Multinodose Scaphitid Cephalopods from the Lower Part of the Pierre Shale and Equivalent Rocks in the Conterminous United States

GEOLOGICAL SURVEY PROFESSIONAL PAPER 483-E

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By WILLIAM A. COBBAN *and* GLENN R. SCOTT

CONTRIBUTIONS TO PALEONTOLOGY

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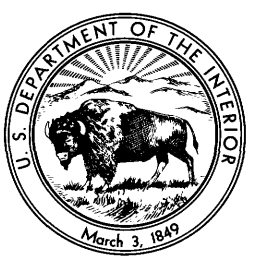
Three species of ammonites, assigned to the new genus Trachyscaphites, *provide a means for the correlation of Upper Cretaceous strata between the Western Interior, the Gulf Coastal Plain, and Europe*



UNITED STATES GOVERNMENT PRINTING OFFICE, WASHINGTON : 1964

UNITED STATES DEPARTMENT OF THE INTERIOR

STEWART L. UDALL, *Secretary*

GEOLOGICAL SURVEY

Thomas B. Nolan, *Director*

The U.S. Geological Survey Library has cataloged this publication as follows:

Cobban, William Aubrey, 1916–

Multinodose scaphitid cephalopods from the lower part of the Pierre Shale and equivalent rocks in the conterminous United States, by William A. Cobban and Glenn R. Scott. Washington, U.S. Govt. Print. Off., 1964.

iii, 13 p. 4 plates, map, diagrs., tables. 29 cm. (U.S. Geological Survey. Professional paper 483–E)

Contributions to paleontology.
Bibliography: p. 12–13.

1. Ammonoidea. 2. Scaphites. 3. Paleontology—Cretaceous. I. Scott, Glenn Robert, 1918—joint author. II. Title. (Series)

For sale by the Superintendent of Documents, U.S. Government Printing Office
Washington, D.C. 20402

CONTENTS

ILLUSTRATIONS

CONTRIBUTIONS TO PALEONTOLOGY

MULTINODOSE SCAPHITID CEPHALOPODS FROM THE LOWER PART OF THE PIERRE SHALE AND EQUIVALENT ROCKS IN THE CONTERMINOUS UNITED STATES

By WILLIAM A. COBBAN and GLENN R. SCOTT

ABSTRACT

Scaphitid ammonites that have three to five rows of nodes on each flank of the living chamber are known from the Pierre Shale at 13 localities in Wyoming, South Dakota, Colorado, and Kansas, and from the equivalent rocks at seven localities in Montana, Wyoming, Utah, and Colorado. Elsewhere in the United States this group of scaphites is known only in Texas where it is represented by one species.

Three species are known from the United States, and all are assigned to a new genus *Trachyscaphites*. These species are, from oldest to youngest, *T. praespiniger* (n. sp.), *T. spiniger* (Schlüter) subsp. *porchi* Adkins, and *T. redbirdensis* (n. sp. and the genotype). European species assigned to this genus are *Scaphites spiniger* Schlüter, *S. pulcherrimus* Roemer, and, questionably, *S. gibbus* Schlüter.

Trachyscaphites is of Campanian age. Schlüter's *Scaphites spiniger* and his *Ammonites* [*Hoplitoplacenticeras*] *coesfeldiensis*, which is found with the scaphite, are well-accepted index fossils for the lower part of the upper Campanian in Europe. The American equivalent of Schlüter's scaphite is interpreted as a geographic subspecies (*porchi* Adkins); it occurs with *Hoplitoplacenticeras* in the Wolfe City Sand Member and Pecan Gap Chalk Member of the Taylor Marl in Texas. *Trachyscaphites spiniger* (Schlüter) subsp. *porchi* Adkins is assigned an early late Campanian age, and the slightly older *T. praespiniger* of the Western Interior is assigned a very late early Campanian age.

INTRODUCTION

Scaphites that have more than two rows of nodes on each flank have been collected from rocks of late early Campanian and early late Campanian age at 20 localities in the Western Interior. Their presence in this area, however, has been noted only once in the literature (Fisher and others, 1960, *Scaphites* cf. *S. pulcherrimus* Roemer on p. 30, table 9). The Western Interior specimens are represented by two new species and a subspecies which, together with other multinodose species of similar age, can be grouped conveniently in a new genus *Trachyscaphites*. The American species are, from oldest to youngest, *Trachyscaphites praespiniger*, n. sp., *T. spiniger* (Schlüter) subsp. *porchi* Adkins, and *T. redbirdensis*, n. sp. The European species assigned to this genus are *Scaphites spiniger* Schlüter, *S. pulcherrimus* Roemer, and possibly *S. gibbus* Schlüter.

The occurrence of multinodose scaphites in the Western Interior is important in dating the rocks in which they occur inasmuch as closely related species are found in the Upper Cretaceous of Europe. Schlüter's *Scaphites spiniger* is an accepted guide fossil to rocks of early late Campanian age in Germany, France, Sweden, Poland, and Russia. *Trachyscaphites spiniger* (Schlüter) subsp. *porchi* Adkins is interpreted as a geographic subspecies of the European species. *Trachyscaphites praespiniger*, n. sp., the earliest of the multinodose species in the Western Interior, seems to be near the age of Schlüter's *Scaphites gibbus*, which lies in the lower part of the range zone of his *S. spiniger*. *Trachyscaphites redbirdensis*, n. sp., has five rows of nodes on each flank, and may be of an age comparable to that of Roemer's *Scaphites pulcherrimus*, which also has five rows of nodes and occurs in rocks above those containing Schlüter's *S. spiniger*.

Trachyscaphites is rare in the Western Interior except in the vicinity of Pueblo, Colo., where specimens of *T. praespiniger* are common but unfortunately are badly crushed. A few uncrushed septate coils of this species have been collected in Wyoming and Utah, but only bits of living chambers have been found. *Trachyscaphites spiniger* subsp. *porchi* is known from only six localities, and all specimens are either crushed or very fragmentary. *Trachyscaphites redbirdensis*, on the other hand, is represented by few, but very well preserved, specimens from limestone concretions.

The figured specimens are in the U.S. National Museum in Washington, D.C. Mr. James H. Smith, of the Mountain Fuel Supply Co. (Salt Lake City), kindly donated three collections of *Trachyscaphites praespini-*

ger from the area south of Rawlins, Wyo., and obtained permission from his company for the authors' publication of these specimens and accompanying stratigraphic data. Mr. James P. Conlin, Fort Worth, Tex., loaned the authors several fine examples of *Trachyscaphites spiniger* subsp. *porchi*, one of which is figured (pl. 3, fig. 8). All photographs were made by Robert E. Burkholder, of the U.S. Geological Survey.

GEOGRAPHIC DISTRIBUTION

Trachyscaphites is known from 20 localities in the Western Interior of the conterminous United States. The general position of each locality is shown by map numbers on figure 1, and the stratigraphic position is indicated by the numbers enclosed by circles on figure 2. Details regarding the localities, stratigraphic assignment, and collectors are given in the table below.

TABLE 1. *Localities at which fossils were collected*

Locality on figs. 1, 2	U.S. Geol. Survey Mesozoic locality	Collector and year of collection, description of locality, and stratigraphic assignment
1	D3866	J. R. Gill, 1962. Reed Hill, 1 mile east of Judith River, in SW¼SE¼NW¼ sec. 14, T. 22 N., R. 16 E., Fergus County, Mont. Claggett Shale, 40 ft above 3.5-ft bentonite bed and 121 ft above base of formation.
2	D3436	J. R. Gill and W. A. Cobban, 1960. About 7.5 miles east of Hardin, in NE¼NW¼NE¼ sec. 13, T. 1 S., R. 34 E., Big Horn County, Mont. Cody Shale, from a gray limestone concretion overlying 18-in. bentonite bed at base of Claggett Shale Member.
3	D2377	J. R. Gill, 1959. Seven miles northwest of Newcastle, in SE¼ sec. 5, T. 45 N., R. 62 W., Weston County, Wyo. Pierre Shale, 188 ft above base of Red Bird Silty Member.
4	D1900	W. J. Mapel and W. A. Cobban, 1958. About 2.2 miles northeast of Red Bird, in W½SW¼NW¼ sec. 13, T. 38 N., R. 62 W., Niobrara County, Wyo. Pierre Shale, from limestone concretions 218 ft above base of Red Bird Silty Member.
5	D2327	W. A. Cobban, 1946. One mile west of Ardmore, in W½ sec. 8, T. 12 S., R. 4 E., Fall River County, S. Dak. Pierre Shale, from limestone concretions in Gammon Ferruginous Member just beneath Ardmore Bentonite Bed of Spivey (1940).
6	D3046	J. H. Smith, 1961. Eighteen miles southeast of Rawlins, in SW¼ sec. 35, T. 19 N., R. 86 W., Carbon County, Wyo. Steele Shale, 942 ft below top.
7	D3290	J. H. Smith, 1961. Eleven miles south of Rawlins, in SE¼ sec. 12, T. 19 N., R. 88 W., Carbon County, Wyo. Steele Shale, 405 ft below top.
8	D3293	J. H. Smith, 1961. Fourteen miles southeast of Rawlins, in SE¼ sec. 24, T. 19 N., R. 87 W., Carbon County, Wyo. Steele Shale, 415 ft below top.
9	23261	W. A. Cobban, 1945. Seven miles southeast of Jensen, in sec. 13, T. 6 S., R. 23 E., Uintah County, Utah. Mancos Shale, from a limestone concretion 344 ft below top.
10	13714	J. B. Reeside, Jr., 1926. East Salt Creek, 9 miles southeast of Carbonera, in NE¼ sec. 31, T. 7 S., R. 102 W., Garfield County, Colo. Mancos Shale, 250 ft below top.
11	D1780	W. J. Hail, 1958. Seventeen miles northwest of Walden, in NE¼ sec. 36, T. 11 N., R. 82 W., Jackson County, Colo. Pierre Shale, from a limestone concretion about 300 ft above base.
12	D843	R. Van Horn, 1956. Northwest shore of Ralston Reservoir, 5.3 miles north-northwest of Golden, in SE¼NW¼SE¼ sec. 32, T. 2 S., R. 70 W., Jefferson County, Colo. Pierre Shale, from ferruginous siltstone concretions 385 ft above base.
13	D267	G. R. Scott, 1954. About 7.5 miles southwest of Littleton, in NW¼SE¼SW¼ sec. 15, T. 6 S., R. 69 W., Jefferson County, Colo. Pierre Shale, about 610 ft above base.
14	D67	G. R. Scott, 1954. About 8 miles southwest of Littleton, in SE¼SW¼NE¼ sec. 22, T. 6 S., R. 69 W., Jefferson County, Colo. Pierre Shale, from a limestone concretion 150 ft below base of Hygiene Sandstone Member and 1,065 ft above base of formation.
15	D1229	G. R. Scott and W. A. Cobban, 1957. Steele Hollow, 1.6 miles south of Pinon, in NE¼NW¼SE¼ sec. 12, T. 19 S., R. 65 W., Pueblo County, Colo. Pierre Shale, from limestone concretions at base of Sharon Springs Member and 428 ft above base of formation.
16	D3454	G. R. Scott, 1961. North of Gnat Hollow and about 7 miles north of Pueblo, in W½NW¼ sec. 25, T. 19 S., R. 65 W., Pueblo County, Colo. Pierre Shale, from limestone concretions at base of Sharon Springs Member and 428 ft above base of formation.
17	D2812	G. R. Scott and W. A. Cobban, 1958. Gnat Hollow, 6 miles north of Pueblo, in NE¼NW¼SE¼ sec. 26, T. 19 S., R. 65 W., Pueblo County, Colo. Pierre Shale, from limestone concretions at base of Sharon Springs Member and 428 ft above base of formation.
18	1367	G. K. Gilbert and G. W. Stose, 1894. About 3.7 miles northeast of Pueblo, in SW¼NE¼SW¼ sec. 8, T. 20 S., R. 64 W., Pueblo County, Colo. Pierre Shale [base o Sharon Springs Member].
19	D3456	G. R. Scott, 1961. About 2 miles southwest of Pinon, in N½SE¼SE¼ sec. 11, T. 19 S., R. 65 W., Pueblo County, Colo. Pierre Shale, 10 ft above base of Sharon Springs Member and 438 ft above base of formation.
20	D2591	G. R. Scott and W. A. Cobban, 1956. One mile northeast of McAllaster, in NE¼ sec. 13, T. 12 S., R. 37 W., Logan County, Kans. Pierre Shale, from a limestone concretion 40 ft below top of Sharon Springs Member.

