaphites nigricollensis* Cobban, n. sp. 1–3, Bottom and side views, and second from last suture of an internal mold, U.S.N.M. 106732. From Carlile shale at map locality 133. 4, About tenth from last suture of a paratype, U.S.N.M. 106731d. From a calcareous concretion 59 feet below top of Turner sandy member of Carlile shale at map locality 114. 5, Cross section of septate whorles of an incomplete specimen, U.S.N.M. 106731c, from same locality as figure 4 (p. 25).

6–10. *Scaphites corvensis* Cobban, n. sp. Side, rear, and bottom views, cross section through straight part of living chamber, and next to last suture of holotype, an internal mold retaining part of the shell, U.S.N.M. 106755. From a calcareous concretion 180 feet above base of Carlile member of Cody shale at map locality 95 (p. 26).

11–17. *Scaphites corvensis* var. *bighornensis* Cobban, n. var. Next to last suture, side, front, rear, top, and bottom views, and cross section through straight part of living chamber of holotype, an internal mold, U.S.N.M 106756. From same locality as figures 6–10 (p. 26).

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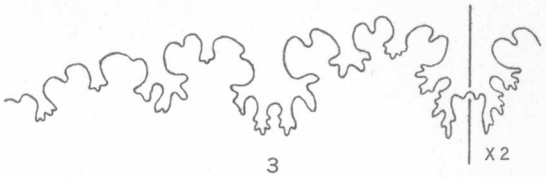

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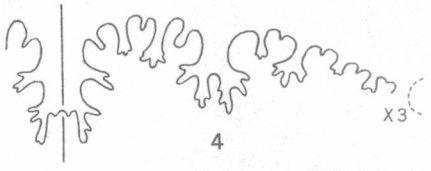

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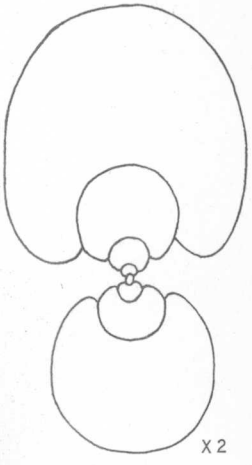

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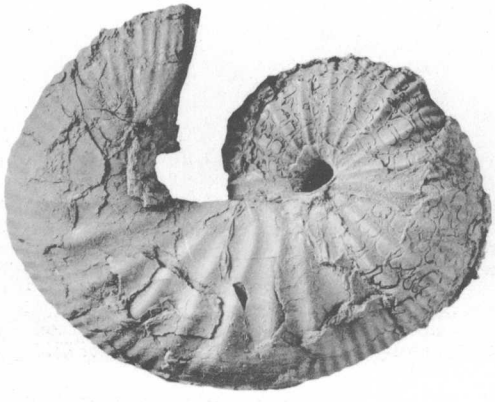

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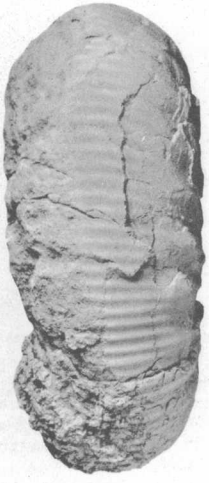

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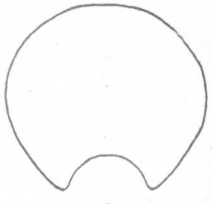

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SCAPHITES OF THE COLORADO GROUP

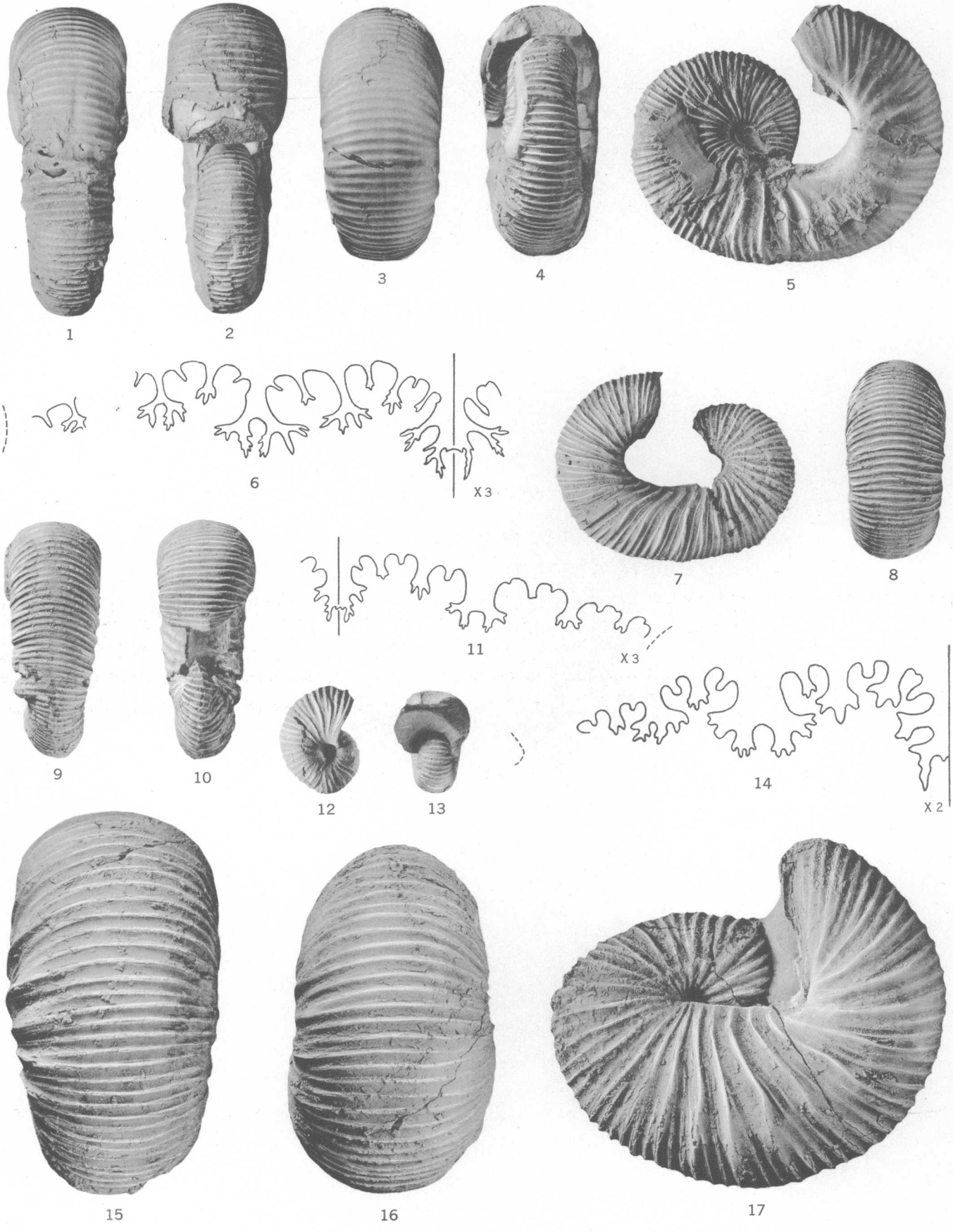
PLATE 8

[All figures natural size except as indicated on plate]

FIGURES 1–6. *Scaphites preventricosus* Cobban var. *artilobus* Cobban, n. var. Bottom, top, rear, front, and side views, and next to last suture (composite) of holotype, U.S.N.M. 106680. From a ferruginous concretion bed 617–634 feet below top of Colorado shale at map locality 34 (p. 27).

7–13. *Scaphites mariasensis* Cobban var. *gracillistriatus* Cobban, n. var. 7–11, Side, rear, bottom, and top views, and second from last suture of holotype, an internal mold, U.S.N.M. 106682. From same locality as figures 1–6. 12, 13, Side and front views of an immature specimen with nearly complete living chamber, U.S.N.M. 106683, from the same locality (p. 28).

14–17. *Scaphites mariasensis* Cobban, n. sp. Last suture, and bottom, rear, and side views of holotype, an internal mold, U.S.N.M. 106681. From same locality as figures 1–6 (p. 28).

