# Middle Triassic Molluscan Fossils of Biostratigraphic Significance from the Humboldt Range, Northwestern Nevada

GEOLOGICAL SURVEY PROFESSIONAL PAPER 1207

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*By* N. J. SILBERLING *and* K. M. NICHOLS

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*Taxonomic and superpositional documentation of an unusually complete faunal succession*

UNITED STATES GOVERNMENT PRINTING OFFICE, WASHINGTON : 1982

UNITED STATES DEPARTMENT OF THE INTERIOR

JAMES G. WATT, *Secretary*

GEOLOGICAL SURVEY

Dallas L. Peck, *Director*

Library of Congress Cataloging in Publication Data
Silberling, Norman John, 1928–
Middle Triassic molluscan fossils of biostratigraphic significance from the Humboldt Range, northwestern Nevada.
(Geological Survey Professional Paper 1207)
Bibliography: p. 71
Supt. of Docs. No.: I 19.16: 1207
1. Mollusks, Fossil. 2. Paleontology—Triassic 3. Geology, Stratigraphic—Triassic. 4. Geology—Nevada—Humboldt Range.
I. Nichols, Kathryn Marion, 1946– joint author. II. Title. III. Series: United States. Geological Survey. Professional Paper 1207.
QE801.S64 564 80–607925

For sale by the Distribution Branch, U.S. Geological Survey
604 South Pickett Street, Alexandria, VA 22304

# CONTENTS



# ILLUSTRATIONS

[Plates 1–3 in pocket, 4–38 follow "Index"]

# TABLES

# MIDDLE TRIASSIC MOLLUSCAN FOSSILS OF BIOSTRATIGRAPHIC SIGNIFICANCE FROM THE HUMBOLDT RANGE, NORTHWESTERN NEVADA

By N. J. SILBERLING and K. M. NICHOLS

ABSTRACT

Cephalopods and bivalves of the genus *Daonella* occur at certain levels throughout the Middle Triassic section in the Humboldt Range, northwestern Nevada. These fossiliferous strata are assigned to the Fossil Hill Member and upper member of the Prida Formation, which here forms the oldest part of the Star Peak Group. The distribution and abundance of fossils within the section is uneven, partly because of original depositional patterns within the dominantly calcareous succession and partly because of diagenetic secondary dolomitization and hydrothermal metamorphism in parts of the range.

Lower and middle Anisian fossil localities are restricted to the northern part of the range and are scattered, so that only three demonstrably distinct stratigraphic levels are represented. Cephalopods from these localities are characteristic of the Caurus Zone and typify the lower and upper parts of the Hyatti Zone, a new zonal unit whose faunas have affinity with those from the older parts of the Varium Zone in Canada.

The upper Anisian and lowermost Ladinian, as exposed in the vicinity of Fossil Hill in the southern part of the range, are extremely fossiliferous. Cephalopod and *Daonella* shells form a major component of many of the limestone interbeds in the calcareous fine-grained clastic section here. Stratigraphically controlled bedrock collections representing at least 20 successive levels have been made from the Fossil Hill area, which is the type locality for the Rotelliformis, Meeki, and Occidentalis Zones of the upper Anisian and the Subasperum Zone of the lower Ladinian. Above the Subasperum Zone fossils are again scarce; upper Ladinian faunas representing the *Daonella lommeli* beds occur at only a few places in the upper member of the Prida Formation.

Although unevenly fossiliferous, the succession of Middle Triassic cephalopod and *Daonella* faunas in the Humboldt Range is one of the most complete of any known in the world. Newly collected faunas from this succession provide the basis for revising the classic monograph on Middle Triassic marine invertebrates of North America published in 1914 by J. P. Smith and based largely on stratigraphically uncontrolled collections from the Humboldt Range. Taxonomic treatment of these collections, old and new, from the Humboldt Range provides the documentation necessary to establish this Middle Triassic succession as a biostratigraphic standard of reference.

Of the 68 species of ammonites described or discussed, 4 are from the lower Anisian, 20 from the middle Anisian, 39 from the upper Anisian, 4 from the lower Ladinian, and 1 from the upper Ladinian. A few additional ammonite species from other localities in Nevada are also treated in order to clarify their morphologic characteristics and stratigraphic occurrence. Other elements in the Middle Triassic molluscan faunas of the Humboldt Range comprise five species of nautiloids and three of coleoids from the middle and upper Anisian parts of the section. Eight more or less stratigraphically restricted species of *Daonella* occur in the upper Anisian and Ladinian.

## INTRODUCTION

### HISTORY

The Humboldt Range in northwestern Nevada (fig. 1) has become a classic locality for Middle Triassic paleontology, partly because fossils of this age are locally abundant and partly because the area was favored by early collectors. By good fortune the most richly fossiliferous Middle Triassic beds in the northern part of the range are closely associated with silver deposits that in 1860 caused one of the many flurries of mining excitement in western Nevada after the discovery of the Comstock Lode. Fossils found in the Humboldt Range by mining men near the boom towns of Unionville and Star City (of which little remains in Star Creek canyon) were acquired by the Geological Survey of California and described by W. M. Gabb in 1864. They were thus among the first marine invertebrates from the New World to be described from rocks of recognized Triassic age.

Additional collections of Middle Triassic fossils from the Humboldt Range were made during the years 1867–69 by members of Clarence King's U.S. Geological Exploration of the Fortieth Parallel. These were described by Meek (1887) in collaboration with Alpheus Hyatt who subsequently visited and collected from the Humboldt Range in 1888 in company with I. C. Russell.

Middle Triassic cephalopods from the Humboldt Range were included in an intended comprehensive study of the marine invertebrate faunas of the North American Triassic by Hyatt of Harvard University and James Perrin Smith of Stanford University. This study was brought to a preliminary conclusion by Smith after Hyatt's death and was published under the title of "Triassic cephalopod genera of America" by Hyatt and Smith in 1905. As part of this study, Smith first visited the Humboldt Range in 1902 and 1903, and he credited L. F. Dunn of Winnemucca, Nev., for directing him to the extremely rich Middle Triassic locality in the southwestern part of the range that came to be known as

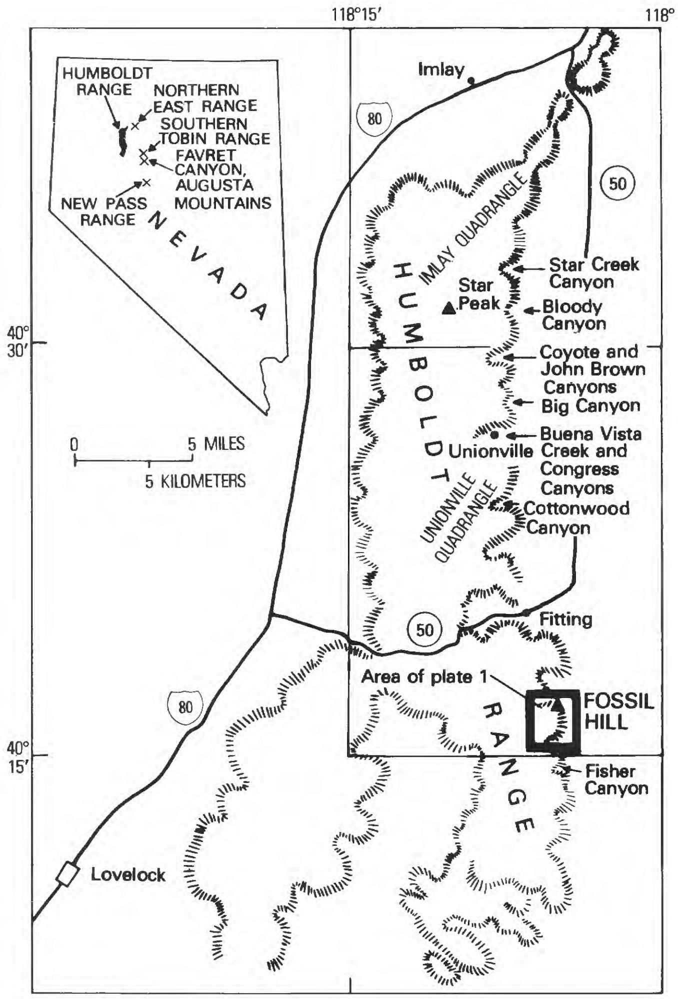


FIGURE 1.—Index map showing the location of Fossil Hill and other pertinent place names within the Humboldt Range, Nev.

"Fossil Hill" (Merriam, 1908, pl. 1, fig. 1; Smith, 1914) (fig. 2). Collections from the Humboldt Range were basis for the monographic treatment of the "Middle Triassic marine invertebrate fauna of North America" published by Smith in 1914. In this publication 128 species of marine invertebrates, including 110 species of ammonites, are described or listed from Fossil Hill alone.

Shortly after Smith drew attention to the richly fossiliferous Middle Triassic localities in the Humboldt Range, large collections were made from Fossil Hill by Percy Train, a professional collector. Although, according to his associates, Smith was quite dismayed at this commercial enterprise, Train was responsible for obtaining much of the Humboldt Range material studied by L. F. Spath (1934; 1951) at the British Museum of National History as well as the collections from the Humboldt Range to be found at many other institutions around the world.

FIGURE 2.—View south across South American Canyon, Humboldt Range, towards Fossil Hill (left foreground). Saurian Hill is in right background.

While extensive collections of Middle Triassic fossils were being made from the Humboldt Range, study of the geologic and stratigraphic setting of this fauna was generally neglected. Until the studies were made by Cameron (1939) in the northern part of the Humboldt Range and by Ferguson, Muller, and Roberts (1951) in the East Range, the next range east of the Humboldt Range, knowledge of the Triassic section in this part of Nevada advanced little beyond the original survey made by the geologists of the Fortieth Parallel expedition (King, 1878). As the richly fossiliferous Middle Triassic beds in the Humboldt Range are rarely more than a few tens of meters thick at any one place, and as they are part of a Triassic section obviously more than a thousand meters thick, it is not surprising that the early collectors, including Smith, tended to regard all of the fossils from these beds throughout the range as part of a single fauna, and little or no effort was made to segregate collections made from different stratigraphic levels.

Most of the Middle Triassic fossils described by Smith (1914) from the Humboldt Range were regarded by him as representative of the "*Daonella dubia* zone." He was aware of some difference in age among the faunas of this zone as shown by statements such as "the upper Anisic stage is certainly represented . . . , and the higher beds of the *Daonella dubia* shaly limestone may represent the lower Ladinic" (Smith, 1914, p. 7). But the faunal associations listed by Smith commonly include species now known to be restricted to the middle Anisian or even in the lower Ladinian. Thus the nature of the faunal succession was largely obscured, which is unfortunate because the paleontologic significance of the Middle Triassic of the Humboldt Range lies not only in its highly fossiliferous nature but in the unusually complete stratigraphic sequence of its different faunas.

The succession of Anisian and lower Ladinian ammonite faunas in the Humboldt Range is, in fact, one of the most complete of any known in the world, and it provides an important biostratigraphic standard of reference for rocks of this age. Moreover, the almost continuously fossiliferous upper Anisian beds afford a unique opportunity for detailed study of the changes in ammonite populations through time and give considerable insight into the evolution and taxonomy of these fossils.

### DESCRIPTION OF STUDY AND ACKNOWLEDGMENTS

The present study was commenced by Silberling in 1956 and carried out at various times during the late 1950's and early 1960's as part of a more general geologic investigation of the Humboldt Range during which the entire range was mapped in some detail by R. E. Wallace, E. B. Tatlock, and N. J. Silberling (Wallace, Tatlock, Silberling, and Irwin, 1969; Wallace, Silberling, Irwin, and Tatlock, 1969; Silberling and Wallace, 1967). The location and geologic setting of paleontologically significant outcrops has thus been fairly well established, but the potential of the area for further paleontologic studies is by no means exhausted. Although about two man-months of pick-and-shovel work were devoted to obtaining bedrock collections from the upper Anisian in the vicinity of Fossil Hill in the southern part of the range, still larger stratigraphically controlled population samples of some taxa would be desirable and would be essential for meaningful statistical study. In the northern part of the range the faunal record of the Middle Triassic is obscured by poor fossil preservation, and discovery of even a single favorably fossiliferous block could add importantly to the known fauna.

During the course of this study much useful information and material on the Middle Triassic paleontology and stratigraphy of Canada, and on the Triassic in general, were received from E. T. Tozer and the late F. H. McLearn of the Geological Survey of Canada. Tozer visited various Triassic exposures in Nevada, including those in the Humboldt Range, in 1964 and has provided encouragement and criticism during the following years.

By the mid-1960's Silberling had organized much of the Middle Triassic material from the Humboldt Range, prepared synonymies of Smith's numerous species, and written some taxonomic description. Nichols completed the study in 1976 while a National Research Council post-doctoral fellow at the U.S. Geological Survey.

Bernhard Kummel of Harvard University aided the present study by providing helpful discussion at various times and by lending the Middle Triassic types from the Whitney collection at the Museum of Comparative Zoology. After a search for Gabb's missing 1864 types at Harvard proved fruitless, some of them were discovered at the Academy of Natural Science of Philadelphia by Ellen J. Moore during a visit by her to that institution. To Horace G. Richards of the Philadelphia academy we are indebted for providing access to these collections and lending those of Gabb's types that were recovered.

Most of the photographic illustrations were prepared by Kenji Sakamoto of the U.S. Geological Survey.

## STRATIGRAPHIC OCCURRENCE AND COMPOSITION OF FAUNAS

### GENERAL STATEMENT

Cephalopods of early Anisian, middle Anisian, late Anisian, early Ladinian, and late Ladinian age are represented in the Middle Triassic of the Humboldt Range, and bivalves of the genus *Daonella* are locally abundant in rocks of late Anisian and Ladinian age. However, the stratigraphic occurrence of these fossils is quite uneven. Parts of the section are much more fossiliferous than others, and only some of the Middle Triassic faunas are found in sequence in any one part of the range.

The fossiliferous Middle Triassic rocks belong to the Prida Formation, the lowest of the formations that locally constitute the Star Peak Group (Nichols and Silberling, 1977). The description of these strata in the Humboldt Range and interpretation of their paleogeographic relationships by Silberling and Wallace (1969) was emended and amplified by Nichols and Silberling (1977) and needs only to be summarized here.[1] Three members of the Prida Formation are recognized: a lower member that includes a basal conglomerate or sandstone overlain by a variety of impure calcareous and dolomitic rocks; a middle member, the Fossil Hill Member, which is dark-gray, commonly fossiliferous, lenticular limestone interbedded with calcareous mudstone, siltstone, and shale; and an upper member of evenly parted, dark-gray or black, laminated, cherty limestone. Within the 5-km (kilometer) length of the Humboldt Range the relative thickness of these three members, and the total thickness of the Prida Formation, undergo pronounced changes owing partly to local relative uplift and erosion during early Anisian time and partly to a southward facies transition of the basinal carbonate rocks of the Prida with carbonate platform rocks of the largely correlative Augusta Mountain Formation. In total thickness the Prida Formation ranges from as little as 60 m (meters) at its southernmost exposures in the range to more than 600 m in the northern part of the range.

Where the Prida was continuously deposited in the

[1]The stratigraphic nomenclature used for the Star Peak Group by Nichols and Silberling (1977) has been adopted by the Geologic Names Committee for use by the U.S. Geological Survey.

northern part of the range, the lower member is as much as 140 m thick and includes in its middle part a unit of carbonate rocks that locally is 60 m thick. At least two completely distinct ammonite faunas of Spathian (late Early Triassic) age occur at different stratigraphic levels in this carbonate unit. The higher of these faunas, which is characteristic of the *Neopopanoceras haugi* Zone, has sometimes been regarded as the basal zone of the Middle Triassic but is correlated by Silberling and Tozer (1968) with the uppermost Lower Triassic *Keyserlingites subrobustus* Zone of Canada and Siberia. A description of this fauna is therefore not included here.

The Fossil Hill Member also attains its greatest thickness of approximately 120 m in the northern part of the Humboldt Range. Here it includes beds older than those at the base of the member farther south and contains ammonite faunas of early, middle, and late Anisian age. Farther south in the range, south of Buena Vista Creek canyon and Unionville, the Fossil Hill Member is less than 60 m thick and contains faunas of late Anisian age only. The type section of the member is on the south side of Fossil Hill within collecting-site A (pl. 1). Here the member is about 60 m thick, but closely spaced minor faults prohibit measurement of its thickness along any single line of section. It rests with sharp contact on quartz-silty, finely crystalline, sugary dolomite at the top of the lower member, and it grades upward through 3–6 m of section into the upper member of the Prida Formation. At site A the stratigraphically lowest molluscan fossils occur about 30 m above the base of the Fossil Hill Member. However, where intra-Prida Formation erosion was greatest in the central part of the range, as in the vicinity of the Arizona Mine about two kilometers southwest of Unionville, these same upper Anisian faunas occur within about 10 m of the base of the member.

Throughout the Humboldt Range the transitional Fossil Hill Member–upper member contact roughly coincides with the Anisian-Ladinian Stage boundary. In its southernmost exposures in the range the upper member is only about 30 m thick and is of earliest Ladinian age. Farther north in the range it thickens to more than 600 m at the expense of overlying rock units of the Star Peak Group, and in its upper part it locally contains faunas of both late Ladinian (latest Middle Triassic) and probable early Karnian (earliest Late Triassic) age. Although the Panther Canyon Member of the Augusta Mountain Formation, the Congress Canyon Formation and some of the Smelser Pass Member of the Augusta Mountain Formation, in the southern part of the range are lateral facies equivalent to the upper member of the Prida Formation in the northern part of the range (Nichols and Silberling, 1977), and hence are of Middle Triassic age, no identifiable ammonites or halobiid pelecypods have been found in these platform carbonate rocks.

All of the Middle Triassic fossils described herein from the Humboldt Range are thus from the Fossil Hill Member and the upper member of the Prida Formation. The successive biostratigraphic units in these rocks and their age assignments, modified from the classification of the North American marine Triassic by Tozer (1967), Silberling and Tozer (1968), and Tozer (1974) are:

| | |
|---|---|
| *Daonella lommeli* beds | late Ladinian |
| *Protrachyceras subasperum* Zone | early Ladinian |
| *Frechites occidentalis* Zone | late Anisian |
| *Parafrechites meeki* Zone | late Anisian |
| *Gymnotoceras rotelliformis* Zone | late Anisian |
| *Acrochordiceras hyatti* Zone | middle Anisian |
| *Lenotropites caurus* Zone | early Anisian |

Following the convention used by most Mesozoic ammonite biostratigraphers, the names of ammonite zones, such as those listed above under the full name of their nominal index species, are generally referred to henceforth in this paper only by the trivial name of their index species. For example, where the context is clear, the name *Lenotropites caurus* Zone is shortened to Caurus Zone.

Some of these biostratigraphic units are much better developed than others, and only the three upper Anisian zones and the lowermost Ladinian zone, as developed at localities near Fossil Hill in the southern part of the range, are stratigraphically contiguous. The others are separated by unfossiliferous beds, leaving room in the section for a number of additional biostratigraphic units of comparable scope. For example, the *Balatonites shoshonensis* Zone, which occurs in the Favret Formation at localities farther east in northwestern Nevada, is not represented in the Humboldt Range. However, in the southern Tobin Range, about 50 km east of Fossil Hill, it has been found stratigraphically bracketed between the Hyatti and Rotelliformis Zones (Burke, 1973, p. 52) as anticipated by Silberling and Tozer (1968).

## LOWER ANISIAN

In the Humboldt Range the oldest age-diagnostic Middle Triassic ammonites are indicative of the Caurus Zone, which has its typical development in northeastern British Columbia (Tozer, 1967; Silberling and Tozer, 1968). Listed in the order of decreasing abundance, these ammonites in the Humboldt Range are:

*Gymnites tregorum* n. sp.
*Isculites meeki* (Hyatt and Smith)
*Lenotropites caurus* (McLearn)
*Paracrochordiceras* aff. *P. americanum* McLearn

This fauna is restricted to about a meter of beds that crop out at U.S. Geological Survey Mesozoic localities M2358, M2367, and M2828 along strike between Star Creek canyon and Bloody Canyon (fig. 1) where the Fossil Hill Member of the Prida Formation attains its greatest thickness in the Humboldt Range. The part of the Fossil Hill Member beneath these fossiliferous beds varies from about 30–45 m thick. Ammonites identified as *Eophyllites* sp. and brachiopods assigned to "*Spirigera*" cf. "*S.*" *stoliczkai* Bittner occur near its base, but the few other ammonites found in this basal part of the member are not well enough preserved to be identified. Above the fossiliferous beds of the Caurus Zone, no fossils have been found in the 30–40 m of section up to the stratigraphically lowest occurrences of Hyatti Zone fossils.

## MIDDLE ANISIAN

The name *Acrochordiceras hyatti* Zone is introduced here for the strata in Nevada referred to by Tozer (1974) as the "*A. hyatti* beds." These strata were originally assigned by Silberling and Tozer (1968; Silberling and Wallace, 1969) to the Varium Zone whose typical occurrence is in northeastern British Columbia. Subsequently, this zone in Canada was recognized as including correlatives in Nevada of both what is now termed the Hyatti Zone and the succeeding Shoshonensis Zone. In the Humboldt Range both the Hyatti Zone and the older Caurus Zone are represented only north of Buena Vista canyon. Farther south in the range, marine strata corresponding in age to these zones are absent.

A complete list of the cephalopods identified from the Hyatti Zone in the Humboldt Range includes:

*Koipatoceras discoideus* n. sp.
*Alanites mulleri* n. sp.
*A. obesus* n. sp.
*Ismidites* aff. *I. marmarensis* Arthaber
*Amphipopanoceras* cf. *A. selwyni* (McLearn)
*Acrochordiceras hyatti* Meek
*Cuccoceras bonaevistae* (Hyatt and Smith)
*Nicomedites* sp.
*Hollandites voiti* (Oppel)
?*Anagymnotoceras moderatum* (McLearn)
*Japonites* cf. *J. sugriva* Diener
*Gymnites perplanus* (Meek)
*Isculites tozeri* n. sp.
*Czekanowskites hayesi* (McLearn)
*Pseudodanubites halli* (Mojsisovics)
*Unionvillites hadleyi* (Smith)
*U. asseretoi* n. sp.
*Intornites mctaggarti* (McLearn)
*I.* cf. *I. nevadanus* (Hyatt and Smith)
*Ussurites* cf. *U. arthaberi* (Welter)
*Aulametacoceras*? *humboldtensis* n. sp.
*Grypoceras whitneyi* (Gabb)

In addition, orthoconic nautiloids are common. Among the ammonites only *Alanites mulleri* and the species of *Acrochordiceras, Cuccoceras, Gymnites, Isculites,* and *Intornites* are fairly well represented in the available collections. Some of the other species listed are represented by only a single specimen. The only other shelly fossils found in the Hyatti Zone are two kinds of bivalves: "*Sphaera*" *whitneyi* Gabb and a *Posidonia*-like form having coarsely rugate ornamentation.

Although the Hyatti Zone is the most fossiliferous part of the Triassic section in the northern part of the range, preservation of fossils is generally poor because of incipient metamorphism. At most places identifiable cephalopods were collected as float or else they could be obtained from only a single bed within the zone, which has a total thickness of at least 45 m.

The typical expression of the Hyatti Zone is designated here as the section that includes USGS Mesozoic localities M2829 and M2830 (Silberling and Wallace, 1967; 1969, pl. 1) in the Fossil Hill Member of the Prida Formation on the east slope of Star Peak. Locality M2830 is about 60 m above the base of the Fossil Hill Member and about 30 m higher in the section than USGS Mesozoic locality M2828, which contains ammonites of the Caurus Zone. Compared with other more or less correlative localities in the lower part of the Hyatti Zone, locality M2830 is represented by only a few ammonites, including *Alanites* cf. *A. mulleri, Acrochordiceras hyatti, Cuccoceras bonaevistae,* and *Intornites mctaggarti.* The last two species listed are especially characteristic of the lower part of the Hyatti Zone. Locality M2829 is approximately 40 m higher in the section and has yielded the following ammonites:

*Alanites* cf. *A. obesus* n. sp.
*Acrochordiceras hyatti* Meek
*Gymnites* cf. *G. perplanus* (Meek)
*Pseudodanubites halli* (Mojsisovics)
*Unionvillites hadleyi* (Smith)
*U. asseretoi* n. sp.
*Intornites* cf. *I. nevadanus* (Hyatt and Smith)

Of these, the last three listed are characteristic of the upper part of the Hyatti Zone. In the northern Humboldt Range, where the Hyatti Zone occurs, the next higher molluscan faunas are at least 45 km stratigraphically above the Hyatti Zone within the Fossil Hill Member and are poorly represented. If any ammonites are found at all here, they are poorly preserved and generally represent the *Frechites nevadanus* beds of the upper Anisian Meeki Zone.

## UPPER ANISIAN

Upper Anisian cephalopod and halobiid bivalve faunas are well represented in the southern part of the Humboldt Range, where they are the oldest Middle Triassic larger invertebrate faunas found. Unlike the scattered occurrences of Anisian molluscan fossils farther north in the Humboldt Range, at favorable localities, such as those in the vicinity of Fossil Hill and Saurian Hill (pl. 1 and fig. 2), large upper Anisian collections can be obtained from bedrock at fairly closely spaced stratigraphic intervals.

Large collections, mostly obtained from stratigraphically mixed, weathered surface debris, were made by J. P. Smith from Fossil Hill and vicinity in the early 1900's and formed the basis for his monograph (Smith, 1914) on Middle Triassic faunas. Using stratigraphically controlled bedrock collections from the same area, Silberling (1962) published a preliminary taxonomic revision of the many species of ammonoids described by Smith from the upper Anisian and a tabular summary of their stratigraphic distribution. With only minor further taxonomic revision, this succession formed the basis for the definition of the Rotelliformis, Meeki, and Occidentalis Zones by Silberling and Tozer (1968), who regarded these zones as a complete representation of the upper Anisian in North America.

In the vicinity of Fossil and Saurian Hills, cephalopod and *Daonella* shells, more or less broken but readily identifiable, are important constituents of lenticular, thin to medium-thick, micritic limestone beds within the Fossil Hill Member of the Prida Formation. These limestone beds are irregularly interstratified with calcareous siltstone, mudstone, and shale and generally occur at 1–2 m intervals. Upper Anisian collections have been obtained from at least 20 different stratigraphic levels within a total thickness of about 25–30 m of strata. To achieve this density of stratigraphically successive samples, a total of 55 bedrock collections were made within collecting-sites A, B, and C, the locations of which are shown on plate 1.

Because the fossiliferous limestone beds are laterally discontinuous, collecting from single measured sections, as at site B, proved unrewarding. At sites A and C (figs. 3 and 4) collections were randomly made across and along strike wherever fossiliferous bedrock could be found at or near the surface of the gullied, thinly soil-covered hillsides. Stratigraphic relations between collections at each site were determined, insofar as possible, by laterally trenching certain beds from which vertical stratigraphic measurements could be made. Plates 2 and 3 are detailed plane-table maps of these sites.

Stratigraphic superposition at these sites can only be directly observed for several collections at a time, owing to lateral lithologic variation and, at site A, small-scale normal faulting. Thus the overall stratigraphic distribution must be obtained by correlating and combining the superpositional data that can be observed within about a dozen different groups of bedrock collections. Some additional stratigraphically restricted collections were made from isolated bedrock exposures and from single loose weathered blocks. To correlate these various collections, the faunal sequence observed within the upper Anisian has been used as a local standard (Silberling, 1962). Twelve successive informal biostratigraphic units, termed "beds," are recognized on the basis of one or more index species of ammonites. The grouping of these informally named beds within the upper Anisian zones is shown on table 1. For all of the collections made near Fossil and Saurian Hills, the superpositional relationships, correlations, and assignments to the biostratigraphic units are given in table 2.

The stratigraphic distribution of the upper Anisian species of ammonites, coleoids, and *Daonella* represented in stratigraphically controlled collections from the Fossil Hill and Saurian Hill area is plotted on table 1. Because successive population samples of some

FIGURE 3.—View northwest towards collecting-site A on the south side of Fossil Hill, Humboldt Range (pl. 1). Fossil localities at this site are on the gullied slope in the center of the view.

FIGURE 4.—View southeast across collecting-site C on the south spur of Saurian Hill, Humboldt Range (pl. 1). The cluster of trees in the center of the view is within site C.

genera tend to show progressive changes in morphology, in some cases suggesting transitions between arbitrarily defined species, the stratigraphic ranges are plotted in the same manner used by Silberling (1962, table 1). To accommodate gradation between species, where such might exist, "the stratigraphic range of those populations in which the majority of specimens fall within the arbitrarily defined morphologic limits of one species is indicated by a row of X's. This range is then extended by plus signs to show the occurrence of specimens that typologically would belong to the same species, but are end-member variants of populations that as a whole have the morphology of a different species of the same genus." The rationale for this procedure is discussed further in Silberling (1962, p. 158–159).

Although it can be described as progressive through time, morphologic change, or the replacement of one species by another in successive stratigraphic levels, within several of the better represented families of upper Anisian ammonites from the vicinity of Fossil Hill cannot be demonstrated to be gradual, as pointed out by Silberling and Nichols (1980). This limitation applies even though population samples were obtained from stratigraphic levels as closely spaced as the occurrence and preservation of the ammonites in the section would permit. Thus the data on table 1 permissibly fit the evolutionary pattern termed "punctuated equilibrium" by Eldredge and Gould (1972) and do not necessarily demonstrate "phyletic gradualism."

The 37 species of upper Anisian ammonites listed in table 1 represent a considerable taxonomic revision of the many species described from the Fossil Hill area by Smith (1914). Of the 110 species of ammonites described or listed by Smith from this locality, 14 either are known to be other than late Anisian in age or are based on apparently pathologic specimens, as explained by Silberling (1962, p. 157–158). Of the remainder, only 5 of the species reported by Smith are not represented in the collections on which the present study is based. These are:

*Gymnites calli* Smith, 1914
*Ptychites evansi* Smith, 1914 [probably best regarded as a *nomen dubium*]
*Trachyceras* (*Anolcites*) *barberi* Smith, 1914
*Ceratites weaveri* Smith, 1914 [holotype from New Pass Range, Nev.]
*Ceratites* (*Paraceratites*) *gabbi* (Meek) of Smith [= *Eudiscoceras gabbi* Meek, 1877; holotype from Cottonwood Canyon, Humboldt Range]

Although not found by us in the Humboldt Range, the morphologically distinctive *Eudiscoceras gabbi* was collected by the late S. W. Muller in the southern Tobin Range (at Stanford University loc. 2766) in association with ammonites of the upper Rotelliformis Zone or lower Meeki Zone.

Only two or three kinds of ammonoids different from those described by Smith were collected during the present investigation from the upper Anisian of the Humboldt Range. These additional occurrences, which are not listed on table 1, include:

*Sturia* cf. *S. sansovinii* Mojsisovics, 1882 [a float specimen from the *Frechites nevadanus* beds of the Meeki Zone or stratigraphically higher]
*Ptychites*? sp. indet. [an immature specimen from the *Parafrechites meeki* beds]
*Discoptychites* sp. [a single fragmentary specimen from the *Paraceratites clarkei* beds of the Rotelliformis Zone. Possibly the same as "*Ptychites*" *evansi* Smith]

In addition to the biostratigraphically useful ammonoids, coleoids, and Daonellas listed on table 1 and discussed above, four different nautiloids, *Michelinoceras*? cf. *M.*? *campanile* (Mojsisovics), *Germanonautilus furlongi* Smith, *Grypoceras whitneyi* (Gabb), and *Paranautilus smithi* Kummel, and the bivalve *Pteria obesus* (Gabb) are described herein as part of the upper Anisian fauna of the Humboldt Range.

Considering the very large amount—probably at least several tons—of paleontological material collected from the Fossil Hill area, the approximately 40 species of ammonites accounted for above most likely represent the total number of taxa of late Anisian age present at this locality. This figure, of course, is dependent on the scope of intraspecific variation accepted by us. Of this total of 40 species, as shown on table 1, the Rotelliformis, Meeki, and Occidentalis Zones have yielded, respectively, a total of 16, 15, and 14 species of ammonites, and each zone is characterized by about 10 uniquely occurring species or species having uniquely overlapping ranges. Some species of coleoids and Daonellas are also restricted in their stratigraphic ranges within the upper Anisian. The greatest diversity of ammonites collected from a single limestone layer is 9 species from USGS locality M144, which is representative of the *Nevadites humboldtensis* beds of the Occidentallis Zone. The average diversity of ammonite species for the 12 biostratigraphic subdivisions or "beds" of the upper Anisian zones is 6.8.

## LOWER LADINIAN

The Anisian-Ladinian Stage boundary, as recognized herein, roughly coincides with the lithologic transition from the Fossil Hill Member upward into the upper member of the Prida Formation. Compared with the Fossil Hill, which consists of calcareous siltstone, mudstone, and shale with lenticular fossiliferous limestone interbeds, the upper member of the Prida is lithlogically more uniform. It consists mostly of laminated, regularly parted, cherty micritic limestone in which the small

TABLE 1.—*Stratigraphic distribution of upper Anisian ammonoids, coleoids, and Daonellas at Fossil Hill and vicinity, Humboldt Range*

[Rows of crosses denote stratigraphic ranges of populations in which the majority of specimens fall within the arbitrary morphologic limits of nominal species. Extension of these ranges by plus signs shows the occurrence of specimens that typologically would belong to the same species, but are end-member variants of populations that as a whole have the morphology of a different species of the same genus. Queries mark the stratigraphic level of questionable occurrences]

| Zone | Beds | AMMONOIDEA SAGECERATIDAE *Sagerceras walteri* Mojsisovics | BEYRICHITIDAE *Gymnotoceras rotelliformis* Meek | *G. blakei* (Gabb) | *Parafrechites meeki* (Mojsisovics) | *P. dunni* (Smith) | *Frechites nevadanus* (Mojsisovics) | *F. occidentalis* (Smith) | CERATITIDAE (Paraceratitinae) *Paraceratites burckhardti* Smith | *P. clarkei* Smith | *P. vogdesi* (Smith) | *P. cricki* Smith | *Eutomoceras* cf. *E. lahontanum* Smith | *E. dalli* Smith | *E. dunni* Smith | *E. laubei* Meek | *Nevadites hyatti* (Smith) | *N. humboldtensis* Smith | *N. furlongi* (Smith) | *N. gabbi* (Smith) | LONGOBARDITIDAE *Longobardites parvus* (Smith) | *L.* cf. *L. zsigmondyi* (Böckh) | APLOCOCERATIDAE *Metadinarites desertorus* (Smith) | *Aplococeras smithi* n. sp. | *A. vogdesi* (Hyatt and Smith) | *A. parvus* (Smith) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Frechites occidentalis* Zone | *Nevadites gabbi* beds | ? | | | | | | XXX | | | | | | | | | | | + | XXXX | | | | | | |
| | *Nevadites furlongi* beds | ? | | | | | | XXXX | | | | | | | | | | | XXX | + | | ? | | | | XX |
| | *Nevadites humboldtensis* beds | ? | | | | | | XXXX | | | | | | | | X | ++ | XXXX | | | | XXXX | | | | XXXX |
| | *Nevadites hyatti* beds | ? | | | | | | XXXX | | | | | | | | XXXX | XXXX | ++ | | | | XXXX | | | | XXXX |
| *Parafrechites meeki* Zone | *Parafrechites dunni* beds | XXXXXXXXXX | | | ++XXXXXXXX | XXXXXXXXXX | | ++ | | | | | | | ++++ | XXXXXXXXXX | | | | | ? | ? | | | XXXXXXXXX | |
| | *Parafrechites meeki* beds | XXXXXXXX | | | XXXXXXXX | | + | | | | | | | | XXXXXXXX | + | | | | | XXXXXXX | | | ++ | XXXXXXXX | |
| | *Frechites nevadanus* beds | XXX | | XX | + | | XXX | | | | | | | + | XXX | | | | | | XXX | | | XXX | | |
| *Gymnotoceras rotelliformis* Zone | *Gymnotoceras blakei* beds | XXXXXXX | +++ | XXXXXXX | | | | | | | | | X | XXXX | ++ | | | | | | XXXXXXX | | | XXXXXXX | | |
| | *Paraceratites cricki* beds | XXXX | XXXX | ++++ | | | | | | | | XXXX | | | | | | | | | XXXX | | X | | | |
| | *Paraceratites vogdesi* beds | XXXXXX | XXXXXX | + | | | | | | | XXXXXX | | | | | | | | | | XXXXXX | | | | | |
| | *Paraceratites clarkei* beds | XXXXX | XXXXX | | | | | | | XXXXX | | | | | | | | | | | XXX | | | | | |
| | *Paraceratites burckhardti* beds | XXXX | XXXX | | | | | | XX | | | | | | | | | | | | | | | | | |

TABLE 1.—*Stratigraphic distribution of upper Anisian ammonoids, coleoids, and Daonellas at Fossil Hill and vicinity, Humboldt Range*—Continued

| Zone | Beds | JAPONITIDAE *Tropigymnites?* cf. *T. planorbis* (Hauer) | PROTEUSITIDAE *Tropigastrites lahontanus* Smith | *T. louderbacki* (Hyatt and Smith) | *Tozerites gemmelaroi* (Arthaber) | *T. humboldtensis* (Smith) | *T. polygyratus* (Smith) | ARCESTIDAE *Proarcestes* cf. *P. balfouri* (Oppel) | *P. gabbi* Meek | MEGAPHYLLITIDAE *Humboldtites septentrionalis* (Smith) | THANAMITIDAE *Thanamites? contractus* Smith | GYMNITIDAE *Gymnites* cf. *G. humboldti* Mojsisovics | *Epigymnites alexandrae* (Smith) | COLEOIDEA XIPHOTEUTHIDIDAE *Atractites* sp. A | *Atractites clavatulus* Smith | *A. solidus* Smith | *A. nevadensis* (Meek) | PELECYPODA POSIDONIIDAE *Daonella americana* Smith | *D.* cf. *D. sturi* (Benecke) | *D.* cf. *D. elongata* Mojsisovics | *D.* cf. *D. moussoni* (Merian) | *D. dubia* (Gabb) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Frechites occidentalis* Zone | *Nevadites gabbi* beds | | | | | | xxx | | xxxx | | | | xxxx | | | | | | | | xxxx | xxxx |
| | *Nevadites furlongi* beds | | | | | | xxxx | | xxxx | | | | xxxx | | | | | | | | xxxx | xxxx |
| | *Nevadites humboldtensis* beds | | | | | xxx | x | | xxxx | xxx | x | | xxxx | | | | xx | | | | xxxx | ? |
| | *Nevadites hyatti* beds | | | | | xxxx | | | xxxx | xxx | | | xxxx | | | | xxxx | | | | xxxx | ? |
| *Parafrechites meeki* Zone | *Parafrechites dunni* beds | | | | xxxxxxxx | | | ? | xx | | | | xxxxxx | | | | xxxxxxxxxx | | | x | ? | |
| | *Parafrechites meeki* beds | | | | xxxxxxx | | | ? | | | | | | | | | xxxxxxx | | | | ?? | |
| | *Frechites nevadanus* beds | | + | xxx | | | | xxx | | | | | | | | xx | | x | x | | | |
| *Gymnotoceras rotelliformis* Zone | *Gymnotoceras blakei* beds | | xxxxxxx | ++ | | | | xxxxxxx | | | | x | | | xx | | | x | xxxxx?x | | | |
| | *Paraceratites cricki* beds | | | | | | | xxxx | | | | | | x | | | | xxxx | | | | |
| | *Paraceratites vogdesi* beds | xxxx | | | | | | xxxxxx | | | | | | | | | | xxxxxx | | | | |
| | *Paraceratites clarkei* beds | | | | | | | xxxxx | | | | | | | | | | xxxxx | | | | |
| | *Paraceratites burckhardti* beds | | | | | | | xxx | | | | | | | | | | xxx | | | | |

TABLE 2.—*Correlation of upper Anisian and lower Ladinian bedrock and single float-block localities at collecting-sites A, B, and C in the vicinity of Fossil Hill and Saurian Hill, Humboldt Range*

[Within each vertical column of numbers, superposition of localities has been objectively determined, and stratigraphic distances in meters between localities are given where known. Vertical scale is not proportional to true stratigraphic thicknesses. Localities are described in table 3]

| Zone | Zonal subdivision | Site A | | | | | | Site B | | Site C | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Subasperum | | | | M147 | | | | | | | | M628<br>M627 | | | |
| Occidentalis | *Nevadites gabbi* beds | | | | | M146<br>4.0 m | | | | M626 | M624 | 3.0 m<br>M623 | | | |
| | *Nevadites furlongi* beds | | | | | M145<br>4.0 m | | | | | 2.4 m | | M625<br>2.1 m | M622 | |
| | *Nevadites humboldtensis* beds | M962A | | M961 | | M144<br>1.8 m | | | | | M620 | | M621<br>3.7 m | 5.2 m | |
| | *Nevadites hyatti* beds | M962 | | | | M144-6 ft (1.8 m) | | | | | | | | | |
| Meeki | *Parafrechites dunni* beds | M968[1] | | | | 6.4 m | | M167<br>5.5 m | | | | | M618<br>4.3 m | M619<br>5.8 m | |
| | *Parafrechites meeki* beds | | | | | M960<br>1.2 m<br>M143 | | | | | M616<br>2.4 m | | M617 | | |
| | *Frechites nevadanus* beds | | M140<br>M138 | M963 | M142 | 4.0 m | | M166 | | M615 | | M612<br>1.8 m | 4.3 m | M614<br>2.4 m | |
| Rotelliformis | *Gymnotoceras blakei* beds | | M137 | | M141 | M964 | | | | | M611<br>1.8 m<br>M609 | M610 | M608 | M607+2 ft (0.6 m)<br>0.6 m<br>M607 | M613 |
| | *Paraceratites cricki* beds | | | | | 7.3 m | M967<br>2.7 m | 6.0 m | | M605+10 ft (3.0 m) | | | | | 4.6 m<br>M606 |
| | *Paraceratites vogdesi* beds | M136<br>1.5 m<br>M136-5 ft (1.5 m) | | | | | M967-9 ft (2.7 m)<br>4.5 m<br>M967-15 ft (4.5 m)<br>0.6 m | M165 | M163<br>1.2 m<br>M162 | 3.0 m<br>M605 | | | | | |
| | *Paraceratites clarkei* beds | 2.1 m<br>M136-7 ft (2.1 m) | | | | M139<br>M966 | M965+3 ft (0.9 m)<br>0.9 m | | | | | | | | |
| | *Paraceratites burckhardti* beds | | | | | | M965 | | M164 | | | | | | |

[1]Collected as float and placed in sequence by faunal content

amount of quartz silt is evenly distributed as scattered grains or concentrated in laminae. Subordinate interstratified thick-bedded units of course-grained bioclastic limestone and carbonate slide breccias are the only other primary rock types in the member and are most important in the higher parts of the section (Silberling and Wallace, 1969). Locally, as in the vicinity of Fossil Hill, much of the upper member is secondarily dolomitized where it stratigraphically underlies the primary dolomite forming the Panther Canyon Member of the Augusta Mountain Formation (Nichols and Silberling, 1977). Deposition of the distinctive basinal limestone of the upper member was interpreted by Nichols and Silberling (1977) to have been relatively rapid and to reflect the development of a carbonate platform farther east in north-central Nevada.

Along with the lithologic change from the Fossil Hill Member to the upper member of the Prida Formation, the cephalopods and *Daonella* shells that are so abundant in the Fossil Hill become scarce and then all but disappear. Only in the lowermost 10 m or so of the upper member are fossils locally well represented, and these beds that are directly above the Occidental Zone in the vicinity of Fossil Hill constitute the type Subasperum Zone of Silberling and Tozer (1968). Impressions of *Daonella rieberi* are locally abundant in the Subasperum Zone, but cephalopods are scarce. Stratigraphically restricted population samples that would permit taxonomic revision and partial synonymy of the primitive species of *Protrachyceras* described from these rocks in the Humboldt Range could not be obtained.

The species that occur together in collections made by us from the Subasperum Zone are:

- *Protrachyceras subasperum* (Meek) [along with the possibly synonymous species *P. americanum* (Mojsisovics) and *P. lahontanum* Smith]
- *Frechites johnstoni* n. sp.
- *Epigymnites alexandrae* (Smith)
- *Daonella rieberi* n. sp.

*Protrachyceras meeki* occurs low in the upper Prida and therefore may also represent the Subasperum Zone.

## UPPER LADINIAN

Above the Subasperum Zone the upper member of the Prida Formation is mostly unfossiliferous. Identifiable fossils, found at only a few places, usually consist of a single species of *Daonella* similar to or identical with the characteristic Alpine upper Ladinian species *D. lommeli* (Wissman).

The most diverse upper Ladinian fauna was collected in float from the upper member in the upper part of Congress Canyon, where the specimens of *Daonella* cf. *D. lommeli* described herein were found associated with *Protrachyceras*?, *Proarcestes*, and *Hungarites*. Of these ammonites, only the specimen of the *Hungarites* is described in order to document the occurrence of this genus in North America. It has also been reported from rocks of about the same age in the New Pass Range, Nev. (Silberling and Tozer, 1968, p. 36). From the same general locality in Congress Canyon, collections made previously by F. N. Johnston include, in addition to *Daonella* cf. *D. lommeli*, the ammonites *Meginoceras* cf. *M. meginae* McLearn, *Protrachyceras* cf. *P. sikanianum* McLearn, and *Thanamites schoolerensis* (McLearn), which are indicative of the Meginae Zone.

Another upper Ladinian species of *Daonella*, *D.* n. sp. ex aff. *D. indica* Bittner, is described from Fisher Canyon in the southern part of the Humboldt Range where it is associated with probable specimens of *D. lommeli*.

## AGE AND CORRELATION

Figure 5 shows the stage and substage assignments adopted herein for the Middle Triassic biostratigraphic units recognized in Nevada and the correlation of these biostratigraphic units with those recognized in Canada. The application of stage and substage terms to the faunal succession in North America follows the classification proposed by Tozer (1967) and Silberling and Tozer (1968). During the early 1960's, when the North American classification was being formulated, little modern data were at hand to indicate how the classical Alpine stages and their subdivisions should be applied; the faunal succession in North America was known in much more detail than that in Alpine Europe where the stage names were originally defined.

In recent years a rekindling of interest in Triassic biostratigraphy of the Alpine-Mediterranean region has greatly improved knowledge of the classical Middle Triassic sections. Some of the more important studies are: the age of the Avisianus Zone in the Italian Alps (Assereto, 1969), the identity of the Binodosus Zone in the northern and southern Alps (Assereto, 1971), the Anisian biostratigraphy of the island of Chios and nearby northwestern Turkey (Assereto, 1972, 1974), the Hallstatt facies of Middle Triassic in Greece (Krystyn and Mariolakos, 1975), conodont biostratigraphy (Kozur, 1974, 1975), the unique ammonite and *Daonella* succession of the Grenzbitumenzone of southern Switzerland in a series of papers by Rieber (culminating in Rieber, 1973), and the type section of the Anisian in Upper Austria (Summesberger and Wagner, 1972). As a consequence of these and other studies, the faunal succession of the Alpine-Mediterranean Anisian is especially well established, as shown by the representative columns included in figure 5. For the most part, agreement exists in the correlation of ammonite faunas between North America and Alpine Europe. The placement of the Anisian-Ladinian Stage boundary and the choice of substage units, however, is unsettled, and typological arguments can be made for several different points of view. Presumably convention will ultimately rule among the various usages that now exist.

To reiterate the argument given by Silberling and Tozer (1968, p. 12), the Anisian-Ladinian boundary in Nevada is placed below the first occurrence of primitive *Protrachyceras* that are characterized by having a discrete ventral furrow and ceratitic saddles. These fossils are known from the southern Alps low in the Buchenstein beds, the lithologic unit associated with the first use of the stage-name Ladinian by Bittner (1892). However, at a time when the youngest faunas of the Anisian were generally regarded as those of the Trinodosus Zone, the Avisianus Zone in the southern Alps was long regarded as Ladinian in age and mistakenly placed in the zonal succession above the position of the earliest species of *Protrachyceras* such as *P. reitzi*. Consequently, even after correction of its superpositional relationships (Assereto, 1969), an argument can still be marshalled for retaining the Avisianus Zone in the Ladinian, as advocated by Kozur (1974, 1975).

## PALEONTOLOGY

### PROCEDURES AND CONVENTIONS

Many of the following descriptions involve species or genera that were previously described from the Humboldt Range by Smith (1914). For these, complete descriptions are provided here only when the concept of Smith's taxa has been considerably altered. Thus the present report is intended to be used in conjunction with the original monograph by Smith.

In addition to primary types, Smith commonly illustrated several or more examples of the species he recognized. Stratigraphically controlled population samples indicate that some of the paratypes or plesiotypes figured by Smith were misidentified. Each specimen figured by Smith must therefore be cited individually in the synonymies. This citation is done by linking together different figure numbers referring to the same specimen by a hyphen and separating the figure numbers of different specimens, where they are written in a series, by a comma.

Suture lines for which the illustrations by Smith

| NORTH AMERICA | | | | | | | ALPINE EUROPE | | |
|---|---|---|---|---|---|---|---|---|---|
| Stages and substages (Silberling and Tozer, 1968) | | Biostratigraphic units: Humboldt Range, Nev. (this paper) | | Tobin Range, Nev. (Burke, 1973, p. 52) | Northeastern British Columbia (Tozer, 1974) | | European Tethys (Kozur, 1974, 1975): Zone | Substage | Stage |
| LADINIAN | upper | | | | Sutherlandi Zone | | Archeleus | Longobard | LADIN |
| | | *Daonella lommeli* beds | | | Maclearni Zone | | | | |
| | | | | | Meginae Zone | | | | |
| | lower | | | | Poseidon Zone | | | | |
| | | Subasperum Zone | | | Subasperum Zone | | Curionii | Fassan | |
| ANISIAN | upper | Occidentalis Zone | | | Chischa Zone | | Reitzi | | |
| | | Meeki Zone | | | Deleeni Zone | | Avisianus | | |
| | | Rotelliformis Zone | | Rotelliformis Zone | | | Trinodosus | Illyr | ANIS |
| | middle | | | Shoshonensis Zone | Varium Zone | upper | Balatonicus | Pelson | |
| | | Hyatti Zone | upper | Hyatti Zone (upper part) | | middle | Ismidicus | Bithynian | |
| | | | lower | | | lower | Osmani | | |
| | lower | Caurus Zone | | | Caurus Zone | | Anodosum | Aegean | |

FIGURE 5 (above and facing page).—Correlation chart showing the stage and substage assignments of Middle Triassic biostratigraphic units in the Humboldt Range and elsewhere in North America compared with biostratigraphic successions, stages, and substages recognized in Alpine Europe. Dashed lines indicate approximate boundaries.

(1914) are adequate are not illustrated again in the present report.

The terminology used herein for sutural elements of ammonites is purely descriptive and is based on the position of different elements on the mature phragmocone; it does not necessarily derive from the ontogenetic development of the elements. The abbreviations S1, S2, and S3 refer to the first, second, and third principal saddles beginning with the most ventral one. L1, L2, and L3 refer to the principal lobes in the same fashion. Minor sutural elements located dorsally of the principal elements are termed auxiliary elements. The ventral lobe is abbreviated VL, and the external saddle, which divides the ventral lobe in some ammonites, is abbreviated ES.

Reference marks on all of the ammonite suture-line drawings are those conventionally used: the arrow points in the orad direction and marks the midline of the venter; straight lines mark the umbilical shoulder, ventro-lateral shoulder, or both; and an arcuate line marks the umbilical seam where it can be located.

Ratios used to express the proportions of coiled cephalopod shells are: greatest width to diameter (W/D), width of umbilicus to diameter (U/D), and greatest width to maximum height (W/H). In reference to the proportions of a single specimen, all of the measurements that enter into these ratios are taken in the same plane that includes the axis of coiling.

Repositories of figured specimens are abbreviated as follows:

| ALPINE EUROPE | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Kokaeli Peninsula, Turkey and Chios (Assereto, 1972, 1974) | | | | Greece (Krystyn and Mariolakos, 1975) | | | Grenzbitumenzone, Switzerland (Rieber, 1973) | | | |
| Biostratigraphic unit | Substage | | Stage | Biostratigraphic unit | Substage | Stage | Fauna | Zone | Substage | Stage |
| | | | | | Longobard | LADIN | | | | LADIN |
| | | | | Protracyceratids with ceratitic sutures | Fassan | | | Curionii Zone | | |
| | | | | Reitzi Zone | Illyr | ANIS | *"Protracyceras"* | Reitzi Zone | Fassan | |
| *Flexoptychites* beds | Illyr | Upper | ANIS | Avisianus Zone | | | *Stoppaniceras*<br>*Daonella elongata*<br>*Ticinites*<br>*Parakellnerites* | Polymorphus Zone | Illyr | ANIS |
| *Paraceratites* beds | | | | | | | | | | |
| *Balatonites* beds | Pelson | | | | Pelson | | | | | |
| Ismidicus Zone | Bithynian | Lower | | | Bithynian | | | | | |
| Osmani Zone | | | | | | | | | | |
| *Paracrochordiceras-Japonites* beds | Aegean | | | | | | | | | |

USNM—National Museum of Natural History, Washington, D.C.
ANSP—Academy of Natural Sciences of Philadelphia
MCZ—Museum of Comparative Zoology, Harvard University

Data on the occurrence of each of the species collected during the present investigation include the number of specimens obtained from each locality. For example, the entry reading "USGS Mesozoic localities M1181 (25+) and M2829 (4)" means that 4 recognizable specimens of the species were collected from locality M2829, and 25 identifiable specimens, plus additional immature or broken specimens, were obtained from locality M1181.

The greatest amount of synonymizing of Smith's species involves those from the upper Anisian of the Fossil Hill area where population samples illustrating the range in intraspecific morphologic variation have been obtained from stratigraphically controlled bedrock collections. Actual or potential intergrading variants that occur together at the same stratigraphic level are regarded here as belonging to the same species. Where stratigraphically successive population samples show a progressive shift in morphology, the cutoff between contiguous species is essentially arbitrary. The population sample from any particular level is assigned to that species whose arbitrarily defined morphologic scope includes the mean morphologic variants of the sample (Silberling, 1962, p. 158).

For some of the better represented single-bed population samples, a roughly normal frequency distribution of morphologic variants can be demonstrated simply by sorting out all of the specimens in the sample into morphotypes that range spectrally from one extreme to the other with respect to one or more characters. Figure 6 illustrates two examples of this kind of distribution. For most species, however, the number of representatives

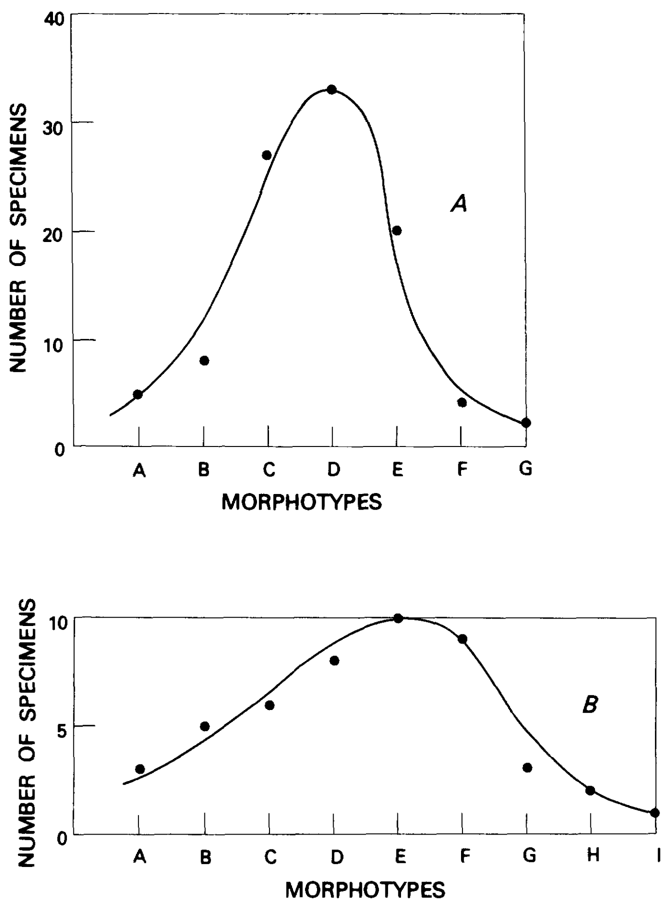


FIGURE 6.—Frequency distributions of morphologically different variants within single species of ammonites from USGS locality M136. *A*, 99 specimens of *Gymnotoceras rotelliformis* divided among morphotypes A–G that range progressively from most compressed, delicately ornamented variants (morphotype A) to most robust, coarsely ornamented variants (morphotype G). *B*, 47 specimens of *Paraceratites vogdesi* divided among the same kind of morphotypes lettered A–I.

from one stratigraphic level is inadequate to demonstrate complete intergradation, and a normal distribution of morphologic variations and a reasonable range in variation within species must be assumed.

Regrouping of the narrowly defined species described by Smith (1914) on the basis of stratigraphically controlled bedrock samples from the same general locality involves little guesswork. Problems arise where the morphology of previously named species, typologically defined from other parts of the world, is represented within the range of morphologic variation of single population-based species. In these cases, the older typological names are ignored on the basis that they represent populations of unknown morphologic range. They are names for concepts that are intrinsically different from the species recognized here. This problem is discussed further in the description of *Paraceratites vogdesi*, which as revised almost certainly includes variants having the morphology of specimens that typify species named in the last century from the Alpine Triassic.

All of the U.S. Geological Survey fossil-locality numbers to which reference is made in this report are described in table 3. The prefix "M" in these numbers denotes that they are recorded in fossil-locality registers maintained at the Menlo Park, Calif., laboratory of the U.S. Geological Survey. Numbers less than M1,000 are recorded in an all-purpose register; those greater than M1,000 are recorded in Mesozoic megafossil registers and these localities are properly referred to as "USGS Mesozoic localities."

## SYSTEMATIC DESCRIPTIONS

**Class CEPHALOPODA**
**Subclass AMMONOIDEA**
**Order CERATITIDA**
**Superfamily HEDENSTROEMIACEAE (Waagen)**
**Family SAGECERATIDAE Hyatt, 1900**
**Genus SAGECERAS Mojsisovics, 1873**
**Sageceras gabbi Mojsisovics, nomen dubium**

Plate 4, figures 1, 2

*Ceratites haidingeri* (Hauer) [in part]. Gabb, 1864, p. 22, pl. 5, figs. 8, 10 [not pl. 4, fig. 9 = *Longobardites* sp.].
*Sageceras gabbi* Mojsisovics, 1873, p. 71 [new name for *Ceratites haidingeri* (Hauer) of Gabb, 1864, pl. 5, figs. 8, 10] Hyatt and Smith, 1905, p. 97, pl. 25, figs. 1–3 [= copy of Gabb, 1864]. Smith, 1914, p. 49, pl. 6, figs. 1–3 [ = copy of Gabb, 1864].

The specimen illustrated (ANSP 30783) is thought to be the original of Gabb's (1864) figures 8 and 10 on his plate 5. In addition to Gabb's label, a note reading "this may be the type figured on pl. 5, f. 10 & 8" was found associated with this specimen in the collections of the Academy of Natural Sciences of Philadelphia. The note is unsigned but is like others that were written by Alpheus Hyatt and accompany Gabb's Triassic fossils at the Philadelphia Academy. The specimen, a complete phragmocone showing the final septum and beginning of the body chamber, is sheared parallel to the plane of symmetry, partly crushed, and badly eroded; it lacks the orad part of the venter, but the estimated maximum diameter of the phragmocone was about 110 mm or roughly the size indicated by Gabb for his figure 10. On Gabb's label the locality is given simply as "Humboldt, Nev." which agrees with the locality given by him (1864, p. 23) in his description of *Goniatites haidingeri*. Like other fossils described by Gabb from the Humboldt Range, this specimen is probably from the Middle Triassic in the vicinity of Buena Vista or Star Canyons. This specimen is specifically unrecognizable owing to its poor preservation.

