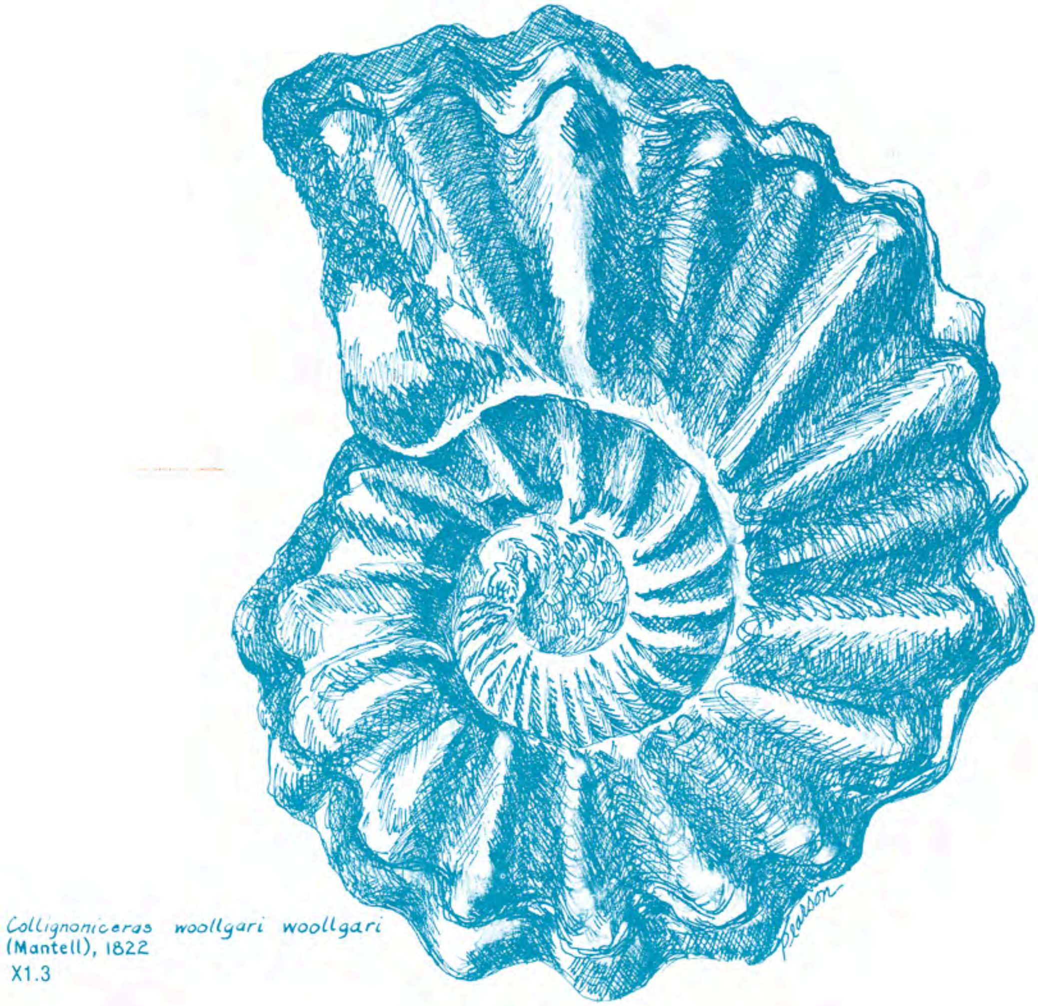
Collignoniceras woollgari woollgari (Mantell) ammonite fauna from Upper Cretaceous of Western Interior, United States

by WILLIAM A. COBBAN and STEPHEN C. HOOK



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Abstract

The middle Turonian ammonite range zone of *Collignoniceras woollgari* (Mantell) is known from Europe and North America as well as from Japan and Australia. In the Western Interior of the United States, the zone is divisible into an older subzone of C. *woollgari woollgari* (Mantell) and a younger subzone of C. *woollgari regulare* (Haas). Ammonites found with C. *woollgari woollgari,* and probably restricted to this subzone, include *Mammites depressus* Powell, *Spathites rioensis* Powell, *Watinoceras cobbani* Collignon, *Hoplitoides* cf. *H. wohltmanni* (von Koenen), *H.* cf. *H. koeneni* Solger, and the new species *Tragodesmoceras socorroense*. Ammonites associated with *C. woollgari regulare,* and probably restricted to this subzone, include *Scaphites larvaeformis* Meek and Hayden, *Tragodesmoceras carlilense* Cobban, and *Binneyites carlilensis* Cobban. The subzone of *C. woollgari woollgari* is best developed in New Mexico where ammonites are common in the upper part of the Mancos Shale tongue underlying the Tres Hermanos Sandstone Member of the Mancos Shale as well as in the lower part of this sandstone member. The subzone of C. *woollgari regulare* is best known from very fossiliferous concretions in the Pool Creek Member of the Carlile Shale in the Black Hills area of South Dakota, Wyoming, and Montana.

Introduction

Rocks of middle Turonian age are very fossiliferous at many localities in the Western Interior of the United States. Two associated species of ammonites, *Collignoniceras woollgari* (Mantell) and *Scaphites larvaeformis* Meek and Hayden, have been used since 1938 as guide fossils to a faunal zone (Stephenson and Reeside, 1938, p. 1638), although the importance of *C. woollgari* had been noted earlier (Stanton, 1893, p. 50; 1909, p. 420). In more recent years, *C. woollgari* alone has served as the name bearer of the zone (for example, Cobban and Reeside, 1952, p. 1018).

Fossils collected in the past few years in New Mexico, Utah, Colorado, and Wyoming have revealed a twofold division of the range zone of *C. woollgari.* The upper part of the zone is characterized by a highly variable form of *C. woollgari* that has been well documented by Haas (1946) and Matsumoto (1965). This form, separated by Haas into a *forma typica* and the varieties *crassa, intermedia, regularis, tenuicostata, praecox,* and *alata,* is abundant and widely distributed in the Western Interior. Most of the associated ammonites have been described and illustrated in several recent reports. In contrast to the upper part of the range zone of C. *woollgari,* the lower part has been poorly known and is limited in its geographic distribution. The European form of C. *woollgari* characterizes this part of the zone. Only two of the associated ammonites range up into rocks that contain the younger form of *C. woollgari.* The purpose of this report is to document the little-known lower part of the range zone of *C. woollgari.*

ACKNOWLEDGMENTS—The collections from New Mexico were made chiefly by S. C. Hook, J. R. Wright, G. L. Massingill, G. Stachura, D. E. Tabet, and T. L. Wallace, all of the New Mexico Bureau of Mines and Mineral Resources, and by C. H. Dane, E. R. Landis, and W. A. Cobban, all of the U.S. Geological Survey. Collections from Colorado were made by Cobban and G. R. Scott, of the U.S. Geological Survey, and those from Wyoming were made by Cobban, E. A. Merewether, and R. E. Burkholder, also all of the U.S. Geological Survey.

Dr. W. J. Kennedy, Oxford University (England), greatly aided us in the interpretation of C. *woollgari* and kindly provided a copy of his unpublished manuscript (coauthored with C. W. Wright and J. M. Hancock) on the collignoniceratid ammonites from England and northern France.

We are grateful to B. W. Cox of the Red Lake Ranch and Dean Fite of the Fite Ranch for permission to collect on their private land and to Denny Apacito, Chapter President, for permission to work on the Alamo Indian Reservation. We also thank Dr. Christina Lochman-Balk, Emeritus Professor of Geology, New Mexico Institute of Mining and Technology, for making her teaching collection of fossils from Carthage and D-Cross Mountain available to us.

Our biostratigraphic work was done in cooperation with the Riley-Alamo project funded by the New Mexico Energy Institute and directed by C. E. Chapin of the New Mexico Bureau of Mines and Mineral Resources.

The specimens illustrated in this report are kept in the National Museum of Natural History in Washington, D.C. Other specimens are stored in the New Mexico Bureau of Mines and Mineral Resources in Socorro, New Mexico, and in the U.S. Geological Survey Mesozoic invertebrate fossil collections at the Federal Center, Denver, Colorado. All photographs were made by R. E. Burkholder of the U.S. Geological Survey.

Turonian ammonite sequence

Stephenson and Reeside (1938, p. 1636-1638) recognized three faunal zones for the Turonian Stage in their paper comparing the Upper Cretaceous rocks of the Gulf of Mexico and the Western Interior. Two fossils were selected as guides for each zone (Fig. 1). A few years later Reeside (1944) presented the same zonation for the Turonian, but he selected just one ammonite as a guide to each zone *(Metoicoceras whitei, Prionotropis woollgari,* and *Prionocyclus wyomingensis).* The Turonian zonation was later greatly refined by Cobban (1951, p. 2197), who recognized nine zones (Fig. 1). Soon after, the *Prionocyclus* aff. *P. reesidei* Sidwell in the uppermost zone was named *P. quadratus* Cobban (1953). The lowest zone, marked by *Sciponoceras gracile* (Shumard) and *Metoicoceras whitei* Hyatt, was subsequently removed from the Turonian and assigned to the top of the underlying Cenomanian Stage (Cobban, 1971, p. 7).

The lower part of the Turonian zonation was further refined by Cobban and Scott (1972, p. 31, 33), who defined a zone of *Mammites nodosoides* (Schlotheim) below that of *Collignoniceras woollgari* (Mantell) and a zone of *Watinoceras coloradoense* (Henderson) below that of *M. nodosoides.* An unnamed zone in the sequence was indicated between the zone of W. *coloradoense* and the Cenomanian zone of *Sciponoceras gracile* (Cobban and Scott, 1972, p. 32). An ammonite, *Nigericeras scot ti* Cobban (1971, p. 18, pl. 9, figs. 1-4; pl. 18, figs. 1-9; text figs. 15-17), found in southeastern Colorado and southwestern New Mexico a few meters above *Sciponoceras gracile,* should be recognized as a Turonian zone just below that of W. *coloradoense.* A still lower Turonian zone, characterized by *Pseudaspidoceras,* will be described by us in another paper.

The upper part of the Turonian zonation was refined somewhat by Dane, Cobban, and Kauffman (1966, p. H8, H9) and Merewether and Cobban (1972, p. D59), but the ammonite zonation in the middle part has received little attention. The range zone of *Collignoniceras woollgari* of earlier reports can now be divided into two subzones: a lower subzone characterized by *Collignoniceras woollgari woollgari* (Mantell) and an upper subzone marked by a later form of C. *woollgari* of which Haas's variety *regularis* (Haas, 1946, p. 154, pl. 16, figs. 1-17; text figs. 10-12, 59-74, 78, 80, 81, 83), raised to subspecific rank, is herein selected as the name bearer. Juveniles of these subspecies are very similar (Pls. 2, 3), and Powell (1963, p. 1225) had noted earlier that coarsely ribbed juveniles of these subspecies could not be separated.

Most localities of C. *woollgari regulare* and C. *woollgari woollgari* (Fig. 2) have one or the other subspecies; but at Pueblo, Colorado, Capitan, New Mexico, and Acoma, New Mexico, where both subspecies are present, *C. woollgari woollgari* is the older subspecies. Near Pueblo, Colorado, *C. woollgari woollgari* occurs in the upper third of the Bridge Creek Limestone Member of the Greenhorn Formation, whereas C. *woollgari regulare* is found in the overlying Fairport Chalky Shale Member of the Carlile Shale (Fig. 3B). A similar sequence of zones may be present elsewhere outside the Western Interior. In the Carthage to D-Cross Mountain area of west-central New Mexico, where the C. *woollgari woollgari* subzone is best developed, the Tres Hermanos Sandstone Member of the Mancos Shale is nonmarine above the top of this subzone and below the *Prionocyclus macombi* Zone (Fig. 3A; Hook and Cobban, 1979, fig. 5; Molenaar, 1974). However, near Acoma, New Mexico, the base of the Tres Hermanos Sandstone Member is apparently in the C. *woollgari regulare* subzone; reconnaissance collecting has so far yielded two specimens of *C. woollgari woollgari* in the underlying Mancos Shale tongue. All previously recorded occurrences of *C. woollgari* from the Tres Hermanos Sandstone Member (Dane, Landis, and Cobban, 1971, p. B20, B21; Hook and Cobban, 1979, fig. 5) should now be referred to C. *woollgari woollgari.*

Mammites depressus Powell (1963, p. 1228, pl. 168, figs. 1-3; pl. 170, figs., 4, 5; pl. 171, fig. 1; text figs. 5e, 6f-h) occurs with C. *woollgari woollgari* at several localities in New Mexico and Colorado (Fig. 3A, B), and Powell (1965, p. 518, 519) recorded *M. depressus* and *Selwynoceras mexicanum* (Bose) together in northern Chihuahua, Mexico. After studying excellent collections of *C. woollgari woollgari* from England and France and large collections of *Selwynoceras mexicanum* from Mexico and Texas, W. J. Kennedy, C. W. Wright, and J. M. Hancock (written communication, 1978) have concluded that these are one species.

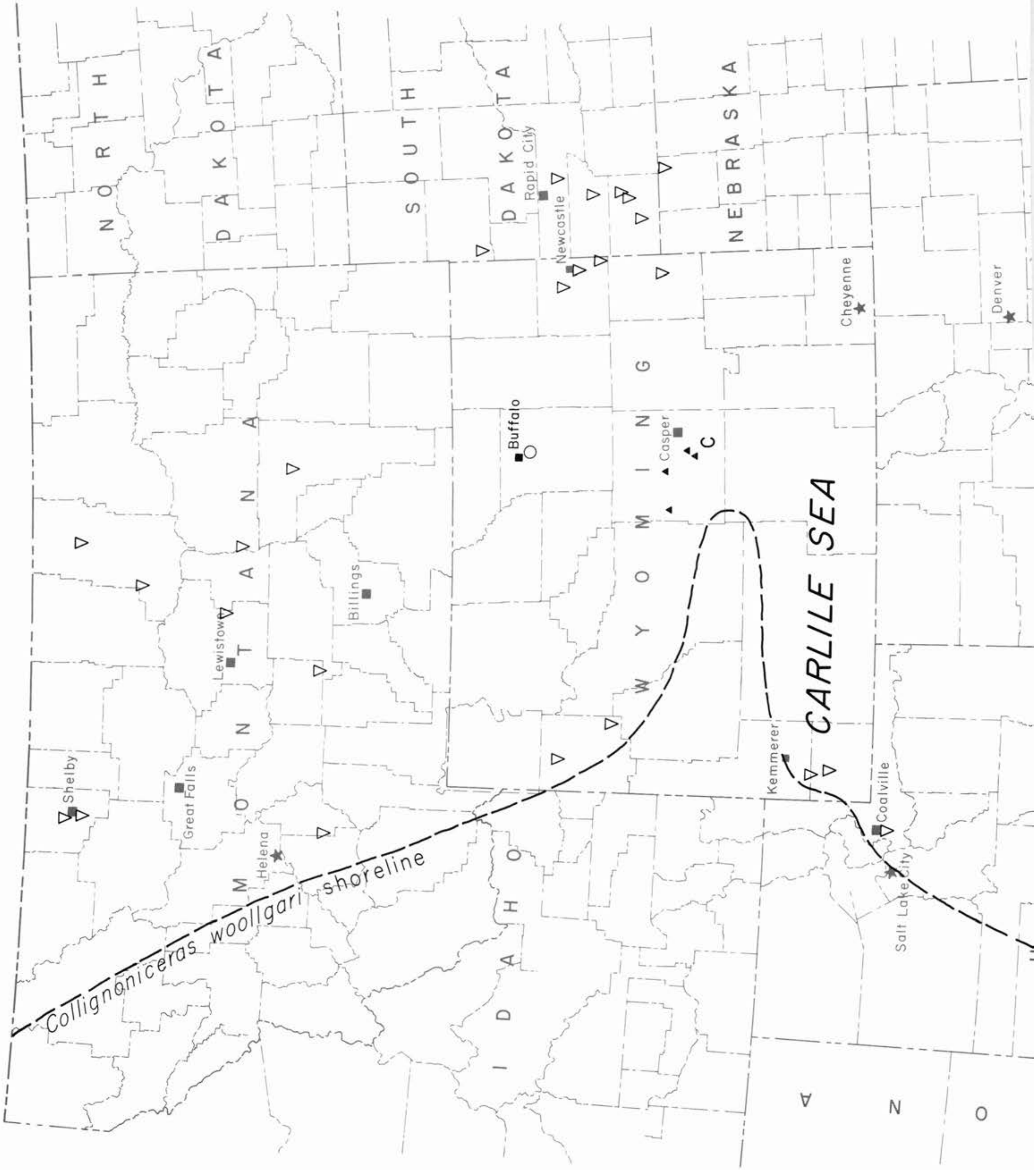
In the Pueblo, Colorado, area (Fig. 3B), *M. depressus* occurs in two beds of limestone separated by only 20 cm of calcareous shale (Cobban and Scott, 1972, p. 22, 23, beds 118-120). An associated ammonite is *M. nodosoides wingi* Morrow (1935, p. 467, pl. 51, fig. 2; pl. 52, figs. 2a-c; text fig. 2), which is at the top of its known range in the Pueblo area. The upper bed of limestone also contains *C. woollgari woollgari*, which is at the base of its known range. *Mammites depressus* thus seems to have a more restricted time range at Pueblo than either C. *woollgari woollgari* or *M. nodosoides.* This situation also exists in the Carthage to D-Cross Mountain area of west-central New Mexico, where *M. depressus* has been collected only from the base of the *C. woollgari woollgari* subzone in the Mancos Shale tongue underlying the Tres Hermanos Sandstone Member (Fig. 3A; Hook and Cobban, 1979, fig. 5). The combined ranges of *M. depressus* and C. *woollgari woollgari* are herein treated as a single subzone that overlaps the top of the *M. nodosoides* Range Zone and underlies the *C. woollgari regulare* subzone.