STRATIGRAPHIC SUMMARY

Trachyscaphites has been found in the Claggett Shale of central Montana, the Claggett Shale Member of the Cody Shale of south-central Montana, the Gammon Ferruginous Member and Red Bird Silty Member of the Pierre Shale of the Black Hills area of eastern Wyoming and southwestern South Dakota, the Steele Shale of south-central Wyoming, the Mancos Shale of northeastern Utah and northwestern Colorado, the lower part of the Pierre Shale of central Colorado, and the Sharon Springs Member of the Pierre Shale of south-central Colorado and western Kansas. The correlation of these formations and members is shown on figure 2. For the general relationships of these units to other formations in the Western Interior, the reader is referred to papers by Cobban and Reeside (1952), Reeside (1957), and Weimer (1960); and for more detailed data concerning some of the correlations, see Scott and Cobban (1959, 1963), Zapp and Cobban (1960, 1962), and Gill and Cobban (1961, 1962).

The sequence of baculites shown on figure 2 serves as a useful time scale to which the species of *Trachyscaphites* can be referred. This succession of

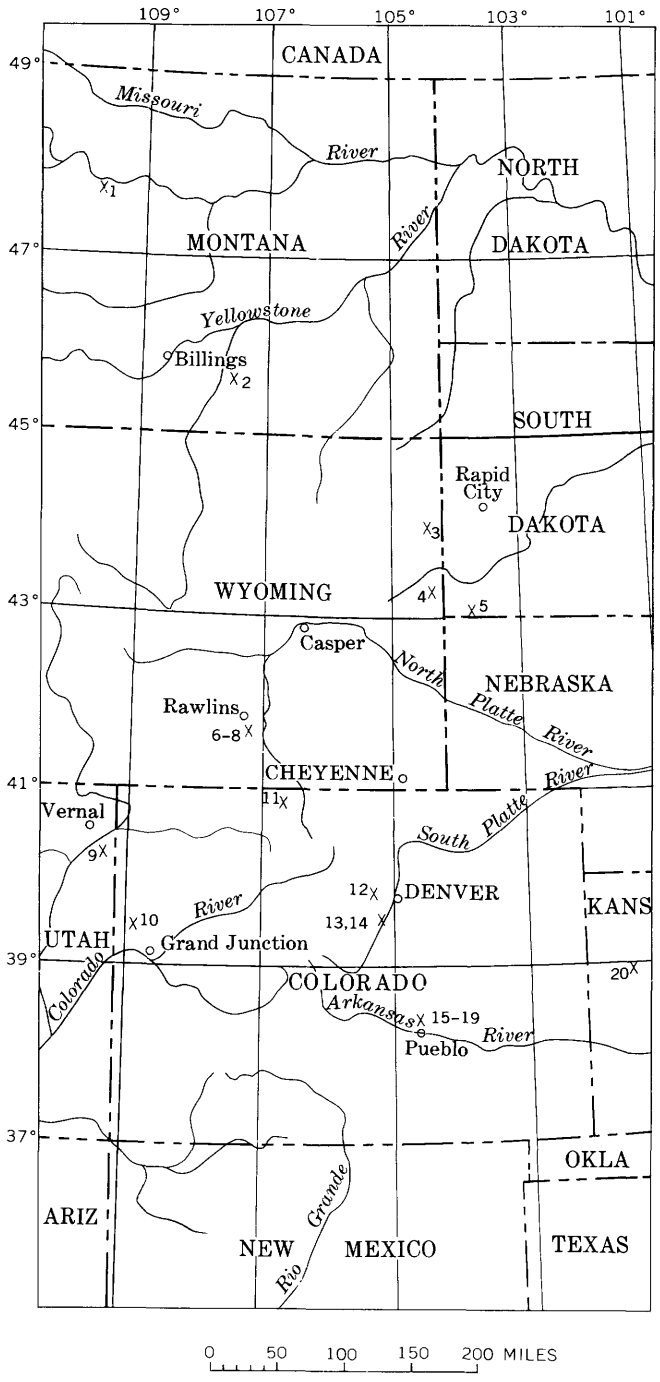


FIGURE 1.—Index map showing localities of *Trachyscaphites*. Numbers refer to the detailed descriptions of localities in the table.

baculites is based largely on the large collections from the Pierre Shale on the west and south flanks of the Black Hills uplift in eastern Wyoming and southwestern South Dakota, from the lower part of the Pierre Shale of the Front Range area in central Colorado, and from the Cody Shale of the Salt Creek oil field in central Wyoming (for a summary of most of this baculitid sequence, see Cobban, 1962a, p. 705, 706). It is possible to subdivide the zone of *Baculites obtusus* into a lower part in which most of the baculites are rather weakly sculptured and an upper part in which most of the specimens are more strongly ornamented. The zone of *B. perplexus* can be subdivided into three subzones of which the oldest and youngest are characterized by baculites having coarsely ribbed venters, whereas the middle subzone is featured by baculites having more finely ribbed venters (*B. gilberti* Cobban).

IMPORTANT ASSOCIATED FOSSILS

Trachyscaphites praespiniger is associated with (1) an early form of *Baculites obtusus* Meek that is more weakly ribbed than the later (or typical) form of the species and (2) a slightly older species of *Baculites* that has very weak flank ribbing. The collections from near Pueblo, Colo. (fig. 1, locs. 15–19), also contain a weakly sculptured species of *Inoceramus* that seems referable to *I. agdjakendensis* Aliev, a species described from the lower Campanian of Russia. Three of the lots from the Pueblo area contain crushed fragments of the ammonite *Delawarella danei* Young (1963, p. 114, pls. 57, 62, 64–66; text figs. 24e. 33b) known elsewhere only from the lower part of the Ozan Formation of southwestern Arkansas (figured as *Mortoniceras* aff. *M. delawarense* by Dane, 1929, pl. 10) and from the Gober Tongue of Austin Chalk in northeast Texas.

Trachyscaphites spiniger subsp. *porchi* occurs with *Baculites mclearni* and the slightly younger *B. asperiformis*. In both zones the subspecies is associated with an undescribed scaphite that is ancestral to the late Campanian *nodosus* group of species. Of considerable interest also is the presence of *Inoceramus azerbaidjanensis* Aliev with *Trachyscaphites spiniger* subsp. *porchi* and *Baculites mclearni* at USGS Mesozoic loc. D843 near Golden, Colo. (fig. 1, loc. 12). This inoceramid has been recorded previously only from the lower Campanian of Russia (Aliev, 1954; Aliev and Khalilov, 1958, p. 290; Dobrov and Pavlova, 1959, p. 148; Rengarten, 1959, p. 480). Associated with the multinodose scaphites from the *Baculites asperiformis* Range Zone near Denver, Colo., is an undescribed *Pteria*-like pelecypod that has concentric folds and, on some individuals, radial folds.

Trachyscaphites redbirdensis is known from only three localities, two of which lie at the base of the *Baculites gregoryensis* Range Zone; the other lies somewhere in the upper part of the *B. perplexus* Range Zone. The collections from the *B. gregoryensis* Range Zone are associated with a fine-ribbed nodeless scaphite and with the same undescribed scaphite found with *Trachyscaphites spiniger* subsp. *porchi*.