TABLE 3.—*Triassic fossil localities in the Humboldt Range and vicinity, north-central Nevada*

[Unless otherwise noted, all localities are in the Fossil Hill Member of the Prida Formation, and collections were made by N. J. Silberling, 1956–65]

| USGS locality | Field locality | Description and collector(s) |
|---|---|---|
| M136–M146 --- | 57–66–1 through 11 | Unionville Quadrangle, Humboldt Range, Pershing County, Nev. Stratigraphically controlled bedrock collections from collecting-site A (pl. 1) on south side of Fossil Hill between South American and Troy Canyons. Approximately 2,000 feet (600 m) NW from SE corner of sec. 19, T. 28 N., R. 35 E. Localities plotted on plate 2. Rotelliformis, Meeki, and Occidentalis Zones. |
| M147 --------- | 57–66–12 | Same locality as M136–M146 except from upper member of Prida Formation and Subasperum Zone. |
| M162 --------- | 57–51–B102 | Union Quadrangle, Humboldt Range, Pershing County, Nev. Bedrock collection from collecting-site B (pl. 1) on west side of low hill capping first small spur south of Fossil Hill between South American and Troy Canyons. Approximately 1,200 ft (370 m) N. 80° W. from SE corner of sec. 19, T. 28 N., R. 35 E., 102 ft (31 m) stratigraphically above base of Fossil Hill Member of Prida Formation. Section complicated by faulting. Rotelliformis Zone. |
| M163 --------- | 57–51–B108 through B110 | Same as M162 except 108–110 ft (33–33.5 m) above base of section. Rotelliformis Zone. |
| M164 --------- | 57–51–F130 | Same as M162 except collected from a single float block at least 130 ft (40 m) above base of section. Rotelliformis Zone. |
| M165 --------- | 57–51–B143 | Same as M162 except 143 ft (43.5 m) above base of section. Rotelliformis Zone. |
| M166 --------- | 57–51–B163 | Same as M162 except 163 ft (50 m) above base of section. Meeki Zone. |
| M167 --------- | 57–51–B180 through B182 | Same as M162 except 180 ft (55 m) above base of section. Meeki Zone. |
| M533 --------- | 58–3 | Unionville Quadrangle, Humboldt Range, Pershing County, Nev. Bedrock collection from north wall of Big Canyon, 11,500 ft (350 m) N. 25° W. from BM 4964. Center of W½NW¼ sec. 14, T. 30 N., R. 34 E. Locality plotted on Wallace and others (1969). Hyatti Zone. |
| M605–M626 --- | 58–30–1 through 21 | Unionville Quadrangle, Humboldt Range, Pershing County, Nev. Stratigraphically controlled bedrock collections from collecting-site C (pl. 1) west side of south spur of Saurian Hill, north side of Troy Canyon. Approximately 4,500 ft±200 ft (1220±60 m) S. 50–55° W. from SE corner of sec. 19, T. 28 N., R. 35 E. Localities plotted on pl. 3. Rotelliformis, Meeki, and Occidentalis Zones. |
| M627–M628 --- | 58–30–22, –23 | Same as M605–M626 except from upper member of Prida Formation. Subasperum Zone. |
| M635 --------- | None | Gilbert Creek SW Quadrangle, Augusta Mountains, Lander County, Nev. Wildhorse quicksilver district. Float collections 3,000 ft (915 m) NW of Wildhorse Mine on north side of Wildhorse Mine road and then north along strike about 1,000 ft (300 m). Shoshonensis Zone. |
| M636 --------- | None | Cain Mountain Quadrangle, Augusta Mountains, Pershing County, Nev. Float collections from high on north wall of Favret Canyon just below Tertiary volcanic rocks and about 2 mi (miles) (3.2 km) from mouth of canyon. NE¼ sec. 12, T. 25 N., R. 39 E. Fossil Hill Member of Favret Formation. Upper Anisian beds. |
| M905 --------- | 59–W–815 | Unionville Quadrangle, Humboldt Range, Pershing County, Nev. Bedrock collection 0.75 mi (1.2 km) south of Indian Creek in gulch bottom, 600 ft (185 m) SE of center sec. 24, T. 29 N., R. 34 E. Upper member of Prida Formation. Subasperum Zone. Collected by R. E. Wallace and D. B. Tatlock, 1959. |
| M907 --------- | 58–7 | Unionville Quadrangle, Humboldt Range, Pershing County, Nev. Bedrock collection from drainage bed of northwest tributary to Congress Canyon. Approximately 700 ft (210 m) due west of center sec. 16, T. 30 N., R. 34 E., and along strike at elevation 7,000 ft (2140 m). Upper member of Prida Formation. Locality plotted on Wallace and others (1969). *Daonella lommeli* beds. |
| M908 --------- | 59–3 | Unionville Quadrangle, Humboldt Range, Pershing County, Nev. Bedrock collection from divide between heads of Peru and Jackson Canyons. Approximately 10,200 ft (3100 m) N. 71° E. from VABM 8882 in center of S½ sec. 34, T. 30 N., R. 34 E. Upper member of Prida Formation. Locality plotted on Wallace and others (1969). Subasperum Zone. |

TABLE 3.—*Triassic fossil localities in the Humboldt Range and vicinity, north-central Nevada*—Continued

| USGS locality | Field locality | Description and collector(s) |
|---|---|---|
| M909 --------- | 59–7 | Unionville Quadrangle, Humboldt Range, Pershing County, Nev. Bedrock collection from Jackson Canyon, along road to Wheeler and Cottonwood Mines, approximately 400 ft (125 m) north of Wheeler Mine. South center sec. 34, T. 30 N., R. 34 E. Locality plotted on Wallace and others (1969). Occidentalis Zone. |
| M911 --------- | 56–35 | Unionville Quadrangle, Humboldt Range, Pershing County, Nev. Bedrock collection from north wall of American Canyon. Approximately 11,350 ft (3450 m) N. 13° W. from Saurian Hill (elevation-point 5852). Locality plotted on Wallace and others (1969). Subasperum Zone. |
| M957 --------- | 60–1 | Unionville Quadrangle, Humboldt Range, Pershing County, Nev. Bedrock collection from west side of south spur of Saurian Hill. Immediately north of collecting-site C (pl. 3). Meeki Zone. |
| M958 --------- | 60–1+3 ft | Same as M957 except 3 ft (0.9 m) stratigraphically higher. |
| M959 --------- | 60–1+12 ft | Same as M957 except 12 ft (3.7 m) stratigraphically higher. |
| M960–M967 --- | 57–66–13 through 20 | Unionville Quadrangle, Humboldt Range, Pershing County, Nev. Stratigraphically controlled bedrock collections from collecting-site A (pl. 1) on south side of Fossil Hill between South American and Troy Canyons. Approximately 2,000 ft (600 m) NW from SE corner sec. 19, T. 28 N., R. 35 E. Localities plotted on pl. 2. Rotelliformis, Meeki, and Occidentalis Zones. |
| M968 --------- | 57–66 | Same locality as M960–M967 except single float-block collection. Meeki Zone. |
| M969 --------- | None | Unionville Quadrangle, Humboldt Range, Pershing County, Nev. Float collection from north side of Congress Canyon, approximately 30 ft (9 m) above canyon bottom and 70 ft (22 m) above base of Fossil Hill Member of Prida Formation. NW¼SE¼ sec. 16, T. 30 N., R. 34 E. Locality plotted on Wallace and others (1969). Hyatti Zone. |
| M970 --------- | None | Float collection from same locality as M969 except approximately 140 ft (43 m) above base of Fossil Hill Member of Prida Formation. Hyatti Zone. |
| M1124 -------- | 58–2 | Unionville Quadrangle, Humboldt Range, Pershing County, Nev. Float collection from divide between Big and Coyote Canyons. SE¼SE¼NW¼ sec. 14, T. 30 N., R. 34 E. Hyatti Zone. |
| M1180 -------- | 58–8 | Unionville Quadrangle, Humboldt Range, Pershing County, Nev. Bedrock collection from crest of divide between Congress and Big Canyons. Center N½SW¼ sec. 15, T. 30 N., R. 34 E. Locality plotted on Wallace and others (1969). Hyatti Zone. |
| M1181 -------- | 57–71 | Unionville Quadrangle, Humboldt Range, Pershing County, Nev. Bedrock collection from north side of John Brown Canyon. NW¼SE¼SE¼ sec. 16, T. 30 N., R. 34 E. Locality plotted on Wallace and others (1969). Hyatti Zone. |
| M1182 -------- | 61–21A | Unionville Quadrangle, Humboldt Range, Pershing County, Nev. Single float-block collection from crest of divide between main forks of Congress Canyon. South-central W½SE¼SW¼ sec. 16, T. 30 N., R. 34 E. Hyatti Zone. |
| M1183 -------- | 61–21B | Same locality as M1182. Single float-block collection. Hyatti Zone. |
| M1184 -------- | 61–21C | Same locality as M1182. Single float-block collection. Hyatti Zone. |
| M1185 -------- | 57–5 | Unionville Quadrangle, Humboldt Range, Pershing County, Nev. Float collection from Congress Canyon. Center SE¼ sec. 16, T. 30 N., R. 34 E. Hyatti Zone. |
| M2358 -------- | 64S–411 | Imlay Quadrangle, Humboldt Range, Pershing County, Nev. Bedrock collection from crest of intermediate spur between Star and Bloody Canyons, near range front. Approximately 150 ft (45 m) stratigraphically above base of Fossil Hill Member of Prida Formation. Center E½ NW¼ sec. 26, T. 31 N., R. 34 E., 11,900 ft (3,620 m) N. 70.5° E. from VABM 9834 (Star Peak). Locality plotted on Silberling and Wallace (1967). Caurus Zone. |
| M2359 -------- | 64S–412 | Imlay Quadrangle, Humboldt Range, Pershing County, Nev. Single float-block collection from crest of intermediate spur between Star and Bloody Canyons. Center W½E½NW¼ sec. 26, T. 31 N., R. 34 E., at approximately 11,750 ft (3,580 m) N. 70° E. from VABM 9834 (Star Peak) and 95 ft (29 m) above M2358. Hyatti Zone. |

TABLE 3.—*Triassic fossil localities in the Humboldt Range and vicinity, north-central Nevada*—Continued

| USGS locality | Field locality | Description and collector(s) |
|---|---|---|
| M2362 -------- | 64S–422 | Imlay Quadrangle, Humboldt Range, Pershing County, Nev. Float collection from crest of divide north of Coyote Canyon near range front. SE¼NE¼NW¼ sec. 2, T. 30 N., R. 34 E. Caurus Zone. |
| M2367 -------- | 64S–434 | Imlay Quadrangle, Humboldt Range, Pershing County, Nev. Bedrock collect/on from crest of divide south of Star Canyon. Same as bed M2358 except approximately 1,000 ft (300 m) farther north along strike. Caurus Zone. |
| M2369 -------- | 64S–436 | Imlay Quadrangle, Humboldt Range, Pershing County, Nev. Bedrock collection from crest of divide south to Star Canyon. Approximately 130–135 ft (39.5–41 m) stratigraphically above M2367. NW¼ sec. 26, T. 31 N., R. 34 E. Locality plotted on Silberling and Wallace (1967). Hyatti Zone. |
| M2819 -------- | 65S–412 | Imlay Quadrangle, Humboldt Range, Pershing County, Nev. Float collection from Star Canyon, approximately 0.4 mi (0.65 km) south of Sheba Mine. Center W½SE¼SW¼ sec. 22, T. 31 N., R. 34, E. Locality plotted on Silberling and Wallace (1967). Hyatti Zone. |
| M2821 -------- | 65S–423 | Imlay Quadrangle, Humboldt Range, Pershing County, Nev. Bedrock collection from crest of spur north of Star Canyon, 245 ft (75 m) above base of Fossil Hill Member of Prida Formation. Center of south boundary of sec. 14, T. 31 N., R. 34 E. Hyatti Zone. |
| M2826 -------- | 65S–461 | Imlay Quadrangle, Humboldt Range, Pershing County, Nev. Bedrock collection from crest of spur on south side of divide between Coyote and Bloody Canyons. Center S½SE¼SE¼ sec. 34, T. 31 N. R. 34 E. Locality plotted on Silberling and Wallace (1967). Hyatti Zone. |
| M2828 -------- | 65S–463 | Imlay Quadrangle, Humboldt Range, Pershing County, Nev. Float collection from Bloody Canyon approximately 0.25 mi (0.4 km) west of Bloody Canyon Mine and 100 ft (30 m) above base of Fossil Hill Member of Prida Formation. Center N½SE¼NE¼ sec. 34, T. 31N., R. 34 E. Caurus Zone. |
| M2829 -------- | 65S–464 | Imlay Quadrangle, Humboldt Range, Pershing County, Nev. Float collection from crest of divide between Coyote and Bloody Canyons approximately 0.3 mi (0.5 km) SW of Bloody Canyon Mine. Center N½NE¼SE¼, sec. 34, T. 31 N., R. 34 E. Hyatti Zone. |
| M2830 -------- | 65S–465 | Imlay Quadrangle, Humboldt Range, Pershing County, Nev. Bedrock collection from crest of divide between Coyote and Bloody Canyons approximately 0.3 mi (0.5 km) SW of Bloody Canyon Mine. NE¼NE¼SE¼, sec. 34, T. 31 N., R. 34 E. Locality plotted on Silberling and Wallace (1967). Hyatti Zone. |
| M2836 -------- | 65S–484 | Unionville Quadrangle, Humboldt Range, Pershing County, Nev. Bedrock collection from crest of spur SE of John Brown Canyon approximately 0.5 mi (0.8 km) south of its mouth. SW¼SW¼NE¼SW¼ sec. 11, T. 30 N., R. 34 E. Locality plotted on Wallace and others (1969). Hyatti Zone. |
| M3093 -------- | 58–30A | Unionville Quadrangle, Humboldt Range, Pershing County, Nev. Float block from near M627 on west side of ridge south of peak of Saurian Hill. Upper member of Prida Formation. Subasperum Zone. |
| M3094 -------- | 57–32 | Unionville Quadrangle, Humboldt Range, Pershing County, Nev. Bedrock collection approximately 0.5 mi (0.8 km) east of Fossil Hill. Center E½SE¼ sec. 19, T. 28 N., R. 35 E. Upper member of Prida Formation. Locality plotted on Wallace and others (1969). Subasperum Zone. |
| M3095 -------- | 56–90X | Buffalo Mountain Quadrangle, Humboldt Range, Pershing County, Nev. Float from uppermost part of upper member of Prida Formation from south wall of Fisher Canyon approximately 80 ft (24 m) stratigraphically below base of Augusta Mountain Formation. 1,000 ft (300 m) south of NE corner sec. 12, T. 27 N., R. 34 E. |
| M5481 -------- | None | Unionville Quadrangle, Humboldt Range, Pershing County, Nev. Bedrock collection from "1,000 ft [300 m] west of Arizona Mine, Unionville district." Upper member of Prida Formation. Subasperum Zone. Collected by F. N. Johnson, 1932. |

**Sageceras walteri Mojsisovics**

Plate 5, figures 10–12

*Sageceras walteri* Mojsisovics, 1882, p. 187, pl. 53, figs. 9a–9c [holotype], 11a–11b?, 12a–12b?, 13? Spath, 1934, p. 56, 58–59.
*Sageceras gabbi* Mojsisovics. Hyatt and Smith, 1905, pl. 74, figs. 8–9; pl. 75, figs. 14–15. Smith, 1914, pl. 11, figs. 8–9; pl. 12, figs. 14–15; pl. 21, figs. 18–20. Silberling, 1962, p. 156.

This species occurs sporadically through most or all of the upper Anisian in the vicinity of Fossil Hill. The stratigraphically lowest specimen collected from bedrock is from the *Paraceratites vogdesi* beds of the Rotelliformis Zone, and the highest specimen was found as float derived from the Occidentalis Zone or higher.

The better preserved specimens from the upper Anisian of Fossil Hill described and illustrated as *S. gabbi* Mojsisovics by Hyatt and Smith (1905) and Smith (1914) are from the same general locality and perhaps from the same part of the stratigraphic section as the specimens on which Gabb based the concept that Mojsisovics named *S. gabbi*. *S. gabbi* is suppressed here as a nomen dubium and the specimens of *Sageceras* from the Middle Triassic of the Humboldt Range are assigned to the Alpine Middle Triassic species *S. walteri* Mojsisovics. Some Nevada specimens were assigned to *S. walteri* by Spath (1934, p. 56, 59) despite the priority of the name *S. gabbi*.

The separation of Middle Triassic forms assigned here to *S. walteri* from the typically Upper Triassic *S. haidingerii* (Hauer, 1847) is a further problem. As pointed out by Spath (1934, p. 58–60), the latter species seems to be distinguished by a wider umbilicus with an abrupt umbilical rim bordered by a spiral depression, but these differences have not been positively demonstrated.

*Figured specimen.*—Plesiotype, USNM 248641.

*Occurrence.*—USGS localities M965 (1), *Paraceratites burckhardti* beds; M139 (1), *Paraceratites clarkei* beds; M607 (3), *Paraceratites cricki* beds, Rotelliformis Zone; M963 (1), *Parafrechites meeki* beds; M618 (1) *Parafrechites dunni* beds, Meeki Zone, vicinity of Fossil Hill, Humboldt Range, Nev.

**Superfamily DINARITACEAE (Mojsisovics, 1882)**
**Family DINARITIDAE**
**Subfamily DINARITINAE**
**Genus KOIPATOCERAS, n. gen.**

*Type species.*—*Koipatoceras discoideus* n. sp.

*Definition.*—Typically small shells; evolute, compressed discoidal in shape with narrow, sharply truncate venter. Smooth or with traces of falcoid ribbing on flanks and at ventral-lateral shoulder. Suture subammonitic; VL shallow, L1 pronounced; only two lateral lobes.

*Discussion.*—Though only three specimens from the Hyatti Zone serve as the basis for this new genus and species, they embody a unique combination of shell characters that sets them apart from any other known Middle Triassic ammonites. The discoidal shape, truncate venter, and simple suture pattern of *Koipatoceras* suggests relationship with the Spathian genus *Stacheites* Kittl, which is included in the subfamily Dinaritinae by Tozer (1971). As compared with the type species of *Stacheites* from Yugoslavia and with *Stacheites* from the *Prohungarites* and *Subcolumbites* beds of Nevada, *Koipatoceras*, as presently known, is more evolute, more ornate, and has a more coarsely subdivided suture.

The name of this new genus is derived from "Koipato," a transliteration of the Piute Indian name for the Humboldt Range (King, 1878, p. 269).

**Koipatoceras discoideus n. sp.**

Plate 4, figures 3–10; text-figure 7

The general characters of this species are those that define the genus. Only three specimens were collected, probably all from the same bed, but these illustrate different stages of variation in strength of ornamentation, which is inversely proportional to the whorl compression. The holotype, the largest of the specimens and having a greatest diameter of 24 mm, is the most compressed (W/D about 0.20) and is ornamented only by weak radial folds on the flanks. Its truncate venter is slightly concave between sharp, ridgelike ventral-lateral margins. On the two paratypes, ribbing is marked by sinuous swellings or bullae on the lower flank and by serrations of the ventral lateral shoulder, which have the form of alternating clavi on the more coarsely ornamented of the two.

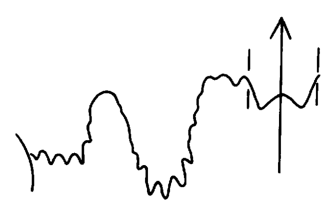

FIGURE 7.—Suture line (× 5) of *Koipatoceras discoideus* n. sp. Holotype, USNM 248631.

The abbreviated external suture line of this species, which has only two lateral lobes and saddles, may be a consequence of the evolute coiling (U/D of holotype 0.31) and whorl height, which is relatively low considering the compressed shape of the shell. Both lateral saddles are weakly crenulate with a few pronounced crenulations on the ventrad side of S1; the lobes are coarsely digitate, and the depth of L1 is about twice that of L2. The broad, shallow ventral lobe is only about one-fourth the depth of L1 and is divided into two points by a low ventral saddle.

*Figured specimens.*—Holotype, USNM 248631; paratypes, USNM 248629 and 248630.

*Occurrence.*—USGS Mesozoic localities M1180 (1) and M1184 (2); Hyatti Zone on ridge between Congress and Big Canyons, Humboldt Range, Nev.

**Subfamily KHVALYNITINAE Shevyrev, 1968**
**Genus ALANITES Shevyrev, 1968**
**Alanites mulleri n. sp.**

Plate 29, figures 31-35; text-figure 8

Dagnoceratid, n. gen., n. sp. A. Silberling and Wallace, 1969, p. 17, table 1.

*Description.*—Compressed (W/D 0.30–0.35 at D > 15 mm); moderately involute (U/D 0.16–0.18). Maximum size exceeding 70 mm.

Flanks flattened; parallel on inner whorls; convergent ventrally from abrupt, narrowly rounded umbilical shoulders on outer whorls. Umbilical margin slightly flaring on body chamber. Venter broadly rounded, delimited from flanks by narrowly rounded ventrolateral shoulders. Width of venter about 0.15 of shell diameter. Umbilical wall roughly perpendicular to flanks.

Ornamentation varies from falcoid growth striae of irregular strength to blunt, foldlike falcoid ribs that are most prominent on lower flanks. Closely spaced (about 3/mm) fine strigae on outer shell surface of mature shell.

Suture as for the genus; details of secondary subdivision variable; S1 and S2 of about equal size, asymmetrically triangular in gross shape on inner whorls, becoming rounded and elongate (about twice as long as wide) on outer whorls (fig. 8).

*Discussion.*—The holotype, having a maximum preserved diameter of about 70 mm, is the largest specimen and is septate to an estimated diameter of about 40 mm.

This species differs from *A. obesus* primarily in its much less robust whorl proportions. From the same loose block from which the type specimens of this species were collected, one small specimen having the same external form and ornamentation has a much more advanced suture as illustrated in figure 8*D* and in this way resembles typical *Ismidites* rather than *Alanites*. *Alanites mulleri* is named in honor of the late Prof. Siemon W. Muller of Stanford University.

*Figured specimens.*—Holotype, USNM 248903; paratypes, USNM 248901 and 248902.

*Occurrence.*—USGS localities M533 (3?), M969 (1); Mesozoic localities M1181 (1?), M2359 (50+; mostly small specimens), M2830 (1?), Hyatti Zone, northeastern part of Humboldt Range, Nev.

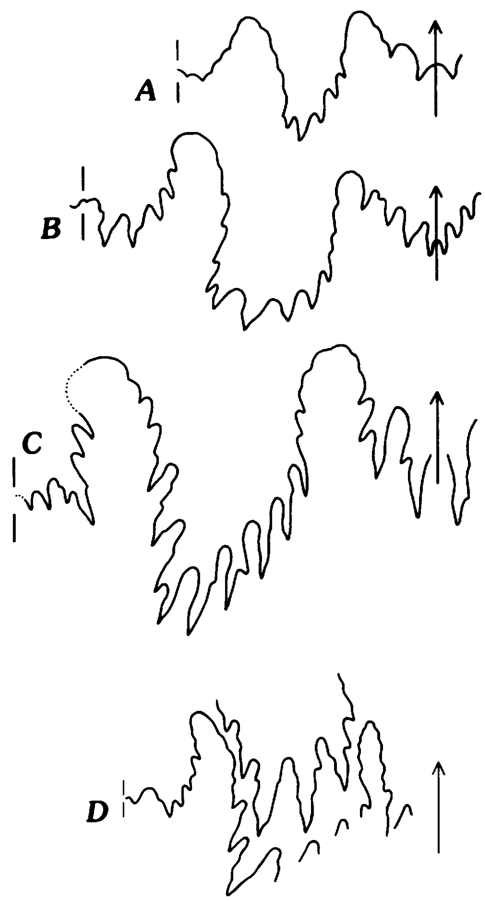


FIGURE 8.—Sutures lines (× 3) of *Alanites mulleri* n. sp. *A*, paratype, USNM 248902. *B*, paratype, USNM 248901. *C*, holotype, USNM 248903, dotted where inferred. *D*, paratype, USNM 248963, specimen not figured.

**Alanites obesus n. sp.**
Plate 28, figures 21-25; text-figure 9

*Description.*—Thick discoidal (W/D 0.5–0.6); moderately evolute (U/D about 0.2). Maximum size exceeding 100 mm.

Inner whorls subquadrate; outer whorls compressed subtrapezoidal. Flanks flattened, becoming concave near raised, narrowly rounded umbilical margin. Umbilical wall approximately perpendicular to adjacent part of flank. Venter broadly rounded, about equal in width to whorl height on inner whorls, becoming relatively narrow (about 0.5 of whorl height at a diameter of 100 mm) with increasing shell size. Ventro-lateral shoulders on inner whorls abrupt, with low, rounded carina; on outer whorls narrowly rounded.

Weak foldlike ribs, swollen on lower flanks and at ventro-lateral shoulders at diameters of 25–30 mm on holotype. Traces of strigation impressed on internal mold.

Suture as for the genus; at a height of 10 mm on the holotype S1 and S2 bluntly rounded in general shape; subammonitic with relatively large-scale subdivisions on the ventral side of S1.

*Discussion.*—The above description is based on only two specimens, both internal molds, whose maximum diameters are about 30 and 100 mm. Though similar in most respects to *A. mulleri*, the much broader whorls of these specimens justify establishing a separate species for them. The larger specimen is septate to an estimated diameter of about 50 mm; its suture (not illustrated) could be only partly exposed, but, in agreement with that of the smaller holotype, the width of its lanceolate lateral lobe is about 0.4 of the whorl height.

Another specimen, 22 mm in diameter, from USGS Mesozoic locality M2829 in the upper part of the Hyatti Zone near Bloody Canyon (Silberling and Wallace, 1969) may belong to this species with which it agrees closely in shape and proportions but from which it differs in having much stronger ornamentation consisting of regular falcoid ribs that are swollen on the lower flanks and enlarged into blunt tubercles on the ventro-lateral shoulders.

Figured *specimens.*—Holotype, USNM 248885; paratype, USNM 248886.

*Occurrence.*—USGS locality M533 (2); USGS Mesozoic locality M2829 (1); Hyatti Zone, Humboldt Range, Nev.

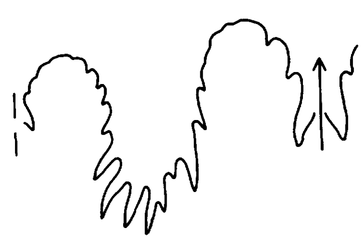

FIGURE 9.—Suture line (× 3) of *Alanites obesus* n. sp. Holotype, USNM 248885.

**Genus ISMIDITES Arthaber, 1915**

**Ismidites aff. I. marmarensis Arthaber**

Plate 28, figures 19–20; text-figure 10

aff. *Ismidites marmarensis* Arthaber, 1915, p. 185, pl. 15, figs. 10a–c.

The whorl shape and suture of a somewhat eroded specimen having a maximum preserved diameter of 49 mm, from the upper part of the Hyatti Zone at USGS locality M970 is more likely that of *Ismidites marmarensis* as described and illustrated by Arthaber than that of the apparently closely related new species of *Alanites* described here. Like *I. marmarensis*, the rounded venter of this specimen grades evenly into the flanks without abrupt change in curvature, and its umbilicus, which is sharply set off from the flanks, is relatively narrow (U/D 0.12). Its suture (fig. 10), though similar to that of *A. mulleri*, differs in having the tip of its first lateral saddle drawn out into an elongated projection which is one-half or less the width of the second saddle. Perhaps owing to the eroded nature of the shell, the peculiar proportions of its first lateral saddles are not, however, as extreme as those typical of *I. marmarensis.*

*Figured specimen.*—Plesiotype, USNM 248884.

*Occurrence.*—USGS locality M970 (1), upper Hyatti Zone, northwestern part of the Humboldt Range, Nev.

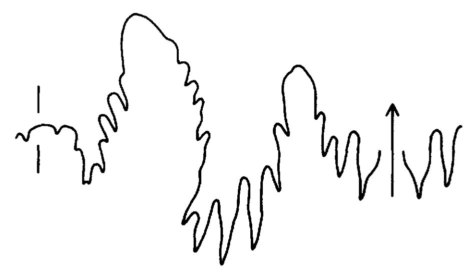

FIGURE 10.—Suture line (× 3) of *Ismidites* aff. *I. marmarensis* Arthaber. Plesiotype, USNM 248884.

**Superfamily MEGAPHYLLITACEAE (Mojsisovics, 1896)**

**Family PARAPOPANOCERATIDAE Tozer, 1971**

**Genus AMPHIPOPANOCERAS Voinova, 1947**

**Amphipopanoceras selwyni (McLearn)**

*Parapopanoceras selwyni* McLearn, 1948, p. 1, pl. 9, figs. 7–9.
*Parapopanoceras testa* McLearn. McLearn, 1969, p. 46, pl. 9, figs. 1, 2 (only).

**Amphipopanoceras cf. A. selwyni (McLearn)**

Plate 6, figures 15, 16; text-figure 11

Only one specimen of a parapopanoceratid has been discovered in the Middle Triassic of the Humboldt Range. The recognition of the species *A. selwyni*, the species to which this specimen is compared, and its inclusion in the genus *Amphipopanoceras* follows E. T. Tozer (written commun. 1974).

*Figured specimen.*—Plesiotype, USNM 248648.

*Occurrence.*—USGS Mesozoic locality M2829 (1); up-

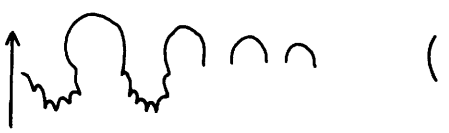

FIGURE 11.—Suture line (× 4) of *Amphipopanoceras* cf. *A. selwyni* (McLearn). Plesiotype, USNM 248648.

per part of Hyatti Zone on the divide between Coyote and Bloody Canyons, Humboldt Range, Nev.

**Family MEGAPHYLLITIDAE Mojsisovics, 1896**
**Genus HUMBOLDTITES, n. gen.**

*Type species.—Megaphyllites septentrionalis* Smith, 1914.

*Diagnosis.*—Involute; inner whorls robust, subquadrate in outline; outer whorls thick discoidal with flattened parallel flanks and arched venter. Inner whorls smooth except for delicate radial striae; outer whorl ornamented by radial constrictions and ridges of uneven spacing and strength. Suture ammonitic with six or more lateral lobes forming a slightly retracted series; saddles progressively decrease in height inwards; principal saddles elongate, tend to be constricted at their bases, crenulate or digitate throughout with no second and third order subdivisions.

*Discussion.*—The single species for which this genus is established was originally included in *Megaphyllites*, but, as noted by Spath (1951, p. 139), it differs from typical members of that genus in having a more ammonitic suture with crenulate rather than monophylletic terminations of the saddles. The suture of *Humboldtites* also differs from that of the other genera included in the Megaphyllitacea like *Parapopanoceras* and *Neopopanoceras*, which are characterized by simple phylloid saddles. Nevertheless, in the general shape of its saddles and pattern of its suture, *Humboldtites* is more like the megaphyllitids than any of the arcestacids, and it is therefore included in the Megaphyllitidae.

**Humboldtites septentrionalis (Smith)**
Plate 28, figures 3-9; text-figure 12

*Megaphyllites septentrionalis* Smith, 1914, p. 42, pl. 21, figs. 4-5 [holotype], 6, 7-9, 10-12.
*"Megaphyllites" septentrionalis* Smith. Silberling, 1962, p. 157.

To the general generic diagnosis several morphologic details can be added for this species, which was found only in the *Nevadites* beds.

The whorls of some of the robust (W/D 0.55-0.65) young shells having diameters less than 15 mm increase regularly in size whereas others have approximately three contractions and bulbous expansions of the shell during each volution. All gradations in the intensity of this irregular growth seem to exist. Larger shells more than 25 mm in diameter have a more strongly arched venter in comparison with the subquadrate inner whorls and are more compressed (W/D about 0.45). The largest specimen collected has part of the body chamber and is 36 mm in diameter. On the venter of this specimen near the broken orad end of its final whorl there is irregular closely spaced strigation in addition to the radial ornament, which is slightly convex on the flanks and most pronounced on the venter.

*Figured specimens.*—Plesiotypes, USNM 248879 to 248881.

*Occurrence.*—USGS localities M144 (1), M620 (3), and M962 (9), lower part of Occidentalis Zone, vicinity of Fossil Hill, Humboldt Range, Nev.


FIGURE 12.—Suture lines of *Humboldtites septentrionalis* (Smith). *A*, plesiotype (× 4), USNM 248880. *B*, plesiotype (× 6.6), USNM 248881.

**Superfamily CERATITACEAE (Mojsisovics, 1879)**
**Family ACROCHORDICERATIDAE Arthaber, 1911**
**Genus PARACROCHORDICERAS Spath, 1934**
**Paracrochordiceras americanun McLearn**

Plate 29, figures 1-9

*Acrochordiceras (Paracrochordiceras) americanum* McLearn, 1946b, p. 3, pl. 5, fig. 1. McLearn, 1969, p. 12, pl. 1, figs. 1-3.

*Figured specimens.*—Plesiotypes, USNM 248887 to 248890.

*Occurrence.*—USGS Mesozoic localities M2358 (9), M2362 (1?), M2367 (3), M2828 (1?); Caurus Zone between Coyote and Star Canyons, Humboldt Range, Nev.

**Acrochordiceras hyatti Meek, 1877**
Plate 4, figures 11-28;
Plate 5, figures 1-7; text-figure 13

*Acrochordiceras hyatti* Meek [in part], 1877, p. 124, pl. 11, fig. 5a [herein selected as lectotype] [not fig. 5]. Hyatt and Smith, 1905,

p. 178 [not pl. 23, figs. 8–11]. Smith, 1914, p. 39, pl. 15, fig. 5a [not pl. 4, figs. 8–11, pl. 15, fig. 5].

*Haydenites hatschekii* Diener, Smith, 1914, p. 114, pl. 33, figs. 1–3. [?] *Haydenites hatschekii* Diener, 1907, p. 72, pl. 6, figs. 1a–1b.

[not] *Acrochordiceras hyatti* Meek. Spath, 1934, p. 394, text-figure 137a–c.

[not] *Acrochordiceras* sp. aff. *A. hyatti* Meek. Tozer, 1972, p. 32, pl. 10, figs. 11–13.

*Description.*—Thick discoidal; inner whorls moderately evolute (U/D 0.30–0.40), outer whorls more involute (U/D about 0.25). Whorl shape and proportions widely variable, changing with increasing shell diameter. Cross section of inner whorls circular, at larger diameters ranging from compressed to depressed with gently to sharply rounded ventral and umbilical shoulders. Final whorl subquadrate with flattened, nearly parallel flanks and broadly rounded venter. Maximum diameter exceeding 150 mm.

Ornamentation modified with growth, varying in strength and ontogenetic development. On inner whorls ribs regularly spaced, nearly straight on flanks, swing slightly forward and pass over venter with or without interruption. Ribbing on phragmocone generally passes through distinct ontogenetic stages: first, ribs decrease in strength on venter, tend to alternate in position across venter, and may even crisscross on venter; next, ribbing becomes strong on venter passing straight across; finally, ribs fade on venter and again tend to alternate on either side. Duration and shell diameter of each ontogenetic stage widely variable.

On body chamber lateral ribs terminate in slightly projected ventral-lateral swellings proportional in size to strength of early ornamentation. Widely spaced tubercles or bullae develop at small diameter at or just below midline of flank, form point of origin for two or three ribs, and are separated by two to five intercalated ribs depending on strength of ribbing. Persistence of tubercles with growth widely variable: tubercles on some variants weakly developed and absent at shell diameters exceeding 20 mm; on more coarsely ornamented variants lateral tubercles may persist to beginning of body chamber at large diameter. Strength and persistence of tubercles proportional to persistence of rounded shape of inner whorls with increasing shell diameter.

Suture ceratitic, nearly subammonitic; principal elements elongate. S1 and S2 of equal height with club-shaped rounded crests but with weak crenulations extending high on sides. L1 coarsely digitate. VL about two-thirds depth of L1; prongs on either side of ES subdivided. One auxiliary saddle external to umbilical shoulder.

*Discussion.*—The two syntypes of *Acrochordiceras hyatti* illustrated by Meek (1877, pl. 11, figs. 5 and 5a) differ from one another, and specimens of these two kinds do not occur in the same populations in Nevada. The morphologic characters of the syntype illustrated by Meek's figure 5 are known only in specimens from the Hyatti Zone, whereas those of the other syntype, Meek's figure 5, distinguish the kind of *Acrochordiceras* found in the Shoshonensis Zone near the base of the Fossil Hill Member of the Favret Formation several tens of kilometers southeast and east of the Humboldt Range in the New Pass Range, Augusta Mountains, and southern Tobin Range (Nichols and Silberling, 1977).

Population samples of *Acrochordiceras* from each of these two zones show a wide range of variation, but little, if any, morphologic overlap exists between them. In comparison with those from the Shoshonensis Zone, those from the Hyatti Zone include specimens having more loosely coiled whorls, which tend to be rounded in cross section rather than thickest near the umbilicus, tubercles that are located laterally or well up on the lower flank rather than near the umbilical shoulder, and a less subdivided suture pattern. Meek's original description of *A. hyatti* clearly refers to the kind of *Acrochordiceras* that occurs in the Hyatti Zone, as he describes the lateral tubercles as being "near or within the middle of each side" and attributes the umbilical position of the tubercles on the specimen illustrated by his figure 5 as probably being due to distortion (Meek, 1877, p. 124). Consequently, the syntype (Meek, 1877, pl. 11, fig. 5a) most closely agreeing with Meek's characterization of the species is selected here as the lectotype of *A. hyatti*, and this specific name is applied to the specimens described here from the Hyatti Zone of the Humboldt Range.

Because of the wide morphologic variation shown by population samples of *Acrochordiceras* from the Shoshonensis Zone, the other syntype of *A. hyatti* (Meek, 1877, pl. 11, fig. 5) can be compared with several previously described European species.

*Acrochordiceras damesi* Noetling (1880) is the oldest name for specimens having this kind of ornamentation and whorl shape, but as originally drawn, the suture of this species differs from that of other *Acrochordiceras* in having a broad, shallow, first lateral lobe and slender saddles whose sides converge toward their crests (Diener, 1907, p. 100). Though these differences may simply be due to a faulty restoration, until more information is available, the specimens from the Shoshonensis Zone in Nevada are provisionally referred to *A. carolinae* Mojsisovics, 1882, the next most prior name. A partial list of possibly synonymous names, judging from the wide variation shown by *Acrochordiceras* cf. *A. carolinae* from Nevada, would include *Acrochordiceras fischeri* Mojsisovics, *A. haueri* Arthaber, *A. pustericum* Mojsisovics, and *A. undatum* Arthaber.

The syntype of *A. hyatti* (Meek, 1877, pl. 11, fig. 5), here assigned to *A.* cf. *A. carolinae*, is illustrated by figures 8 and 9, on plate 5. The suture of *A.* cf. *A.*

*carolinae*, text-figure 14, is subammonitic with incipient crenulation of the crests of the principal saddles and some second-order subdivision of the first lateral lobe.

The specimen from the Whitney Collection in the Museum of Comparative Zoology, Harvard University, on which Hyatt and Smith (1905), Smith (1914), and Spath (1934) based their concept of *A. hyatti* is of the kind assigned here to *A.* cf. *A. carolinae*. The locality of this and some other specimens from the Whitney Collection is given as "the Shoshone Mountains, Nevada," which may refer to the New Pass Range as suggested by Smith (1914, p. 239).

The only locality given by Meek (1887, p. 126) for *A. hyatti* is "New Pass, Desatoya Mountains [New Pass Range], Nevada." In the New Pass Range, specimens like Meek's syntype that is assigned here to *A.* cf. *A. carolinae* occur, along with an abundance of other ammonites characteristic of the Shoshonensis Zone, in float collections made near the base of the fossiliferous Middle Triassic section. However, ammonites like those from the upper part of the Hyatti Zone in the Humboldt Range are also represented in some collections, and thus the lectotype of *A. hyatti*, which is like specimens elsewhere restricted to the Hyatti Zone, could have been obtained from this level in the New Pass Range, although the stratigraphic relations are unclear. As the 40th Parallel exploration (King, 1878) collections studied by Meek include specimens from both the New Pass and Humboldt Ranges, it is also possible that Meek's locality is in error and that the lectotype of *A. hyatti* was actually collected in the Humboldt Range.

The character of the body chamber of *Acrochordiceras* was evidently unknown at the time that Diener (1907) established the genus *Haydenites*. The large specimen illustrated by Diener as the type species, *H. hatschekii*, appears to be nothing more than a fully developed *Acrochordiceras* showing the peculiar modification of the body chamber. *Haydenites hatschekii*, as originally described from the Middle Triassic of India, generally agrees with *Acrochoridiceras hyatti* in ornamentation, suture, whorl shape, and modification of the shell with growth, and the two species are at least congeneric. The lectotype of *A. hyatti* is nearly identical with the corresponding part of the larger of the two specimens from the Humboldt Range figured by Smith (1914, pl. 33, figs. 1–2) as *Haydenites hatschekii*.

Two other species of *Acrochordiceras, A. foltsense* and *A. alternans*, were described by Smith (1914, p. 38–39) from the Humboldt Range. The former species is based on a single specimen from the Upper Anisian at Fossil Hill and may be a pathologic *Gymnotoceras* as suggested by Spath (1934, p. 393). *Acrochordiceras alternans*, on the other hand, appears to be an *Acrochordiceras* and resembles *A. hyatti* in having a growth stage marked by weakening and alternation of the ribs on the venter. However, the two specimens assigned to *A. alternans* by Smith are more involute than any of the *Acrochordiceras* from the Hyatti Zone, and they might represent a stratigraphically distinct population, possibly transitional between *A. hyatti* and *A.* cf. *A. carolinae.*

*Figured specimens.*—Lectotype, USNM 12514 (originally figured by Meek, 1877, pl. 11, fig. 5a); plesiotypes, USNM 248632 to 248640.

*Occurrence.*—USGS localities M533 (20+), M970 (3); USGS Mesozoic localities M1124 (2), M1180 (12+), M1181 (5), M1184 (3), M2819 (10), and M2829 (12+); Hyatti Zone between Buena Vista and Star Canyons on east side of Humboldt Range, Nev.


FIGURE 13.—Suture lines (× 2) of *Acrochordiceras hyatti* Meek. *A*, plesiotype, USNM 248983, specimen not figured. *B*, plesiotype, USNM 248638.

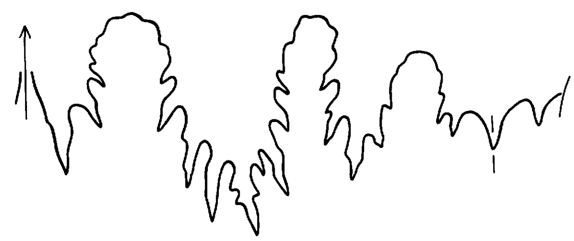

FIGURE 14.—Suture line (× 2) of *Acrochordiceras* cf. *A. carolinae* Mojsisovics. Plesiotype, USNM 248984.

**Family BALATONITIDAE Spath, 1951**
**Genus CUCCOCERAS Diener, 1905**
**Cuccoceras bonaevistae (Hyatt and Smith)**

Plate 20, figures 1–12; text-figure 15

*Dinarites bonae-vistae* Hyatt and Smith, 1905, p. 162, pl. 60, figs. 1–4 [holotype], 6–7.
*Cuccoceras bonae-vistae* (Hyatt and Smith). Smith, 1914, p. 71, pl. 10, figs. 1–4, 6–7.

This species is well represented in the Hyatti Zone of the Humboldt Range. Allowing for some variation in the strength and density of the ribbing and in the spacing of the periodic constrictions, the inner whorls are adequately characterized in Hyatt and Smith's original description. Attention is drawn, however, to the peculiar modification of the ornamentation on the outer whorl.

As the shell increases in diameter beyond about 25 mm, the ribs bordering the apicad side of each constriction become enlarged and develop a slight forward-directed bend at or above the midflank. With further increase in shell size, generally at diameters exceeding 40 mm, tubercles develop at the point of bending and ultimately extend forward across the constriction, joining with the next orad rib. Thus, on the body chamber of the adult shell, the ribs bordering the pronounced constrictions pass more or less straight across the venter and then coalesce in tubercles, which interrupt the constrictions on the upper flank. On the flanks below the tubercles the constrictions are less conspicuous and continue to the umbilical margin following a prosiradiate course. Accompanying this change in ornament, the whorls become thicker and the venter more broadly rounded.

*Figured specimens.*—Holotype, USNM 74383 (originally figured by Hyatt and Smith, 1905, pl. 60, figs. 1-4); plesiotypes, USNM 248786 to 248789.

*Occurrence.*—USGS localities M533 (25+), M969 (4); USGS Mesozoic localities M1124 (10+), M1181 (5), M1182 (3), M1184 (2), M2359 (50+), M2821 (5), M2829 (2), M2830 (5), and M2836 (5); Hyatti Zone, northeastern Humboldt Range, Nev.

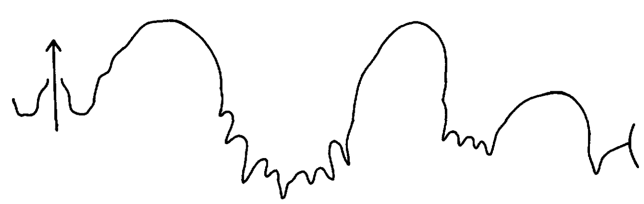

FIGURE 15.—Suture line (× 3) of *Cuccoceras bonaevistae* (Hyatt and Smith). Plesiotype, USNM 248786.

**Family CERATITIDAE Mojsisovics, 1879**
**Subfamily BEYRICHITINAE (Spath, 1934)**
**Genus NICOMEDITES Toula, 1896**
**Nicomedites sp.**

Plate 6, figures 9-11; text-figure 16

One specimen of a beyrichitid, whose distinction lies in its rather featureless character, was collected from the Hyatti Zone. The incomplete shell has a maximum diameter of 36 mm, is involute (U/D about 0.14) and compressed discoidal (W/D about 0.35) in shape, and has flattened flanks that converge to an evenly rounded, blunt venter. Only weak falcoid folds are visible on the flanks of the otherwise smooth shell. The suture is ceratitic, nearly subammonitic, with incipient crenulations high on the sides of the somewhat asymmetric saddles and with coarsely digitate lobes.

The suture line of this specimen is generally like that of *Hollandites* aff. *H. voiti* collected from approximately the same stratigraphic level, but its tight coiling and weak ornamentation differ from those characteristic of *Hollandites*. *Beyrichites* has been applied in a broad sense to various similar unspecialized beyrichitids but it typically has a subtrigonal whorl cross section with a narrowly arched venter and has a rather advanced suture line. Of the recognized genera of beyrichitids, *Nicomedites* seems most applicable to involute shells that have an unmodified whorl shape and a relatively simple suture pattern like that of the present specimen.

*Figured specimen.*—USNM 248646.

*Occurrence.*—USGS locality M533 (1); Hyatti Zone, between Big and Coyote Canyons, Humboldt Range, Nev.

FIGURE 16.—Suture line (× 3) of *Nicomedites* sp. Figured specimen, USNM 248646.

**Genus HOLLANDITES Diener, 1905**
**Hollandites voiti (Oppel)**

*Ammonites voiti* Oppel, 1863, p. 276, pl. 77, fig. 1.
*Ceratites voiti* (Oppel). Diener, 1895, p. 8, pl. 2, figs. 1a-1b, 2a-2b [holotype].
*Ceratites (Hollandites) voiti* (Oppel). Diener, 1907, p. 60, pl. 7, figs. 3a-3b, 4.

**Hollandites aff. H. voiti (Oppel)**

Plate 6, figures 1-6; text-figure 17

*Hollandites* sp. Silberling and Wallace, 1969, p. 17, table 1.

*Hollandites* is represented from the Hyatti Zone by about 20 specimens, most of which are immature. The ontogenetic variation and ontogenetic development is not adequately shown by these specimens; though they differ in some details of their suture and ornamentation from previously described species of *Hollandites*, they are generally similar to the type species, *H. voiti* (Oppel).

The largest unbroken specimen (pl. 6, figs. 3-5), having a greatest diameter of 71 mm, shows the compressed discoidal shape (W/D about 0.25), excentrumbilicate (U/D of outer whorl 0.31) high whorls, and smooth, rounded venter characteristic of *Hollandites*. About one-half of the outer whorl of this specimen represents the body chamber. The ceratitic suture, with slender, somewhat asymmetric saddles, agrees in plan and degree of complexity with that of *Hollandites*. The broad, deep first lateral lobe is much larger than the second lateral lobe, the second lateral saddle is slightly higher than the first lateral saddle, and of the three auxiliary saddles only the outermost is prominent.

Inner whorls, like the specimen illustrated by figures 1 and 2 on plate 6, are ornamented by regular, nontubercular, somewhat sigmoidal ribs that arise at the umbilical shoulder or by intercalation, cross the flanks with uniform strength, and then fade where they are projected strongly forward on the ventral-lateral shoulder. Some more strongly ornamented small specimens develop weak umbilical bullae on the primary ribs.

With increasing shell size, the ribbing is reduced to slightly convex folds, which are restricted to the middle part of the flanks and fade ventrally by branching into striae that swing sharply forward onto the venter. This style of ornamentation differs somewhat from that of typical Indian representatives of *Hollandites* whose ribs on the outer whorls tend to develop umbilical or lateral tubercles and to extend to the ventral-lateral shoulders where they are commonly emphasized as projected swellings. However, the large whorl fragment illustrated by figure 6 on plate 6 has coarse simple ribs that are most pronounced near the middle of the flank and at the ventral-lateral shoulder. The ribbing of this fragment, from the same block of matrix as the other two specimens of *Hollandites* illustrated on plate 6, is like that characteristic of the final whorl of typical *Hollandites*.

The specimens from the upper Anisian of the Humboldt Range assigned by Smith (1914) to *Hollandites*, i.e., those he included in *"Ceratites (Hollandites)" montis-bovis* and *"C. (H)" organi* Smith, possess the subammonitic suture, whorl shape, ornamentation, and keeled venter of younger genera of beyrichitids and are regarded here as variants of *Parafrechites meeki*, revised, and *Frechites occidentalis*, revised.

*Figured specimens.*—Plesiotypes USNM 248642 to 248644.

*Occurrence.*—USGS localities M969 (5), M533 (6+); USGS Mesozoic localities M1180 (5), M1181 (2), and M2836 (1); Hyatti Zone, vicinity of Congress Canyon, Humboldt Range, Nev.

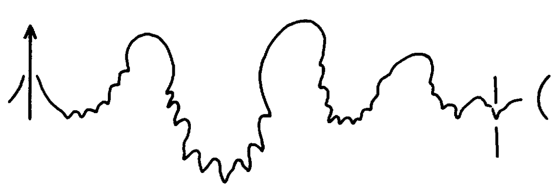

FIGURE 17.—Suture line (× 3) of *Hollandites* aff. *H. voiti* (Oppel). Plesiotype, USNM 248643.

**Genus ANAGYMNOTOCERAS McLearn**
**?Anagymnotoceras moderatum (McLearn)**

Plate 6, figures 7–8

*Gymnotoceras moderatum* McLearn, 1948, p. 3, pl. 10, fig. 10.
*Anagymnotoceras moderatum* (McLearn). McLearn, 1966, pl. 1, fig. 8.
*Anagymnotoceras* aff. *A. moderatum* (McLearn). Silberling and Wallace, 1969, table 1, p. 17.

*Figured specimen.*—Plesiotype USNM 248645.

*Occurrence.*—USGS Mesozoic locality M2822 (2); Hyatti Zone, northern Humboldt Range, Nev.

**Genus GYMNOTOCERAS Hyatt, 1877**

*Gymnotoceras* Hyatt *in* Meek, 1877, p. 110 [type species *Ammonites blakei* Gabb, 1864, by original designation].

*Revised description.*—Discoidal, compressed; moderately involute. Cross-sectional shape of phragmacone whorls subtrigonal with acutely rounded periphery. On body chamber periphery becomes broadly rounded to subtabulate near the aperture.

Ribbing nearly absent to strong, decreasing in strength on outer whorl. Ribs falcoid or projected, may branch or intercalate on lower flanks or have weak lateral bullae and faint marginal swellings. Bluntly rounded keel on strongly ornamented inner whorls.

Suture typically subammonitic with rounded crenulate saddles. First lateral lobe broad, deeper than ventral lobe, roughly twice as deep as second lateral lobe. Ventral lobe divided by low, generally triangular, ventral saddle. First lateral saddle broader and as high as or higher than second lateral saddle. One or two auxiliary saddles external to umbilical shoulder.

*Discussion.*—Ammonites of the genera *Gymnotoceras, Parafrechites,* and *Frechites* are among the best represented in collections from the Fossil Hill area. Stratigraphically controlled samples totalling nearly 2,000 specimens were collected either from bedrock or from single loose weathered blocks and represent different levels throughout the upper Anisian.

Only two intergrading stratigraphically restricted species of *Gymnotoceras* occur in the Fossil Hill area as the scope of *Gymnotoceras* is herein changed from former usage by Silberling (1962), Silberling and Tozer (1968), and Silberling and Wallace (1969). Allowing for a certain amount of variation in ornamentation, whorl shape, and degree of compression, *Gymnotoceras* is distinguished from other ceratitacids by its narrowly rounded phragmocone periphery. The generic names *Philippites* and *Beyrichites* have also been applied to ammonites from Fossil Hill here included in *Gymnotoceras*, but for the typical examples of neither of these genera, which might be junior synonyms of *Gymnotoceras*, is the shape and ornament of the inner whorls sufficiently well known.

**Gymnotoceras rotelliformis Meek**

Plate 7, figures 1–27; plate 8, figures 1–5

*Gymnotoceras rotelliforme* Meek, 1877, p. 111, pl. 10, figs. 9–9a.
*Beyrichites rotelliformis* (Meek). Hyatt and Smith, 1905, p. 155, pl. 23, figs. 1–2, 3–5, 6–7a; pl. 58, figs. 1–4?, 5–6, 7–9?, 10–12?, 13–15?. Smith, 1914, p. 118, pl. 4, figs. 1–2, 3–5, 6–7a; pl. 8, figs. 1–4?, 5–6, 7–9?, 10–12?, 13–15?; pl. 14, figs. 9–9a; pl. 31, figs. 1–2?, 3–4, 5–6?; pl. 91, figs. 1–2, 3–4?, 5–7, 8?, 9–10?. Spath, 1934, p. 422.
*Ceratites (Philippites) argentarius* Smith, 1914, p. 107, pl. 63, figs. 1–3 [holotype], 4–6, 7–8, 9–11, 12–14?.
*Beyrichites tenuis* Smith, 1914, p. 119, pl. 32, figs 1–2 [holotype], 3–4, 5–6?; pl. 89, figs. 15–17, 18–20.
*Philippites? argentarius* Smith. Spath, 1934, p. 419.
*Gymnotoceras argentarius* (Smith). Silberling, 1962, p. 156.
[not] *Beyrichites rotelliformis* (Meek). Smith, 1904, p. 379, pl. 43, figs. 13–14; pl. 45, fig. 5 [= *Gymnotoceras blakei* (Gabb), revised].

*Revised description.*—Discoidal, compressed (immature W/D 0.30–0.40, mature 0.30–0.50); moderately involute (immature U/D 0.15–0.30, mature 0.12–0.25). Transition from immature to mature morphology at diameter 30–40 mm; maximum diameter exceeding 85 mm. Venter acutely rounded, without ventral shoulders, on phragmocone, becoming broadly rounded with growth in some forms.

Ribbing on immature shell widely variable in strength from weak to strong, fading with growth. Ribs falcoid, commonly branching from swollen primary ribs on lower flanks and weakening on upper flanks; ventral tips of ribs slightly enlarged. No tubercles on ribs. Blunt ventral keel distinct only on more strongly ornamented immature shells; fades with growth.

Suture simple, subammonitic with four rounded finely crenulate external saddles decreasing progressively in height inwards.

*Discussion.*—This species, as revised, shows a wide range of morphologic variation and complete intergradation with *Gymnotoceras blakei,* which characterizes the beds immediately overlying those with *G. rotelliformis.* Immature specimens of both *G. rotelliformis* and *G. blakei* are distinctive in having high whorls whose flanks taper to a narrowly rounded acute venter, but *G. rotelliformis* lacks the regular falcoid ribs which cross the flanks with uniform strength in *G. blakei*. In some variants of *G. rotelliformis* the outer whorl thickens rapidly and the acute venter of the inner whorls becomes bluntly rounded.

The average morphology of *G. rotelliformis*, as revised, is closest to that of specimens included in *G. argentarius* by Smith (1914) but with less inflated whorls. Meek's type specimen of *G. rotelliformis* agrees with weakly ornamented variants of populations that include forms with the average morphology, but its ornament approaches that of *G. blakei* in which it was included by Silberling (1962, p. 156).

*Figured specimens.*—Holotype, USNM 12526, originally figured by Meek, 1877, pl. 10, figs. 9–9a; plesiotypes, USNM 248654 to 248665.

*Occurrence.*—*Paraceratites burckhardti, P. clarkei,* and *P. vogdesi* beds, grading into *Gymnotoceras blakei* in the *Paraceratites cricki* and *Gymnotoceras blakei* beds. USGS localities M136 (100+), M136 −5 ft (1.5 m) (12), M139 (22), M163 (14), M164 (30+), M165 (20), M605 (38), M606 (14), M607 (3), M608 −8 ft (2.5 m) (6), M965 (100+), M965 +3 ft (0.9 m) (18), M966 (40), M967 (3), and M967 −9 ft (2.7 m) (7); Rotelliformis Zone, vicinity of Fossil Hill, Humboldt Range, Nev.

**Gymnotoceras blakei (Gabb)**

Plate 8, figures 6–19; plate 9, figures 1–18

*Ammonites blakei* Gabb, 1864, p. 24, pl. 4, figs. 14–15.
*Ceratites (Gymnotoceras) blakei* (Gabb) [in part]. Hyatt and Smith, 1905, p. 173, pl. 22, figs. 10–11, 12–14?, 15–17?, 18–20?, 21–23? [not figs. 1–3, 4–5, 7–9 = *Parafrechites meeki* (Mojsisovics), revised]. Smith, 1914, p. 109, pl. 3, figs. 10–11, 12–14?, 15–17?, 18–20?, 21–23?, pl. 16, figs. 8–10, 17–19; pl. 66, figs. 1–2, 3–4?, 5–6?, 7–8? [not pl. 14, fig. 10b; pl. 65, figs. 14–16? = *Parafrechites meeki* (Mojsisovics), revised].
*Beyrichites falciformis* Smith, 1914, p. 116, pl. 91, figs. 11–13 [holotype]; pl. 92, figs. 1–2, 3–5, 6–8. Spath, 1934, p. 423.
*Gymnotoceras blakei* (Gabb). Spath, 1934, p. 427, text-figure 145? Silberling, 1962, p. 156.
[not] *Gymnotoceras blakei* (Gabb). Meek, 1877, p. 113, pl. 10, figs. 10–10a, 10b [=*Parafrechites meeki* (Mojsisovics), revised], pl. 11, figs. 6–6a [=*Frechites nevadanus* (Mojsisovics), revised]. Spath, 1934, p. 427, text-figure 145? [=?*Parafrechites meeki* (Mojsisovics), revised]. Kummel *in* Arkell and others, 1957, fig. 182, no. 1a–1c? [=?*P. meeki* (Mojsisovics), revised].
[not] *Ceratites (Gymnotoceras) blakei* (Gabb). Smith, 1904, p. 386, pl. 43, figs. 9–10; pl. 44, figs. 2, 3 [=*Parafrechites meeki* (Mojsisovics), revised].

*Revised description.*—Discoidal, compressed (immature W/D about 0.32–0.40, mature about 0.30); involute (immature U/D 0.15–0.25, mature about 0.15). Transition from immature to mature morphology at diameter 30–40 mm; maximum diameter more than 80 mm. Venter of immature shell acute, narrowly rounded, without ventral shoulders; with maturity venter becomes bluntly rounded, but whorls remain narrow. Closely spaced falcoid dichotomous nontubercular ribs extend with uniform strength from umbilicus to venter on immature whorls. With growth, ribs fade beginning on lower flanks, leaving faint projected swellings on outer flanks of mature shell. Blunt ventral keel on ribbed immature whorls; fades with growth. External suture simple, subammonitic with rounded crenulate first and second lateral saddles and two auxiliary saddles.

*Discussion.*—The average morphology of *Gym-*

*notoceras blakei* differs from that of *G. rotelliformis*, which occurs stratigraphically lower, in having regular falcoid ribbing and narrower whorls, but the two species intergrade, and transitional populations include individuals with the average morphology of both. At the upper limit of its stratigraphic range, *G. blakei* coexists without morphologic intergradation with *Frechites nevadanus*. *Parafrechites meeki*, which ranges from the *Frechites nevadanus* beds upwards, differs from *G. blakei* mainly in having relatively low whorls with a broadly rounded or subtabulate venter.

Of seven numbered specimens (ANSP 1227–1233) at the Academy of Natural Sciences of Philadelphia labeled as the type lot of *Ammonites blakei* Gabb, the lectotype (ANSP 1227) selected here, though secondarily deformed, is the only one that resembles Gabb's original illustration (1864, pl. 4, figs. 14–15) in the degree of compression and shape of the whorls. Accompanying this specimen is a note reading "this is obviously same species as Gabb's type of Blakei, pl. 4, f. 14, and may be the type, A.H." This note was evidently written by Alpheus Hyatt who based the genus *Gymnotoceras* on this species. Among the other specimens in the type lot that were not illustrated by Gabb, ANSP 1228 belongs to *Frechites nevadanus*, ANSP 1229 agrees with either *Parafrechites dunni* or *P. meeki*, and ANSP 1230 to 1233 belong to *P. meeki*. The lectotype has thicker whorls and is less regularly ribbed than average specimens in populations of *G. blakei*, as revised; it is in closest agreement with forms found in the lower part of the *G. blakei* beds.

The large specimen figured as *Ceratites (Gymnotoceras) blakei* by Smith (1914, pl. 65, figs. 14–16) and refigured by Spath (1934, p. 428, text-fig. 145) and by Kummel (*in* Arkell and others, 1957, fig. 182, 1a–1c) is more robust than any specimens found in the *G. blakei* beds. This specimen is too large to positively identify but probably should be assigned to *Parafrechites meeki* (Silberling, 1962, p. 156).

*Figured specimens.*—Lectotype, ANSP 1227 (probably the specimen on which Gabb's figures, 1864, pl. 4, figs. 14–15, were based); plesiotypes, USNM 248666 to 248678.

*Occurrence—Gymnotoceras blakei* beds, stratigraphically above the occurrence of *G. rotelliformis* and below that of *Parafrechites meeki*. USGS localities M137 (24), M141 (19), M142 (23), M607 +2 ft (0.6 m) (16), M608 (32), M609 (7), M610 (7), M611 (40), M613 (13), and M964 (35); Rotelliformis Zone, vicinity of Fossil Hill, Humboldt Range, Nev.

### Genus PARAFRECHITES n. gen.

*Type species.—Parafrechites meeki* (Mojsisovics).

*Definition.*—Thickly discoidal to moderately compressed, moderately involute. Venter broadly and evenly rounded or with subtle ventral shoulders. Bluntly rounded keel on inner whorls. Mature venter smooth.

Strong, regular falcoid ribbing on inner whorls fading adorally. Ribs rarely have weak umbilical bullae or faint ventro-lateral swellings.

Suture simple, subammonitic with rounded crenulate first and second lateral saddles; L1 relatively prominent, as many as two auxiliary saddles external to the umbilical seam.

*Discussion.*—A new generic name for these relatively nondescript beyrichitids is desirable so that the other upper Anisian genera *Gymnotoceras* and *Frechites* can be recognized as morphologically distinctive entities. *Parafrechites* is easily distinguished from *Gymnotoceras* by its broadly rounded venter and from *Frechites* by the absence of tubercles and distinct ventral-lateral shoulders.