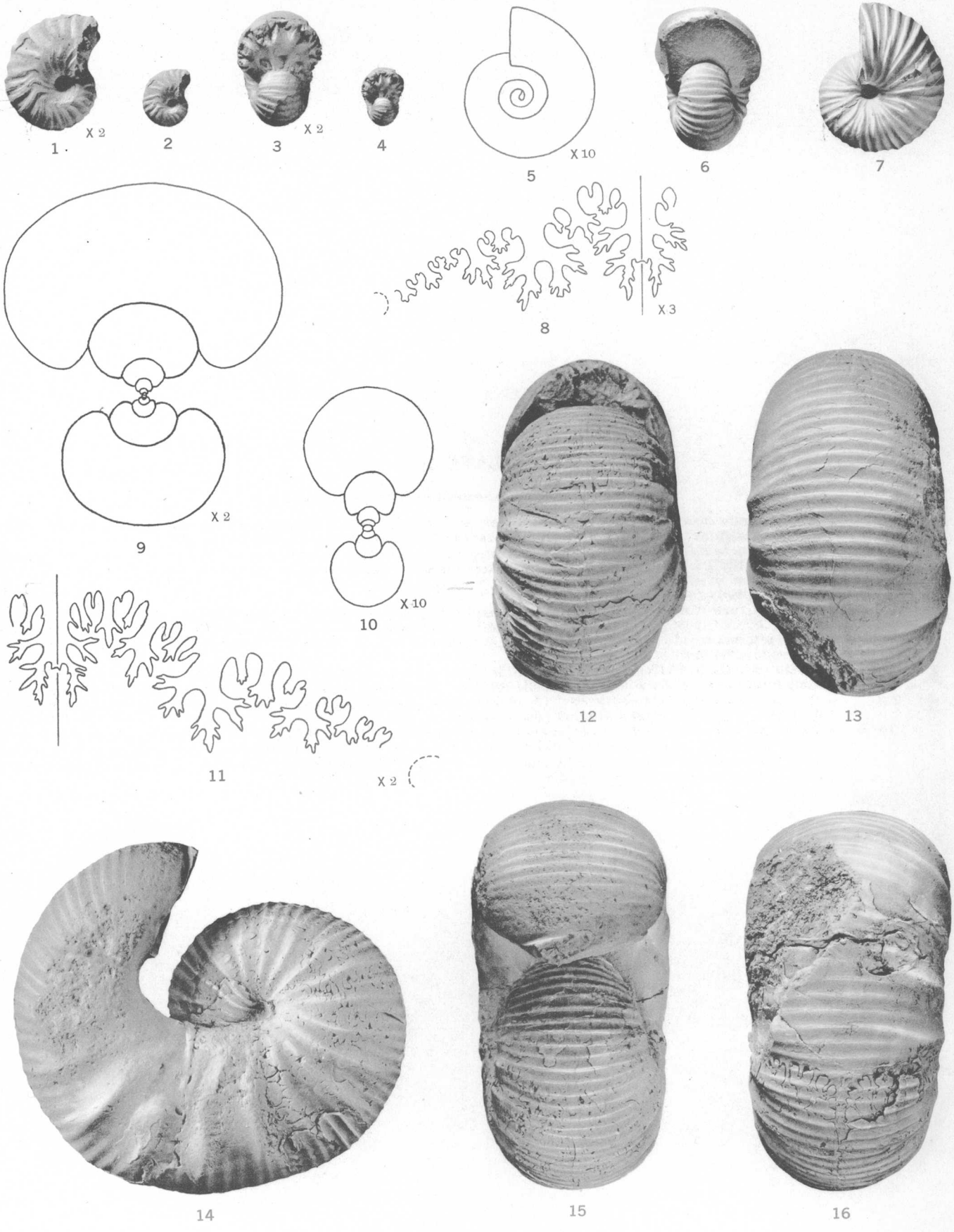


SCAPHITES OF THE COLORADO GROUP

PLATE 9

[All figures natural size except as indicated on plate]

FIGURES 1–16. *Scaphites preventricosus* Cobban, n. sp. 1–4, Side and front views of internal whorls at diameter of 11.8 mm. of a specimen retaining most of the shell, U.S.N.M. 106676d. From a bed of calcareous concretions 514–525 feet below top of Colorado shale at map locality 35. 5, Side view of the earliest whorls of a specimen at diameter of 2.8 mm., U.S.N.M. 106676a, from the same locality. 6–8, Front and side views, and last suture of an immature specimen with most of the living chamber, U.S.N.M. 106676c, from the same locality. 9, Cross section through septate whorls at diameter of 32.5 mm. of an incomplete specimen, U.S.N.M. 106679. From a bed of calcareous concretions in the Colorado shale 202–207 feet above top of a calcareous member of Greenhorn age at map locality 48. 10, Cross section at diameter of 4 mm. of an immature specimen, U.S.N.M. 106676b, from same locality as figures 1–4. 11–16, Sixth from last suture, and front, rear, side, top, and bottom views of holotype, an internal mold, U.S.N.M. 106675, from same locality as figures 1–4 (p. 26).



SCAPHITES OF THE COLORADO GROUP

PLATE 10

[All figures natural size except as indicated on plate]

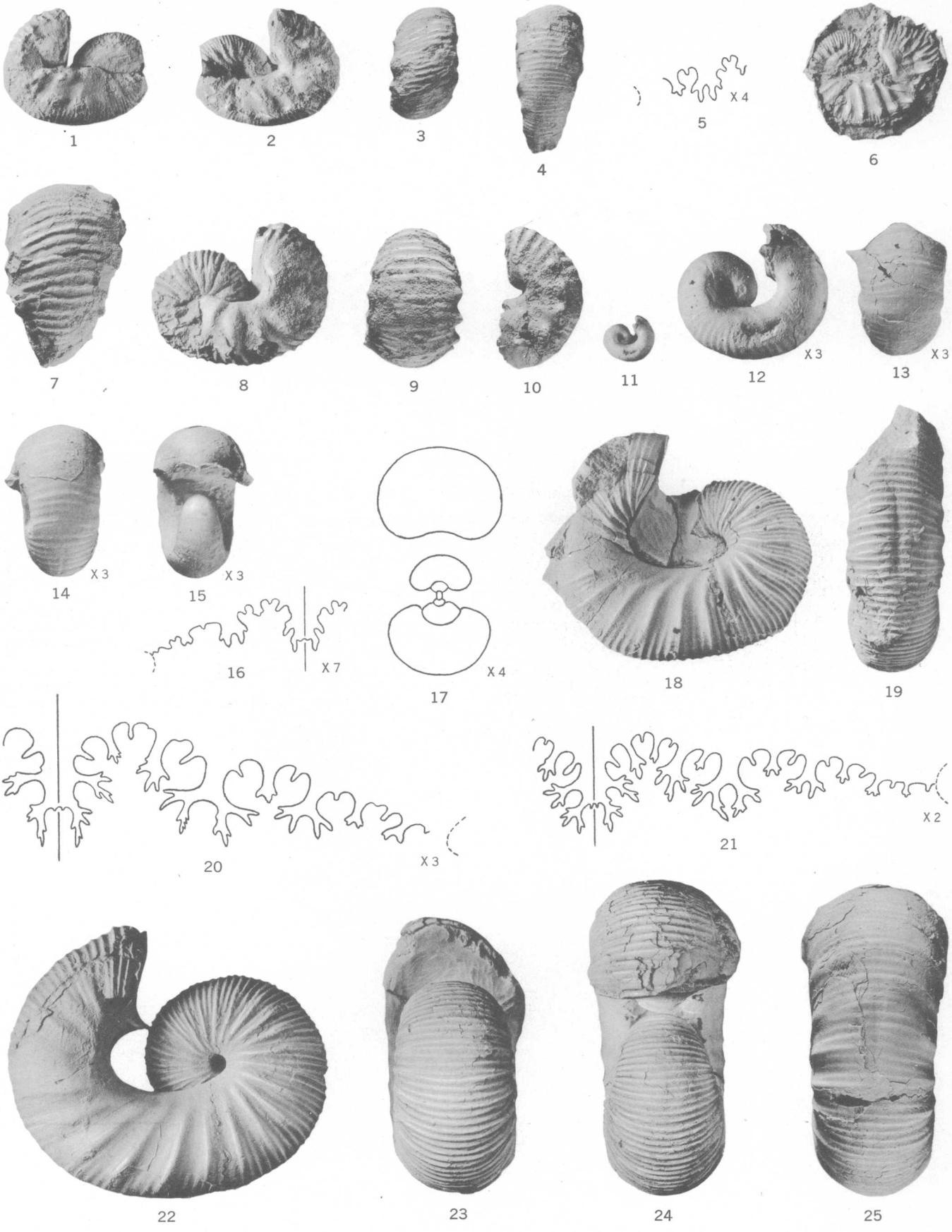
FIGURES 1–4. *Scaphites frontierensis* Cobban, n. sp. Side, rear, and bottom views of holotype, an internal mold, U.S.N.M. 106704. From a sandstone bed 180 feet below top of Frontier formation at map locality 180 (p. 30).

5, 6. *Scaphites uintensis* Cobban, n. sp. 5, First lateral lobe and part of adjoining saddles of last suture of paratype, U.S.N.M. 106703. From the Mancos shale 180 feet above top of Frontier sandstone member at map locality 248. 6, Side view of an artificial cast made from the holotype, an impression in shale, U.S.N.M. 106702, from same locality as figure 5 (p. 29).