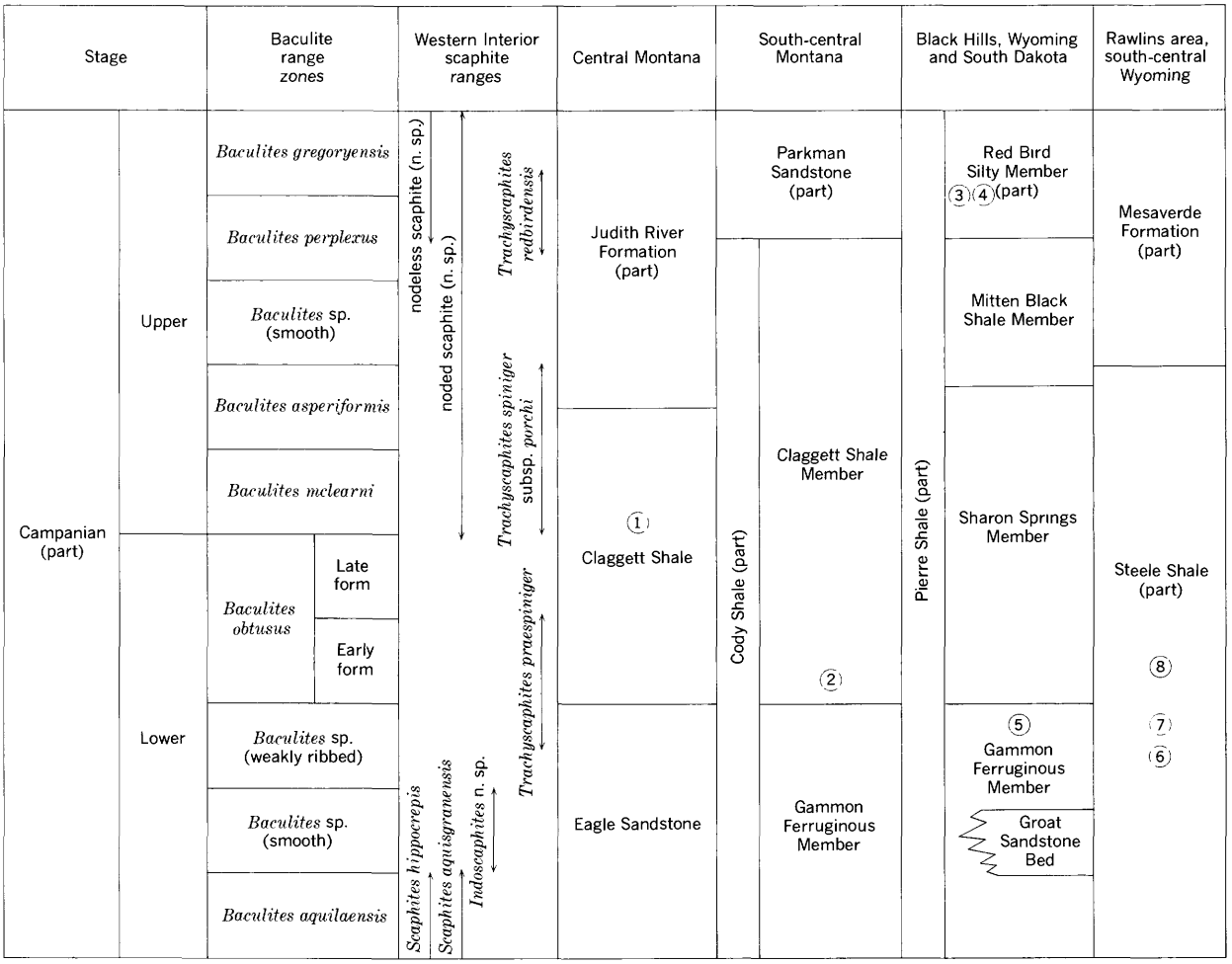


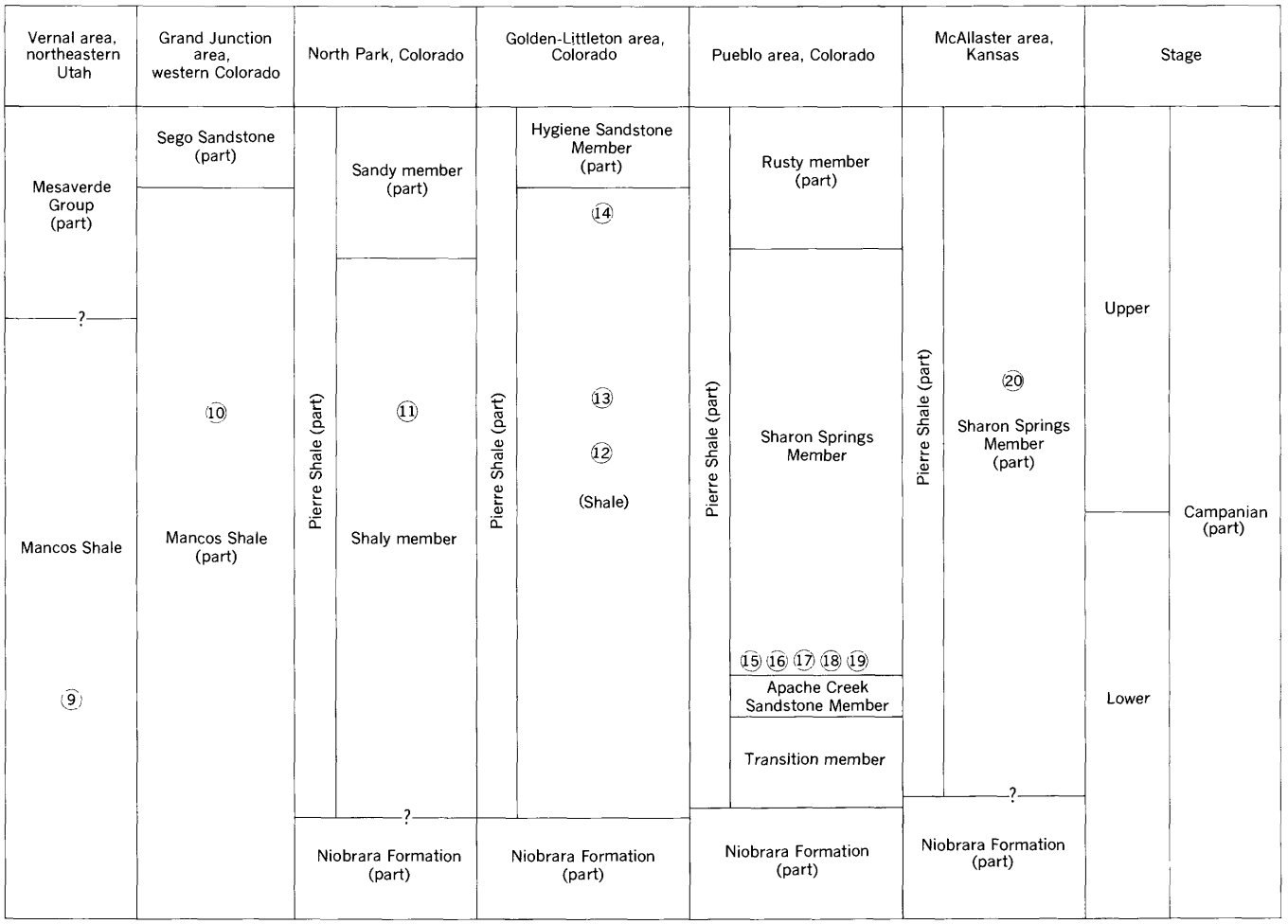
FIGURE 2.—Correlation of part of the Campanian rocks in the Western graphic positions of *Trachyscaphites*. The circled numbers indicate ties shown on figure 1.

COMPARISONS WITH OTHER SCAPHITID FAUNAS

GULF COASTAL PLAIN

The only multinodose scaphites recorded from rocks of late early Campanian or early late Campanian age from the Gulf Coastal area are two forms described by Adkins (1929, p. 205, 206) as the new species *Scaphites aricki* and *S. porchi*. Both came from the same locality near Austin, Tex., where they occur in a phosphatic bed about 150 feet above the base of the Taylor Marl. Studies of scaphites from this locality as well as from other outcrops of comparable age in Texas have convinced the authors that Adkins' two forms represent one variable species which is herein interpreted as a geographic subspecies of the European *Trachyscaphites spiniger*. Adkins' name *porchi* has page priority over *aricki* and, accordingly, the Gulf Coast scaphite is assigned as *T. spiniger* (Schlüter) subsp. *porchi* Adkins.

Associated fossils from the type locality of *T. spiniger* subsp. *porchi* include ammonites described by Adkins as the new species *Baculites taylorensis*, *Parapachydiscus travisi*, and *Hamites? taylorensis*. *Baculites taylorensis* is most closely related to *B. asperiformis* Meek; both have widely spaced lateral nodes, but *B. taylorensis* is a stouter species that retains its nodes to greater diameters. *Trachyscaphites spiniger* subsp. *porchi* is present in USGS Mesozoic collections from the Anacacho Limestone in southwestern Texas. Near San Antonio a brittle chalky limestone, regarded "as an eastward-thinning wedge of the Anacacho limestone" by Stephenson (1937, p. 136), contains this scaphite associated with *Baculites taylorensis*. In northeastern Texas the scaphite occurs in the Wolfe City Sand Member and overlying Pecan Gap Chalk Member of the Taylor Marl. Associated fossils in a collection (USGS Mesozoic loc. 9710) at hand from the Wolfe City Sand Member include *Inoceramus azerbaidjanensis*, *Baculites* cf. *B. mclearni*, and fragments of *Hoplitoplacenticeras*. Associated fossils in three collections examined from the Pecan Gap Chalk



Interior showing baculitid zones, scaphitid ranges, and the strati-
the stratigraphic positions of *Trachyscaphites* and refer to locali-

Member include *Baculites* cf. *B. mclearni* at two localities and *B. taylorensis* at one locality. Young (1963, p. 64) recorded *Hoplitoplacenticeras* sp. aff. *Metaplacenticeras? bowersi* Anderson from the base of the Pecan Gap. These occurrences of *Hoplitoplacenticeras* in the Wolfe City and Pecan Gap are of considerable interest inasmuch as the only specimen of this genus known to the authors from the Western Interior is a fragment that may be *H. coesfeldiense* (Schlüter) var. *schlüteri* Mikhailov from the *Baculites asperiformis* Range Zone in south-central Wyoming (Cobban, 1963).

The presence of *Trachyscaphites spiniger* subsp. *porchi*, *Baculites* cf. *B. mclearni*, and *Inoceramus azerbaidjanensis*, in the Wolfe City Sand Member permits its correlation with rocks in the Range Zone of *Baculites mclearni* in the Western Interior. The Pecan Gap probably correlates with part of this Range Zone as well as with the Range Zone of *Baculites asperiformis*. Representatives of *Trachyscaphites* older than *T. spiniger* have not been found in the Gulf Coastal Plain. A correlation between the Western Interior rocks containing *T. praespiniger* and the Ozan Formation of southwestern Arkansas and the Gober Tongue of Austin Chalk of northeast Texas is suggested by the occurrences of *Delawarella danei* Young.