### Parafrechites meeki (Mojsisovics)

Plate 11, figures 7–23; plate 12, figures 1–29; plate 13, figures 1–5

*Gymnotoceras blakei* (Gabb), Meek, 1877, p. 113, pl. 10, figs. 10–10b.
*Ceratites meeki* Mojsisovics, 1888, p. 168 [new name for *Gymnotoceras blakei* (Gabb) of Meek, 1877, pl. 10, figs. 10–10b].
*Ceratites (Gymnotoceras) blakei* (Gabb). Smith, 1904, p. 386, pl. 43, figs. 9–10; pl. 44, figs. 2, 3. Hyatt and Smith, 1905, p. 173, pl. 22, figs. 1–3, 4–5, 7–9. Smith, 1914, p. 109, pl. 14, fig. 10b; pl. 65, figs. 14–16?
*Ceratites (Gymnotoceras) meeki* Mojsisovics. Smith, 1914, p. 111, pl. 14, figs. 10–10a; pl. 69, figs. 1–2, 3–4, 5–6, 7–9, 10–13, 14–16, 17–19.
*Ceratites tenuispiralis* Smith, 1914, pl. 46, figs. 17–19 [holotype], 20–22, 23?, 24–25?.
*Ceratites washburnei* Smith, 1914, p. 103, pl. 92, figs. 9–11 [holotype], 12–14, 15–17.
*Ceratites (Hollandites) montis-bovis* Smith, 1914, p. 105, pl. 58, figs. 1–4 [holotype], 5–7, 8–11, 12–14, 15–16?, 17–20?.
*Ceratites (Hollandites) organi* Smith [in part], 1914, p. 105, pl. 55, figs. 1–2, 3–4?, 5–7, 8–10 [not pl. 54, figs. 1–9; ?pl. 55, figs. 11–30 = *Frechites occidentalis* (Smith), revised].
*Ceratites (Gymnotoceras) beckeri* Smith, 1914, p. 109, pl. 3, figs. 4–5, 7–9; pl. 66, figs. 10–13 [holotype], 14–15, 16–19, 20–22, 23, 24–26, 27–29?.
*Ceratites (Gymnotoceras) russelli* Smith, 1914, p. 111, pl. 3, figs. 1–3 [holotype], 6; pl. 67, figs. 1–3, 4–7, 8–9, 10–12, 13–15.
*Ceratites (Gymnotoceras) wemplei* Smith, 1914, p. 113, pl. 68, figs. 1–3 [holotype], 4–6, 7–9.
*Gymnotoceras meeki* (Mojsisovics). Spath, 1934, p. 430. Silberling, 1962, p. 156.
*Frechites tenuispiralis* (Smith). Spath, 1934, p. 453.
*Gymnotoceras russelli* Smith. Spath, 1934, p. 429.
*Gymnotoceras wemplei* Smith. Spath, 1934, p. 431.
*Gymnotoceras washburnei* (Smith) [in part]. Silberling, 1962, p. 156.

*Revised description.*—Thick discoidal (immature W/D 0.40–0.45, mature 0.35–0.40, W/D of bullate variants in lower part of stratigraphic range may exceed 0.5); moderately involute (immature and mature U/D 0.20–0.30). Transition to mature morphology not marked; loss of ornament begins at diameter 40–50 mm. Maximum diameter exceeds 80 mm. Venter broadly rounded to subtabulate at all growth stages.

Ribbing strong and regular, projected or slightly falcoid across flanks. Primary ribs enlarged or slightly bullate on lower flanks below bifurcation point on more coarsely ribbed variants. Ventral tips of ribs slightly enlarged on forms tending to develop ventral-lateral shoulders. Strong umbilical bullae and distinct projected ventral-lateral tubercles only on some variants in lower part of stratigraphic range. Blunt ventral keel persistent to diameters exceeding 40 mm.

Suture simple, subammonitic with rounded crenulate first and second lateral saddles and usually only one discrete auxiliary saddle external to the umbilical shoulder.

*Discussion.—Parafrechites meeki*, as revised, is distinguished by its broadly rounded or subtabular venter, by the strong, regular ribbing, by the generally poor development of tubercles or bullae on the ribs, and by the persistence of the immature ornamentation to relatively large shell diameters.

The principal variations in populations from the middle part of the *P. meeki* beds are in the density of the ribbing and the degree of angularity at the ventral-lateral shoulders. The average morphology of these populations is close to that of forms included by Smith in "*Ceratites (Gymnotoceras) russelli*." Although Smith (1914, p. 110-112) contended that intergradation did not occur among the various species he included in "*Gymnotoceras*," Spath (1934, p. 428–429) pointed out the close alliance of "*G.*" *meeki*, "*G.*" *russelli*, "*G.*" *beckeri*, and "*G. blakei*" (of Smith) and the existence of many "passage forms" between them among the stratigraphically random collections from Fossil Hill at the British Museum. Intergradation is well shown in the population samples on which the present revision is based.

Populations from the lower part of the *Parafrechites meeki* beds show a greater amount of variation and range in morphology from relatively robust end members with umbilical bullae and coarse ribs terminating in ventral-lateral swellings or tubercles to regularly ribbed, non-tuberculate, compressed, high-whorled end members. The lectotype (Meek, 1877, pl. 10, figs. 10–10a) of *P. meeki*, selected here, is in closest agreement with forms from the lower part of the stratigraphic range of *P. meeki*, as revised.

The holotype of *Ceratites (Hollandites) montis-bovis*, included in *Gymnotoceras* by Spath (1934, p. 427) and in *P. meeki* here, is more involute and more delicately ribbed than the characteristic form of *P. meeki* as revised, and may be transitional to *P. dunni*, which characterizes the beds stratigraphically above those with *P. meeki*. However, a morphologic intergradation between *P. meeki* and *P. dunni* is not demonstrated by the available stratigraphically controlled collections, perhaps because the number of specimens represented is too small.

*Figured specimens.*—Lectotype, USNM 12512 (originally figured by Meek, 1877, pl. 10, figs. 10–10a); plesiotypes, USNM 74301 (holotype of *Gymnotoceras russelli* Smith, 1914, pl. 3, figs. 1–3), USNM 74391 (holotype of *G. beckeri* Smith, 1914, pl. 66, figs. 10–13), and USNM 248694 to 248710.

*Occurrence.—Parafrechites meeki* beds; stratigraphically above *Frechites nevadanus* beds and ranging stratigraphically upwards into the *P. dunni* beds. USGS localities M138 (9), M140 (60+), M143 (21), M612 (17); M616 (9), M617 (15), M958 (100+), M960 (150+), and M963 (60+); Meeki Zone, vicinity of Fossil Hill, Humboldt Range, Nev.

**Parafrechites dunni (Smith)**

Plate 13, figures 6–30

*Beyrichites dunni* Smith, 1914, p. 116, pl. 32, figs. 7–8 [holotype], 9–10, 11–12?. Spath, 1934, p. 423.

*Beyrichites osmonti* Smith, 1914, p. 117, pl. 31, figs. 7–8 [holotype], 9–10, 11–12, 13–14?; pl. 89, fig. 14?.

*Gymnotoceras dunni* (Smith). Silberling, 1962, p. 156.

[?] *Ceratites williamsi* Smith, 1914, p. 82, pl. 47, figs. 11–14 [holotype], 15–16, 17–18?.

[?] *Ceratites (Philippites) ransomei* Smith, 1914, p. 108, pl. 99, figs. 1–3 [holotype], 4.

*Revised description.*—Discoidal, moderately compressed (W/D 0.33–0.40); involute (U/D 0.15–0.20). Whorl shape and proportions constant with growth. Maximum diameter more than 65 mm. Venter broadly rounded, grading imperceptibly into flanks or delimited by poorly developed ventral-lateral shoulders.

Ornamentation generally restricted to inner whorls and variable in strength, nearly absent on some forms and commonly lost at shell diameters of more than 30 mm. Ribbing, when developed on immature shell, dense and regular; ribs projected or slightly falcoid, branching on lower flanks. Weak umbilical bullae and ventral swellings on ribs only on inner whorls of coarsely ornamented variants. Outer whorls smooth except for falcoid growth lines projected across venter. Blunt ventral keel developed in proportion to strength of ribbing, usually weakly developed for at least part of one volution even on smoothest variants.

Suture subammonitic with rounded, weakly crenulated first and second lateral saddles and two auxiliary saddles external to the umbilical seam.

*Discussion.*—This species is distinguished by a poor development or early loss of ornamentation and by its thick discoidal whorls having a broad, rounded, or slightly tabular venter. Some specimens, like those included by Smith in *"Beyrichites" osmonti*, are nearly devoid of ornamentation, and for this reason they were assigned to *Beyrichites* by Smith who derived this genus directly from *Gymnotoceras* by a progressive loss of sculpture. These smooth forms are included here in *Parafrechites* because they are like end-member variants of population in which more average forms possess the characteristic ribbing and ventral keel of *Parafrechites* on their inner whorls. Most of the species of beyrichitids from Fossil Hill tend to become less ornamented with growth and show some individual variation in the strength of sculpture. Consequently, specific assignment of an isolated specimen may be difficult; for example, the paratype of *"Beyrichites" osmonti* Smith (1914, pl. 89, fig. 14) might belong to the present species, as revised, or be a smooth and perhaps premature variant of *Gymnotoceras rotelliformis*, revised.

Some large, strongly sculptured specimens with the characteristic ornament and whorl shape of *P. meeki* occur with populations of *P. dunni* in collections from a single bed. Forms transitional between the two species appear to be lacking in these collections, perhaps because of the relatively small size of these samples.

The lithologic character of the beds characterized by *P. dunni* differs from that of the beds stratigraphically above and below in being more sandy and pervasively stained with ferric oxides. Matrix material like that of the *P. dunni* beds can be recognized on one of the paratypes of *"Beyrichites" osmonti* Smith (1914, pl. 31, figs. 9–10), on a paratype of *"B." dunni* Smith (1914, pl. 32, figs. 9–10), and possibly on the holotype of *"B." dunni*. The holotype of *"Ceratites" williamsi* Smith, questionably included in *Parafrechites dunni*, as revised, bears a shell fragment probably referable to *Daonella dubia*, a species occurring stratigraphically above the *P. dunni* beds; *"C." williamsi* may be a smooth variant closely related to forms like *"C." rotuloides* Smith as suggested by Smith (1914, p. 83), and hence it might belong with the group of Smith's species included here in *Frechites occidentalis*.

The suture line of *"Ceratites (Philippites)" ransomei* as illustrated by Smith (1914, pl. 99, fig. 4) is oversimplified; the saddles on the suture of this specimen are slightly crenulate rather than being smoothly rounded.

*Figured specimens.*—Plesiotypes, USNM 248712 to 248721.

*Occurrence.*—Restricted to the *Parafrechites dunni* beds, stratigraphically above the *P. meeki* beds and below the *Frechites occidentalis* beds. USGS localities M167 (20+), M618 (24), M619 (40+), M959 (20+), and M968 (60+); Meeki Zone, vicinity of Fossil Hill, Humboldt Range, Nev.

### Genus FRECHITES Smith, 1932

*Frechites* Smith [type species *Ceratites humboldtensis* Hyatt and Smith, 1905, by original designation].

*Revised description.*—Thickly discoidal to moderately compressed; moderately involute. Whorl section on inner whorls has broadly rounded venter, changing on outer phragmacone and body chamber to subtrapezoidal with flattened venter and distinct rounded ventral-lateral shoulders. Venter on inner whorls has bluntly rounded keel, on outer whorls is smooth. Falcoid simple, branching or intercalating ribs having ventral swellings or distinct blunt tubercles at ventral-lateral shoulders and on some having bullae or spines on lower flanks. Suture subammonitic, L1 relatively prominent; one or two auxilliary saddles beyond S2.

#### Frechites nevadanus (Mojsisovics)

Plate 9, figures 19–25; plate 10, figures 1–24;
plate 11, figures 1–6

*Gymnotoceras blakei* (Gabb). Meek, 1877, pl. 11, figs. 6–6a.

*Ceratites nevadanus* Mojsisovics, 1888, p. 168 [new name for *Gymnotoceras blakei* (Gabb) of Meek, 1877, pl. 11, figs. 6–6a]. Smith [in part], 1914, p. 101, pl. 15, figs. 6–6a, pl. 64, figs. 1–2?, 8–9? [not? figs. 3–7, 10–12, 13–14 = ?*Frechites occidentalis* (Smith), revised], pl. 65, figs. 1–4?, 5–7?, 8–9?, 10–11?, 12–13?.

*Ceratites humboldtensis* Hyatt and Smith, 1905, p. 170, pl. 57, figs. 1–3 [lectotype selected by Spath (1934, p. 447)], 4–5, 6–7, 8–11, 12–13?, 14–16?, 17–18?, 19–21?, 22–23?. Smith, 1914, pl. 7, figs. 1–3, 4–5, 6–7, 8–11, 12–13?, 14–16?, 17–18?, 19–21?, 22–23?; pl. 61, figs. 1–3, 4–5, 6–7, 8–12, 13–15. Arthaber, 1915, p. 120, text-fig. 7e–7f.

*Ceratites cornutus* Smith, 1914, p. 98, pl. 62, figs. 1–4 [holotype], 5–7, 8–9, 10–12, 13–15, 16–17?.

*Ceratites emmonsi* Smith [in part], 1914, p. 98, pl. 60, figs. 13–15 [holotype], 19–21; [not figs. 16–18 = *Frechites occidentalis* (Smith), revised].

*Ceratites spinifer* Smith [in part], 1914, p. 103, pl. 59, figs. 1–3 [holotype], 9–10 [not figs. 4–7 = *Paraceratites cricki* Smith, revised]; pl. 60, figs. 1–3, 4–6, 7–9?, 10–12.

*Ceratites (Gymnotoceras) hersheyi* Smith, 1914, p. 110, pl. 93, figs. 1–3 [holotype], 4–6?, 7–8?, 9–10?, 11–12?, 13–14?.

*Frechites humboldtensis* (Hyatt and Smith). Smith, 1932, p. 32. Spath, 1934, p. 447.

*Frechites cornutus* (Smith). Spath, 1934, p. 449.

*Frechites emmonsi* (Smith). Spath, 1934, p. 449.

*Frechites spinifer* (Smith). Spath, 1934, p. 448.

*Gymnotoceras (Frechites) nevadanus* (Mojsisovics). Silberling, 1962, p. 156.

[not] *Frechites nevadanus* (Mojsisovics). Spath, 1934, p. 450 [=*Frechites occidentalis* (Smith), revised].

*Revised description.*—Thick discoidal (immature W/D about 0.40, mature 0.45–0.60); moderately involute (U/D about 0.25). Transition from immature to mature sculpture beginning at diameter of 25–35 mm; maximum diameter more than 85 mm. Immature whorl cross section subquadrate with venter broadly arched; mature cross section trapezoidal owing to pronounced tubercles on lower flanks and broad flattened venter.

Ribs on immature shell coarse and regular, running from umbilical shoulders onto venter and branching on lower flanks. Transition to mature ornamentation by enlargement of ribs into tubercles at ventral-lateral shoulders and then by development on lower flanks of coarse umbilical tubercles from which two or three ribs diverge. Decrease in strength of ribs on outer whorl accompanied by elongation of ventral-lateral tubercles into low clavi. Umbilical tubercles on mature shell spinose, rising from broad swellings, or elongated radially with their tips sometimes curved adapically. Blunt ventral keel conspicuous on immature whorls, gradually diminishing in strength. Broad venter of mature shell smooth, gently arched, flat, or even slightly biconcave bordered by rows of ventral-lateral tubercles or clavi.

Suture subammonitic with crenulate saddles. First lateral saddle and lobe prominent; one or two discrete auxiliary saddles beyond second lateral saddle.

*Discussion.*—Young stages of *F. nevadanus* are indistinguishable from those of *Parafrechites meeki*, but mature shells of the latter species, even from possibly transitional populations in the lower part of its stratigraphic range, failed to develop the broad flattened venter and pronounced umbilical tubercles of the former species.

Robust tubercular variants of *F. occidentalis* closely resemble the mature form of the present species. They differ from *F. nevadanus* by the early loss or poor development of the ventral keel, the higher and more rectangular cross section of their early whorls, the more bullate character of the umbilical tubercles on the mature shell, and the shape of their ventral-lateral tubercles, which are more in the form of projected swellings than discrete tubercles or clavi.

On Meek's holotype of *F. nevadanus* the part of the shell bearing the ventral keel is not well preserved, but the presence of a keel is strongly suggested. The nature of the tubercles and venter also indicate that this name is properly applied to the present group. From his study of stratigraphically random specimens, Smith had no way of knowing that populations like those included here in *F. nevadanus* do not include forms like the robust tuberculate variants of *F. occidentalis*, and several of the specimens figured by him as belonging to the former species evidently belong to the latter. This incorrect assignment, in addition to an erroneous conception of Meek's type specimen, led Smith (1914, p. 101) and Spath (1934, p. 450) to characterize *F. nevadanus* as differing from the other species of Smith's "group of *'Ceratites' humboldtensis*" (= *Frechites*) by lacking a ventral keel.

*Figured specimens.*—Holotype, USNM 12512 (originally figured by Meek, 1877, pl. 11, figs. 6–6a); plesiotypes, USNM 248679 to 248693.

*Occurrence.*—Restricted to *Frechites nevadanus* beds, stratigraphically above *Gymnotoceras blakei* beds and below *Parafrechites meeki* beds. USGS localities M142 (4), M166 (100+), M614 (120+), M615 (35+), and M957 (35+); Meeki Zone, vicinity of Fossil Hill, Humboldt Range, Nev.

**Frechites occidentalis (Smith)**

Plate 13, figures 31–34; plate 14, figures 1–33

*Ceratites occidentalis* Smith, 1914, p. 84, pl. 44, figs. 21–23 [holotype], 24–25, 26–28; pl. 45, figs. 1–2, 3–4, 5–7?, 8–9?, 10–11?, 12–13?.
*Ceratites applanatus* Smith, 1914, p. 80, pl. 53, figs. 9–11 [holotype], 12–14?.
*Ceratites rotuloides* Smith, 1914, p. 80, pl. 47, figs. 1–3 [holotype], 4–5, 6–7, 8–10?.
*Ceratites altilis* Smith, 1914, p. 83, pl. 45, figs. 14–16, 17–18, 19–20, 21–22?; pl. 67, figs. 19–21 [holotype].
*Ceratites gilberti* Smith, 1914, p. 84, pl. 98, figs. 1–3 [holotype].
*Ceratites karpinskyi* Smith, 1914, p. 100, pl. 44, figs. 4–6 [holotype], 7–8, 9–10, 11–12?, 13–15?, 16–18?, 19–20?.
*Ceratites nevadanus* (Mojsisovics) [in part]. Smith, 1914, pl. 64, figs. 3–7, 10–12, 13–14. Spath, 1934, p. 450.
*Ceratites pilatus* Smith, 1914, p. 102, pl. 46, figs. 1–4, 5–6, 7–8, 9–10, 11–12?, 13–14?, 15–16?; pl. 89, figs. 10–13 [holotype].
*Ceratites (Hollandites) organi* Smith, 1914, p. 105, pl. 54, figs. 1–4 [holotype], 5–6, 7–9; pl. 55, figs. 11–12?, 13–15?, 16–18?, 19–20?, 21–23?, 24–26?, 27–30?.
*Frechites occidentalis* (Smith). Spath, 1934, p. 452.
*Frechites rotuloides* (Smith). Spath, 1934, p. 454.
*Frechites altilis* (Smith). Spath, 1934, p. 453.
*Frechites karpinskyi* (Smith). Spath, 1934, p. 451.
*Frechites pilatus* (Smith). Spath, 1934, p. 451.
*Gymnotoceras occidentalis* (Smith). Silberling, 1962, p. 156.
*Gymnotoceras washburnei* (Smith) [in part]. Silberling, 1962, p. 156.
[?]*Ceratites (Philippites) lawsoni* Smith, 1914, p. 108, pl. 56, figs. 1–5 [holotype], 6–8, 9–11, 12–13; pl. 57, figs. 1–3, 4–6, 7–9?, 10–13?, 14–17?.
[?]*Ceratites (Gymnotoceras) spurri* Smith, 1914, p. 112, pl. 67, figs. 16–18 [holotype].

*Revised description.*—Discoidal, moderately compressed (W/D 0.33–0.40, W/D of bullate variants may exceed 0.45); moderately involute (immature U/D 0.25–0.32, mature 0.18–0.30, mainly 0.20–0.25). Loss of ventral keel and development of distinct ventral-lateral shoulders usually occurs at diameters less than 25 mm; ornamentation fades on outer whorl. Maximum diameter about 80 mm; some fully mature shells may not exceed 60 mm diameter. Venter subtabulate, broadly arched between rounded, but distinct, ventral-lateral shoulders, which are commonly emphasized by tubercles at ventral ends of ribs.

Ribbing coarse but widely variable in strength. Primary ribs give rise to two or three branches on lower flanks. On some robust variants primary ribs bullate or represented by large umbilical tubercles below bifurcation point. Other forms coarsely ribbed without umbilical tubercles or bullae; some variants nearly smooth with faint wide ribs. Ventral ends of ribs enlarged into projected swellings or tubercles at ventral-lateral shoulders. Blunt ventral keel only on inner whorls.

Suture simple, subammonitic with rounded crenulate first and second lateral saddles and one or two auxiliary saddles external to the umbilical shoulder.

Larger stratigraphically controlled collections might demonstrate that populations in the lower part of the stratigraphic range of *F. occidentalis* bear a stronger resemblance to *Parafrechites meeki*, a possible ancestor, than do those that occur higher. These possibly transitional populations were grouped into a distinct species, *"Gymnotoceras" washburnei*, by Silberling (1962, p. 156), but their range of morphologic variation is here regarded as too similar to that of *Frechites occidentalis* for specific separation. The various "species" described by Smith that were included in *"G." washburnei* (Smith) by Silberling are therefore included in either *Parafrechites meeki* or *Frechites occidentalis*, as revised.

*"Ceratites (Philippites)" lawsoni* Smith was referred to *Frechites* by Spath (1934, p. 418–419) and is provisionally included here in *F. occidentalis*, although no specimens with the exaggerated curved bullae of Smith's holotype are present in the stratigraphically controlled collections. Some coarsely ribbed variants of *Parafrechites dunni*, as revised here, resemble the paratypes of *"C. (P.)" lawsoni* Smith and suggest a possible transition from *P. dunni* to *F. occidentalis*.

The inclusion of *"Ceratites" altilis* Smith and *"C. (Hollandites)" organi* Smith in *F. occidentalis* is substantiated by shell fragments of *Daonella dubia* and *D. moussoni* adhering to the holotypes of these species. These bivalves are indicative of the Occidentalis Zone.

*Figured specimens.*—Plesiotypes, USNM 248722 to 248739.

*Occurrence.*—From the *Parafrechites dunni* beds stratigraphically upwards into the *Nevadites gabbi* beds. USGS localities M144–6 ft (1.8 m) (10), M144 (6+), M145 (50+), M622 (7), M623 (10), M624 (35+), M625 (24+), M626 (50+), M961 (11), M962 (10), and M962A (6). Upper part of Meeki Zone and Occidentalis Zone, vicinity of Fossil Hill, Humboldt Range, Nev.

**Frechites johnstoni n. sp.**

Plate 15, figures 1-5; text-figure 18

*Gymnotoceras* n. sp. Silberling, 1962, p. 158.

*Description.*—Discoidal, compressed (W/D about 0.33) shell becoming increasingly involute as size increases (U/D immature 0.20–0.24, mature 0.15). Flanks flattened, converging to narrow, broadly arched venter. Ventral-lateral shoulders distinct. Ribs falcoid, simple or bifurcating, densely and regularly spaced (about 40 per volution on outer flank), persistent to relatively large shell diameter (more than 60 mm) but fading on orad part of body chamber. Bullae and tubercles lacking, but ventral tips of ribs enlarged, tending to increase angulation of ventral-lateral shoulders. Blunt low ventral keel on inner whorls fades with increasing shell size, not discernible beyond diameters of about 30 mm.

Suture simple, subammonitic; L1 relatively prominent; two auxiliary saddles and lobes.

*Discussion.*—This new species of beyrichitid is placed in *Frechites* because of its subtabulate venter, and it differs from other species of this genus in having higher, more compressed whorls and in lacking tuberculation.

This species is named in honor of Francis Newlands Johnston, who, in addition to his important study of Upper Triassic ammonites from the New Pass Range, Nev., also collected Triassic ammonites from the Humboldt Range, including the type lot of this species.

*Figured specimens.*—Holotype, USNM 248740; paratype, USNM 248741.

*Occurrence*—Subasperum Zone. USGS locality M627 (2) and USGS Mesozoic locality M3093 (1), vicinity of Fossil Hill; USGS locality M905 (1) associated with *Protrachyeras* cf. *P. americanum* (Mojsisovics) between Cottonwood Canyon and Fitting; and USGS Mesozoic locality M5481 (4), the type lot from a single limestone block associated with *Protrachyceras* cf. *P. subasperum* (Meek), Arizona Mine area near Unionville, Humboldt Range. Nev.

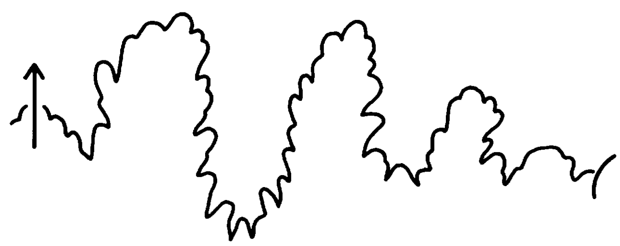

FIGURE 18.—Suture line (× 4) of *Frechites johnstoni* n. sp. Holotype, USNM 248740.

**Subfamily PARACERATITINAE Silberling, 1962**
**Genus PARACERATITES Hyatt, 1900**
**Paraceratites burckhardti Smith**

Plate 15, figures 6–18

*Ceratites (Paraceratites) burckhardti* Smith, 1914, p. 90, pl. 52, figs. 19–21 [holotype].

*Revised description.*—Discoidal, compressed (W/D mainly about 0.30 measured between lateral nodes, maximum W/D of robust variants including nodes more than 0.45); moderately involute (U/D 0.20–0.25). Maximum diameter exceeding 100 mm. Flanks broadly rounded, subparallel; ventral-lateral shoulders marked by tubercles but not sharply rounded. Venter high and narrow, extending well above ventral-lateral tubercles as a blunt keel that persists to shell diameters of more than 70 mm.

Ribs on inner whorls at diameters less than 30 mm regular, projected or slightly falcoid, branching from umbilical swellings and terminating in projected ventral swellings. With increasing shell growth ribs bifurcate at lateral tubercles developed below midline of flanks on most primary ribs. On outer whorls ribs become weak and irregular, whereas lateral tubercles, numbering about 10 per whorl, develop into pronounced widely spaced nodes at or below midline of flank. Ventral-lateral tubercles persist as projected swellings corresponding to ventral tips of ribs, outnumber lateral nodes 3:1 to 3.5:1, become weak coalescing clavae on outermost whorl.

Suture ceratitic. S1 and S2 high and entire; only one discrete auxiliary saddle. L2 and divided VL about equal in depth and two-thirds that of L1. Lobes coarsely digitate.

*Discussion.*—This species occurs in the stratigraphically lowest collections obtained from the vicinity of Fossil Hill. The pronounced development of widely spaced lateral nodes and the high, bluntly carinate venter, extending well above the ventral-lateral tubercles, distinguish *P. burckhardti* from the stratigraphically succeeding species *P. clarkei* and *P. vogdesi*, as revised. By these same characters *P. burckhardti* closely resembles *P. cricki*, the stratigraphically highest species of *Paraceratites* in the Rotelliformis Zone. Though their stratigraphic ranges are not contiguous and those of other species intervene, *P. burckhardti* and *P. cricki* are readily separated only by the lower proportion (2:1) of ventral-lateral to lateral tubercles and the more regular ribbing of the latter.

Some compressed variants of *P. burckhardti*, especially from USGS locality M164, which may be the stratigraphically lowest ammonite collection from the Rotelliformis Zone, have poorly defined ventral-lateral shoulders and lateral tubercles that arise low on the flanks from umbilical bullae.

*Figured specimens.*—Plesiotypes, USNM 248742 to 248747.

*Occurrence.*—*Paraceratites burckhardti* beds, stratigraphically below the occurrence of *P. clarkei*. USGS localities M164 (6) and M965 (40+); Rotelliformis Zone, vicinity of Fossil Hill, Humboldt Range, Nev.

**Paraceratites clarkei Smith**

Plate 16, figures 1–12

*Ceratites (Paraceratites) clarkei* Smith, 1914, p. 91, pl. 40, figs. 15–17 [holotype], 18–20, 21–23; pl. 52, figs. 1–3, 4–6, 7–8, 9–11.

*Ceratites (Paraceratites) newberryi* Smith [in part], 1914, p. 92, pl. 40, figs. 6–8, 9–11 [not figs. 1–3, 4–5, 13–14?= *Paraceratites vogdesi* (Smith), revised].

*Ceratites (Paraceratites) trinodosus* Mojsisovics [in part]. Smith, 1914, p. 92, pl. 39, fig. 6; pl. 52, figs. 15–18 [not pl. 39, figs. 1–2, 3–5, 7–8?, 9–10, 11–13?, 14–16?, 17–19?; pl. 52, figs. 12–14 = *Paraceratites vogdesi* (Smith), revised].

*Ceratites beecheri* Smith [in part], 1914, p. 94, pl. 43, figs. 18–20 [not figs. 15–17, 21–22, 23–24?, 25–26? = *Nevadites humboldtensis* Smith, revised].

*Nevadites fontainei* Smith [in part], 1914, p. 122, pl. 41, figs 16–17, 18–19, 20–22; pl. 51, figs 5–9 [ not pl. 41, figs. 23?, 24–25?, 26–27?; pl. 51, figs. 1–4 = *Nevadites humboldtensis* Smith, revised].

*Paraceratites clarkei* Smith. Spath, 1934, p. 445. Silberling, 1962, p. 156 [in part].

[?]*Ceratites rectangularis* Smith, 1914, p. 85, pl. 41, figs. 14–15 [holotype].

[?]*Ceratites (Paraceratites) wardi* Smith, 1914, p. 94, pl. 53, figs. 4–6 [holotype], 7–8.

*Revised description.*—Compressed discoidal to thick discoidal (W/D 0.30–0.50); width of umbilicus proportional to whorl thickness (U/D 0.25–0.35). Maximum diameter exceeding 70 mm. Ventral-lateral shoulders abrupt, emphasized by tubercles; venter broadly rounded with low, blunt ventral keel of variable strength on inner whorls. Cross section of whorls subrectangular.

Ribbing and tuberculation variable in strength proportional to whorl thickness. On inner whorls of compressed forms, ribs delicate and falcoid, originate singly or in pairs from indistinct umbilical tubercles, terminate at sharp ventral-lateral tubercles elongated parallel to projected ventral tips of ribs; lateral tubercles developed last, spaced irregularly on consecutive or alternate ribs below midline of flanks. On more robust shells coarse primary ribs join umbilical with lateral tubercles on lower flanks. Most primary ribs bifurcate at lateral tubercles, some rejoin at ventral-lateral tubercles; ratio of ventral-lateral to lateral tubercles less than 2:1. On outer whorls ribbing becomes weak and irregular, lateral and ventral-lateral tubercles dominate ornamentation. Strength of ventral-lateral tubercles equals or exceeds that of lateral tubercles.

Suture ceratitic, like that of *P. burckhardti.*

*Discussion.*—This species occupies a stratigraphic position intermediate between that of *P. burckhardti* and *P. vogdesi* and in some respects combines the morphologic characters of these species, although complete intergradation with them is not exhibited. The position of the lateral tubercles low on the flanks is like that of *P. burckhardti*, whereas the comparable or greater strength of the ventral-lateral compared with the lateral tubercles and the wide, broadly rounded venter are in agreement with *P. vogdesi*. The young stages of compressed strongly keeled variants of *P. clarkei* are indistinguishable from specimens of *P. burckhardti* of comparable size and proportions on which the lateral tubercles are not yet fully developed.

*Paraceratites clarkei* was recognized as a distinct species by Silberling (1962, p. 156), but due to insufficient stratigraphic control its occurrence was misplaced between that of *P. vogdesi* and of *P. cricki.* Though few in number, subsequent stratigraphically controlled collections amply verify the correct stratigraphic position of *P. clarkei.*

*Figured specimens.*—Plesiotypes, USNM 248748 to 248753.

*Occurrence—Paraceratites clarkei* beds, stratigraphically between the occurrence of *P. burckhardti* and *P. vogdesi*. USGS localities M136 −7 ft (2.1 m) (1), M606 −8 ft (2.5 m) (4), M966 (30+), and M967 −15 ft (4.5 m) (2); Rotelliformis Zone, vicinity of Fossil Hill, Humboldt Range, Nev.

**Paraceratites vogdesi (Smith)**

Plate 16, figures 13–28; plate 17, figures 1–5

*Ceratites vogdesi* Smith, 1904, p. 384, pl. 43, figs. 7 [holotype], 8; pl. 44, fig. 1 [holotype].

*Ceratites (Paraceratites) vogdesi* Smith. Smith, 1914, p. 89, pl. 35, figs. 4–6 [holotype], 7–9?.

*Ceratites (Paraceratites) newberryi* Smith [in part], 1914, p. 92, pl. 40, figs. 1–3 [holotype], 4–5, 13–14? [not figs. 6–8, 9–11 = *Paraceratites clarkei* Smith, revised].

*Ceratites (Paraceratites) trinodosus* Mojsisovics [in part]. Smith, 1914, p. 92, pl. 39, figs. 1–2, 3–5, 7–8?, 9–10, 11–13?, 14–16?, 17–19?; pl. 52, figs. 12–14 [not pl. 39, fig. 6, pl. 52, figs. 15–18 = *Paraceratites clarkei* Smith, revised].

*Ceratites fissicostatus* Hauer. Smith, 1914, p. 96, pl. 53, figs. 1–3.

*Ceratites haguei* Smith, 1914, p. 97, pl. 42, figs. 1–2 [holotype], 3–5; pl. 43, figs. 1–2a, 3–5?, 6–7?, 8–10?.

*Paraceratites vogdesi* (Smith). Spath, 1934, p. 444. Silberling, 1962, p. 156 [in part].

[?] *Ceratites kingi* Smith, 1914, p. 85, pl. 41, figs. 1–3a [holotype], 4, 5–6, 7–8?, 9?, 10–11?, 12–13?.

[?] *Ceratites (Paraceratites) trojanus* Smith, 1914, p. 88, pl. 36, figs. 1–3 [holotype], 4–5; pl. 37, figs. 1–3, 4–5.

[?] *Ceratites crassicornu* Smith, 1914, p. 95, pl. 43, figs. 11–12 [holotype], 13–14?.

[?] *Ceratites ecarinatus* Hauer. Smith, 1914, p. 96, pl. 44, figs. 1–3.

[?] *Paraceratites trojanus* Smith. Spath, 1934, p. 443.

*Revised description.*—Discoidal, moderately compressed (W/D 0.30–0.35 between lateral tubercles or spines); width of umbilicus widely variable proportional to whorl width and strength of ornamentation (U/D 0.22–0.32). Maximum diameter exceeding 95 mm. Ventral-lateral shoulders abrupt, emphasized by tubercles; venter broadly rounded with indistinct low keel on inner whorls. Whorl cross section subrectangular in compressed, weakly ornamented forms, hexagonal in robust forms with coarse lateral spines.

Ribbing and tuberculation widely variable in strength proportional to width of whorls and umbilicus. On inner whorls ribs weakly falcoid, branch from umbilical shoulder or at midflank, terminate in projected tubercles. Lateral tubercles above midline of flanks, first appear at about 25-mm diameter on average forms, at less than 20 mm on coarsely ornamented robust variants, may be absent on extremely compressed variants. On average outer whorls, lateral tubercles develop into forward-curving hornlike spines whose length amounts to half the maximum whorl width. Umbilical tubercles develop parallel with lateral tubercles on more coarsely ornamented variants, fade on outer whorl. Ventral-lateral tubercles develop into pronounced clavi on outer whorl, alternate in position on either side of low, broadly rounded venter, extend above height of midline of venter. On outer whorl ribbing weak and irregular, ornamentation dominated by lateral spines and ventral-lateral clavi.

Suture ceratitic, like that of *P. burckhardti* with high entire principal saddles, deep L1, coarsely digitate lobes, and only one auxiliary saddle.

*Discussion.*—*Paraceratites vogdesi* shows perhaps the greatest range in morphologic variation of any ammonite species in the Fossil Hill fauna. Nevertheless, it is readily separated from the stratigraphically subjacent and also variable *P. clarkei* by the position of the lateral tubercles or spines which are above the midline of the flanks in the former and on the lower flanks of the latter. The broad, low venter of *P. vogdesi* and the relative prominence of the ventral-lateral clavi compared with the lateral spines distinguish this species from *P. cricki* and *P. burckhardti* which occur respectively higher and lower in the section.

*Paraceratites clarkei* was erroneously considered morphologically and stratigraphically transitional from *P. vogdesi* to *P. cricki* by Silberling (1962, p. 156). Further collecting proved this interpretation incorrect, and no clearly transitional forms were found between the stratigraphic occurrence of these two species. Possible intergradation between *P. vogdesi* and *P. cricki* might be represented by the specimens described by Smith as *Ceratites (Paraceratites) trojanus* and questionably included here in the revised *P. vogdesi*. The lateral spines of these forms are borne high on the flanks as in *P. vogdesi* but, like those of *P. cricki*, are much more pronounced than the weak ventral- lateral tubercles.

As pointed out by Spath (1934, p. 436), the specimens from fossil Hill assigned by Smith to *Paraceratites trinodosus* Mojsisovics, which are included here partly in *P. vogdesi* and partly in *P. clarkei*, developed coarser sculpture than the Alpine types of this species. Nevertheless, among the wide range of morphologic variants assigned here to *P. clarkei*, individuals closely similar to the types of *P. trinodosus* are expectable, and among the variants of *P. vogdesi* some specimens are very close to the typical specimens of the Alpine species *Ceratites fissicostatus* Hauer and *C. ecarinatus* Hauer. Despite their priority, application of any of these Alpine specific names to the species of *Paraceratites* recognized herein from Nevada seems unwise because the morphologic range of the populations represented by these European names is unknown, and on a population basis the European species may differ considerably. These European specific names represent a different kind of concept than the specific entities recognized here and the two are not strictly comparable. Until the European and Nevadan species can be compared on a population basis it seems preferable for the purpose of taxonomy to regard Smith's usage of these European names as misidentifications.

*Figured specimens.*—Plesiotypes, USNM 248754 to 248763.

*Occurrence.*—*Paraceratites vogdesi* beds, stratigraphically between the occurrence of *P. clarkei* and *P. cricki*. USGS localities M136 (50+), M136 −5 ft (1.5 m) (4), M163 (9), M165 (8), M605 (20+), M606 (24), and M967 −9 ft (2.7 m) (3); *Rotelliformis* zone, vicinity of Fossil Hill, Humboldt Range, Nev.

**Paraceratites cricki Smith**

Plate 17, figures 6–20

*Ceratites (Paraceratites) cricki* Smith, 1914, p. 87, pl. 37, figs. 6–9 [holotype], 10–11, 12–13; pl 38, figs. 1–2, 3–4, 5–6, 7–8, 9–10?, 11–12?; pl. 47, figs. 19–21, 22–24?.

*Ceratites (Paraceratites) taurus* Smith, 1914, p. 88, pl. 35, figs. 1–2 [holotype], 3.

*Paraceratites cricki* Smith. Spath, 1934, p. 443. Silberling, 1962, p. 156 [in part].

*Revised description.*—Inner whorls discoidal, compressed (W/D 0.25–0.30); outer whorl more robust (W/D between lateral nodes of outer whorl 0.30–0.42). Moderately involute (U/D 0.20–0.25), outer whorl somewhat more evolute (U/D of robust outer whorls as much as 0.30). Maximum diameter exceeds 90 mm; compressed forms attain larger diameter than robust variants. Ventral-lateral shoulders abrupt, emphasized by tubercles on inner whorls. Venter widely variable in width proportional to thickness of whorls, raised into blunt keel extending well above ventral-lateral tubercles, bluntly fastigate on robust outer whorls.

Ribbing on inner whorls strong and regular. Primary ribs branch on lower flank; ribs terminate in projected ventral-lateral swellings or tubercles. At about 20-mm diameter lateral tubercles develop at bifurcation point of primary ribs; weak nonpersistent umbilical tubercles may also develop. With increasing shell growth lateral tubercles increase rapidly in strength. On outer whorl 8 to 10 pronounced spinose lateral nodes dominate ornamentation. Ventral-lateral tubercles spaced in regular 2:1 ratio to lateral nodes or tubercles, with increasing shell diameter become clavate and finally coalesce into ventral-lateral ridge on orad part of outer whorl.

Suture ceratitic; L1 wide, twice depth of L2 and divided VL; upper half of S1 and S2 entire; only one discrete auxiliary saddle.

*Discussion.*—This is the stratigraphically highest species of *Paraceratites* occurring at Fossil Hill. Its high, keeled or fastigate venter and pronounced lateral nodes are in strong contrast with the morphology of *P. vogdesi* and *P. clarkei*, the species occurring successively lower in the section. It is therefore surprising that *P. cricki* closely resembles *P. burckhardti*, the stratigraphically lowest paraceratite whose occurrence is separated from that of *P. cricki* by about 6 m of section. The shape of the venter and development of tuberculation is the same in both species; the principal distinctions between them are the more abrupt and angular ventral-lateral shoulders of *P. cricki* and the ratio of ventral-lateral to lateral tubercles, which is regularly 2:1 in *P. cricki* but 3:1 or more in *P. burckhardti*. Unfortunately, the available stratigraphically controlled collections are insufficient to show whether *P. cricki* is j homeomorph of *P. burckhardti* derived through transitions with the stratigraphically intervening *P. clarkei* and *P. vogdesi*, or whether it represents a morphologic stock that suddenly reappears in the section, presumably by migration from some other area.

The holotype of *P. cricki* is from the New Pass Range, about 100 km southeast of the Humboldt Range, where it has been collected subsequently from beds now assigned to the Favret Formation. Specimens from the Favret Formation in the Augusta Mountains, about 55 km east-southeast of Fossil Hill, were found in association with *Gymnotoceras blakei* and *Tropigymnites* sp. and are thus from a stratigraphic level comparable to that at which *P. cricki* occurs at Fossil Hill.

*Figured specimens.*—Plesiotypes, USNM 248764 to 248770 from the vicinity of Fossil Hill in the Humboldt Range.

*Occurrence.*—*Paraceratites cricki* beds, above the occurrence of *P. vogdesi*, and with populations transitional between *Gymnotoceras rotelliformis* and *G. blakei*. USGS localities M605 +10 ft (3 m) (1), M607 (40+), and M967 (10+); Rotelliformis Zone, vicinity of Fossil Hill, Humboldt Range, Nev.

**Genus EUTOMOCERAS Hyatt, 1877**

**Eutomoceras cf. E. lahontanum Smith**

Plate 18, figure 1

cf. *Eutomoceras lahontanum* Smith, 1914, p. 63, pl. 28, figs. 8–11 [holotype].

This species was placed in synonomy with *Eutomoceras dalli* Smith in the preliminary summary of the Fossil Hill fauna by Silberling (1962, p. 156). It is provisionally regarded here as a distinct species because its peculiar morphology is not duplicated in the available but admittedly small samples of *E. dalli*, and a single specimen that may agree with Smith's holotype of *E. lahontanum* was collected about a meter stratigraphically below the occurrence of *E. dalli*. This specimen, illustrated here, is mainly part of an outer whorl on which the ornamentation is reduced, but strong bullae, like those of *E. lahontanum*, can be seen on the umbilical part of the penultimate whorl. Also, the width of the venter is proportional to that of *E. lahontanum* and greater than that of *E. dalli*.

*Eutomoceras lahontanum* may be a connecting link between *Paraceratites cricki* and *Eutomoceras dalli*; the single specimen assigned to *E. lahontanum* is from a stratigraphic position intermediate between those of these two species. On *E. lahontanum* the strong umbilical bullae and distinct ventral-lateral shoulders, which on the holotype are ornamented by widely spaced paired tubercles, suggest affinity to *Paraceratites cricki*. But the discrete high keel, the origin of the bullae at the umbilical shoulder, and the bifurcating falcoid ribs of *E. lahontanum* are more in agreement with *Eutomoceras*.

*Figured specimen.*—Plesiotype, USNM 248771.

*Occurrence.*—USGS locality M610 (1), lower part of *Gymnotoceras blakei* beds, Rotelliformis Zone, vicinity of Fossil Hill, Humboldt Range, Nev.

**Eutomoceras dalli Smith**

Plate 18, figures 2–7

*Eutomoceras (Halilucites) dalli* Smith, 1914, p. 65, pl. 29, figs. 1–4 [holotype], 5, 6–8, 9–10?.

*Hungarites fittingensis* Smith [in part], 1914, p. 58, pl. 90, figs. 5–7 [holotype] [not? pl. 29, figs. 12–14 = ?*Eutomoceras dunni* Smith]

*Eutomoceras dalli* Smith [in part]. Silberling, 1962, p. 156.

[not] *Hungarites* aff. *H. fittingensis* Smith. Kiparisova, 1961, p. 164–165, pl. 32, figs. 3a–3c.

*Eutomoceras dalli* is the stratigraphically lowest of an evidently intergraditional succession of species that includes *E. dalli, E. dunni*, and *E. laubei*. Compared with younger species of this series, *E. dalli* has a wider umbilicus (U/D about 0.25), thicker whorls, a wider venter, and coarser ribbing that commonly branches from enlarged primary ribs on the lower flanks. The development of irregularly spaced papillae on the ribs, a feature characteristic of *Eutomoceras*, is widely variable among individuals of a single population. Papillation is generally absent at shell diameters of less than 30 mm; on the outer whorl the strong ornamentation is reduced to discontinuous smooth weak ribs.

As suggested by Spath (1951, p. 11), the holotype of *"Hungarites" fittingensis* Smith is a fragment of the outer whorl of a *Eutomoceras;* the remainder of this specimen is restored with plaster. Traces of coarse papillae are visible on the apicad part of this fragment, and its whorl shape and proportions are like those of *E. dalli*. Smith's paratype of *"Hungarites" fittingensis*, also part of an outer whorl, is more like *E. dunni* in shape.

The assignment by Smith of *E. dalli* to *Halilucites*, which he treated as a subgenus of *Eutomoceras*, seems incorrect in view of the nonpapillate ribbing of the typical European representatives of *Halilucites*. Spath (1951, p. 11) was probably correct that *Eutomoceras* and *Halilucites* are distinct, perhaps geographically isolated, derivatives from *Paraceratites*.

*Figured specimens.*—Plesiotypes, USNM 248772 to 248775.

*Occurrence.*—USGS localities M137 (4), M141 (4), M611 (11), M613 (7), and M964 (1); *Gymnotoceras blakei* beds, Rotelliformis Zone, vicinity of Fossil Hill, Humboldt Range, Nev.

**Eutomoceras dunni Smith**

Plate 18, figures 8–15

*Eutomoceras dunni* Smith, 1904, p. 381, pl. 43, fig. 11 [holotype]; pl. 44, fig. 4 [holotype]. Smith, 1914, p. 62, pl. 27, figs. 14–16, 17, 18–19, 20–21, 22–23?, 24–25?. Silberling, 1962, p. 156.

*Eutomoceras breweri* Smith, 1914, p. 61, pl. 28, figs. 1–4 [holotype], 5, 6–7a.

*Eutomoceras laubei* Meek [in part]. Smith, 1914, p. 63, pl. 26, figs. 7–8, 9, [not *E. laubei* on pls. 10, 24, 27, and 90 = *Eutomoceras laubei* Meek].

[?] *Hungarites fittingensis* Smith, 1914 [in part], p. 58, pl. 29, figs. 12–14 [not pl. 90, figs. 5–7 = *Eutomoceras dalli* Smith].

*Eutomoceras dunni* is intermediate between *E. dalli* and *E. laubei* in the width of its umbilicus (U/D about 0.20), its whorl thickness, and the strength of its ribbing and papillation. As with *E. dalli*, the development of papillation varies among individuals and with the stage of growth. Hence, the separation by Smith of *E. breweri* Smith from *E. dunni*, from which it differs only in the weaker development of papillae on the ribs, is impractical.

*Figured specimens.*—Plesiotypes, USNM 248776 to 248779.

*Occurrence.*—*Frechites nevadanus* beds at USGS localities M137+4 ft (1.2 m) (2), M142 (6), and M614 (4); *Parafrechites meeki* beds at USGS localities M166 (3), M612 (1), M616 (2), M958 (3), and M960 (1); Meeki Zone, vicinity of Fossil Hill, Humboldt Range, Nev.

**Eutomoceras laubei Meek**

Plate 19, figures 1–6

*Eutomoceras laubei* Meek, 1877, p. 126, pl. 10, figs. 8–8a [holotype]. Hyatt and Smith, 1905, p. 131, pl. 60, figs. 7–10, 11. Smith, 1914, [in part], p. 63, pl. 10, figs. 7–10, 11; pl. 14, figs. 8–8a; pl. 27, figs. 1–2, 3–4, 5–7?, 8–10?, 11–13?; pl. 90, figs. 1–4 [not pl. 26, figs. 7–8, 9 = *Eutomoceras dunni* Smith]. Silberling, 1962, p. 156.

Among the known species of *Eutomoceras, E. laubei* is the stratigraphically highest. Although the available samples are relatively small, complete morphologic transition evidently exists between this species and *E. dunni,* which is characteristic of the beds immediately underlying those with *E. laubei.*

Compared with *E. dunni, E. laubei* is more finely sculptured, lacks enlarged primary ribs on the lower flanks, is more involute (U/D about 0.10 to 0.15), and has thinner whorls whose flanks converge towards a narrow venter.

Following Spath's suggestion, two of the specimens included by Smith (1914) in *E. laubei* are transferred here to *E. dunni,* with which their relatively evolute coiling is in better agreement.

In stating that *E. laubei* was first discovered by geologists of the 40th Parallel Survey in the New Pass Range in association with *"Acrochordiceras hyatti,"* Smith (1914, p. 64) introduced an unwarranted stratigraphic assumption. In the original description of these two species, Meek (1877, p. 128) did indicate that the "locality and position" of *E. laubei* is the same as that of *"Acrochordiceras hyatti,"* but for the latter his entry (p. 126) is simply: "New Pass, Desatoya Mountains [New Pass Range], Nevada; Trias." The Triassic section of the New Pass Range, about 100 km southeast of the Humboldt Range, includes ammonite-bearing beds of both the Hyatti and Meeki Zones, and there is therefore no reason to believe that *Eutomoceras laubei,* which is restricted to the upper part of the Meeki Zone in the Humboldt Range, occurs in the Hyatti Zone of the New Pass Range.

*Figured specimens.*—Holotype, USNM 12528 (originally figured by Meek, 1877, pl. 10, figs. 8–8a), plesiotypes, USNM 248780 and 248781.

*Occurrence.*—*Parafrechites dunni* beds, Meeki Zone, at USGS localities M618 (7), M619 (6), M959 (1+), and M968 (4); lower Occidentalis Zone at USGS localities M144 (1), M144 −6 ft (1.8 m) (4), M620 (2), and M962 (10+); vicinity of Fossil Hill, Humboldt Range, Nev.

#### Genus NEVADITES Smith

*Nevadites* Smith, 1914, p. 121 [type species *N. merriami* Smith, 1914, a subjective synonym of *Nevadites hyatti* (Smith, 1904), by original designation].

Stratigraphically restricted collections of *Nevadites* show a wide range in morphologic variation. Because of the relatively large size and ornate character of these ammonites, bedrock collections sufficiently large and well preserved to completely demonstrate a normal frequency distribution and complete morphologic intergradation of variants could not be obtained. Nevertheless, the mutual occurrence in a single bed of morphologically distinct but closely related forms evidences their specific identity.

All of the ammonites referred by Smith (1914) to *Anolcites* are regarded here as belonging to *Nevadites,* thereby enlarging the original concept of the genus. Even in the stratigraphically highest species, however, in which the two rows of ventral spines are closest together, no trace of a ventral furrow, the distinguishing feature of *Protrachyceras,* is present. Otherwise, the youngest *Nevadites,* as revised here, are in all respects similar to *Protrachyceras* and are logical direct ancestors of this and all other clydonitacids.

#### Nevadites hyatti (Smith)

Plate 22, figures 24–29; plate 23, figures 1–7

*Trachyceras (Anolcites) hyatti* Smith, 1904, p. 389, pl. 43, fig. 12 [holotype]; pl. 45, figs. 1 [holotype], 2.
*Nevadites hyatti* (Smith). Smith, 1914, p. 124, pl. 77, figs. 1–3, 4–5, 6–8, 9–11?, 12–13?. Silberling, 1962, p. 157.
*Nevadites merriami* Smith, 1914, p. 125, pl. 75, figs. 1–3 [holotype], 4–6, 7–8, 9–11, 12–14; pl. 76, figs. 1–2?, 3–6?, 7–10?, 11–13?, 14–16.

Inner whorls at diameters of about 20 mm have regular ribbing with umbilical and ventral tubercles and a subrectangular cross section with the width nearly equal to the height. With increasing shell diameter the whorl outline becomes hexagonal as lateral spines develop and become increasingly pronounced slightly above the midline of the flanks. Accompanying increase in relative size of the lateral and ventral tubercles, the ribs become increasingly coarse, irregular, and interrupted. On large shells the whorl width measured at the interspaces is about the same as or a little greater than the height; the maximum width measured to the tips of the lateral spines may be as much as twice the corresponding whorl height.

Except for weak extensions of the ribs, the venter is smooth and flattened at all growth stages. The ratio of ventral width between the tips of the ventral spines to the whorl height averages about 0.60 for small shells and about 0.70 for the largest specimens; the range in this ratio for outer whorls is 0.55–0.75.

Populations of *Nevadites hyatti,* as revised, in comparison with the stratigraphically higher populations of *N. humboldtensis,* as revised, include specimens that on the average have thicker whorls, broader venters, fewer but stronger ribs, and more pronounced tuberculation. These distinctions are apparent only in comparing populations from different stratigraphic levels; the morphologic variation of the two species overlaps and complete transition between them could take place within stratigraphically intermediate samples.

The basis for separating the six species that Smith assigned to *Nevadites* into these two morphologically more encompassing species is illustrated by the scatter diagram (fig. 19) on which the width of the venter measured between the tips of the ventral spines is plotted against the corresponding whorl height for two sets of specimens, one set representing a stratigraphic level 2–2.5 m higher than the other. A similar diagram, in which the scattering of points representing specimens from different levels would fall into two distinct but overlapping areas, could be obtained by plotting whorl width against whorl height. Figure 19 shows that Smith's "species" conform to one or the other cluster of points that are regarded here as characterizing the revised species *N. hyatti* and *N. humboldtensis.*

Younger species referred here to *Nevadites,* but originally included by Smith (1914) in *Anolcites,* differ

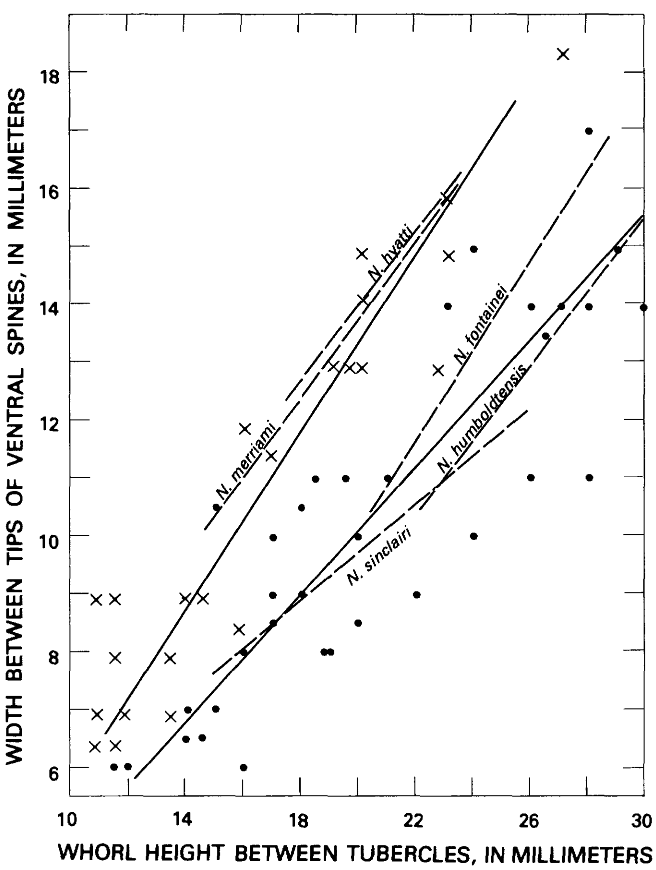


FIGURE 19.—Scatter diagram comparing the width across the venter between the tips of the ventral spines to the corresponding whorl height measured between the tubercles for specimens in population samples of *Nevadites* from different stratigraphic levels. Dots are specimens of *N. hyatti,* revised, from USGS localities M144 −6 ft and M962; crosses are specimens of *N. humboldtensis,* revised, from the stratigraphically higher USGS localities M144 and M962A. For comparison, the trend of width between the ventral spines with increasing whorl height is plotted as a dashed line for each holotype of five of the so-called "species" of *Nevadites* recognized by Smith (1914). Comparable lines for the specimens assigned to *N. whitneyi* (Gabb) by Smith (1914) would be close to those representing the type specimens of Smith's "species" here included in *N. humboldtensis.*

from both *N. hyatti* and *N. humboldtensis* in having four or more rows of tubercles in addition to being generally more discoidal and involute and in having a narrower venter between the rows of ventral spines.

*Figured specimens.*—Holotype, USNM 74268 (originally illustrated by Smith, 1904, pl. 43, fig. 12 and pl. 45, fig. 1), plesiotypes, USNM 248827 to 248831.

*Occurrence.*—USGS localities M144 −6 ft (1.8 m) (11), M621 (11), and M962 (21); lower part of *Nevadites* beds, Occidentalis Zone, vicinity of Fossil Hill, Humboldt Range, Nev.

**Nevadites humboldtensis Smith**

Plate 23, figures 8–19; plate 24, figures 1–4

*Nevadites humboldtensis* Smith, 1914, p. 123, pl. 78, figs. 1–3 [holotype]; pl. 79, figs. 1–3, 4–6, 7–8, 9–10. Silberling, 1962, p. 157.

*Nevadites fontainei* Smith [in part], 1914, p. 122, pl. 41, figs. 23?, 24–25?, 26–27?; pl. 51, figs. 1–4 [holotype]. [Not pl. 41, figs. 16–17, 18–19, 20–22, pl. 51, figs 5–9 = *Paraceratites clarkei* Smith, revised].

*Nevadites sinclairi* Smith, 1914, p. 126, pl. 81, figs. 17–19 [holotype]; pl. 82, figs. 1–3.

*Nevadites whitneyi* (Gabb) [in part]. Smith, 1914, p. 126, pl. 80, figs. 1–3, 4–5, 6–8; pl. 81, figs. 1–3, 4–5, 6–7, 8–9, 10–13, 14–16? [not? pl. 48, figs. 4–5 copied from Gabb (1864), genus and species unrecognizable].

*Ceratites beecheri* Smith [in part], 1914, p. 94, pl. 43, figs. 15–17 [holotype], 21–22, 23–24?, 25–26? [not figs 18–20 = *Paraceratites clarkei*].

[?] *Trachyceras (Anolcites) gracile* Smith, 1914, p. 132, pl. 82, figs. 4–5 [holotype], 6–7?, 8–9?.

The morphologic variation within populations included in *Nevadites humboldtensis* overlaps that of *N. hyatti,* but as a whole specimens of the former have narrower whorls (W/H about 0.90 measured at the interspaces), denser and more regular ribbing, and relatively weaker tuberculation than those of the latter.

Lateral tubercles appear early in the ontogeny of *N. humboldtensis* and are commonly well developed at diameters less than 15 mm. On the outer whorls the lateral tubercles of densely ribbed, relatively high-whorled variants are relatively small and are located just below the midflanks, whereas on coarsely ornamented variants they are on the upper flanks.

As with *N. hyatti,* the venter of *N. humboldtensis* is smooth and flattened at all growth stages; a low keel like those on the *Paraceratites* described by Smith as paratypes of *N. fontainei* is never present. The ratio of ventral width between the tips of the ventral spines to whorl height averages about 0.50 for whorls of more than 15 mm in height; the extremes for outer whorls range from 0.40 to 0.63 and thus overlap the range of ratios for *N. hyatti* (fig. 19).

Ornamentation of the holotype of *N. humboldtensis* is coarser than that of average specimens in populations included under this name and is more like that of *N.*

*hyatti*. However, none of the populations to which the latter name is applied include specimens with such a narrow ventral width or with whorls as high in proportion to their width.

One of the two specimens of *Ceratites whitneyi* Gabb originally illustrated by Gabb (1864) was selected as the type of *"Trachyceras" americanum* by Mojsisovics (1886, p. 149), leaving the specimen portrayed by Gabb's plate 4, figures 11 and 11a as the implicit type of *C. whitneyi*. This specimen, for which no locality is given in the original description, was considered a *Nevadites* by Smith, and if this were so, *N. whitneyi* (Gabb) would be the prior name for the specimens included here in *N. humboldtensis*. Part of the type lot of *Ceratites whitneyi*, including three small unfigured specimens (ANSP 1222–1224) of *Nevadites* and the holotype of *"Trachyceras" americanum* Mojsisovics (ANSP 1220–1221, different numbers for two parts of the same specimen), were located at the Academy of Natural Sciences of Philadelphia with Gabb's original label. The specimen corresponding to Gabb's figures 11 and 11a on plate 4 could not be found, and a note written by Alpheus Hyatt and found with the type lot indicates that this specimen has been missing since before 1900. The small, numbered specimens of *Nevadites* in the type lot were contained in a pillbox from a drug store in Palo Alto, Calif., suggesting that J. P. Smith of Stanford University may have borrowed this collection at some time during his study of the Middle Triassic fauna and perhaps based his concept of *C. whitneyi* upon them. Because the figured type is missing and Gabb's illustrations of it (pl. 4, figs. 11, 11a) are unrecognizable, *C. whitneyi* is considered here a nomen dubium. The distance between the ventral spines shown on Gabb's diagrammatic whorl outline (fig. 11a) is considerably less than that of *Nevadites humboldtensis*, and the specimen portrayed might be a younger *Nevadites* or even a *Protrachyceras*, assuming that it came from the Middle Triassic of the Humboldt Range.