7–10. *Scaphites sagensis* Cobban, n. sp. 7, 8, Bottom and side views of holotype, a distorted specimen retaining part of the shell, U.S.N.M. 106696. From upper part of Frontier formation at map locality 195. 9, 10, Rear and side views of the internal mold of an incomplete living chamber, U.S.N.M. 106697. From upper part of Frontier formation at map locality 196 (p. 30).

11–17. *Scaphites auriculatus* Cobban, n. sp. 11–16, Side, rear, bottom, and top views, and last suture of holotype, an internal mold retaining part of the shell, U.S.N.M. 106684. From a bed of calcareous concretions 514–525 feet below top of Colorado shale at map locality 35. 17, Cross section through the septate whorls and living chamber of an adult specimen, U.S.N.M. 106685, from the same locality (p. 30).

18–25. *Scaphites preventricosus* Cobban var. *sweetgrassensis* Cobban. 18–20, Side and bottom views, and fourth from last suture of a small internal mold retaining some of the shell, U.S.N.M. 106678, from same locality as figures 11–16. 21–25, Second from last suture, and side, front, top, and bottom views of holotype, an internal mold, U.S.N.M. 106677, from the same locality (p. 27).



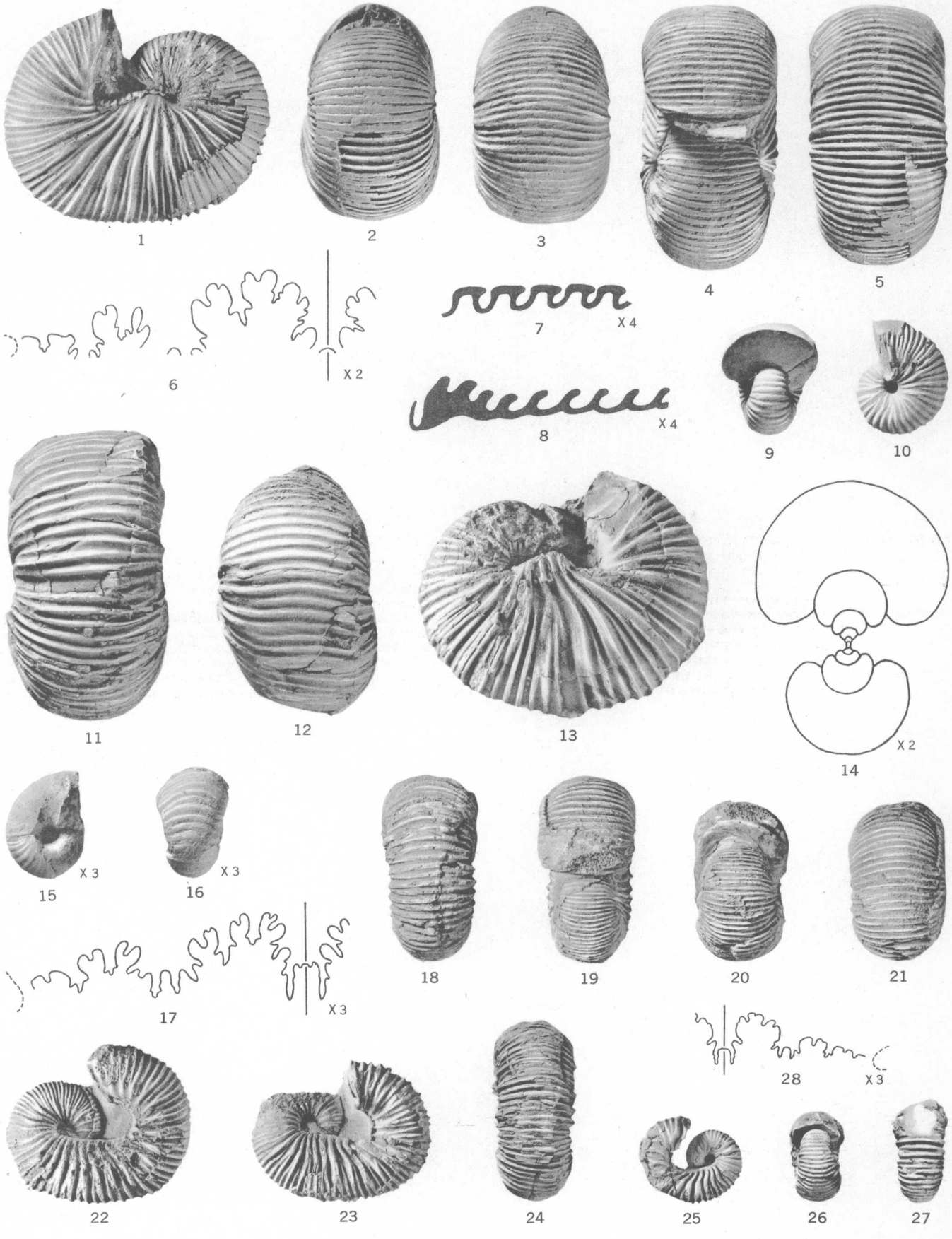
SCAPHITES OF THE COLORADO GROUP

PLATE 11

[All figures natural size except as indicated on plate]

FIGURES 1–14. *Scaphites impendicostatus* Cobban, n. sp. 1–8, Side, front, rear, top, and bottom views, last suture, cross section of shell on straight part of living chamber, and cross section of shell at oral end of living chamber of holotype, an internal mold retaining part of the shell, U.S.N.M. 106686. From a bed of calcareous concretions in the Colorado shale 183–197 feet above top of calcareous member of Greenhorn age at map locality 47. 9, 10, Front and side views of an immature specimen with most of the shell, U.S.N.M. 106687, from the same locality. 11–13, Bottom, rear, and side views of a coarsely ribbed specimen, an internal mold with part of the shell, U.S.N.M. 106689. From the Colorado shale 500–580 feet below the top at map locality 20. 14, Cross section of septate whorls at diameter of 26 mm. of an incomplete specimen, U.S.N.M. 106688. From a limestone concretion at base of Niobrara shale member of Cody shale at map locality 91 (p. 28).

15–28. *Scaphites impendicostatus* var. *erucoides* Cobban, n. var. 15, 16, Side and rear views of an immature specimen, an internal mold with nearly complete living chamber, U.S.N.M. 106691, from same locality as figure 14. 17–22, Third from last suture, and bottom, top, front, rear, and side views of holotype, an internal mold, U.S.N.M. 106690. From a sandstone bed at top of Frontier formation at map locality 199. 23, 24, Side and bottom views of an internal mold with some of the shell, U.S.N.M. 106692a. From a bed of calcareous concretions 514–525 feet below top of Colorado shale at map locality 35. 25–28, Side, front, and bottom views, and next to last suture (composite) of a small adult specimen, U.S.N.M. 106692b, possessing fewer ribs than the typical form. From same locality as figures 23, 24 (p. 29).