The association of *M. depressus* and *C. woollgari*

woollgari in Chihuahua, Mexico, parallels the association at Pueblo, but at some other localities in Mexico and Texas, the upper Turonian ammonite *Prionocyclus* Meek (1876, p. 452) has been recorded with *M. depressus* (Powell, 1967, p. 318-320) and *C. woollgari woollgari (as Selwynoceras mexicanum* Powell, 1963, p. 1225; 1965, p. 520). In the Western Interior, the oldest species of *Prionocyclus is P. hyatti* (Stanton) (1893, p. 176, pl. 42, figs. 5-8), which was derived from *C. woollgari. Prionocyclus hyatti* then gave rise to a lineage of species that continued to the end of the Turonian (Fig. 1).

Stephenson and Reeside, 1938		Cobban, 1951		Cobban and Hook, this report			
Scaphites warreni, Prionocyclus wyomingensis	Turonian	*Scaphites corvensis, Prionocyclus* aff. *P. reesidei*	Turonian	*Prionocyclus quadratus, Scaphites corvensis*		Turonian	upper
		Scaphites nigricollensis		*Prionocyclus novimexicanus*	*Scaphites nigricollensis*		
		Scaphites whitfieldi, Prionocyclus wyomingensis			*Scaphites whitfieldi*		
		Scaphites ferronensis		*Prionocyclus wyomingensis*	*Scaphites ferronensis*		
		Scaphites warreni, Prionocyclus macombi			*Scaphites warreni*		
				Prionocyclus macombi			
		Scaphites carlilensis, Collignoniceras hyatti		*Prionocyclus hyatti, Scaphites carlilensis*			middle
Prionotropis woolgari, Scaphites larvaeformis		*Scaphites larvaeformis, Collignoniceras woollgari*		*Collignoniceras woollgari*	*C. woollgari regulare*		
					C. woollgari woollgari		
Inoceramus labiatus, Metoicoceras whitei		*Watinoceras reesidei, Inoceramus labiatus*		*Mammites nodosoides*			lower
				Watinoceras coloradoense, Vascoceras birchbyi			
				Nigericeras scotti			
				Pseudaspidoceras, vascoceratids, etc.			
		Sciponoceras gracile, Metoicoceras whitei		*Sciponoceras gracile, Metoicoceras whitei*		uppermost Cenomanian	

FIGURE 1—TURONIAN AMMONITE ZONATION IN THE WESTERN INTERIOR.



N O R T H
D A K O T A
S O U T H
D A K O T A
N E B R A S K A
M O N T A N A
W Y O M I N G
I D A H O
Rapid City
Newcastle
Cheyenne
Denver
Buffalo
Casper
C
CARLILE SEA
Billings
Lewistown
Shelby
Great Falls
Helena
Kemmerer
Coalville
Salt Lake City
Collignoniceras woollgari shoreline

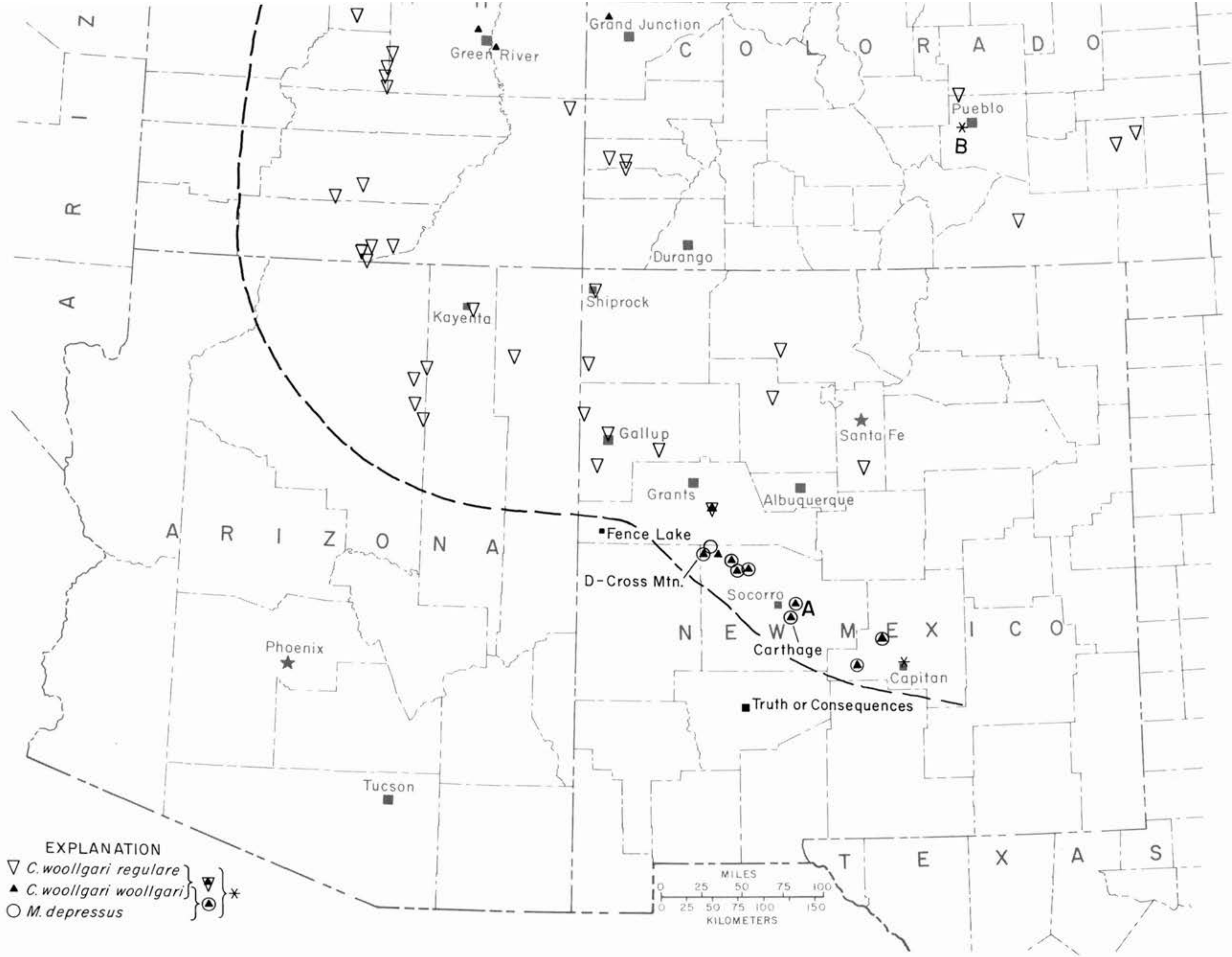


FIGURE 2—Map of the Western Interior showing localities where *Collignoniceras woollgari regulare* (Haas), *C. woollgari woollgari* (Mantell), and *Mammites depressus* Powell have been collected. The approximate location of the Cretaceous shoreline during the time represented by the *C. woollgari* Zone is also shown. Several nearby localities may be included under a single symbol. A, B, and C refer to columnar sections shown in Fig. 3.

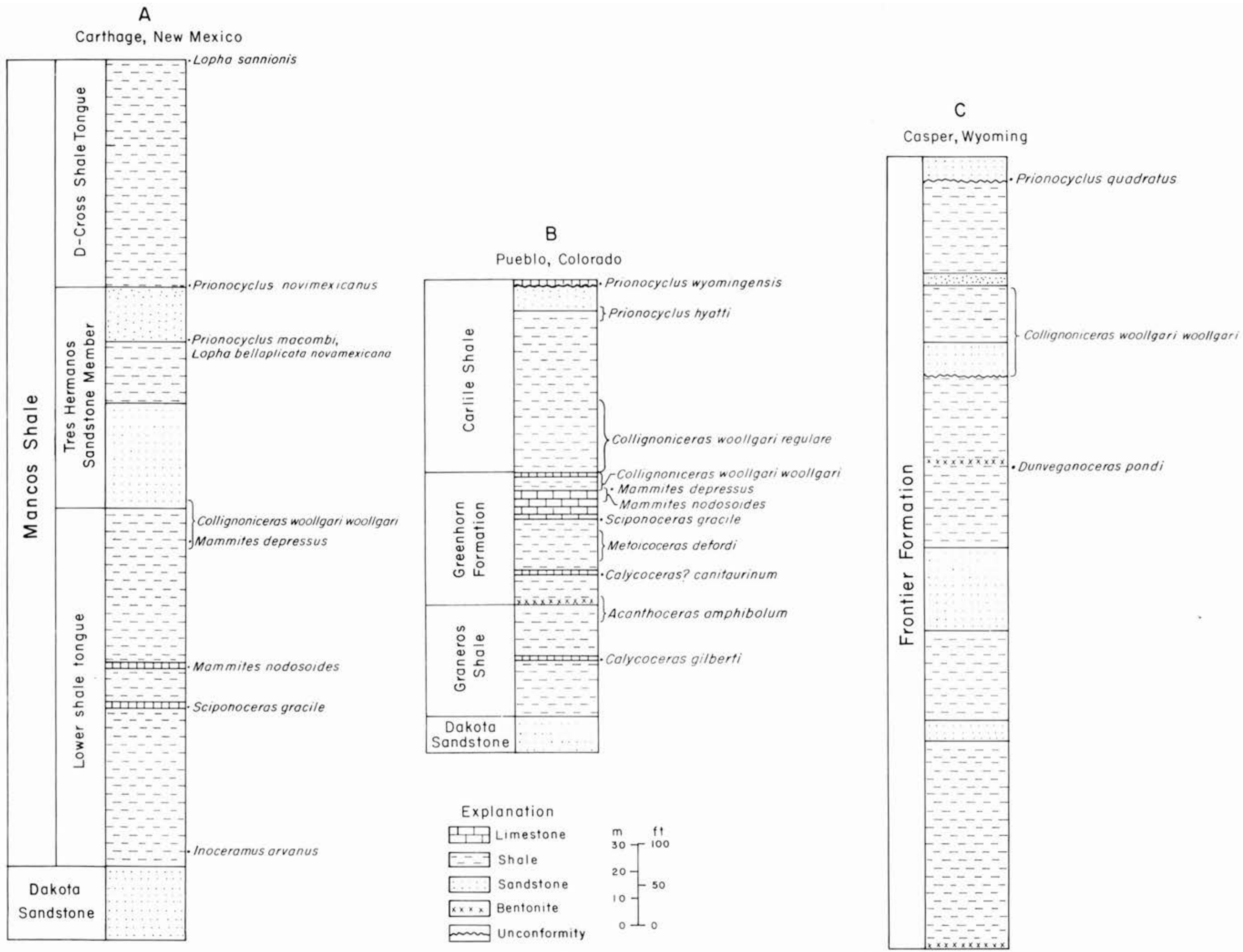


FIGURE 3—Generalized columnar sections of Cenomanian and Turonian rocks near A) Carthage, New Mexico, B) Pueblo, Colorado, and C) Casper, Wyoming, showing stratigraphic positions of *Collignoniceras woollgari regulare* (Haas), *C. woollgari woollgari* (Mantell), and *Mammites depressus* Powell, as well as positions of other zonal fossils (section B is modified from Scott, 1964; section C is modified from Cavanaugh, 1976).

Mollusks of *Collignoniceras woollgari woollgari* subzone

Fossils in the subzone of *Collignoniceras woollgari woollgari* in the Western Interior vary according to lithology and locality. The most diverse faunas are in nearshore marine sandstone.

In west-central New Mexico, the zone includes the lower part of the Tres Hermanos Sandstone Member of the Mancos Shale and the upper part of the underlying Mancos Shale tongue. Brown-weathering calcareous sandstone concretions in the Tres Hermanos Sandstone Member are often very fossiliferous and contain a varied molluscan fauna in the Carthage to D-Cross Mountain area (Fig. 2). The following bivalves were collected:

Modiolus sp.
Pinna cf. *P. guadalupae* Böse
Phelopteria gastrodes (Meek)
Pseudoptera sp.
Inoceramus cuvieri Sowerby
Mytiloides mytiloides (Mantell)
Crassostrea soleniscus (Meek)
Ostrea sp.
Pleuriocardia (Dochmochardia) n. sp.
Cymbophora emmonsi (Meek)
Tellina modesta Meek
Protodonax sp.
Veniella mortoni Meek and Hayden
Aphrodina sp.
Cyprimeria sp.
Legumen ellipticum Conrad
Pholadomya sp.
Laternula lineata (Stanton)
Psilomya aff. *P. concentrica* (Stanton)

Gastropods from the Tres Hermanos Sandstone Member in its type area near Puertecito, New Mexico were identified as follows by N. F. Sohl, of the U.S. Geological Survey (written communication, 1966, 1967):

Perissoptera? sp.
Pugnellus (Gymnarus) fusiformis Meek
Gyrodes conradi Meek
G. aff. G. depressa Meek
Pyropsis coloradoensis Stanton
Tectaplica? utahensis (Meek)
Carota cf. *C. dalli* (Stanton)
Olividae n. gen. and n. sp.

Ammonites from the Tres Hermanos Sandstone Member include the following:

Baculites yokoyamai Tokunaga and Shimizu
Tragodesmoceras sp.
Proplacenticeras pseudoplacenta (Hyatt)
Spathites rioensis Powell
Hoplitoides cf. *H. wohltmanni* (von Koenen)
Collignoniceras woollgari woollgari (Mantell)

Limestone concretions in the upper part of the Man-cos Shale tongue underlying the Tres Hermanos Member contain a less diverse and deeper water fauna. The following mollusks were found in the Carthage to D-Cross Mountain area of west-central New Mexico:

Mytiloides subhercynicus (Seitz)
Carota sp.
Baculites yokoyamai Tokunaga and Shimizu
Tragodesmoceras socorroense Cobban and Hook, n. sp.
Proplacenticeras pseudoplacenta (Hyatt)
Watinoceras cobbani Collignon
Mammites depressus Powell
M. nodosoides (Schlotheim)
Spathites rioensis Powell
Hoplitoides cf. *H. koeneni* Solger
Collignoniceras woollgari woollgari (Mantell)
Neoptychites? sp.

Tragodesmoceras, which is represented by a single specimen in the Tres Hermanos Sandstone Member, is rather common in the underlying Mancos Shale tongue in the D-Cross Mountain area. *Baculites* and *Collignoniceras* are rare in the Mancos Shale tongue, in contrast to their abundance in the Tres Hermanos Sandstone Member.

In western Colorado, C. *woollgari woollgari* also occurs with a varied molluscan fauna. Northwest of Grand Junction, large brown-weathering sandstone concretions 34 m above the base of the Mancos Shale contain the following fossils:

Pinna petrina White
Exogyra n. sp.
Pycnodonte? sp.
Camptonectes sp.
Pleuriocardia (Dochmocardia) n. sp.
Cymbophora sp.
Legumen sp.
Laternula lineata (Stanton)
corbulid
Paleopsephaea cf. *P. patens* Stephenson
Collignoniceras woollgari woollgari (Mantell)

In southeastern Colorado, where C. *woollgari woollgari* occurs in limestone beds in the upper part of the Bridge Creek Limestone Member of the Greenhorn Formation, molluscan diversity is low (Fig. 3B). Fossils associated with *C. woollgari woollgari* consist of numerous specimens of *Mytiloides mytiloides* (Mantell) and very few specimens of *Baculites yokoyamai* Tokunaga and Shimizu, *Mammites depressus* Powell, *M. nodosoides wingi* Morrow, and *Tragodesmoceras* sp.

In the Frontier Formation in the Casper area in central Wyoming, the sandstone unit that contains *C. woollgari woollgari* has very few other fossils (Fig. 3C). The only bivalve species observed is *Inoceramus cuvieri* Sowerby, and the only cephalopods associated with *C. woollgari woollgari are Baculites yokoyamai, Tragodesmoceras* sp. (fragments of large individuals), and a single fragment of the belemnite *Actinocamax*.

Farther northwest, near Buffalo in north-central Wyoming, the subzone of C. *woollgari woollgari* lies low in a 12.5-m thick calcareous sandstone unit, in the upper part of the Frontier Formation (84 m above the base of the Cody Shale of Hose, 1955, p. 98, unit 11). Here sandy limestone concretions contain the following assemblage (updated from that reported by Hose):

Serpula sp.
Mytiloides labiatus (Schlotheim)
Ostrea sp.
Cerithiopsis n. sp.
Mammites depressus Powell
Tragodesmoceras socorroense Cobban and Hook, n. sp.