*Figured specimens*.—Plesiotypes, USNM 248832 to 248839.

*Occurrence*.—USGS localities M144 (25+), M620 (18+), M622 (15+), M961 (25+), and M962A (20+); *Nevadites humboldtensis* beds, Occidentalis Zone, vicinity of Fossil Hill, Humboldt Range, Nev.

**Nevadites furlongi (Smith)**

Plate 24, figures 5–7

*Trachyceras (Anolcites) furlongi* Smith, 1914, p. 130, pl. 83, figs. 1–4 [holotype], 5–7; pl. 84, figs. 1–2, 3–5, 6–8, 9–11?, 12–13?.
[?] *Trachyceras (Anolcites) meeki* Mojsisovics [in part], Smith, 1904, pl. 45, fig. 3.

Compared with *Nevadites gabbi*, which occurs 5 to 10 ft higher in the section, *N. furlongi* has more robust whorls, a wider umbilicus, coarser ribs, and stronger tubercles. From older species of the genus, *N. furlongi* differs in having besides the umbilical and ventral rows of tubercles both a ventral-lateral and a lateral row of tubercles. The ribs bifurcate at the lateral row, which migrates to the upper flank and becomes exaggerated in size on the outer whorl.

*Figured specimens*.—Plesiotypes, USNM 248840 and 248841.

*Occurrence*.—USGS localities M145 (3), M623 (8), and M625 (3); *Nevadites furlongi* beds, Occidentalis Zone, vicinity of Fossil Hill, Humboldt Range, Nev.

**Nevadites gabbi (Smith)**

Plate 24, figures 8–11

*Trachyceras (Anolcites) gabbi* Smith, 1914, p. 132, pl. 9, figs. 3–6, 7–9?, 10–12?, 13–15?, 16–17?; pl. 11, figs. 4–5, 6–7?; pl. 85, figs. 11–12 [holotype]; pl. 86, figs. 1–3, 4–6, 7–9?, 10–11?.
*Trachyceras (Anolcites) meeki* Mojsisovics. Hyatt and Smith, 1905 [in part], pl. 59, figs. 3–6, 7–9?, 10–12?, 13–15?, 16–17?; pl. 74, figs. 4–5, 6–7?.
[?]*Trachyceras (Anolcites) meeki* Mojsisovics. Smith, 1904 [in part], pl. 45, fig. 4.

*Nevadites* from the stratigraphically highest of the beds characterized by this genus agree with Smith's concept of *"Anolcites" gabbi* but are difficult to compare with the poorly preserved type specimens of this species.

Compared with *N. furlongi*, the whorls of *N. gabbi* are higher and narrower, and the ribbing and tuberculation are more delicate. The inner whorls have four rows of tubercles as with *N. furlongi*, but with growth two additional lateral rows commonly developed. In his original description, Smith mentioned only four rows, and his statement (Smith, 1914, p. 131) that the spines of *"Anolcites" gabbi* are more numerous than those of *"A." furlongi* may be in reference to the number of spines per spiral rather than the number of rows of spirals. Nevertheless, some specimens with the delicate ornamentation of *N. gabbi* develop as many as six rows. Unfortunately, the number of spine spirals on the holotype is indefinite owing to its poor preservation.

*Figured specimens*.—Plesiotypes, USNM 248842 and 248843.

*Occurrence*.—USGS localities M146 (6), M624 (8), and ?M626 (1); *Nevadites gabbi* beds, Occidentalis Zone, vicinity of Fossil Hill, Humboldt Range, Nev.

**Family HUNGARITIDAE Waagen, 1895**
**Genus HUNGARITES Mojsisovics, 1879**
**Hungarites sp.**

Plate 20, figures 13–14

A single poorly preserved specimen of this genus was collected from the upper member of the Prida Formation at Congress Canyon, associated with *Daonella lommeli*, *Proarcestes*, and shell fragments of *Protrachyceras?* of late Ladinian age. Though not adequate for specific assignment, the specimen is illustrated here as the only true *Hungarites* yet found in the Middle Triassic of the Humboldt Range.

The suture could not be exposed, but the nearly smooth flanks, proportions of the fastigate venter, and degree of involution closely resemble those of the septate inner whorls of *Hungarites pradoi* illustrated by Mojsisovics (1882, pl. 32, figs. 7, 8) from the Ladinian of Spain and of the specimen assigned to the same species by Diener (1908, p. 18, pl. 4, fig. 11) from the Ladinian *Daonella* shales of Spiti.

*Figured specimen.*—Plesiotype, USNM 248790.

*Occurrence.*—USGS locality M907; upper part of the upper member of the Prida Formation, Congress Canyon, Humboldt Range, Nev.

**Superfamily PINACOCERATACEAE (Mojsisovics, 1879)**
**Family JAPONITIDAE Tozer, 1971**
**Genus TROPIGYMNITES Spath, 1951**
**Tropigymnites planorbis (Hauer)**

*Sibyllites planorbis* Hauer, 1896, p. 271, pl. 12, figs. 1–8.
*Tropigymnites planorbis* (Hauer). Spath, 1951, p. 102.

**Tropigymnites? cf. T. Planorbis (Hauer)**
Plate 26, figures 1–4

*Gymnites (Anagymnites) acutus* Hauer. Smith, 1914, p. 54, pl. 97, figs. 13–14.
*Tropigymnites planorbis* (Hauer). Silberling, 1962, p. 157.

Following the suggestion by Spath (1951, p. 100), specimens like that assigned to the gymnitid species *Anagymnites acutus* (Hauer) by Smith (1914) are questionably placed in the genus *Tropigymnites*. Unfortunately, the suture could not be exposed on any of the specimens from the Humboldt Range. Because the whorl shape and shell proportions of *Tropigymnites* and *Anagymnites* are similar, Smith's generic assignment remains a possibility. Assignment of the present species to *Tropigymnites* is favored because it occurs stratigraphically below any of the species of *Tropigastrites*, and it may therefore be the earliest representative of the succession of celtitid species, each of which characterizes a different level of the upper Anisian. Moreover, externally similar specimens found in the *Paraceratites cricki* beds of the Favret Formation in the Augusta Mountains have a simple suture pattern like that of *Tropigymnites* with three subammonitic saddles. These specimens from Augusta Mountain, which occupy a stratigraphic position intermediate between that of the present species and that of *Tropigastrites gemmellaroi*, differ from the present species only in having a narrower umbilicus and higher whorls.

At comparable shell diameters the specimens provisionally assigned here to *Tropigymnites planorbis* have somewhat higher and more compressed whorls than the typical specimens from the Dinaric Alps as illustrated by Hauer (1896).

*Figured specimens.*—Plesiotypes USNM 248844 and 248845.

*Occurrence.*—USGS localities M136 (4) and M605 (1), *Paraceratites vogdesi* beds, Rotelliformis Zone, vicinity of Fossil Hill, Humboldt Range, Nev.

**Genus JAPONITES Mojsisovics, 1893**
**Japonites cf. J. sugriva Diener**

cf. *Japonites sugriva* Diener, 1895, p. 32, pl. 7, figs. 1a–1c.

A single specimen collected in the Humboldt Range by I. C. Russell and Alpheus Hyatt in 1888 is the only known representative of *Japonites* found thus far in North America.

The maximum preserved diameter of about 135 mm of this specimen approximately corresponds to the end of its phragmocone. Its evolute coiling, robust subtrigonal whorl shape, and ornamentation of radial umbilical folds are comparable to those of *Japonites sugriva* Diener. The suture could not be prepared in detail, but its general plan is like that characteristic of *Japonites*, having three prominent lateral saddles followed by a series of low auxiliary elements that are directed radially and do not form a retracted suspensive lobe like that distinctive of *Gymnites*.

Russell and Hyatt's locality description reads simply "Star Peak Triassic—Unionville, Nevada," which might suggest that the specimen came from the Hyatti Zone, the most fossiliferous part of the section in the immediate vicinity of Unionville. This source is confirmed by a small ammonite embedded in the matrix that fills the small part of the body chamber preserved on the specimen. This small ammonite is like those from USGS Mesozoic locality M2829, and elsewhere in the Humboldt Range, that may be finely ornamented variants of *Unionvillites hadleyi* Smith and that have been found only in the upper part of the Hyatti Zone.

**Family GYMNITITIDAE (Waagen, 1895)**
**Genus GYMNITES Mojsisovics, 1882**
**Gymnites tregorum n. sp.**
Plate 31, figures 6–12, text-figure 20

*Leiophyllites*? sp. A. Silberling and Wallace, 1969, p. 17, table 1.

*Description.*—Discoidal, compressed (W/D 0.20–0.25); evolute (U/D 0.35–0.40). Flanks flattened and venter evenly rounded. Umbilical wall low and steep.

Shell surface smooth except for weak, irregular, slightly falcoid radial folds that cross the venter.

Suture ammonitic. On one poorly preserved specimen three principal elements are recognized. First saddle is coarsely crenulate.

*Discussion.*—Compared with the specimens assigned here to *Gymnites perplanus* from the Hyatti Zone in the Humboldt Range, *G. tregorum* has lower whorls, stronger surficial ornamentation, and a less subdivided S1. *G. tregorum* also does not attain the large size of *G. perplanus.*

This species is named in honor of Mr. and Mrs. R. H. Trego of Unionville, Nev.

*Figured specimens.*—Holotype USNM 248915; paratypes USNM 248914, 248916, and 248917.

*Occurrence.*—USGS Mesozoic localities M2358 (30+) and M2367 (14+); Caurus Zone, northern Humboldt Range, Nev.

FIGURE 20.—Suture line (× 4) of *Gymnites tregorum* n. sp. Paratype, USNM 248917.

**Gymnites perplanus (Meek)**

Plate 30, figures 11-16; text-figure 21

*Arcestes? perplanus* Meek, 1877, p. 120, pl. 11, figs. 7-7a.
*Gymnites perplanus* (Meek). Smith, 1914, p. 54, pl. 15, figs. 7-7a.

This species is characteristic of the Hyatti Zone in the northern part of the Humboldt Range. The original two specimens on which the species is based were collected by the 40th Parallel Survey in the vicinity of Buena Vista Creek canyon where this zone is the most fossiliferous part of the section. Smith (1914, p. 54) recorded *Gymnites perplanus* from the upper Anisian at Fossil Hill in the southern part of the Humboldt Range, but this occurrence is not documented.

The suture of *G. perplanus*, illustrated here for the first time, is like that characteristic of the genus and has two complexly subdivided principal lobes and a retracted suspensive lobe that is subdivided into auxiliary elements. As in other species of the genus, L1 is much larger than L2, and S2 is somewhat larger than S1. The suture of *G. perplanus*, as observed in several specimens, differs from that of species occurring at higher levels in the Anisian of the Humboldt Range chiefly in the number of auxiliary elements on the suspensive lobe. External of the umbilical seam are only three individualized, trifid auxiliary lobes, whereas younger species that are no more involute than *G. perplanus* are characterized by five or more such lobes. A relatively small number of discrete auxiliary elements may also be characteristic of other species like *G. sankara* Diener from India and *G. volzi* Welter from Timor that are from deposits of probable mid-Anisian age and hence of about the same age as *G. perplanus.*

*Figured specimens.*—Holotype, USNM 12531 (originally figured by Meek, 1877, pl. 11, figs. 7-7a); plesiotypes, USNM 248908 and 248909.

*Occurrence.*—USGS localities M533 (8), M970 (1); USGS Mesozoic localities M1180 (2), M1181 (3), M1184 (2), M2826 (1), and M2829 (5); Hyatti Zone in northern part of the Humboldt Range, Nev.

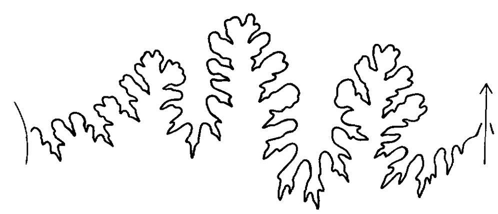

FIGURE 21.—Suture line (× 1.75) of *Gymnites perplanus* (Meek). Plesiotype, USNM 248909.

**Gymnites cf. G. humboldti Mojsisovics**

Plate 31, figure 1; text-figure 22

cf. *Gymnites humboldti* Mojsisovics, 1882, p. 235, pl. 55, figs. 1-3.
*Gymnites* cf. *G. incultus* (Beyrich, 1867). Silberling, 1962, p. 158.

A single phragmocone of a relatively involute (U/D 0.28), compressed *Gymnites* having a maximum preserved diameter of about 100 mm was collected in place from the *Gymnotoceras blakei* beds of the Rotelliformis Zone in the vicinity of Fossil Hill. Except for conspicuous falcoid growth striae of irregular strength, the shell is smooth and lacks the spiral row of tubercles characteristic of *Epigymnites alexandrae* Smith, which occurs stratigraphically higher. The suspensive lobe of the suture (fig. 22) is subdivided by six or possibly seven discrete auxiliary lobes, which is twice the number found in *G. perplanus* (Meek) from the Hyatti Zone. The suture pattern, lack of ornamentation, and degree of in-

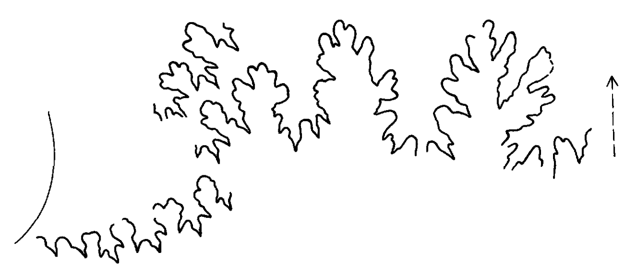

FIGURE 22.—Suture line (× 1.75) of *Gymnites* cf. *G. humboldti* Mojsisovics. Plesiotype, USNM 248911. Some fine detail lost in preparation.

volution of this specimen are comparable to those of *G. humboldti* Mojsisovics, which was originally described from the upper Anisian of the Hallstatt Limestone in Austria.

*Figured specimen.*—Plesiotype, USNM 248911.

*Occurrence.*—USGS locality M609, *Gymnotoceras blakei* beds, Rotelliformis Zone, vicinity of Fossil Hill, Humboldt Range, Nev.

**Gymnites? calli Smith**

*Gymnites calli* Smith, 1914, p. 53, pl. 26, figs. 1-1a.

The only known specimen of this species is the holotype that was collected near Fossil Hill in the southern part of the Humboldt Range. The shell is considerably less evolute (U/D about 0.14) than other species of *Gymnites* from the Humboldt Range and is perhaps too tightly coiled for inclusion in this genus as presently delimited (Arkell and others, 1957, p. L184). The suture pattern, however, is that typical of *Gymnites*.

Although no additional specimens were found during the present study, shell fragments of *Nevadites* and *Daonella dubia* in the matrix of the type specimen indicate that it was derived from the upper part of the Occidentalis Zone.

**Genus EPIGYMNITES Diener, 1916**
**Epigymnites alexandrae (Smith)**

Plate 31, figure 13

*Gymnites alexandrae* Smith, 1914, p. 52, pl. 23, fig. 1; pl. 24, figs. 1-2, 3?, 4-4a?, 5-6?, 7-9?, %-12?; pl. 25, fig. 1?. Silberling, 1962, p. 156.

Several incomplete specimens from different localities in the vicinity of Fossil Hill are ornamented by a single spiral row of tubercles on the middle of the flank and otherwise agree in whorl shape and suture pattern with this species. The stratigraphically lowest of these specimens is from the *Parafrechites dunni* beds at the top of the Meeki Zone and the highest is from the Subasperum Zone. *Epigymnites alexandrae* thus ranges through the upper part of the upper Anisian and at least the lower part of the lower Ladinian.

An imprint of *Daonella* cf. *D. moussoni* on the type specimen of *G. alexandrae* (Smith, 1914, pl. 23, fig. 1) indicates that it was derived from the upper part of the Occidentalis Zone. The ratio U/D for this specimen is 0.365. The "cotype" (Smith, 1914, pl. 25, fig. 1; Stanford University type colln. no. 5429) is appreciably more involute (U/D 0.305) and generally resembles *G. ecki* Mojsisovics, which was originally described from the calcare di Clapsavon of northeastern Italy and is supposedly of late Ladinian age.

*Figured specimen.*—Plesiotype, USNM 248918.

*Occurrence.*—USGS localities M619 (1), *Parafrechites dunni* beds, upper part of Meeki Zone; M624 (2) and M625 (1), upper part of Occidentalis Zone; one float specimen from the Occidentalis Zone of collecting-site C; USGS Mesozoic locality M 3094 (1), Subasperum Zone; vicinity of Fossil Hill, Humboldt Range, Nev.

**Family STURIIDAE (Kiparisova, 1958)**
**Genus STURIA Mojsisovics, 1882**
**Sturia cf. S. japonica Diener, 1915**

Plate 30, figures 17-18

cf. *Sturia japonica* Diener, 1915b, p. 18, pl. 6, figs. 1-2.

Part of a large septate whorl of *Sturia*, having a maximum whorl height of about 150 mm, was found in the Fossil Hill area as float derived from the Meeki Zone or stratigraphically higher. The suture of this specimen cannot be traced in detail, but it is illustrated photographically to show its general pattern and the degree of complexity of its subdivision.

According to Kiparisova (1961, p. 180), *Sturia japonica* differs from the type species, *S. sansovinii* (Mojsisovics), mainly in having the spiral furrows on the umbilical part of the flanks more widely spaced, but the validity of this specific distinction has perhaps not been adequately tested as implied by Onuki and Bando (1959, p. 101) who placed the two species in synonymy.

*Figured specimen.*—USNM 248910.

*Occurrence.*—Float at USGS locality M614, Meeki Zone (?), vicinity of Fossil Hill, Humboldt Range, Nev.

**Genus DISCOPTYCHITES Diener, 1916**
**Discoptychites sp.**

Text-figures 23 and 24

?*Discoptychites evansi* (Smith). Silberling, 1962, p. 157.
[?] *Ptychites evansi* Smith, 1914, p. 47, pl. 21, figs. 3-3a.

A septate fragment of the ventral part of a large ammonite having the compressed, subtrigonal whorl shape and suture pattern of *Discoptychites* was collected in place from the *Paraceratites clarkei* beds of the Rotelliformis Zone at Fossil Hill. This fragment could belong to the same species as the specimen named *Ptychites evansi* by Smith (1914) though this specific name should probably be regarded as a nomen dubium. Smith's specimen lacks outer whorls comparable in size to the present specimen, but its whorl shape is similar, and fragments of *Daonella americana* in its matrix indicate that it came from either the Rotelliformis or Meeki Zones.

Other than the *Sturia* previously described, the only other ptychitid found thus far in the Humboldt Range is an indeterminate immature specimen of *Ptychites*? from the Meeki Zone at USGS Mesozoic locality M960.

*Figured specimen.*—USNM 248985.

*Occurrence.*—USGS locality M139, *Paraceratites clarkei* beds, Rotelliformis Zone, vicinity of Fossil Hill, Humboldt Range, Nev.

FIGURE 23.—Suture line (× 1.5) of *Discoptychites* sp. Figured specimen, USNM 248985.

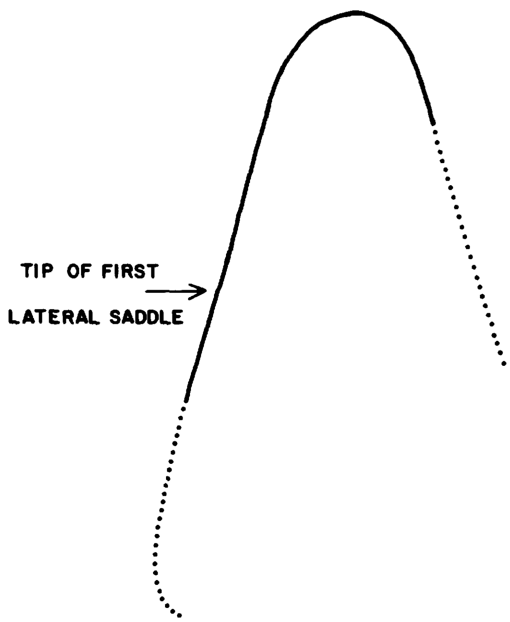


FIGURE 24.—Diagrammatic cross section (natural size) of the outer part of an incomplete whorl of *Discoptychites* sp.; dotted where inferred. Figured specimen, USNM 248985.

**Family ISCULITIDAE Spath, 1951**
**Genus ISCULITES Mojsisovics, 1886**

*Isculites* Mojsisovics, 1886, p. 154 [type species *I. hauerinus* (Stolicska) by monotypy].

*Smithoceras* Diener, 1907, p. 97 [type species *S. drummondi* Diener by monotypy].

*Spitisculites* Diener, 1916, p. 101 [type species *Isculites hauerinus* (Stolicska) by original designation].

*Alloptychites* Spath, 1951, p. 151 [type species *Ptychites meeki* Hyatt and Smith by original designation].

**Isculites meeki (Hyatt and Smith)**

Plate 28, figures 10–18; plate 29, figures 10–13; text-figure 25

*Ptychites meeki* Hyatt and Smith, 1905, p. 87, pl. 25, figs. 6–8 [holotype], 8–10, 11–12. Smith, 1914, p. 47, pl. 6, figs. 6–8, 8–10, 11–12.

*Alloptychites meeki* (Hyatt and Smith). Spath, 1951, p. 151.

*Isculites meeki* (Hyatt and Smith). Silberling and Wallace, 1969, table 1, p. 17.

*Revised description.*—Inner whorls moderately involute and subglobose with evenly rounded venter and flanks; at diameters of 20–30 mm W/D = 0.50–0.75 and mean U/D = 0.22 for nine specimens; umbilical shoulder narrowly rounded, umbilical wall steep, nearly perpendicular. Outer whorls slightly uncoiled and more compressed, generally with flattened, subparallel flanks; at diameters > 40 mm W/D is mostly 0.40–0.50 and mean U/D = 0.254 for 13 specimens; umbilical wall shallower and more sloping as a function of egression. Maximum diameter exceeds 75 mm, but specimens having diameter > 50 mm uncommon.

Surface smooth except for growth striae of irregular strength. One or more constrictions and flares near aperture.

Suture only known from holotype; weakly subammonitic; S1, S2, and S3 of equal height, S1 and S2 broadly rounded in shape; L1 and L2 of equal depth and width, equal to VL in depth.

*Discussion.*—The type lot of this species is from the Whitney collection in the Museum of Comparative Zoology, Harvard University, and was originally collected at Star Creek canyon in the Humboldt Range. Hyatt and Smith (1905, p. 87; Smith, 1914, p. 47), for reasons not stated, gave the stratigraphic horizon as lower Ladinian, but during the present study *I. meeki* has only been found in the lower Anisian Caurus Zone in the vicinity of Star Creek canyon.

None of the many specimens from the two localities from which the present collections were made show the details of the suture, but its general plan and the proportions of its major elements are like that of the suture on the holotype.

Compared with other species of the genus, when fully grown *I. meeki* is more compressed and its venter remains broadly rounded rather than becoming more narrowly arched as in *I. hauerinus*. Although the shell proportions and rate of maturity are evidently widely variable, egression of the outer whorls is definitely shown. The relative increase in the size of the umbilicus with growth as indicated by the means of the U/D ratios for shells smaller in diameter than 30 mm and those larger than 40 mm is significant at a probability level of 0.01.

*Figured specimens.*—Holotype, MCZ 3998 (originally figured by Hyatt and Smith, 1905, p. 25, figs. 6–8);

paratype, MCZ 3900 (originally figured by Hyatt and Smith, 1905, pl. 25, figs. 9–10); plesiotypes, USNM 248882 and 248883; USNM 248891 and 248892.

*Occurrence.*—USGS Mesozoic localities M2358 (75+) and M2367 (35+), Caurus Zone between Bloody Canyon and Star Creek canyon, Humboldt Range, Nev.

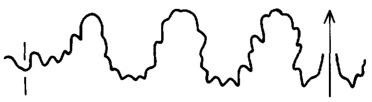

FIGURE 25.—Suture line (× 3) of *Isculites meeki* (Hyatt and Smith). Holotype, MCZ 3998.

**Isculites tozeri n. sp.**

Plate 30, figures 1–10; text-figure 26

*I.* n. sp. ex aff. *I. drummondi* (Diener). Silberling and Tozer, 1968, p. 38.

*Isculites* n. sp. Silberling and Wallace, 1969, table 1, p. 17.

*Description.*—Inner whorls moderately involute and globose; at diameters of 15–25 mm W/D = 0.65–1.00 and the mean U/D = 0.18 for seven specimens; umbilical shoulder narrowly rounded, umbilical wall steeply sloping or perpendicular. Outer whorls more compressed (W/D = 0.50–0.90 at D > 35 mm) with marked egression of umbilical margin (mean U/D = 0.23 for 19 specimens of D > 35 mm). Body chamber modified to arched or bluntly subtrigonal cross-sectional shape, reverting to parabolic cross section at apertural margin. Diameter of complete shells mostly 40–50 mm; estimated diameter of largest available specimen 50–55 mm.

Surface smooth except for nearly straight growth striae of irregular strength. Projected constriction and flare just apicad of aperture.

Suture known only from one specimen; subammonitic; S1, S2, and S3 broadly rounded in shape and of about equal height and proportions.

*Discussion.*—This species is characteristic of the Hyatti Zone, and compared with *Isculites meeki* from the stratigraphically lower Caurus Zone, it has on the average a more robust shell. On a scatter diagram (fig. 27) comparing width and diameter of specimens of *Isculites tozeri* from USGS locality M533 and USGS Mesozoic locality M2359 and of *I. meeki* from localities M2358 and M2367 the shell proportions of the two species plot in two generally distinct but overlapping fields. Both samples of *I. meeki* plotted on figure 27 show about the same variation in shell proportions, as might be expected because they were collected only about 0.5 km apart probably from within the same few meters of section. The two plotted samples of *I. tozeri*, however, are from localities several kilometers apart and may represent different levels within the Hyatti Zone. They differ in their average proportions at diameters greater than 35 mm, the sample from locality M533 retaining a more globose shape of the body chamber. Although W/D ratios of the larger specimens of *I. tozeri* from locality M2358 overlap with those of *I. meeki*, shells of the two species are still readily distinguished by their different whorl shape, *I. meeki* having flattened, subparallel flanks and *I. tozeri* having a parabolic or subtrigonal outline widest at the umbilical shoulder.

The only suture line that could be prepared from the present samples of *I. tozeri* is more ammonitically crenulated than that of the holotype of *I. meeki*, but the general applicability of this distinction is uncertain.

Of the Indian species herein regarded as belonging to *Isculites*, *Smithoceras drummondi* Diener (1907, p. 98, pl. 12, figs. 3a–3c) is like *I. tozeri* in its shell proportions, shape, and suture line, but the illustrated specimen of this species is still septate at a diameter greater than 60 mm, and it is thus much larger than any of the specimens of *I. tozeri* from Nevada. As *S. drummondi* is known from only two specimens, further comparison with *I. tozeri* is not possible.

*Isculites tozeri* is named for E. T. Tozer of the Geological Survey of Canada.

*Figured specimens.*—Holotype, USNM 248905; paratypes, USNM 248904, 248906, and 248907.

*Occurrence.*—USGS locality M533 (40+) and USGS Mesozoic locality M2359 (50+), Hyatti Zone, northern part of Humboldt Range, Nev. Also represented from the Hyatti Zone of the Humboldt Range at USGS Mesozoic localities M1181 (2), M1182 (2), ?M1183 (5+), ?M2819 (3), M2821 (6), and ?M2829 (1).

FIGURE 26.—Suture line (× 3) of *Isculites tozeri* n. sp. Holotype, USNM 248905.

**Superfamily DANUBITACEAE (Spath, 1951)**
**Family DANUBITIDAE**
**Genus CZEKANOWSKITES Diener, 1915**
**Czekanowskites hayesi (McLearn)**

Plate 19, figures 16–19

"*Ceratites*" *hayesi* McLearn, 1946a, sheet 2, pl. 1, fig. 2.

*Czekanowskites hayesi* (McLearn). McLearn, 1969, p. 43–44, pl. 1, figs. 4–8.

The specimen illustrated is one of the only two found of this species and was collected from the Hyatti Zone of the Humboldt Range. The suture cannot be observed, but externally these specimens are nearly identical with

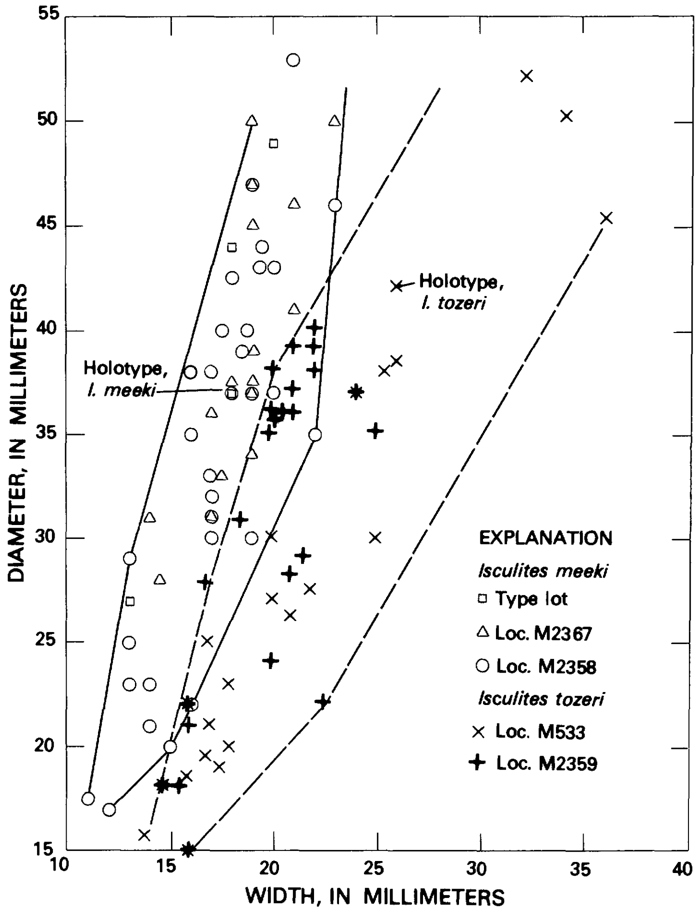


FIGURE 27.—Scatter diagram comparing width and diameter of specimens of *Isculites tozeri* n. sp. from USGS locality M533 and USGS Mesozoic locality M2359 with *Isculites meeki* (Hyatt and Smith) from USGS Mesozoic localities M2358 and M23679 Solid lines enclose all points for *I. meeki*; dashed lines all points for *I. tozeri*.

the holotype of *Czekanowskites hayesi* , a cast of which was provided us through the courtesy of the late F. H. McLearn along with casts of several variants.

*Figured specimen.*—Plesiotype, USNM 248785.

*Occurrence.*—USGS locality M970 (1) and USGS Mesozoic locality M2359 (1), upper Hyatti Zone, Humboldt Range, Nev.

**Genus PSEUDODANUBITES Hyatt, 1900**

**Pseudodanubites halli (Mojsisovics)**

Plate 19, figures 7–15; text-figure 28

*Clydonites laevidorsatus* (Hauer). Meek, 1877, p. 109, pl. 10, figs. 7 [herein selected as lectotype of *Danubites halli* Mojsisovics], 7a.

*Danubites halli* Mojsisovics, 1896, p. 696 [new name for "*Clydonites laevidorsatus* (Hauer)" of Meek, 1877].

*Tropigastrites halli* (Mojsisovics) [in part]. Smith, 1914, pl. 14, figs. 7, 7a [not figs. of "*T. halli*" on pls. 6, 12, 18, and 88 = *Tropigastrites gemmellaroi* Arthaber].

*Pseudodanubites? halli* (Mojsisovics). Silberling and Wallace, 1969, table 1, p. 17.

[not] *Celtites halli* Mojsisovics. Hyatt and Smith, 1905, p. 125, pl. 25, figs. 4–4a, 5, 5a–5b; pl. 75, figs. 1–1a, 2–3, 4–5 [= ?*Tropigastrites gemmellaroi* Arthaber].

This specific name was applied by Hyatt and Smith (1905) and Smith (1914) to specimens of *Tropigastrites* from the Rotelliformis Zone, but specimens like those figured by Meek and for which Mojsisovics proposed the name *Danubites halli* differ from *Tropigastrites* in whorl shape and ornamentation and occur in the Hyatti Zone.

The serpenticone inner whorls of *Pseudodanubites halli* are roughly quadrate in cross section with gently rounded umbilical and ventral-lateral shoulders and a broadly arched venter. The flanks are ornamented by blunt straight ribs and the venter is smooth. A gradual change in the shape of the outer whorls is produced by further arching of the venter into a bluntly fastigate shape. Although the periphery becomes narrowly rounded, it is not sharp as in *Tropigastrites*. Accompanying this change in whorl shape, the ribs first tend to become bulbous and enlarged at the ventral-lateral shoulder and then on the outer whorl project forward onto the venter. The correspondence of ribs on either side of the outer whorl is irregular; where they coincide in position, they pass over the narrowly rounded ventral margin only slightly diminished in strength.

Some variation in whorl compression and strength of ribbing occurs among individuals from the same bed. Compressed variants tend to have less bulbous ribs, which extend onto the venter at a smaller diameter, as on the specimen illustrated by figures 7–9, plate 19. This particular specimen may be from a somewhat higher level than others in the Hyatti Zone but is generally the same as some variants found in association with specimens like the lectotype.

The suture is simple in plan with three broad, subammonitically crenulate external saddles of about equal height. L1 is about twice the depth of L2 and slightly deeper than VL which is divided by an elongate triangular ES.

This species differs from typical *Danubites* in the modified fastigate shape and ornamentation of its outer whorl, the absence of any kind of a ventral keel, and its subammonitic suture with relatively low and broad saddles. It is assigned to *Pseudodanubites*, although its typical species, *P. dritarashtra* (Diener, 1895), differs from the present species in two important respects: the suture, though described as being more advanced than that of *Danubites*, is still ceratitic, and the venter bears a "thread-like keel" (Diener, 1895, p. 30). Otherwise, *P. dritarashtra* as described by Diener is in close agreement with *P. halli* in whorl shape and ornamentation.

The relationship of *P. halli* to some species of *Tropigastrites* that have similar ornament and equally evolute coiling, is evidently close. Although the ribs of

*Tropigastrites* are restricted to the lower flanks and the venter has a sharp fastigate margin, the suture is generally the same in plan and degree of complexity. Thus *P. halli* is in some respects intermediate between *Pseudodanubites* and *Tropigastrites*. This poses a problem in familial assignment because these genera are currently placed (Tozer, 1971) in different superfamilies: respectively the Danubitacea and Nathorstitacea.

*Figured specimens.*—Lectotype, USNM 12522 (originally figured by Meek, 1877, pl. 10, fig. 7); plesiotypes, USNM 248782 to 248784.

*Occurrence.*—USGS Mesozoic localities M1124 (1), M1180 (7), M1181 (2), M1184 (1), and M1185 (1), and M2829 (10+), Humboldt Range, Nev.

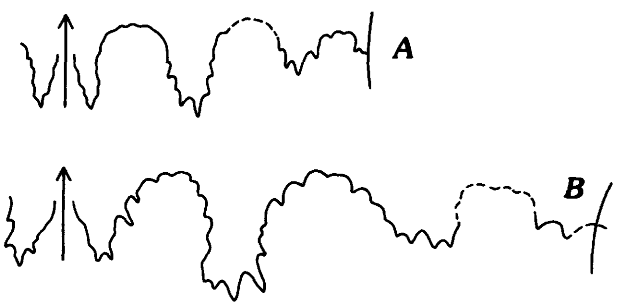


FIGURE 28.—Suture lines (× 4) of *Pseudodanubites halli* (Mojsisovics), dashed where approximate. *A*, plesiotype, USNM 248986, specimen not figured. *B*, plesiotype, USNM 248784, suture line reversed.

#### Genus UNIONVILLITES n. gen.

*Type species.—Unionvillites hadleyi* (Smith).

*Definition.*—Discoidal, strongly evolute; typically with low subquadrate to broadly arched whorls. Well-developed rounded ventral keel. Regularly spaced, typically tuberculate, projected radial ribs. Suture incompletely known but simple and short, having subammonitic saddles, L1 much deeper than L2 or VL.

*Discussion.*—Specimens of species included in this genus are neither well represented nor completely known morphologically. Nevertheless, among mid-Anisian ammonites they embody a unique combination of characters quite unlike that of any previously described genus. Because they are easily recognized and serve as markers for the upper part of the Hyatti Zone, introducing a new genus for them, even though incompletely characterized, is useful. No other middle Anisian ammonites, except the inner whorls of longobarditinids, possess tuberculate ribbing and a strong persistent ventral keel. The outer margin of *Balatonites*, in which *Unionvillites hadleyi* was originally placed, is quite different in having ventral spines on ribs that cross the venter rather than being ventrally carinate.

#### Unionvillites hadleyi (Smith)

Plate 6, figures 17–23

*Balatonites hadleyi* Smith, 1914, p. 119, pl. 90, figs. 8–10.

The following description is based largely on Smith's holotype plus a few other well-preserved specimens from the Tobin Range and Augusta Mountains.

The shell is thickly discoidal (W/D about 0.40 at D less than 30 mm), but widely umbilicate (U/D 0.50–0.55). In addition to the well-developed, persistent ventral keel, ornamentation consists of regularly but widely spaced projected primary ribs, each of which bears a bullate spine on the flanks and then projects sharply forward, fading toward the keel. On the venter between each primary rib, an additional rib is inserted and the projection of both primary and secondary ribs tends to serrate the keel. The holotype has 16 primary ribs per volution. The suture, as partly seen on a specimen from the Augusta Mountains, is simple in form, having three principal lateral elements and apparently slightly crenulate subammonitic saddles. It is mainly distinguished by having VL much shallower than L1.

*Figured specimens.*—Holotype, USNM 74432; paratypes, USNM 248649 and 248650.

*Occurrence.*—USGS Mesozoic localities M1181 (1), M2829 (1), upper Hyatti Zone, northern Humboldt Range, Nev. Better represented in the upper Hyatti Zone at the southern tip of the Tobin Range and in the Augusta Mountains several tens of kilometers east and southeast of the Humboldt Range.

#### Unionvillites asseretoi n. sp.

Plate 6, figures 24–28; text-figure 29

*Description.*—Evolute and compressed, at diameter of 30 mm, W/D = 0.32 and U/D = 0.50. Low subquadrate whorls with well-developed, persistent ventral keel. Umbilical wall gently sloping, umbilical shoulder absent.

Ornamentation consists of regularly spaced projected ribs with strong ventral swellings. The holotype has 37 ribs per volution. Suture known only from one specimen; subammonitic, three principal elements; VL much shallower than L1. This species is named in honor of the late Riccardo Assereto.

*Discussion.*—This species is characteristic of the Hyatti Zone, and compared with *Unionvillites hadleyi* from the same stratigraphic level, it has a more discoidal shell, more ribs per volution and lacks bullate spines. The suture of *Unionvillites asseretoi* is about the same as *Unionvillites hadleyi*.

*Figured specimens.*—Holotype, USNM 248653; paratypes, USNM 248651 and 248652.

*Occurrence.*—USGS Mesozoic locality M2829 (6), upper Hyatti Zone, northern Humboldt Range, Nev.

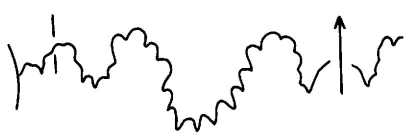

FIGURE 29.—Suture line (× 4) of *Unionvillites asseretoi* n. sp. Paratype, USNM 248652.

**Family LONGOBARDITIDAE (Spath, 1951)**
**Subfamily GROENLANDITINAE Asserto, 1966**
**Genus LENOTROPITES Popov, 1961**
**Lenotropites caurus (McLearn)**

Plate 29, figures 14–30; text-figure 30

*"Hungarites" caurus* McLearn, 1948, p. 1, pl. 11, figs. 1, 2.
*Lenotropites caurus* (McLearn). Tozer, 1967, p. 69, 71, pl. 7, figs. 1a, b.

*Figured specimens.*—Plesiotypes, USNM 248893 to 248900.

*Occurrence.*—USGS Mesozoic localities M2358 (8), M2367 (4), M2828 (8+), M2362 (20+); Caurus Zone, northern Humboldt Range, Nev.

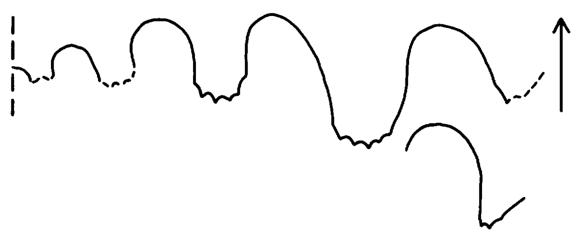

FIGURE 30.—Suture line (× 3) of *Lenotropites caurus* (McLearn), dashed where approximate. Plesiotype, USNM 248896.

**Subfamily LONGOBARDITINAE**

The species of *Longobardites* recognized from the Humboldt Range are, in stratigraphically ascending order: *Intornites mctaggarti* (McLearn) from the lower part of the Hyatti Zone; *Longobardites parvus* (Smith) from the Rotelliformis and Meeki Zones; and *L.* cf. *L. zsigmondyi* (Böckh) from the Occidentalis Zone. A fourth species, *I. nevadanus* Hyatt and Smith, which is typical of the Shoshonensis Zone in other parts of northwestern Nevada, may also occur in the Humboldt Range in the upper part of the Hyatti Zone. *Intornites nevadanus* thus occurs in Nevada at a level intermediate between that of *I. mctaggarti* and that of *L. parvus* and is described here on the basis of specimens from the Shoshonensis Zone of the New Pass Range in order to clarify the correct usage of this name.

Mature shells of all four species of longobarditinids from Nevada are smooth, compressed, acutely terminated oxycones and have the same distinctive pseudoadventitious suture pattern in which the height of S2 exceeds that of S1 and the depth of L2 exceeds that of L1. The term "pseudoadventitious" was introduced by McLearn (1951) because these unusual proportions of the principal suture elements result from differential development during ontogeny from a normal pattern of saddles and lobes that progressively decrease in size dorsally, and this pattern is not a true adventitious arrangement in which the ventral elements are developed by subdivision of VL.

Compared with the outer whorls of *Intornites mctaggarti* and *I. nevadanus*, those of *L. parvus* and *L.* cf. *L. zsigmondyi* have a different configuration of the growth lines and are on the average more compressed. The inner whorls, however, provide the principal means of separating the different species and determining their generic assignment. *Intornites mctaggarti*, the oldest species recognized in Nevada, has robust, evolute, keeled, ornate inner whorls that pass by gradual transition into the involute, compressed oxyconic mature whorls. The distinctive shape and ornament of the inner whorls may persist to diameters exceeding 25 mm, and the pseudoadventitious suture characteristic of the outer whorls is not developed until the whorls are more than 15 mm high. Successively younger species have young stages less divergent from the mature morphology and develop the mature oxyconic shape and pseudoadventitious suture line at progressively smaller shell diameters. The inner whorls of *L.* cf. *L. zsigmondyi*, the youngest species, have essentially the same shape as the outer whorls at diameters of less than 10 mm. Although the morphology of the inner whorls and rate at which they mature is widely variable among individuals from the same stratigraphic level, little overlap exists between the combined characters of different species.

The distinguishing features of the different species are given on table 4.

The morphologic differences between successive species of longobarditinids in Nevada suggests a biogenetic pattern whereby recapitulation of an evolute, thick-whorled, costate, carinate, ceratitically septate ancestor recedes farther and farther back into the ontogeny of successive species until it is no longer recognizable in the youngest of the species. Such an evolutionary relationship appears to exist between *Intornites mctaggarti* and *I. nevadanus*, which in Nevada may be connected by stratigraphically intermediate, morphologically transitional populations, and also between *L. parvus* and *L.* cf. *L. zsigmondyi*. The phyletic relationship between *I. nevadanus* and *L. parvus* is obscure, but even so, the implication is strong

TABLE 4.—*Morphologic comparison of longobarditinids from Nevada*

[D, shell diameter; H, whorl height; $L_1$, $L_2$, first and second lateral lobes of suture line; $S_2$, second lateral saddle of suture line; U, width of umbilicus; W, shell width; >, greater than; <, less than].

| Stratigraphic occurrence | Species | Configuration of growth striae on oxyconic outer whorls | Suture | | Character of inner whorls at D 15 mm | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Minimum whorl height at which depth of $L_2>L_1$ (mm) | Number of auxiliary saddles inside of $S_2$ at H 10-mm | Whorl proportion W/H | Involution U/D | Venter | Ornamentation |
| Occidentalis Zone | *Longobardites* cf. *L. zsigmondyi* (Böckh). | Convex | 7 | 5–7 | 0.25–0.4 | <0.05 | Acute, narrowly tapered. | Radial striae only. |
| Rotelliformis and lower Meeki Zones | *L. parvus* (Smith) | Convex | 12 | 5–7 | 0.4–0.7 | <0.10 | Acute, bluntly tapered. | Varying from radial striae to widely spaced radial folds and depressions on lower flanks. |
| Shoshonensis Zone | *Intornites nevadanus* (Hyatt and Smith). | Falcoid to biconvex. | 15 | 4–5 | 0.4–0.7, mostly <0.5. | 0.05–0.15, mostly <0.10. | Acute, bluntly tapered, with or without discrete rounded ventral keel. | Varying from radial striae to bullate radial ribs on lower flanks. |
| Lower part of Hyatti Zone | *Intornites mctaggarti* (McLearn) | Falcoid to biconvex. | >15 | No data | 0.7–1.5 | 0.15–0.40, mostly >0.25. | Acute, bluntly tapered to broadly rounded with a discrete, rounded ventral keel. | Bullate radial ribs on varying strength on lower flanks or whorl sides. Spiral striae on thick-whorled variants. |

that progressive development of the oxyconic shape and distinctive suture pattern of *Longobardites* from a nonoxyconic ceratitic ancestor may have taken place during one or more relatively brief parts of Anisian time.

**Genus INTORNITES Assereto, 1966**
**Intornites mctaggarti (McLearn)**

Plate 20, figures 15–35; text-figure 31

*Longobardites mctaggarti* McLearn, 1946a, p. 2, pl. 2, fig. 5.
*Longobardites larvalis* McLearn, 1948, p. 20, pl. 9, figs. 3–4; Silberling and Tozer, 1968, p. 38.
*Longobardites* cf. *L. larvalis* McLearn. Silberling and Wallace, 1969, table 1, p. 17.
*Intornites mctaggarti* (McLearn). Tozer, 1971, p. 1017.

*Description.*—Mature shell oxyconic, compressed (W/D about 0.25); venter narrowly tapered, acutely terminated; umbilicus nearly closed. Diameter of phragmocone exceeds 60 mm. Surface smooth except for growth lines that describe pronounced convex curve on lower flank, recurve about two-thirds of distance across flank, and form a smaller convex curve on outer flank.

Inner whorls at diameters less than 10 mm evolute, round or depressed oval in cross section, ornamented by distinct rounded ventral keel and short, coarse, concave radial ribs on lateral margins. Indistinct furrows border keel and strigae cross ribs on more depressed, coarsely ornamented variants. Whorl shape, strength of ornament, and rate of maturing of inner whorls widely variable; at diameter of 15 mm whorl proportions (W/H) varies from 0.7 to 1.5, width of umbilicus (U/D) varies from 0.15 to 0.40, mostly exceeds 0.25.

Transition to oxyconic mature morphology gradual, from 10 to 30 mm. During transition lower flanks ornamented by irregular ribs that commonly bear bullae at position corresponding to original lateral ribs of earlier whorls.

Suture ceratitic; principal lobes coarsely crenulate; principal saddles high and narrow; ES about two-thirds height of S1. Sutures closely spaced with sides of successive saddles touching or nearly so. At diameters less than 15 mm proportions of principal elements normal: in height S1 equal or greater than S2, S2>S3; in depth L1>L2, L2>>L3. Two or three auxiliary saddles follow S3 whose apex is inside midline of flank. Pseudoadventitious pattern develops by transitions at diameters more than 15 mm. On outer phragmocone height and breadth of S1<S2, S2 = S3; depth and breadth of L1<L2, L2<<L3. Three or four auxiliary saddles follow S3 whose apex is approximately at midline of flank.

*Figured specimens.*—Plesiotypes, USNM 248791 to 248799.

*Occurrence.*—USGS localities M533 (40+), M969 (3?); USGS Mesozoic localities M1124 (11), ?M1182 (7), ?M1184 (1), ?M1185 (2), M2830 (20+), and M2836 (5); lower part of Hyatti Zone, Humboldt Range, Nev.

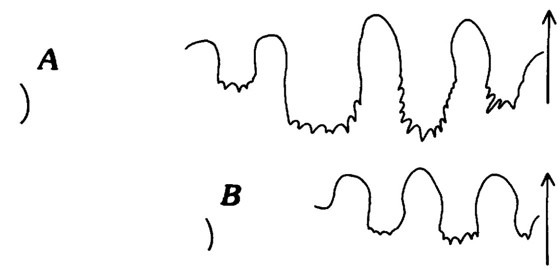


FIGURE 31.—Suture lines (× 3) of *Intornites mctaggarti* (McLearn). *A*, plesiotype, USNM 248792. *B*, plesiotype, USNM 248987, specimen not figured.

**Intornites nevadanus (Hyatt and Smith)**

Plate 21, figures 1–18; text-figure 32

*Longobardites nevadanus* Hyatt and Smith [in part], 1905, p. 132, pl. 25, figs. 13–16 [holotype], 17–18 [not pls. 58 and 75 = *L. parvus* (Smith) and (or) *L.* cf. *L. zsigmondyi* (Böckh)]. Smith, 1914, p. 50, pl. 6, figs. 13–16, 17–18 [not pls. 8, 12, and 30 = *L. parvus* (Smith) and (or) *L.* cf. *L. zsigmondyi* (Böckh)]. McLearn, 1951, p. 13. Silberling and Wallace, 1969, table 1, p. 17.
*Longobardites canadensis* McLearn, 1946a, p. 1, pl. 3, figs. 1 [holotype], 5–6. McLearn, 1948, pl. 3, figs. 1, 5–6; pl. 10, fig. 3.
*Longobardites intornatus* McLearn, 1946, p. 1, pl. 1, fig. 1.
*Longobarditoides nevadanus* (Hyatt and Smith). Shevyrev, 1961, p. 74.
[?] *Longobardites* cf. *nevadanus* Hyatt and Smith. Frebold, 1930, p. 302, pl. 1, figs. 11–12.
*Longobardites (Intornatus) nevadanus* Hyatt and Smith [in part]. Assereto, 1966, p. 963, pl. 69, figs. 5, 7; pl. 70, figs. 1, 3, 4, 6.

*Description.*—Mature shell like that of *I. intornatus*, compressed oxyconic, with narrow, acutely terminated venter, closed umbilicus, and asymmetrically biconvex growth striae. Maximum diameter of phragmacone exceeds 100 mm.

Inner whorls at diameters of 10 to 15 mm discoidal, compressed (W/H mostly 0.4–0.5); flanks broadly rounded, narrowly to bluntly convergent; umbilicus narrow but open (U/D 0.05–0.15); discrete rounded keel on venter of more robust variants. Flanks smooth or ornamented with regular falcoid ribs that fade on upper flank; ribs bullate on lower flanks of more thickly whorled evolute variants.

Smooth, tightly involute oxyconic mature morphology attained by gradual transition at diameters between 15 and 30 mm.

Mature suture with characteristic pseudoadventitious longobarditinid pattern and proportions, five to seven auxiliary saddles (including S3). Pseudoadventitious pattern (L2>L1 in depth and breadth) not developed below whorl heights less than 15 mm; generally S2>S1 by whorl height of 10 mm.

*Discussion.*—The range in variation among young stages of *Intornites nevadanus* may overlap that of *I. mctaggarti*, but at a given diameter the inner whorls of *I.*

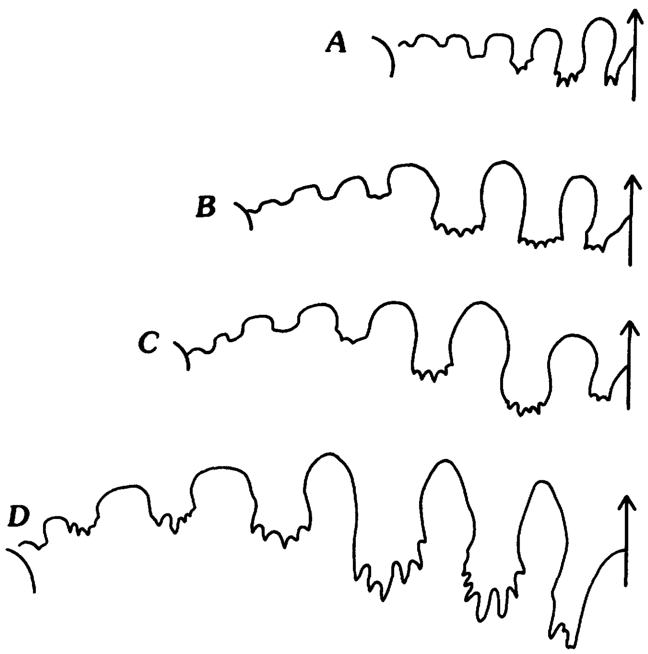


FIGURE 32.—Suture lines (× 5) of *Intornites nevadanus* (Hyatt and Smith). *A*, plesiotype, USNM 248803. *B*, plesiotype, USNM 248988, specimen not figured. *C*, holotype, MCZ 3902. *D*, plesiotype, USNM 248803.

*nevadanus* are on the average much more compressed and involute. From those of *Longobardites parvus* they differ in having regular ribbing and in most cases a discrete ventral keel.

Growth striae on smooth mature whorls of *I. nevadanus* are unevenly biconvex in contrast with those of *L. parvus,* which describe a single asymmetric convex curve. In fact, among longobarditinids from Nevada the nature of the growth striae serves to distinguish all mature shells of *Intornites* from those of the stratigraphically higher genus *Longobardites*. This is not a generic distinction generally, however, because the lectotype selected by Assereto (1966) for the type species of *Longobardites, L. breguzzanus* Mojsisovics, has biconvex growth striae in addition to other *Intornites*-like characteristics such as distinct ventral shoulders and a sutural development essentially like that of *I. nevadanus*. In all respects it is closest to nonkeeled, relatively smooth variants of *I. nevadanus*, so that the only generally applicable distinction between *Longobardites*, as typified by its type-species lectotype, and *Intornites* is the absence of a distinct ventral keel on the inner whorls of the former, and this derives from the nature of a type specimen rather than a population sample. Thus, in view of the real differences between the various middle and upper Anisian species of longobarditinids, their separation into genera is unfortunately artificial.

Confusion regarding the characteristics of *I. nevadanus* has resulted from the original description by Hyatt and Smith (1905), which was based partly on the small, poorly preserved type specimens, presumably all from the Shoshonensis Zone of the New Pass Range, about 100 km southeast of the Humboldt Range, and partly on younger specimens from the upper Anisian at Fossil Hill. The greatest diameter of the holotype is 20 mm and that of the paratype figured by Hyatt and Smith is 10 mm. Both are somewhat eroded internal molds on which a ventral keel, if present, is obscure and the surface sculpture not preserved. Although they correspond with relatively compressed, involute, smooth variants among the inner whorls of populations included here in *I. nevadanus*, by themselves they are not adequate to separate *I. nevadanus* from other younger species of longobarditinids. Fortunately, one previously unfigured paratype (MCZ 3903a) shows the keeled venter and biconvex growth striae of the inner whorl that distinguishes populations from the Shoshonensis Zone from those that occur in higher zones of the Nevada Middle Triassic. The population sample upon which the present description is based is from the type locality of the Shoshonensis Zone (at USGS locality M635) in the Wildhorse mining district in the low hills north of the New Pass Range, whereas the type specimens were probably collected farther south in the New Pass Range. Equivalence of the stratigraphic level represented by this population sample with that represented by the type lot is evidenced by a shell fragment on one of the unfigured paratypes (MCZ 3903b) of a distinctive pelecypod referred to *Enteropleura* cf. *E. bittneri* Kittl, which is characteristic of the Shoshonensis Zone in the Wildhorse district and elsewhere.

Several collections from relatively high in the Hyatti Zone of the Humboldt Range include immature specimens of *Intornites* whose shell proportions and strength of ornamentation are intermediate between those of the average young stages of *I. mctaggarti* and *I. nevadanus*. These may be compared with *I. intornatus,* which characterizes the middle part of the Varium Zone in Canada (Tozer, 1971, p. 1017).

*Figured specimens.*—Holotype, MCZ 3902 (originally figured by Hyatt and Smith, 1905, pl. 25, figs. 13-16); paratypes, MCZ 3904 (originally figured by Hyatt and Smith, 1905, pl. 25, figs. 17-18), and MCZ 3903a (previously unfigured); plesiotypes, USNM 248800 to 248804.

*Occurrence.*—USGS locality M635 (60+); Shoshonensis Zone in the lower part of the Fossil Hill Member of the Favret Formation, Wildhorse mining district, hills north of New Pass Range, Nev. Localities from which *I. nevadanus* is questionably represented relatively high in the Hyatti Zone in the northern Humboldt Range are USGS Mesozoic localities M1181 (25+) and M2829 (4).

**Genus LONGOBARDITES Mojsisovics, 1882**

**Longobardites parvus (Smith)**

Plate 21, figures 19–25; text-figure 33

*Longobardites nevadanus* Hyatt and Smith, 1905, p. 132, pls. 58 and 75 [in part]. Smith, 1914, p. 50, pls. 8, 12, and 30 [in part].
*Dalmatites parvus* Smith, 1914, p. 60, pl. 30, figs. 1–2 [holotype], 3–4, 5–7, 8–9?, 10–12?.
*Dalmatites minutus* Smith, 1914, p. 59, pl. 29, figs. 15–16 [holotype], 17–19, 20–21. [not "*Neodalmatites minutus* (Smith)" of Popov, 1961, p. 64].
*Neodalmatites parvus* (Smith). Spath, 1951, p. 24.
*Longobardites hyatti* Shevyrev, 1961, p. 74 [holotype = *L. nevadanus* Hyatt and Smith, 1905, pl. 58, fig. 16 (and 17–18)].
*Longobardites parvus* (Smith). Silberling, 1962, p. 157.

*Description.*—Mature shell compressed (W/D about 0.20), oxyconic; flanks broadly convex, converge to narrow, acutely terminated venter; umbilicus closed. Maximum diameter exceeds 60 mm. Surface smooth except for asymmetric convex growth striae, the most orad point of which is above midline of flank.

Inner whorls at diameters of 10 to 15 mm involute (U/D less than 0.10) with acute, unkeeled, bluntly tapered venter; strength of ornamentation proportional to variable whorl thickness (W/H 0.4–0.7). Ornamentation varies from convex striae on compressed variants to widely spaced radial folds and depressions on lower flank of robust variants. Immature ornament, even on most coarsely sculptured variants, not persistent beyond diameter of 25 mm.

Mature suture with characterisitc pseudoadventitious *Longobardites* pattern (S1<S2, L1<L2) and proportions; six or more auxiliary saddles (including S3) at whorl height of 20 mm. Lobes weakly digitate in comparison with those of *I. nevadanus*; sides of saddles smooth. S2 may exceed height of S1 at whorl height less than 10 mm, but L2 does not exceed L1 in depth at whorl height of less than 12 mm.

*Discussion.*—Stratigraphically controlled population samples show that small ornamented specimens like those named *Dalmatites parvus* and *D. minutus* by Smith, and for which the genus *Neodalmatites* was established by Spath, are gradational into less robust, smooth shells like some of those misidentified as *Longobardites nevadanus* by Hyatt and Smith and by Smith. And further, they show that small shells like Smith's "*Dalmatites*" are the inner whorls of smooth oxycones having the distinctive pseudoadventitious suture pattern of *Longobardites*. Smith (1914, p. 59) described "*Dalmatites*" *minutus* as a dwarf form ornamented at maturity with coarse radial folds, but the holotype, which has a greater diameter of 20.5 mm and is the largest specimen illustrated by Smith, is entirely septate. Also, contrary to Smith's statement that "*Dalmatites*" *parvus* lacks the characteristic "adventitious lobes" of *Longobardites*, at a whorl height of about 15 mm on the holotype L2 is deeper than L1, and the suture therefore is pseudoadventitious.

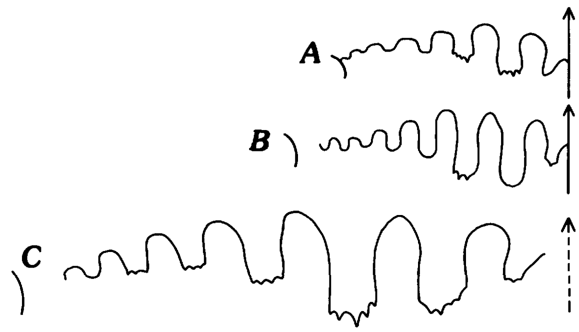


FIGURE 33.—Suture lines (× 3) of *Longobardites parvus* (Smith). *A*, plesiotype, USNM 248807, suture line reversed. *B*, plesiotype, USNM 248989, specimen not figured. *C*, plesiotype, USNM 248990, specimen not figured, suture line reversed.

Inner whorls of *Longobardites parvus* differ from those of *I. nevadanus* in never possessing a discrete ventral keel or regular falcoid ribbing, and the outer whorls differ in having convex rather than biconvex growth striae. From *Longobardites* cf. *L. zsigmondyi*, which occurs stratigraphically higher in the Humboldt Range, *L. parvus* is distinguished mainly by its more robust and less oxyconic inner whorls.

The single fragmentary specimen from northeastern Siberia assigned to *Neodalmatites minutus* (Smith) by Popov (1961, p. 64) is said to have a distinct ventral keel, a feature not found in the typical specimens of this species, which herein is placed in synonomy with *Longobardites parvus* (Smith). Other Siberian species assigned to "*Neodalmatites,*" like "*N.*" *kharaulakhensis* Popov (1961, p. 64) and "*N.*" *grumulus* (Kiparisova) (Vozin and Tikhomirova, 1964, p. 75) are also keeled forms and differ still further from typical *Neodalmatites* in having three to five fewer auxiliary elements in their suture lines at equivalent shell diameters. The generic assignment of these Siberian species is thus regarded as incorrect. Unfortunately, Popov (1961) has established both a "*Neodalmatites* Zone" in Siberia and a "Subfamily Neodalmatitinae" based on this misconception of the genus *Neodalmatites,* which is no more than a synonym of *Longobardites* (Tozer 1971, p. 1017).