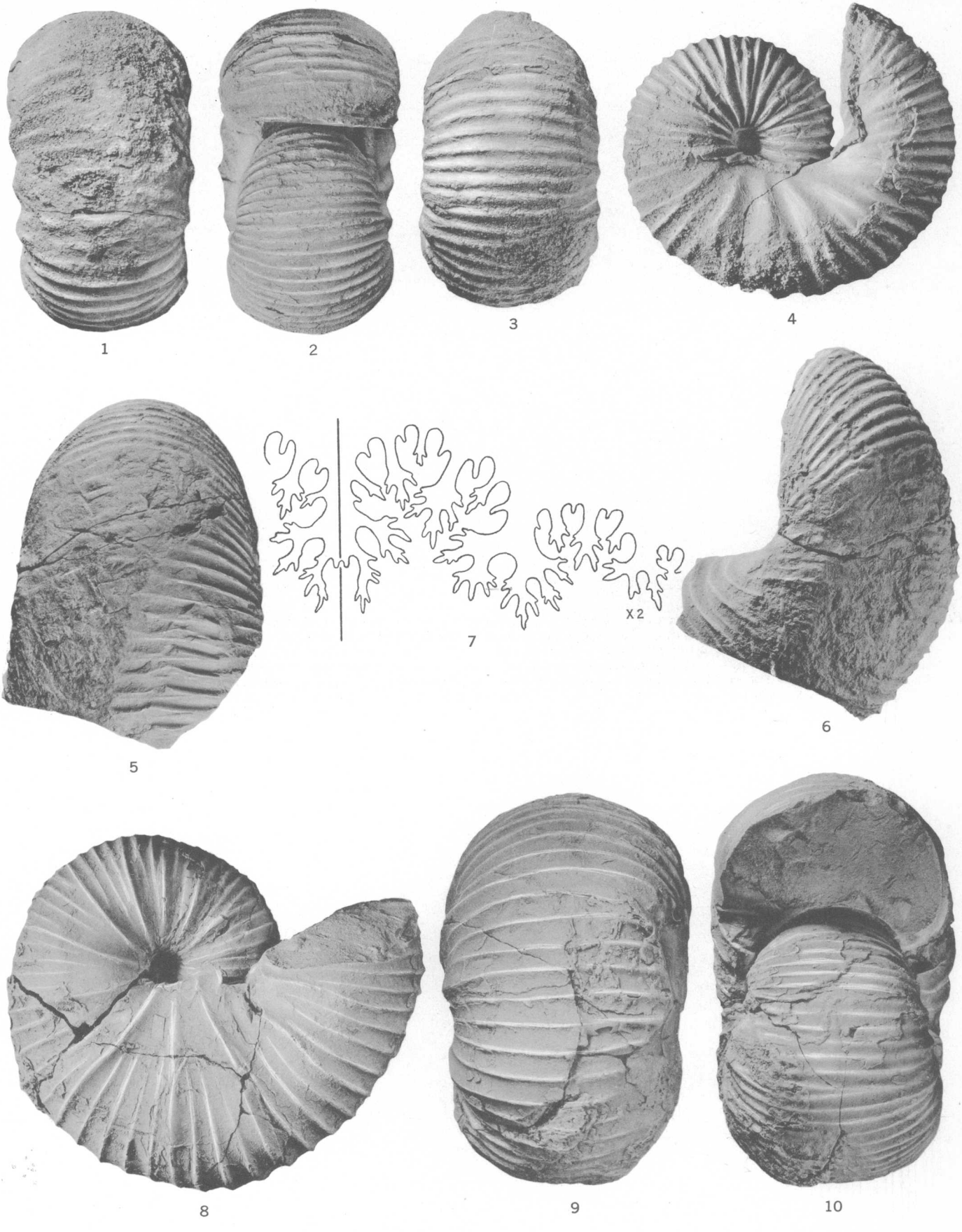


SCAPHITES OF THE COLORADO GROUP

PLATE 12

[All figures natural size except as indicated on plate]

FIGURES 1–10. *Scaphites ventricosus* Meek and Hayden. 1–4, Bottom, top, rear, and side views of a specimen retaining part of the shell, U.S.N.M. 106700. From a sandstone bed 538 feet above base of Cody shale at map locality 177. 5, 6, Rear and side views of an internal mold of an incomplete adult living chamber, U.S.N.M. 106699, showing the right-angle bend between the aperture and the umbilical wall. From a ferruginous concretion bed 306–392 feet below top of Colorado shale at map locality 18. 7, Suture of a specimen, U.S.N.M. 106698, from same locality as figures 5, 6. 8–10, Side, bottom, and top views of holotype, U.S.N.M. 1903. From Colorado shale at map locality 55 (p. 31).



SCAPHITES OF THE COLORADO GROUP

PLATE 13

[All figures natural size except as indicated on plate]

FIGURES 1–10. *Clioscaphites saxitonianus* (McLearn). 1–5, Side and rear views and suture of the internal whorls of a specimen, U.S.N.M. 106739b. From a calcareous concretion in the Colorado shale 165 feet below the top at map locality 38. 6–10, Side, top, rear, and bottom views, and last suture of an internal mold retaining a little of the shell, U.S.N.M. 106739a, from the same locality (p. 36).

11–13. *Scaphites ventricosus* Meek and Hayden. Side, rear, and bottom views of a slightly crushed internal mold, U.S.N.M. 106757. From a ferruginous concretion 330 feet below top of Colorado shale at map locality 39 (p. 31).

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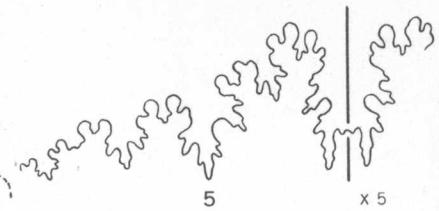

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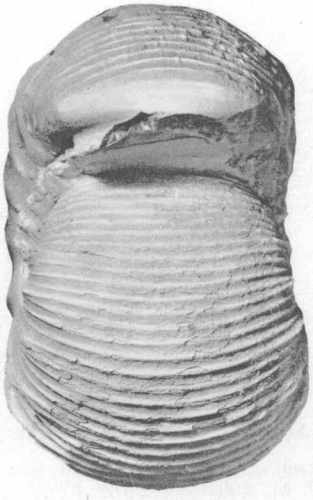

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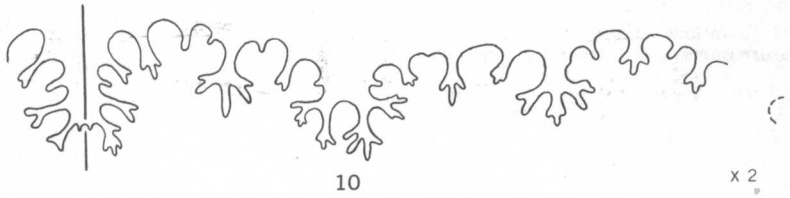

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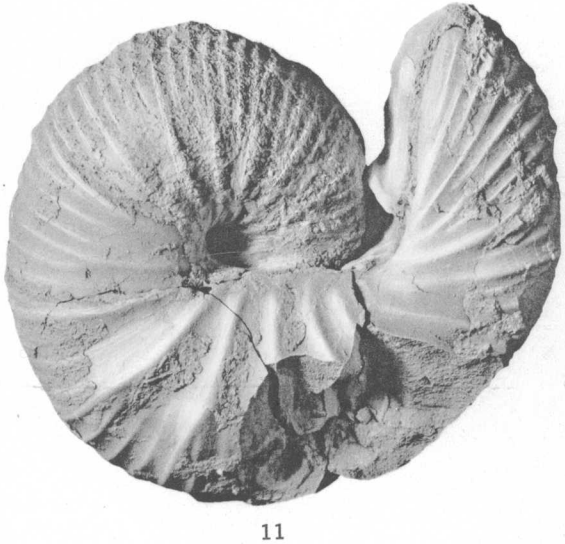

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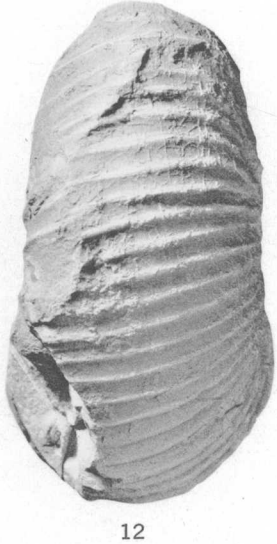

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SCAPHITES OF THE COLORADO GROUP

PLATE 14

[All figures natural size except as indicated on plate]

FIGURES 1–10. *Scaphites tetonensis* Cobban, n. sp. 1–5, Side, rear, top, and bottom views, and next to last suture of a partly crushed small paratype, U.S.N.M. 106708. From Cody shale 1,283 feet above base at map locality 179. 6–10, Side, rear, bottom, and top views, and last suture of holotype, an internal mold, U.S.N.M. 106707. From Cody shale 500 feet above base at map locality 177 (p. 31).

11–16. *Scaphites binneyi* Reeside. 11–15, Last suture, and top, bottom, rear, and side views of a stout variant, an internal mold, U.S.N.M. 106705. From the Cody shale 574–774 feet above base at map locality 201. 16, Suture at diameter of 22 mm. of a specimen, U.S.N.M. 106706. From the Cody shale 450–574 feet above the base at map locality 200 (p. 32).

17–21. *Scaphites interjectus* Reeside. Seventh from last suture, and side, rear, top, and bottom views of a small specimen, U.S.N.M. 106701. From a calcareous concretion in the Cody shale about 1,500 feet above the base at map locality 189 (p. 32).