Another ammonite, reported as *Watinoceras* cf. W. *coloradoense* (Henderson), can be interpreted as *C. woollgari woollgari.* The specimen, consisting of a little less than half a whorl about 67 mm in diameter, has an umbilical diameter of 19 mm (ratio 0.29) and 13 ribs per half whorl. Double ventrolateral tubercles are present, but the venter is not preserved. Inasmuch as *Watinoceras coloradoense* is now known to be slightly older than *Mammites depressus,* the specimen is more likely to be C. *woollgari woollgari.*

Position of *Collignoniceras woollgari woollgari* subzone in the Turonian

The range zone of *Collignoniceras woollgari* has long been accepted as middle Turonian in age (for example, Spath, 1926, table opposite p. 80; Muller and Schenck, 1943, fig. 6; Wright and Wright, 1951, p. 30; Basse de Menorval and Sornay, 1959, p. 15, 16; Wright, 1963, p. 612; Matsumoto, 1977, p. 64, 72). However, in the Western Interior, the subzone of C. *woollgari woollgari* could be assigned a very late early Turonian age based on some of the mollusks. At Pueblo, Colorado, and in west-central New Mexico, C. *woollgari woollgari* is associated with *Mytiloides mytiloides* (Mantell); and near Buffalo, Wyoming, *Mammites depressus* Powell occurs with *M. labiatus* (Schlotheim). The bivalves are very closely related, and some authorities (for example, Seitz, 1934) regard them as variants of the same species *(M. labiatus).* This species or species group is widely distributed over much of the world, and there is general agreement that it marks the lower Turonian.

According to the investigations of the Turonian of Nigeria by Reyment (1955, p. 98, 99), the presence of *Mammites* and *Watinoceras* in the C. *woollgari woollgari* subzone argues for a late early Turonian age. Reyment noted that the lower part of the lower Turonian was characterized by several genera of vascoceratid ammonites, whereas the upper part of the lower Turonian contained the genera *Watinoceras, Benueites, Neoptychites, Hoplitoides, Mammites, Kamerunoceras, Pachydesmoceras,* and *Choffaticeras.* In a later work, Reyment (1969, p. 139) applied the term "vascoceratan zone" to the older of these two main lower Turonian zones, and the term "benueitan zone" to the younger (also referred to as "vascoceratid association" and "benueitid association," respectively, by Reyment and Tait, 1972, p. 320). The ammonites of the *C. woollgari woollgari* subzone clearly lie in Reyment's benueitan zone.

A middle Turonian age assignment for Reyment's benueitan zone is favored by Collignon (1966, 1967), who worked with faunas from Morocco that are similar to those from Nigeria. Collignon (1966, p. 67) recognized a middle Turonian zone of *Benueites benueensis* and *Watinoceras guentherti,* which also contains *Watinoceras cobbani,* a species found in the *C. woollgari woollgari* subzone in New Mexico.

We are accepting the middle Turonian assignment for the range zone of C. *woollgari;* this assignment seems to be favored by Kennedy, Wright, Hancock, Matsumoto, Collignon, and many other persons currently investigating Cretaceous ammonites and stratigraphy. A very low or basal position in the middle Turonian for the subzone of C. *woollgari woollgari* is indicated by the faunal assemblages from the Western Interior.

Systematic paleontology of the ammonite fauna

Family BACULITIDAE Meek, 1876

GENUS *BACULITES* Lamarck, 1799

TYPE SPECIES: *Baculites vertebralis* Defrance, 1830

The diagnostic features of this genus were summarized by Cobban and Scott (1972, p. 48) as follows:

> This genus comprises Upper Cretaceous ammonites that are straight to slightly curved in all their growth except for an initial planospiral coil of one or two whorls. The cross section is ordinarily oval, but it may be elliptical, subcircular, circular, or triangular. The adult aperture has a short dorsal lappet, lateral sinus, and a longer ventral lappet that is either straight or partly curved upward. The venter is commonly crossed by ribs that have conspicuous forward arching. The flanks may be ornamented by arcuate ribs whose concave side is forward or by arcuate tubercles or nodate tubercles. The suture, which is simple to complex, has bifid *E, L,* and *U,* undivided *I,* and three bifid saddles.
>
> *Baculites* has a worldwide distribution in strata of Turonian through Maestrichtian age. It evolved from *Sciponoceras* by losing the constrictions and lengthening and straightening the ventral rostrum.

Baculites yokoyamai Tokunaga and Shimizu
P1. 4, figs. 9, 10

Baculites (Lechites) yokoyamai Tokunaga and Shimizu, 1926, p. 195, pl. 22, fig. 5a, b; pl. 26, fig. 11.
Baculites besairiei Collignon, 1931, p. 37, pl. 5, figs. 6, 6a, 7, 7a, 8, 8a, 9.
Baculites cf. *B. yokoyamai* Tokunaga and Shimizu. Matsumoto, 1959, p. 118, text fig. 26.
Baculites yokoyamai Tokunaga and Shimizu. Matsumoto and Obata, 1963, p. 30, pl. 8, fig. 5; pl. 10, figs. 1-6; pl. 11, figs. 1, 4, 5; pl. 12, fig. 3; pl. 14, fig. 4; text figs. 72-87.
Baculites besairiei Collignon. Collignon, 1965, p. 18, pl. 420, figs. 1745, 1746.
Baculites cf. *B. yokoyamai* Tokunaga and Shimizu. Cobban and Scott, 1972, p. 48, pl. 20, figs. 15-21.
_____ Hattin, 1975, pl. 8, figs. F-H.
______Kennedy, 1977, text fig. 17 (1, 2).
______Hattin, 1977, p. 187, fig. 6 (2).

Baculites yokoyamai is a small, straight species that has a very small angle of taper and a nearly elliptical cross section. The venter has closely spaced ribs that may be very weak, and the flanks are usually smooth. An occasional specimen has closely spaced arcuate flank ribs that are barely discernible. The suture is very simple for the genus.

This species was originally described from rocks of Coniacian Age in Japan. The species has also been found in the Coniacian of Madagascar and California. *Baculites yokoyamai* is such a generalized and simple form that small, dominantly smooth, simple sutured baculites from pre-Coniacian rocks in the Western Interior of the United States cannot be distinguished from it. The time span of the species in the Western Interior is entirely through the Turonian.

Baculites yokoyamai is common in the Tres Hermanos Sandstone Member of the Mancos Shale in the Carthage area. Specimens in our collections do not exceed 17 mm in diameter, and all the larger specimens are somewhat crushed. A body chamber that has a complete aperture is shown in Pl. 4, figs. 9, 10. Baculites are rare in the upper part of the Mancos Shale tongue underlying the Tres Hermanos Sandstone Member.

Crushed specimens, identified as *Baculites* cf. *B. yokoyamai* (Cobban and Scott, 1972, p. 22, 23, units 118, 131), in the subzone of *Collignoniceras woollgari woollgari* at Pueblo, Colorado, are certainly that species. A few specimens of *B. yokoyamai* have also been found in this subzone in central Wyoming.

TYPE-Hypotype USNM 252805.

Family MUNIERICERATIDAE Wright, 1952

GENUS *TRAGODESMOCERA S* Spath, 1922

TYPE SPECIES: *Desmoceras clypealoides* Leonhard, 1897

Desmoceras clypealoides Leonhard (1897, p. 57, pl. 6, figs. 2a, b), the ammonite on which Spath (1922, p. 127) based his genus *Tragodesmoceras,* is a moderately involute form characterized by a whorl section higher than wide having a very narrowly rounded venter. Ribs are sinuous and cross the venter with forward arching. Thickened ribs occur periodically. The suture is very incised and has a broad trifid lateral lobe.

Tragodesmoceras socorroense Cobban and Hook, n. sp.
P1. 5, figs. 9, 10; Pls. 6, 7; **P1. 11,** fig. 10; Fig. **4**

Great size, inflated whorls, and persistence of ribbing to a late growth stage characterize this species. The holotype is half an adult phragmocone that has a diameter of approximately 460 mm, an umbilical width of 130 mm (ratio to diameter 0.28), and a breadth of 159 mm. All visible whorls have inflated triangular sections, with the greatest width at the umbilical shoulder (Fig. 4). The umbilical wall is steep, and the shoulder is sharply rounded. Nine low, broad rectiradiate ribs are present on the last half whorl. Each begins at the umbilical shoulder and crosses most of the flank. The ribs weaken toward the adoral end of the whorl, where they become barely discernible. The larger end of this phragmocone is probably at the base of the body chamber. A huge specimen (Pl. 7) from the Buffalo area of north-central Wyoming, originally identified as *Puzosia* aff. *P. planulata* (Sowerby) (Hose, 1955, p. 98), is another large adult of *T. socorroense.* This specimen, 555 mm in diameter, has a diameter of 455 mm at the base of the body chamber, which compares favorably to the Socorro County specimen.

Juvenile whorls up to a diameter of about 100 mm have strong primary and secondary ribs that are narrower than the interspaces. Primary ribs are sigmoidal and rise from bullae on the umbilical shoulder. Each pair of primaries is separated by three to four secondary ribs that arise about midflank. All ribs bend forward on the venter, where they are of equal height and form conspicuous chevrons. Each rib may rise into a low nodate siphonal tubercle. A paratype (Pl. 5, figs. 9, 10) that shows the juvenile ribbing very well has 25 ventral ribs for half a whorl at a diameter of 92 mm. Primary ribs number five at this diameter.

The suture of *T. socorroense* is complex (Pl. 11, fig. 10); it closely resembles that of *T. carlilense* Cobban (1971, text fig. 8).

Juvenile whorls of *T. socorroense* resemble those of *T. bassi* Morrow (1935, p. 468, pl. 52, figs. la-c; pl. 53, figs. 3-5; text figs. 1, 3) in their conspicuous ribbing, but *T. bassi* is a much smaller and more slender species that has smooth adult whorls. *Tragodesmoceras carlilense* Cobban (1971, p. 8, pl. 3, figs. 1, 2; pl. 4, figs. 1-16; pl. 5, figs. 1-5; text figs. 6-8) has more weakly ornamented juvenile whorls and smooth adult whorls that have a more broadly rounded venter.

In New Mexico, *T. socorroense* has been found only in northwestern Socorro County and in adjacent Valencia County in septarian limestone concretions in the upper part of the Mancos Shale tongue underlying the Tres Hermanos Sandstone Member. The holotype is from the NW 1/4NE 'A NW 1/4 sec. 16, T. 4 N., R. 7 W., Pueblo Viejo Mesa 71/2 ' quadrangle.

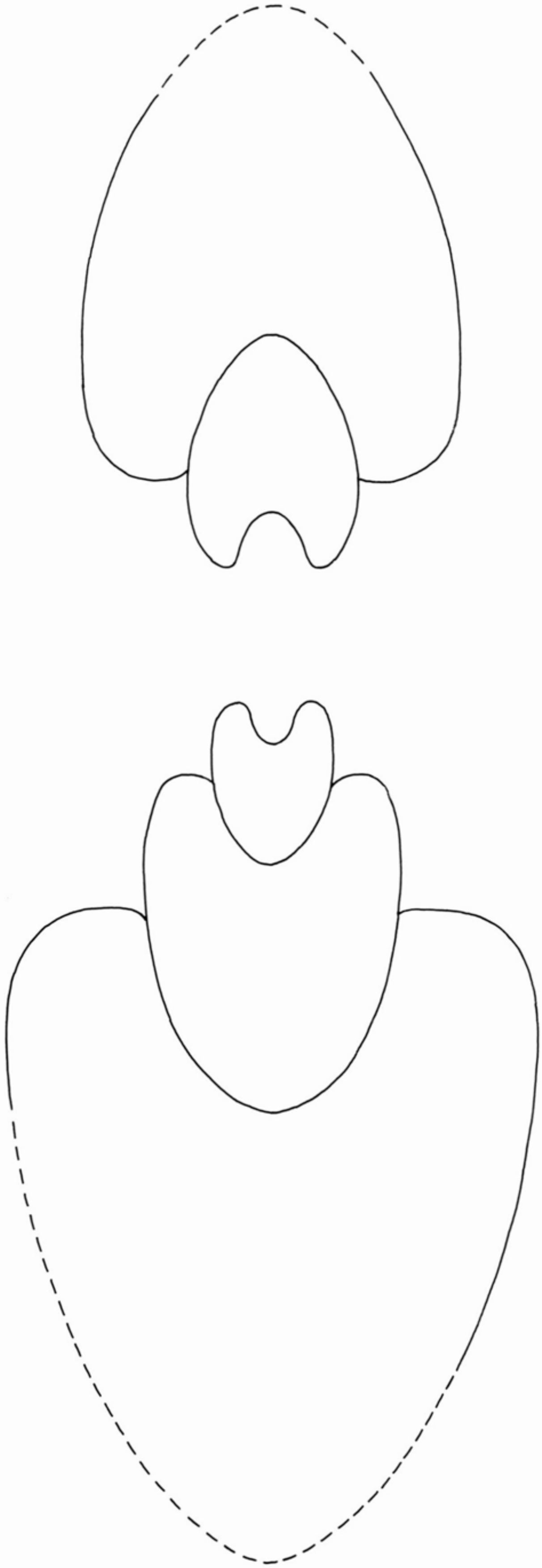


FIGURE 4—WHORL SECTION, × ½, OF THE HOLOTYPE OF *TRAGODESMOCERAS SOCORROENSE* COBBAN AND HOOK, N. SP., at a diameter of approximately 460 mm; holotype USNM 252806; dashed where reconstructed.

TYPES—Holotype USNM 252806; paratypes USNM 252807, 252808, 255608.

Family PLACENTICERATIDAE Hyatt, 1900

GENUS *PROPLACENTICERAS* Spath, 1926

TYPE SPECIES: *Placenticeras fritschi* de Grossouvre, 1893

Spath (1926, p. 79) proposed this genus for ammonites that resemble *Placenticeras fritschi* de Grossouvre (1893, p. 124, pl. 5, figs. la, b, 2a-c). Wright (1957, p. L390) diagnosed the genus as follows:

> Compressed, with flat or slightly convex sides and narrow flat venter; nearly smooth, with or without slight conical umbilical tubercles and ventrolateral clavi and crescentric ribs on outer part of sides. Suture with fewer auxiliary elements than in the later *Placenticeras*.

***Proplacenticeras pseudoplacenta* (Hyatt)**
Pl. 8, figs. 1-5

Placenticeras placenta (DeKay)? Stanton, 1893, p. 169, pl. 39, fig. 1 only [published 1894].
Placenticeras pseudoplacenta Hyatt, 1903, p. 216, pl. 43, figs. 3-11; pl. 44.
_____ Grabau and Shimer, 1910, p. 219, text fig. I 497a-d.
_____ Reeside, 1927, p. 8, pl. 2, figs. 20, 21.
Proplacenticeras pseudoplacenta (Hyatt). Hattin, 1977, fig. 8 (12) on p. 189.

As Reeside (1927, p. 8) noted, Hyatt did not present a clear definition of this species. Reeside summarized the species as having whorls about twice as high as wide, with flanks flattened in juveniles and very broadly rounded in adults, and having either a smooth shell or inconspicuous nodes and ribs. The suture has somewhat short lobes and saddles that are only moderately incised.

A few specimens from the lower part of the Tres Hermanos Sandstone Member and from septarian limestone concretions in the upper part of the underlying Mancos Shale can be assigned to *P. pseudoplacenta.* Most are small phragmocones 50-80 mm in diameter. None has tubercles, but most have very weak, broad, falcoid ribs on the outer part of the flank. The species has not been found in the subzone of *Collignoniceras woollgari woollgari* outside New Mexico.

TYPES—Hypotypes USNM 252809, 252810.

Family ACANTHOCERATIDAE Hyatt, 1900

Subfamily MAMMITINAE Hyatt, 1900

GENUS *MAMMITES* Laube and Bruder, 1887

TYPE SPECIES: *Ammonites nodosoides* Schlotheim, 1829

This genus is typically stout and usually has a rectangular to squarish whorl section and a flattened to slightly concave venter. Ornamentation is dominated by conspicuous nodate to bullate umbilical tubercles and nodate to clavate inner and outer ventrolateral tubercles. No other tubercles are present. Ribs are usually rectiradiate; they may be somewhat prominent on juveniles but are generally inconspicuous on adults. The suture is rather simple and characterized by a very broad first lateral lobe.

Mammites depressus Powell
Pl. 9; Pl. 10, figs. 1-3; Figs. 5, 6

Mammites? depressus Powell, 1963, p. 1228, pl. 168, figs. 1-3; pl. 170, figs. 4, 5; pl. 171, fig. 1; text figs. 5e, 6f-h.
_____ Powell, 1967, p. 313, text figs. *2-5*.
Mammites? sp., Cobban and Scott, 1972, p. 81.

This is a very unusual species, because it has an exceptionally depressed whorl section and a wide umbilicus. The whorl section is considerably wider than high; an adult whorl section illustrated by Powell (1967, text fig. 3) has a height of only 40 percent of the width. Smaller individuals have less depressed whorls, but all specimens illustrated by Powell have whorls wider than high. On adults the inner ventrolateral tubercles become very large and are directed outward. The outer ventrolateral tubercles are reduced in size, are located on the flattened venter, and are better referred to as ventral tubercles.