Specimens from Fossil Hill like those assigned here to *L. parvus*, and in particular like that illustrated by Hyatt and Smith (1905, pl. 58, figs. 16–18) as an example of *L. nevadanus*, were provided with the name *L. hyatti* by Shevyrev (1961, p. 74) because he regarded their suture pattern as being adventitious, unlike some other specimens of *L. nevadanus* described by Hyatt and Smith. These others, like the type specimens of the species, which are too small to have the pseudoadventitious suture pattern developed on them, were regarded by Shevyrev as having a normal suture pattern and were therefore assigned to his new genus *Longobarditoides*. Proper understanding of the ontogenetic development and stratigraphic position of the species to which these Nevada specimens belong obviates the need for the specific name *Longobardites hyatti*, but, as suggested by Assereto (1966, p. 960), the generic name *Longobarditoides* might be usefully applied to shells having a tendency toward a distinctly tricarinate whorl shape.

*Figured specimens.*—Plesiotypes, USNM 248805 to 248808.

*Occurrence.*—USGS localities M139 (1), *Paraceratites clarkei* beds, Rotelliformis Zone; M607 (7), *Paraceratites cricki* beds, Rotelliformis Zone; M137 (2), M141 (9), M607 +2 ft (0.6 m) (3), M608 (1), M611 (12), M613 (1), and M964 (7), *Gymnotoceras blakei* beds, Rotelliformis Zone; M142 (3), *Parafrechites nevadanus* beds, Meeki Zone; M140 (10+), M143 (8), and M960 (15+), *Parafrechites meeki* beds, Meeki Zone; ?M619 (1), *Parafrechites dunni* beds, Meeki Zone, vicinity of Fossil Hill, Humboldt Range, Nev.

**Longobardites zsigmondyi (Böckh)**

*Ammonites (Sageceras) zsigmondyi* Böckh, 1874, p. 177, pl. 4, fig. 14.
*Longobardites zsigmondyi* (Böckh). Mojsisovics, 1882, p. 185, pl. 52, figs. 4a–4c.

**Longobardites cf. L. zsigmondyi (Böckh)**

Plate 21, figures 26–28; text-figure 34

*Longobardites nevadanus* Hyatt and Smith, 1905, p. 132, pls. 58 and 75 [in part]. Smith, 1914, p. 50, pls. 8, 12, and 30 [in part].
*Longobardites* n. sp.? cf. "*Longobardites* indet. ex aff. *L. zsigmondyi*" of Mojsisovics. Silberling, 1962, p. 157.

*Description.*—Oxyconic compressed (W/D about 0.20) at shell diameters exceeding 10 mm; umbilicus closed; venter acute, narrowly tapered, on outer whorl may become slightly fastigate with faint ventral-lateral edges. Maximum observed diameter of complete shell 40 mm, of phragmocone 20 mm. Surface smooth except for convex growth striae.

Venter becomes acute at diameters of 4 mm or less; innermost whorls may have faint umbilical ornamentation like that of *Longobardites parvus*.

Suture with pseudoadventitious *Longobardites* pattern (S1<S2, L1<L2) and proportions at whorl heights exceeding 10 mm; six or more auxiliary saddles (including S3) at whorl-height 15 mm. Lobes weakly digitate, sides of saddles smooth.

*Discussion.*—Of the two species of *Longobardites* described from Nevada, *L.* cf. *L. zsigmondyi* achieved the mature form and suture pattern of *Longobardites* at a smaller size. This apparent accelerated development and the smaller diameter of the full-grown shell are the only essential differences between *L.* cf. *L. zsigmondyi* and *L. parvus*. The rate of maturity with respect to shell

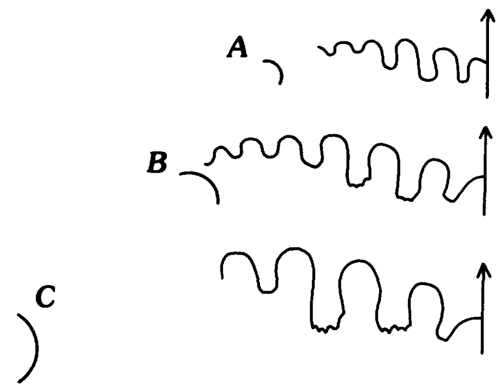


FIGURE 34.—Suture lines (× 5) of *Longobardites zsigmondyi* (Böckh), all reversed. *A, B,* and *C,* all of plesiotype, USNM 248809, at different whorl heights.

diameter of the present species, which is nearly restricted to the lower part of the Occidentalis Zone, may be transitional with the somewhat slower rate characteristic of *L. parvus*, which occurs stratigraphically lower. Gradation, if it exists, between the two species is obscured by the scarcity of *Longobardites* in the higher parts of the Meeki Zone.

Three small specimens of *Longobardites* from separate localities in the upper part of the Occidentalis Zone of the Fossil Hill area, above the occurrence of *L.* cf. *L. zsigmondyi*, have relatively robust, bluntly terminated whorls, weak ribs on the lower flanks, and discrete ventral keels. On the larger two of these specimens the suture is pseudoadventitious (L1<L2) at a whorl height of 10 mm. These may represent another distinct species, morphologically reminiscent of *I. nevadanus* but suturally as advanced as *L.* cf. *L. zsigmondyi*.

According to Mojsisovics, *Longobardites zsigmondyi* (Böckh) typically occurs in the *Protrachyceras reitzi* zone of the southern Alps and differs from *L. breguzzanus*, a possible senior synonym of *I. nevadanus*, in having more auxiliary lobes and in being more compressed with a narrower aperture. Unfortunately, Böckh's only specimen is an internal mold that does not show the configuration of the growth lines. However, convex growth lines, like those of the present specimens from Nevada, are present on the specimen from the *Protrachyceras archelaus* zone illustrated by Mojsisovics (1882, pl. 52, figs. 3a–3b) as "*Longobardites* cf. *zsigmondyi.*"

*Figured specimens.*—Plesiotypes, USNM 248809 and 248810.

*Occurrence.*—?USGS locality M968 (5), *Parafrechites dunni* beds, upper Meeki Zone; USGS localities M144 (5), M144 −6.5 ft (2.0 m) (4), M620 (5), M621 (4), M622 (11), M961 (15+), M962 (20+), M962A (7), ?M623 (1), lower part of Occidentalis Zone, vicinity of Fossil Hill, Humboldt Range, Nev.

**Family APLOCOCERATIDAE Spath, 1951**
**Genus METADINARITES Spath, 1951**
**Metadinarites desertorus (Smith)**

*Dinarites desertorum* Smith, 1914, p. 60, pl. 89, figs. 3–4 [holotype], 5–7; pl. 98, figs. 13–14, 15–16, 17–18.
*Metadinarites desertorus* (Smith). Spath, 1951, p. 37.
[?]*Dinarites? pygmaeus* Smith, 1914, p. 70, pl. 89, figs. 8–9 [holotype].

**?Metadinarites desertorus (Smith)**

Plate 21, figures 29–30; text-figure 35

*?Metadinarites desertorum* (Smith). Silberling, 1962, p. 157.

None of the present specimens from stratigraphically controlled collections is identical with the types of *M. desertorus* (Smith). Nevertheless, two small ammonites from the *Paraceratites cricki* beds, Rotelliformis Zone, are questionably assigned to *M. desertorus* and may be transitional between this species and species of *Aplococeras* that occur stratigraphically higher.

The whorl shape and proportions of the two specimens under consideration here are like that of *Aplococeras smithi* from the overlying *Gymnotoceras blakei* beds. The configuration of the growth striae on their flanks, however, is less sinuous and more nearly rectiradiate compared with the strongly convex and rursiradiate striae characteristic of *Aplococeras*. The suture pattern shown by one of the specimens also differs from that of *Aplococeras* in having a slightly crenulate L1 about equal in depth to VL.

Compared with the holotype of *M. desertorus*, neither of the present specimens is as strongly ornamented, but the specimen illustrated does have a few rectiradiate ribs parallel to the growth striae on the lower flanks. The suture agrees in plan with that of *M. desertorus*, but the lobes are less subdivided and the auxiliary series less distinct, differences that might be attributed to the whorl height represented by Smith's (1914, pl. 89, fig. 7) figured suture being nearly twice that represented by the suture illustrated here. The regular increase in whorl thickness with growth shown by the present specimens is an obvious difference from the typical examples of *M. desertorus* whose robust inner whorls thicken only gradually, producing an extremely shallow umbilicus.

Taken as a whole, the shell proportions, ornament, and suture of the present specimens are intermediate between *Metadinarites* and *Aplococeras*, which suggests that forms with the typical morphology of *Metadinarites desertorus* may occur stratigraphically lower in the Rotelliformis Zone.

*Figured specimen.*—Plesiotype, USNM 248811.

*Occurrence.*—USGS locality M967 (2); *Paraceratites cricki* beds, Rotelliformis Zone, vicinity of Fossil Hill, Humboldt Range, Nev.

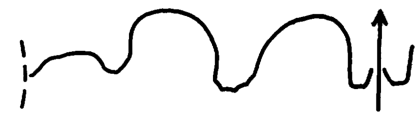

FIGURE 35.—Suture line (× 8) of *?Metadinarites desertorus* (Smith). Plesiotype, USNM 248811.

**Genus APLOCOCERAS Hyatt, 1900**
**Aplococeras smithi n. sp.**

Plate 21, figures 31–37; text-figure 36

*Pseudaplococeras nudus* (Smith). Silberling, 1962, p. 157.

*Description.*—Discoidal, compressed (W/D 0.25–0.30); evolute (U/D 0.40–0.45). Maximum diameter more than 35 mm, probably not much exceeding 40 mm. Whorls thickly ovate in cross section, becoming more compressed with growth.

Ornamentation restricted to transverse striae, which are bundled together forming numerous closely spaced riblets on lower flanks. Course of striae strongly convex, curving back on lower flanks, rectiradiate on upper flank, and forming shallow sinus on venter.

Suture goniatitic to subceratitic. In some specimens L1 and even L2 slightly crenulate. Depth of L1 twice that of VL, nearly three times that of L2. Only one auxiliary saddle external to umbilical seam.

*Discussion.*—The name *Pseudaplococeras nudus* (Smith) was incorrectly applied to this species by Silberling (1962, p. 157). The holotype of *Lecanites nudus* Smith has compressed whorls with nearly parallel flanks and weak umbilical bullae; it is in better morphologic agreement with weakly ornamented variants in populations of *A. vogdesi* (Hyatt and Smith). The paratype (designated the "cotype" by Smith, 1914, pl. 98) of *Lecanites nudus* is too featureless for positive identification; its suture as illustrated by Smith lacks the deep L1 characteristic of *Aplococeras* and in plan is more like that of *Metadinarites*. Because neither *L. nudus* nor the other specific names proposed by Smith are suitable for the present species, a new name, *A. smithi*, is established here.

Some variants of *A. vogdesi*, particularly those in the lower part of its stratigraphic range, have thickly ovate whorls like those of *A. smithi* but differ in having bullae or well-defined ribs on the lower flanks. Other variants of *A. vogdesi* in the upper part of its stratigraphic range lack ribs or bullae but can be distinguished from *A. smithi* by their more compressed whorls and flattened flanks.

*A. smithi* is named in honor of James Perrin Smith.

*Figured specimens.*—Holotype, USNM 248812; paratypes, USNM 248813 to 248815.

*Occurrence.*—USGS localities M607 +2 ft (0.6 m) (1), M608 (5), and M613 (1), *Gymnotoceras blakei* beds,

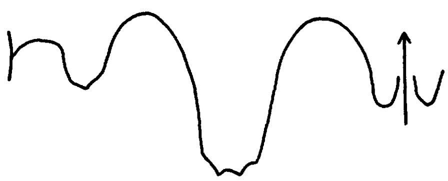

FIGURE 36.—Suture line (× 7) of *Aplococeras smithi* n. sp. Holotype, USNM 248812.

Rotelliformis Zone; M142 (1), M612 (1), and M614 (1), *Frechites nevadanus* beds; Meeki Zone, vicinity of Fossil Hill, Humboldt Range, Nev.

**Aplococeras vogdesi (Hyatt and Smith)**

Plate 22, figures 1–17; text-figure 37

*Lecanites vogdesi* Hyatt and Smith, 1905, p. 139, pl. 60, figs. 12–15 [holotype], 16–17, 18–19?, 20–22?; pl. 75, figs. 10, 11–13?. Smith, 1914, p. 67, pl. 10, figs. 12–15, 16–17, 18–19?, 20–22?; pl. 12, figs. 10, 11–13?; pl. 30, figs. 17, 18–19, 20, 21–22, 23–24, 28?; pl. 88, figs. 24–25.
*Pseudaplococeras vogdesi* (Hyatt and Smith). Spath, 1951, p. 37. Silberling, 1962, p. 157.
*Lecanites crassus* Smith, 1914, p. 66, pl. 89, figs. 1–2 [holotype].
*Lecanites nudus* Smith, 1914, p. 66, pl. 98, figs. 8–9 [holotype], 10–12?.

This species is quite variable in ornamentation and whorl shape. Populations in the lower part of its stratigraphic range tend to have more robust whorls and ornamentation dominated by approximated convex umbilical ribs in comparison with stratigraphically higher populations in which the whorls are commonly narrower and more flat sided and in which the ornamentation consists mainly of irregular umbilical bullae of variable strength. Recognition of more than one species, however, seems impractical because of the wide morphologic overlap between populations from different stratigraphic levels.

The average morphology of *A. vogdesi* differs from that of *A. smithi* in the more pronounced umbilical ribs or bullae of the former. Weakly ornamented variants of *A. vogdesi* resemble *A. smithi* more closely but are generally more compressed with flattened flanks. Such variants occur in the stratigraphically highest populations of *A. vogdesi* and may be forerunners of *A. parvus* from which they differ in having thicker and more involute whorls.

The identity of the genus *Pseudaplococeras* proposed by Spath (1951, p. 37) for *Lecanites vogdesi* of Hyatt and Smith (1905) with the Alpine genus *Aplococeras* was pointed out by Asseretto (1969) who considers the species *A. vogdesi*, as redefined herein, as a synonym of, and the same age as, *A. avisianus*, the holotype of *Aplococeras*.

*Figured specimens.*—Holotype, USNM 74385 (originally figured by Hyatt and Smith, 1905, pl. 60, figs. 12–15), plesiotypes, USNM 248816 to 248823.

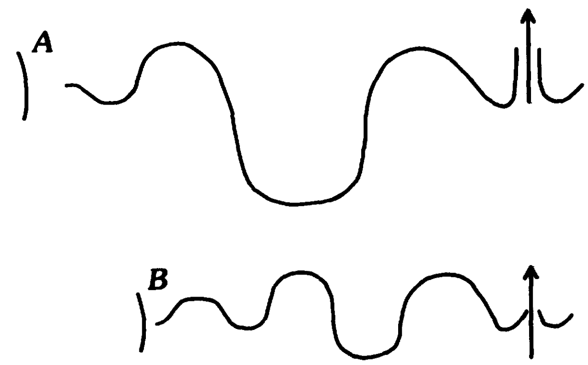


FIGURE 37.—Suture lines (× 7) of *Aplococeras vogdesi* (Hyatt and Smith), reversed. *A*, plesiotype, USNM 248820. *B*, plesiotype, USNM 248821.

*Occurrence.*—USGS localities M140 (5), M143 (1), M958 (16), and M960 (45), *Parafrechites meeki* beds; M167 (3), M618 (2), M619 (12), M959 (9), and M968 (20+), *Parafrechites dunni* beds; Meeki Zone, vicinity of Fossil Hill, Humboldt Range, Nev.

**Aplococeras parvus (Smith)**

Plate 22, figures 18–23; text-figure 38

*Lecanites parvus* Smith, 1914, p. 66, pl. 30, figs. 25–26 [holotype], 27?; pl. 88, figs. 26–28.
*Pseudaplococeras parvus* (Smith). Silberling, 1962, p. 157.

Representatives of this species form a well-defined entity that is morphologically distinct and stratigraphically separated from *A. vogdesi*. The whorls are smooth except for growth striae, and they are thinner (W/D about 0.20) and more loosely coiled (U/D 0.45–0.55) than those of *A. vogdesi*. No specimens transitional between the two species were found, and yet these species are clearly congeneric; both have a goniatitic suture with L1 exaggerated in size and convex rectiradiate growth striae.

The cross section of the whorls was described by Smith (1914) as "miter-shaped," i.e., arched with convex sides and an acute venter. This whorl shape characterizes only the outermost volution; the venter of the inner whorls is broadly rounded, grading imperceptibly into subparallel flattened flanks.

*Figured specimens.*—Plesiotypes, USNM 248824 to 248826.

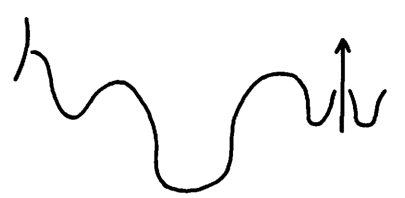

FIGURE 38.—Suture line (× 7) of *Aplococeras parvus* (Smith). Plesiotype, USNM 248826.

*Occurrence.*—USGS localities M144 minus 6 ft (1.8 m) (6), M144 (1), M620 (1), M622 (1), M623 (6), M961 (10), M962 (12), and M962A (2), *Nevadites* beds, Occidentalis Zone, vicinity of Fossil Hill, Humboldt Range, Nev.

**Superfamily NATHORSTITACEAE (Spath, 1951)**
**?Family PROTEUSITIDAE Spath, 1951**
**Genus TROPIGASTRITES Smith, 1914**
**Tropigastrites lahontanus Smith**

Plate 26, figures 5–17

*Tropigastrites lahontanus* Smith, 1914, p. 28, pl. 19, figs. 14–15a [holotype] [not figs. 16–17, 18–19a, 20–21a?, 24–26? = *Tozerites gemmellaroi* (Arthaber)]. Silberling, 1962, p. 157.
*Tropigastrites halli* (Mojsisovics) [in part]. Smith, 1914, p. 27, pl. 18, figs. 11–12, 13–14a?; pl. 88, figs. 14–15? [not specimens on pls. 6, 12, and 88 included in *Tozerites gemmellaroi* (Arthaber); not pl. 14, figs. 7, 7a = *Pseudodanubites? halli* (Mojsisovics)].
*Tropigastrites rothpletzi* Smith, 1914, p. 31, pl. 19, figs. 1–3 [holotype], 4–5, 6–7, 8–9?, 10–11?, 12–13a?, 22–23?; pl. 86, figs. 24–26.
*Tropigastrites neumayri* (Mojsisovics) [in part]. Smith, 1914, p. 29, pl. 18, figs. 15–16a, 17–17a, 18–19?, 20–21a?, 22–23?.
[?] *Gymnites (Anagymnites) rosenbergi* Smith, 1914, p. 55, pl. 26, figs. 2–3a [holotype], 4–5?, 6?.

The discrimination of species in the genus *Tropigastrites* and the choice of specific names among the partly synonomous names proposed by Smith (1914) is not entirely satisfactory. Populations of *Tropigastrites* are evidently quite variable, but the range of variation can seldom be demonstrated in a single collection owing to the scarcity of specimens. Further, isolated, stratigraphically random specimens, like those described by Smith, may agree with variants of more than one of the species based on the collective characters of specimens from different collections representing restricted parts of the section.

*Tropigastrites lahontanus* includes discoidal, compressed (W/D 0.23–0.30, mostly about 0.26), evolute (U/D about 0.5, not less than 0.45) shells with thick whorls, the outer two or three of which are arch shaped in cross section with a broadly fastigate venter. The largest specimens are about 60 mm in diameter. Prosiradiate ornamentation varies in strength from striae to regularly spaced umbilical ribs or bullae. The suture is ceratitic to subammonitic with S1 completely crenulate in some specimens; L1 is about equal to or greater in depth than VL.

*Tropigastrites lahontanus* probably grades into *T. louderbacki*, which is the next higher species in the section and from which it is distinguished mainly by having thinner and more closely coiled whorls.

*Figured specimens.*—USNM 248846 to 248851, 248983.

*Occurrence.*—USGS localities M137 (1), M141 (1), M607 +2 ft (0.6 m) (4), M608 (5), M609 (6), M611 (1), M964 (1); *Gymnotoceras blakei* beds, Rotelliformis Zone, vicinity of Fossil Hill, Humboldt Range, Nev.

**Tropigastrites louderbacki (Hyatt and Smith)**

Plate 26, figures 18–36; text-figure 39

*Sibyllites louderbacki* Hyatt and Smith, 1905, p. 58, pl. 74, figs. 10–12 [holotype].
*Tropigastrites louderbacki* (Hyatt and Smith). Smith, 1914, p. 29, pl. 11, figs. 10–12; pl. 18, figs. 3–6, 9–10a?; pl. 88, figs. 4–5, 6–9, 10–13?. Silberling, 1962, p. 157.
*Tropigastrites powelli* Smith, 1914, p. 31, pl. 18, figs. 1–2, 7–8a; pl. 97, figs. 1–4 [holotype], 5–6, 7–8?, 9–10, 11–12.
*Tropigastrites trojanus* Smith, 1914, p. 32, pl. 17, figs. 1–4 [holotype], 5 and 10?, 6–9, 11–13, 14, 15–19, 20–22?, 23?, 24–27?, 28–30?. Silberling, 1962, p. 157.
*Japonites louderbacki* (Hyatt and Smith). Diener 1915a, p. 158.
[?] *Tropigastrites obliterans* Smith, 1914, p. 30, pl. 87, figs. 27–29 [holotype], 30–32.

This species, which is fairly common in the *Frechites nevadanus* beds, is characterized by thick fastigate whorls whose width may be half again as much as their height. The shell is thus thicker (W/D 0.35–0.50, mostly about 0.40) than in *T. lahontanus* and is also on the average more involute (U/D 0.40–0.50, mostly about 0.45). Eccentric and more open coiling accompanied by an increase in the relative height of the final whorl begins at shell diameters ranging from 20 to 40 mm; much of the morphologic variation within a single population can be attributed to some specimens having matured at smaller diameters than others. Ornamentation consists of prosiradiate umbilical ribs or bullae that fade on the final eccentrumbilicate whorl.

The simple subammonitic suture line as illustrated by Smith (1914) for some of the specimens included in this revised species is correct. S1 is prominent with the crenulation on its flanks decreasing in strength towards its summit. The broad VL, which is divided by a prominent ES, is about equal in depth to L1.

The holotype of *T. trojanus* Smith, the type species of *Tropigastrites* by original designation (Smith, 1914, p. 25), clearly falls within the scope of this expanded species for which *T. louderbacki* is the prior name. However, some specimens assigned by Smith (1914) to *T. trojanus*, like that illustrated by his plate 17, figures 5 and 10, reproduced in Arkell and others (1957, fig. 202, 5a), differ in having narrower and more loosely coiled whorls and may be transitional to *T. lahontanus*, as revised.

*Figured specimens.*—Holotype, USNM 74400 (originally figured by Hyatt and Smith, 1905, pl. 74, figs. 10–12); plesiotypes, USNM 248852 to 248859.

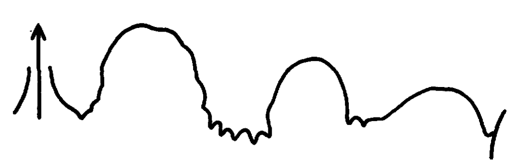

FIGURE 39.—Suture line (× 5) of *Tropigastrites louderbacki* (Hyatt and Smith). Plesiotype, USNM 248852.

*Occurrence.*—USGS localities M137 +4 ft (1.2 m) (1), M142 (3), M166 (22), M612 (1), M614 (25+), M615 (2), and M957 (7); *Frechites nevadanus* beds, Meeki Zone, vicinity of Fossil Hill, Humboldt Range, Nev.

### Genus TOZERITES, n. gen.

*Type species.*—*Tozerites humboldtensis* (Smith).

*Definition.*—Discoidal, compressed, evolute shells having broadly rounded to weakly fastigate outer margin. Ornamented by projected bullate umbilical ribs fading on outer whorl. Suture ceratitic; VL markedly deeper than L1 that is weakly serrate; L2 weakly differentiated.

*Discussion.*—This genus evidently evolved from *Tropigastrites* from which it differs primarily in the proportions and simplicity of its suture. The stratigraphically higher species also differ from *Tropigastrites* in their nonfastigate whorl shape and more projected ribbing. *Tozerites gemmellaroi* is transitional in these characters. The Alpine specimens named *Celtites neumayri* by Mojsisovics (1893, p. 348, pl. 200, figs. 5a–5b, 6) outwardly resemble members of this genus. Smith (1914) applied this specific name to specimens from Nevada, which he placed in *Tropigastrites*, but the suture pattern of Mojsisovics' specimens is unknown. Spath (1951, p. 99) mentioned a large specimen from Bosnia, identified as "*Tropigastrites neumayri*, var. *crassiplicata* (Mojsisovics)," as having VL about twice as deep as L1, which suggests its inclusion in *Tozerites*.

This genus is named in honor of E. T. Tozer.

### Tozerites gemmellaroi (Arthaber)

Plate 27, figures 1–13; text-figure 40

*Celtites halli* (Mojsisovics). Hyatt and Smith, 1905, p. 125, pl. 25, figs. 4–4a [herein selected as lectotype of *Celtites gemmellaroi* Arthaber], 5? [specimen missing], 5a–5b?; pl. 75, figs. 1–1a?, 2–3?, 4–5?.

*Celtites gemmellaroi* Arthaber, 1911, p. 266 [new name for "*Celtites halli* H. & Sm."]

*Tropigastrites halli* (Mojsisovics) [in part]. Smith, 1914, p. 27, pl. 6, figs. 4–4a, 5?, 5a–5b?; pl. 12, figs. 1–1a?, 2–3?, 4–5?; pl. 88, figs. 16–18, 19–20, 21–23 [not specimens on pls. 18 and 88 included in *Tropigastrites lahontanus* Smith; not pl. 14, figs. 7, 7a,= *Pseudodanubites? halli* (Mojsisovics)].

*Tropigastrites lahontanus* Smith, 1914, p. 28, pl. 19, figs. 16–17, 18–19a, 20–21a?, 24–26?.

*Tropigastrites rothpletzi* Smith. Silberling, 1962, p. 157.

*Tropigastrites neumayri* (Mojsisovics) [in part]. Smith, 1914, p. 26, pl. 88, figs. 1–3.

This species, occurring in the *Parafrechites meeki* and *P. dunni* beds of the Meeki Zone, is the stratigraphically lowest species of *Tozerites* and is in some respects transitional with *Tropigastrites*, which ranges up into the lowest beds of the Meeki Zone. Sutures of specimens from the *P. dunni* beds have the unusually deep VL characteristic of *Tozerites*, but sutures cannot be seen on outwardly similar specimens from the *P. meeki* beds, and their generic assignment is thus uncertain; in whorl shape and ornamentation they are similar to *Tropigastrites lahontanus*.

Specimens positively assigned to *T. gemmellaroi* are compressed (W/D 0.20–0.30) and evolute (U/D 0.50–0.60). The largest of these specimens barely exceeds 30 mm in diameter and shows a loss of ornament suggesting maturity. The whorl shape is broadly rounded in the juvenile shell, but the shape of the outer whorl is proportionally narrower and fastigate on most specimens. About 19–20 projected bullate ribs of fairly even spacing and strength characterize inner whorls but fade on outer whorls.

The stratigraphically higher *Tozerites humboldtensis* and *T. polygyratus* lack fastigate whorls at any growth stage and have umbilical ribs that are much more strongly projected.

The lectotype of *T. gemmellaroi* was described and illustrated by Hyatt and Smith (1905) and was misidentified by them as belonging to *Danubites halli* Mojsisovics, for which they used the new combination *Celtites halli* (Mojsisovics). Because this combination was a secondary homonym of the Permian species *Celtites (Paraceltites) halli* Gemmellaro, 1887, Arthaber (1911) proposed *Celtites gemmellaroi* as a replacement for "*Celtites Halli* H. & Sm." Although Arthaber was probably unaware that the specimens included by Hyatt and Smith in *Celtites halli* (Mojsisovics) were misidentified, his name, *Celtites gemmellaroi*, is nonetheless the first and only available name for ammonites of this kind.

*Figured specimens.*—Lectotype, USNM 74305 (originally figured by Hyatt and Smith, 1905, pl. 25, figs. 4–4a); plesiotypes, USNM 248860 to 248864.

*Occurrence.*—Questionably represented from USGS localities M140 (1), M143 (3), M167 (1), M958 (6), and M963 (4), *Parafrechites meeki* beds; positively identified from M618 (6), M619 (9), M959 (6+), and M968 (7), *Parafrechites dunni* beds; Meeki Zone, vicinity of Fossil Hill, Humboldt Range, Nev.

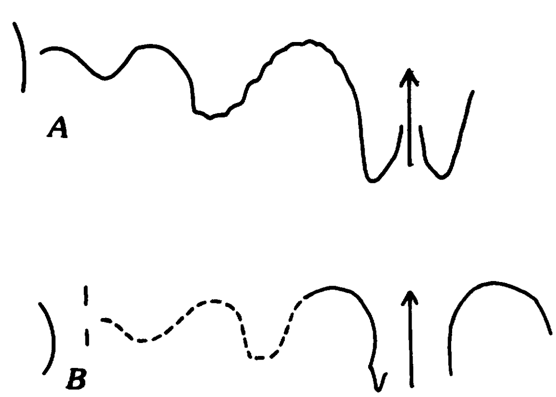


FIGURE 40.—Suture lines of *Tozerites gemmellaroi* (Arthaber). *A*, plesiotype, USNM 248864 (× 8). *B*, lectotype, USNM 74305 (× 5), dashed where approximate.

**Tozerites humboldtensis (Smith)**

Plate 27, figures 14–23; text-figure 41

*Columbites humboldtensis* Smith, 1914, p. 36, pl. 20, figs. 26–28 [holotype]; pl. 87, figs. 1–3, 4–5, 6–9, 10–11, 12–14?.
*Columbites plicatulus* Smith, 1914, p. 37, pl. 20, figs. 15–16 [holotype], 17–18, 19–22, 23?, 24–25?; pl. 87, figs. 15–16, 17–18, 19–23.
*Celtites? humboldtensis* (Smith). Silberling, 1962, p. 157.

This species is in some respects transitional between *Tozerites gemmellaroi* and *T. polygyratus*. Though it is stratigraphically intermediate between these two species, morphologic intergradation with them has not been observed.

The proportions of the evolute (U/D 0.45–0.55), thick-whorled (W/D 0.30–0.35) shell are like those of the inner whorls of *Tozerites gemmellaroi*, from which *T. humboldtensis* differs in lacking a fastigate final whorl, in having a more subquadrate whorl shape with better defined flanks, and in having the strongly prosiradiate umbilical ribs and bullae irregularly spaced and of uneven strength. The whorl shape and prosiradiate ribbing in turn resemble that of *T. polygyratus*, from which *T. humboldtensis* differs in having more tightly coiled and thicker whorls and irregular spacing and strength of the ribs.

*"Columbites" plicatulus* was described by Smith as a separate species with more robust whorls and coarser sculpture than *"C." humboldtensis*. Complete gradation between these two forms is suggested by specimens from a single bed; consequently the name *T. humboldtensis* (Smith) is revised to include both forms named by Smith.

*Figured specimens.*—Plesiotypes, USNM 248865 to 248869.

*Occurrence.*—USGS localities M144 (6), M144 minus 6 ft (1.8 m) (1), M620 (4), M621 (1), and 962 (4); *Nevadites hyatti* and *N. humboldtensis* beds; Occidentalis Zone, vicinity of Fossil Hill, Humboldt Range, Nev.

FIGURE 41.—Suture line (× 5) of *Tozerites humboldtensis* (Smith). Plesiotype, USNM 248991, specimen not figured.

**Tozerites polygyratus (Smith)**

Plate 27, figures 24–29

*Celtites polygyratus* Smith, 1914, p. 35, pl. 20, figs. 1–2 [holotype], 3, 4, 5–6?, 7–8a?.
*Celtites gabbi* Smith. Silberling, 1962, p. 157.
[?] *Celtites gabbi* Smith, 1914, p. 34, pl. 20, figs. 9–10 [designated here as lectotype], 11–12, 13–14?.

This species is distinguished by its compressed (W/D 0.25–0.30), extremely evolute (U/D 0.55–0.60) shell and its subquadrate whorl shape. The venter is broadly rounded and grades into flattened, subparallel flanks, which on the inner whorls are ornamented by regularly spaced strongly prosiradiate ribs.

Unfortunately, the suture is unknown except for the goniatitic pattern drawn by Smith (1914, pl. 20, fig. 8a) from a specimen presumably of this species only several millimeters in diameter.

Specific separation of *"Celtites gabbi"* Smith from typical *Tozerites polygyratus*, from which it differs in having higher, narrower whorls and more delicate ribbing, seems impractical, though intergradation of the two forms at the same stratigraphic level cannot be demonstrated by the present collections. *"Celtites gabbi"* was proposed by Smith as a new name for *"Goniatites laevidorsatus* (Hauer)" of Gabb (1864) [not *"Clydonites laevidorsatus* (Hauer)" of Meek (1877) = *Danubites halli* Mojsisovics, 1896], but it is unclear whether Smith intended Gabb's specimen or one of his own to serve as holotype. Seven specimens representing *Pseudodanubites*?, *Aplococeras*, *Tropigastrites*, and possibly *Tozerites*, were found in the collections of the Academy of Natural Sciences of Philadelphia (lot ANSP 30782) associated with Gabb's original label, but none of these agrees closely with Gabb's figure of *"Goniatites laevidorsatus."* Although *"C. gabbi"* is considered a probable synonym of *Tozerites polygyratus*, to avoid possible confusion the largest of the specimens figured by Smith (1914, pl. 20, figs. 9–10) is selected here as lectotype of *Celtites gabbi* Smith.

*Figured specimens.*—Plesiotypes, USNM 248870 to 248872.

*Occurrence.*—USGS localities M622 (10+), M624 (3), M626 (1), and M962A (1), upper part of *Nevadites* beds; Occidentalis Zone, vicinity of Fossil Hill, Humboldt Range, Nev.

**Family THANAMITIDAE Tozer, 1971**
**Genus THANAMITES Diener, 1908**
**Thanamites? contractus (Smith)**

Plate 6, figures 12–14

*Nannites contractus* Smith, 1914, p. 45, pl. 21, figs. 13–15 [holotype], 16–17a.
*Nannites? contractus* Smith. Silberling, 1962, p. 157.

A single small specimen from the *Nevadites* beds agrees closely in whorl shape, development, and size with this species. The shell of this specimen is globose and moderately involute to a diameter of 7 or 8 mm, after which the coiling becomes eccentric and the whorl shape narrow and subtrigonal. This modification appears to be that of the final whorl, though the greatest diameter is only 12 mm. The suture illustrated by Smith (1914, pl. 21, fig. 17a) from a minute specimen assigned to this species is goniatitic and normal, VL having a depth equal to that of L1. As such it is like that of *Thanamites* from the Ladinian of British Columbia (E. T. Tozer, written commun., 1974). The specimens from Nevada also resemble this genus in general form and excentrumbilicate coiling, and hence they are questionably assigned to *Thanamites* rather than retained in the typically Karnian genus *Nannites*.

*Figured specimen.*—Plesiotype, USNM 248647.

*Occurrence.*—USGS locality M144 (1), *Nevadites humboldtensis* beds, Occidentalis Zone, vicinity of Fossil Hill, Humboldt Range, Nev.

**Superfamily ARCESTACEAE (Mojsisovics, 1875)**
**Family ARCESTIDAE**
**Genus PROARCESTES Mojsisovics, 1893**
**Proarcestes balfouri (Oppel)**

*Ammonites balfouri* Oppel, 1863, p. 285, pl. 80, fig. 5.
*Proarcestes balfouri* (Oppel). Diener, 1895, p. 83, pl. 27, figs. 6, 7a–7c.

**Proarcestes cf. P. balfouri (Oppel)**

Plate 27, figures 30–35; text-figure 42

*Arcestes (Proarcestes) hartzelli* Smith, 1914, p. 43, pl. 93, figs. 17–18 [holotype].
*Arcestes (Proarcestes) quadrilabiatus* Hauer. Smith, 1914, p. 44, pl. 93, figs. 15–16.
*Arcestes (Proarcestes)* cf. *A. (P.) bramantei* Mojsisovics. Silberling, 1962, p. 157.

*Proarcestes* from the Rotelliformis Zone and the lower part of the Meeki Zone are readily distinguished from those occurring higher in the Meeki Zone and in the Occidentalis Zone by their more globose shell and semicircular ventral outline. Assignment of these specimens to a distinct species is thus justified, but the choice of a specific name is complicated by the profusion of available names, many of which are very narrow in concept. The whorl shape, shell proportions, and suture line of the present specimens are closely similar to those of *Arcestes (Proarcestes) balfouri* (Oppel) from the Himalayan Middle Triassic as well as to those of several subsequently described species of about the same age such as *A. (P.) bramantei* Mojsisovics. The validity of these various species, which are distinguished by minor differences such as slight variations in shell proportions or in the number and configuration of constrictions, cannot be evaluated on the basis of their published descriptions. Moreover, the available material from the Humboldt Range, including the specimens described by Smith, is inadequate for detailed comparison. Consequently, the arcestids from the lower part of the upper Anisian are tentatively assigned to *P. balfouri*, which was the first to be named among several closely related and probably partly synonymous species.

Compared with *P. gabbi*, which occurs stratigraphically higher, *P.* cf. *P. balfouri* has a wider shell (W/D 0.80–1.0) and a semicircular rather than parabolic ventral outline. The suture line of both species is similar. ES is elongate, more than half the height of S1, and has parallel subdivided flanks; S1 is asymmetric owing to a pronounced first-order subdivision on its ventral side.

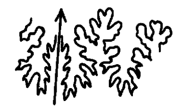

FIGURE 42.—Suture line (× 2) of *Proarcestes* cf. *P. balfouri* (Oppel), reversed. Plesiotype, USNM 248992, specimen not figured.

*Figured specimens.*—Plesiotypes, USNM 248873 and 248874.

*Occurrence.*—USGS locality M965 (4), *Paraceratites burckhardti* beds; M967 (1), *Paraceratites cricki* beds; M137 (4), M608 (10), and M609 (1), *Gymnotoceras blakei* beds; Rotelliformis Zone; M612 (1) and M615 (2), *Parafrechites nevadanus* beds; M960 (1?), *Parafrechites meeki* beds; M167 (2?), *Parafrechites dunni* beds; Meeki Zone, vicinity of Fossil Hill, Humboldt Range, Nev.

**Proarcestes gabbi (Meek)**

Plate 27, figures 36–45;
Plate 28, figures 1–2; text-figure 43

*Arcestes gabbi* Meek, 1877, p. 121, pl. 10, figs. 6–6a [holotype], 6b.
*Arcestes ausseanus* Hauer. Gabb, 1864, p. 25, pl. 3, figs. 16–17.
*Arcestes (Proarcestes) gabbi* Meek. Smith, 1914, p. 43, pl. 14, figs. 6–6a, 6b; pl. 21, figs. 1–2; pl. 48, figs. 1–3; pl. 93, figs. 19–19a, 20. Silberling, 1962, p. 157.

This species is characteristic of the Occidentalis Zone. Compared with *Proarcestes* cf. *P. balfouri* from lower in the section, it has a relatively compressed shell (W/D 0.70–0.85 at about 20 mm in diameter, 0.55–0.75 at larger diameters) and a parabolic rather than semicircular ventral outline. The maximum size exceeds 75 mm in diameter.

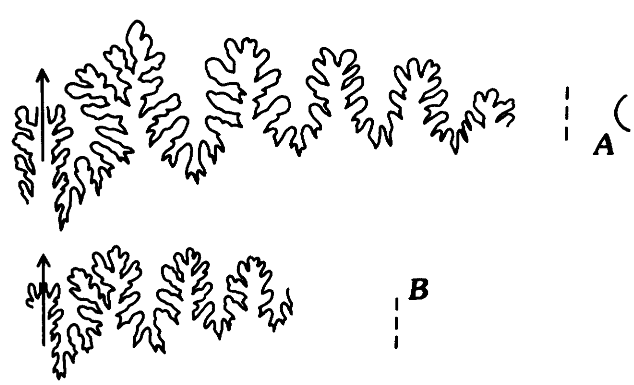


FIGURE 43.—Suture lines (× 2) of *Proarcestes gabbi* (Meek). *A*, plesiotype, USNM 248878. *B*, plesiotype, USNM 248877.

The range in shell proportions within a single population is illustrated by figure 44. Unfortunately, the collections of *P.* cf. *P. balfouri* are insufficient for graphical treatment, but several specimens from different localities in the *Gymnotoceras blakei* beds are plotted for comparison.

*Proarcestes gabbi* may be synonymous with *P. extralabiatus* Mojsisovics from the Alpine Middle Triassic, but the two species are not comparable without knowing the morphologic limits of populations including typical specimens of *P. extralabiatus* Mojsisovics.

*Figured specimens.*—Holotype, USNM 12523 (originally illustrated by Meek, 1877, pl. 10, figs. 6-6a); plesiotypes, USNM 248875 to 248878.

*Occurrence.*—USGS locality M968, *Gymnotoceras dunni* beds, Meeki Zone; M144 −6 ft (1.8 m) (6), M144 (6), M620 (1), M961 (1), M962 (100+), M146 (15+), M623 (12+), and M624 (2), Occidentalis Zone. ?USGS locality M627 (1), lowermost Subasperum Zone. Vicinity of Fossil Hill, Humboldt Range, Nev.

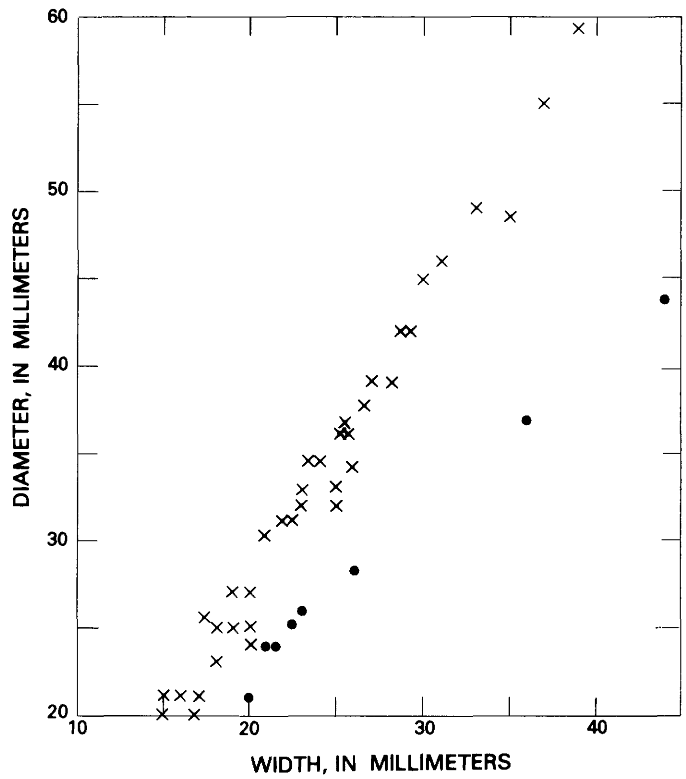


FIGURE 44.—Scatter diagram of shell width plotted against corresponding diameter for 37 specimens of *Proarcestes gabbi* from USGS locality M962 in the *Nevadites hyatti* beds (crosses). Equivalent points (dots) for several specimens of *P.* cf. *P. balfouri* from different localities in the *Gymnotoceras blakei* beds are plotted for comparison.

#### Genus PROTRACHYCERAS Mojsisovics, 1893

Several species of Protrachyceras have been described from the Subasperum Zone immediately overlying the Occidentalis Zone in the Humboldt Range. The boundary between these two zones is more or less coincident with the gradational contact between the impure calcareous rocks of the Fossil Hill Member of the Prida Formation, which locally are highly fossiliferous, and the dark, laminated limestone and dolomite of the upper member of the Prida Formation in which fossils are generally scarce. Consequently, collections from the Subasperum Zone are meager, and stratigraphically successive population samples that would demonstrate the taxonomic and stratigraphic relations of the previously described species of *Protrachyceras* are not available.

The few isolated specimens of this genus collected during the present study indicate that the type specimens of the following species were derived from the lowermost part of the Subasperum Zone within ten meters or so stratigraphically above the occurrence of *Nevadites:*

*Protrachyceras subasperum* (Meek, 1877) [= *Trachyceras judicaricum* var. *subasperum* Meek, 1877, pl. 11, figs. 2-2b] *P. meeki* (Mojsisovics, 1882, p. 108 [= *"Trachyceras judicaricum* Mojsisovics" of Meek, 1877, pl. 11, figs. 1-1a].

*P. americanum* (Mojsisovics, 1886, p. 149) [= *Ceratites whitneyi* Gabb, 1864, pl. 4, figs. 12-12a].

*P. lahontanum* Smith, 1914.

*P. dunni* Smith, 1914.

The type specimens of the first three species listed are reillustrated here by figures 12–16, plate 24 and figures 1–5, plate 25. *Protrachyceras springeri*, described from an unknown locality and stratigraphic position in the northern Humboldt Range by Smith (1914, p. 136), differs from the species listed above in having a more discrete, narrow ventral furrow and is more like specimens collected at a considerably higher stratigraphic level in the Prida Formation. *Ammonites homfrayi* Gabb, assigned to *Protrachyceras* and provisionally listed as being represented in the Fossil Hill fauna by Smith (1914, p. 11) is a *Sirenites* of probable Late Triassic age.

*Protrachyceras subasperum, P. americanum,* and *P. lahontanum* form a closely related group characterized by a relatively broad and indistinct ventral furrow and a similar pattern of tuberculation. Persistent umbilical, ventral-lateral, and ventral spiral rows of tubercles are common to all three species; two additional rows of spines, an upper lateral and a lower lateral row making a total of five rows, may have completed the basic pattern on the inner whorls. With growth the lateral spines became obsolescent or one lateral row became obsolete while the other became emphasized as widely spaced tubercles of exaggerated size. This kind of ontogenetic development, which results in mature whorls like those of the type specimens of these three species, is shown by small collections associated with *Daonella rieberi* and *Frechites johnstoni.* Small mutually occurring specimens in such collections show a fairly wide range in morphology, as might be expected, and range from relatively compressed, involute, finely sculptured individuals to those with more robust, evolute, and coarsely sculptured whorls. These variations that can be demonstrated among small individuals suggest that some of the obvious differences in shell proportions and ornamentation among large shells, like the type specimens, may be due to variation in ontogenetic development within a single species.

The holotype of *P. meeki* represents another closely related form with a similarly developed ventral furrow but with duplication of the lateral rows of spines, producing a total of seven rows in which the spines are of more or less equal strength. This pattern may persist to large shell diameters as shown by the plesiotype figured by Hyatt and Smith (1905, pl. 59, figs. 1–2) on which two of the lateral spine rows first commence to become enlarged at the expense of the other two at a shell diameter of about 80 mm.

Contrary to Smith's (1914, p. 134) description, *P. dunni* differs from the other species of *Protrachyceras* considered here in lacking a distinct ventral furrow. The ventral spines alternate across the midline of the venter and are connected in crisscross fashion by continuations of the ribs. It should be noted that the holotype and only described specimen of this species is partly pathologic; a healed injury of some kind has displaced the venter to one side and altered the spacing of the lateral tubercles for about one-fifth of the outer whorl. Assuming that this abnormality is not related to its more general morphologic distinctions, the simple tuberculation and poorly developed ventral furrow suggest that this species is transitional between *Nevadites* and *Protrachyceras*. Possibly conspecific with *P. dunni* are the holotype of *Nevadites barberi*, which has more regular and stronger tuberculation than *N. gabbi* and a venter like that of *P. dunni*, and one of the specimens originally illustrated by Hyatt and Smith (1905, pl. 74, figs. 1–3) as *Trachyceras (Anolcites) meeki.*

**Superfamily CLYDONITACEAE (Mojsisovics, 1879)**
**Family ARPADITIDAE Hyatt, 1900**
**Subfamily SIRENITINAE, Tozer, 1971**
**Genus SIRENITES Mojsisovics, 1893**
**Sirenites homfrayi (Gabb)**

Plate 25, figures 6–7; text-figure 45

*Ammonites homfrayi* Gabb, 1864, p. 26, pl. 4, figs. 18–19.
*Trachyceras (Protrachyceras) homfrayi* (Gabb). Smith, 1914, p. 134, pl. 16, figs. 11–13.
*Trachyceras (Paratrachyceras) homfrayi* (Gabb). Kutassy, 1933, p. 682.

This species, which is not part of the Middle Triassic fauna of the Humboldt Range, is redescribed here to prevent further confusion concerning its identity and age.

*Description of holotype.*—Partly crushed, completely septate internal mold. Discoidal, compressed, and moderately involute in shape. Maximum measureable diameter about 47 mm, corresponding maximum width about 13 mm, width of umbilicus 8.5 mm.

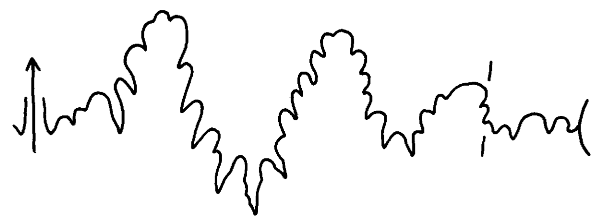

FIGURE 45.—Suture line (× 3) of *Sirenites homfrayi* (Gabb). Holotype, ANSP 30793.

Ornamented by closely spaced falcoid ribs bearing small spines in spiral rows of varying strength. Ribs originate at umbilical shoulder or by intercalation on lower flanks. Number of spiral spine rows obscure, at least eight including umbilical and ventral-lateral rows. Ribs split at ventral-lateral tubercles, project strongly forward to ridges bordering ventral furrow, and form closely spaced elongate ventral tubercles slanting forward and towards the ventral midline, giving the ventral ridges a ropelike appearance. Ventral furrow narrow and distinct.

Suture ammonitic. S1 and S2 narrow with converging sides, deeply scalloped. L1 with incipient secondary subdivision, much larger than L2. One discrete auxiliary saddle at umbilical shoulder.

*Discussion.*—Confusion concerning generic assignment and age of this species has resulted from the inadequacies of Gabb's original description and illustrations. According to Gabb (1864, p. 26–27), *Ammonites homfrayi* was collected with *"Ammonites" billingsianus* Gabb at an unspecified locality in the East Range, the next range east of the Humboldt Range. Under the impression that the latter species was a *Monophyllites* like that found in the upper Anisian at Fossil Hill, Smith (1914) assigned *"A." homfrayi* to *Protrachyceras*, though he stated that no specimens from his *"Daonella dubia* zone" could positively be identified with it and that it may have come from higher in the Middle Triassic than the beds equivalent to the *Ceratites trinodosus* zone.

Kutassy (1933, p. 682) placed *"A." homfrayi* in *Paratrachyceras* and regarded it as Anisian in age. This generic assignment was also adopted by Spath (1951, p. 42–43), who regarded the age of the species as Ladinian.

Evidently none of these authors had an opportunity to examine the type specimen, which was located by us in the reference collections of the Academy of Natural Sciences of Philadelphia, and they were misled by Gabb's original drawing, which fails to show the splitting of the ribs at the ventral-lateral shoulder and the consequent doubling of the number of tubercles on the ridges bordering the ventral furrow. These features, in addition to the suture line, clearly place *"A." homfrayi* in the genus *Sirenites*. It is similar to the species in the group of *S. senticosus* described by Mojsisovics (1893, p. 727–740) from the lower Karnian of the Alps, and thus it was probably collected from the Smelser Pass Member of the Augusta Mountain Formation, which is largely Karnian in age (Nichols and Silberling, 1977).

*Figured specimen.*—Holotype, ANSP 30793 (originally illustrated by Gabb, 1864, pl. 4, figs. 18–19).

**Order PHYLLOCERATIDA**
**Superfamily PHYLLOCERATACEAE (Zittel, 1884)**
**Family USSURITIDAE Hyatt, 1900**
**Genus USSURITES Hyatt, 1900**
**Ussurites cf. U. arthaberi (Welter)**

Plate 32, figures 3–4; text-figure 46

*Ammonites billingsianus* Gabb. Gabb, 1870, p. 8, pl. 5, fig. 3.
*Monophyllites billingsianus* (Gabb). Hyatt and Smith, 1905, p. 94, pl. 24, figs. 3–4. Smith, 1914, p. 48, pl. 5, figs. 3–4 [not pl. 22 = *Monophyllites* cf. *M. sphaerophyllus* (Hauer); not pl. 48, figs. 8–9 = *Monophyllites* cf. *M. agenor* (Münster)].
cf. *Monophyllites arthaberi* Welter, 1915, p. 115, pl. 89, figs. 1a–1c.
cf. *Ussurites arthaberi* (Welter). Spath, 1934, p. 301.
*Ussurites billingsianus* (Gabb). Spath, 1934, p. 286, fig. 100i.

The only phylloceratacids found in the Middle Triassic of the Humboldt Range during the present study were a few specimens from the Hyatti Zone that are comparable to *Ussurites arthaberi* Welter.

As noted by Spath (1934, p. 299), the specimen from the Whitney Collection (Museum of Comparative Zoology, Harvard University) illustrated as *"Monophyllites billingsianus"* by Hyatt and Smith (1905, pl. 24, figs. 3–4), and reillustrated by Smith (1914, pl. 5, figs. 3–4), is a *Ussurites*. It agrees with those illustrated here as *Ussurites* cf. *U. arthaberi* in having only three distinct saddles on its external suture and in lacking subdivision on the ventral side of the second saddle. The locality of this specimen is given only as "Middle Triassic, East Range, Humboldt Mountains, Nevada."

The specimen described by Gabb (1870, pl. 5, fig. 3) as *"Ammonites billingsianus,"* subsequent to his (Gabb,


FIGURE 46.—Suture lines (× 2) of *Ussurites* cf. *U. arthaberi* (Welter). *A*, plesiotype, USNM 248919. *B*, plesiotype, USNM 248993, specimen not figured.

1864) original description of this species, is also a *Ussurites* like *U. arthaberi*. No locality was given for this specimen by Gabb who erroneously regarded its suture as that characteristic of his species *"Ammonites" billingsianus*.

*Figured specimen.*—Plesiotype, USNM 248919.

*Occurrence.*—USGS locality M533 (1); USGS Mesozoic localities M1181 (1) and M1185 (1); float from Hyatti Zone in northern part of the Humboldt Range, Nev.

**Genus MONOPHYLLITES Mojsisovics, 1879**
**Monophyllites cf. M. sphaerophyllus (Hauer)**

cf. *Ammonites sphaerophyllus* Hauer, 1850, p. 113, pl. 18, figs. 11a–11d.
cf. *Monophyllites sphaerophyllus* (Hauer). Mojsisovics, 1882, p. 206, pl. 79, figs. 1–2, 3.
*Monophyllites billingsianus* (Gabb). Smith, 1914, p. 48, pl. 22, figs. 1–2?, 3–4a, 5? [not pl. 5, figs. 3–4 = *Ussurites* cf. *U. arthaberi* (Welter); not pl. 48, figs 8–9 = *Monophyllites* cf. *M. agenor* (Münster)].

Three specimens from the fossiliferous upper Anisian or lowermost Ladinian beds at Fossil Hill are illustrated by Smith (1914) as *"Monophyllites billingsianus."* Shell fragments of *Daonella* in the matrix of the specimen illustrated by figures 3–4a on Smith's plate 22 confirm this stratigraphic assignment. As pointed out by Spath (1934, p. 300), the suture of this specimen has the slightly more complex subdivision of the second saddle that distinguishes *Monophyllites* from *Ussurites*, and it is comparable to the suture of *Monophyllites sphaerophyllus* (Hauer).

Spath noted that according to Smith's locality data *Monophyllites* and *Ussurites* evidently occur together in Nevada, but this is not necessarily so: the *Monophyllites* from Fossil Hill illustrated by Smith are younger than the *Ussurites* illustrated here from the northern part of the Humboldt Range, and the localities and stratigraphic positions of the *Ussurites* illustrated by Gabb (1870), Hyatt and Smith (1905), and Smith (1914) are unknown.

**Monophyllites cf. M. agenor (Münster)**

Plate 32, figures 1–2; text-figure 47

cf. *Ammonites (Ceratites) agenor* Münster, 1834, p. 15, pl. 2, fig. 9.
*Ammonites billingsianus* Gabb, 1864, p. 26, pl. 5, figs. 20–20a.
cf. *Monophyllites agenor* (Münster). Mojsisovics, 1882, p. 205, pl. 78, figs. 6, 7, 8–9.
cf. *Mojsvarites agenor* (Münster). Mojsisovics, 1902, p. 316.
*Monophyllites billingsianus* (Gabb). Smith, 1914, p. 48, pl. 48, figs. 8–9 [not pl. 22 = *Monophyllites* cf. *M. sphaerophyllus* (Hauer); not pl. 5, figs. 3–4 = *Ussurites* cf. *U. arthaberi* (Welter)].

A specimen recently located by us in the collections of the Academy of Natural Sciences of Philadelphia is

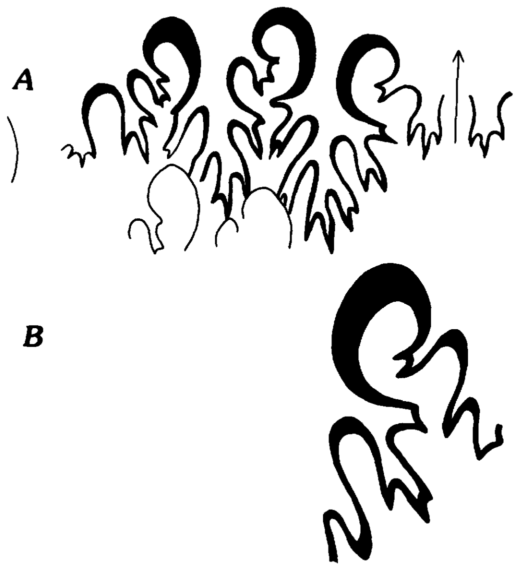


FIGURE 47.—Suture lines (natural size) of *Monophyllites* cf. *M. agenor* (Münster). *A*, holotype, ANSP 30794, at whorl height of 20.5 mm. *B*, ventral saddle of same specimen at whorl height of 33 mm.

believed to be the holotype of *Ammonites billingsianus* Gabb. Although it bore no identifying marks or labels when found in the ANSP collections, it agrees closely with Gabb's original description and generalized illustration. A note, apparently written by Alpheus Hyatt, accompanied the specimen and reads: "This is undoubtedly *Amm. Billingsianus* Gabb and I think it is the type—A.H."

Although *Ammonites billingsianus* has previously been regarded as both an Anisian *Monophyllites* or *Ussurites*, probably because of the simple suture of a specimen erroneously illustrated by Gabb (1870) under this specific name, the holotype is a *Monophyllites* comparable to *M. agenor* (Münster). According to Gabb (1864, p. 27), *Ammonites billingsianus* was found in the East Range of Nevada along with *Ammonites homfrayi* Gabb, which is shown here to be a *Sirenites* of early Karnian age. As *Monophyllites agenor* is characteristic of the Alpine early Karnian (Mojsisovics, 1882, p. 206, 209), the ages of *Ammonites billingsianus* Gabb [= *Monophyllites* cf. *M. agenor* (Münster)] and *Ammonites* [= *Sirenites*] *homfrayi* Gabb, based on the proper identification of their holotypes, are thus in agreement. Neither of these species is a component of the Middle Triassic fauna of the Humboldt Range.

*Description of holotype.*—Completely septate; somewhat sheared along plane of symmetry. Maximum preserved diameter about 90 mm; corresponding maximum width about 34 mm and width of umbilicus about 30 mm. Whorls slightly more compressed than shown in Gabb's cross section (Gabb, 1864, pl. 5, fig. 20a); W/H about 0.76.

Surface of outer shell, as preserved in patches, nearly smooth, lacking regular transverse striation.

Suture line monophyllic with incipient diphyllic subdivision of all three lateral saddles, like that typical of *Monophyllites*.

Fragments of trachyceratid ammonites included in matrix.

*Figured specimen.*—Holotype, ANSP 30794 (originally illustrated by Gabb, 1864, pl. 5, figs. 20–20a).

**Subclass NAUTILOIDEA**
**Order NAUTILIDA**
**Family TAINOCERATIDAE Hyatt, 1883**
**?Genus AULAMETACOCERAS Miller and Unklesbay, 1942**
***Aulametacoceras? humboldtensis* n. sp.**

Plate 31, figures 2–5.

*Description.*—Whorls depressed, subtrapezoidal (e.g., holotype having W/H = 1.85) to subquadrate (e.g., paratype having W/H = 1.5). On paratype U/D of internal mold is 0.27. Paratype, of which orad half of outer whorl is body chamber, is largest available specimen and has maximum preserved diameter about 50 mm.

Venter biconvex with median sulcus; ventrolateral shoulders angular; flanks broadly convex to flat; umbilical shoulders broadly rounded on internal mold, narrowly rounded on outer shell; umbilical walls steep.

Three longitudinal ridges on venter on either side of ventral sulcus; ridges evenly spaced between ventrolateral shoulder and edge of sulcus; interspaces broader than ridges. Width across sulcus between the ridges bordering it about one-fourth width of venter. Ventrolateral shoulder marked by row of tubercles, density of which estimated as 25–30 per volution. Ventrolateral tubercles project onto outer flanks as low, slightly rursiradiate folds that fade on flanks; flanks otherwise unornamented. Umbilical shoulder apparently not ornamented.

Suture as for family; siphuncle unknown.