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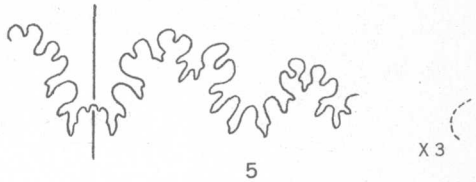

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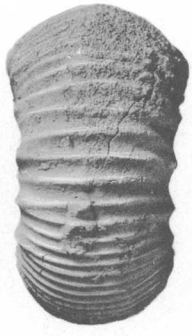

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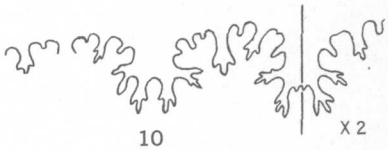

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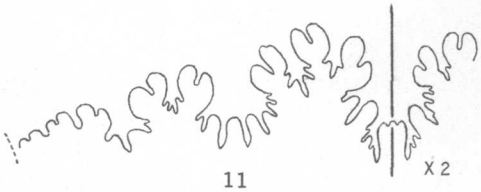

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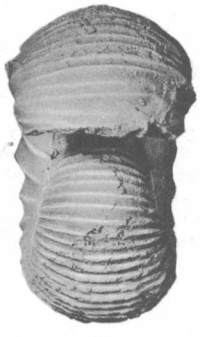

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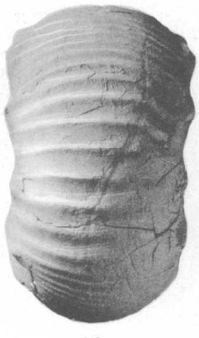

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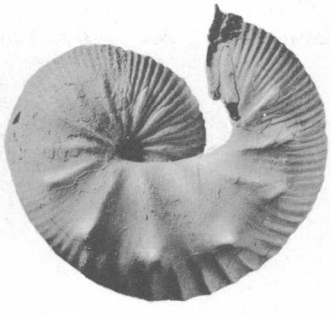

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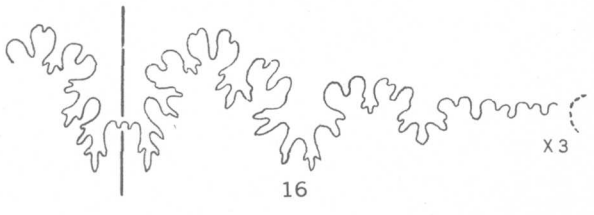

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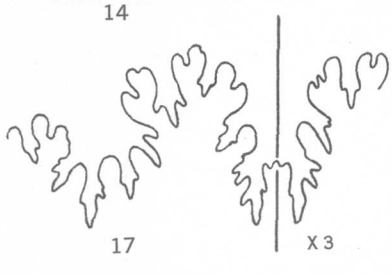

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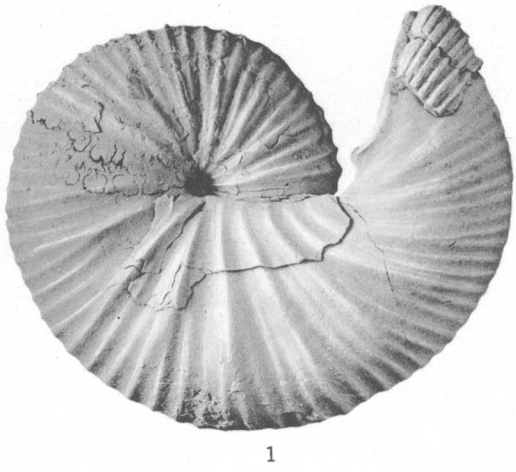
SCAPHITES OF THE COLORADO GROUP

PLATE 15

[All figures natural size except as indicated on plate]

FIGURES 1–5. *Scaphites depressus* Reeside var. *stantoni* Reeside. Side, rear, top, and bottom views, and last suture of a specimen, U.S.N.M. 106695, transitional from *S. ventricosus*. From a ferruginous concretion 370 feet above base of Cody shale at map locality 148 (p. 33).

6–8. *Scaphites depressus* Reeside. Second from last suture, and side and rear views of a specimen retaining much of the shell, U.S.N.M. 106693. From a calcareous concretion about 700 feet above base of Cody shale at map locality 145 (p. 32).



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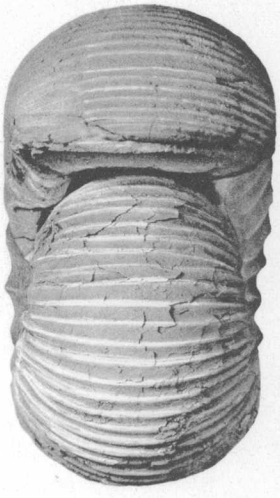

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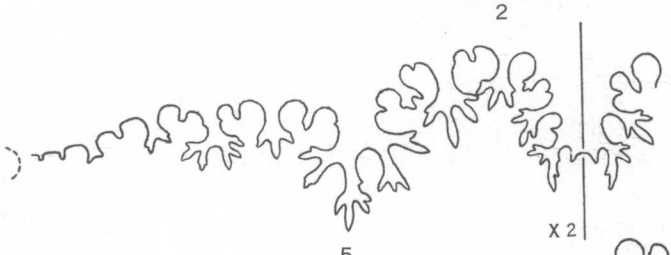

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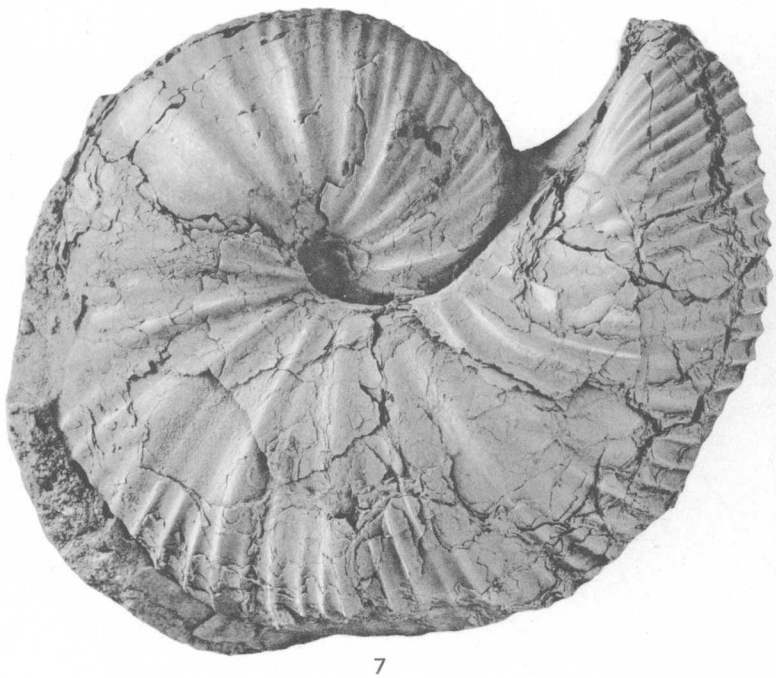

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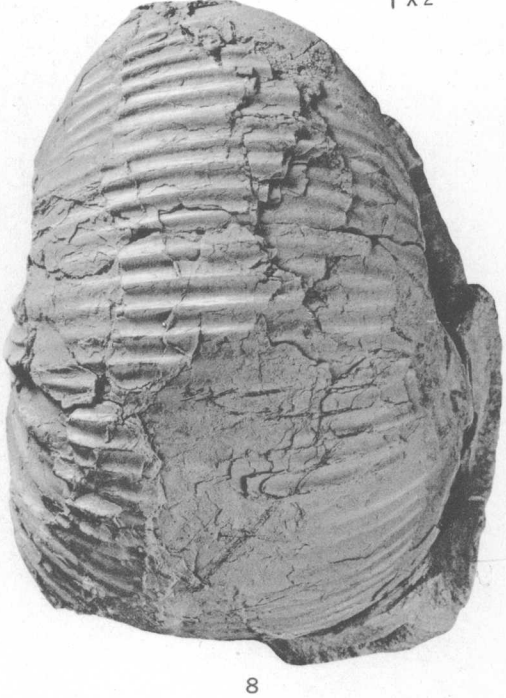

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SCAPHITES OF THE COLORADO GROUP

PLATE 16

[All figures natural size except as indicated on plate]

FIGURES 1–11. *Clioscaphites montanensis* Cobban, n. sp. From a bed of calcareous concretions 234–252 feet below top of Colorado shale at map locality 33. 1–5, Side, rear, top, and bottom views, and last suture of holotype, U.S.N.M. 106716. 6–8, Side, front, and rear views of an internal mold of septate whorls at diameter of 13 mm. of a specimen, U.S.N.M. 106717c. 9–11, Side, top, and bottom views of an internal mold retaining some of the shell, U.S.N.M. 106717b (p. 34).

12–14. *Clioscaphites montanensis* Cobban var. *hesperius* Cobban, n. var. Side, rear, and bottom views of holotype, U.S.N.M. 106718, from the same locality (p. 34).