The holotype, from 432 m above the base of the Ojinaga Formation in Chihuahua, Mexico, is a corroded phragmocone 90 mm in diameter. The umbilical ratio is 0.30, and the tubercle count for half a whorl is 5 for the umbilical tubercules and 8 for the ventrolateral and ventral ones. Tubercles are nodate and located on weak ribs that are rectiradiate to slightly prorsiradiate. Ventral tubercles are set a little ahead of the ventrolateral ones.

The species attains a large size; Powell (1967, p. 318) recorded several specimens 200-300 mm in diameter.

Mammites depressus has been found at several localities in New Mexico, from Capitan northwest to the D-Cross Mountain area. North of this belt, the species has been found only near Pueblo, Colorado, and near Buffalo, Wyoming.

The New Mexican occurrences are in the upper part of the Mancos Shale tongue that underlies the Tres Hermanos Sandstone Member. Most specimens are large adults 300-440 mm in diameter that have umbilical ratios of 38-39 percent. Diameters at the base of the body chamber of three specimens are 297, 320, and 335 mm. Whorl sections are considerably wider than high, with the greatest width between the opposite umbilical tubercles (Fig. 5). Venters are flattened to depressed. These large whorls usually have equal numbers of large nodate umbilical and ventrolateral tubercles that number 5-7 per half whorl. Ventral tubercles, which are as large as the ventrolateral ones on small specimens, weaken and disappear when the conch attains a diameter of 100-130 mm.

Specimens of *M. depressus* in the Pueblo, Colorado, area are extremely poorly preserved and can easily be mistaken for limestone concretions. The few specimens found attain sizes comparable to the large specimens from New Mexico, and one was at least 480 mm in diameter (Cobban and Scott, 1972, p. 81). The specimens occur in two closely spaced beds of limestone in the upper part of the Bridge Creek Limestone Member of the Greenhorn Formation.

The Wyoming occurrence is limited to a single specimen from the upper part of the Frontier Formation near Buffalo. The specimen is incomplete, but it has a diameter of about 250 mm at the base of the body chamber, where the whorl section is considerably wider than high and is broadly elevated in the middle of the venter (Fig. 6). A large specimen illustrated by Powell (1967, fig. 3) has a similar raised ventral area.

TYPES-Hypotypes USNM 252811-252815.

Mammites nodosoides (Schlotheim)
P1. 8, figs. 6, 7

For synonomy and illustrations, see Cobban and Scott, 1972, p. 77-81.

This species differs from *M. depressus* in having a nearly square whorl section; it also may be a smaller form. At Pueblo, Colorado, *M. nodosoides* forms a distinct zone in the upper part of the Bridge Creek Limestone Member of the Greenhorn Formation. There, as well as at D-Cross Mountain, New Mexico, *M. depressus* occurs with *M. nodosoides* at the top of this zone.

An occasional fragment of *Mammites* in the collections of *M. depressus* from New Mexico may represent *M. nodosoides.* Unquestioned specimens of *M. nodosoides* occur at Truth or Consequences, Acoma, D-Cross Mountain, and Carthage, New Mexico.

TYPES-Hypotype USNM 252816.

GENUS *WATINOCERAS* Warren, 1930

TYPE SPECIES: *Watinoceras reesidei* Warren, 1930

Cobban and Scott (1972, p. 75) defined *Watinoceras* as follows:

> This is a moderately evolute genus that has somewhat compressed whorls, narrow but conspicuous ribs, and umbilical, lower ventrolateral, and upper ventrolateral tubercles of which the upper ventrolateral ones are the strongest. The siphonal area is narrow, somewhat flattened, and bordered by the high closely spaced upper ventrolateral tubercles. Ribs are prorsiradiate and, on the inner whorls, sigmoidal. The suture is rather simple and has a wide slightly incised first lateral saddle and much narrower lateral lobe.

Watinoceras seems to be confined to the lower and middle Turonian. The genus has been recorded from the Western Interior of the United States and from Canada, Alaska, Texas, Mexico, England, Turkestan, Spain, Morocco, Cameroon, Madagascar, and Japan. In the Western Interior, *Watinoceras* has been known from two species in the Greenhorn Formation of Colorado and Kansas. *Watinoceras coloradoense* (Henderson) (1908, p. 259, pl. 13, figs. 10, 11) forms a zone just below that of *Mammites nodosoides* in the Bridge Creek Limestone Member of the Greenhorn Formation in southeastern Colorado (Cobban and Scott, 1972, p. 32, 33). *Watinoceras reesidei* Warren (1930, p. 67, pl. 3, fig. 2; pl. 4, figs. 9-12), which may be present in this zone in

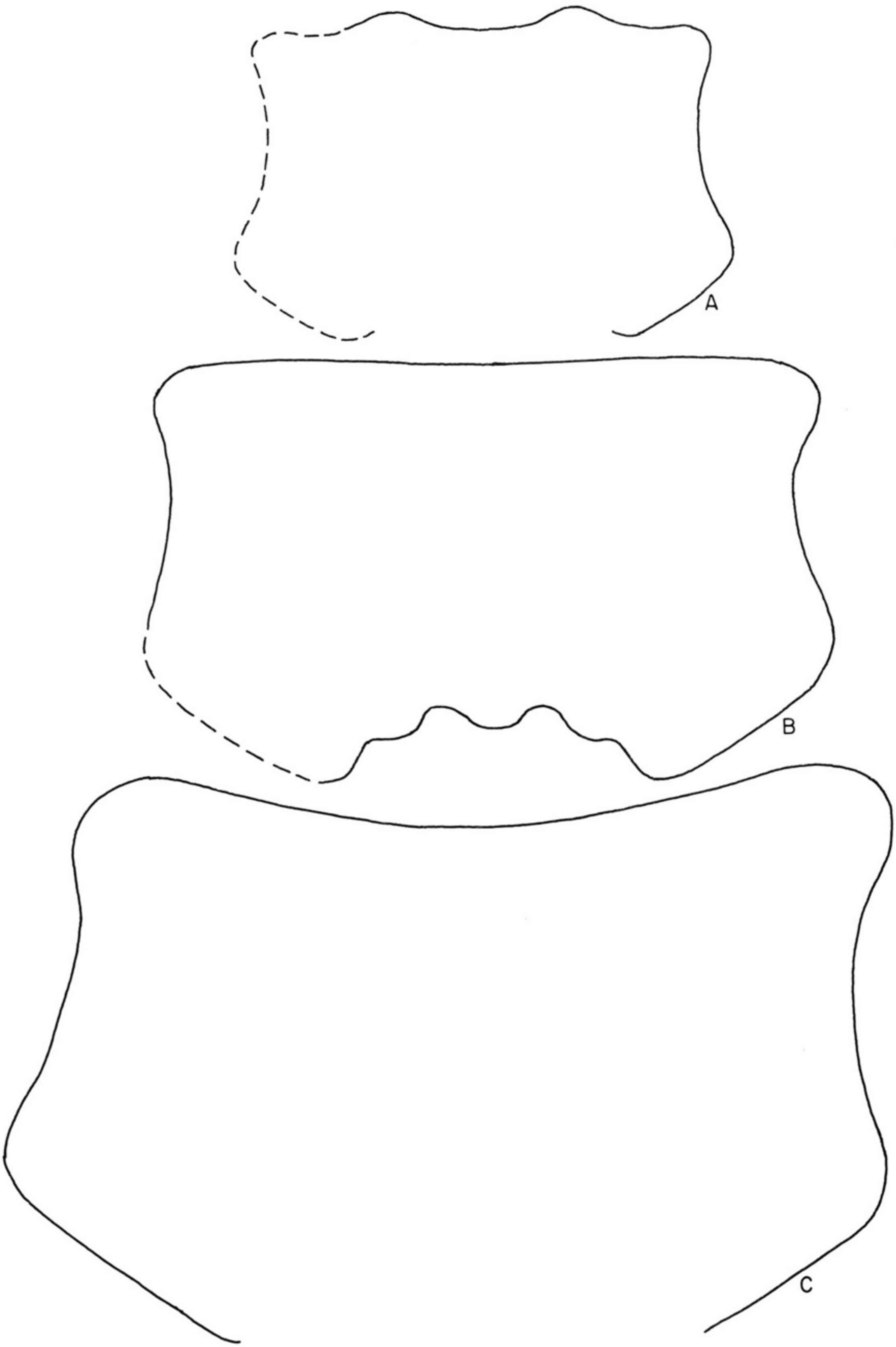


FIGURE 5—Whorl sections, ×0.9, of *Mammites depressus* Powell, from the upper part of the Mancos Shale tongue underlying the Tres Hermanos Sandstone Member at USGS Mesozoic locality D10298, east of D-Cross Mountain in the SW¼ sec. 17, T. 3 N., R. 8 W., Socorro County, New Mexico. A) hypotype USNM 252813; B) hypotype USNM 252814; C) hypotype USNM 252811 (Pl. 9; Pl. 10, fig. 3); dashed where reconstructed.

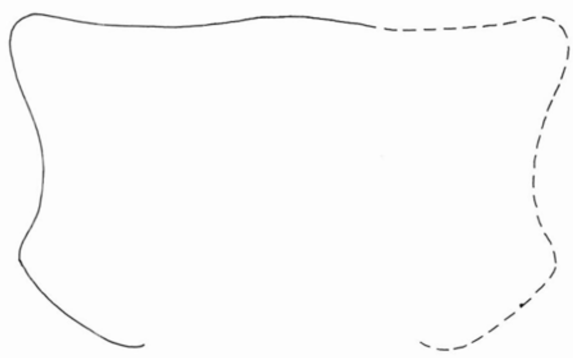


FIGURE 6—WHORL SECTION, ×½, AT THE BASE OF THE BODY CHAMBER OF *MAMMITES DEPRESSUS* POWELL from a sandstone concretion in the upper part of the Frontier Formation (87 m above base of Cody Shale of Hose, 1955, p. 98) at USGS Mesozoic locality 22819 in the SW¼NW¼ sec. 12, T. 49 N., R. 83 W., Johnson County, Wyoming; hypotype USNM 252815; dashed where reconstructed.

Colorado, is common in about the age-equivalent part of the Greenhorn of central Kansas (Hattin, 1975, p. 66).

Watinoceras has been found in the subzone of *Collignoniceras woollgari woollgari* at only one locality in the Western Interior; several specimens were found in a limestone concretion in the upper part of the Mancos Shale tongue below the Tres Hermanos Sandstone Member in the D-Cross Mountain area of west-central New Mexico.

Watinoceras cobbani **Collignon**

Pl. 5, figs. 1-8; Figs. 7, 8

Watinoceras cobbani Collignon, 1966, p. 36, pl. 19, figs. 8, 8a, b.

Collignon characterized this small species as having a wide umbilicus, a squarish whorl section, smooth inner whorls, and a strongly ornamented outer whorl. Umbilical and inner and outer ventrolateral tubercles are present. Primary ribs rise from the umbilical tubercles and cross the flank, where they are separated by one or two secondary ribs. All ribs bear two rows of ventrolateral tubercles, with the stronger ones on the primary ribs. From the row of inner ventrolateral tubercles, the ribs curve forward and cross the venter in chevrons. Collignon reported the holotype as having a diameter of 23 mm and an umbilical width of 6 mm (ratio of 0.26). His photograph of the holotype, however, suggests a wider umbilicus with a ratio of about 0.31. About 19 or 20 ribs cross the venter on the last half whorl.

One nearly complete specimen and several fragments from the *Collignoniceras woollgari woollgari* subzone in the Mancos Shale of west-central New Mexico seem assignable to W. *cobbani*. The nearly complete specimen (Pl. 5, figs. 1-3), which lacks only the aperture, has a diameter of 27.7 mm, an umbilical width of 9.2 mm (ratio of 0.36), and a ventral rib count of 20 per half whorl. The whorl section of the body chamber is slightly higher than wide, with flattened flanks; its costal section has a depressed venter, whereas its intercostal section has a broadly rounded venter (Fig. 7). The umbilical wall is steep, and the umbilical shoulder is sharply rounded. Inner whorls are poorly preserved but seem to have smooth flattened flanks. Other specimens clearly show the smooth inner whorls (P1. 5, figs. 4, 5).

The specimens from the Mancos Shale show that closely spaced, forwardly curved umbilical tubercles first appear well back on the last septate whorl and continue on the body chamber, probably to the aperture. These tubercles number 10-12 per half whorl. On the last part of the phragmocone and on the body chamber, each umbilical tubercle gives rise to one or two prorsiradiate primary ribs, which are weak and flexuous on crossing the flank. Near midflank one or two flexuous secondary ribs rise between the primaries, and at the ventrolateral shoulder, all ribs become strong and curved forward, crossing the venter as chevrons. On the older half of the body chamber, each rib rises into inner and outer nodate to bullate ventrolateral tubercles or into incipient tubercles. All tubercles weaken on the younger end of the body chamber, but ventral ribbing remains strong.

Only a small part of the suture is visible on one specimen (Fig. 8). The suture is simple and has a broad bifid lateral lobe that is a little narrower than the first lateral saddle.

One specimen (Pl. 5, figs. 7, 8), which has only incipient ventrolateral tubercles, has the general form and ribbing of W. *jaekeli* (Solger) from the lower Turonian of west Africa. *Watinoceras jaekeli,* originally described as *Acanthoceras (Pedioceras?) jaekeli* by Solger (1904, p. 125, pl. 4, fig. 5a, b; text figs. 22, 23) and redescribed by

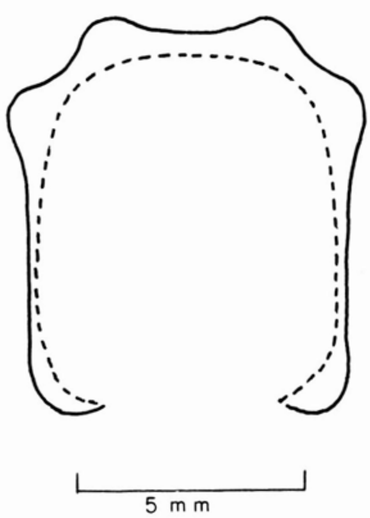


FIGURE 7—COSTAL (SOLID LINE) AND INTERCOSTAL (DASHED LINE) SECTIONS, ×6, OF *WATINOCERAS COBBANI* COLLIGNON AT A DIAMETER OF 20.8 MM, from the upper part of the Mancos Shale tongue underlying the Tres Hermanos Sandstone Member at USGS Mesozoic locality D10298 in the SE¼SW¼ sec. 17, T. 3 N., R. 8 W., Socorro County, New Mexico (Pl. 5, figs. 1-3); hypotype USNM 252820.

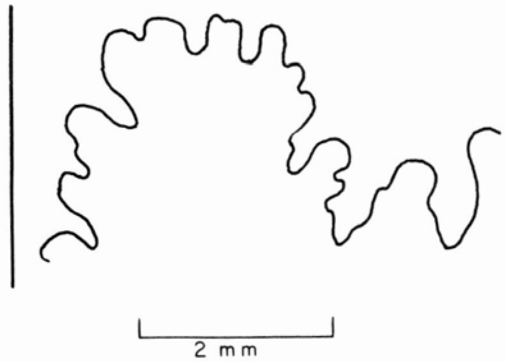


FIGURE 8—PARTS OF THE EXTERNAL AND LATERAL LOBES AND THE INTERVENING SADDLE, ×13, OF *WATINOCERAS COBBANI* COLLIGNON, from the upper part of the Mancos Shale tongue underlying the Tres Hermanos Sandstone Member at USGS Mesozoic locality D10298 in the SE¼SW¼ sec. 17, T. 3 N., R. 8 W., Socorro County, New Mexico; hypotype USNM 252820.

Reyment (1958, p. 56, pl. 3, fig. 2a, b; pl. 4, fig. 3a, b), may differ from the New Mexico specimen only in having a smooth siphonal band.

Watinoceras guentherti Reyment (1957, p. 57, pl. 9, fig. 6a-c), from the lower Turonian of west Africa, resembles the more tuberculate specimens from New Mexico in its small size, smooth inner whorls with flattened flanks, and the ornamented body chamber on which ribs cross the venter in chevrons. Reyment's species, however, is a little more involute, and the tubercles are smaller and weaker.

Watinoceras cobbani has been found at only one locality in the Western Interior, near D-Cross Mountain in northwestern Socorro County, New Mexico (USGS Mesozoic locality D10298, in the SW 1/4 sec. 17, T. 3 N., R. 8 W.). Here the specimens occurred in a septarian limestone concretion in the upper part of the Mancos Shale tongue underlying the Tres Hermanos Sandstone Member. Other concretions in this part of the Mancos Shale at this locality contain *Collignoniceras woollgari woollgari*, *Mammites depressus* Powell, *Tragodesmoceras socorroense* n. sp., and other ammonites of the C. *woollgari woollgari* subzone.

TYPES-Hypotypes USNM 252817-252820.

Family VASCOCERATIDAE Spath, 1925

GENUS *SPATHITES* Kummel and Decker, 1954

TYPE SPECIES: *Spathites chispaensis* Kummel and Decker, 1954

Kummel and Decker (1954, p. 311) proposed *Spathites* for involute vascoceratid ammonites that have a smooth body chamber whose whorl section is subquadrate with flattened flanks and angular shoulders. Inner whorls have umbilical and inner and outer ventrolateral tubercles and sparse primary and secondary ribs. The simple external suture has three narrow, little-incised lateral lobes separated by broad, little-incised saddles.