EUROPE

Schlüter (1876, p. 252) indicated the occurrence of his *Scaphites spiniger*, *S. gibbus*, *Ammonites* [*Hoplitoplacenticeras*] *coesfeldiensis*, and *A.* [*Hoplitoplacenticeras*] *vari*, in his zone of *Ammonites coesfeldiensis*. Two of his species, *S. spiniger* and *A. vari*, were shown as ranging on up into his next higher zone of *Heteroceras* [*Bostrychoceras*] *polyplocum*, to which zone Schlüter assigned Roemer's *Scaphites pulcherrimus*. Most subsequent workers (for example, Grossouvre, 1893, p. 255; Nowak, 1916, p. 67; Pozaryski, 1938, p. 18; Mikhailov, 1951, p. 109) have shown that *Scaphites gibbus* occurs only in the lower part of the Range Zone of *S. spiniger*,

and some authors (for example, Grossouvre, 1893, p. 255; Milhailov, 1951, p. 108; Naidin and Shimanskii, 1959, p. 214; Moskvin and Naidin, 1959, p. 506) have indicated *Hoplitoplacenticeras* is the same age as *S. gibbus*. *Scaphites spiniger* has been shown as ranging up through the level of *S. pulcherrimus* by most European authors, but Pozaryski (1938, p. 19; 1948, p. 116) showed *S. spiniger* as an older species.

Thus, it is apparent that clearly defined zones in Europe based on species of *Trachyscaphites* cannot be determined from a survey of the literature. Some sort of zoning seems probable, judging from the restriction of *Trachyscaphites? gibbus* to the lower part of the Range Zone of *T. spiniger* and the possibility that *T. pulcherrimus* could be younger than *T. spiniger*.

A correlation of the Range Zone of *Trachyscaphites spiniger* in the United States with the lower part of the reported range of this species in Europe seems unquestioned. The European equivalents of *T. praespiniger* and *T. redbirdensis* are not so apparent. *Trachyscaphites redbirdensis* and *T. pulcherrimus* are probably of comparable age. Both have five rows of nodes on the flanks, and both occupy positions well above the lowest occurrence of *T. spiniger*. *Trachyscaphites praespiniger*, on the other hand, is more difficult to correlate inasmuch as no trachyscaphitid has been recorded from Europe below rocks containing *T. spiniger*. Grossouvre (1901, p. 801) proposed for the Campanian four zones of which the youngest (Zone à *Pachydiscus neubergicus*) is now assigned to the Maestrichtian. Of the other zones, *Placenticeras* [*Diplacmoceras*] *bidorsatum* characterized the oldest, *Mortoniceras* [*Delawarella*] *delawarense* marked the middle, and *Hoplites* [*Hoplitoplacenticeras*] *vari* defined the youngest. The zone of *Placenticeras bidorsatum* was said to contain *Scaphites hippocrepis* and *S. aquisgranensis*, species found below the level of *Trachyscaphites* in the United States (fig. 2). Scaphites were not recorded from the zone of *Mortoniceras delawarense*, but inasmuch as the overlying zone contained *T. spiniger* and *T.? gibbus* some sort of correlation of the *Mortoniceras delawarense* zone with the Range Zone of *T. praespiniger* seems possible. This correlation is further strengthened by the occurrence of *Delawarella danei* associated with *T. praespiniger* near Pueblo, Colo. *Delawarella danei* is in the Range Zone of *Delawarella delawarensis*, according to Young (1963, p. 115).

AGE

Grossouvre's (1901, p. 830) division of the Campanian into a lower and upper part has been followed by most workers. His recognition of *Hoplitoplacenticeras*, *Trachyscaphites spiniger*, and *T.? gibbus* as guide fossils to the upper Campanian has been verified by many investigators (for example, Pozaryski, 1938, p. 18; Jeletzky, 1951, p. 18; Riedel, 1951, p. 392; Naidin and Shimanskii, 1959, p. 214, 215), and Seitz (1953, p. 149) defined the base of the upper Campanian in Germany on the appearance of these species. Grossouvre's scheme of subdividing the lower Campanian into a lower zone characterized by *Placenticeras* [*Diplacmoceras*] *bidorsatum* and an upper zone marked by *Mortoniceras* [*Delawarella*] *delawarense* was followed by Muller and Schenck (1943, text fig. 6) in their recommendations for the zones of the standard Cretaceous. Among the fossils listed by Grossouvre (1901, p. 830) in his *Placenticeras* [*Diplacmoceras*] *bidorsatum* zone were *Scaphites hippocrepis*, *S. aquisgranensis*, *S. binodosus*, *Pachydiscus dülmensis*, and *Actinocamax* [*Gonioteuthis*] *granulatus*. His *Mortoniceras* [*Delawarella*] *delawarense* zone was said to contain *Actinocamax* [*Gonioteuthis*] *quadratus* and a few other fossils. Schlüter (1876, p. 252, 254) had earlier indicated that *Scaphites hippocrepis* (as *S. cuvieri* Morton) and *Gonioteuthis quadrata* (as *Actinocamax quadratus*) occurred in the upper zone in Germany. Jeletzky (1955, p. 480) also showed the occurrence of these fossils in the same zone and, in addition, he assigned *Scaphites aquisgranensis*, *S. binodosus*, and *Pachydiscus dülmensis* to this zone. This shift of *S. hippocrepis* and *S. aquisgranensis* from the lower part of the lower Campanian to the upper part was revealed also in a recent French paper (Basse and Sornay, 1959, p. 21).

If *Scaphites hippocrepis* and *S. aquisgranensis* are accepted as marking the upper zone of the lower Campanian and *Trachyscaphites spiniger* and *Hoplitoplacenticeras* as marking the lower part of the upper Campanian, the problem arises as to what zone the American *T. praespiniger* should be assigned. *Trachyscaphites praespiniger* is certainly much more closely related to *T. spiniger* than to *Scaphites hippocrepis* or *S. aquisgranensis*, and this favors a late Campanian assignment. Yet the association of *Delawarella danei* and *Inoceramus agdjakendensis* with *T. praespiniger* favors an assignment to the upper part of the lower Campanian. An assignment to the uppermost part of the lower Campanian seems to be the best choice in light of the associated fossils and the occurrence of *T. praespiniger* in rocks older than *Hoplitoplacenticeras*.

SYSTEMATIC DESCRIPTIONS

Genus TRACHYSCAPHITES Cobban and Scott, n. gen.

Trachyscaphites, with *T. redbirdensis*, n. sp., as genotype, is proposed for moderately large, typically robust scaphites that have the younger and greater part of the living chamber separated from the septate coil by a considerable gap. Ornamentation consists of three to

five rows of nodes on each flank and dense ribbing, which on the living chamber tends to be weak and not differentiated into strong primaries and weaker secondaries as in most scaphite groups. The suture is moderately complex and has a broad bifid first lateral lobe and a much smaller trifid second lateral lobe.

The assignment of the European *Scaphites spiniger*, *S. gibbus*, and *S. pulcherrimus* has been a problem to many workers. Nowak (1912) proposed the genus *Acanthoscaphites* for large scaphites that have whorls higher than wide, straight ribs with nodose thickening near the umbilicus, and, in the adults, one to three rows of nodes on each flank and ordinarily a midventral row. Nowak designated as the genotype *Scaphites tridens* Kner (1850, p. 10, pl. 2, figs. 1a, 1b), a large form having on the living chamber a row of midventral nodes flanked by a row of ventrolateral nodes. As variants of *Acanthoscaphites tridens*, Nowak assigned *Scaphites trinodosus* Kner (1850, p. 11, pl. 2, figs. 2a–c) that has midventral, ventrolateral, and lateral nodes; *S. varians* Lopuski (1911, p. 120, pl. 4, figs. 1–3; text fig. 4) with umbilical nodes in addition to those on *S. trinodosus; S. quadrispinosus* Geinitz (1850, p. 116, pl. 7, fig. 2; pl. 8, fig. 2) with ventrolateral and lateral nodes; and *S. trispinosus* Geinitz (1850, p. 116, pl. 7, figs. 1a, 1b) with midventral and ventrolateral nodes. In addition, Nowak proposed another variety, *bispinosus*, that has only ventrolateral nodes. To his new genus *Acanthoscaphites*, Nowak assigned with a query Schlüter's *S. gibbus* which has umbilical, ventrolateral, and two rows of lateral nodes. No mention was made of the multinodose *S. spiniger* Schlüter or of *S. pulcherrimus* Roemer, but in a later paper Nowak (1916, p. 63) assigned these to his *Acanthoscaphites*. This assignment of *S. spiniger* and *S. pulcherrimus* has been accepted by most workers (for example, Reeside, 1927, p. 27; Adkins, 1929, p. 205; Wolansky, 1932, p. 9; Pozaryski, 1938, p. 18; 1948, p. 70; Mikhailov, 1951, p. 96, 100; Naidin and Shimanskii, 1959, p. 195). Although Nowak (1912, p. 565) at first considered *S. gibbus* Schlüter as a possible member of *Acanthoscaphites*, he later assigned it to his genus *Hoploscaphites*. Reeside (1927, p. 27), however, considered *S. gibbus* as belonging to Meek's subgenus *Discoscaphites*, an assignment followed by most recent Russian authors (for example, Mikhailov, 1951, p. 94; Naidin and Shimanskii, 1959, p. 197; Moskvin and Naidin, 1959, p. 506; Pasternak, 1959, p. 85).

Trachyscaphites differs from *Acanthoscaphites* by its smaller size, whorls wider than high, simpler suture, lack of midventral nodes, and straighter living chamber which has the younger part separated considerably from the chambered whorls. The authors believe Nowak made his genus *Acanthoscaphites* too inclusive, and that it should be restricted to a group of large tightly coiled scaphites in which midventral nodes are ordinarily present. In addition, the suture is highly incised for a scaphite, the ribs are straight, and the nodes are usually present only on the living chamber. In its very large size, tight degree of coiling, and complex suture pattern, *Acanthoscaphites* seems to be a parallel development of the American *Rhaeboceras Meek* (1876, p. 462). These genera differ by the presence of midventral nodes on *Acanthoscaphites* and by the development of nodelike primary ribs on the living chamber of *Rhaeboceras*. Both forms occupy high positions in the Late Cretaceous close to the boundary of the Campanian and Maestrichtian. In the United States, *Rhaeboceras* is known only from the very late Campanian Range Zones of *Baculites reesidei* Elias and *B. jenseni* Cobban (for the treatment of these baculites, see Cobban, 1962b). On the other hand, the forms of *Acanthoscaphites* that possess midventral nodes seem to be restricted to the Maestrichtian where they are almost confined to the lower half (Pozaryski, 1938, p. 18: Jeletzky, 1951, p. 18; Mikhailov, 1951, p. 109; Ødum, 1953, p. 29; Schmid, 1955, p 83; Naidin and Shimanskii, 1959, p. 215; Pasternak, 1959, p. 84).