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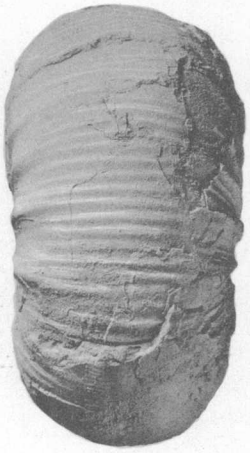

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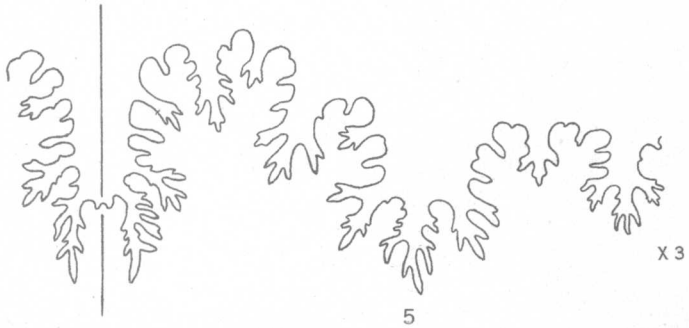

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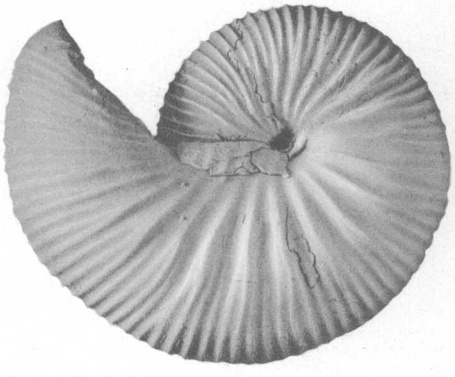

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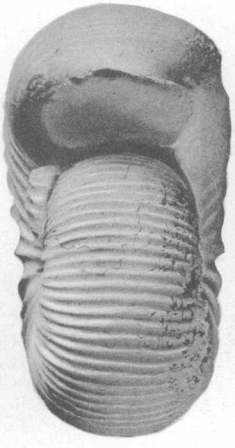

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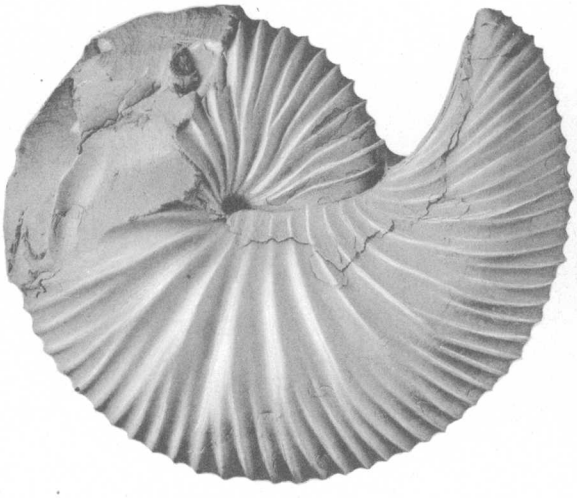

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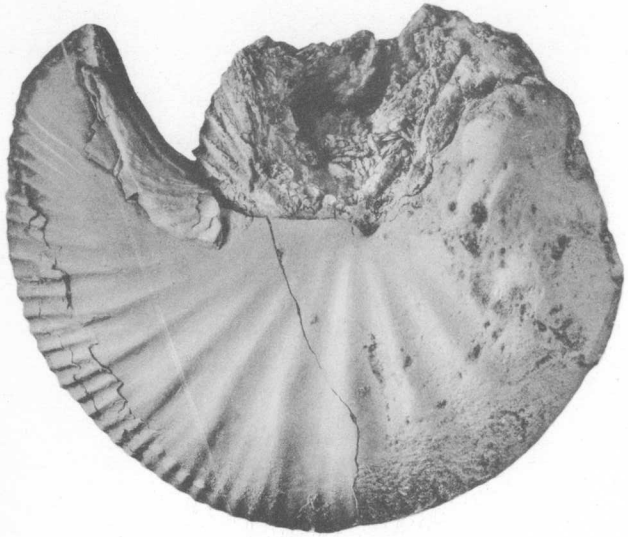
SCAPHITES OF THE COLORADO GROUP

PLATE 17

[All figures natural size except as indicated on plate]

FIGURES 1–3. *Clioscaphites montanensis* Cobban, n. sp. Side and bottom views, and suture at diameter of 56 mm. of a large internal mold, U.S.N.M. 106717d. From a bed of calcareous concretions 234–252 feet below top of Colorado shale at map locality 33 (p. 34).

4–7. *Clioscaphites montanensis* Cobban var. *hesperius* Cobban, n. var. Bottom, front, and side views, and second from last suture of a large internal mold, U.S.N.M. 106719, from the same locality (p. 34).



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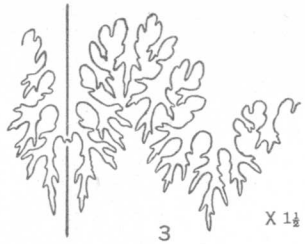

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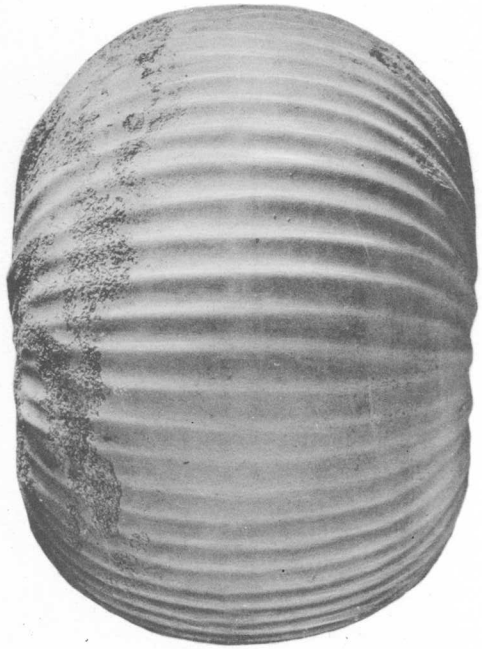

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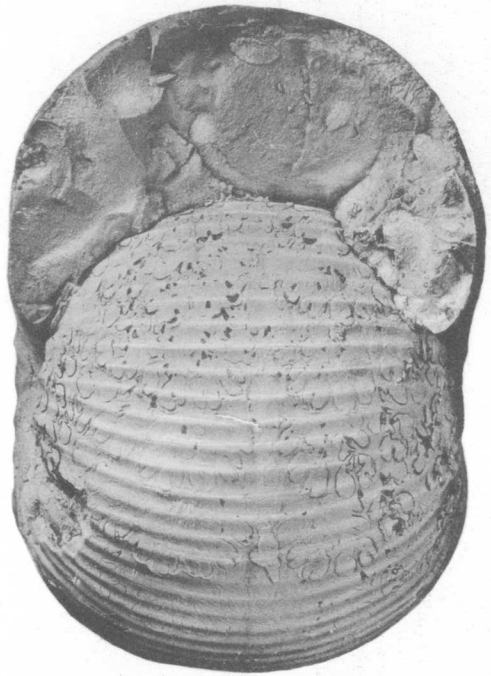

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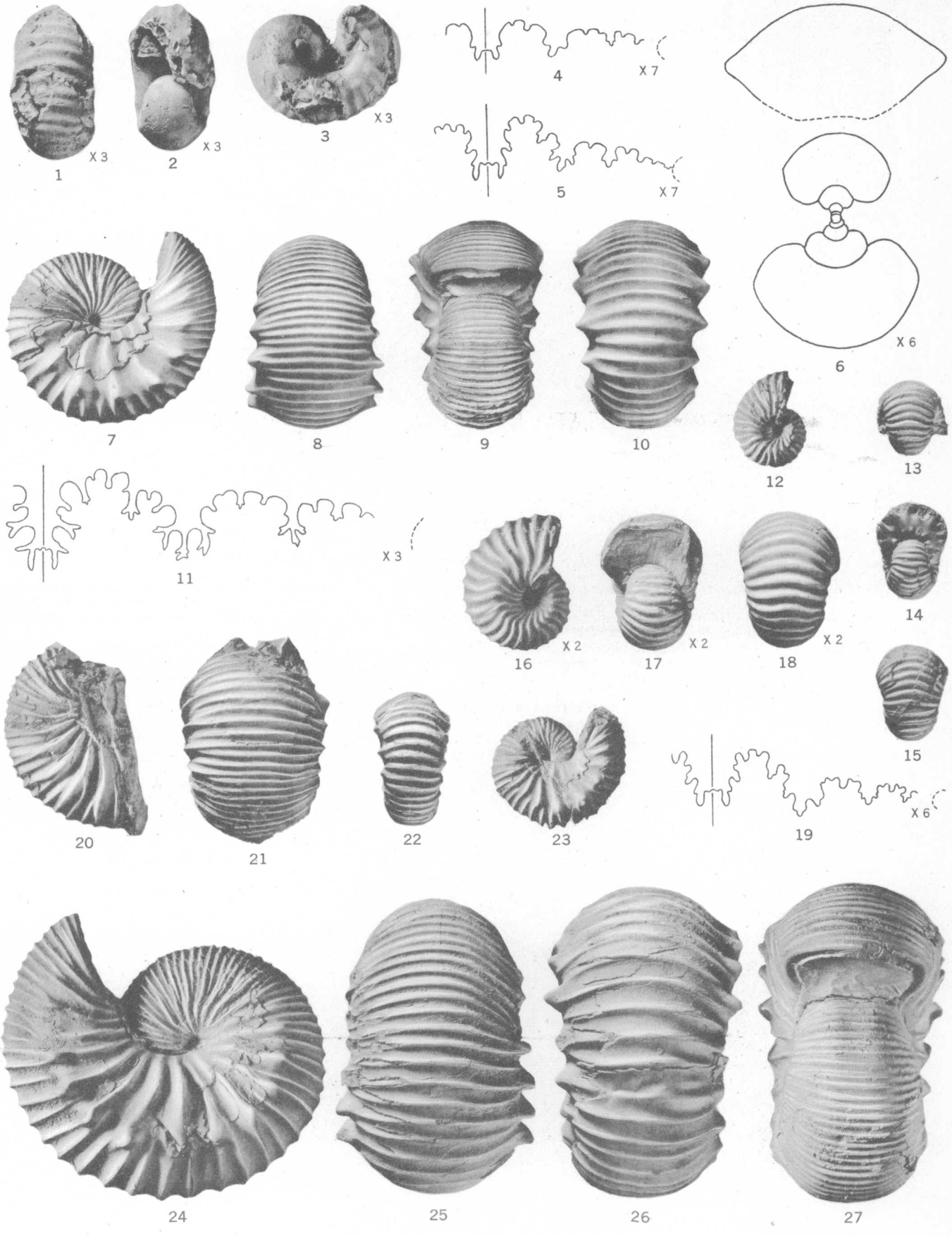
SCAPHITES OF THE COLORADO GROUP