Spathites is represented by very few species, all of middle Turonian age. The genus is known from New Mexico, Texas, Mexico, and possibly Brazil.

Spathites rioensis Powell

Pl. 2, figs. 1-4; Pl. 5, figs. 11, 12; Pl. 8, figs. 8-13; Pl. 11, figs. 1-9; Pl. 12, figs. 4-6; Fig. 9

Spathites rioensis Powell, 1963, p. 1228, pl. 169, fig. 2; pl. 170, figs. 1-3, 6, 7; text figs. 5j, 6c-e.

The venter is concave on the phragmocone and flat on the body chamber. Internal whorls are robust and have strong nodate to bullate umbilical tubercles and paired clavate ventrolateral tubercles. Ribbing on the inner whorls is sparse and consists of thick primaries and secondaries. The primaries begin at the umbilical tubercles and cross the flank to the inner ventrolateral tubercles, where they bend forward slightly, and rise into the outer ventrolateral tubercles. The ribs then weaken and trend straight across the venter. Powell observed that the primaries numbered 6 or 7 per whorl and that each pair of primaries was separated by 1 to 3 secondaries. Ribs and tubercles persist on to the older part of the body chamber, where they weaken and gradually disappear toward the aperture. The body chamber section is subtrapezoidal with flattened flanks and venter. The external suture shown by Powell (1963, text figs. 5j, 6e) is rather simple and has a narrow external lobe and 3 or 4 other narrow lobes separated by much broader saddles.

Powell observed that the ornamentation extended on to the older part of the body chamber, in contrast to that of the holotype of *Spathites (S. chispaensis* Kummel and Decker), which is confined to the phragmocone. An unfigured paratype in the Powell collection of *S. rioensis* from the type locality at Cannonball Hill in Chihuahua, Mexico, (Pl. 11, figs. 8, 9) has the umbilical tubercles and both rows of ventrolateral tubercles present on the entire body chamber. The presence of ornamentation on the body chamber combined with the sulcate venter recalls *Jeanrogericeras* Wiedmann (1959, p. 740) from the lower Turonian of Europe and north Africa; however, the type of *Jeanrogericeras, Ammonites reveliereanus* Courtiller (1867, p. 4, pl. 3, figs. 1, 2), is a phragmocone. Wiedmann (1959, p. 741; 1964, p. 126) assigned two adult specimens of *Mammites binicostatus* Petrascheck (1902, p1. 8, figs. la, b, 3a, b) to *Jeanrogericeras* and, in addition, illustrated a large adult 132 mm in diameter (Wiedmann, 1959, pl. 2, figs. 7-9; 1964, text fig. 10a-c). These specimens seem to have only one row of ventrolateral tubercles on the body chamber. Until more is known about *Jeanrogericeras,* we are accepting Powell's assignment of *Spathites rioensis.*

Powell's specimens came from limestone concretions 432 m above the base of the Ojinaga Formation in Chihuahua, Mexico. Associated ammonites included *Collignoniceras woollgari woollgari* (reported as *Se!-wynoceras mexicanum)* and *Mammites depressus.*

Spathites rioensis has been found in the C. *woollgari woollgari* subzone in west-central New Mexico. The species is uncommon, and most specimens are fragments from the lower part of the Tres Hermanos Sandstone Member of the Mancos Shale. One large phragmocone measures 98 mm in diameter (Pl. 5, figs. 11, 12). Adults have depressed venters (Pl. 5, fig. 12; Pl. 8, figs. 8-13; Fig. 9) and weak ornamentation.

TYPES-Paratype USNM 255607; hypotypes USNM 252821-252827, 255604-255606, 258941.

GENUS *NEOPTYCHITES* Kossmat, 1895

TYPE SPECIES: *Ammonites telinga* Stoliczka, 1865

This genus includes extremely involute ammonites whose outer whorls have a high triangular section with a moderately narrow rounded venter. The adult body chamber is generally smooth, and the aperture is constricted. The earliest whorls are smooth except for periodic constrictions; later juvenile whorls are ribbed without tubercles.

The genus is restricted to the Turonian, and most recorded occurrences are from the lower part. *Neoptychites* is widely distributed; the genus is known from New Mexico, Colorado, Texas, Mexico, Colombia, Trinidad, Spain, France, Syria, Israel, Tunisia, Algeria, Morocco, Nigeria, Cameroon, Madagascar, and India.

Neoptychites? sp.
Pl. 4, figs. 5-8

Two juvenile ammonites that may represent *Neoptychites* came from the limestone concretion containing *Watinoceras cobbani* Collignon in the D-Cross Mountain area. The larger specimen (Pl. 4, figs. 5, 6), 17.7 mm in diameter, has a body chamber occupying about 60 percent of the outer whorl. This whorl is higher than wide and has broadly rounded flanks and a rather narrowly rounded venter. Three widely spaced constrictions are present on the body chamber. Each begins at the umbilicus, trends straight across the flank to the ventrolateral shoulder where the constriction curves forward slightly, and crosses the venter with forward arching. The constrictions are strongest on the venter and the outer part of the flank, and each is bounded on the adapical side by a thickened rib. The smaller specimen (Pl. 4, figs. 7, 8), 11.6 mm in diameter, also has a body chamber occupying about two-thirds of the outer whorl. This specimen is stouter than the other one but, otherwise, resembles it in its smooth shell and widely spaced constrictions bounded on their adapical side by a thick rib. These small specimens resemble the small inner whorls of various species of *Neoptychites* illustrated by Solger (1904, pl. 3, fig. 4) from Cameroon, by Pervinquiere (1907, pl. 27, fig. 4a, b) from Tunisia, by Leanza (1967, pl. 1, figs. 5, 6) from Colombia, and by Reyment (1972, text fig. 7) from Trinidad.

FIGURE 9—WHORL SECTION, NATURAL SIZE, OF *SPATHITES RIOENSIS* POWELL, from the upper part of the Mancos Shale tongue underlying the Tres Hermanos Sandstone Member at USGS Mesozoic locality D10258, in the SW¼NE¼ sec. 33, T. 3 N., R. 6 W., Socorro County, New Mexico (Pl. 8, figs. 8, 9); hypotype USNM 252824.

TYPES-Figured specimens USNM 252966, 252967.

Family COILOPOCERATIDAE Hyatt, 1903

GENUS *HOPLITOIDES* von Koenen, 1898

TYPE SPECIES: *Hoplitoides latesellatus* von Koenen, 1898

Hoplitoides is a very involute and compressed ammonite that has a sulcate to flat venter on the early whorls and a sharply rounded venter on the later whorls. Adult whorls are smooth, but the early whorls may have weak sigmoidal ribs crossing the entire flank and a few very weak umbilicial bullae. The suture is little incised and is characterized by a very broad but short lateral lobe that tends to be asymmetrically bifid.

The type species, *H. latesellatus* von Koenen (1898, p. 56, pl. 6, figs. 1-3), came from the lower Turonian of Cameroon. Reyment (1955, p. 77) believed *H. latesellatus* is a synonym of *H. ingens* described earlier as *Neoptychites? ingens* von Koenen (1897, p. 12, pl. 1, fig. 4; pl. 2, figs. 5, 8).

Hoplitoides is known chiefly from lower Turonian strata, but it has been recorded as high as the lower Coniacian. The genus has been found in New Mexico, Mexico, Peru, Colombia, Brazil, Trinidad, Cameroon, Nigeria, Algeria, Tunisia, Egypt, Spain, Israel, and Syria.

Hoplitoides cf. *H. koeneni* Solger
Pl. 4, figs. 1, 2

A crushed specimen of *Hoplitoides*, from a limestone concretion in the upper part of the Mancos Shale tongue underlying the Tres Hermanos Sandstone Member, resembles *H. koeneni* Solger (1904, p. 151, pl. 4, figs. 8, 9, text figs. 42, 43) in its ribbed inner whorls, simple suture, and truncated venter extending out to a moderately large diameter. The New Mexico specimen seems to differ only in the narrower truncated venter.

The specimen, from USGS Mesozoic locality D10260 in the SW 1/4 NE 'A sec. 8, T. 3 S., R. 3 E., Socorro County, is 76 mm in diameter and has most of the body chamber preserved. The specimen was broken in order to observe the last septate whorl, which has a narrow sulcate venter and low, broad, straight flank ribs numbering 10 per half whorl. These ribs are strongest on the outer part of the flank, and every second or third rib extends to the umbilicus. The ribs weaken on the body chamber and nearly disappear. The venter is incompletely preserved on the body chamber, but in a few places it seems to be narrowly truncated. Only part of the external suture is visible; it has a simple pattern much like that illustrated for *H. koeneni* by Solger (1904, text figs. 42b, 43b) and Reyment (1955, text fig. 37a).

TYPE—Figured specimen USNM 252968.

Hoplitoides cf. *H. wohltmanni* (von Koenen)

P1. 4, figs. 3, 4; Figs. 10, 11

Two internal molds from the basal part of the Tres Hermanos Sandstone Member of the Mancos Shale resemble *Hoplitoides wohltmanni* (von Koenen, 1897, p. 12, pl. 1, fig. 2; pl. 2, figs. 3, 9) in the whorl section and suture. The smaller specimen (Pl. 4, figs. 3, 4) is a phragmocone 95 mm in diameter that is almost smooth and has a truncated venter out to a diameter of at least 65 mm. The venter is not preserved on most of the rest of the specimen, but where it can be seen again at a diameter of 91 mm, it is narrowly rounded. The larger specimen, most of a smooth body chamber, has a narrowly rounded venter like that of *H. wohltmanni* (von Koenen, 1897, pl. 2, fig. 3) (Fig. 10). The suture of the phragmocone (Fig. 11) is moderately complex and closely resembles sutures illustrated by von Koenen (1897, pl. 2, fig. 9) and Solger (1904, text figs. 25-27) for *H. wohltmanni.*

The specimens are from USGS Mesozoic locality D5773 in the NW 'ANW 1/4 , sec. 24, T. 3 N., R. 7 W., Socorro County. Associated fossils included *Collignoniceras woollgari woollgari* (Mantell).

TYPES—Figured specimens USNM 252969, 255609.

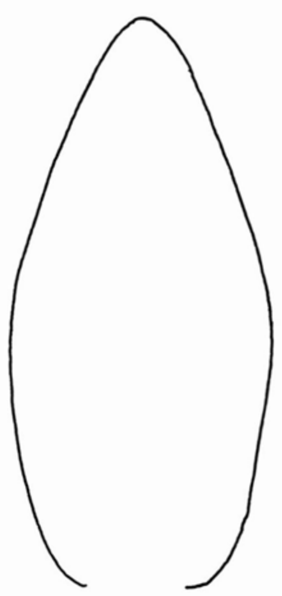


FIGURE 10—CROSS SECTION, NATURAL SIZE, THROUGH THE OLDER PART OF A BODY CHAMBER OF *HOPLITOIDES* CF. *H. WOHLTMANNI* (VON KOENEN) from the lower part of the Tres Hermanos Sandstone Member of the Mancos Shale at USGS Mesozoic locality D5773 in the NW¼NW¼ sec. 24, T. 3 N., R. 7 W., Socorro County, New Mexico; figured specimen USNM 255609.

Family COLLIGNONICERATIDAE Wright and Wright, 1951

Subfamily COLLIGNONICERATINAE Wright and Wright, 1951

GENUS *COLLIGNONICERAS* Breistroffer, 1947

TYPE *SPECIES: Ammonites woollgari* Mantell, 1822

Wright (1957, p. L426) has given the following diagnosis of this genus:

> Compressed in early stages, with rounded or high and clavate siphonal tubercles tending to form serrate keel; with straight or slightly sinuous ribs and weak umbilical and strong ventrolateral tubercles; later whorls tend to be squarer in section with exaggerated ventrolateral tubercle which may absorb even the umbilical tubercle.

The status of the genus *Collignoniceras* Breistroffer (1947) has been thoroughly discussed by Matsumoto and Wright (1966). The closely related genus *Selwynoceras* Warren and Stelck (1940, p. 51) had been treated as a genus having priority over *Collignoniceras* by Powell (1963, p. 1223-1225). On the application of Matsumoto and Wright (1966), the International Commission on Zoological Nomenclature (1968) ruled that *Collignoniceras* should be given priority over *Selwynoceras* by any author who considers these names to be synonymous at any level within the genus-group. Wright (1957, p. L426) and Matsumoto (1965, p. 10) believed *Collignoniceras* and *Selwynoceras* differed enough to preserve the name of *Selwynoceras,* which is treated by them as a subgenus of *Collignoniceras.* These differences were summarized by Matsumoto (1965, p. 10) as follows:

> Subgenus *Collignoniceras* . . . The ventral keel is more continuous than in *Selwynoceras,* especially in the adolescent and preceding growth-stages. The ribs are remarkably projected on

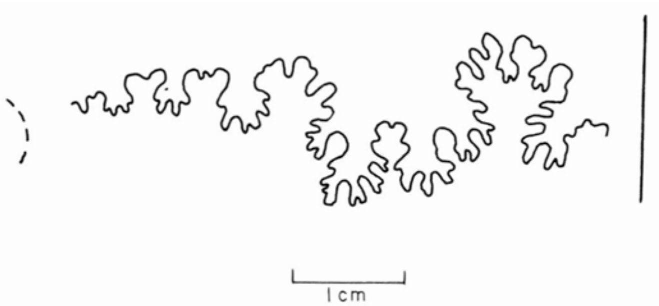


FIGURE 11—EXTERNAL SUTURE, ×1.5, AT A DIAMETER OF 91.5 MM OF AN ADULT PHRAGMOCONE OF *HOPLITOIDES* CF. *H. WOHLTMANNI* (VON KOENEN) from lower part of the Tres Hermanos Sandstone Member of the Mancos Shale at USGS Mesozoic locality D5773 in the NW¼NW¼ sec. 24, T. 3 N., R. 7 W., Socorro County, New Mexico (Pl. 4, figs. 3, 4); figured specimen USNM 252969.

the venter, forming chevrons. On the outer whorls secondary or intercalated ribs are almost absent or occur infrequently.

Subgenus *Selwynoceras* . . . The ventral keel is not well developed, but represented by a train of discontinuous mid-ventral clavi. The ribs are not much projected on the venter. The secondary or intercalated ribs persist up to later stages of growth and occur more frequently than in *Collignoniceras.*

Studies in progress by W. J. Kennedy, C. W. Wright, and J. M. Hancock (written communication, 1978) reveal that the lectotype of *C. woollgari* (Mantell, 1822, p. 197, pl. 21, fig. 16; refigured by Sharpe, 1854, pl. 11, fig. la, b) has an intermediate growth stage characteristic of *Selwynoceras* and that *Selwynoceras* and *Collignoniceras* cannot be separated. These authors have also concluded that C. *schlüterianum* (Laube and Bruder) of Europe and *C. mexicanum* (Böse) of North America cannot be distinguished from *C. woollgari*.

Collignoniceras woollgari woollgari (Mantell) P1. 1, figs. 1-11; Pl. 2, figs. 5-22; Pl. 4, figs. 11, 12; Pl. 5, figs. 13-16; Pl. 12, figs. 1, 2

Ammonites woollgari Mantell, 1822, p. 197, p1. 21, fig. 16; pl. 22, fig. 7.

_____ Sowerby, 1828, p. 165, pl. 587, fig. 1.

_____Sharpe, 1854, p. 27, pl. 11, figs. la, b, 2a, b [published 1855].

Ammonites woolgari (sic) Mantell. Courtiller, 1867, p. 7, pl. 8, figs. 1-4.

_____ Schlüter, 1872, p. 25, pl. 9, figs. 1-5 (not pl. 12, figs. 5, 6).

_____ Fritsch and Schlönbach, 1872, p. 30, pl. 3, figs. 1-3; pl. 4, figs. 1, 2; pl. 14, fig. 6; pl. 15, fig. 6 (not pl. 2, figs. 1, 2).

_____ Geinitz, 1872, p. 184, pl. 33, figs. 1-4.

Ammonites woollgari Mantell. Dixon, 1878, pl. 21, fig. 16.

Acanthoceras woollgari (Mantell). Laube and Bruder, 1887, p. 235, unnumbered text *fig.*

Acanthoceras schlüterianum Laube and Bruder, 1887, p. 236, pl. 29, figs. 2a, b, 3; unnumbered text fig.

Acanthoceras woollgari (Mantell). Petrascheck, 1902, p. 149, text figs. 7, 8.

Acanthoceras cfr. *woollgari* (Mantell). Petrascheck, 1902, p. 148, pl. 12, figs. 2, 3; text fig. 6.

Acanthoceras schlüterianum Laube and Bruder. Petrascheck, 1902, p. 150, p1. 10, fig. 3a, b; pl. 11, fig. 3; pl. 12, fig. 1.

Prionotropis schlüterianum (Laube and Bruder). Pervinquière, 1907, p. 275.

Prionotropis woolgari (sic) (Mantell). Arkhangel'skii, 1916, p. 46, pl. 6, figs. 3, 4.

Prionotropis schlüterianum (Laube and Bruder). Diener,. 1925, p. 156.

Prionotropis woollgari (Mantell). Diener, 1925, p. 157.

Prionotropis woollgari (Mantell) var. *mexicana* Böse, 1927, p. 262, pl. 11, figs. 11, 12 [published 1928].