*Discussion.*—Kummel (1953, p. 27) characterized *Aulametacoceras* as having "the general physiognomy of *Metacoceras* but with longitudinal ribs on the venter," and following Miller and Unklesbay (1942, p. 726) he included in it besides the Permian type species, *A. mckeei* Miller and Unklesbay, the Karnian species *Nautilus rectangularis* Hauer. Like *N. rectangularis*, the new species *Aulametacoceras? humboldtensis* differs from typical *Aulametacoceras* in having a more subquadrate whorl shape, in having a median sulcus more or less differentiated from the rest of the venter, and in lacking tuberculation of the umbilical margin. From *Nautilus rectangularis, Aulametacoceras? humboldtensis* differs mainly in its more involute proportions and broader, more rapidly expanding whorls. Hence these two Triassic species resemble each other much more than they do the type species of *Aulametacoceras*, and they might justifiably be placed in a distinct genus except that ornate tainoceratids are presently too poorly represented to allow grouping of the few described species into phylogenetically meaningful genera.

The Lower or Middle Triassic specimen from the Primoyre Region of the U.S.S.R. described by Kiparisova (1961, p. 16, pl. 1, figs. 4a-4c) as a new species and subgenus of *Pleuroceras*, i.e., *P. (Ussurinautilus) amurensis*, is similar to *A.? humboldtensis* in the configuration and ornamentation of its venter, but it is said to have lateral ribs and longitudinal ridges.

*Figured specimens*.—Holotype, USNM 248912; paratype, USNM 248913.

*Occurrence*.—USGS locality M533 [1 (paratype)]; USGS Mesozoic localities M2369 (1), and M2359 [2 (including holotype)]; Hyatti Zone in northern part of Humboldt Range, Nev.

### Genus GERMANONAUTILUS Mojsisovics, 1902
### Germanonautilus furlongi Smith

Plate 32, figures 5–6

*Germanonautilus furlongi* Smith, 1914, p. 142, pl. 95, figs. 1-2. Kummel, 1953, p. 29, pl. 3, figs. 12–13, text-fig. 12.

Two large specimens of this species, each of which is about the same size as Smith's holotype or Kummel's plesiotype, were collected as float from the upper Anisian beds at collecting-site C near Fossil Hill. One specimen was associated in the same block with a specimen of *Parafrechites meeki*, and the matrix of the other agrees lithologically with the rock type unique to the *Parafrechites dunni* beds; hence both specimens were probably derived from the Meeki Zone.

On one of these specimens, a phragmocone having a maximum preserved diameter of about 95 mm, the outer shell is remarkably well preserved and shows the finer details of ornamentation. The growth striae are markedly biconvex on the flanks and strongly rursiradiate near the umbilical margin. On the venter they describe a deep hyponomic sinus. The abrupt umbilical shoulder is ridgelike, and, as shown on the holotype, is bordered by shallow furrows on the adjacent part of the umbilical wall and lower flank. The ventrolateral shoulder, which on the internal mold is broadly rounded, has on the outer shell two angulations, each of which is expressed as a faint longitudinal ridge. On the ventral surface are several more faint longitudinal ridges. The surface of an intermediate shell layer on the venter bears Runzelschichten ornamentation in addition to fine lirae that form a reticulate pattern with the impressions of the growth striae.

The small bodychamber segment illustrated by figures 5–6 on plate 32 was also collected as float from collecting-site C and was probably derived from the *Parafrechites dunni* beds of the Meeki Zone. Umbilical and ventrolateral ridges on this specimen correspond to those on the larger specimen described above, but are more strongly expressed, the ventrolateral ridges being visible on the internal mold. On the outer shell, which is preserved in small patches, bundling of the growth striae where they pass over these ridges produces a faint irregular tuberculation suggestive of that of *Mojsvaroceras*.

*Figured specimen*.—Plesiotype, USNM 248920.

*Occurrence*.—Float at USGS locality M608, Meeki Zone, Fossil Hill, Humboldt Range, Nev.

### Family GRYPOCERATIDAE Hyatt *in* Zittel, 1900
### Genus GRYPOCERAS Hyatt, 1883
### Grypoceras whitneyi (Gabb)

Plate 32, figures 9–11

*Nautilus whitneyi* Gabb, 1864, p. 19, pl. 3, figs. 2–3.
*Grypoceras whitneyi* (Gabb). Smith, 1914, p. 141, pl. 16, figs. 2–3; pl. 99, figs. 5–7. Kummel, 1953, p. 53, pl. 5, fig. 1; pl. 6, figs. 1–4.

*Grypoceras*, apparently conspecific with *G. whitneyi* (Gabb), were found during the present study in the Hyatti Zone of the middle Anisian and the Rotelliformis and Meeki Zones of the upper Anisian. Gabb's type specimen from the "Buena Vista district" could be from any of these zones, as fossiliferous beds of both middle and late Anisian age occur in the general vicinity of Unionville, i.e., the Buena Vista mining district. Smith's plesiotype from the Wheeler mine area south of Unionville is probably from the upper Anisian.

Smith's and Kummel's descriptions, based on Smith's plesiotype, adequately describe the holotype, which was recently located in the collections of the Academy of Natural Sciences of Philadelphia.

*Figured specimen*.—Holotype, ANSP 30792 (originally illustrated by Gabb, 1864, pl. 3, figs. 2–3).

*Occurrence*.—USGS locality M533 (10+); USGS Mesozoic locality M1181 (1), Hyatti Zone, northern part of the Humboldt Range; USGS localities M965 (1), Rotelliformis Zone, M142 (1) and one float specimen from the *Parafrechites dunni* beds, Meeki Zone, vicinity of Fossil Hill, Humboldt Range, Nev.

### Family LIROCERATIDAE Miller and Youngquist, 1949
### Genus PARANAUTILUS Mojsisovics, 1902
### Paranautilus smithi Kummel

Plate 32, figures 7–8

*Paranautilus multicameratus* (Gabb). Smith, 1914, p. 143, pl. 95, figs. 3–4 [not pl. 16, figs. 4–5 = *P. multicameratus* (Gabb)].
*Paranautilus smithi* Kummel, 1953, p. 71, pl. 4, figs. 11–12; pl. 8, figs. 12–13, text-fig. 36.

Kummel (1953) justifiably established this species for the specimen previously described by Smith (1914) as

*Paranautilus multicameratus* (Gabb) because Smith's specimen differs from Gabb's figure of *"Nautilus" multicameratus* (Gabb, 1864, pl. 3, figs. 4–5) in lacking a ventral median depression at a comparable diameter and in lacking the lirate ornament said by Gabb (1864, p. 20) to be present on his specimen.

A badly crushed *Paranautilus* (ANSP 30790), consisting largely of phragmocone, was recently found in the collections of the Academy of Natural Sciences of Philadelphia associated with a note that was evidently written by Alpheus Hyatt and reads "It is possible that a part of this [specimen] may have been used for Gabb's [figures of *"Nautilus" multicameratus*]." A label also found with the specimen gives the locality as "Dun Glen, Nev.," which corresponds with the type locality of *"N." multicameratus*. However, this specimen is about 110 mm in diameter and is thus much larger than the holotype of *"N." multicameratus* should be, according to Gabb's figures. Moreover, it lacks the depressed venter and other distinguishing features shown by Gabb's figures. It is thus evidently not the holotype of *"N." multicameratus*, which species is probably best regarded as a *nomen dubium*.

The large specimen of *Paranautilus smithi*, illustrated by figures 7–8, plate 32, was collected in place from the lower part of the Occidentalis Zone near Fossil Hill. It is septate to a diameter of about 150 mm; the maximum preserved diameter is about 160 mm, beyond which part of the body chamber is preserved for another quarter whorl. This specimen adds to the knowledge of *P. smithi* by showing the transition in whorl shape from the inner whorls, which have broadly rounded flanks and venter, to the mature body chamber, which is more nearly trapezoidal, having nearly flat convergent flanks and a flat venter.

*Figured specimen.*—Plesiotype, USNM 248921.

*Occurrence.*—USGS localities M143 (1), M612 (1), and M963 (1), Meeki Zone, vicinity of Fossil Hill; M620 (2), M961 (1), and M965 (1), Occidentalis Zone, vicinity of Fossil Hill, Humboldt Range, Nev.

### Order ORTHOCERIDA
### Family ORTHOCERATIDAE M'Coy, 1844
### ?Genus MICHELINOCERAS Foerste, 1932
#### Michelinoceras? cf. M.? campanile (Mojsisovics)

Plate 33, figures 1–2

cf. *Orthoceras campanile* Mojsisovics, 1882, p. 291, pl. 113, figs. 1, 2a–2b, 3, 4a–4b, 11a–11b.

Orthoconic nautiloids occur in all of the Anisian zones in the Humboldt Range wherever cephalopod faunas are well developed. Longitudinal thin sections of two specimens from the Meeki Zone in the Fossil Hill area are illustrated to show the simple internal structure of these shells. The siphuncle is central and cylindrical, contracting only slightly at the septal necks, which are orthochoanitic, or nearly so. Neither siphuncular nor cameral deposits are present.

Following Sweet (*in* Teichert and others, 1964) these orthocones are tentatively included in *Michelinoceras*, although the typical members of this genus are of early Paleozoic age and possess cameral deposits. Kiparisova (1961), among others, has described similar Triassic orthocones under the generic name *Trematoceras* Eichwald, but the type species of this genus, *T. elegans* (Münster), is characterized by a unique arrangement of episeptal and mural deposits in the chambers.

*Figured specimens.*—Plesiotypes, USNM 248922 and 248923.

*Occurrence.*—USGS localities M139 (1), M608 (15+), M611 (1), Rotelliformis Zone; M142 (6+), M618 (1), M619 (3), M958 (1), Meeki Zone; M144 (3), M144 minus 6 ft (1.8 m) (1), M620 (1), M622 (7+) M961 (2) and M962 (1), Occidentalis Zone, vicinity of Fossil Hill, Humboldt Range, Nev.

### Subclass COLEOIDEA
### Order AULACOCERIDA
### Family XIPHOTEUTHIDIDAE Naef, 1922
### Genus ATRACTITES Gümbel, 1861

Smooth aulacocerid coleoids referred to *Atractites* are fairly common in the upper Anisian of the Humboldt Range as well as that at other localities in northwestern Nevada. All of the specimens collected near Fossil Hill are broken segments, mostly of rostra. Several specimens were also collected from the lower and middle Anisian Caurus and Hyatti Zones of the Humboldt Range, but for some reason all of these are pieces of phragmocones rather than of the more durable rostra.

Allowing for some variation, rostra from different stratigraphic levels within the upper Anisian have distinctive shapes, and some can be identified with the species recognized on the basis of rostra by Smith (1914). Phragmocones associated with these rostra, however, are externally alike regardless of stratigraphic position, and the recognition by Smith of *"Atractites böckhi* (Stürzenbaum)," a species originally based on part of a phragmocone, is meaningless.

Recognition of species among the *Atractites* guards described here is somewhat tenuous owing to their fragmentary nature and the apparent morphologic variation among specimens from the same stratigraphic level. Nonetheless, three generalized but morphologically distinct and stratigraphically restricted groups are recognized and treated as separate species. The material at hand suggests that greater taxonomic refinement might be possible if collections were more complete and that species of *Atractites*, based on the shape of guards, may be as narrowly limited in stratigraphic ranges as the species of ammonites with which they occur.

The few relatively well-preserved *Atractites* phragmocones from the upper Anisian of Nevada confirm some of the morphologic characters that Jeletzky (1966) has found to be characteristic of the Order Aulacocerida. Two specimens, one (pl. 33, figs. 3–4) from the Rotelliformis Zone near Fossil Hill in the Humboldt Range and the other (pl. 34, figs. 1–3) from the Meeki Zone of the Favret Formation in the Augusta Mountains, show the configuration of the conothecal striae. Both of these specimens are incomplete phragmocones, but in all probability they correspond with the associated rostra, which are like those described herein. On the flanks of these phragmocones the conothecal striae are inclined orally towards the dorsum, forming an angle of about 60° with the axis of the shell; on the dorsum, they describe a broad, orally convex curve, and on the venter an orally concave curve. Hence, in agreement with Jeletzky's observations, they lack a discrete dorsal proostracum, and they have no ventral proostracum.

Thin sections of the specimen mentioned above from the Favret Formation, *Atractites* sp. C, and of another specimen from the same locality, *Atractites* sp. B, show the structure of the siphuncle and septal necks in some detail, although not completely. They can be interpreted to have the same structure as that described by Jeletzky (1966, p. 20–22) for aulacocerids in general, but not that illustrated by his text-figure 3, which is incorrectly drafted (J. A. Jeletsky, written commun., 1969). The larger of these specimens, *Atractites* sp. C, consists of eight camera of the phragmocone expanding in dorsal-ventral diameter from 17 to 24.5 mm. In thin section the septa are seen to be mostly broken away except along the ventral side in the vicinity of the siphuncle. Though evidently composed originally of faintly lamellar calcareous material, the septa are preserved as filmy inclusions in the mosaic of calcite crystals that fill the camera and replace the shell material. In vertical section (fig. 48; pl. 33, fig. 7) each septum is strongly curved forward as it approaches the dorsal side of the septal foramen and is joined on its ventral side with a necklike structure of similar composition. The internal lamination of the septum does not appear to bend back in retrochoanitic fashion so as to be continuous with that of this necklike structure, and hence the true septal necks are best described as achoanitic or slightly prochoanitic. The necklike structure is evidently a modified connecting ring that is distinctly two layered and whose outer surface is attached to the apicad side of the prochoanitic septal neck. This necklike part of the connecting ring follows the curvature of the septum in a dorsad-apicad direction for a short distance and then projects apically, forming a funnellike siphuncle wall. The thickness and composition of each funnel is like that of the septa for about one-third camera apicad of its septum of origin, after which it thins and becomes dark in color, as if it was partly composed of organic matter, and its two-layered construction becomes indistinct. In the smaller sectioned specimen (pl. 33, fig. 6), which is the alveolar part of a phragmocone, each funnellike connecting ring of the siphuncle wall extends a little over 1½ camera apicad from its septum of origin and invaginates within the funnel produced by the preceding septum. The siphuncle wall in this specimen thus consists of two funnellike invaginated connecting rings in the orad part of each chamber and one connecting ring in the apicad part. The apicad extent of each funnel in the larger specimen described above is obscured by discoloration within the siphuncle but seems to be similar, at least the orad part of the siphuncle wall between successive chambers being formed by two invaginated connecting rings.

**Atractites sp. A.**

Plate 33, figures 3–4

*Figured specimen.*—USNM 248924.

*Occurrence.*—USGS locality M136, Rotelliformis Zone, vicinity of Fossil Hill, Humboldt Range, Nev.

**Atractites sp. B.**

Plate 33, figure 6

*Figured specimen.*—USNM 248926.

*Occurrence.*—USGS locality M636, upper Anisian, Favret Canyon, Augusta Mountains, Nev.

**Atractites sp. C.**

Plate 33, figure 7; plate 34, figures 1–3; text-figure 48

*Figured specimen.*—USNM 248927.

*Occurrence.*—USGS locality M636c, Meeki Zone, Favret Canyon, Augusta Mountains, Nev.

**Atractites clavatulus Smith**

Plate 33, figure 5; plate 34, figures 6–11

*Atractites clavatulus* Smith, 1914, p. 139, pl. 96, figs. 11–12 [holotype], 13, 14.

The stratigraphically lowest well-represented belemnite guards from the Fossil Hill area are from the *Gymnotoceras blakei* beds of the Rotelliformis Zone and are comparable with the specimens described by Smith as *Atractites clavatulus*. They are distinguished by their clavate shape, thickly ovate or elliptical cross section, and the deep apicad penetration of the alveolus into the bulbous part. The amount of constriction that produces the clavate shape varies among individual specimens, and the constriction of the horizontal diameter is com-

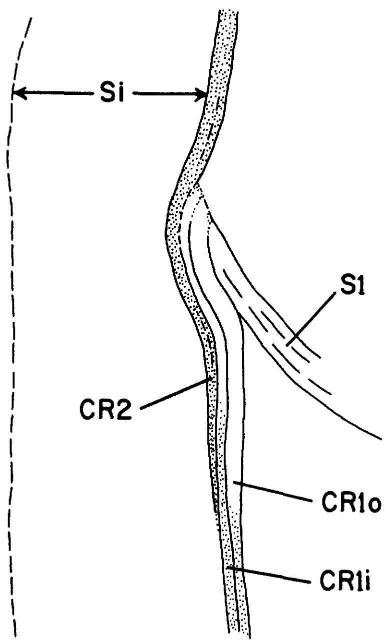


FIGURE 48.—Siphuncular structure (× 25) of *Atractites* sp. C (USNM 248927) from the upper Anisian of the Favret Formation, Augusta Mountains, Nev. Diagrammatic interpretation of dorso-ventral median section illustrated by plate 33, figure 7. Orad direction upward; ventral side to left. Si, interior of siphuncle; Si, septum; CR1i and CR1o, inner and outer layers of connecting ring originating at S1; CR2, undifferentiated layers of connecting ring originating at next orad septum. Ventral wall of siphuncle is not preserved, and details in the vicinity of septal foramina and apicad termination of CR2 are not clearly shown on the specimen.

monly greater in relation to the amount of constriction of the dorso-ventral diameter. Apicad of the inflated part, the guard is drawn out into a gradually tapering, much compressed apex of unknown length.

A fragment (USNM 248929; pl. 34, figs. 4–5) of a much inflated clavate guard from the *Paraceratites cricki* beds, just below the occurrence of *A. clavatulus*, has a nearly circular cross section, and only the apicad tip of the alveolus is represented at the orad end of the inflated part of the guard. The alveolus thus seems to have been situated farther orad in the guard than it is in *A. clavatulus*, and this specimen may represent *Atractites elegans* Smith (1914, pl. 96, fig. 10).

*Figured specimens*.—Plesiotypes, USNM 248925, 248930, and 248931.

*Occurrence*.—USGS locality M608 (16), *Gymnotoceras blakei* beds, Rotelliformis Zone, vicinity of Fossil Hill, Humboldt Range, Nev.

**Atractites solidus Smith**

Plate 34, figures 12–25

*Atractites solidus* Smith, 1914, p. 140, pl. 96, figs. 1–2 [holotype], 3–4, 5.

This species was found only in the *Frechites nevadanus* beds of the Meeki Zone. The alveolar part of the guard is robust with its width and height approximately equal. In contrast to the broadly rounded dorsal side and flanks, the ventral side is flattened and bears a longitudinal median depression or groove of varying strength. Viewed laterally, the dorsal margin is nearly straight, whereas the ventral margin tends to be broadly bowed in a bellowlike curve. The guard is only slightly constricted towards its orad end, lateral constriction being more pronounced than dorso-ventral constriction. Apicad of the alveolus the sides taper more rapidly than the dorsum or venter, producing a long, laterally compressed apex, the tip of which is not preserved on any of the available specimens.

The specimen illustrated by Smith (1914, pl. 96, figs. 8–9) as "*Atractites nevadensis* (Meek)" may belong to *A. solidus* but is larger and more generalized in shape.

*Figured specimens*.—Plesiotypes, USNM 248932 to 248936.

*Occurrence*.—USGS localities M142 (3), M166 (1), M612 (1), and M614 (3); *Frechites nevadanus* beds, Meeki Zone, vicinity of Fossil Hill, Humboldt Range, Nev.

**Atractites nevadensis (Meek)**

Plate 34, figures 26–33

*Belemnites nevadensis* Meek, 1877, p. 138, pl. 12, figs. 7–7b [holotype].
*Atractites burckhardti* Smith, 1914, p. 139, pl. 96, figs. 6–7 [holotype].
[not] *Atractites nevadensis* (Meek). Smith, 1914, p. 139, pl. 96, figs. 8–9.

Meek's typical specimen of this species borders on being specifically unidentifiable, and yet it shows a high degree of lateral compression of the guard at a relatively large diameter, which is the characteristic feature of the specimens grouped under this name. This is also the diagnostic feature attributed to *Atractites burckhardti* by Smith. In the alveolar region the lateral diameter of the guard amounts to 0.60 to 0.75 of the dorso-ventral diameter and the cross section is either elliptical or ovate with the dorsal side more broadly rounded than the ventral. The apex of the guard is even more compressed than the orad part and seems to vary in length, some specimens being more bluntly terminated than others. None of the specimens are more than faintly constricted towards the orad end of the guard.

Specimens answering this general description characterize both the *Parafrechites meeki* and the stratigraphically higher *Nevadites* beds, but more adequate material might demonstrate the presence of more than one species in this part of the section. One specimen from the *Nevadites* beds (pl. 34, figs. 31–33) is unique in having a pair of pronounced dorsal-lateral grooves that elevate the dorsal margin into a ridge, diverge apically in dorsal view, and in lateral view seem to outline the position of the alveolus within the guard. The ventral margin of this part of the guard is narrowly rounded so that the cross-sectional outline approaches that of the ace of spades. This specimen somewhat resembles the guard of the Upper Triassic genus *Calliconites* Gemmellaro which, however, bears ventral-lateral as well as dorsal-lateral grooves.

*Figured specimens.*—Plesiotypes, USNM 248937 to 248939.

*Occurrence.*—USGS localities M140 (1), M143 (2), M616 (1), M958 (1), and M963 (1), *Parafrechites meeki* beds, Meeki Zone; M144 (3), M621 (2), and M962 (1), Occidentalis Zone, vicinity of Fossil Hill, Humboldt Range, Nev.

### Class BIVALVIA
### Order PTERIOIDA
### Family PTERIIDAE Gray, 1847
### Genus PTERIA Scopoli, 1777

[?] *Rhynchopterus* Gabb, 1864, p. 31 [type species *Rhynchopterus obesus* Gabb, by monotypy].

The name *Rhynchopterus* Gabb is a junior homonym of *Rhynchopterus* Shrank, 1798, originally used in combination with the trivial name of a weevil. According to Charles W. O'Brien, Department of Entomology, University of California, Berkeley (written commun., 1962), Shrank's name may have resulted from a *lapsus calami* wherein another name used by Shrank, *Rhychophorus*, was intended. Nevertheless, *Rhynchopterus* Shrank is still an available name, and *Rhynchopterus* Gabb should be suppressed. Rather than erect a new generic name for *Rhynchopterus* Gabb, which is still imperfectly known, Gabb's genus is regarded as a probable synonym of *Pteria*, sensu lato.

#### Pteria? obesus (Gabb)

Plate 38, figures 8–9

*Rhynchopterus obesus* Gabb, 1864, p. 32, pl. 5, figs. 30a–30b. Smith, 1914, p. 145, pl. 16, figures 16–17. Newell *in* Cox and others, 1969, p. N305, fig. C39, 3.

Besides the ubiquitous shells and fragments of *Daonella*, specimens of this relatively inflated, smooth pteriid(?) are the only other common noncephalopod molluscan shells found in the upper Anisian at Fossil Hill. Seventy-five specimens are represented among the stratigraphically controlled bedrock collections and are evenly distributed throughout the section from the *Paraceratites vogdesi* beds of the Rotelliformis Zone to the *Nevadites furlongi* beds of the Occidentalis Zone. Among these specimens left valves outnumber right valves 2:1.

Little can be added to the published description of this species other than that the right valves are approximately mirror images of the left, except for being less inflated. The hinge structure could not be prepared on any of the available specimens.

The specimen illustrated was found along with others of Gabb's types at the Academy of Natural Sciences of Philadelphia and is thought to be the holotype, although as with Gabb's other specimens, there was no mark or label associated with the specimen to indicate this. The slab bearing this specimen contains *Nevadites furlongi* and *Daonella dubia* and is thus from the Occidentalis Zone. This and other specimens from the upper part of the upper Anisian on the average tend to be more elongate than those from low in the substage, but otherwise they are generally the same.

*Figured specimen.*—Holotype?, ANSP 30791.

### Family POSIDONIIDAE Frech, 1909
### Genus DAONELLA Mojsisovics, 1874

Daonellas are an important component of the upper Anisian and Ladinian faunas of the Humboldt Range. They are abundant enough so that fragments of their shells make up an appreciable part of some limestone beds, and distinct species from different levels in the section commonly can be distinguished by obvious morphologic features. Nevertheless, characterization of species among these shells, and for that matter among Halobias and Daonellas in general, is less than satisfactory, for despite their local abundance, relatively complete large-size specimens, adequately showing the morphology, are difficult to obtain.

Some of the more abundant upper Anisian Daonellas from the Humboldt Range can be assigned to *Daonella americanum* and *D. dubia*, species originally described from the Humboldt Range. Other kinds generally resemble forms described from the Alps and yet differ in details that might prove to be taxonomically significant if better material were available for study. These specimens are compared with Alpine species such as *D. sturi*, *D. moussoni*, and *D. elongata*, each of which was the earliest of its kind to be described. As used herein these names represent groups of potentially or actually more narrowly defined and more stratigraphically restricted specific entities, which can be recognized in exceptional geologic situations such as that described by Rieber (1968, 1969). In favorable situations, as Rieber has demonstrated, detailed evolutionary trends among Daonellas can be established, and the recognition of numerous narrowly defined specific entities is justified. More commonly, however, ideal material is lacking, and more generalized, broader species concepts, such as those adopted herein, are appropriate. Even so, such species are still biostratigraphically useful and have resolving power for stratigraphic subdivision at about the level of one ammonite zone.

In order to characterize the differences in shell shape among different kinds of Daonellas, the conventions used here for measuring the size, shape, and ribbing of these shells are illustrated on figure 49.

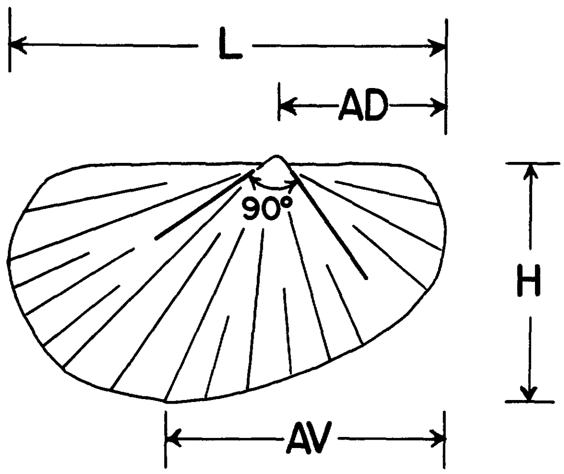


FIGURE 49.—Diagrammatic sketch of the right valve of a *Daonella* showing the conventions used in measuring and describing these shells. L, length; H, height; AD, anterior-dorsal length; AV, anterior-ventral length. Also shown is the position of the centrally located 90° of arc within which the number of ribs or radial furrows are counted.

**Daonella americana Smith**

Plate 35, figures 1–7

*Daonella americana* Smith, 1914, p. 143, pl. 49, figs. 4–5 [holotype], 6, 7?, 8?, 9?. Silberling, 1962, table 1, p. 157 [in part].

*Description.*—Shell elongate (H/L about 0.50); obliquely subtrigonal (AV/L about 0.69). Ribbing produced by generally weak radial striae arranged randomly by relative strength except on central part of shell where coarsest striae tend to be widely and evenly spaced, imparting to the ribbing a distinctly grouped or regularly subdivided character. About 8–10 coarse striae per 90° of arc in central field of ribbing; generally several (rarely as many as 10) weaker striae per coarse striation.

*Figured specimens.*—Plesiotypes, USNM 248940 to 248946.

*Occurrence.*—USGS localities M965, M136 minus 7 ft (2.1 m), M139, M162, M966, M136, M163, M606, M967 minus 9 ft (2.7 m), M607, M967, and M964, Rotelliformis Zone; USGS locality M612, *Frechites nevadanus* beds, lowermost Meeki Zone; vicinity of Fossil Hill, Humboldt Range, Nev.

**Daonella cf. D. sturi (Benecke)**

Plate 35, figures 8–12

cf. *Halobia sturi* Benecke, 1868, p. 55, pl. 4, figs. 9a–9b, 10, 11.
cf. *Daonella sturi* (Benecke). Mojsisovics, 1874, p. 17, pl. 2, figs. 7–8.
*Daonella americana* Smith [in part]. Silberling, 1962, table 1, p. 157.

The shells compared with this Alpine species differ from *Daonella americana* in being more elongate (H/L about 0.40) and correspondingly more oblique (AV/L about 0.74). More importantly, the nature of the ribbing differs in that the ribs are not grouped according to strength. Instead, striae or interspaces of varying strength tend to separate each rib or pair of ribs, and the width of the most pronounced interspaces rivals that of the rounded, flat-topped, undivided ribs between them. Characteristically, several or more successive ribs among those in the central part of the shell are of about the same strength and spacing. Within a 90° arc in the central part of the rib field, the ribs vary in strength by a factor of several times, but they generally total 15–20 in number.

At Fossil Hill the stratigraphic range of *Daonella* cf. *D. sturi* overlaps that of *D. americana*, but on any one bedding surface shells of only one species or the other occur.

*Figured specimens.*—Plesiotypes, USNM 248947 to 248951.

*Occurrence.*—USGS localities M607+2.0 ft (0.6 m), M608, M609, and M613, *Gymnotoceras blakei* beds, uppermost Rotelliformis Zone; M142, *Frechites nevadanus* beds, lowermost Meeki Zone, vicinity of Fossil Hill, Humboldt Range, Nev.

**Daonella cf. D. elongata Mojsisovics**

Plate 36, figures 1–5

cf. *Daonella elongata* Mojsisovics, 1874, p. 13, pl. 2, fig. 9.
*Daonella* cf. *D. elongata* Mojsisovics. Silberling, 1962, p. 157.

Daonellas having a bizarre, extremely elongate (H/L 0.20–0.30), oblique shape, fine, fairly regular ribs, and anteriorly pronounced commarginal folds resemble members of the Alpine species group of *Daonella elongata* and are the first record of such forms from outside of the Alps. Among the narrowly defined specific entities placed in an evolutionary series within this species group by Rieber (1968), the Nevada specimens most closely resemble "*Daonella vaceki* Kittl," as characterized by Rieber.

*Figured specimens.*—Plesiotypes, USNM 248952 to 248956.

*Occurrence.*—USGS locality M968, float block derived from the *Parafrechites dunni* beds, upper part of Meeki Zone, vicinity of Fossil Hill, Humboldt Range, Nev.

**Daonella cf. D. moussoni (Merian)**

Plate 36, figures 6–9; plate 37, figures 1–3

cf. *Posidonomya moussoni* Merian *in* Escher v. d. Linth, 1853, p. 93, pl. 5, figs. 46, 47, 48.

cf. *Daonella moussoni* (Merian). Mojsisovics, 1874, p. 9, pl. 3, figs. 18, 19.

*Daonella moussoni* (Merian). Smith, 1914, p. 144, pl. 50, figs. 4, 5–6, 7, 8, 9?, 10–11.

*Daonella* cf. *D. moussoni* (Merian). Silberling, 1962, p. 157.

Like the Alpine forms with which they are compared, these shells are relatively high (H/L 0.75–0.80) and erect (AV/L 0.50–0.55) and have densely spaced ribs (about two or three per millimeter) that are fairly equal in strength, generally not varying in width by more than two times. Commarginal folds are pronounced on the umbonal part of the shell. Most of the more or less complete specimens are small, less than 20 mm in length, and the largest specimen (pl. 36, fig. 8) apparently did not exceed 60 mm in length.

Similar shells in the southern Alps that were first assigned to *Daonella moussoni* have been named *D. pseudomoussoni* and *D. luganensis* by Rieber (1969) and apparently characterize about the same part of the upper Anisian as do the specimens from Nevada.

*Figured specimens.*—Plesiotypes, USNM 248957 to 948960.

*Occurrence.*—?USGS localities M140, M143, and M959, middle and upper Meeki Zone; USGS localities M145, M146, ?M620, M621, M622, M623, M624, M625, M626, M909, M961, M962, and M962a, throughout Occidentalis Zone, vicinity of Fossil Hill and the Arizona mine area south of Buena Vista Canyon, Humboldt Range, Nev.

**Daonella dubia (Gabb)**

Plate 36, figures 10–15

*Halobia? dubia* Gabb, 1864, p. 30, pl. 5, figs. 28a–28b [lectotype selected by Silberling, 1962, p. 153, footnote 2], [not fig. 28].

*Daonella dubia* (Gabb). Mojsisovics, 1874, p. 22. Smith, 1904, p. 405, pl. 44, fig. 5. Smith, 1914, p. 143, pl. 14, fig. 5; pl. 44, figs. 10, 11?; pl. 50, figs. 1, 2?, 3?. Silberling, 1962, p. 157.

*Daonella lindstroemi* Mojsisovics. Smith, 1914, p. 144, pl. 49, figs. 1–3.

[?] *Halobia (Daonella) lommeli* Wissman. Meek, 1877, p. 100, pl. 10, fig. 5.

*Description.*—Relatively large (L exceeding 100 mm), elongate (L about twice H), obliquely subtrigonal (AV/L 0.70–0.80) shells having distinctly grouped or bundled ribs. In central part of shell pronounced radial grooves, wider than they are deep and irregularly spaced at about 10–12 per 90° of arc, define first-order ribs. These are further subdivided by second-order striae into flat-topped secondary ribs whose surfaces bear several more fine radial striae. Commarginal growth striae or folds generally obscure.

*Discussion.*—Compared with the stratigraphically lower *Daonella americana*, which of the species in Nevada most closely resembles *D. dubia*, the principal radial grooves that produce the ribbing are much stronger on *D. dubia* by a factor of two or three times, and the ribs are not so regularly bundled or grouped into two generally distinct size classes. *Daonella fascicostata*, described by Rieber (1969, p. 671, pl. 4, figs. 1–2, 4–6, and 8) from the southern Alps, is very similar and perhaps conspecific with *D. dubia*, the differences cited by Rieber between these species being largely attributable to the inadequacies of the figures of *D. dubia* published by Smith (1914).

*Figured specimens.*—Lectotype, ANSP 20785; plesiotypes, USNM 248961 to 248965.

*Occurrence.*—?USGS localities M144, M620, and M621, lower part of Occidentalis Zone; USGS localities M145, M623, M624, M625, and M626, upper part of Occidentalis Zone, vicinity of Fossil Hill, Humboldt Range, Nev.

**Daonella rieberi n. sp.**

Plate 37, figures 4–9; plate 38, figures 1–2

*Daonella* aff. *D. taramellii* Silberling and Wallace, 1969, p. 20.

*Description.*—Moderately elongate (H/L 0.60–0.65), obliquely ovate (AV/L 0.60–0.70) shells having beak well forward on dorsal margin (AD/L 0.35–0.50). Numerous (35–40 per 90° of arc in midshell) flat-topped ribs as much as about 1 mm in width and generally do not vary in width by more than two or three times. Interrib striae much narrower than average width of ribs and of uniform strength. Commarginal folds generally prominent, especially near umbo.

*Discussion.*—From the stratigraphically lower shells assigned here to *Daonella* cf. *D. moussoni*, *D. rieberi* differs in its more oblique and ovate shape and its broader ribs. Among Alpine forms *D. rieberi* resembles the roughly correlative species *D. taramellii* Mojsisovics except for being more ovate and elongate.

This species is named for Hans Rieber whose studies of the Grenzbitumenzone in the southern Alps have added importantly to knowledge of Anisian Daonellas.

*Figured specimens.*—Holotype, USNM 248969. Paratypes, USNM 248970 to 248975.

*Occurrence*—USGS localities M147 (the type locality of *D. rieberi* where it is associated in bedrock collection with *Protrachyceras* cf. *P. americanum* Mojsisovics) and M628, vicinity of Fossil Hill; USGS Mesozoic locality M3094, associated in float collection with *Protrachyceras* cf. *P. meeki*, vicinity of Fossil Hill; USGS locality M911, American Canyon about 2.5 km north-northwest of Fossil Hill; USGS locality M908, Arizona mine area south of Buena Vista Creek canyon. All from Subasperum Zone, Humboldt Range, Nev.

**Daonella n. sp. ex aff. D. indica Bittner**

Plate 38, figures 3–4

aff. *Daonella indica* Bittner, 1899, p. 39, pl. 7, figs. 4, 5, 6, 7, 8, 9, 10, 11.

Two slabs of buff calcareous siltstone from beds of probable late Ladinian age about 160 m above the base of the upper member of the Prida Formation in the southern part of the Humboldt Range contain fairly large (L at least 100 mm) Daonellas that embody a unique set of characters. They are neither well enough represented nor well enough tied into the stratigraphic section to warrant naming them and are designated here simply as having affinity with *Daonella indica*, an upper Ladinian Himalayan species.

Like *D. indica* these shells have a high (H/L about 0.80), roughly equilateral and circular outline and numerous (about 30 per 90° of arc in midshell) flat-topped primary ribs that are similar to one another in width. However, in contrast with *D. indica* in which a secondary radial groove tends to divide each primary rib into two parts, the flat surfaces of the primary ribs on the Nevada specimens bear several very fine radial striae.

On one of the two illustrated slabs (pl. 38, fig. 4) a negative *Daonella* impression having the ribbing pattern of *D. lommelli* confirms the upper Ladinian stratigraphic assignment of this collection based on its stratigraphic level.

*Figured specimens.*—Plesiotypes, USNM 248978 and 248979.

*Occurrence.*—USGS Mesozoic locality M3095, south wall of Fisher Canyon, southern Humboldt Range, Nev.

**Daonella cf. D. lommeli (Wissmann)**

Plate 38, figures 5–7

cf. *Halobia lommeli* Wissmann, *in* Wissmann and Münster, 1841, p. 22, pl. 16, fig. 11.

cf. *Daonella lommeli* (Wissmann). Mojsisovics, 1874, p. 19, pl. 2, figs. 12, 13.

Daonellas having the distinctive appearance of the Alpine upper Ladinian species *Daonella lommeli* occur in the Humboldt Range in several places well above the base of the upper member of the Prida Formation (Silberling and Wallace, 1969, p. 20). Like the typical Alpine examples, they show the distinctly bundled pattern of ribbing produced by radial furrows of several different orders of strength tending to subdivide the shell surface into regularly dichotomous ribs. They also show the characteristic tendency for the ribs to be broadly curved, convex in the anterior direction.

*Figured specimens.*—Plesiotypes, USNM 248980 to 248982.

*Occurrence.*—USGS locality M970, Congress Canyon, northern Humboldt Range, Nev.

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# INDEX

[Italic page numbers indicate major references]

# PLATES 4-38

[Contact photographs of the plates in this report are available, at cost, from U.S. Geological Survey Library, Federal Center, Denver, Colorado 80225]

## PLATE 4

[All figures natural size unless otherwise indicated]

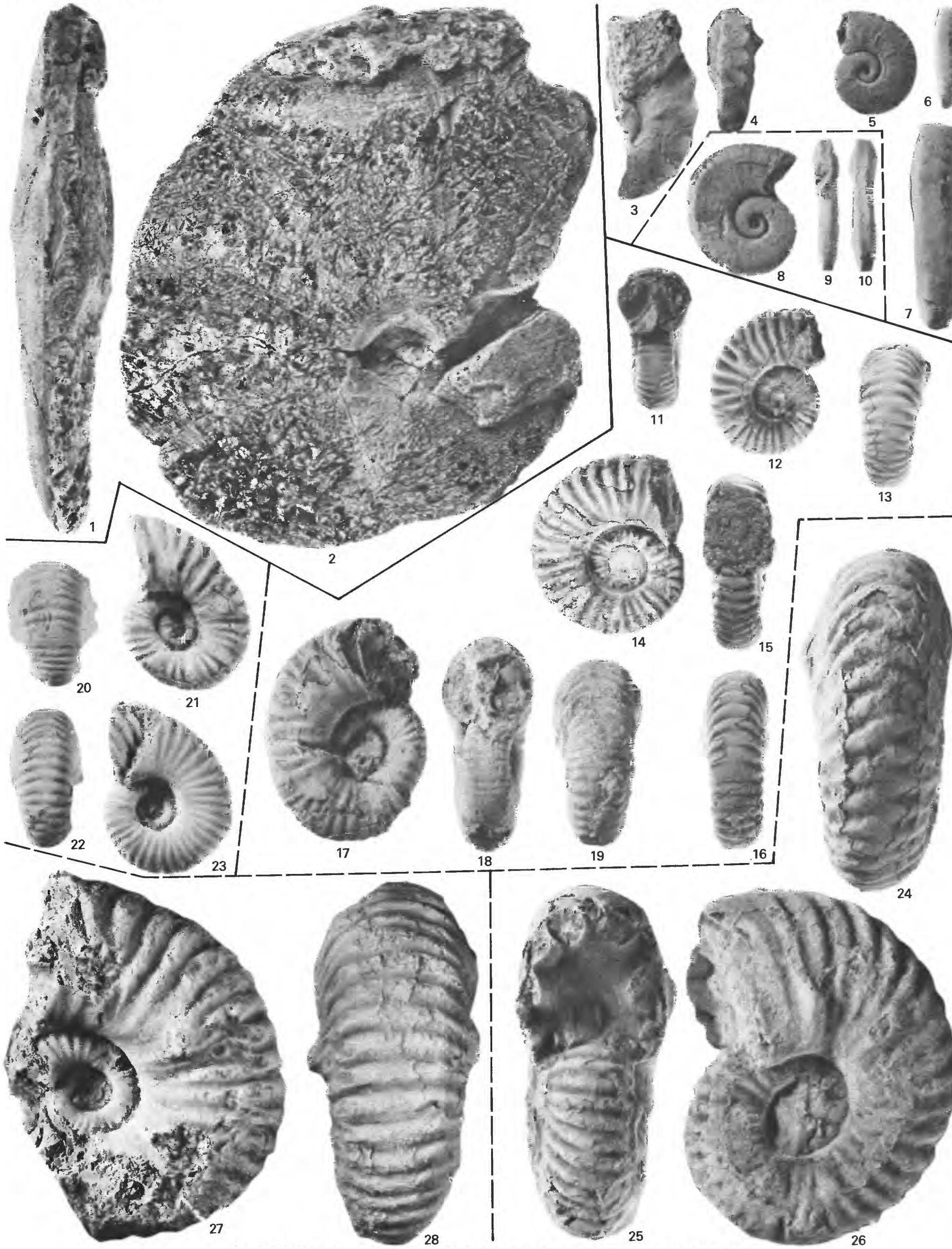
FIGURES 1–2. *Sageceras gabbi* Mojsisovics (p. 14). Lectotype, ANSP 30783, Humboldt Range, Nev.; stratigraphic occurrence unknown.

3–10. *Koipatoceras discoideus* n. sp. (p. 18). Hyatti Zone.

- 3–4. Paratype, USNM 248629, USGS Mesozoic loc. M1184, × 2.
- 5–6. Paratype, USNM 248630, USGS Mesozoic loc. M1184.
- 7. Same as figure 6, × 2.
- 8–10. Holotype, USNM 248631, USGS Mesozoic loc. M1180.

11–28. *Acrochordiceras hyatti* Meek (p. 21). Hyatti Zone, unless otherwise indicated.

- 11–13. Plesiotype, USNM 248632, USGS loc. M533.
- 14–16. Plesiotype, USNM 248633, USGS loc. M533.
- 17–19. Plesiotype, USNM 248634, USGS loc. M533.
- 20–21. Plesiotype, USNM 248635, USGS Mesozoic loc. M1180.
- 22–23. Plesiotype, USNM 248636, USGS Mesozoic loc. M1184.
- 24–26. Plesiotype, USNM 248637, USGS Mesozoic loc. M2821.
- 27–28. Lectotype, USNM 12514, probably from New Pass Range, Nev.; stratigraphic occurrence unknown.




*SAGECERAS*, *KOIPATOCERAS*, AND *ACROCHORDICERAS*

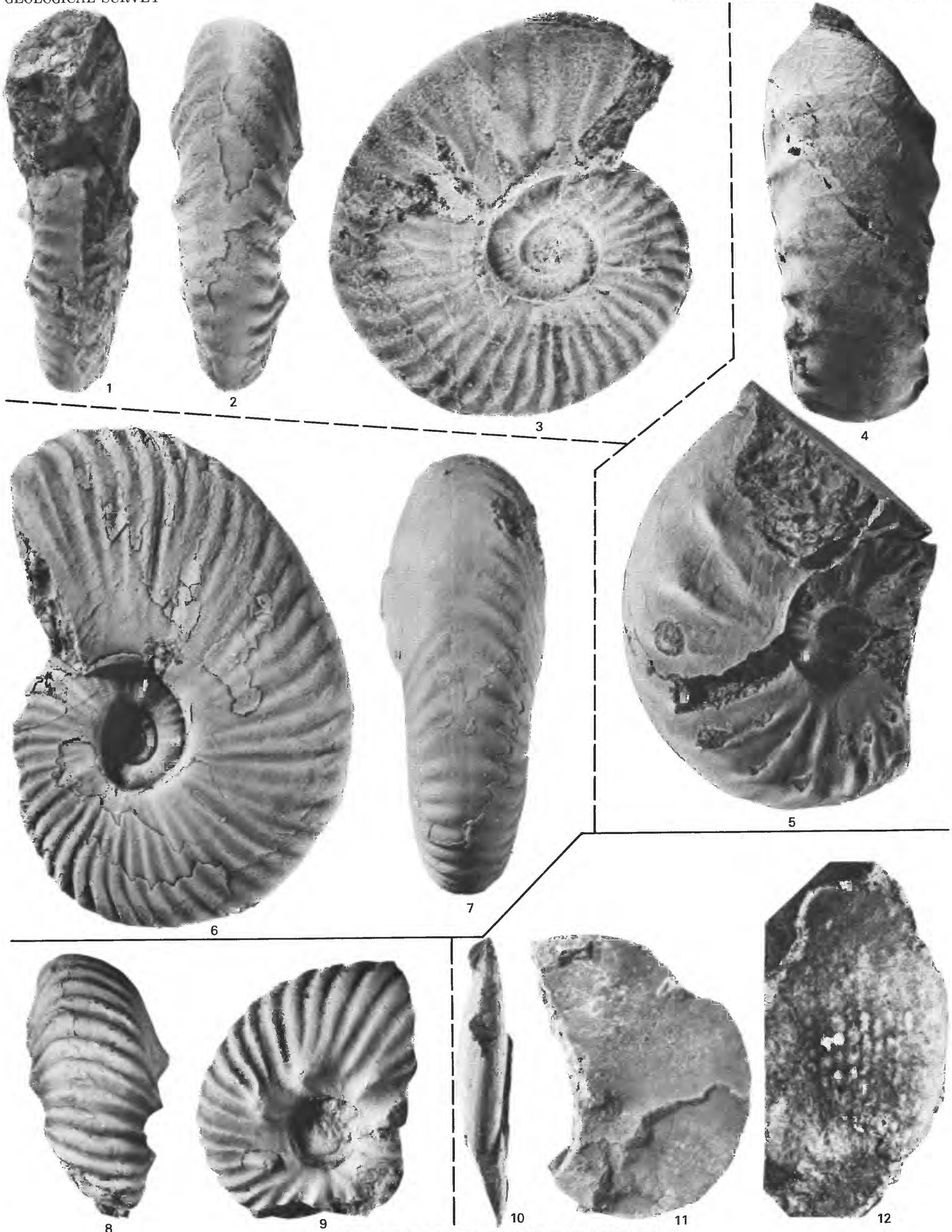
## PLATE 5

[All figures natural size unless otherwise indicated]

FIGURES 1–7. *Acrochordiceras hyatti* Meek (p. 21). Plesiotypes, Hyatti Zone.
- 1–3. USNM 248638, USGS loc. M533.
- 4–5. USNM 248639, USGS loc. M970, × ½.
- 6–7. USNM 248640, USGS Mesozoic loc. M1180.

8–9. *Acrochordiceras* cf. *A. carolinae* Mojsisovics (p. 23).
- Plesiotype, USNM 12514, New Pass Range, Nev.; stratigraphic occurrence unknown.

10–12. *Sageceras walteri* Mojsisovics (p. 18). Rotelliformis Zone.
- 10–11. Plesiotype, USNM 248641, USGS loc. M139.
- 12. Same as figure 11, showing suture, × 2.




*ACROCHORDICERAS* AND *SAGECERAS*

# PLATE 6

[All figures natural size unless otherwise indicated]

FIGURES 1–6. *Hollandites voiti* (Oppel) (p. 24). Plesiotypes, USGS loc. M969, Hyatti Zone.
- 1–2. USNM 248642.
- 3–5. USNM 248643.
- 6. USNM 248644.

7–8. *?Anagymnotoceras moderatum* (McLearn) (p. 25). Plesiotype, USNM 248645, USGS Mesozoic loc. M2822, Hyatti Zone.

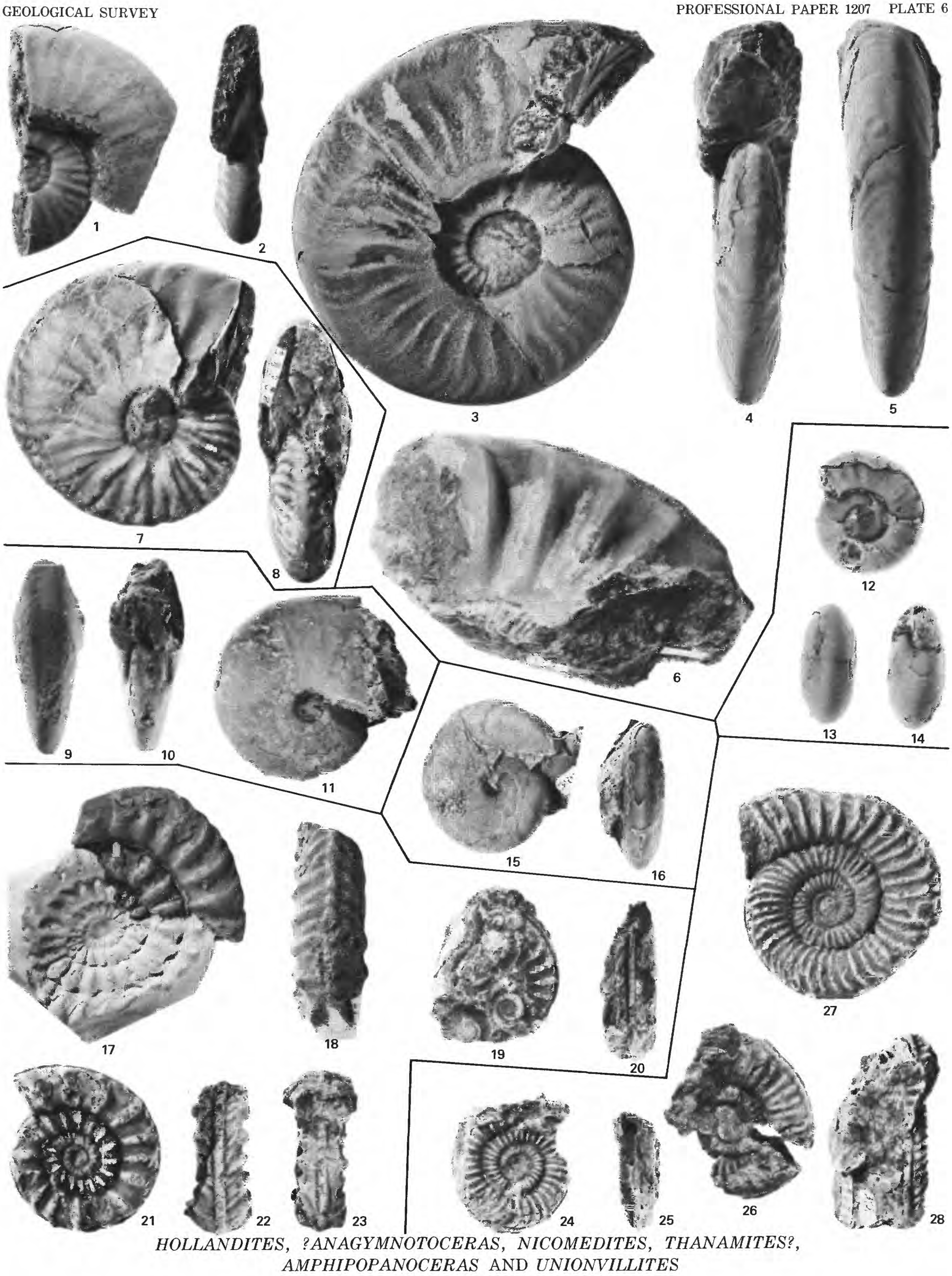
9–11. *Nicomedites* sp. (p. 24).
USNM 248646, USGS loc. M533, Hyatti Zone.

12–14. *Thanamites? contractus* (Smith) (p. 56). Plesiotype, USNM 248647, USGS loc. M144, Occidentalis Zone, × 2.

15–16. *Amphipopanoceras* cf. *A. selwyni* (McLearn) (p. 20). Plesiotype, USNM 248648, USGS Mesozoic loc. M2829, Hyatti Zone.

17-23. *Unionvillites hadleyi* (Smith) (p. 45). Hyatti Zone.
- 17–18. Plesiotype, USNM 248649, USGS Mesozoic loc. M2829. Specimen is partly a plaster cast from an external mold.
- 19–20. Plesiotype, USNM 248650, USGS Mesozoic loc. M1181.
- 21-23. Holotype, USNM 74432, from near Unionville, Humboldt Range, Nev.

24–28. *Unionvillites asseretoi* n. sp. (p. 45). USGS Mesozoic loc. M2829, Hyatti Zone.
- 24–25. Paratype, USNM 248651.
- 26. Paratype, USNM 248652.
- 27–28. Holotype, USNM 248653.




*HOLLANDITES, ?ANAGYMNOTOCERAS, NICOMEDITES, THANAMITES?,*
*AMPHIPOPANOCERAS* AND *UNIONVILLITES*

# PLATE 7

[All figures natural size]

FIGURES 1–27. *Gymnotoceras rotelliformis* Meek (p. 26), Rotelliformis Zone.

1–3. Holotype, USNM 12516, "Buena Vista Canyon, Humboldt Range, Nevada" (Meek, 1877).
4–5. Plesiotype, USNM 248654, USGS loc. M136.
6–8. Plesiotype, USNM 248655, USGS loc. M136.
9–10. Plesiotype, USNM 248656, USGS loc. M136.
11–12. Plesiotype, USNM 248657, USGS loc. M136.
13–14. Plesiotype, USNM 248658, USGS loc. M136.
15–16. Plesiotype, USNM 248659, USGS loc. M136.
17–19. Plesiotype, USNM 248660, USGS loc. M136.
20–21. Plesiotype, USNM 248661, USGS loc. M136.
22–24. Plesiotype, USNM 248662, USGS loc. M136.
25–27. Plesiotype, USNM 248663, USGS loc. M136.


*GYMNOTOCERAS*

## PLATE 8

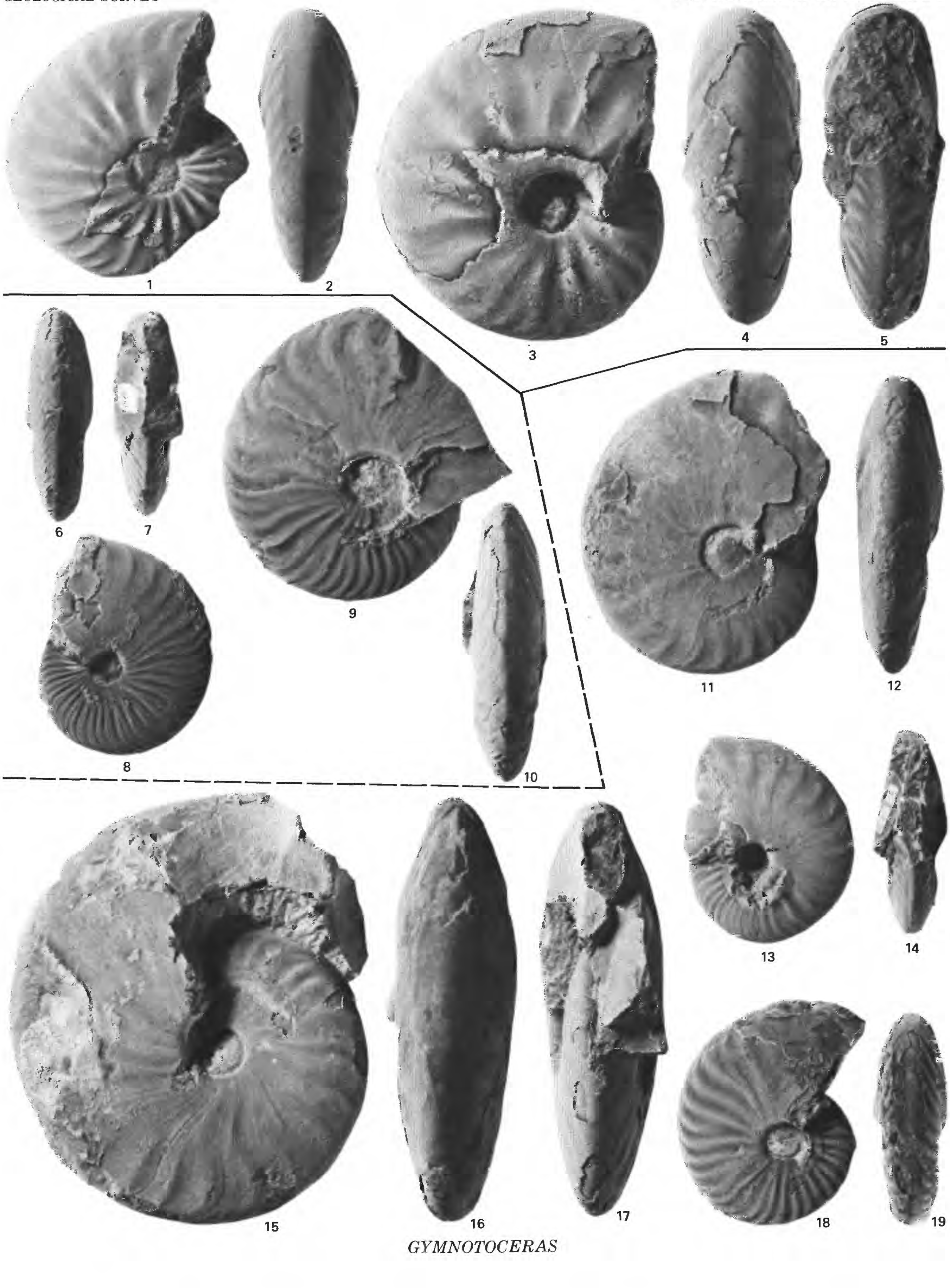
[All figures natural size]

FIGURES 1–5. *Gymnotoceras rotelliformis* Meek (p. 26). Plesiotypes, USGS loc. M165, Rotelliformis Zone.

- 1–2. USNM 248664.
- 3–5. USNM 248665.

6–19. *Gymnotoceras blakei* (Gabb) (p. 26). Plesiotypes, Rotelliformis Zone.

- 6–8. USNM 248666, USGS loc. M141.
- 9–10. USNM 248667, USGS loc. M141.
- 11–12. USNM 248668, USGS loc. M611
- 13–14. USNM 248669, USGS loc. M611.
- 15–17. USNM 248670, USGS loc. M611.
- 18–19. USNM 248671, USGS loc. M611.



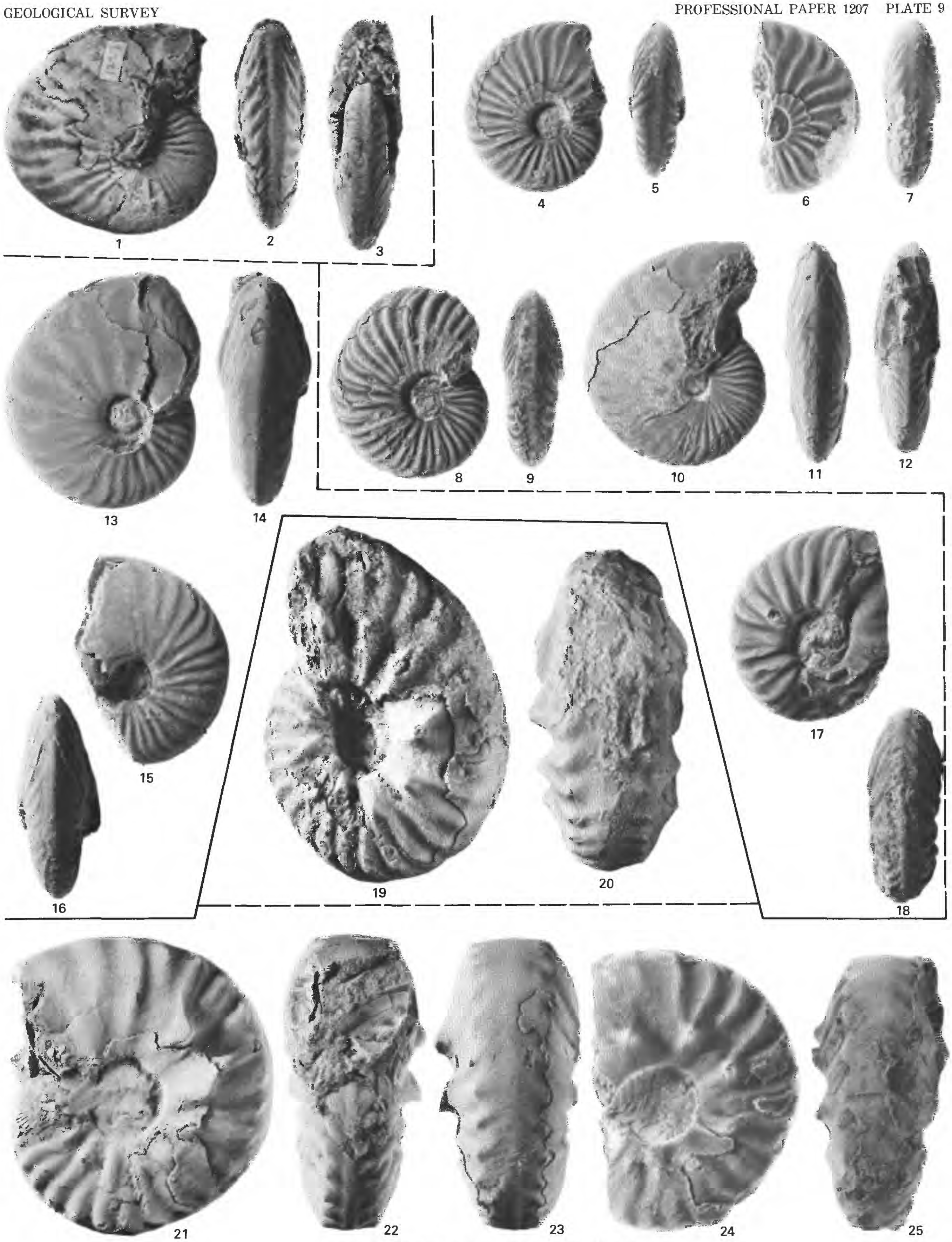

*GYMNOTOCERAS*

# PLATE 9

[All figures natural size]

FIGURES 1–18. *Gymnotoceras blakei* (Gabb) (p. 26). Rotelliformis Zone.
- 1–3. Holotype, ANSP 1227, near Star Canyon, Humboldt Range, Nev.
- 4–5. Plesiotype, USNM 248672, USGS loc. M964.
- 6–7. Plesiotype, USNM 248673, USGS loc. M964.
- 8–9. Plesiotype, USNM 248674, USGS loc. M964.
- 10–12. Plesiotype, USNM 248675, USGS loc. M964.
- 13–14. Plesiotype, USNM 248676, USGS loc. M608.
- 15–16. Plesiotype, USNM 248677, USGS loc. M608.
- 17–18. Plesiotype, USNM 248678, USGS loc. M608.