Trachyscaphites differs from *Discoscaphites* Meek (1876, p. 415, genotype, *Ammonites conradi* Morton) and *Hoploscaphites* Nowak (1912, p. 565, genotype, *Scaphites constrictus* Sowerby) by its more robust shell, living chamber more extended away from the septate coil, and different node arrangement. The genotypes of *Discoscaphites* and *Hoploscaphites* are Maestrichtian species that have tightly coiled compressed shells. *Discoscaphites* has four to nine rows of nodes on each side, whereas *Hoploscaphites* has one or two rows or more rarely none. *Hoploscaphites* has been applied to several species older than the genotype, such as the forms commonly assigned to the European *Scaphites roemeri* d'Orbigny and the American *Scaphites nodosus* Owen. These older species approach *Trachyscaphites* by having comparable extended living chambers and, for some individuals, robust shells, but none has the lateral row of nodes, and all have clearly defined primary ribs on the living chambers.

Trachyscaphites redbirdensis Cobban and Scott, n. sp.

Plate 1, figures 1–7; text figure 3

This species is known from only six specimens, of which two are complete adults, two are septate coils, and two are fragments of living chambers. The species is characterized by four or five rows of nodes on each flank. On the living chamber each row of nodes is

either considerably larger or smaller than the adjacent rows.

The early whorls were not studied in detail owing to their coarsely crystalline calcite filling which tended to shatter during preparation of the specimens. All whorls down to the smallest diameter observed, 3.5 mm, are wider than high. The rise of ornamentation could not be determined on the earliest whorls, but at a diameter of 3.5 mm ventrolateral swellings are discernible. The outer septate whorl is ornamented by strong rectiradiate ribs and sharp nodes. On the last half whorl about 10 primary ribs extend from small umbilical nodes out to the lower part of the flank where they terminate in a row of larger umbilicolateral nodes. Two secondary ribs extend from most of the nodes to the middle of the flank where they terminate in a row of lateral nodes. From these nodes secondaries and intercalaries cross the remainder of the flank and venter. These ribs may be neatly arranged in pairs of which each pair is separated from adjacent pairs by a narrow furrow (pl. 1, fig. 1). Sharp ventrolateral and ventral nodes are present in the raised area between the furrows. The nodes in all but the umbilical row on each flank of the septate whorls tend to be of equal size.

Ribbing on the living chamber is not so distinct or so regular as that on the septate coil. Ribs crossing the venter number from 50 to 57. The nodes, likewise, are not regular in size, but instead they are differentiated into rows of strong nodes alternating with rows of weak ones. On each flank of the holotype five rows of nodes are present, and all extend to the aperture where they again become nearly equal in size. The rows are almost equally spaced and can be conveniently described as umbilical, umbilicolateral, lateral, ventrolateral, and ventral. The umbilical nodes are small and bullate and number 10 or 11 on the living chamber. The umbilicolateral nodes are much larger, number 13 or 14, and are rounded on the earlier part of the living chamber and bullate on the later part. The lateral nodes are small, rounded, and number 22. The ventrolateral nodes are the largest; they number 18 and are rounded to slightly clavate on the earlier part of the living chamber and rounded to bullate on the later part. The ventral nodes are small, rounded to bullate, and number 19 or 20. The distance across the venter between the two rows of ventral nodes is slightly more than that separating the ventral and ventrolateral rows of nodes.

The holotype (pl. 1, figs. 3–5, 7) is an internal mold 113 mm high, 103 mm wide, and 63 mm thick. The aperture is slightly constricted and has a dorsal lappet.

The other complete adult (unfigured paratype USNM 132312), from the same locality as the holotype, is 71 mm high and has poorly defined umbilical nodes. The ventrolateral nodes are more clavate than those on the holotype.

The sutures of the holotype and a paratype of *Trachyscaphites redbirdensis* are shown on text figure 3. The first lateral saddle is as broad or broader than the ventral lobe. It is divided asymmetrically by a lobe which, on the holotype, is unusually large. The first lateral lobe is bifid, about as wide as the ventral lobe, and has a very broad base. The second lateral saddle is narrow and very asymmetrically bifid in which the ventrad part is the smaller. The second lateral lobe is much smaller than the first lateral lobe and is asymmetrically trifid.

Trachyscaphites redbirdensis resembles *T. spiniger* (Schlüter, 1872, p. 82, pl. 25, figs. 1–7) by the numerous rows of nodes on the living chamber and septate coil, but on the German species the nodes are more uniform in size and the umbilical row is missing. *Trachyscaphites pulcherrimus* (Roemer, 1841, p. 91, pl. 14, fig. 4) resembles *T. redbirdensis* by possessing five rows of nodes, some of which disappear on the living chamber; those rows that do persist do not alternate in size. *Trachyscaphites pulcherrimus* is also a more slender species that has a more involute septate coil and a less extended living chamber. The specimen figured by Mikhailov (1951, p. 96, pl. 18, figs. 83, 84) more closely resembles *T. redbirdensis* than any figured by Schlüter

FIGURE 3.—Sutures of *Trachyscaphites redbirdensis* Cobban and Scott, n. sp., ×2. *A*, Paratype USNM 132310 at diameter of about 35 mm (pl. 1, fig. 1). *B*, Holotype USNM 132309 at diameter of 47 mm (pl. 1, figs. 3–5, 7).

(1872, p. 85, pl. 26, figs. 1–5), or Grossouvre (1893, p. 250, pl. 32, figs. 6, 9a, 9b).

Types: Holotype USNM 132309; paratypes USNM 132310–132313.

Occurrences: Wyoming, locs. 3, 4; Colorado, loc. 14.

Trachyscaphites spiniger (Schlüter)

1872. *Scaphites spiniger* Schlüter, Palaeontographica, v. 21, p. 82, pl. 25, figs. 1–7.
1885. *Scaphites spiniger* Schlüter. Moberg Sveriges geol. undersökning, ser. C, no. 73, pt. 2, p. 28, pl. 3, figs. 6–8.
1889. *Scaphites spiniger* Schlüter. Griepenkerl, Palaeont, Abh., v. 4, pt. 5, p. 405.
1893. *Scaphites spiniger* Schlüter. Grossouvre, Les ammonites de la craie supérieure, p. 252.
1902. *Scaphites spiniger Schlüter.* Wollemann, Kgl. preussische geol. Landesanst., new ser., no. 37, p. 107.
1915. *Scaphites spiniger* Schlüter. Frech, Centralbl. Mineralogie Jahrg. 1915, no. 21, p. 564, text fig. 13.
1916. *Acanthoscaphites spinger* (Schlüter). Nowak, K.-k. Geol. Reichsanst. Verh., 1916, no. 3, fig. opposite p. 66.
1925. *Scaphites (Acanthoscaphites) spiniger* Schlüter. Diener, Fossilium Catalogus, I, Animalia, pt. 29, p. 207.
1927. *Acanthoscaphites spiniger* (Schlüter). Reeside, U.S. Geol. Survey Prof. Paper 150–B, p. 34.
1951. *Acanthoscaphites spiniger* (Schlüter). Mikhailov, Akad. Nauk SSSR, Inst. geol. nauk Trudy, no. 129, Geol. ser. no. 50, p. 100, pl. 19, fig. 92.
1952. *Scaphites spiniger* Schlüter. Basse, *in* Piveteau, Jean, ed., Traité paléontologie, v. 2, p. 612.
1954. *Scaphites (Acanthoscaphites) spiniger* Schlüter. Hägg, Sveriges geol. undersökning, ser. C, v. 47, no. 6, p. 58.

Schlüter illustrated three examples from Haldem and Darup, Germany, of which one (Schlüter, 1872, pl. 25, fig. 4) is in the Geologisch-palaeontologisches Institut und Museum, Bonn, Germany. The others may have been lost during World War II (Dr. Hans Mensink, written communication, Apr. 25, 1958). None of the specimens was complete. The largest example figured (Schlüter, 1872, pl. 25, figs. 1–3) is composite and consists of the septate whorls and about two-thirds of the living chamber of a robust individual to which Schlüter added the oral part of another individual. The composite nature of this example is scarcely apparent in Schlüter's drawing, although he drew attention to it and also pointed out that "Die laterale Knotenreihe liegt in Folge Verdrückung des Gehäuses zu tief." Schlüter's beautiful illustration has been copied much and reproduced in many textbooks (for example, Zittel, 1900, fig. 1189; Abel, 1924, fig. 297; Chavan and Montocchio, 1956, cover; Davitashvili, 1958, fig. 257; Müller, 1960, fig. 271; Termier and Termier, 1960, fig. 2333). A second specimen figured by Schlüter (1872, pl. 25, figs. 5, 6) consists of about two-thirds of the younger end of a living chamber in which lies an aptychus. It is the most densely ribbed of his figured specimens, and his drawing suggests that the complete living chamber probably had about 100 ribs crossing the venter. Schlüter's third and extant specimen is badly crushed and lacks the oral end of the living chamber. It is the smallest and the most slender of the three examples. A plaster cast of this specimen is at the Federal Center. Denver, Colo.

Moberg (1885, pl. 3, figs. 6a, 6b) figured a complete adult from the Campanian of Sweden. It is a stout individual that shows a conspicuous change from rather coarse ribbing on the septate coil to fine weak ribbing on the living chamber. Ribs crossing the venter of the living chamber number about 100.

Frech (1915, fig. 13 on p. 565) illustrated a well-preserved living chamber from Haldem, Germany. This individual, which is as slender as the extant specimen of Schlüter, has about 100 ribs crossing the venter.

Mikhailov (1951, pl. 19, fig. 92) figured a septate coil and the beginning of the living chamber of a moderately large individual from Russia. It reveals irregularities in the strength of the ribs.