Pseudaspidoceras? chispaense Adkins, 1931, p. 51, pl. 3, figs. 1, 2.

Pseudaspidoceras? n. sp. A Adkins, 1931, p. 53, pl. 3, figs. 3, 4.

Prionotropis woolgari (sic) (Mantell). Roman, 1938, p. 455, pl. 56, fig. 434, a, b.

Collignoniceras woollgari (Mantell). Wright and Wright, 1951, p. 30.

Cobban, Rohrer, and Erdmann, 1956, p. 1270, text figs. 1B-H.

Collignoniceras (Collignoniceras) woollgari (Mantell). Wright, 1957, p. L426, text fig. 547 (3a, b).

Collignoniceras (Selwynoceras) schlueterianum (Laube and Bruder). Wright, 1957, p. L426, text fig. 547 (la, b).

Collignoniceras (Selwynoceras) mexicanum (Bose). Matsumoto, 1959, p. 106.

Selwynoceras mexicanum (Bose). Powell, 1963, p. 1225, pl. 166, figs. 2-7; pl. 167, figs. 1, 3-8; pl. 168, fig. 4; text figs. 2a-e, 3a-h, *4a-g*.

Collignoniceras woollgari (Mantell). Matsumoto, 1971, p. 130, pl. 21, *fig.* 4, text fig. 1.

Cobban and Scott, 1972, p. 94, pl. 14, fig. 5; pl. 30, fig. 1; pl. 37, figs. 9, 10.

_____Cobban, 1976, pl. 120, p. 1, fig. 7.

Wright and Wright (1951, p. 35) designated the lectotype, a small adult from the Middle Chalk of England (Mantell, 1822, pl. 21, fig. 16; Sharpe, 1854, pl. 11, fig. la, b). The innermost whorls are not visible, but the last inner whorl has about 17 conspicuous prorsiradiate ribs separated by much broader interspaces. Each rib has a conical inner ventrolateral tubercle, an outer clavate ventrolateral tubercle, and a clavate siphonal tubercle; and most ribs originate from bullate umbilical tubercles. Secondary ribs appear on the outer part of the flank on the older third of the outer whorl, and each terminates in a low clavate siphonal tubercle. Primary ribs become farther apart on the outer whorl, where they number about 12. The inner ventrolateral tubercles on the primary ribs rapidly increase in size on the outer whorl and rise into strong horns that support the weakened ventrolateral clavi. The umbilical tubercles gradually move out onto the flank on the outer whorl, where they weaken and merge into the ventrolateral horn. Opposite horns are connected by a pair of weak ribs that support siphonal clavi.

Kennedy, Wright, and Hancock (written communication, 1978) have thoroughly treated the European form of *C. woollgari*. They observed that inner whorls are moderately evolute and have 27-32 ribs per whorl at diameters of 10-15 mm and have 17-24 ribs at diameters of 40-50 mm. Secondary ribs are absent in the inner whorls. Adults have variable ornamentation, but at some growth stage secondary ribs are usually present, and siphonal clavi may be more numerous than the ventrolateral tubercles. Primary ribs on the adults may rise into ventrolateral horns or may become flange-like.

Specimens from the Western Interior have all of the features observed by Kennedy, Wright, and Hancock. The collections are chiefly from the basal part of the Tres Hermanos Sandstone Member in west-central New Mexico and from the upper part of the Frontier Formation in central Wyoming. Small to medium-sized specimens dominate the New Mexico collections, whereas medium to large specimens dominate the Wyoming collections. Seventeen of the New Mexico specimens are suitable for measurements of the shell diameter, umbilical diameter, whorl breadth, and rib density. Unfortunately, the Wyoming specimens, which occur in a coarse-grained to pebbly sandstone bed, are badly fragmented and usually distorted.

Umbilical ratios and number of ribs per half whorl at diameters from 16.4 to 101.2 mm for the 17 New Mexico specimens are shown in Fig. 12. Umbilical ratios are mostly from 29 to 38 percent and show little change as the shell enlarges. The number of ribs per half whorl ranges from 11 to 19 in the juveniles and decreases to 10 to 12 in medium-sized specimens.

Juvenile whorls are seldom preserved on the Wyoming specimens. Some medium-sized individuals have only primary ribs up to a diameter of 100 mm; others have primaries and secondaries. The few large specimens that consist of half a whorl or more have body

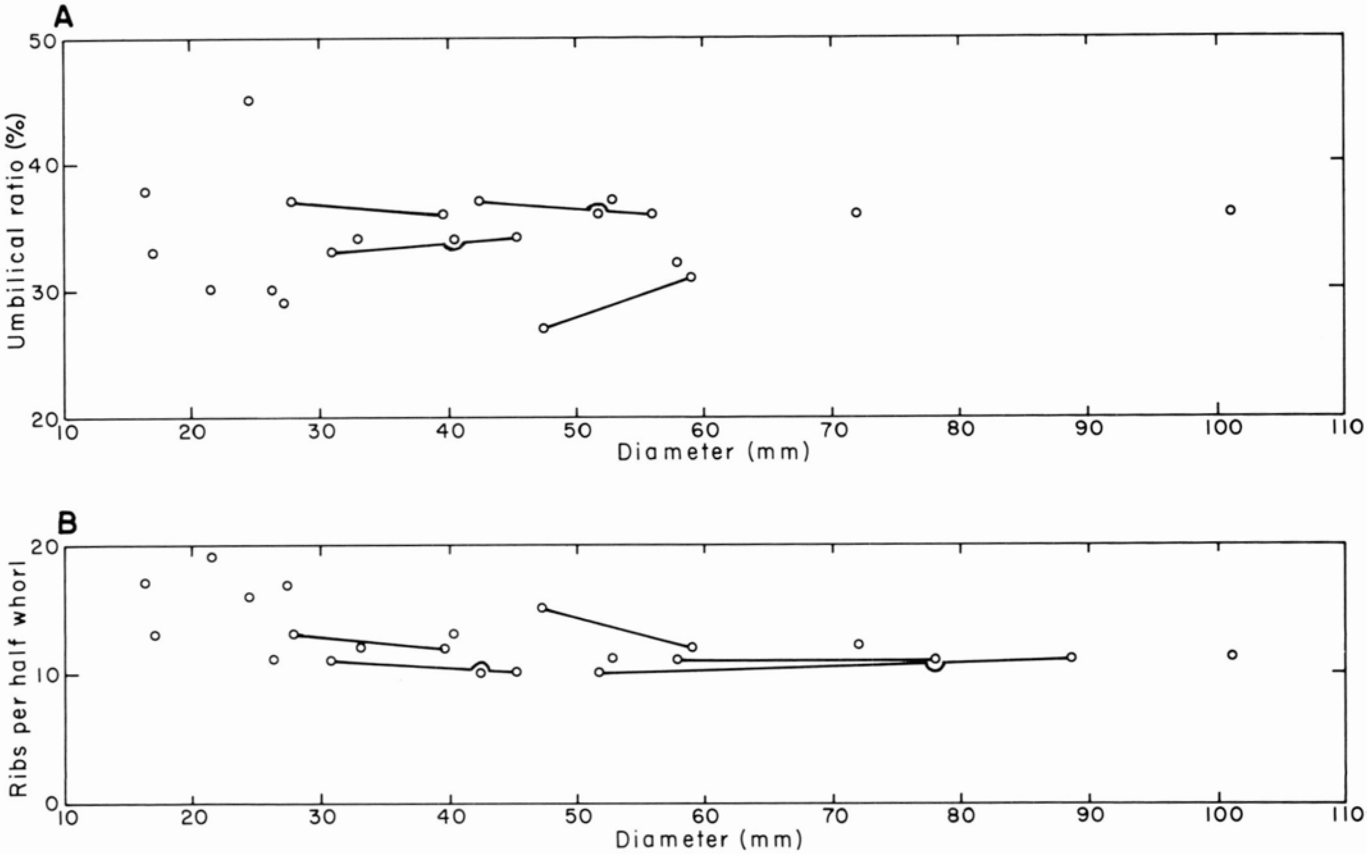


FIGURE 12—SCATTER DIAGRAMS SHOWING A) UMBILICAL RATIOS IN PERCENT AND B) NUMBER OF VENTRAL RIBS IN HALF A WHORL OF *COLLIGNONICERAS WOOLLGARI WOOLLGARI* from the lower part of the Tres Hermanos Sandstone Member at nine localities in west-central New Mexico; circles connected by lines represent measurements on a single specimen.

chambers that begin at some diameter between 140 and 200 mm. Secondary ribs are common on the outer whorl of the adult phragmocone, but they tend to disappear on the adult body chamber. There the primary ribs either increase in height and absorb the tubercles to form conspicuous flanges that cross the flanks and venter, or the umbilical and siphonal tubercles increase in height to give a triangular appearance to the whorl section. Both types of adult whorls were observed in the Mexican material by Powell (1963, p. 1225). On the adoral part of the adult body chamber, ribs tend to become farther apart and prorsiradiate.

Collignoniceras woollgari woollgari differs from the younger *C. woollgari regulare* (Pl. 3; Pl. 12, fig. 3) by having some adult stage characterized by secondary ribs, more siphonal tubercles than ventrolateral ones, and looped ribs connecting opposite ventrolateral horns. Occasional secondary ribs are present on a few individuals of C. *woollgari regulare*, but they are conspicuous only on the early whorls of the uncommon variety *praecox* Haas (1946, p. 155, pl. 16, figs. 22-33; pl. 17, figs. 1-5; pl. 18, figs. 1, 8, 9; text figs. 15-18, 79, 84-90).

Ammonites percarinatus Hall and Meek (1856, p. 396, pl. 4, fig. 2a, b) has been considered a synonym of *C. woollgari* (Meek, 1876, p. 455; Stanton, 1893, p. 174; Haas, 1946, p. 150, 151). Hall and Meek's two figured specimens are very small individuals that have dense flexuous ribs (38-45 ribs per whorl) "sometimes nodose towards the periphery." The specimens came from the Carlile Shale in northeastern Nebraska. Specimens in the U.S. Geological Survey's collections from this area are also small. The inner ventrolateral tubercles are either very weak or absent, which differentiates the species from C. *woollgari*. *C. percarinatum* may be a slightly younger species than *C. woollgari regulare* but older than *Prionocyclus hyatti* (Stanton).

TYPES—Hypotypes USNM 252725, 252784-252799, 255610, 258939.

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Plates

PLATES 1-12

PLATE 1

(All figures are natural size.)

Figures		*Page*
1-11	*Collignoniceras woollgari woollgari* (Mantell).	21

1-3 Hypotype USNM 252784, from lower part of Tres Hermanos Sandstone Member of Mancos Shale at USGS Mesozoic locality D5773 in NW¼NW¼ sec. 24, T. 3 N., R. 7 W., Socorro County, New Mexico.

4 Ventral view of hypotype USNM 252785, from lower part of Tres Hermanos Sandstone Member at USGS Mesozoic locality D10242 in N½SW¼ sec. 9, T. 5 S., R. 2 E., Socorro County, New Mexico.

5, 6 Hypotype USNM 252786, from lower part of the Tres Hermanos Sandstone Member at USGS Mesozoic locality D10259 in SW¼NE¼ sec. 33, T. 3 N., R. 6 W., Socorro County, New Mexico.

7 Ventral view of hypotype USNM 252789, from upper part of the Bridge Creek Limestone Member of Greenhorn Formation at USGS Mesozoic locality D5293 in SW¼ sec. 30, T. 20 S., R. 65 W., Pueblo County, Colorado.

8, 9 Hypotype USNM 252790, from lower part of Tres Hermanos Sandstone Member at USGS Mesozoic locality D10243 in SE¼NE¼ sec. 9, T. 5 S., R. 2 E., Socorro County, New Mexico.

10,11 Hypotype USNM 252797, from a sandstone in Frontier Formation at USGS Mesozoic locality D9338 in NE¼NW¼ sec. 32, T. 34 N., R. 81 W., Natrona County, Wyoming.

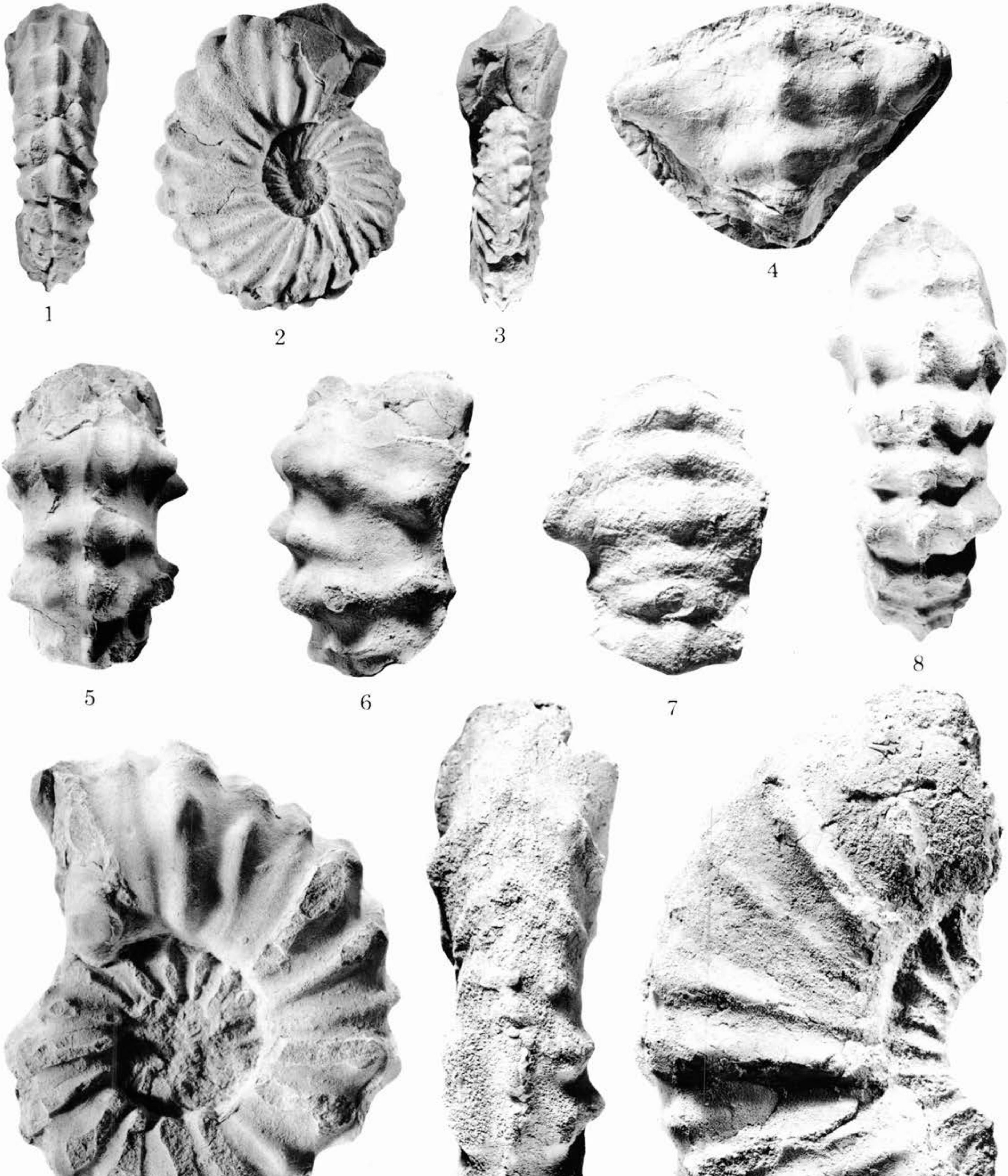
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PLATE 2

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Figures — *Page*

1-4 *Spathites rioensis* Powell. 18

1, 2 Hypotype USNM 252821, from a septarian limestone concretion in upper part of Mancos Shale tongue underlying Tres Hermanos Sandstone Member at USGS Mesozoic locality D10246 in N½SE¼ sec. 8, T. 5 S., R. 2 E., Socorro County, New Mexico.

3, 4 Hypotype USNM 252823, from basal part of Tres Hermanos Sandstone Member at USGS Mesozoic locality D10465 in the SW¼SW¼ sec. 10, T. 5 S., R. 2 E., Socorro County, New Mexico.

5-22 *Collignoniceras woollgari woollgari* (Mantell). 21

5, 6 Hypotype USNM 252787, from lower part of the Tres Hermanos Sandstone Member at USGS Mesozoic locality D10259 in SW¼NE¼ sec. 33, T. 3 N., R. 6 W., Socorro County, New Mexico.

7-9 Hypotype USNM 252793, from basal part of Tres Hermanos Sandstone Member at USGS Mesozoic locality D10297 in NW¼NW¼ sec. 29, T. 3 N., R. 8 W., Socorro County, New Mexico.

10, 11 Hypotype USNM 252791, from lower part of Tres Hermanos Sandstone Member at USGS Mesozoic locality D10243 in SE¼NE¼ sec. 9, T. 5 S., R. 2 E., Socorro County, New Mexico.

12, 13 Hypotype USNM 252794, from basal part of Tres Hermanos Sandstone Member at USGS Mesozoic locality D10240 in SE¼SE¼ sec. 8, T. 5 S., R. 2 E., Socorro County, New Mexico.