19–25. *Frechites nevadanus* (Mojsisovics) (p. 29). Meeki Zone.
- 19–20. Holotype, USNM 12512, Cottonwood Canyon, Humboldt Range, Nev.
- 21–23. Plesiotype, USNM 248679, USGS loc. M615.
- 24–25. Plesiotype, USNM 248680, USGS loc. M615.



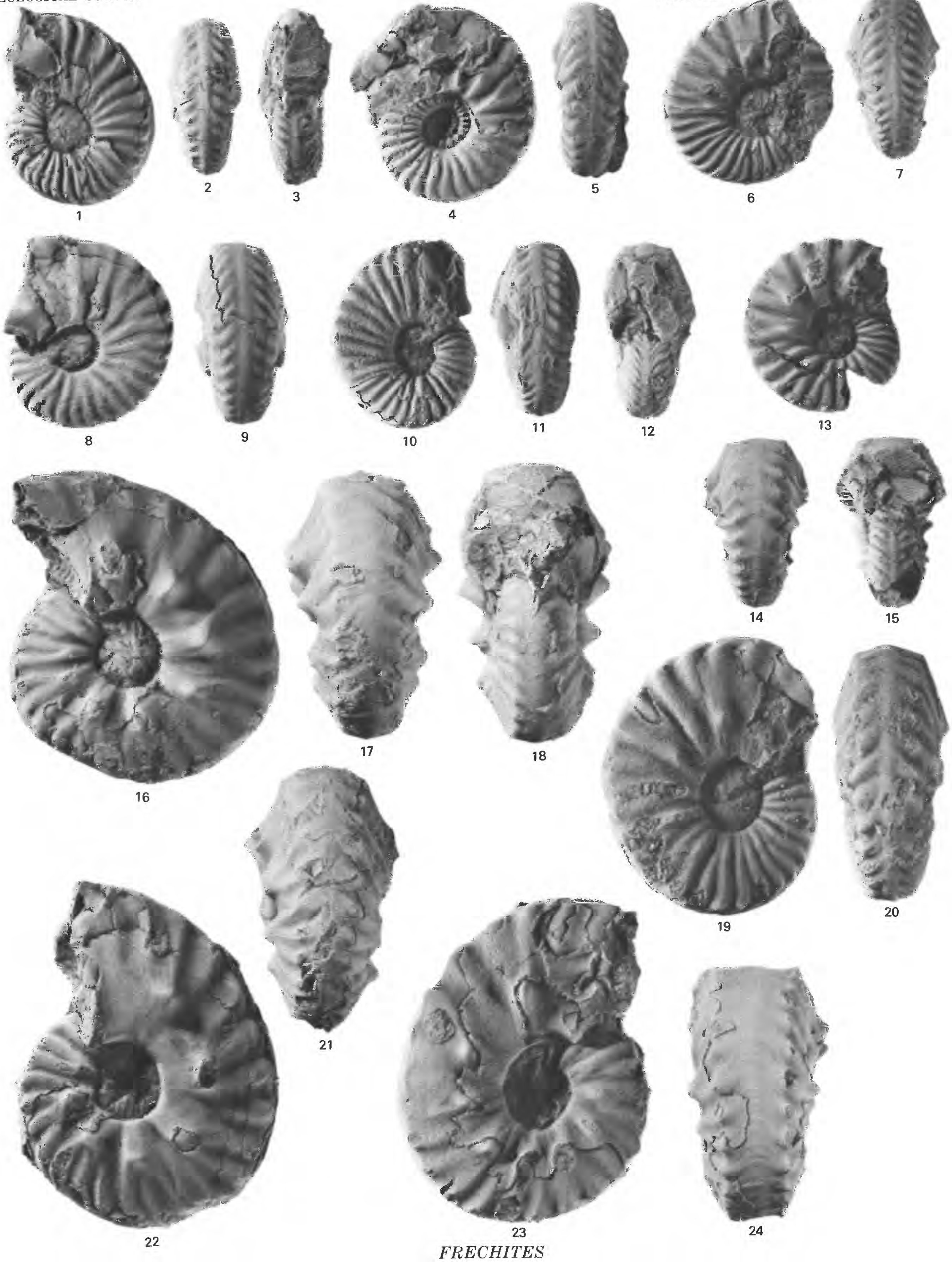

*GYMNOTOCERAS* AND *FRECHITES*

## PLATE 10

[All figures natural size]

FIGURES 1–24. *Frechites nevadanus* (Mojsisovics) (p. 29). Plesiotypes, USGS loc. M166, Meeki Zone.

1–3. USNM 248681.
4–5. USNM 248682.
6–7. USNM 248683.
8–9. USNM 248684.
10–12. USNM 248685.
13–15. USNM 248686.
16–18. USNM 248687.
19–20. USNM 248688.
21–22. USNM 248689.
23–24. USNM 248690.




*FRECHITES*

## PLATE 11

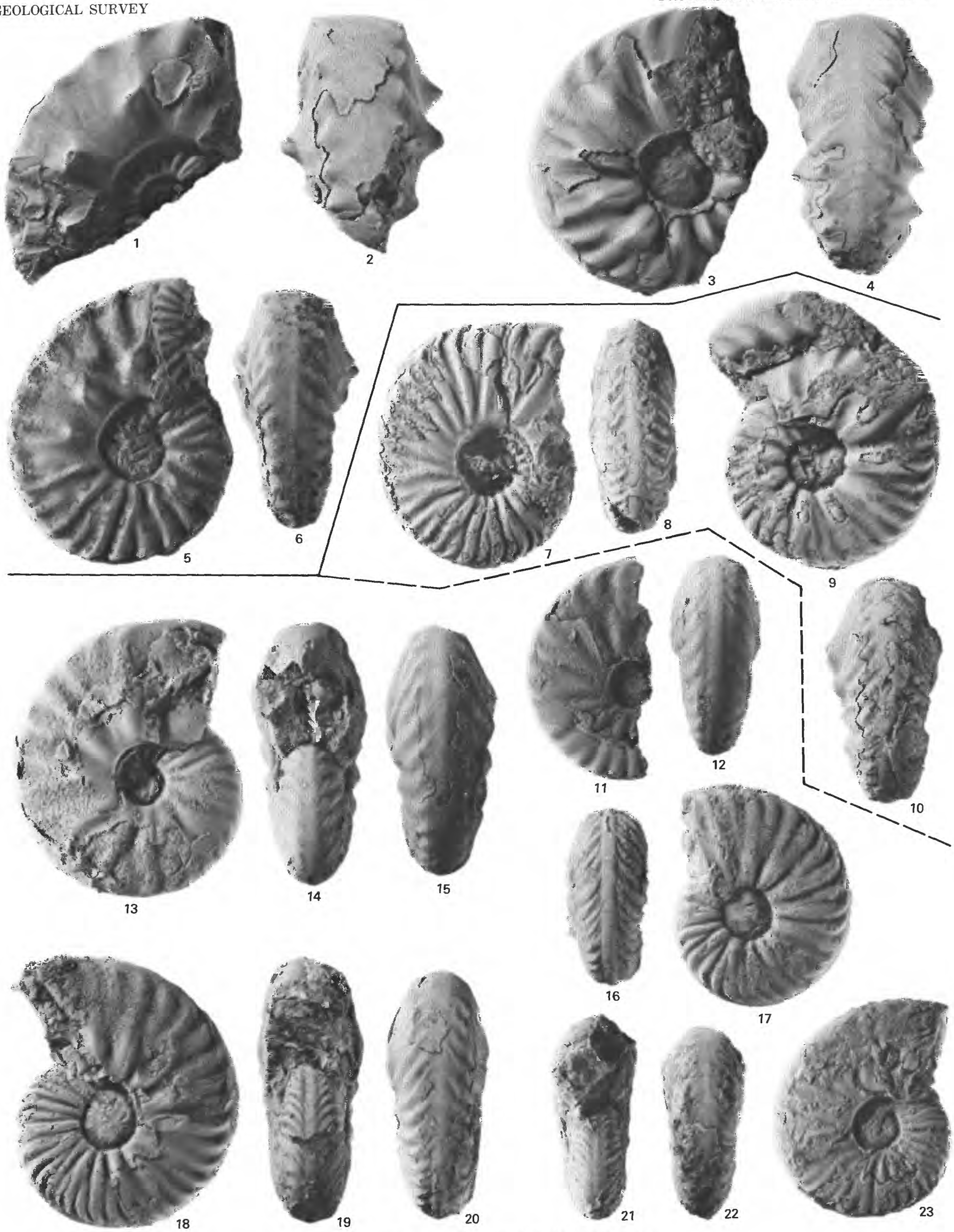
[All figures natural size]

FIGURES 1–6. *Frechites nevadanus* (Mojsisovics) (p. 29). Plesiotypes, USGS loc. M164, Meeki Zone.

- 1–2. USNM 248691.
- 3–4. USNM 248692.
- 5–6. USNM 248693.

7–23. *Parafrechites meeki* (Mojsisovics) (p. 27). Plesiotypes, Meeki Zone.

- 7–8. USNM 248694, USGS loc. M958.
- 9–10. USNM 248695, USGS loc. M958.
- 11–12. USNM 248696, USGS loc. M143.
- 13–15. USNM 248697, USGS loc. M143.
- 16–17. USNM 248698, USGS loc. M143.
- 18–20. USNM 248699, USGS loc. M143.
- 21–23. USNM 248700, USGS loc. M143.




*FRECHITES* AND *PARAFRECHITES*

## PLATE 12

[All figures natural size]

FIGURES 1–29. *Parafrechites meeki* (Mojsisovics) (p. 27). Meeki Zone.

1–2. Holotype, USNM 12512, Cottonwood Canyon, Humboldt Range, Nev.

3–5. Plesiotype, USNM 74301, Fossil Hill, Humboldt Range, Nev. [originally illustrated by Smith, 1914, as the holotype of "*Ceratites (Gymnotoceras) russelli* Smith"].

6–7. Plesiotype, USNM 248701, USGS loc. M140.

8–10. Plesiotype, USNM 248702, USGS loc. M140.

11–13. Plesiotype, USNM 248703, USGS loc. M140.

14–16. Plesiotype, USNM 248704, USGS loc. M140.

17–18. Plesiotype, USNM 248705, USGS loc. M140.

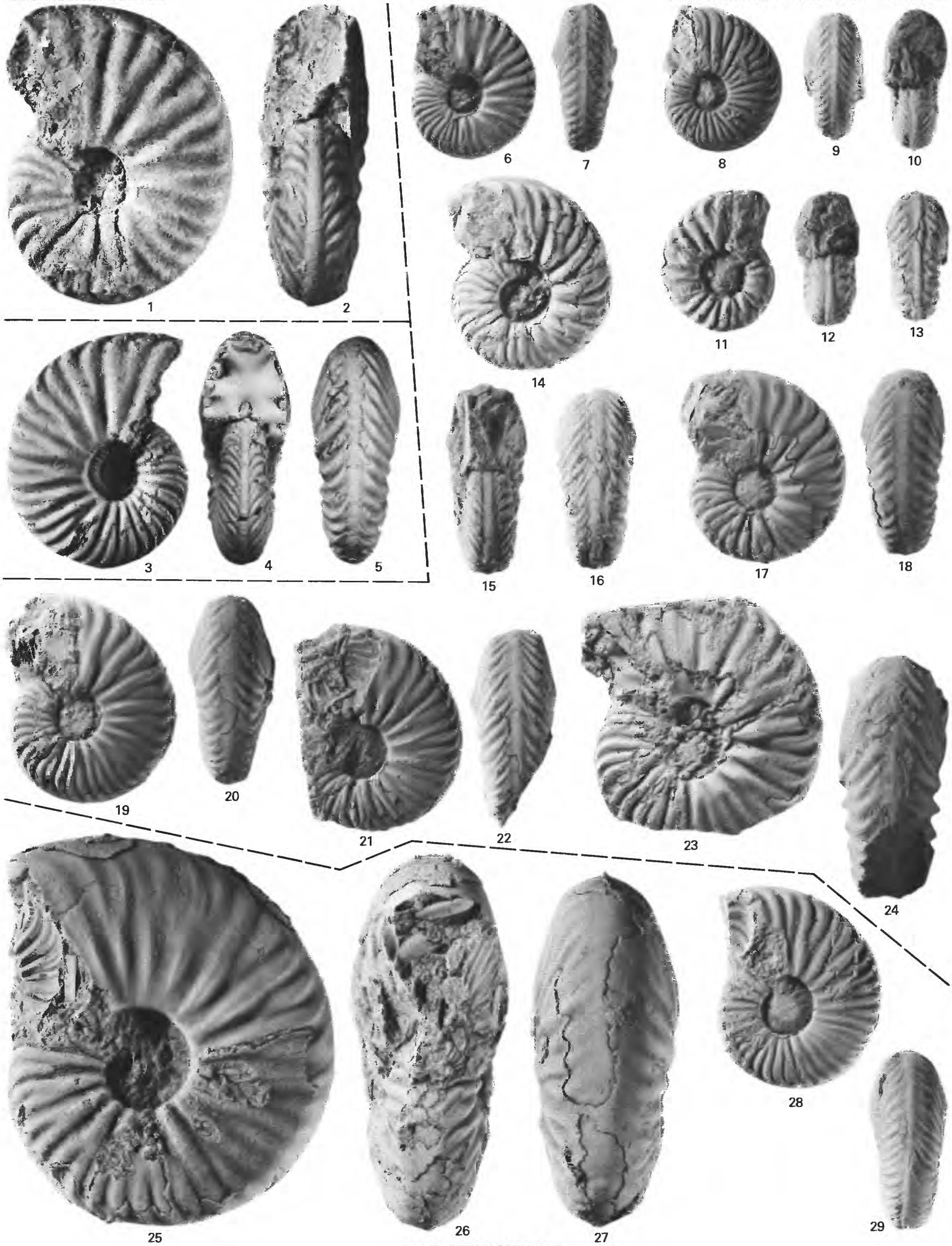
19–20. Plesiotype, USNM 248706, USGS loc. M140.

21–22. Plesiotype, USNM 248707, USGS loc. M140.

23–24. Plesiotype, USNM 248708, USGS loc. M140.

25–27. Plesiotype, USNM 248709, USGS loc. M960.

28–29. Plesiotype, USNM 248710, USGS loc. M960.




*PARAFRECHITES*

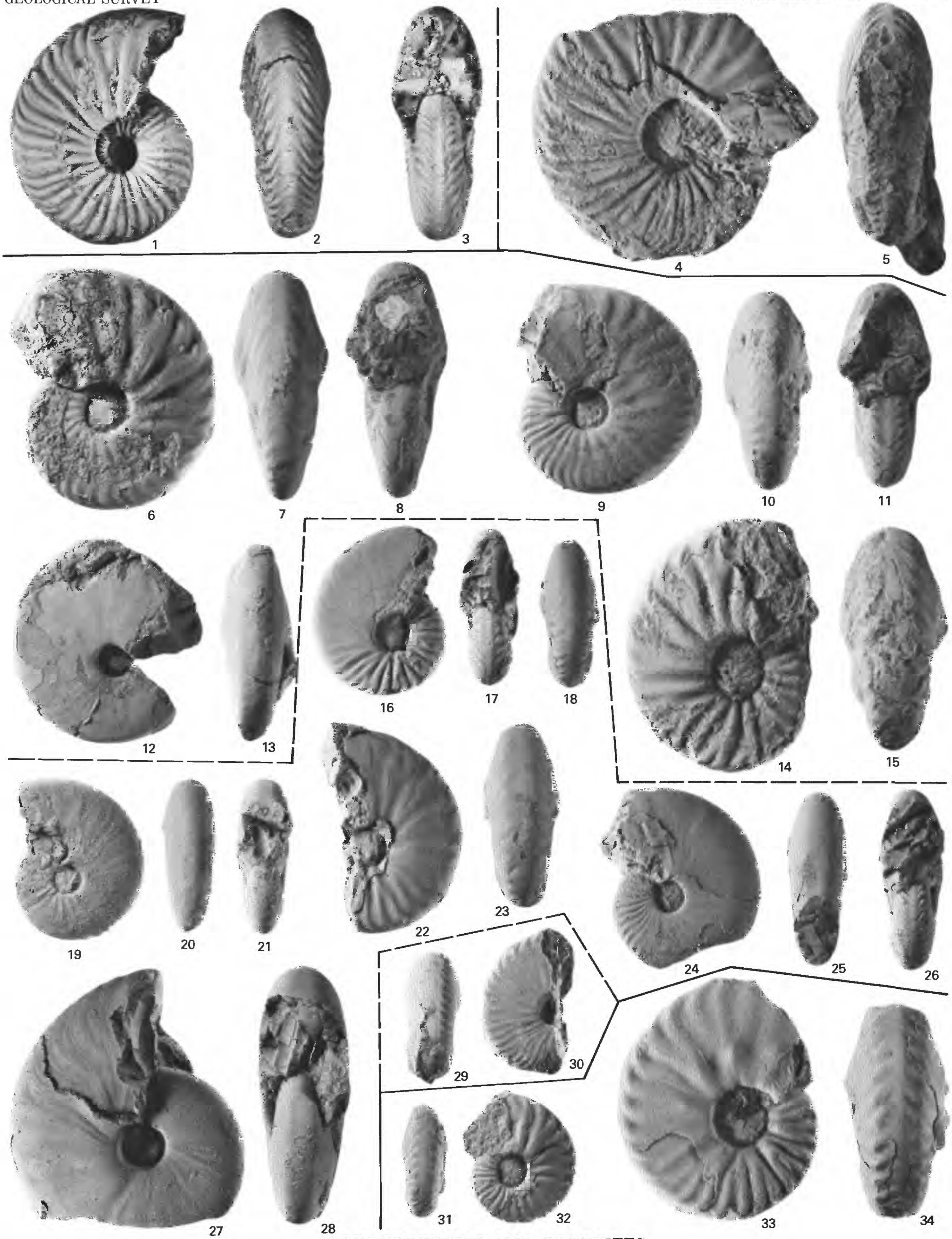
## PLATE 13

[All figures natural size]

FIGURES 1–5. *Parafrechites meeki* (Mojsisovics) (p. 27). Plesiotypes, Meeki Zone.
- 1–3. USNM 74391, Fossil Hill, Humboldt Range, Nev. [illustrated by Smith, 1914, as the holotype of *"Ceratites (Gymnotoceras) beckeri* Smith"].
- 4–5. USNM 248711, USGS loc. M618.

6–30. *Parafrechites dunni* (Smith) (p. 28). Plesiotypes, Meeki Zone.
- 6–8. USNM 248712, USGS loc. M618.
- 9–11. USNM 248713, USGS loc. M618.
- 12–13. USNM 248714, USGS loc. M618.
- 14–15. USNM 248715, USGS loc. M618.
- 16–18. USNM 248716, USGS loc. M968.
- 19–21. USNM 248717, USGS loc. M968.
- 22–23. USNM 248718, USGS loc. M968.
- 24–26. USNM 248719, USGS loc. M968.
- 27–28. USNM 248720, USGS loc. M968.
- 29–30. USNM 248721, USGS loc. M619.

31–34. *Frechites occidentalis* (Smith) (p. 30). Plesiotypes, USGS loc. M144 minus 6.0 ft. (1.8 m), Occidentalis Zone.
- 31–32. USNM 248722.
- 33–34. USNM 248723.



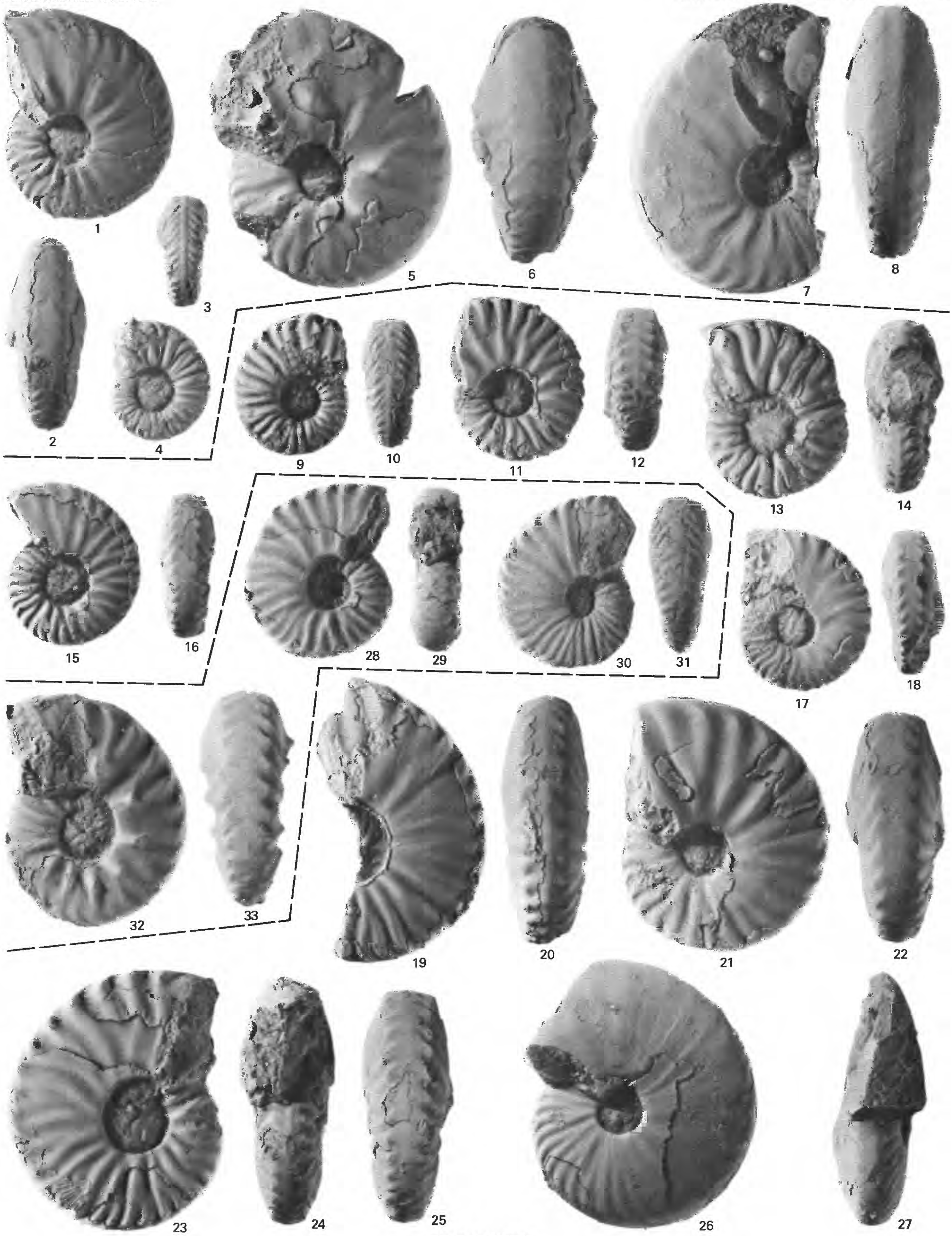

*PARAFRECHITES* AND *FRECHITES*

# PLATE 14

[All figures natural size]

FIGURES 1–33. *Frechites occidentalis* (Smith) (p. 30). Plesiotypes, Occidentalis Zone.

1–2. USNM 248724, USGS loc. M962.
3–4. USNM 248725, USGS loc. M962.
5–6. USNM 248726, USGS loc. M962.
7–8. USNM 248727, USGS loc. M962.
9–10. USNM 248728, USGS loc. M145.
11–12. USNM 248729, USGS loc. M145.
13–14. USNM 248730, USGS loc. M145.
15–16. USNM 248731, USGS loc. M145.
17–18. USNM 248732, USGS loc. M145.
19–20. USNM 248733, USGS loc. M145.
21–22. USNM 248734, USGS loc. M145.
23–25. USNM 248735, USGS loc. M145.
26–27. USNM 248736, USGS loc. M145.
28–29. USNM 248737, USGS loc. M624.
30–31. USNM 248738, USGS loc. M624.
32–33. USNM 248739, USGS loc. M624.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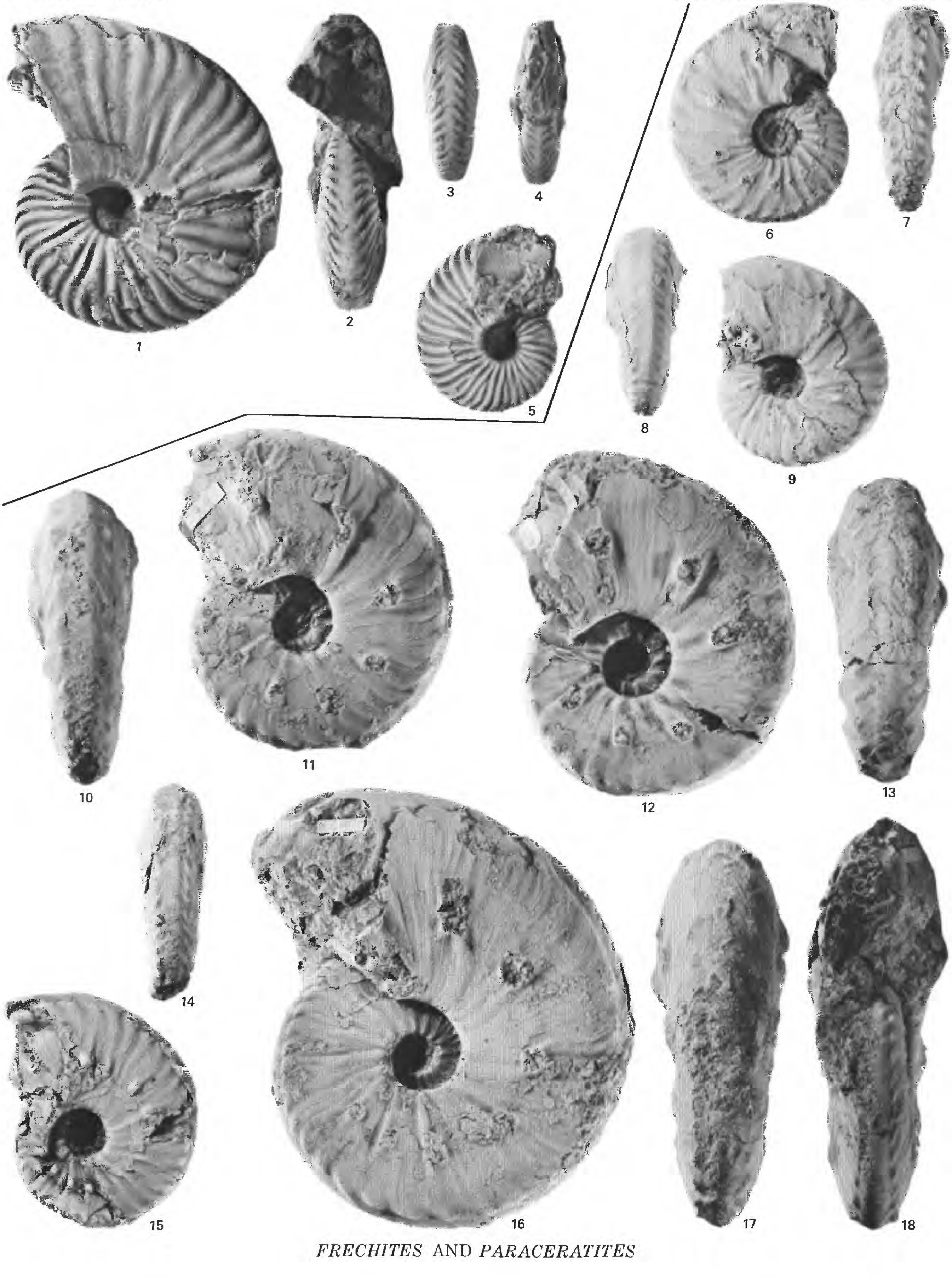
*FRECHITES*

# PLATE 15

[All figures natural size]

FIGURES 1–5. *Frechites johnstoni* n. sp. (p. 31). USGS Mesozoic loc. M5481, Subasperum Zone.
- 1–2. Holotype, USNM 248740.
- 3–5. Paratype, USNM 248741.

6–18. *Paraceratites burckhardti* Smith (p. 31). Plesiotypes, USGS loc. M965, Rotelliformis Zone.
- 6–7. USNM 248742.
- 8–9. USNM 248743.
- 10–11. USNM 248744.
- 12–13. USNM 248745.
- 14–15. USNM 248746.
- 16–18. USNM 248747.




*FRECHITES* AND *PARACERATITES*

# PLATE 16

[All figures natural size]

FIGURES 1–12. *Paraceratites clarkei* Smith (p. 32). Plesiotypes, Rotelliformis Zone.
1–2. USNM 248748, USGS loc. M608 minus 8 ft (2.5 m).
3–4. USNM 248749, USGS loc. M136 minus 7 ft (2.1 m).
5–6. USNM 248750, USGS loc. M966.
7–8. USNM 248751, USGS loc. M966.
9–10. USNM 248752, USGS loc. M966.
11–12. USNM 248753, USGS loc. M966.

13–28. *Paraceratites vogdesi* (Smith) (p. 33). Plesiotypes, USGS loc. M136, Rotelliformis Zone.
13–14. USNM 248754.
15–16. USNM 248755.
17–18. USNM 248756.
19–20. USNM 748757.
21–22. USNM 248758.
23–24. USNM 248759.
25–26. USNM 248760.
27–28. USNM 248761.

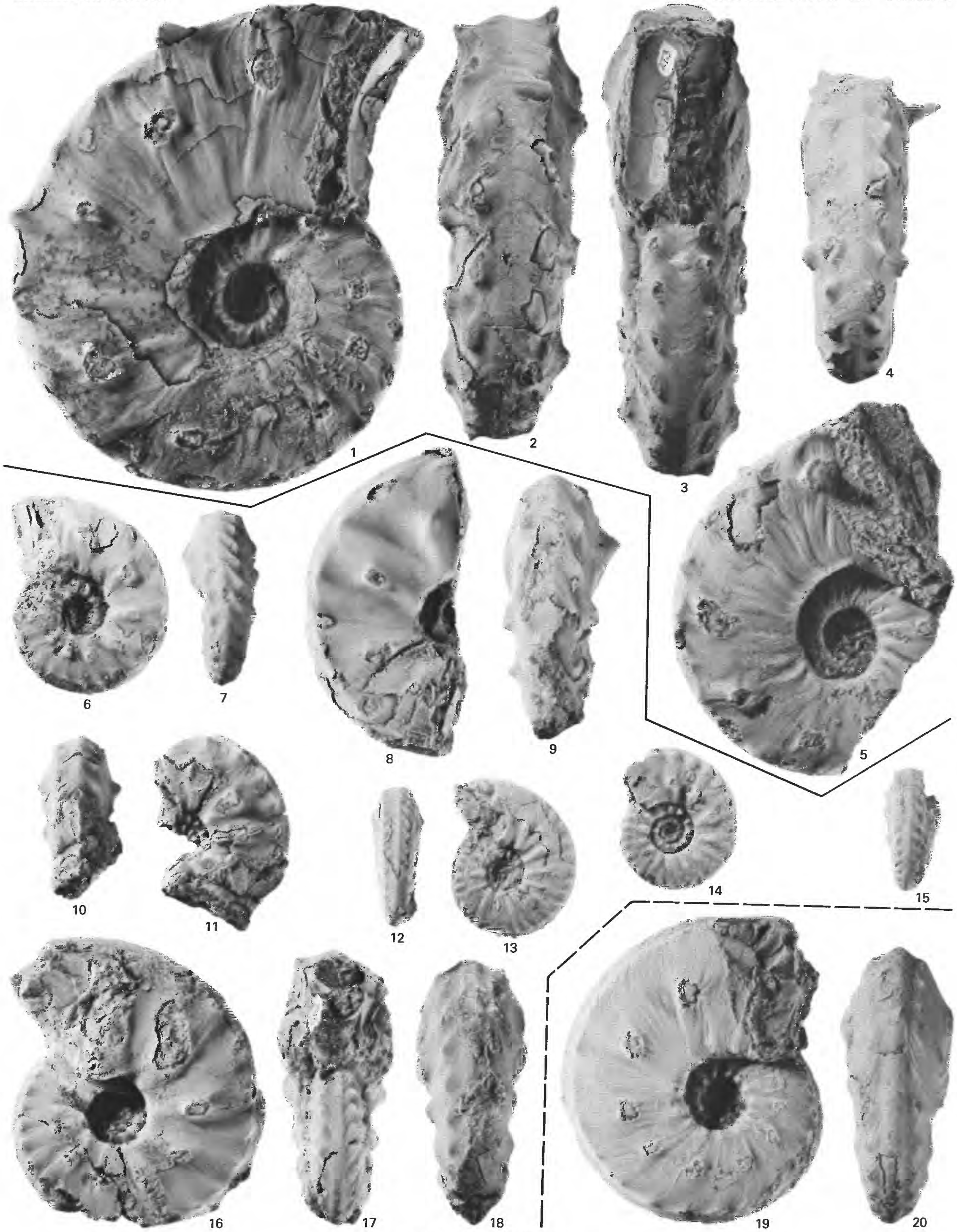

*PARACERATITES*

## PLATE 17

[All figures natural size]

FIGURES 1–5. *Paraceratites vogdesi* (Smith) (p. 33). Plesiotypes, USGS loc. M136, Rotelliformis Zone.
- 1–3. USNM 248762.
- 4–5. USNM 248763.

6–20. *Paraceratites cricki* Smith (p. 34). Plesiotypes, Rotelliformis Zone.
- 6–7. USNM 248764, USGS loc. M607.
- 8–9. USNM 248765, USGS loc. M607.
- 10–11. USNM 248766, USGS loc. M607.
- 12–13. USNM 248767, USGS loc. M607.
- 14–15. USNM 248768, USGS loc. M607.
- 16–18. USNM 248769, USGS loc. M607.
- 19–20. USNM 248770, USGS loc. M605 plus 10 ft (3.0 m).




*PARACERATITES*

## PLATE 18

[All figures natural size]

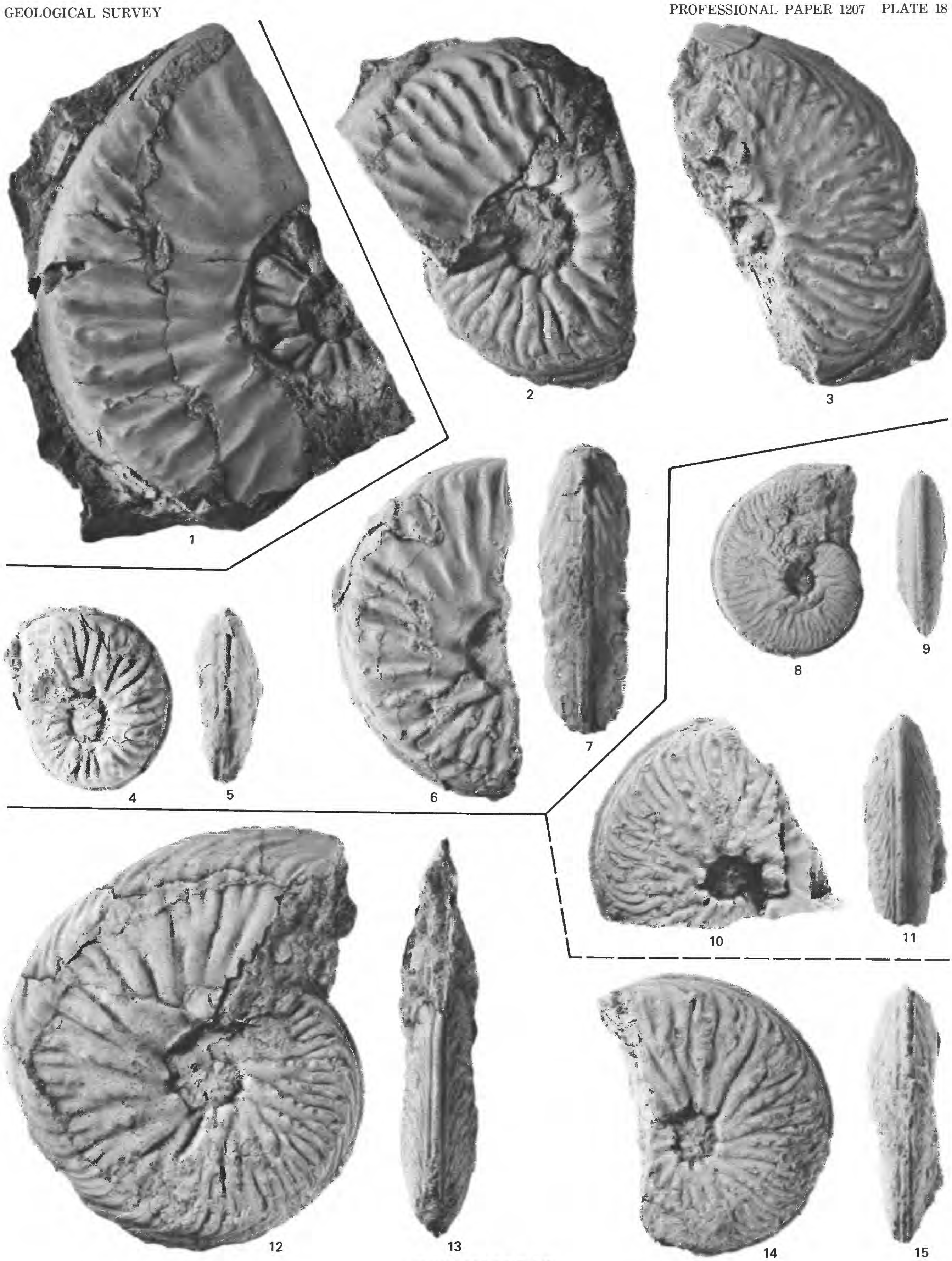
FIGURE 1. *Eutomoceras* cf. *E. lahontanum* Smith (p. 34). Plesiotype, USNM 248771, USGS loc. M610, Rotelliformis Zone.

2–7. *Eutomoceras dalli* Smith (p. 35). Plesiotypes, USGS loc. M611, Rotelliformis Zone.

- 2. USNM 248772.
- 3. USNM 248773.
- 4–5. USNM 248774.
- 6–7. USNM 248775.

8–15. *Eutomoceras dunni* Smith (p. 35). Plesiotypes, Meeki Zone.

- 8–9. USNM 248776, USGS loc. M142.
- 10–11. USNM 248777, USGS loc. M142.
- 12–13. USNM 248778, USGS loc. M137 plus 4 ft (1.2 m).
- 14–15. USNM 248779, USGS loc. M137 plus 4 ft (1.2 m).




*EUTOMOCERAS*

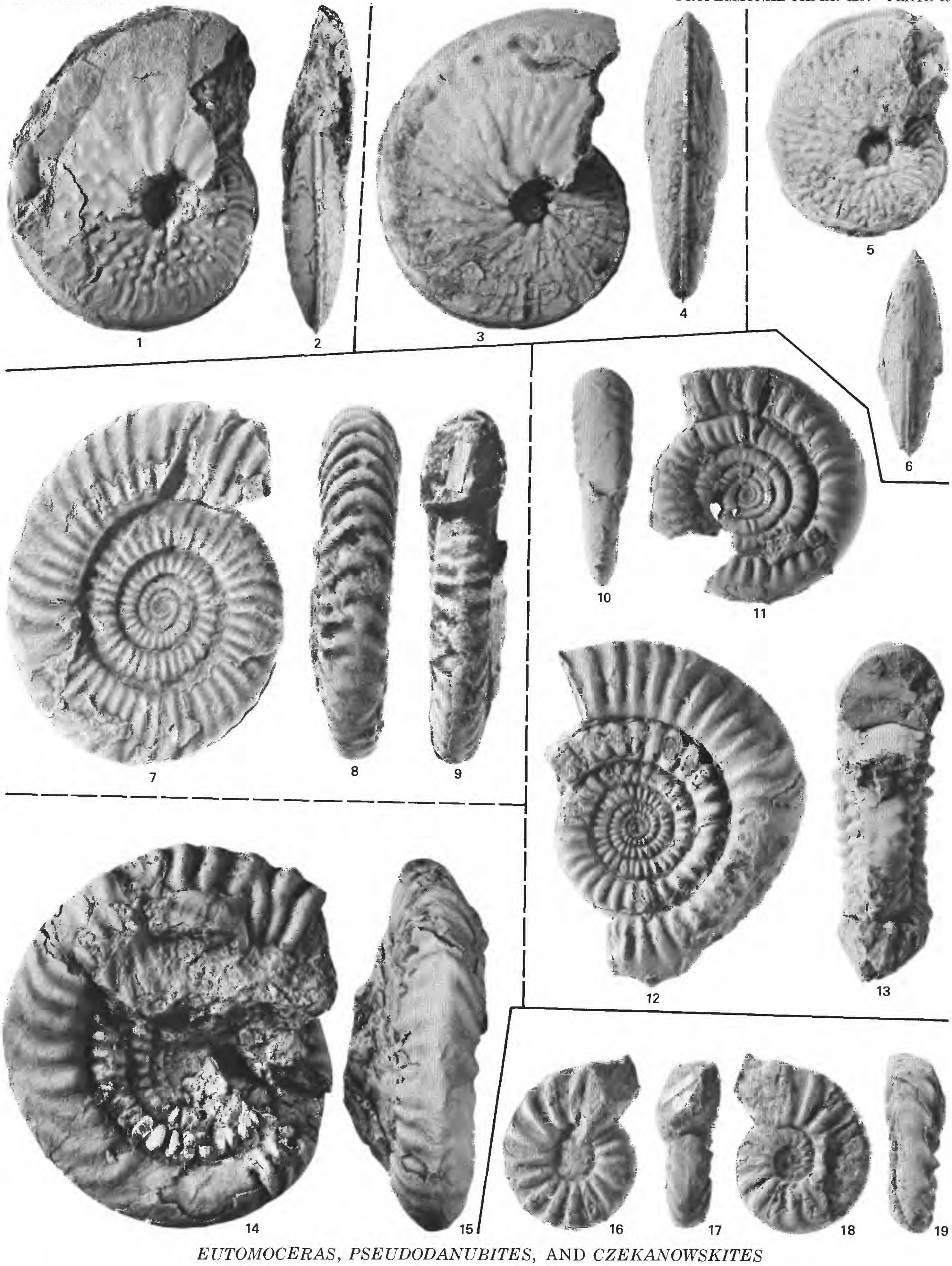
## PLATE 19

[All figures natural size]

FIGURES 1–6. *Eutomoceras laubei* Meek (p. 35).
- 1–2. Holotype, USNM 12528, New Pass Range, Nev.
- 3–4. Plesiotype, USNM 248780, USGS loc. M962, Occidentalis Zone.
- 5–6. Plesiotype, USNM 248781, USGS loc. M618, Meeki Zone.

7–15. *Pesudodanubites halli* (Mojsisovics) (p. 44). Plesiotypes, Hyatti Zone.
- 7–9. USNM 248782, USGS loc. M970.
- 10–11. USNM 248783, USGS Mesozoic loc. M1181.
- 12–13. USNM 248784, USGS Mesozoic loc. M1181.
- 14–15. USNM 12522, Congress Canyon, Humboldt Range, Nev.

16–19. *Czekanowskites hayesi* (McLearn) (p. 43). Plesiotype, USNM 248785, USGS loc. M970, Hyatti Zone.




*EUTOMOCERAS*, *PSEUDODANUBITES*, AND *CZEKANOWSKITES*

## PLATE 20

[All figures natural size unless otherwise indicated]

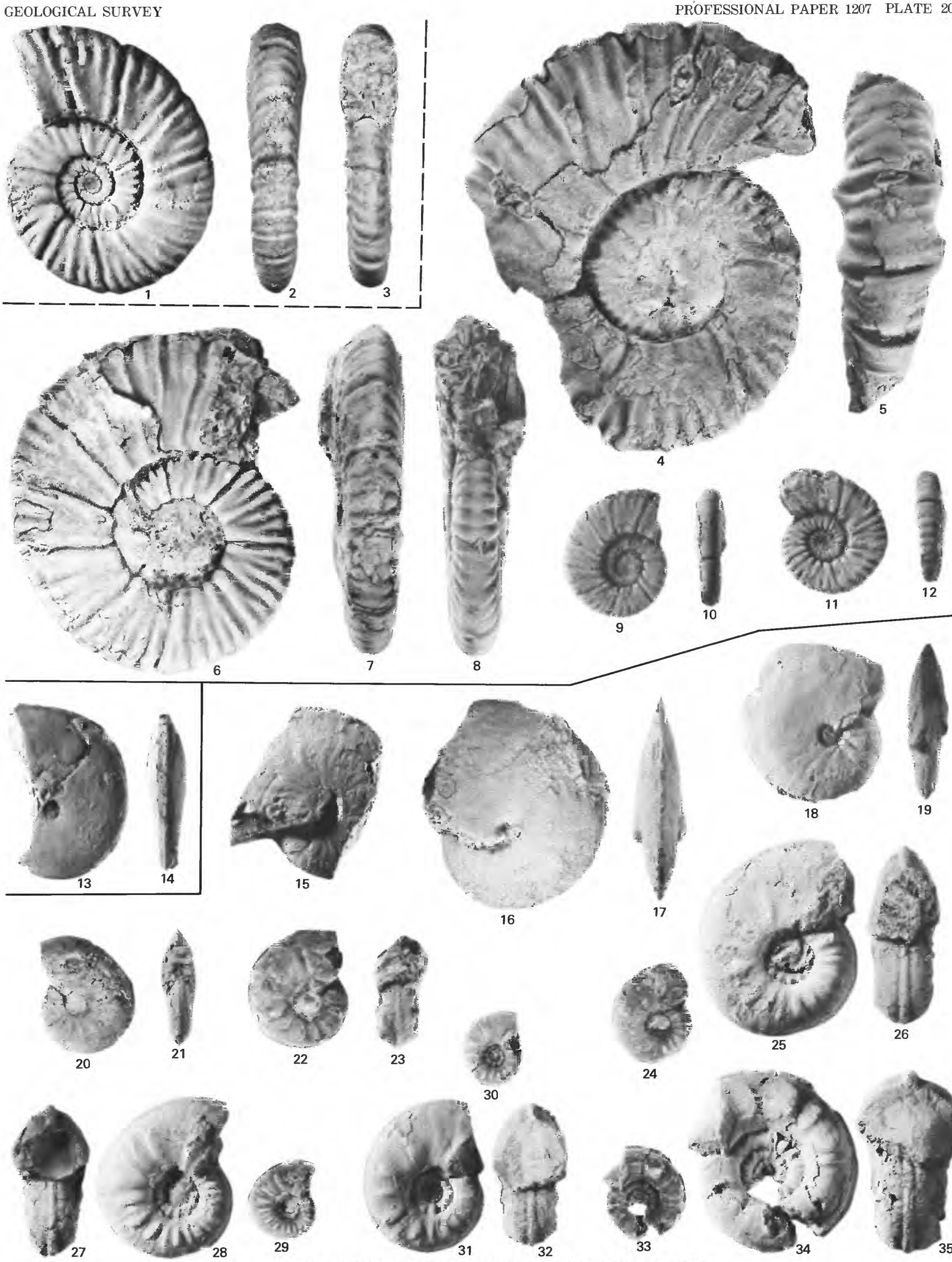
FIGURES 1–12. *Cuccoceras bonaevistae* (Hyatt and Smith) (p. 23). Hyatti Zone.

- 1–3. Holotype, USNM 74383, Unionville, Buena Vista Canyon, Humboldt Range, Nev.
- 4–5. Plesiotype, USNM 248786, USGS loc. M533.
- 6–8. Plesiotype, USNM 248787, USGS loc. M533.
- 9–10. Plesiotype, USNM 248788, USGS loc. M533.
- 11–12. Plesiotype, USNM 248789, USGS loc. M533.

13–14. *Hungarites* sp. (p. 38). Plesiotype USNM 248790, USGS loc. M907, upper Ladinian.

15–35. *Intornites mctaggarti* (McLearn) (p. 48). Plesiotypes, USGS loc. M533, Hyatti Zone.

- 15. USNM 248791.
- 16–17. USNM 248792.
- 18–19. USNM 248793.
- 20–21. USNM 248794.
- 22–23. USNM 248795.
- 24. USNM 248796.
- 25–26. Same as figure 24, × 2.
- 27–28. USNM 248797, × 2.
- 29. Same as figure 28.
- 30. USNM 248798.
- 31–32. Same as figure 30, × 2.
- 33. USNM 248799.
- 34–35. Same as figure 33, × 2.




*CUCCOCERAS*, *HUNGARITES*, AND *INTORNITES*

## PLATE 21

[All figures natural size unless otherwise indicated]

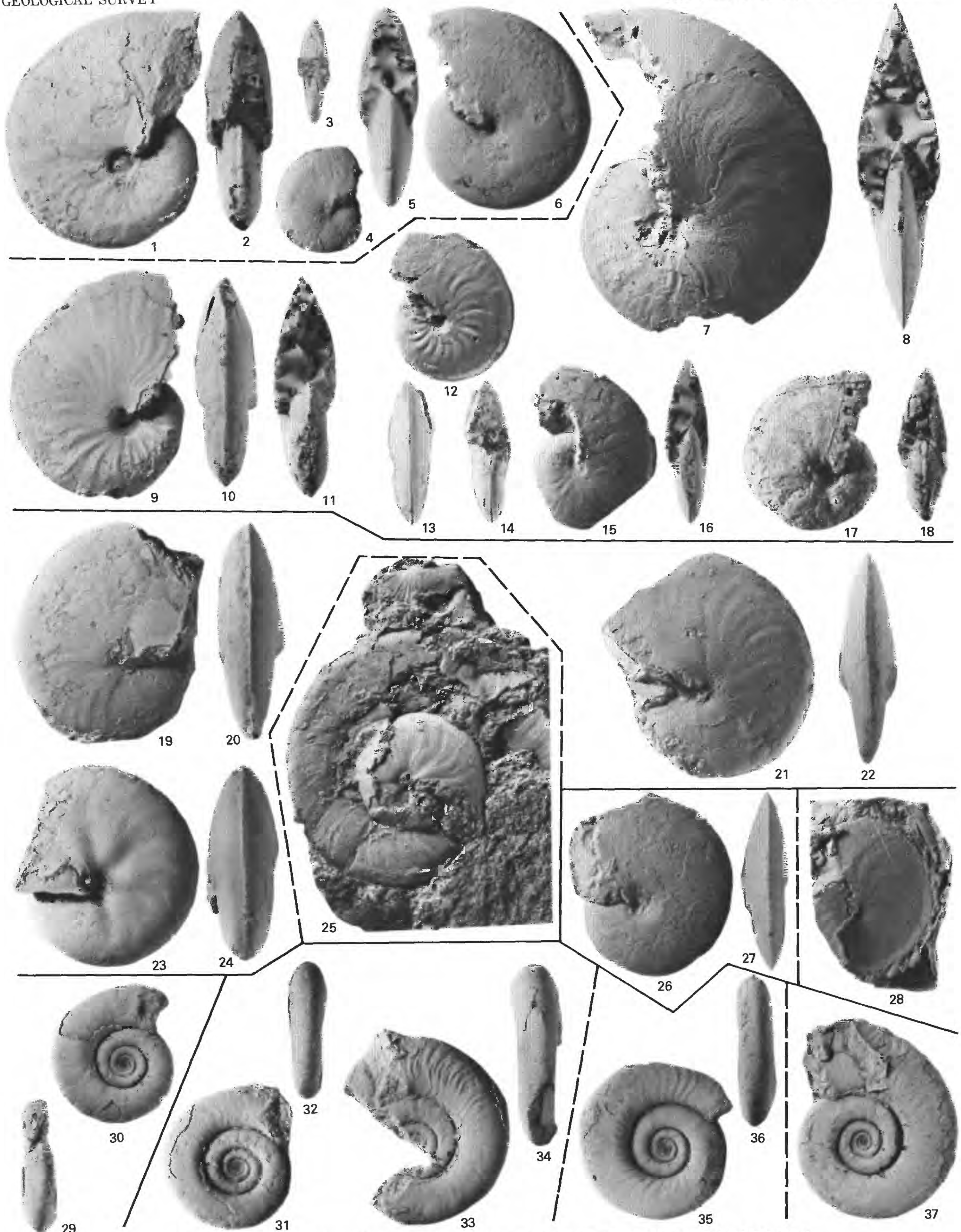
FIGURES 1–18. *Intornites nevadanus* (Hyatt and Smith) (p. 48). Shoshonensis Zone.
- 1–2. Paratype, MCZ 3903a, New Pass Range, Nev., × 2.
- 3–4. Paratype, MCZ 3904, New Pass Range, Nev., × 2.
- 5–6. Holotype, MCZ 3902, New Pass Range, Nev., × 2.
- 7–8. Plesiotype, USNM 248800, USGS loc. M635.
- 9–11. Plesiotype, USNM 248801, USGS loc. M635, × 2.
- 12–14. Plesiotype, USNM 248802, USGS loc. M635.
- 15–16. Plesiotype, USNM 248803, USGS loc. M635.
- 17–18. Plesiotype, USNM 248804, USGS loc. M635.

19–25. *Longobardites parvus* (Smith) (p. 50). Plesiotypes, Rotelliformis Zone.
- 19–20. USNM 248805, USGS loc. M611, × 2.
- 21–22. USNM 248806, USGS loc. M611.
- 23–24. USNM 248807, USGS loc. M611, × 2.
- 25. USNM 248808, USGS loc. M964.

26–28. *Longobardites zsigmondyi* (Böckh) (p. 51). Plesiotypes, Occidentalis Zone.
- 26–27. USNM 248809, USGS loc. M961, × 2.
- 28. USNM 248810, USGS loc. M962.

29–30. *Metadinarites desertorus* (Smith) (p. 52). Plesiotype, USNM 248811, USGS loc. M967, Rotelliformis Zone.

31–37. *Aplococeras smithi*, n. sp. (p. 52).
- 31–32. Holotype, USNM 248812, USGS loc. M608, Rotelliformis Zone.
- 33–34. Paratype, USNM 248813, USGS loc. M608, Rotelliformis Zone.
- 35–36. Paratype, USNM 248814, USGS loc. M613, Rotelliformis Zone.
- 37. Paratype, USNM 248815, USGS loc. M142, Meeki Zone.




*INTORNITES*, *LONGOBARDITES*, *METADINARITES*, AND *APLOCOCERAS*

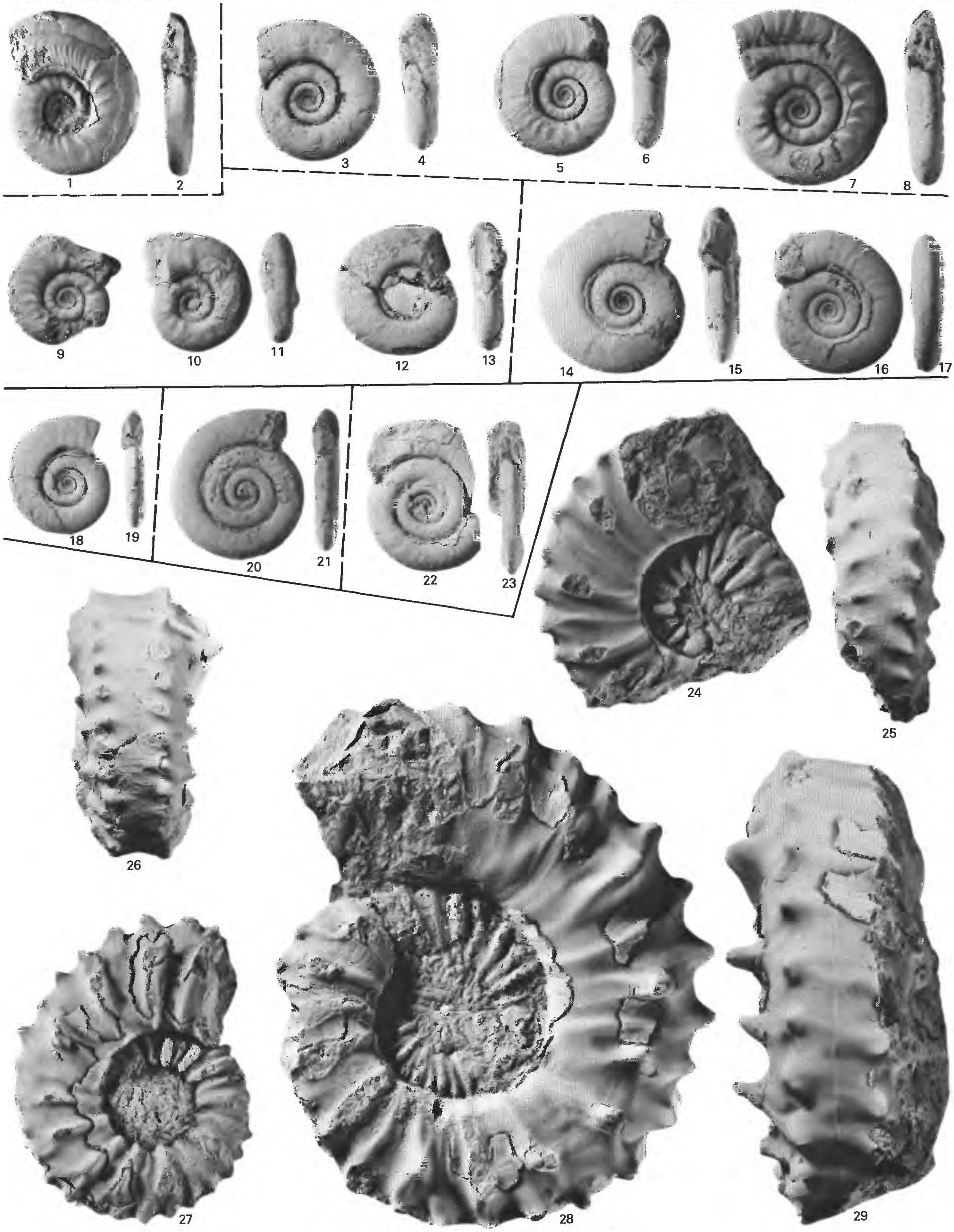
# PLATE 22

[All figures natural size]

FIGURES 1–17. *Aplococeras vogdesi* (Hyatti and Smith) (p. 53). Meeki Zone.
- 1–2. Holotype, USNM 74385, Fossil Hill, Humboldt Range, Nev.
- 3–4. Plesiotype, USNM 248816, USGS loc. M960.
- 5–6. Plesiotype, USNM 248817, USGS loc. M960.
- 7–8. Plesiotype, USNM 248818, USGS loc. M960.
- 9. Plesiotype, USNM 248819, USGS loc. M619.
- 10–11. Plesiotype, USNM 248820, USGS loc. M619.
- 12–13. Plesiotype, USNM 248821, USGS loc. M619.
- 14–15. Plesiotype, USNM 248822, USGS loc. M968.
- 16–17. Plesiotype, USNM 248823, USGS loc. M968.

18–23. *Aplococeras parvus* (Smith) (p. 53). Plesiotypes, Occidentalis Zone.
- 18–19. USNM 248824, USGS loc. M144 minus 6.0 ft (1.8 m).
- 20–21. USNM 248825, USGS loc. M623.
- 22–23. USNM 248826, USGS loc. M962A.

24–29. *Nevadites hyatti* (Smith) (p. 36). Plesiotypes, USGS loc. M144 minus 6.0 ft (1.8 m).
- 24–25. USNM 248827.
- 26–27. USNM 248828.
- 28–29. USNM 248829.




*APLOCOCERAS* AND *NEVADITES*

## PLATE 23

[All figures natural size]

FIGURES 1–7. *Nevadites hyatti* (Smith) (p. 36). Occidentalis Zone.

1–3. Holotype, USNM 74268, Fossil Hill, Humboldt Range, Nev.

4–5. Plesiotype, USNM 248830, USGS loc. M144 minus 6.0 ft (1.8 m).

6–7. Plesiotype, USNM 248831, USGS loc. M144 minus 6.0 ft (1.8 m).

8–19. *Nevadites humboldtensis* Smith (p. 37). Plesiotypes, USGS loc. M144, Occidentalis Zone.

8–9. USNM 248832.