From the works of Schlüter, Moberg, Frech, and Mikhailov, the authors believe *Trachyscaphites spiniger* can be characterized as a moderately large species that ranges from a stout involute form to a smaller, slenderer, and less involute form. The living chamber is long, and more than half of it is completely freed from the septate coil. Sculpture consists of dense ribbing and four rows of nodes on each side. The ribs are slightly flexuous to nearly straight, and as many as 100 cross the venter of the living chamber. On the last septate whorl ribbing is irregular and interrupted by node development. Some ribs tend to be grouped on high areas separated by furrows. These can be seen on Mikhailov's illustration (1951, pl. 19, fig. 92) as well as on a specimen at hand from Haldem. On the living chamber ribbing is uniform, dense, and, judging from Frech's and Moberg's illustrations, very weak. The ribs completely cover the flanks, but there seems to be no differentiation into strong primaries and weaker secondaries as in most other genera of scaphites.

The four rows of nodes are independent of the ribs according to Mikhailov (1951, p. 100) who referred to them as pupkovyi [umbilical], bokovoi [lateral], vneshne-bokovoi [outer-lateral], and vneshnii [outer]. In terms of the node arrangement on *Trachyscaphites redbirdensis*, *T. spiniger* lacks the umbilical row and has only the umbilicolateral, lateral, ventrolateral, and ventral rows. The umbilicolateral nodes are located some distance from the umbilical wall although not so far as indicated on the Darup specimen of Schlüter (1872, pl. 25, fig. 1). These nodes are rounded and number about 6 to 8 on the living chamber. The lateral nodes are also rounded to slightly clavate, but they

tend to be smaller, judging from Frech's and Moberg's figures and from Griepenkerl's description (1889, p. 405). They number about 12 to 16 on the living chamber. The ventrolateral nodes are rounded on the septate coil; but they become clavate on the living chamber, where they number about 14 to 18 and tend to be larger than the lateral nodes. The ventral nodes, likewise, are rounded on the septate coil and clavate on the living chamber, where they number about 15 to 20. They are comparable in size to the ventrolateral nodes. The ventral, ventrolateral, and lateral rows of nodes are about equally spaced, but the umbilicolateral row is a little farther removed. Each row persists to, or almost to, the aperture. Judging from Moberg's complete specimen, the distance across the venter separating the two rows of ventral nodes is about the same as the distance between the ventral and ventrolateral rows, although Schlüter's drawings show a much wider area between the rows of ventral nodes.

The authors are not aware of a published illustration of the suture. Grossouvre (1908, text fig. 13) figured the suture for a juvenile scaphite which he referred to as *Scaphites* cf. *spiniger*. His specimen came from the Chalk of Spiennes in Belgium, which apparently is of early Maestrichtian age and younger than *Trachyscaphites spiniger* (Jeletzky, 1951, p. 19).

Trachyscaphites spiniger (Schlüter) subsp. porchi Adkins

Plate 2, figures 1–23; plate 3, figures 1–11; text figure 4

1929. *Scaphites porchi* Adkins, Texas Univ. Bull. 2901, p. 205, pl. 5, figs. 1–3.

1929. *Scaphites aricki* Adkins, Texas Univ. Bull. 2901, p. 206, pl. 5, figs. 7, 8.

1963. *Acanthoscaphites* sp. cfr. *A. spiniger* (Schlüter). Young, Texas Univ. Pub. 6304, p. 49, pl. 4, figs. 1, 6, 7; pl. 5, figs. 1, 4, 5.

Adkins' *Scaphites porchi* was based on fragments of four living chambers preserved as phosphatic internal molds. The holotype consists of the older three-fourths of an adult living chamber that belonged to an individual whose height was possibly 50 mm (about the size of plesiotype USNM 132319, pl. 2, figs. 8–10). The holotype is robust and has a depressed cross section. Ornamentation consists of four rows of strong nodes on each flank; the umbilicolateral, ventrolateral, and ventral nodes are of about equal size, and the lateral nodes are slightly smaller. All rows are nearly equally spaced including the distance across the venter between the two rows of ventral nodes. The umbilicolateral and lateral nodes are rounded, whereas the ventrolateral and ventral nodes are clavate. Ribs are not visible on this internal mold.

Adkins' *Scaphites aricki* was based on phosphatic internal molds of a septate coil with the beginning of the living chamber (holotype), and the larger part of a living chamber (paratype) from the same locality as the holotype of his *S. porchi*. The holotype is from a stout individual that was about the size of plesiotype USNM 132321 (pl. 3, figs. 10, 11). It is mostly the chambered part and is ornamented by four rows of nodes on each flank and by numerous thin but conspicuous ribs. The ribs, which are straight, can be divided into primaries and secondaries. Each primary bears an umbilicolateral node and terminates in the lateral node; at this point the rib branches into two or three secondaries which, together with intercalated ribs, cross the remainder of the flank and venter. On the earlier part of this septate coil, the area between the primary ribs tends to extend on across the venter as a narrow furrow separating higher areas on which two or three secondaries are located as well as the ventrolateral and ventral nodes. This character can be seen on many specimens from Texas and the Western Interior (for example, pl. 2, figs. 15, 16, 19, 20, 23) as well as on the earlier part of a septate coil of a specimen of *T. spiniger* at hand from Haldem, Germany. The septate coil of *T. spiniger* figured in a lateral view by Mikhailov (1951, pl. 19, fig. 92) would probably show this feature if viewed ventrally. The nodes on Adkins' holotype are of similar size and are rounded; each row is about equally spaced including the distance between the two ventral rows. Adkins did not illustrate his paratype, an incomplete living chamber, the ornament of which is described as "Ribbing and tuberculation on the straight limb are similar [to the septate holoytpe] but more open."

After studying collections referable to Adkins' *Scaphites porchi* and *S. aricki* from several localities in Texas including the type locality of these scaphites, the authors believe that these forms represent a single species that ranges from a large stout variant (*aricki*) to a smaller and more slender form (*porchi*). This represents normal variation for scaphites (Cobban, 1951, p. 4). The smallest adult figured (pl. 2, figs. 6, 7) is about 3½ times as small as the largest (pl. 3, fig. 9).

The septate coils of specimens whose living chambers resemble the holotype of Adkins' *Scaphites porchi* are more slender than the holotype of his *S. aricki* but otherwise do not differ, and many are transitional from slender to stout. The sculpture of the living chamber shows the greatest amount of variation, ranging from strongly noded internal molds without ribs to more weakly noded internal molds with weak but dense ribbing. Where present, the ribs reveal no differentiation into stronger primaries and weaker secondaries. The four rows of nodes resemble those of the European examples of *Trachyscaphites spiniger*. The umbilico-

lateral nodes are rounded and situated away from the umbilical wall. The lateral nodes are rounded to clavate and may be as large as the umbilicolateral nodes or very much smaller (compare pl. 2, fig. 8 with pl. 3, fig. 1). The ventrolateral and ventral nodes are clavate and about the size of the umbilicolateral nodes. The lateral, ventrolateral, and ventral rows of nodes are about equally spaced, and the distance across the venter between the two ventral rows is comparable. Each row of nodes extends to the aperture. The number of nodes on the living chambers of the specimens examined is summarized as follows, together with a summary of the nodes on *T. spiniger porchi* as figured by Schlüter, Moberg, and Frech:

Fossil	Umbilicolateral	Lateral	Ventrolateral	Ventral
Trachyscaphites spiniger	6–8	13–16	14–18	15–20
subsp. *porchi*	4–6	7–13	10–12	10–13

The moderately complex suture is characterized by the very broad-based bifid first lateral lobe and the much smaller trifid second lateral lobe. The first lateral saddle is asymmetrically bifid and as large as the ventral lobe. Sutures of two specimens from Texas are shown on figure 4.

The American specimens differ from the European species by possessing fewer nodes on the living chamber and by a tendency toward stronger tuberculation accompanied by loss of ribbing on internal molds. These differences seem sufficient to regard the American form as a geographic subspecies.

Types: Plesiotypes USNM 132314–132332.

Occurrences: Montana, loc. 1; Colorado, locs. 10–13; Kansas, loc. 20.

Trachyscaphites praespiniger Cobban and Scott, n. sp.

Plate 4, figures 1–13; text figure 5

This species is characterized by three or, rarely, four rows of flank nodes of which generally only one row (lateral) persists entirely around the last septate whorl. Ribbing is strong on the septate coil and weak on the living chamber.

The septate whorls are stout and wider than high in the smallest cross section observed (6 mm). Ribs are well developed at a diameter of 16 mm, but the diameter at which they first appear was not determined. The last half whorl has about 10 or 11 primary ribs which begin at the umbilicus and curve slightly forward on crossing much of the flank. Most of these ribs terminate in small rounded lateral nodes. From the row of lateral nodes secondary ribs extend on across the venter where they number about 30 on the last half whorl. The lateral

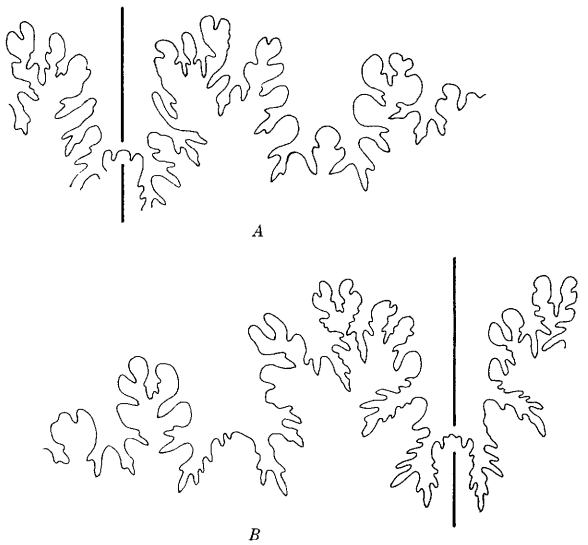


FIGURE 4.—Sutures of *Trachyscaphites spiniger* (Schlüter) subsp. *porchi* Adkins, ×2. *A*, Plesiotype USNM 132322 (pl. 2, fig. 19). *B*, Plesiotype USNM 132323 at diameter of 38 mm (pl. 2, figs. 20–23).

row of nodes is present on the entire outer septate whorl. On the younger half of the whorl small rounded ventrolateral nodes ordinarily appear. On a few individuals ventrolateral and ventral nodes may occur along with the lateral nodes around the entire outer septate whorl.