14, 15 Hypotype USNM 252795, from same locality as figs. 12, 13.

16, 17 Hypotype USNM 252792, from same locality as figs. 10, 11.

18, 19 Hypotype USNM 252796, ×3, from lower part of Tres Hermanos Sandstone Member at USGS Mesozoic locality D10242 in N½SW¼ sec. 9, T. 5 S., R. 2 E., Socorro County, New Mexico.

20 Hypotype USNM 252788, from same locality as figs. 5, 6.

21, 22 Hypotype USNM 252725, from Frontier Formation at USGS Mesozoic locality D10376 in SE¼NW¼ sec. 32, T. 34 N., R. 81 W., Natrona County, Wyoming.

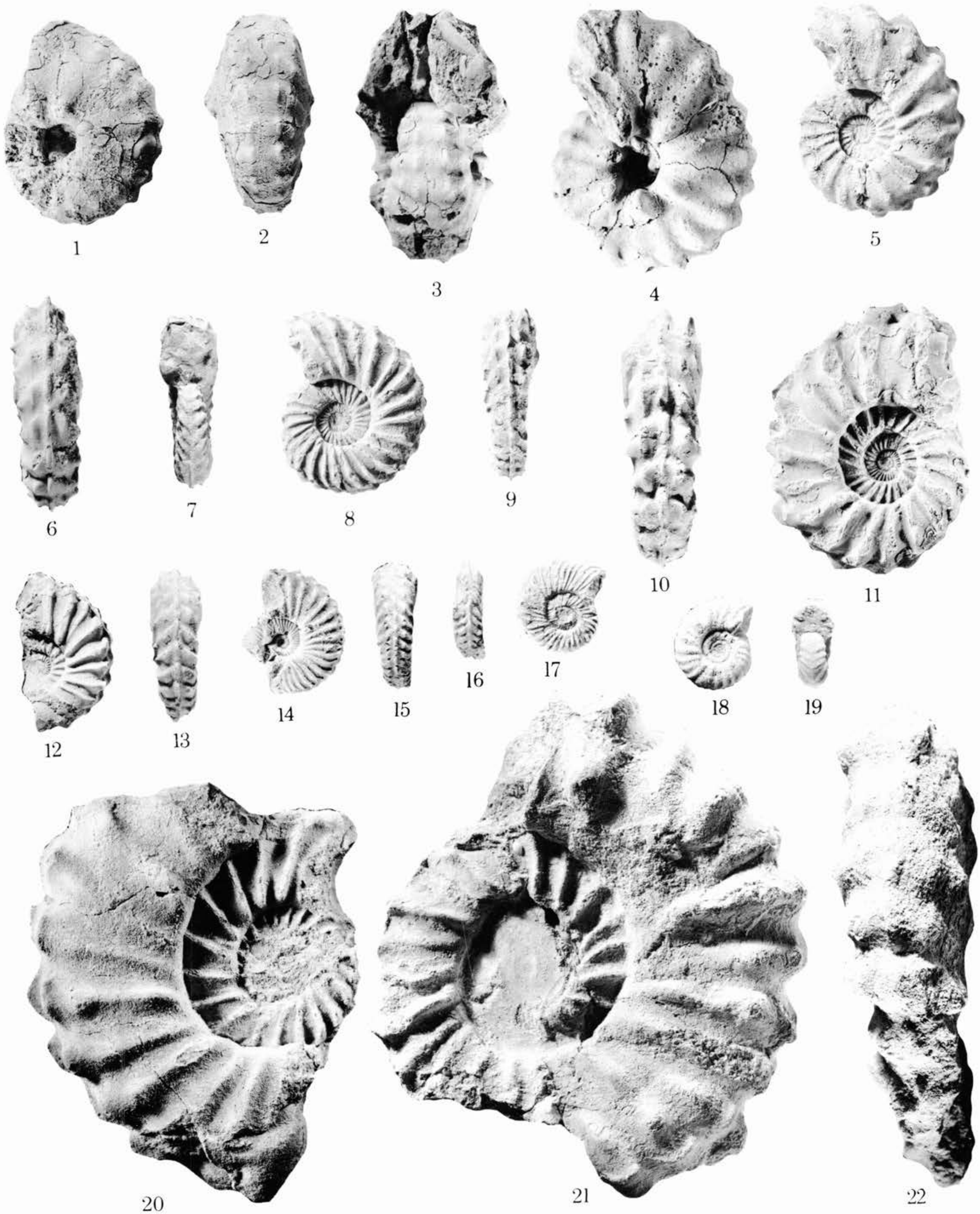
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PLATE 3

(All figures are natural size.)

From limestone concretions in lower part of Carlile Shale on west flank of the Black Hills uplift in Weston County, Wyoming.

1-3 Hypotype USNM 252800, from 19-21 m above base of Carlile Shale at USGS Mesozoic locality 21792 in NW¼ sec. 31, T. 45 N., R. 61 W.

4-6 Hypotype USNM 220384, from same locality.

7, 8 Hypotype USNM 252801, from 18 m below base of Turner Sandy Member at USGS Mesozoic locality D9896 in NW¼ sec. 35, T. 46 N., R. 63 W.

9-11 Hypotype USNM 252802, from same locality as figs. 1-3.

12 Hypotype USNM 252803, from same locality.

13, 14 Hypotype USNM 252804, from same locality as figs. 7, 8.

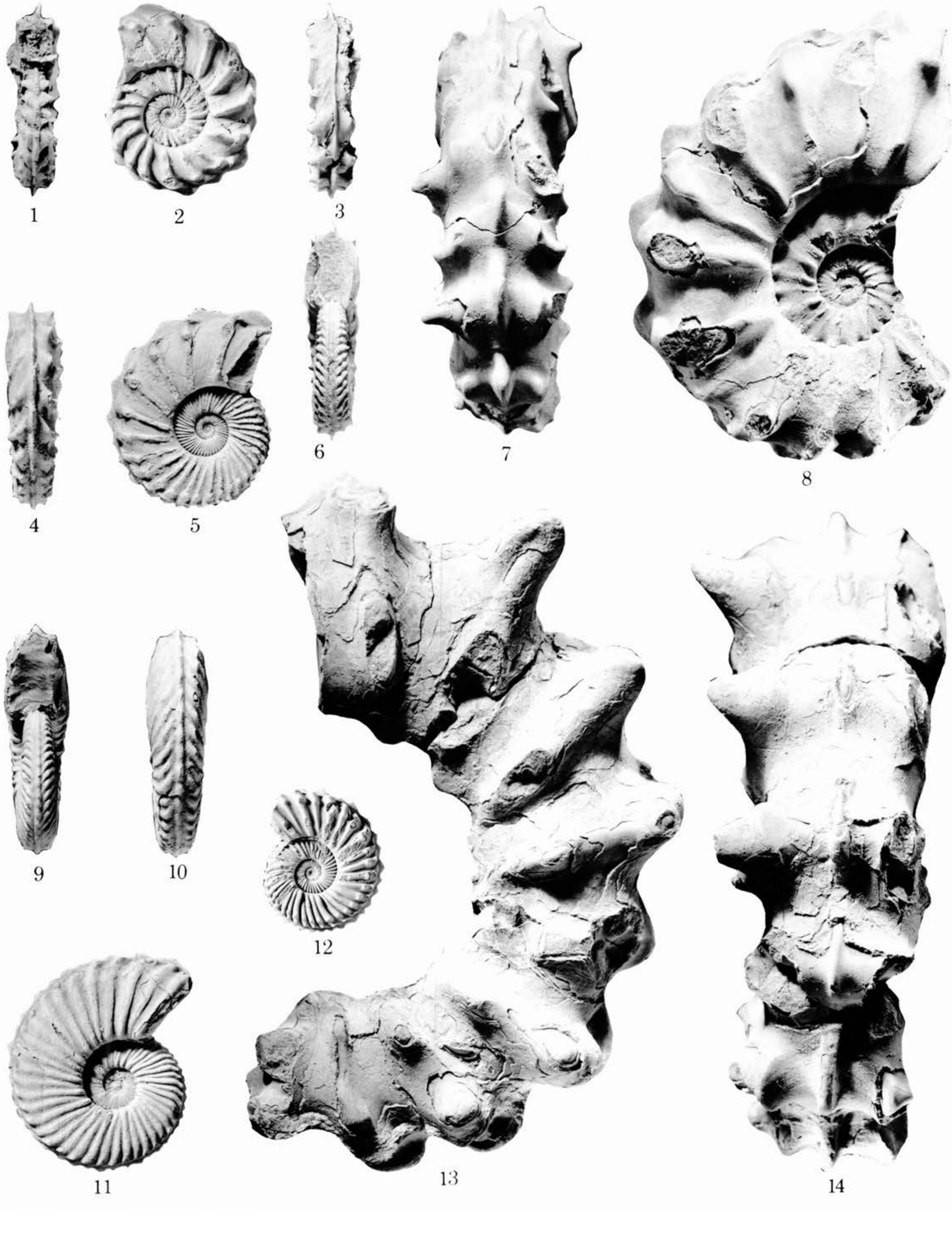
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PLATE 4

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1, 2	*Hoplitoides* cf. *H. koeneni* Solger	19
	Figured specimen USNM 252968, from upper part of the Mancos Shale tongue underlying Tres Hermanos Sandstone Member at USGS Mesozoic locality D10260, in SW¼NE¼ sec. 8, T. 3 S., R. 3 E., Socorro County, New Mexico.	
3, 4	*Hoplitoides* cf. *H. wohltmanni* (von Koenen)	20
	Figured specimen USNM 252969, from lower part of Tres Hermanos Sandstone Member at USGS Mesozoic locality D5773 in NW¼NW¼ sec. 24, T. 3 N., R. 7 W., Socorro County, New Mexico. See Fig. 10 for suture.	
5-8	*Neoptychites?* sp.	19
	From a limestone concretion in Mancos Shale tongue underlying Tres Hermanos Sandstone Member at USGS Mesozoic locality D10298 in SE¼SW¼ sec. 17, T. 3 N., R. 8 W., Socorro County, New Mexico.	
	5, 6 Figured specimen USNM 252966.	
	7, 8 Figured specimen USNM 252967.	
9, 10	*Baculites yokoyamai* Tokunaga and Shimizu	13
	Lateral and ventral views of hypotype USNM 252805, from lower part of Tres Hermanos Sandstone Member at USGS Mesozoic locality D10243 in SE¼NE¼ sec. 9, T. 5 S., R. 2 E., Socorro County, New Mexico.	
11, 12	*Collignoniceras woollgari woollgari* (Mantell).	21
	Hypotype USNM 252798, part of an adult body chamber, from Frontier Formation at USGS Mesozoic locality D10376 in SE¼NW¼ sec. 32, T. 34 N., R. 81 W., Natrona County, Wyoming.	

PLATE 4

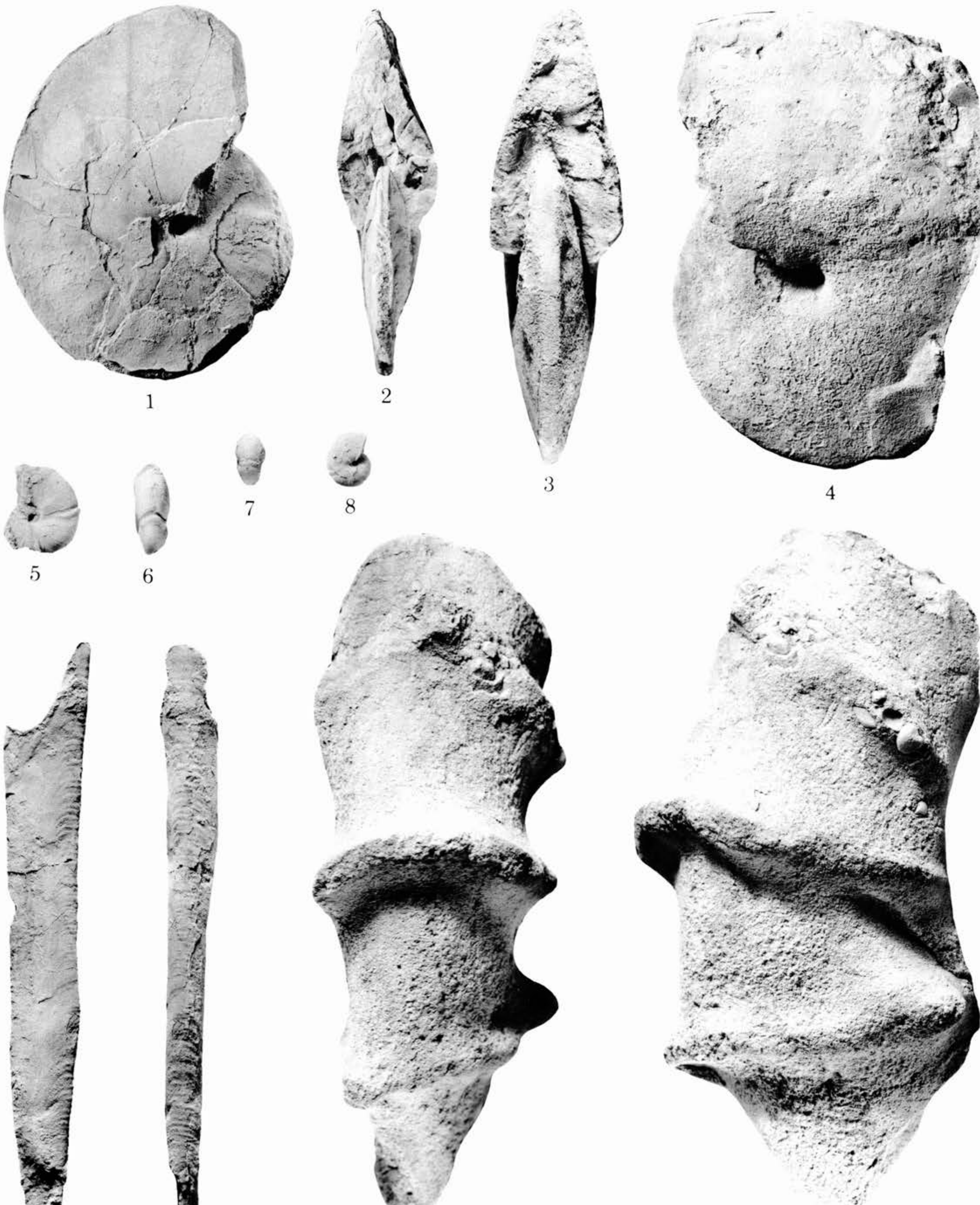

PLATE 5

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1-8 *Watinoceras cobbani* Collignon 17

From a septarian limestone concretion in upper part of Mancos Shale tongue underlying Tres Hermanos Sandstone Member at USGS Mesozoic locality D10298 in SE¼SW¼ sec. 17, T. 3 N., R. 8 W., Socorro County, New Mexico.

1-3 Side, rear, and top views of hypotype USNM 252817 associated with part of another specimen. See Fig. 7 for whorl section.

4 Latex cast of hypotype USNM 252818.

5, 6 Hypotype USNM 252819.

7, 8 Hypotype USNM 252820.

9, 10 *Tragodesmoceras socorroense* Cobban and Hook, n. sp. 13

Paratype USNM 252807, from same locality as figs. 1-8.

11, 12 *Spathites rioensis* Powell 18

Hypotype USNM 252822, from lower part of Tres Hermanos Sandstone Member at USGS Mesozoic locality D10246 in N½SE¼ sec. 8, T. 5 S., R. 2 E., Socorro County, New Mexico.

13-16 *Collignoniceras woollgari woollgari* (Mantell) 21

13 Hypotype USNM 255610, from upper part of Mancos Shale tongue underlying Tres Hermanos Sandstone Member at USGS Mesozoic locality D10485 in E½E½ sec. 8, T. 5 S., R. 2 E., Socorro County, New Mexico.

14-16 Hypotype USNM 252799, from a sandstone concretion 34 m above base of Mancos Shale at USGS Mesozoic locality D10445 in SE¼NW¼ sec. 5, T. 1 N., R. 3 W., Mesa County, Colorado.