PLATE 18

[All figures natural size except as indicated on plate]

FIGURES 1–6. *Scaphites coloradensis* Cobban, n. sp. From calcareous concretions 234–252 feet below top of Colorado shale at map locality 33. 1–4, Bottom, top, and side views, and next to last suture of holotype, an internal mold, U.S.N.M. 106715. 5, 6, Fourth from last suture, and cross section through septate whorls and oral end of living chamber of an adult specimen, U.S.N.M. 106714 (p. 33).

7–27. *Clioscaphites vermiformis* (Meek and Hayden). From same locality as figures 1–6. 7–11, Side, rear, top, and bottom views, and last suture of a small specimen retaining the shell on the septate whorls and partly on the living chamber, U.S.N.M. 106713d. 12–15, Side, bottom, front, and rear views of the internal whorls at diameter of 18.5 mm. of a specimen retaining much of the shell, U.S.N.M. 106713e. 16–19, Side, front, and rear views, and last suture of an immature specimen, an internal mold with complete living chamber, U.S.N.M. 106713f. 20, 21, Side and bottom views of the internal mold of the older part of the living chamber of a sharp-ribbed variant, U.S.N.M. 106713b. 22, 23, Bottom and side views of the smallest known adult specimen, U.S.N.M. 106713c. 24–27, Side, rear, bottom, and top views of a slightly larger than average adult specimen, U.S.N.M. 106713a (p. 35).

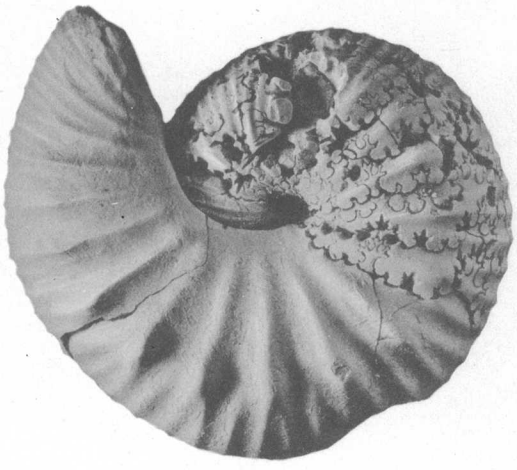


SCAPHITES OF THE COLORADO GROUP

PLATE 19

[All figures natural size except as indicated on plate]

FIGURES 1–10. *Clioscaphites vermiformis* (Meek and Hayden) var. *toolensis* Cobban, n. var. 1–5, Side, top, bottom, and rear views, and second suture (composite) from last of holotype, U.S.N.M. 106709. From a bed of calcareous concretions 234–252 feet below top of Colorado shale at map locality 33. 6–8, Last suture, and side and top views of the septate coil and part of the living chamber of a densely ribbed specimen, U.S.N.M. 106712. From a calcareous concretion near middle of Cody shale at map locality 98. 9, Fragment of the living chamber of the largest known specimen, U.S.N.M. 106710, from same locality as figures 1–5. 10, Cross section of septate whorls of an adult, U.S.N.M. 106711. From a calcareous concretion in the Niobrara member of the Cody shale at map locality 96 (p. 36).



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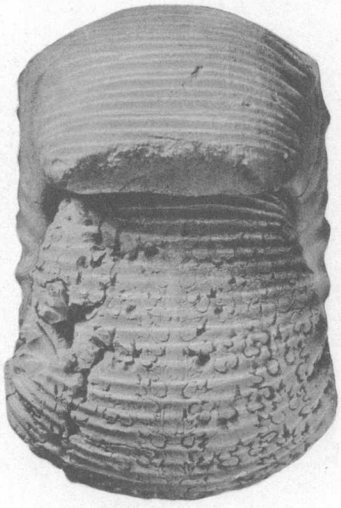

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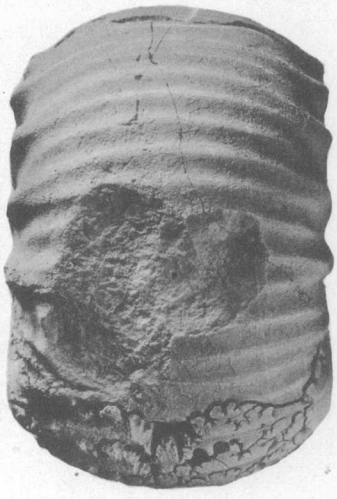

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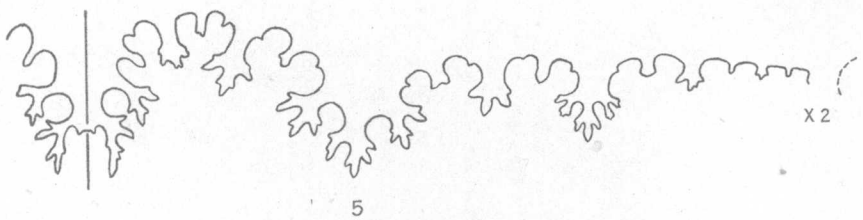

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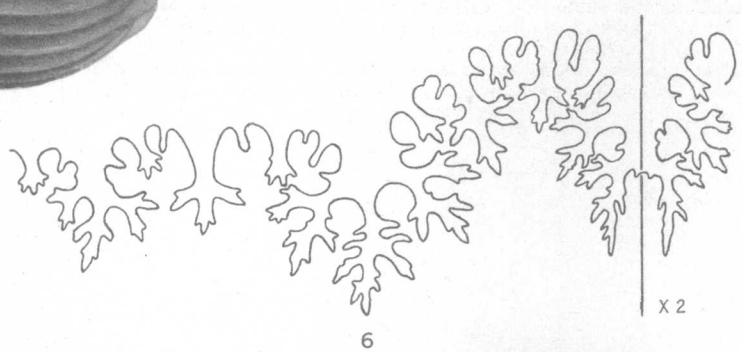

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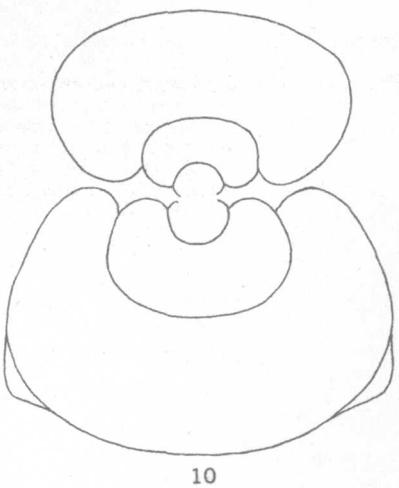

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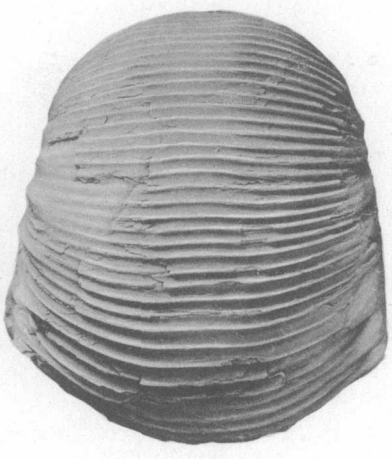