All living chambers (six) at hand are badly crushed. Ribs are usually very weak and number 45 to 55. Clearly defined primary ribs are present only on the older part. Nodes are conspicuous and ordinarily occur in three almost equally spaced rows, umbilicolateral, lateral, and ventrolateral. All nodes are of similar size and for the most part are rounded, and each row extends to the aperture. The nodes in the umbilicolateral row number 4 to 7, and those in the lateral row number 10 to 12. About 10 ventrolateral nodes are present on one individual, but the number on other specimens could not be determined. One specimen (pl. 4, fig. 13) is unusual by having a row of nodes between the lateral and ventrolateral rows on the younger part of the last septate whorl. Another speciment (pl. 4, fig. 12), that may be a large variant of this species, has conspicuous ribbing on the living chamber.

The holotype (pl. 4, fig. 10) is a crushed adult that retains its shell material. It is 73 mm high and 64 mm wide. The living chamber has 7 umbilicolateral nodes and 11 lateral nodes. The distance separating the umbilicolateral row from the lateral row is a little more than that separating the lateral and ventrolateral rows.

Sutures of two paratypes (USNM 132336, 132340) are shown on text figure 5. The sutures are similar to those of *Trachyscaphites spiniger*.

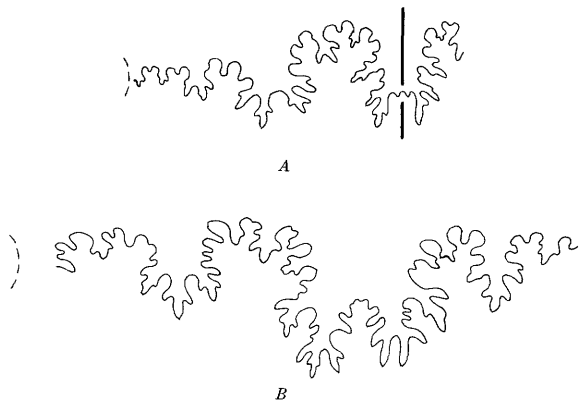


FIGURE 5.—Sutures of *Trachyscaphites praespiniger* Cobban and Scott, n. sp., ×2. *A*, Paratype USNM 132340 at diameter of 19 mm. *B*, Paratype USNM 132336 at diameter of about 48 mm (pl. 4, fig. 13).

Trachyscaphites praespiniger differs readily from other species of *Trachyscaphites* by the lesser number of rows of nodes and by the presence on most specimens of only one row of nodes (lateral) entirely around the last septate whorl. The ribbing on the living chamber is sparse in contrast to that on *T. spiniger*.

Types: Holotype, USNM 132333; paratypes, USNM 132334–132340.

Occurrences: Montana, loc. 2; South Dakota, loc. 5; Wyoming, locs. 6–8; Utah, loc. 9; Colorado, locs. 15–19.

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PLATES 1–4

PLATE 1

[All figures natural size]

FIGURES 1–7. *Trachyscaphites redbirdensis* Cobban and Scott (p. E7).

1. Rear view of the last septate whorl of a paratype from a limestone concretion 218 feet above the base of the Red Bird Silty Member of the Pierre Shale at loc. 4 (text fig. 1). USNM 132310.
2. Rear view of part of the living chamber of a paratype from a limestone concretion 188 feet above the base of the Red Bird Silty Member of the Pierre Shale at loc. 3 (text fig. 1). USNM 132313.

3–5, 7. Top, rear, side, and front views of the holotype from the same loc. as figure 1. USNM 132309.

6. View of a fragment of the living chamber of a paratype oriented to show the differences in size of the umbilicolateral, lateral, ventrolateral, and ventral nodes. From the same locality as figure 1. USNM 132311.

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TRACHYSCAPHITES REDBIRDENSIS COBBAN AND SCOTT

PLATE 2

[All figures natural size]

FIGURES 1–23. *Trachyscaphites spiniger* (Schlüter) subsp. *porchi* Adkins (p. E10).

1–3. Side, front, and rear views of the septate coil of the slender form of the species from the Wolfe City Sand Member of the Taylor Marl at USGS Mesozoic loc. D4006, on Texas Highway 34, 1.3 miles west of Ladonia, Fannin County, Tex. USNM 132314.

4, 5. Rear and side views of a small specimen from the same locality. USNM 132315.

6, 7. Side and top views of an unusually small adult living chamber from the same locality. USNM 132316.

8–10. Side, rear, and front views of an adult from the Wolfe City Sand Member of the Taylor Marl at USGS Mesozoic loc. 9711, at a cut of the Gulf, Colorado & Santa Fe Railway 1.5 miles northeast of Wolfe City, Hunt County, Tex. USNM 132319.

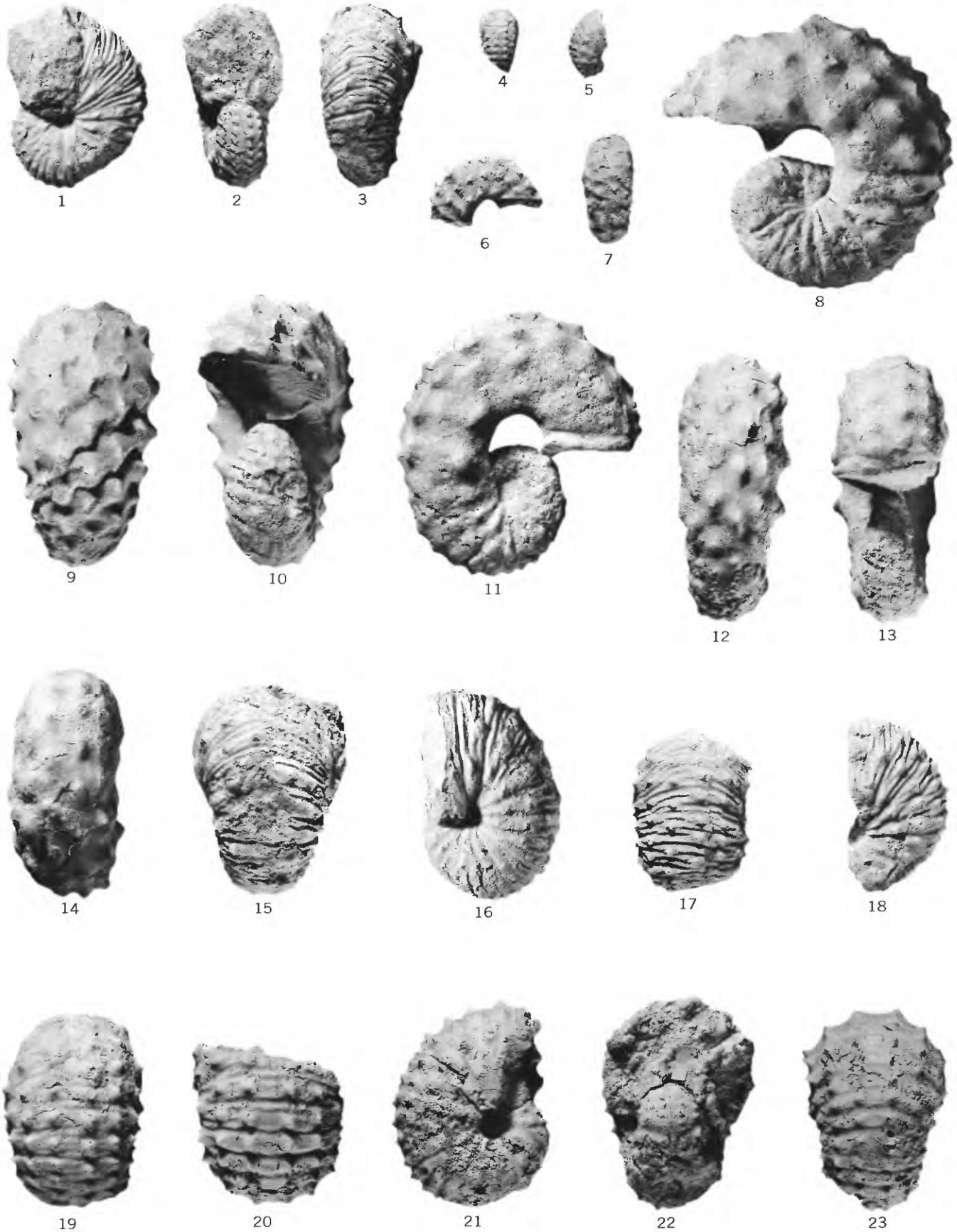
11–14. Side, rear, front, and top views of the internal mold of a very slender adult from the Pecan Gap Chalk Member of the Taylor Marl at USGS Mesozoic loc. 9713, near the Gulf, Colorado & Santa Fe Railway about 0.8 mile east of Pecan Gap, Delta County, Tex. USNM 132320.

15, 16. Rear and side views of the septate coil of a specimen from the same locality as figures 1–3 showing the furrows between groups of ribs. USNM 132317.

17, 18. Rear and side views of another specimen from the same locality. USNM 132318.

19. Rear view of a stout septate specimen from the Pecan Gap Chalk Member of the Taylor Marl at USGS Mesozoic loc. 9561, 3 miles southeast of Wolfe City, Hunt County, Tex. For suture, see text figure 4*A*. USNM 132322.

20–23. Top, side, front, and rear views of a topotype, a septate internal mold from the Pecan Gap Chalk Member of Taylor Marl at USGS Mesozoic loc. D104 on the Austin-Manor road 1.7 miles east of bridge over Walnut Creek, Travis County, Tex. For suture, see text figure 4*B*. USNM 132323.