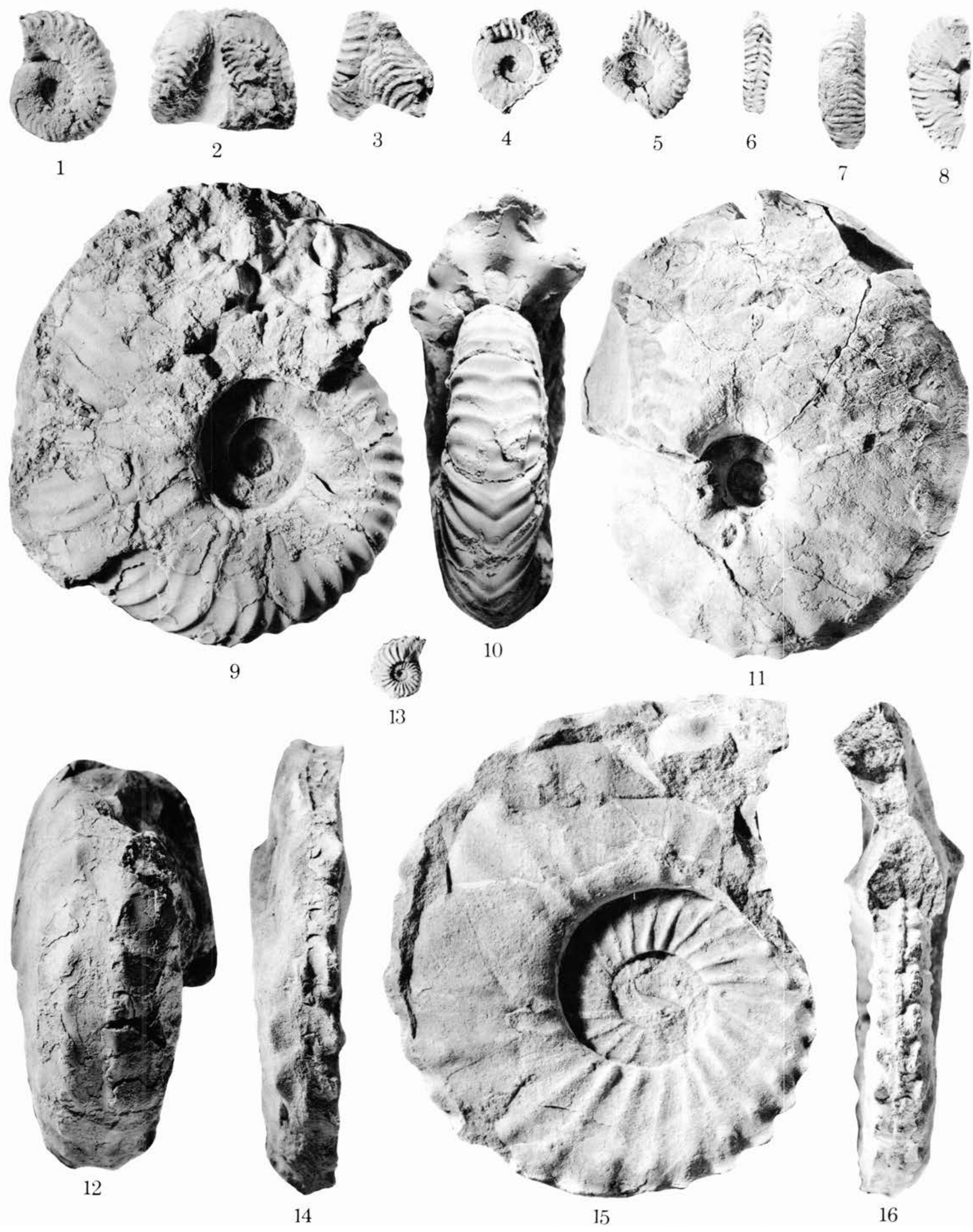
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PLATE 6

Figures		*Page*
1, 2	*Tragodesmoceras socorroense* Cobban and Hook, n. sp.	13

Ventral and lateral views, × ½, of holotype USNM 252806, from upper part of Mancos Shale tongue underlying Tres Hermanos Sandstone Member at USGS Mesozoic locality D10303 in NE¼NW¼ sec. 16, T. 4 N., R. 7 W., Socorro County, New Mexico. See Fig. 4 for whorl section.

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PLATE 7

Tragodesmoceras socorroense Cobban and Hook, n. sp. 13

Lateral view, × 1/3, of paratype USNM 252808, from a sandstone concretion in Frontier Formation at USGS Mesozoic locality 22819 in SW 1/4 NW 1/4 sec. 12, T. 49 N., R. 83 W., Johnson County, Wyoming.

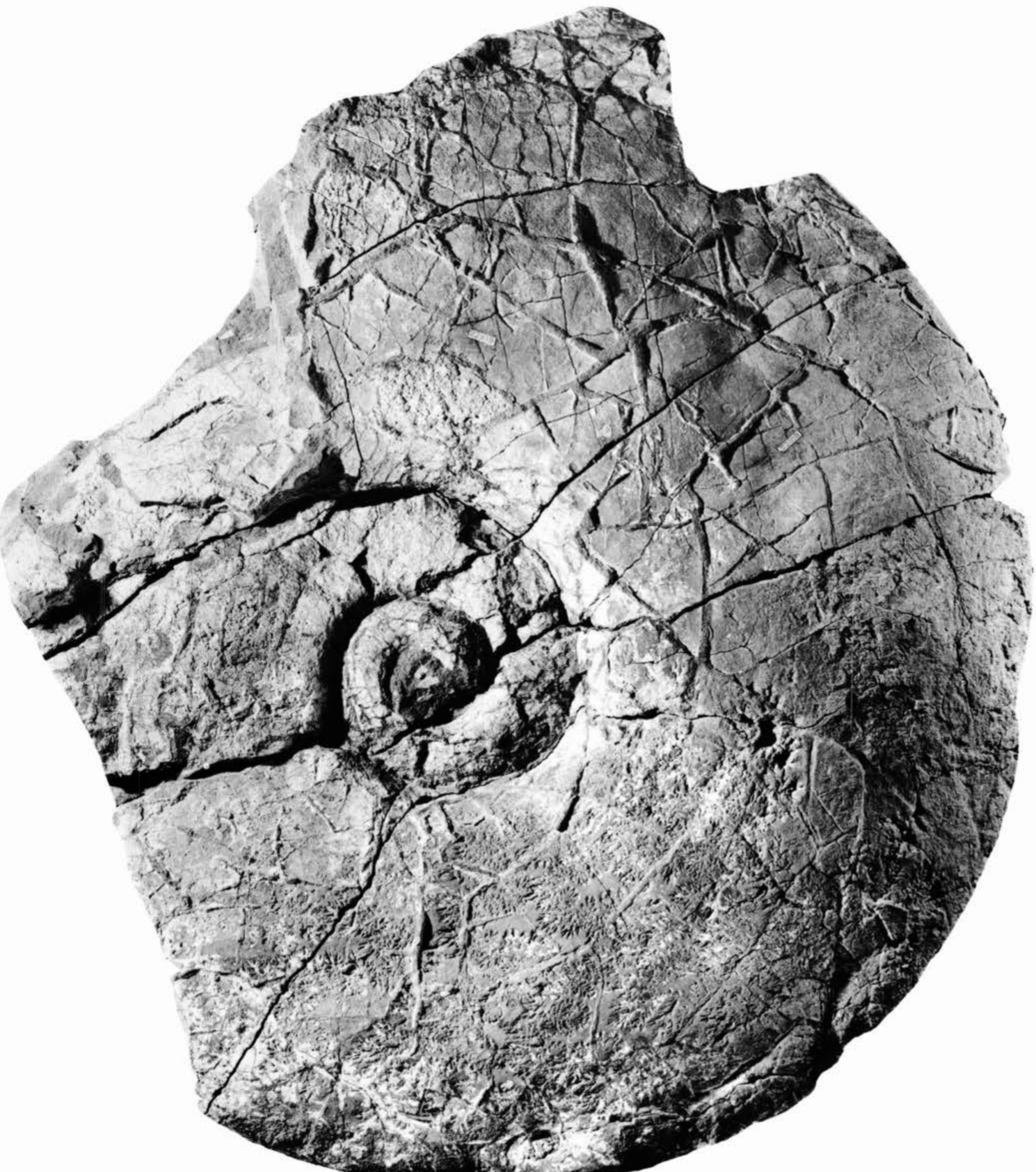

PLATE 8

(All figures are natural size.)

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1-5	*Proplacenticeras pseudoplacenta* (Hyatt)	14
	1-3 Hypotype USNM 252809, from lower part of Tres Hermanos Sandstone Member of Mancos Shale at USGS Mesozoic locality D10243 in SE¼NE¼ sec. 9, T. 5 S., R. 2 E., Socorro County, New Mexico.	
	4, 5 Hypotype USNM 252810, from basal part of Tres Hermanos Sandstone Member at USGS Mesozoic locality D10240 in SE¼SE¼ sec. 8, T. 5 S., R. 2 E., Socorro County, New Mexico.	
6, 7	*Mammites nodosoides* (Schlotheim)	15
	Lateral and ventral views of hypotype USNM 252816, a fragment of a phragmocone from upper part of the Mancos Shale tongue underlying Tres Hermanos Sandstone Member at USGS Mesozoic locality D10298 in SE¼SW¼ sec. 17, T. 3 N., R. 8 W., Socorro County, New Mexico.	
8-13	*Spathites rioensis* Powell	18
	8, 9 Hypotype USNM 252824, from upper part of Mancos Shale tongue underlying Tres Hermanos Sandstone Member at USGS Mesozoic locality D10258 in SW¼NE¼ sec. 33, T. 3 N., R. 6 W., Socorro County, New Mexico. See Fig. 9 for whorl section.	
	10 Hypotype USNM 252825, from lower part of Tres Hermanos Sandstone Member at USGS Mesozoic locality D10241 in NE¼SE¼ sec. 8, T. 5 S., R. 2 E., Socorro County, New Mexico.	
	11, 12 Lateral and ventral views of hypotype USNM 252826, a piece of a large phragmocone, from same locality.	
	13 Ventral view of hypotype USNM 252827, a somewhat crushed phragmocone, from same locality.	


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PLATE 9

Mammites depressus Powell 15

Side view, × ⅔, of hypotype USNM 252811, from upper part of Mancos Shale tongue underlying Tres Hermanos Sandstone Member at USGS Mesozoic locality D10298 in SE¼SW¼ sec. 17, T. 3 N., R. 8 W., Socorro County, New Mexico. See Pl. 10, fig. 3 for ventral view and Fig. 5c for whorl section.

PLATE 10

Figures *Page*

1-3 *Mammites depressus* Powell 15

From upper part of the Mancos Shale tongue underlying Tres Hermanos Sandstone Member at USGS Mesozoic locality D10298 in SE¼SW¼ sec. 17, T. 3 N., R. 8 W., Socorro County, New Mexico.

1, 2 Hypotype USNM 252812, natural size.

3 Hypotype USNM 252811, × ⅔. See Pl. 9 for lateral view.

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PLATE 11

(All figures are natural size.)

Figures — *Page*

1-9 *Spathites rioensis* Powell 18

1-3 Hypotype USNM 255604, from upper part of Mancos Shale tongue underlying Tres Hermanos Sandstone Member at USGS Mesozoic locality D10258 in NE¼ sec. 33, T. 3 N., R. 6 W., Socorro County, New Mexico.

4, 5 Hypotype USNM 255605, from same stratigraphic level at USGS Mesozoic locality D10472 in NW¼SW¼ sec. 34, T. 3 N., R. 6 W., Socorro County, New Mexico.

6, 7 Hypotype USNM 255606, from same locality as Figs. 4, 5.

8, 9 Paratype USNM 255607, from a bed of limestone concretions 433 m above base of Ojinaga Formation at Cannonball Hill locality of Powell (1963, p. 1217) in Chihuahua, Mexico. This excellent specimen, one of Powell's unfigured paratypes, had been given by Powell to the late James P. Conlin of Fort Worth, Texas, who in turn donated it to the U.S. Geological Survey.

10 *Tragodesmoceras socorroense* Cobban and Hook n. sp. 13

Paratype USNM 255608, from upper part of Mancos Shale tongue underlying Tres Hermanos Sandstone Member at USGS Mesozoic locality D10296 in NE¼NW¼ sec. 15, T. 2 N., R. 5 W., Socorro County, New Mexico.

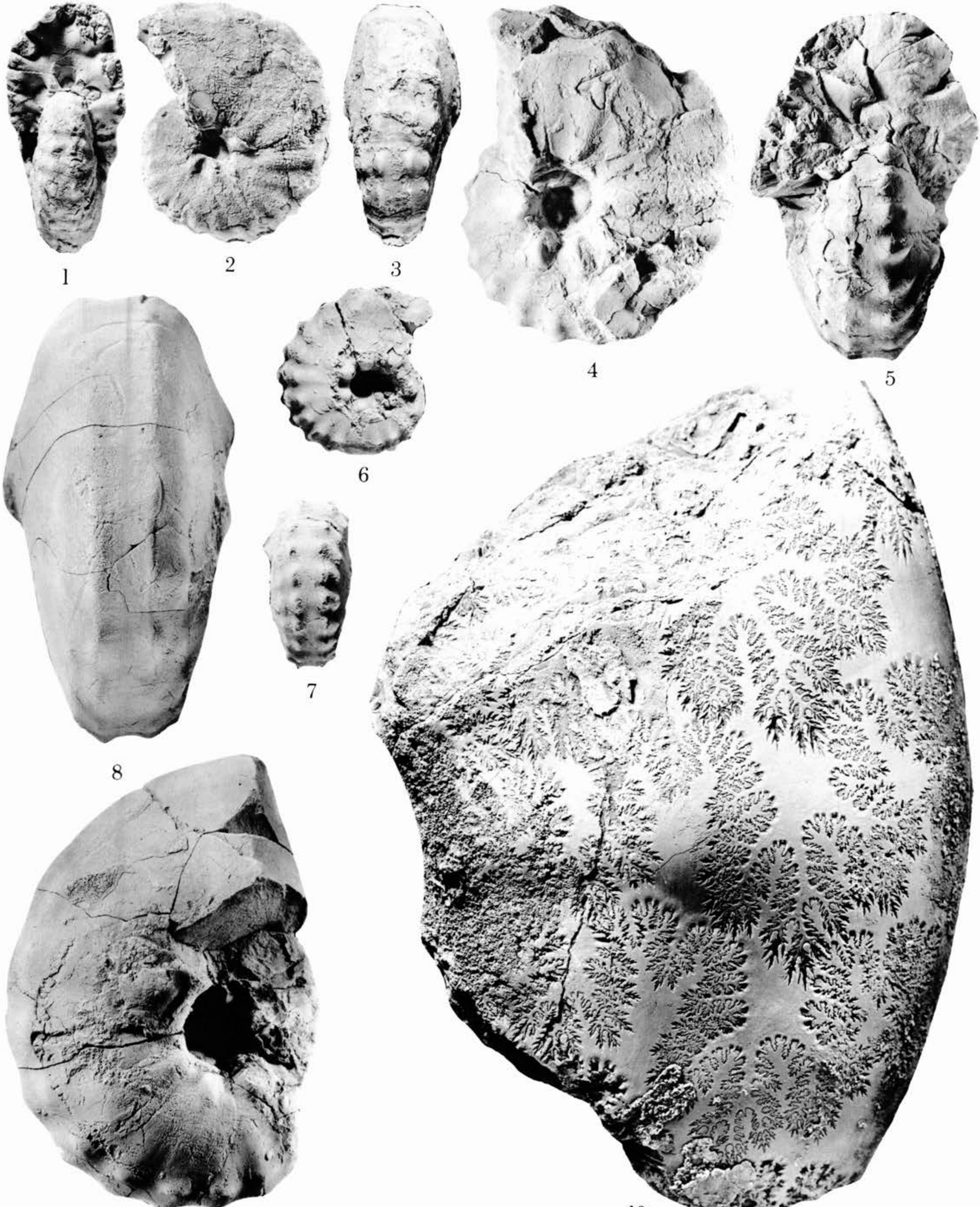

PLATE 12

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Figures		*Page*
1, 2	*Collignoniceras woollgari woollgari* (Mantell). . . . . Hypotype USNM 258939, from a septarian limestone concretion in Mancos Shale tongue underlying Tres Hermanos Sandstone Member at USGS Mesozoic locality D10525 in W½NW¼ sec. 10, T. 4 N., R. 7 W., Valencia County, New Mexico.	21
3	*Collignoniceras woollgari regulare* (Haas). . . . . Hypotype USNM 258940, from a limestone concretion 18 m below base of Turner Sandy Member of Carlile Shale at USGS Mesozoic locality D9896 in NW¼ sec. 35, T. 46 N., R. 63 W., Weston County, Wyoming.	22
4-6	*Spathites rioensis* Powell. . . . . Hypotype USNM 258941, collected by Mr. Raymond Escoffier, Socorro, New Mexico, from lower part of Tres Hermanos Sandstone Member of Mancos Shale, in NE¼NE¼SW¼ sec. 9, T. 5 S., R. 2 E., Socorro County, New Mexico.	18

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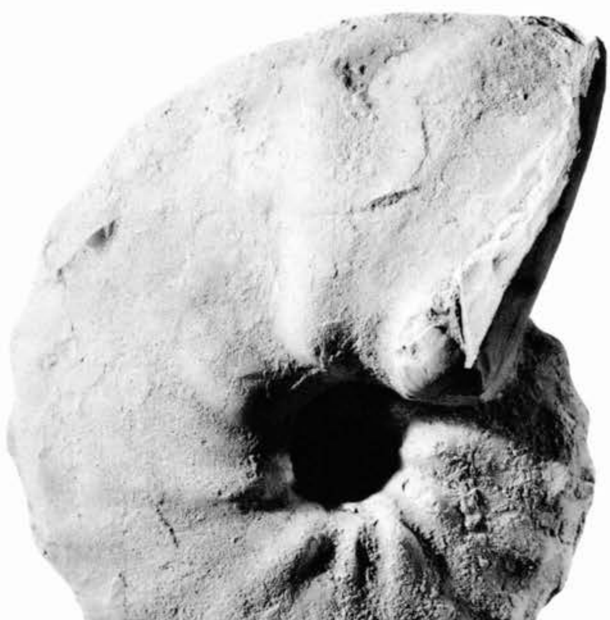

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