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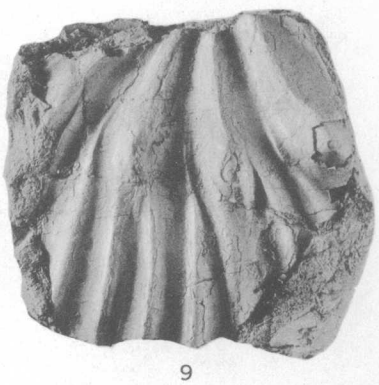

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SCAPHITES OF THE COLORADO GROUP

PLATE 20

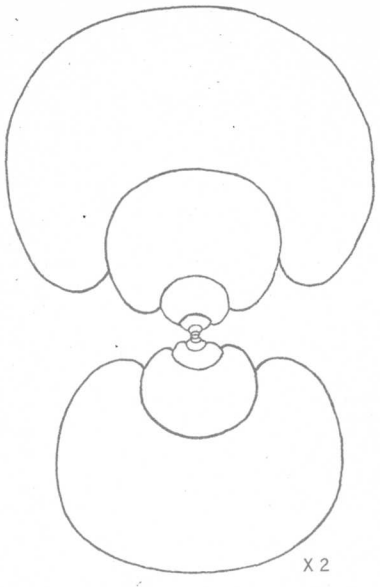
[All figures natural size except as indicated on plate]

FIGURES 1–4. *Clioscaphites montanensis* Cobban, n. sp. From calcareous concretions 234–252 feet below top of Colorado shale at map locality 33. 1, Cross section of septate whorls of an internal mold at diameter of 38 mm., U.S.N.M. 106726b. 2–4, Side and front views, and last suture of the internal mold of an immature specimen with complete living chamber, U.S.N.M. 106726a (p. 34).

5–7. *Clioscaphites saxitonianus* (McLearn) var. *keytei* Cobban, n. var. Side, top, and bottom views of holotype, an internal mold retaining part of the shell, U.S.N.M. 106727. From a calcareous concretion near top of Apishapa shale at map locality 266 (p. 37).

8–11. *Clioscaphites? choteauensis* Cobban, n. sp. Side, bottom, and rear views, and last suture of holotype, U.S.N.M. 106728. From a calcareous concretion near top of Colorado shale at map locality 44 (p. 38).

12–16. *Clioscaphites platygastrus* Cobban, n. sp. Last suture, and side, rear, top, and bottom views of holotype, an internal mold, U.S.N.M. 106729. From a calcareous concretion in upper part of Colorado shale at map locality 10 (p. 36).



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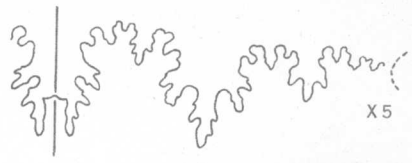

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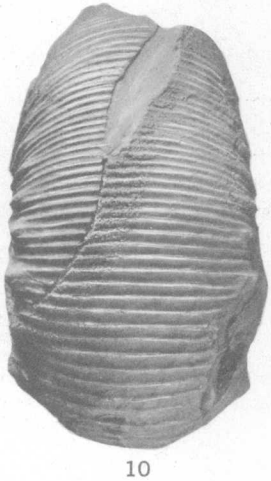

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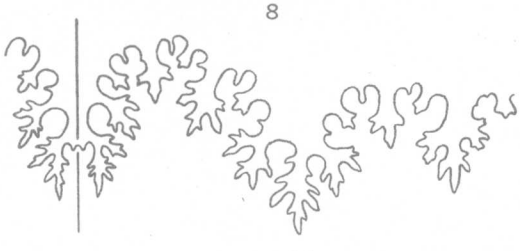

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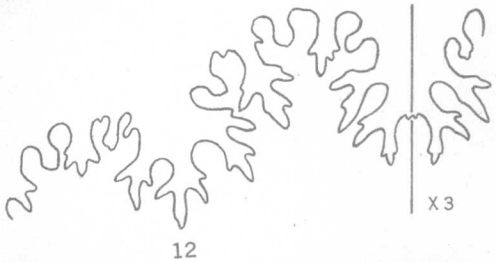

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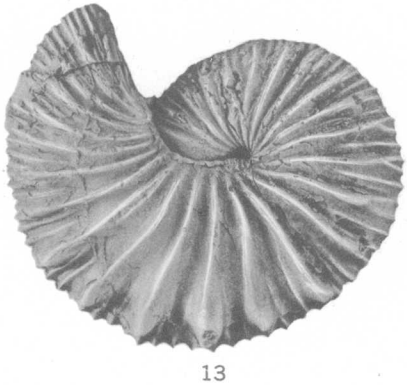

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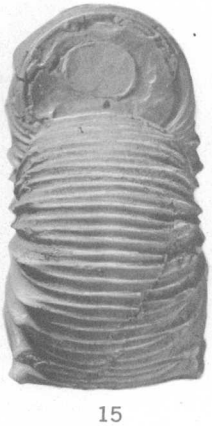

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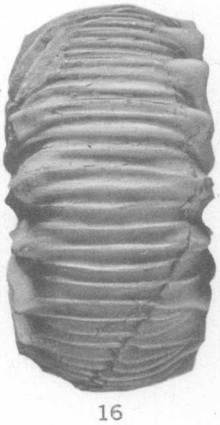

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SCAPHITES OF THE COLORADO GROUP

PLATE 21

[All figures natural size except as indicated on plate]

FIGURES 1–9. *Clioscaphites novimexicanus* (Reeside). 1–3, Side and top views, and third from last suture of a nearly complete internal mold with some of the shell, U.S.N.M. 106722a. From near top of Colorado shale at map locality 14. 4–6, Side, front, and rear views of the internal whorls of a specimen at diameter of 16.5 mm., U.S.N.M. 106721b. From a calcareous concretion 10 feet below top of Colorado shale at map locality 30. 7, Suture of an incomplete specimen, U.S.N.M. 106721a, from same locality as figures 4-6. 8, Side view of an artificial cast made from the impression of a specimen, U.S.N.M. 106722b, from same locality as figures 1–3. 9, Rear view of a fragment of a stout variant, an internal mold, U.S.N.M. 106723. From a concretionary bed 23 feet below top of Colorado shale at map locality 13 (p. 37).

10–23. *Desmoscaphites erdmanni* Cobban, n. sp. From same locality as figures 4–6. 10, 11, Side and rear views of holotype, an internal mold of most of a living chamber, U.S.N.M. 106724. 12, 13, Side and front views of an incomplete specimen showing the coarse-ribbed outer septate whorl and beginning of the fine-ribbed living chamber, U.S.N.M. 106725c. 14–18, Side and rear views, and last suture of an internal mold of a young specimen with part of the living chamber, U.S.N.M. 106725a. 19, Cross section of septate whorls at diameter of 9 mm. of an internal mold, U.S.N.M. 106725b. 20–23, Side and front views of a septate internal mold showing constrictions and beginning of ribbing, U.S.N.M. 106725d (p. 38).

24–26. *Scaphites leei* Reeside. From same locality as figures 4–6. 24, 25, Rear and side views of internal mold of a living chamber and part of septate whorl, U.S.N.M. 106720b. 26, Next to last suture of a plesiotype, U.S.N.M. 106720a (p. 34).


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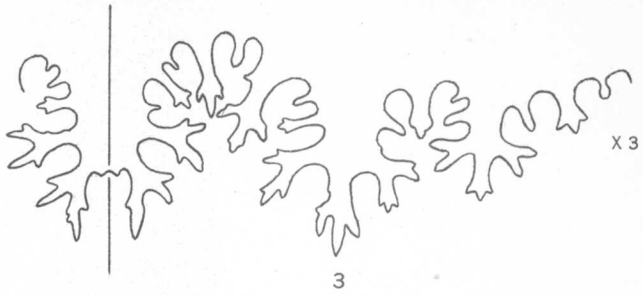

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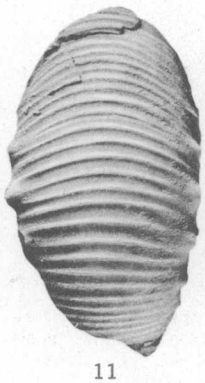
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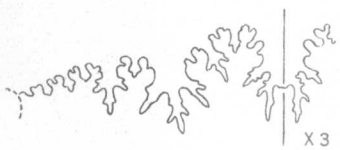

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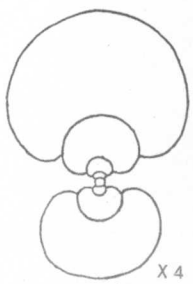

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SCAPHITES OF THE COLORADO GROUP