TRACHYSCAPHITES SPINIGER (SCHLÜTER) SUBSP. *PORCHI* ADKINS

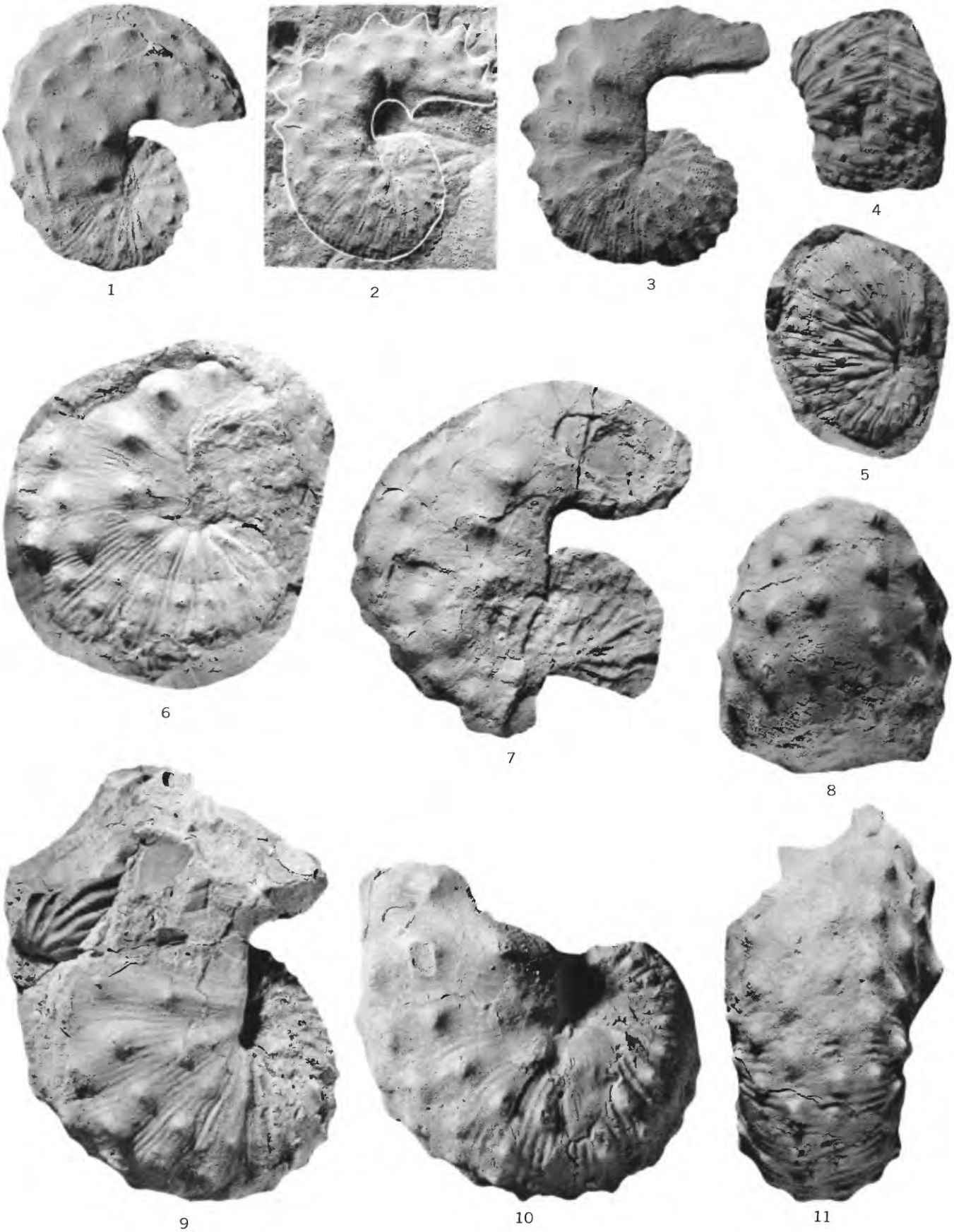
PLATE 3

[All figures natural size]

FIGURES 1–11. *Trachyscaphites spiniger* (Schlüter) subsp. *porchi* Adkins (p. E10).

1. Side view of a crushed adult, an internal mold, showing the small size of the lateral nodes. From the Anacacho Limestone at USGS Mesozoic loc. 7651, on west-flowing branch of Salado Creek about 7 miles northeast of San Antonio, Bexar County, Tex. USNM 132324.
2. Side view of another adult, from the same locality, showing very large ventrolateral nodes in contrast to the small lateral nodes. Only two of the ventral nodes on the living chanber are visible. USNM 132325.
3. Side view of another adult, from the same locality, showing large umbilicolateral and ventrolateral nodes in contrast to the much smaller lateral nodes. USNM 132326.
4. Rear view of a crushed septate coil from locality 10 (text fig. 1). USNM 132327.
5. Side view of a crushed septate coil with its shell material from locality 13 (text fig. 1). USNM 132330.
6. Side view of a rubber cast of part of an adult from the same locality as figure 4. USNM 132328.
7. Side view of a crushed adult from the same locality. USNM 132329.
8. Top view of the younger part of a stout living chamber, an internal mold, from the Pecan Gap Chalk Member of the Taylor Marl, on the Cox farm 3 miles southeast of Wolfe City, Hunt County, Tex. Number 7608 in the private collection of James P. Conlin, Fort Worth, Tex. Plastotype, USNM 132331.
9. Side view of part of an adult associated with *Inoceramus azerbaidjanensis* Aliev, from the Wolfe City Sand Member of the Taylor Marl, at USGS Mesozoic loc. 9710 at a cut along the Gulf, Colorado & Santa Fe Railway 1.5 miles northeast of Wolfe City, Hunt County, Tex. USNM 132332.

10, 11. Side and rear views of an uncrushed specimen, an internal mold, showing the septate coil and the older part of the living chamber. From the Pecan Gap Chalk Member of the Taylor Marl, at USGS Mesozoic loc. 9713, near the Gulf, Colorado & Santa Fe Railway about 0.8 mile east of Pecan Gap, Delta County, Tex. USNM 132321.



TRACHYSCAPHITES SPINIGER (SCHLÜTER) SUBSP. *PORCHI* ADKINS

PLATE 4

[All figures natural size]

FIGURES 1–11, 13. *Trachyscaphites praespiniger* Cobban and Scott, n. sp. (p. E11).

1, 2. Rear and side views of the outer septate whorl of a paratype retaining part of the shell material, from a limestone concretion at loc. 6 (text fig. 1). USNM 132337.

3, 4. Rear and side views of the next inner whorl of the paratype shown on figures 1, 2. USNM 132337.

5, 6. Side and front views of part of a paratype, from the same locality, showing the numerous nodes on the living chamber in contrast to the fewer nodes on the septate coil. USNM 132338.

7. Side view of a shell-covered paratype, from loc. 17 (text fig. 1), that shows narrow furrows bounding some of the primary ribs. USNM 132334.

8, 9. Front and side views of a paratype, a septate coil, from loc. 9 (text fig. 1), showing the persistence of the lateral row of nodes. USNM 132339.

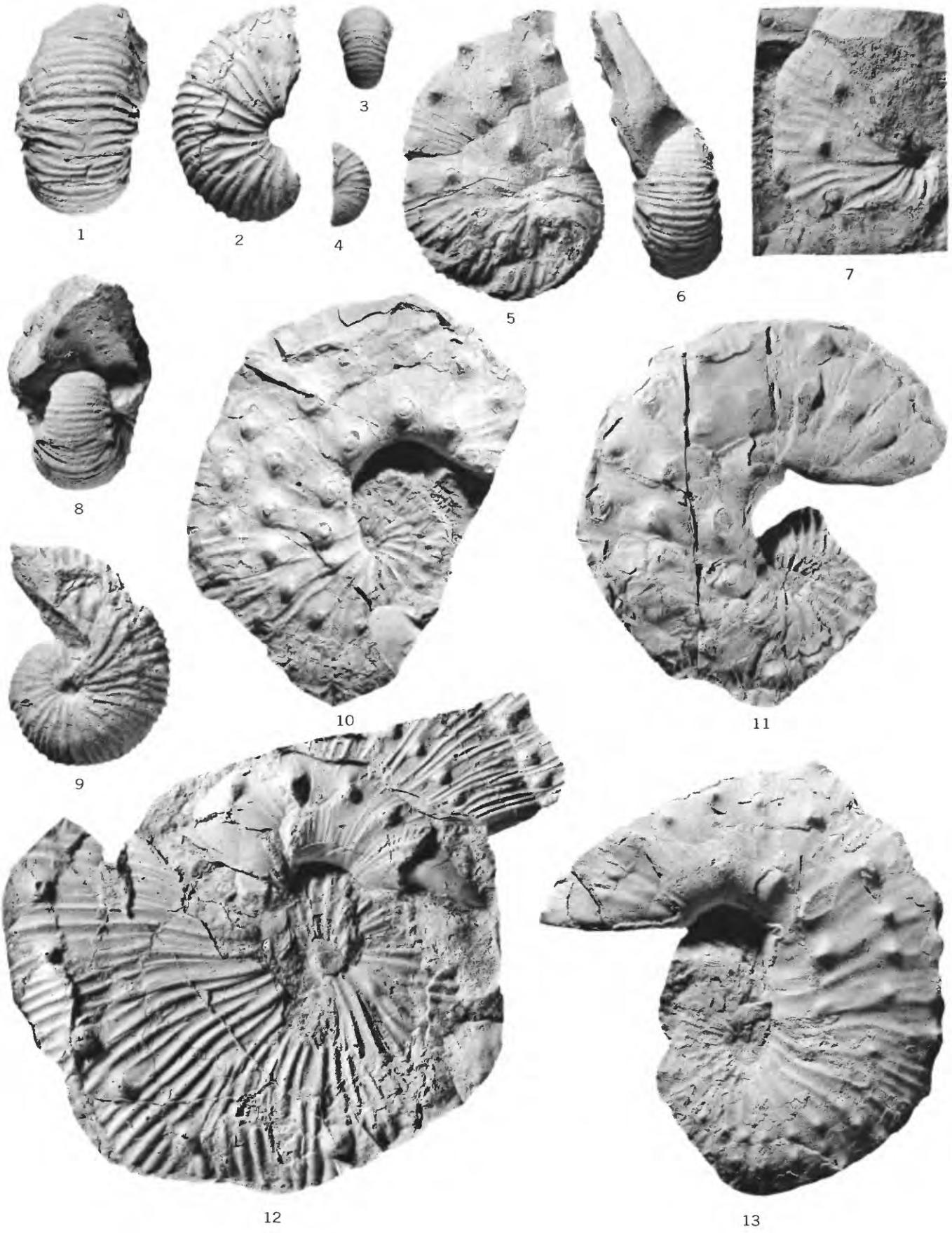
10. Side view of the holotype from loc. 17 (text fig. 1). USNM 132333.

11. Side view of a crushed paratype, from the same locality, that retains most of the shell material. USNM 132335.

13. Side view of another crushed adult from this locality showing an additional row of nodes on the septate coil. The suture is shown in text figure 5B. USNM 132336.

12. *Trachyscaphites* cf. *T. praespiniger* Cobban and Scott, n. sp. (p. E11).

Side view of a rubber cast of a large crushed and broken adult from loc. 5 (text fig. 1). This specimen has stronger and denser ribbing than that on the typical form of the species. USNM 132372.



TRACHYSCAPHITES PRAESPINIGER COBBAN AND SCOTT