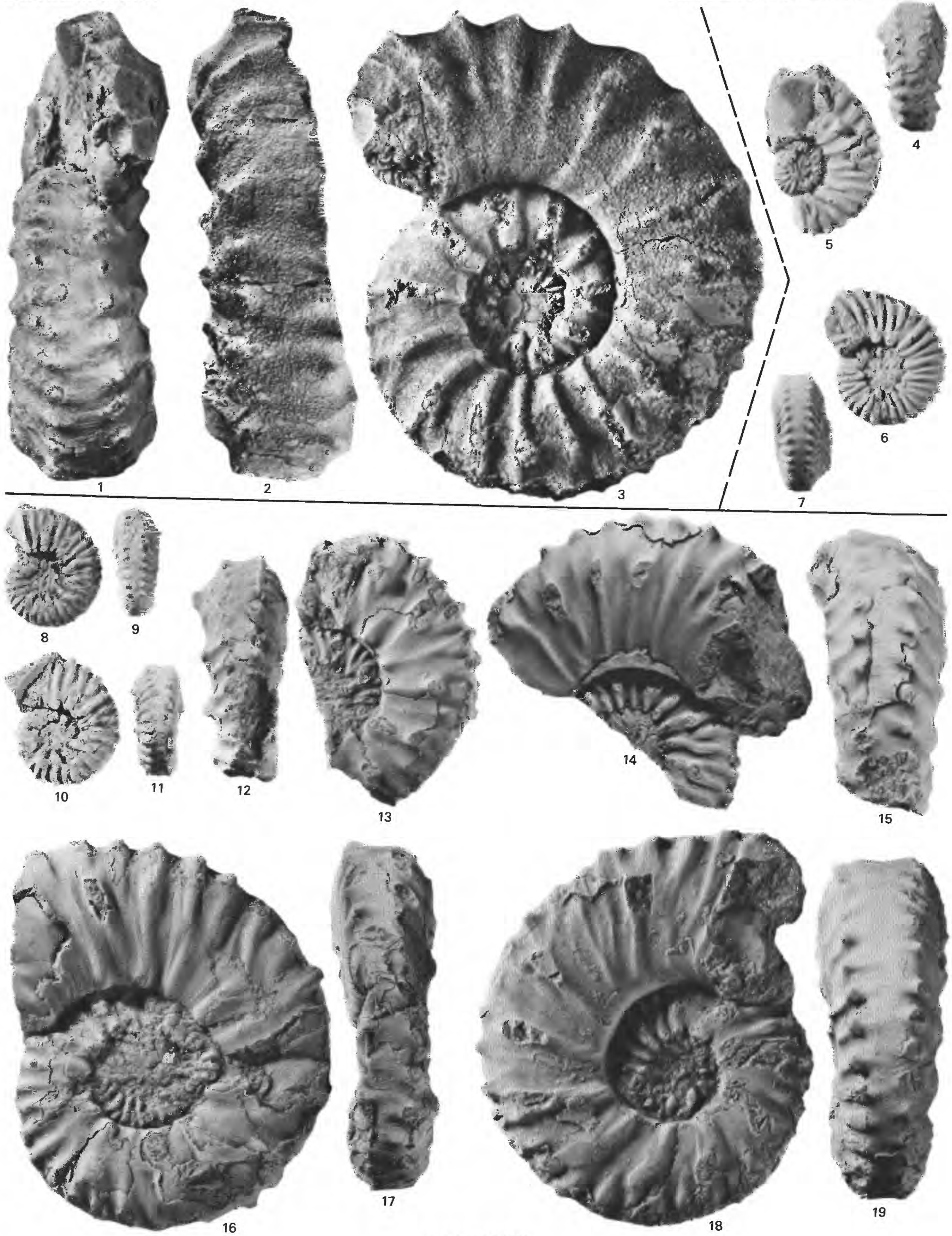
10–11. USNM 248833.

12–13. USNM 248834.

14–15. USNM 248835.

16–17. USNM 248836.

18–19. USNM 248837.




*NEVADITES*

## PLATE 24

[All figures natural size]

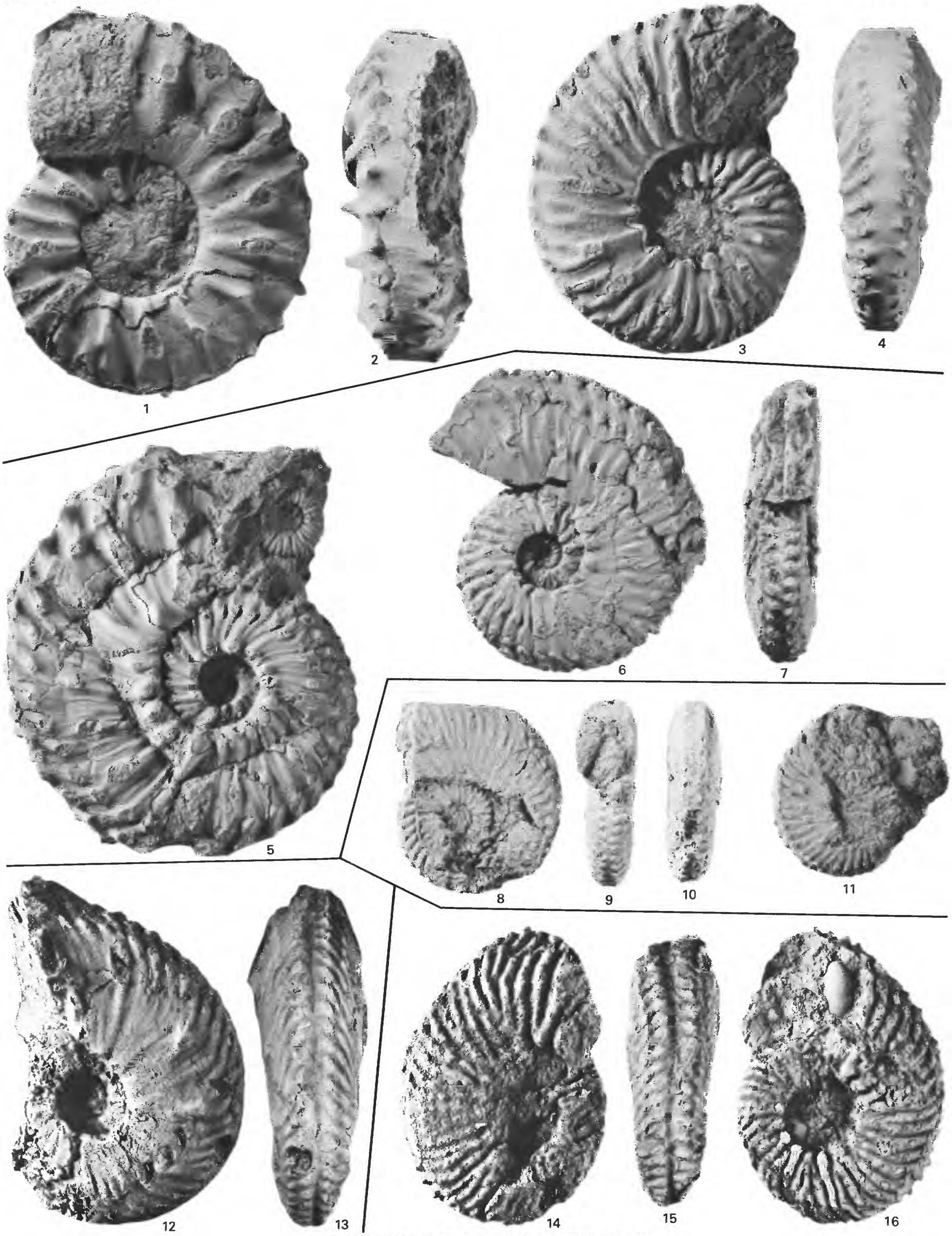
FIGURES 1–4. *Nevadites humboldtensis* Smith (p. 37). Plesiotypes, USGS loc. M144, Occidentalis Zone.
- 1–2. USNM 248838.
- 3–4. USNM 248839.

5–7. *Nevadites furlongi* (Smith) (p. 38). Plesiotypes, USGS loc. M145, Occidentalis Zone.
- 5. USNM 248840.
- 6–7. USNM 248841.

8–11. *Nevadites gabbi* (Smith) (p. 38). Plesiotypes, USGS loc. M146, Occidentalis Zone.
- 8–10. USNM 248842.
- 11. USNM 248843.

12–13. *Protrachyceras subasperum* (Meek) (p. 58). Holotype, USNM 20223, Cottonwood Canyon, Humboldt Range, Nev.

14–16. *Protrachyceras meeki* (Mojsisovics) (p. 58). Holotype, USNM 12529, Cottonwood Canyon, Humboldt Range, Nev.

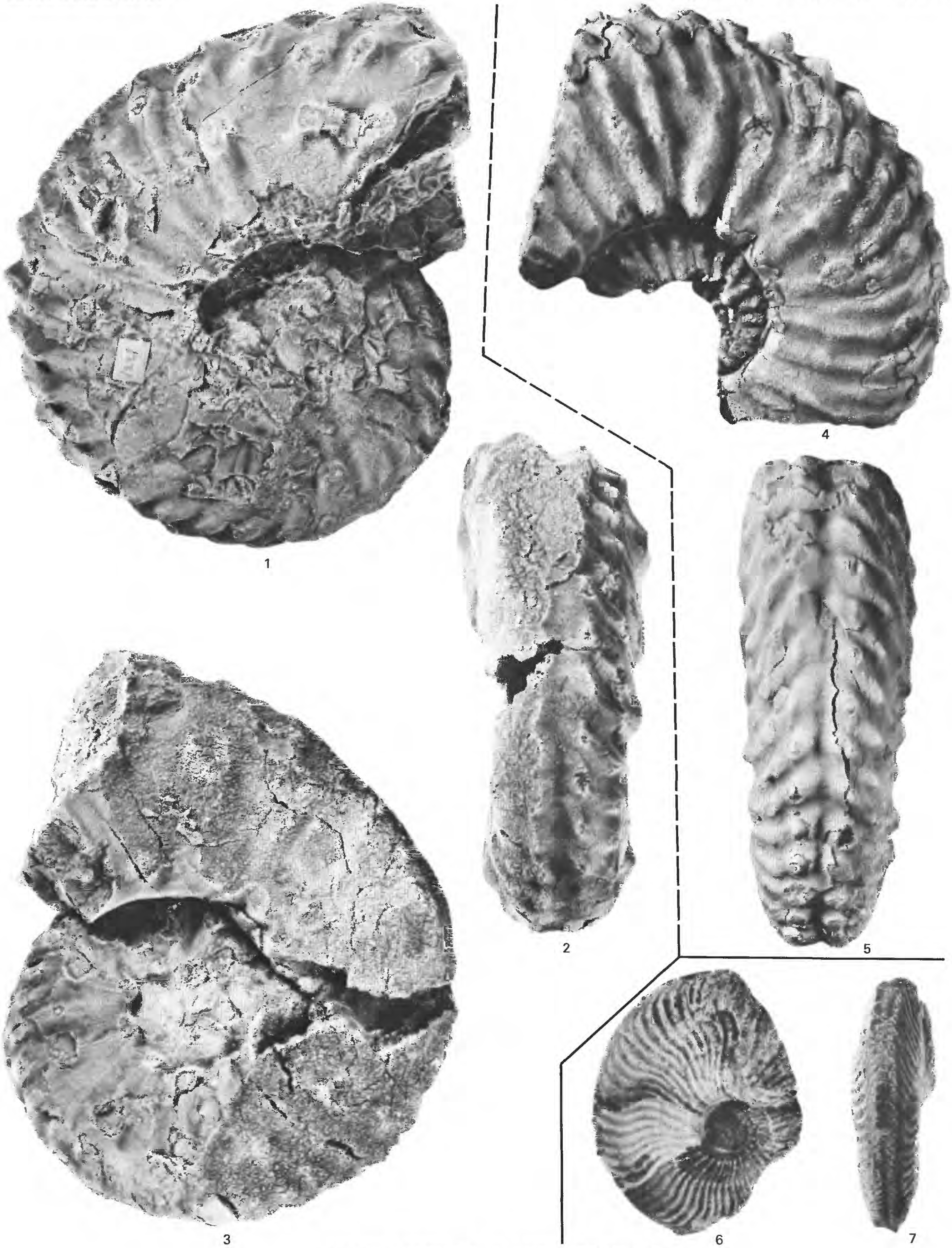



*NEVADITES* AND *PROTRACHYCERAS*

## PLATE 25

[All figures natural size]

FIGURES 1–5. *Protrachyceras americanum* (Mojsisovics) (p. 58).
1–3. Holotype, ANSP 1221, locality unknown but probably Humboldt Range, Nev.
4–5. Plesiotype figured by Meek, 1877, USNM 12527, Cottonwood Canyon, Humboldt Range, Nev.
6–7. *Sirenites homfrayi* (Gabb) (p. 59). Holotype, ANSP 30793, East Range, Nev.




*PROTRACHYCERAS* AND *SIRENITES*

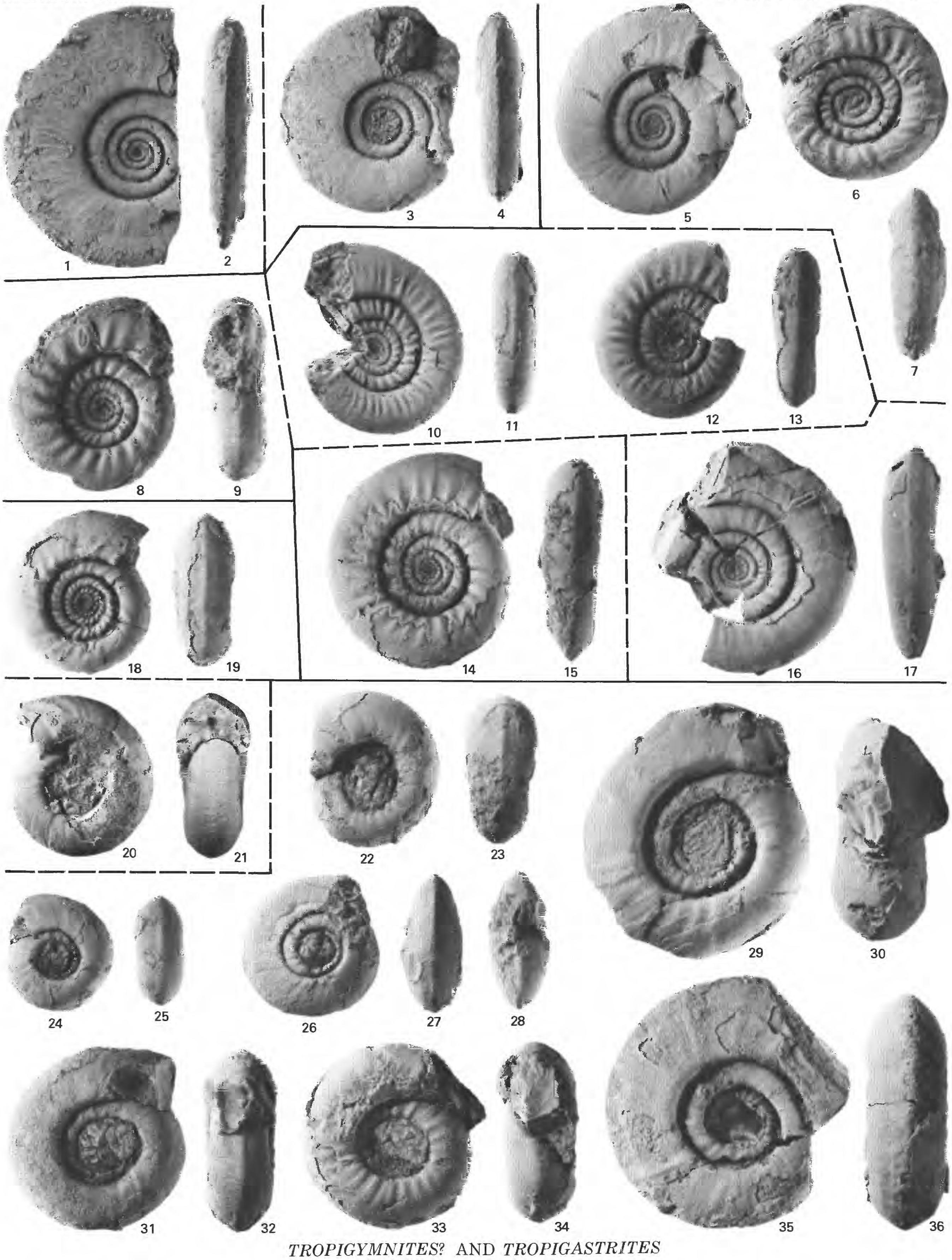
## PLATE 26

[All figures natural size]

FIGURES 1–4. *Tropigymnites?* cf. *T. planorbis* (Hauer) (p. 39). Plesiotypes, Rotelliformis Zone.
- 1–2. USNM 248844, USGS loc. M605.
- 3–4. USNM 248845, USGS loc. M136.

5–17. *Tropigastrites lahontanus* Smith (p. 54). Plesiotypes, Rotelliformis Zone.
- 5. USNM 248846, USGS loc. M609.
- 6–7. USNM 248983, USGS loc. M609.
- 8–9. USNM 248847, USGS loc. M141.
- 10–11. USNM 248848, USGS loc. M608.
- 12–13. USNM 248849, USGS loc. M608.
- 14–15. USNM 248850, USGS loc. M964.
- 16–17. USNM 248851, USGS loc. M611.

18–36. *Tropigastrites louderbacki* (Hyatt and Smith) (p. 54). Meeki Zone.
- 18–19. Plesiotype, USNM 248852, USGS loc. M142.
- 20–21. Holotype, USNM 74400, vicinity of Fossil Hill, Humboldt Range, Nev.
- 22–23. Plesiotype, USNM 248853, USGS loc. M166.
- 24–25. Plesiotype, USNM 248854, USGS loc. M166.
- 26–28. Plesiotype, USNM 248855, USGS loc. M166.
- 29–30. Plesiotype, USNM 248856, USGS loc. M166.
- 31–32. Plesiotype, USNM 248857, USGS loc. M166.
- 33–34. Plesiotype, USNM 248858, USGS loc. M166.
- 35–36. Plesiotype, USNM 248859, USGS loc. M166.




*TROPIGYMNITES*? AND *TROPIGASTRITES*

## PLATE 27

[All figures natural size]

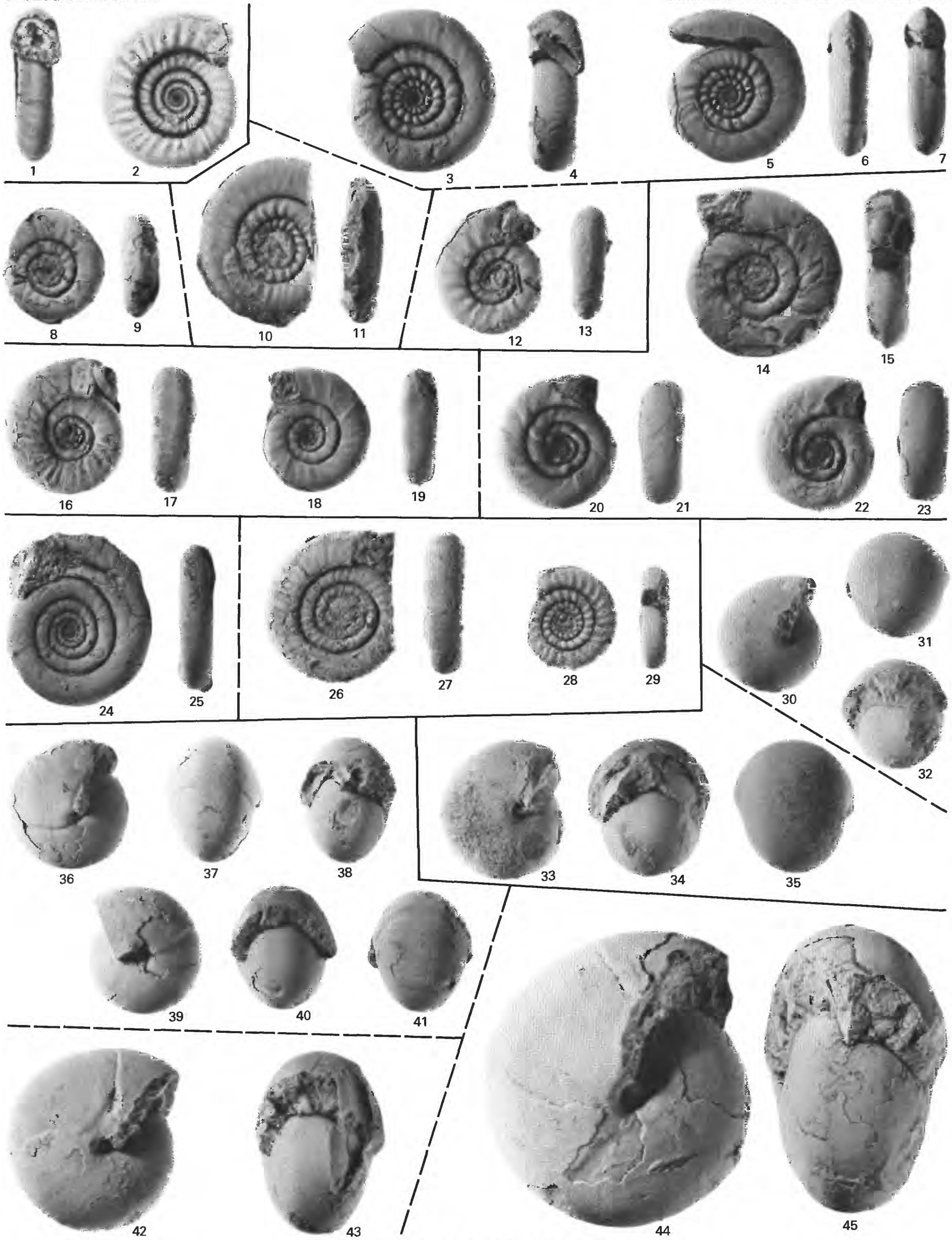
FIGURES 1–13. *Tozerites gemmellaroi* (Arthaber) (p. 55). Meeki Zone.
- 1–2. Lectotype, USNM 74305, vicinity of Fossil Hill, Humboldt Range, Nev.
- 3–4. Plesiotype, USNM 248860, USGS loc. M968.
- 5–7. Plesiotype, USNM 248861, USGS loc. M968.
- 8–9. Plesiotype, USNM 248862, USGS loc. M619.
- 10–11. Plesiotype, USNM 248863, USGS loc. M618.
- 12–13. Plesiotype, USNM 248864, USGS loc. M619.

14–23. *Tozerites humboldtensis* (Smith) (p. 56). Plesiotypes, Occidentalis Zone.
- 14–15. USNM 248865, USGS loc. M144.
- 16–17. USNM 248866, USGS loc. M962.
- 18–19. USNM 248867, USGS loc. M962.
- 20–21. USNM 248868, USGS loc. M144.
- 22–23. USNM 248869, USGS loc. M144.

24–29. *Tozerites polygyratus* Smith (p. 56). Plesiotypes, Occidentalis Zone.
- 24–25. USNM 248870, USGS loc. M624.
- 26–27. USNM 248871, USGS loc. M622.
- 28–29. USNM 248872, USGS loc. M622.

30–35. *Proarcestes* cf. *P. balfouri* (Oppel) (p. 57). Plesiotypes, Rotelliformis Zone.
- 30–32. USNM 248873, USGS loc. M609.
- 33–35. USNM 248874, USGS loc. M137.

36–45. *Proarcestes gabbi* Meek (p. 57). Plesiotypes, Occidentalis Zone.
- 36–38. USNM 248875, USGS loc. M962.
- 39–41. USNM 248876, USGS loc. M962.
- 42–43. USNM 248877, USGS loc. M620.
- 44–45. USNM 248878, USGS loc. M144.




*TOZERITES* AND *PROARCESTES*

# PLATE 28

[All figures natural size]

FIGURES 1–2. *Proarcestes gabbi* (Meek) (p. 57). Holotype, USNM 12523, near Cottonwood Canyon, Humboldt Range, Nev.

3–9. *Humboldtites septentrionalis* (Smith) (p. 21). Plesiotypes. Occidentalis Zone.

- 3–5. USNM 248879, USGS loc. M962.
- 6–7. USNM 248880, USGS loc. M245.
- 8–9. USNM 248881, USGS loc. M620

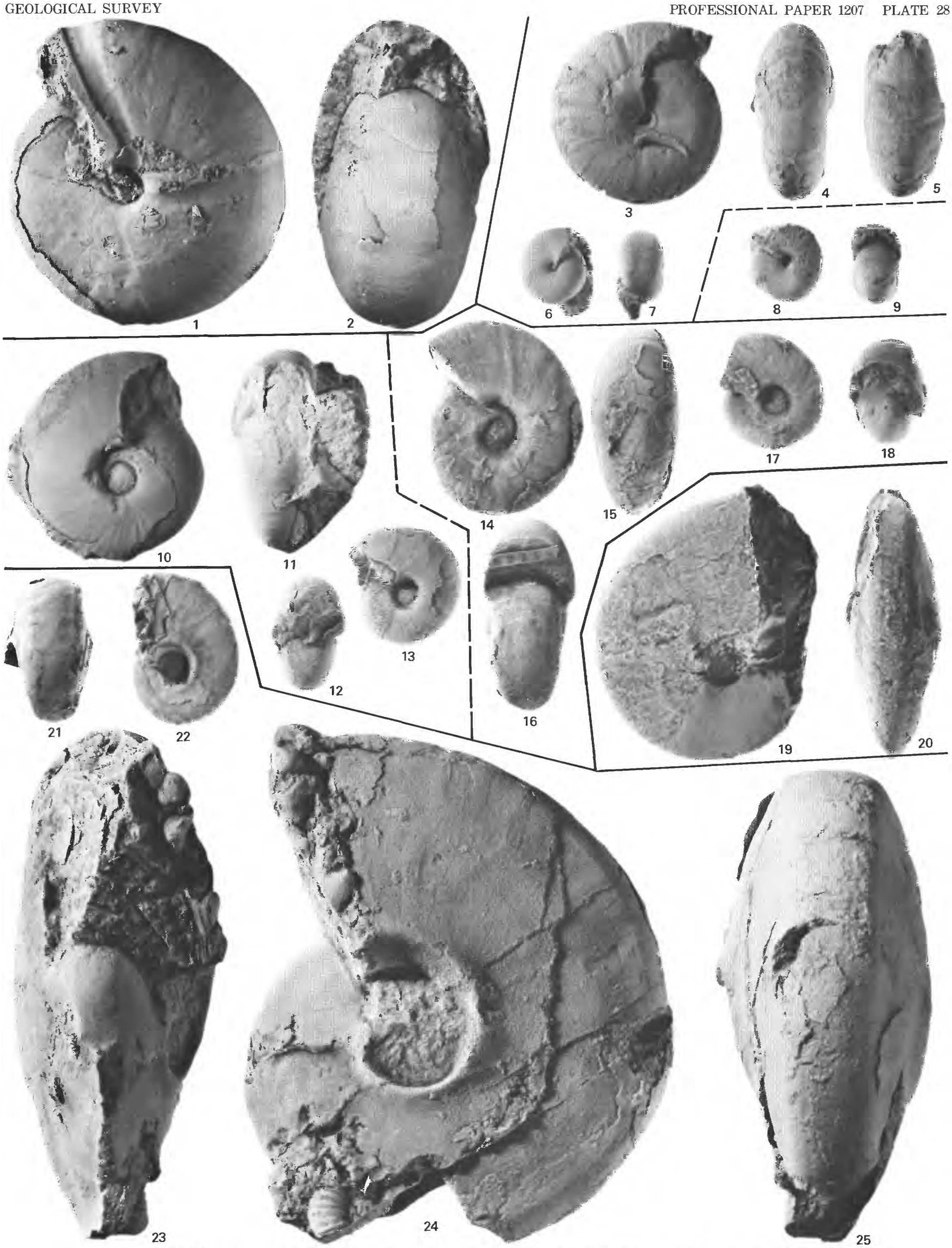
10–18. *Isculites meeki* (Hyatt and Smith) (p. 42).

- 10–11. Holotype, MCZ 3998, Star Canyon, Humboldt Range, Nev.
- 12–13. Paratype, MCZ 3900, Star Canyon, Humboldt Range, Nev.
- 14–16. Plesiotype, USNM 248882, USGS Mesozoic loc. M2358, Caurus Zone.
- 17–18. Plesiotype, USNM 248883, USGS Mesozoic loc. M2358, Caurus Zone.

19–20. *Ismidites* aff. *I. marmarensis* Arthaber (p. 20). Plesiotype, USNM 248884, USGS loc. M970, Hyatti Zone.

21–25. *Alanites obesus* n. sp., (p. 19). USGS loc. M533, Hyatti Zone.

- 21–22. Holotype, USNM 248885.
- 23–25. Paratype, USNM 248886.




*PROARCESTES*, *HUMBOLDTITES*, *ISCULITES*, *ISMIDITES*, AND *ALANITES*

## PLATE 29

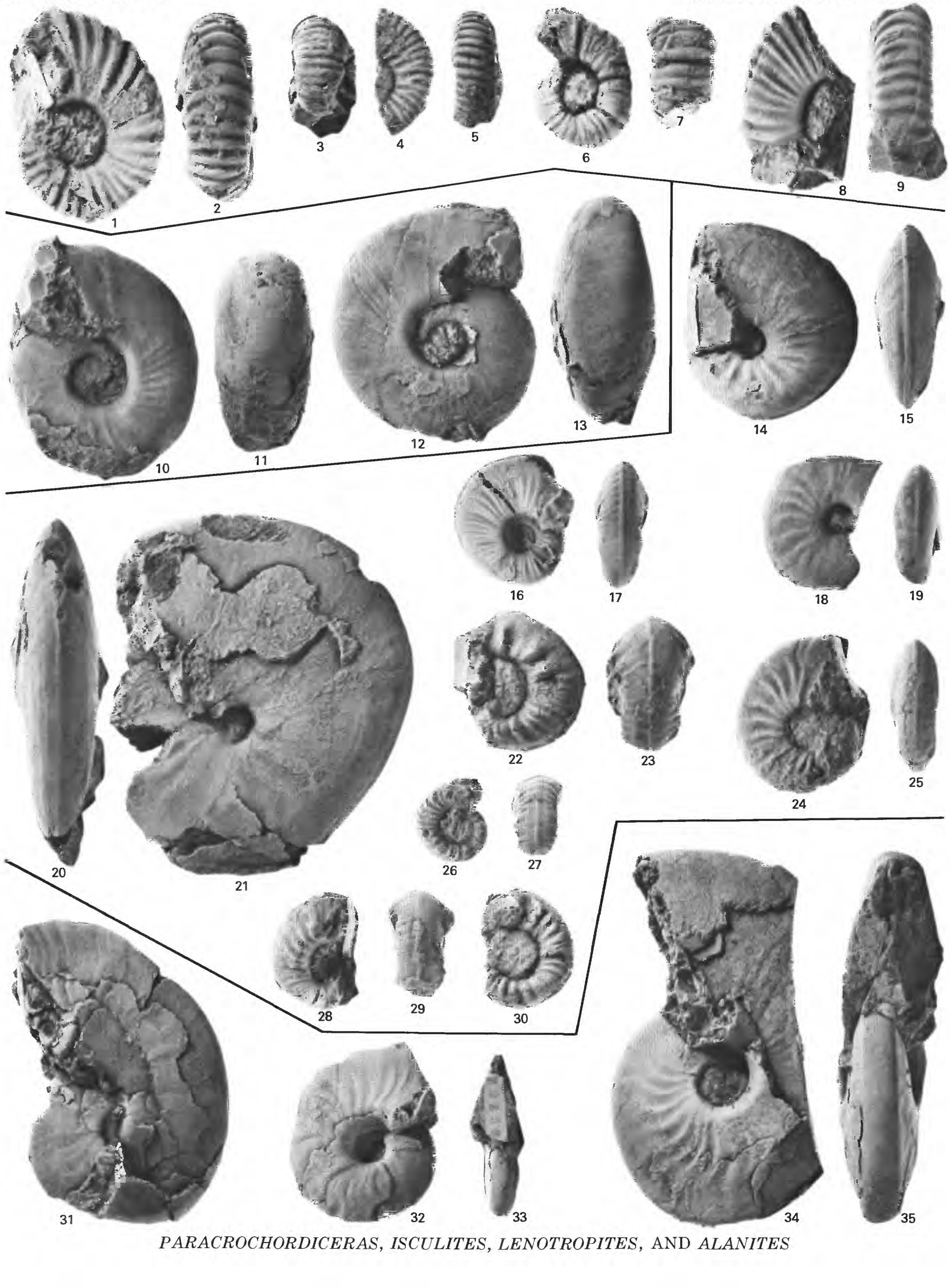
[All figures natural size]

FIGURES 1–9. *Paracrochordiceras americanum* McLearn (p. 21). Plesiotypes, USGS Mesozoic loc. M2358, Caurus Zone.
- 1–2. USNM 248887.
- 3–5. USNM 248888.
- 6–7. USNM 248889.
- 8–9. USNM 248890.

10–13. *Isculites meeki* (Hyatt and Smith) (p. 42). Plesiotypes, USGS Mesozoic loc. M2358, Caurus Zone.
- 10–11. USNM 248891.
- 12–13. USNM 248892.

14–30. *Lenotropites caurus* (McLearn) (p. 46). Plesiotypes, USGS Mesozoic loc. M2358, Caurus Zone.
- 14–15. USNM 248893.
- 16–17. USNM 248894.
- 18–19. USNM 248895.
- 20–21. USNM 248896.
- 22–23. USNM 248897.
- 24–25. USNM 248898.
- 26–27. USNM 248899.
- 28–30. USNM 248900.

31–35. *Alanites mulleri* n. sp., (p. 19). USGS Mesozoic loc. M2359, Hyatti Zone.
- 31. Paratype, USNM 248901.
- 32–33. Paratype, USNM 248902.
- 34–35. Holotype, USNM 248903.




*PARACROCHORDICERAS, ISCULITES, LENOTROPITES,* AND *ALANITES*

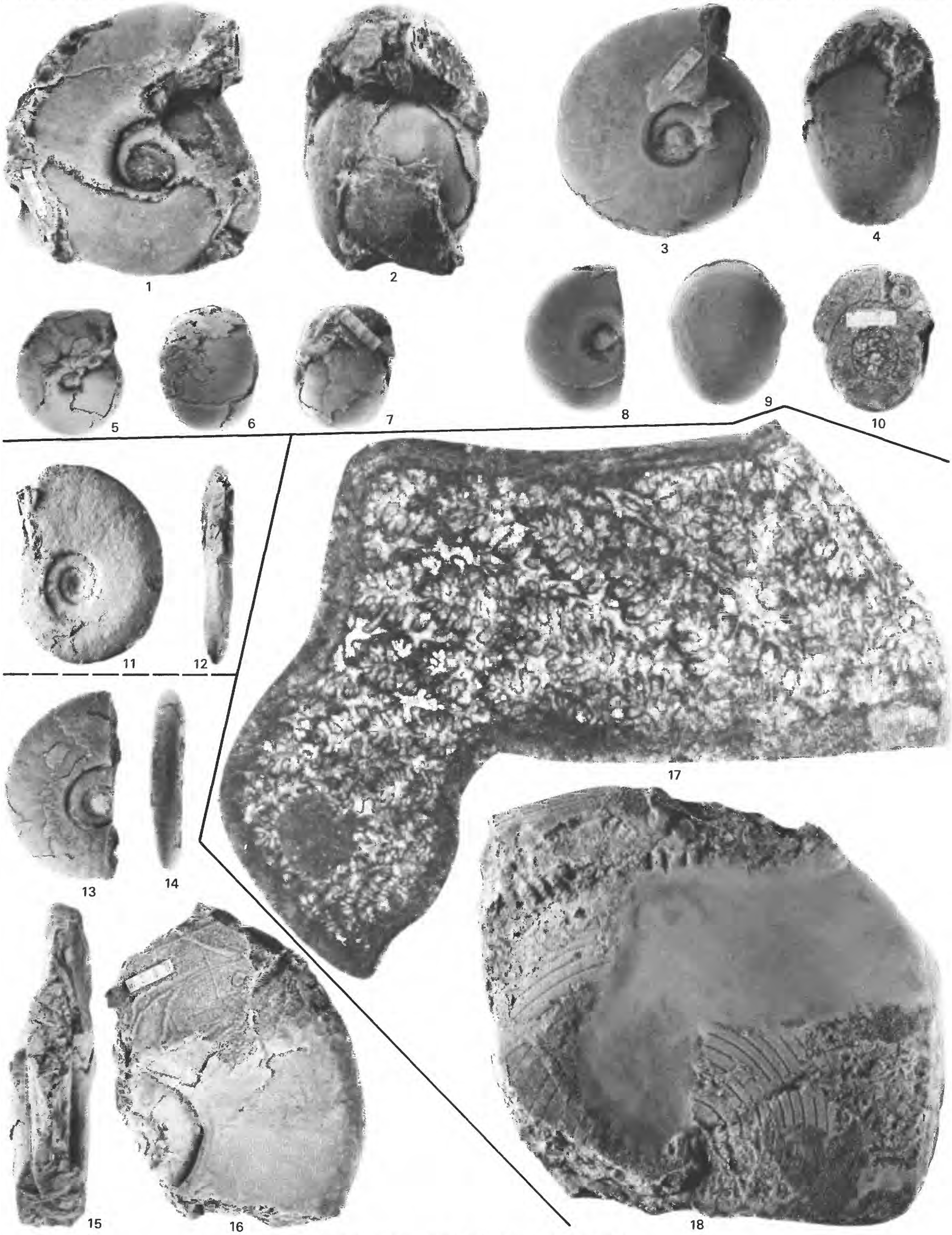
## PLATE 30

[All figures natural size unless otherwise indicated]

FIGURES 1–10. *Isculites tozeri* n. sp. (p. 43). USGS loc. M533, Hyatti Zone.
- 1–2. Paratype, USNM 248904.
- 3–4. Holotype, USNM 248905.
- 5–7. Paratype, USNM 248906.
- 8–10. Paratype, USNM 248907.

11–16. *Gymnites perplanus* (Meek) (p. 40).
- 11–12. Holotype, USNM 12531, Buena Vista Canyon, Humboldt Range, Nev.
- 13–14. Plesiotype, USNM 248908, USGS loc. M533, Hyatti Zone.
- 15–16. Plesiotype, USNM 248909, USGS loc. M533, Hyatti Zone.

17–18. *Sturia* cf. *S. japonica* Diener (p. 41). USGS loc. M614, float from Meeki Zone or higher.
- 17. Suture of specimen illustrated by figure 18 (USNM 248910).
- 18. Plesiotype, USNM 248910, × ½.




*ISCULITES, GYMNİTES* AND *STURIA*

## PLATE 31

[All figures natural size]

FIGURE 1. *Gymnites* cf *G. humboldti* Mojsisovics (p. 40). Plesiotype, USNM 248911, USGS loc. M609, Rotelliformis Zone.

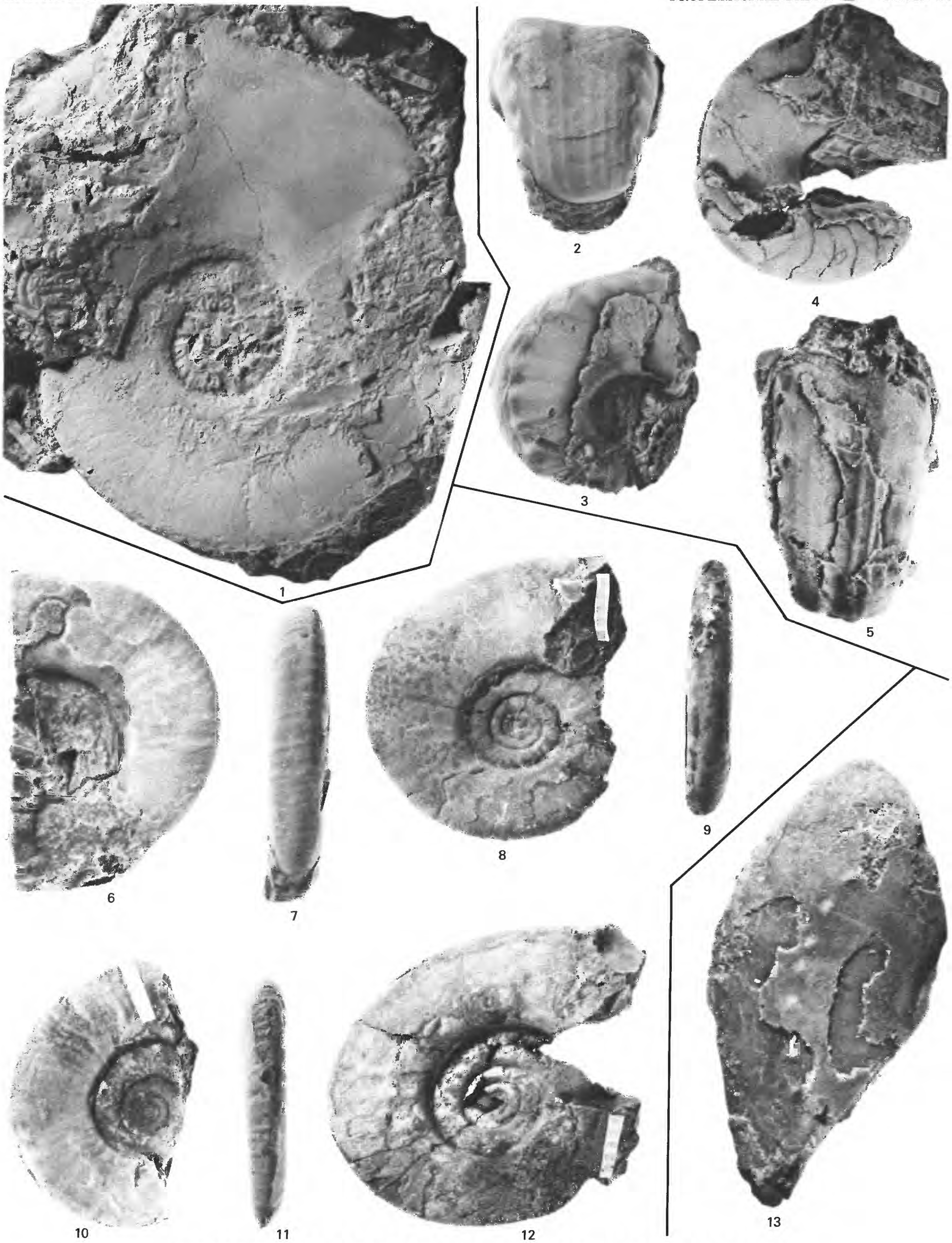
2–5. *Aulametacoceras? humboldtensis* n. sp. (p. 61). Hyatti Zone.

- 2–3. Holotype, USNM 248912, USGS Mesozoic loc. M2359.
- 4–5. Paratype, USNM 248913, USGS loc. M533.

6–12. *Gymnites tregorum* n. sp. (p. 39). USGS Mesozoic loc. M2358, Caurus Zone.

- 6–7. Paratype, USNM 248914.
- 8–9. Holotype, USNM 248915.
- 10–11. Paratype, USNM 248916.
- 12. Paratype, USNM 248917.

13. *Epigymnites alexandrae* (Smith) (p. 41). Plesiotype, USNM 248918, USGS loc. M619, Meeki Zone.




*GYMNITES, AULAMETACOCERAS?, GYMNITES* AND *EPIGYMNITES*

## PLATE 32

[All figures natural size unless otherwise indicated]

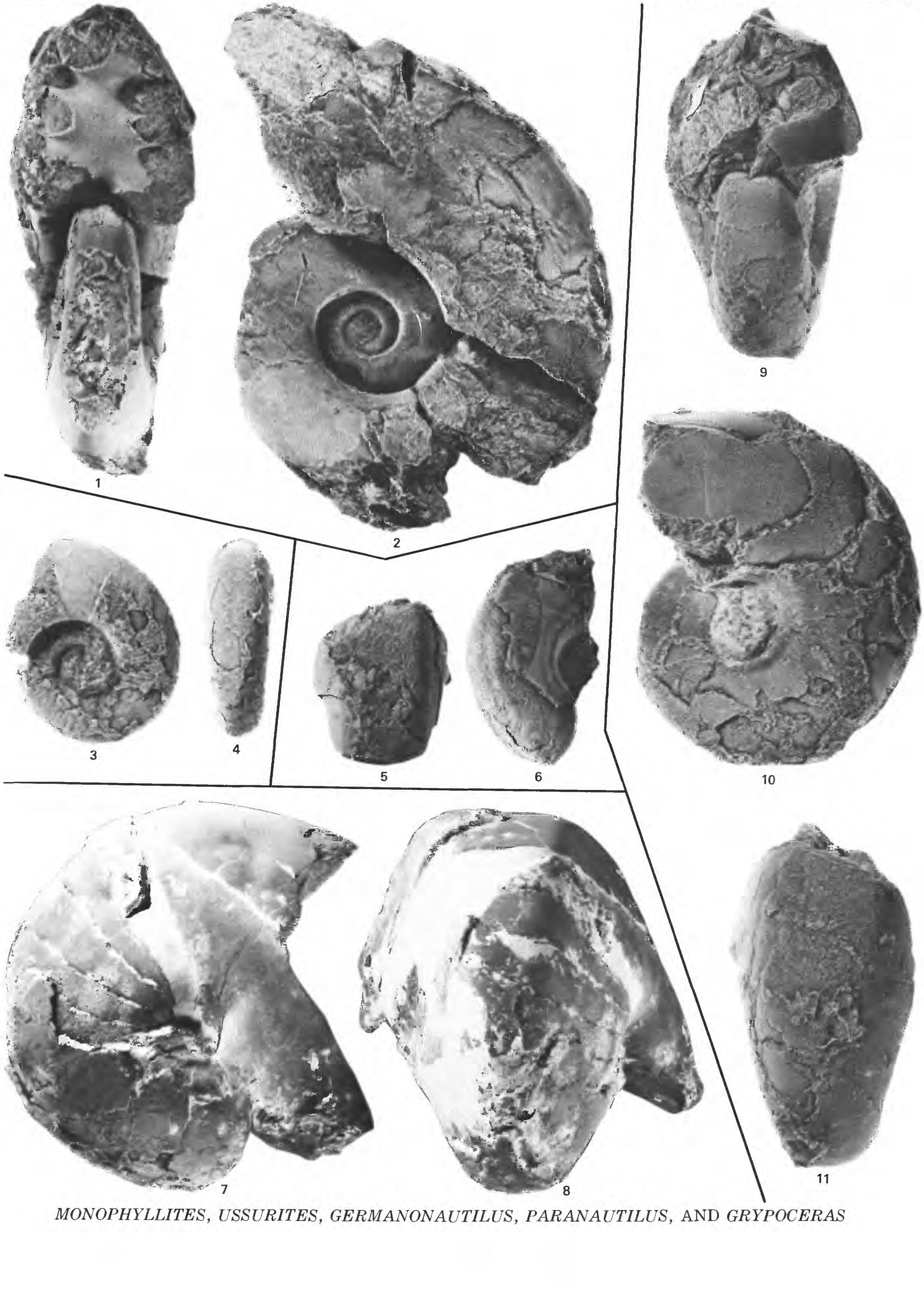
FIGURES 1–2. *Monophyllites* cf. *M. agenor* (Münster) (p. 60). Holotype, ANSP 30794, East Range, Nev.

3–4. *Ussurites* cf. *U. arthaberi* (Welter) (p. 60). Plesiotype, USNM 248919, USGS Mesozoic loc. M1185, Hyatti Zone.

5–6. *Germanonautilus furlongi* Smith (p. 62). Plesiotype, USNM 248920, USGS loc. M608 (float), probably from Meeki Zone.

7–8. *Paranautilus smithi* Kummel (p. 62). Plesiotype, USNM 248921, USGS loc. M620, Occidentalis Zone, × ½.

9–11. *Grypoceras whitneyi* (Gabb) (p. 62). Holotype, ANSP 30792, vicinity of Buena Vista Canyon, Humboldt Range, Nev.




*MONOPHYLLITES, USSURITES, GERMANONAUTILUS, PARANAUTILUS,* AND *GRYPOCERAS*

## PLATE 33

FIGURES 1–2. *Michelinoceras?* cf. *M.? campanile* (Mojsisovics) (p. 63). Plesiotypes, Meeki Zone.

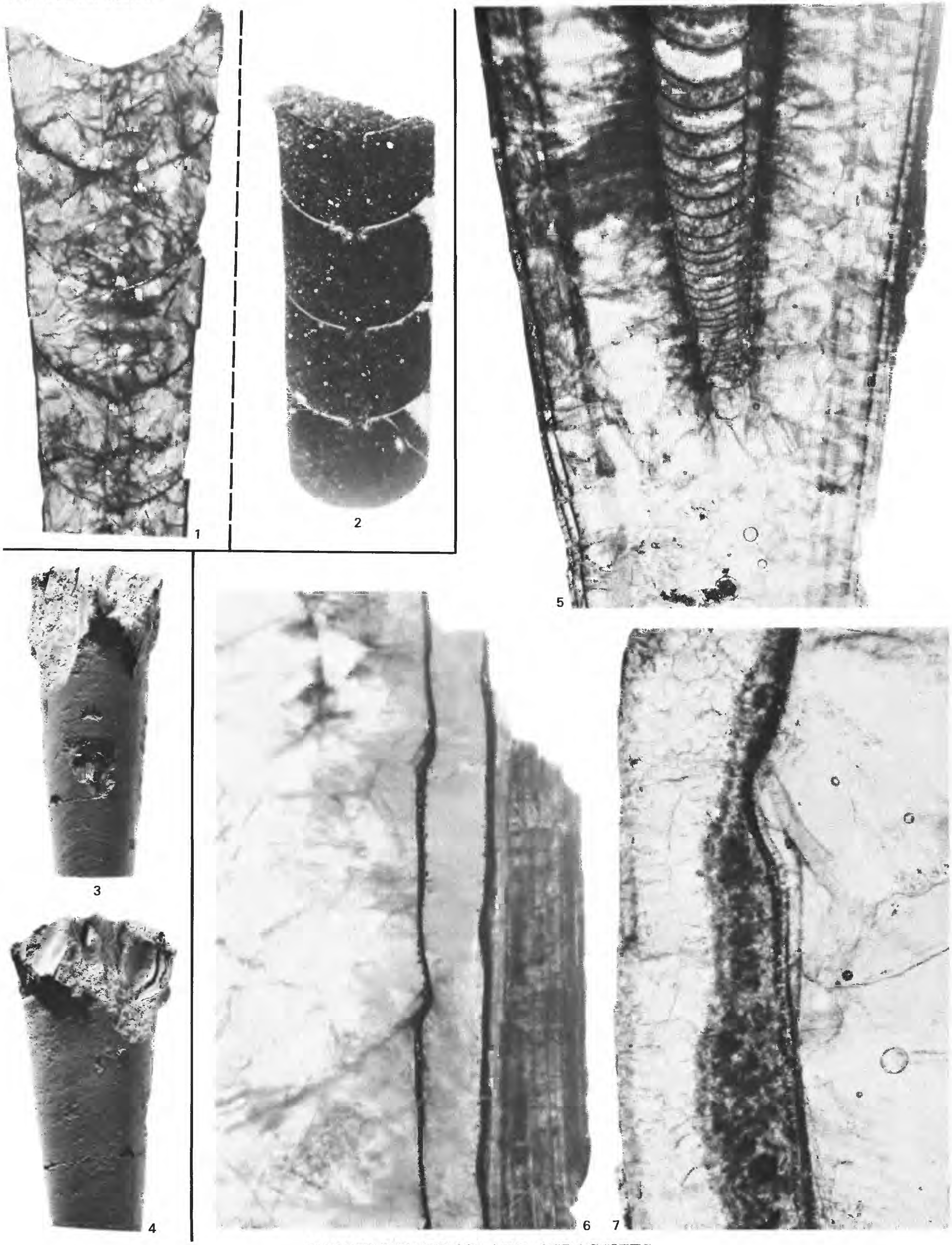
1. Longitudinal cross section, USNM 248922, USGS loc. M142, × 5.
2. Longitudinal cross section, USNM 248923, USGS loc. M619, × 5.

3–4. *Atractites* sp. A (p. 64). Dorsal and lateral views, USNM 248924, USGS loc. M136, Rotelliformis Zone, natural size.

5. *Atractites clavatulus* Smith (p. 64). Plesiotype, dorso-ventral median section showing tip of alveolus and protoconch within the guard, USNM 248925, USGS loc. M608, Rotelliformis Zone, × 11.5.

6. *Atractites* sp. B (p. 64). Dorso-ventral median section showing siphuncle; orad direction upward, camera and septa to left, ventral shell wall to right. USNM 248926, USGS loc. M636, (Favret Canyon, Augusta Mountains, Nev.), upper Anisian, × 11.5.

7. *Atractites* sp. C (p. 64). Dorso-ventral median section showing septal neck, connecting rings, and siphuncle (on left side); orad direction upward; see text-figure 48 for interpretation. Plate 34, figures 1–3 show specimen before thin sectioning. USNM 248927, USGS loc. M636c (Favret Canyon, Augusta Mountains, Nev.), Meeki Zone, × 23.



*MICHELINOCERAS?* AND *ATRACTITES*

## PLATE 34

[All figures natural size; all lateral views oriented so that dorsal side is nearest dorsal view (if any) and ventral side is nearest ventral view (if any)].

FIGURES 1–3. *Atractites* sp. C (p. 64). Dorsal, lateral, and ventral views, USNM 248927, specimen before it was destroyed for thin section (pl. 33, fig. 7), USGS loc. 636c (Favret Canyon, Augusta Mountains, Nev.), Meeki Zone.

4–5. ?*Atractites elegans* Smith (p. 64). Lateral and dorsal views, plesiotype, USNM 248929, USGS loc. M967, Rotelliformis Zone.

6–11. *Atractites clavatulus* Smith (p. 64). Plesiotypes, USGS loc. M608, Rotelliformis Zone.

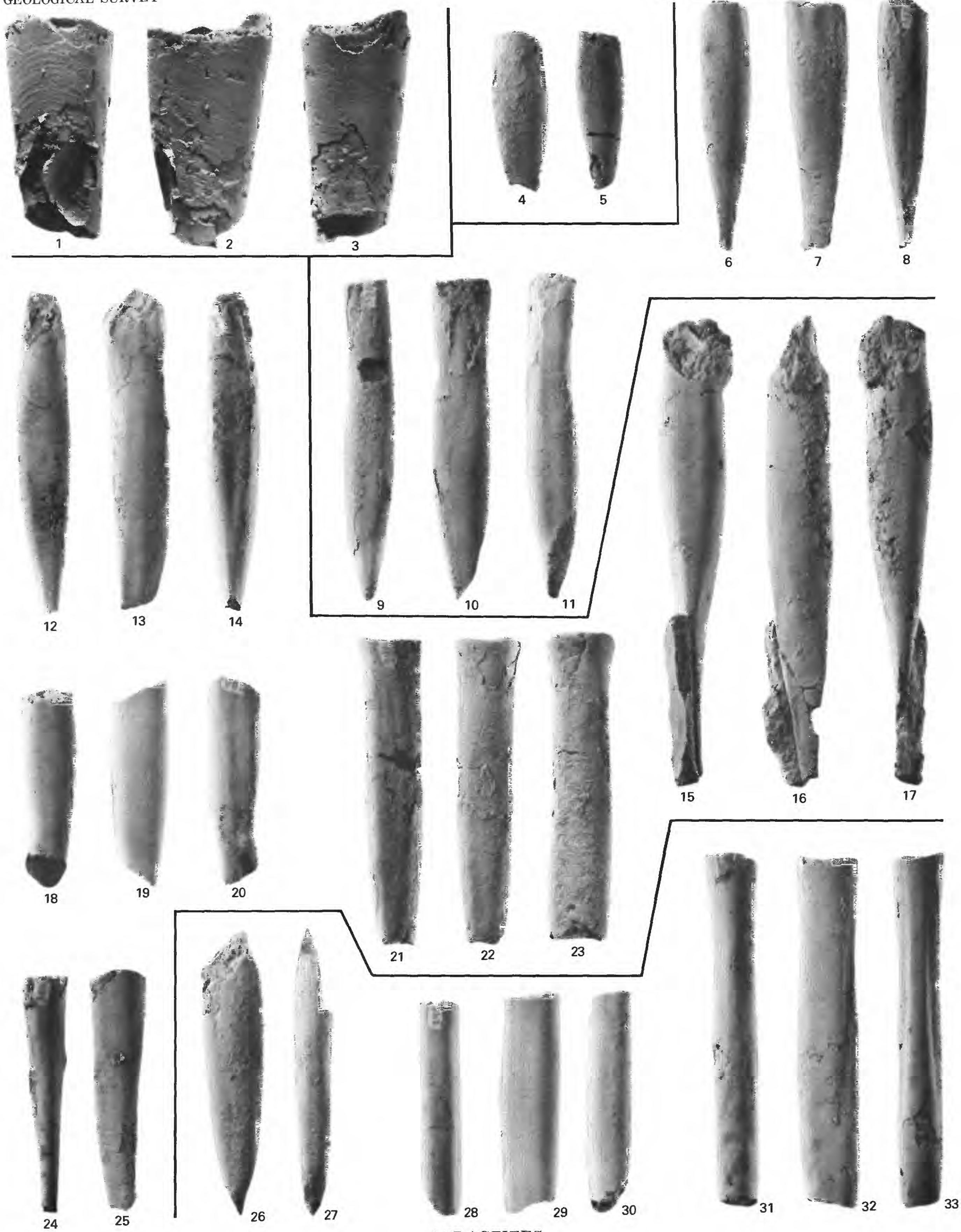
- 6–8. Dorsal, lateral, and ventral views, USNM 248930.
- 9–11. Ventral, lateral, and dorsal views, USNM 248931.

12–25. *Atractites solidus* Smith (p. 65). Plesiotypes, Meeki Zone.

- 12–14. Dorsal, lateral, and ventral views, USNM 248932, USGS loc. M614.
- 15–17. Ventral, lateral, and dorsal views, USNM 248933, USGS loc. M142.
- 18–20. Dorsal, lateral, and ventral views, USNM 248934, USGS loc. M142.
- 21–23. Ventral, lateral, and dorsal views, USNM 248935, USGS loc. M614.
- 24–25. Ventral and lateral views, USNM 248936, USGS loc. M166.

26–33. *Atractites nevadensis* (Meek) (p. 65). Plesiotypes.

- 26–27. Lateral and dorsal views, USNM 248937, USGS loc. M621, Occidentalis Zone.
- 28–30. Ventral, lateral, and dorsal views, USNM 248938, USGS loc. M963, Meeki Zone.
- 31–33. Ventral, lateral, and dorsal views, USNM 248939, USGS loc. M144, Occidentalis Zone.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*ATRACTITES*

## PLATE 35

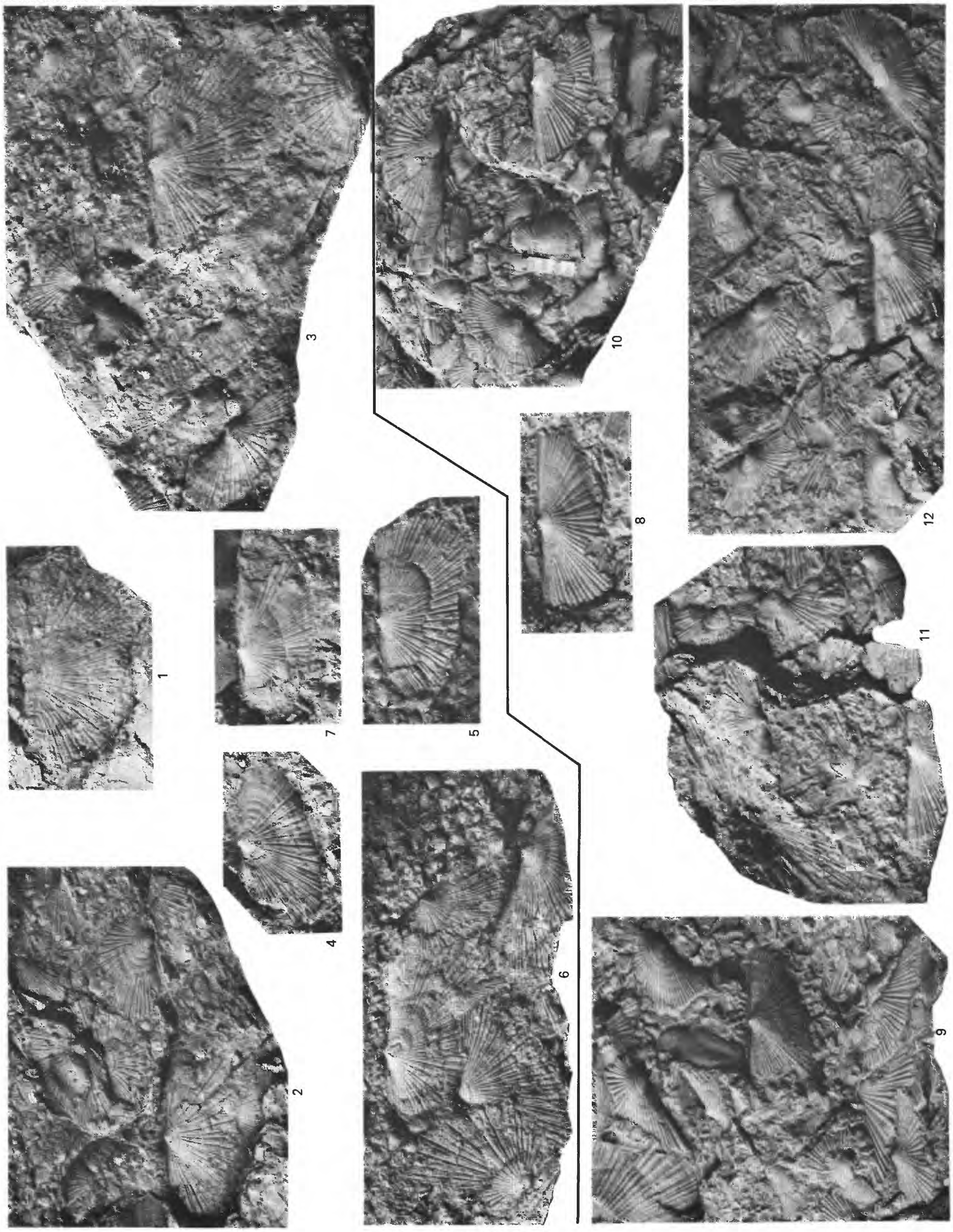
[All figures natural size]

FIGURES 1–7. *Daonella americana* Smith (p. 67). Plesiotypes, Rotelliformis Zone.

1. USNM 248940, USGS loc. M964.
2. USNM 248941, USGS loc. M162.
3. USNM 248942, USGS loc. M162.
4. USNM 248943, USGS loc. M163.
5. USNM 248944, USGS loc. M163.
6. USNM 248945, USGS loc. M163.
7. USNM 248946, USGS loc. M965.

8–12. *Daonella* cf. *D. sturi* (Benecke) (p. 67). Plesiotypes.

8. USNM 248947, USGS loc. M607 plus 2.0 ft (0.6 m), Rotelliformis Zone.
9. USNM 248948, USGS loc. M607 plus 2.0 ft (0.6 m), Rotelliformis Zone.
10. USNM 248949, USGS loc. M608, Rotelliformis Zone.
11. Latex impression, USNM 248950, USGS loc. M142, Meeki Zone.
12. USNM 248951, USGS loc. M609, Rotelliformis Zone.




*DAONELLA*

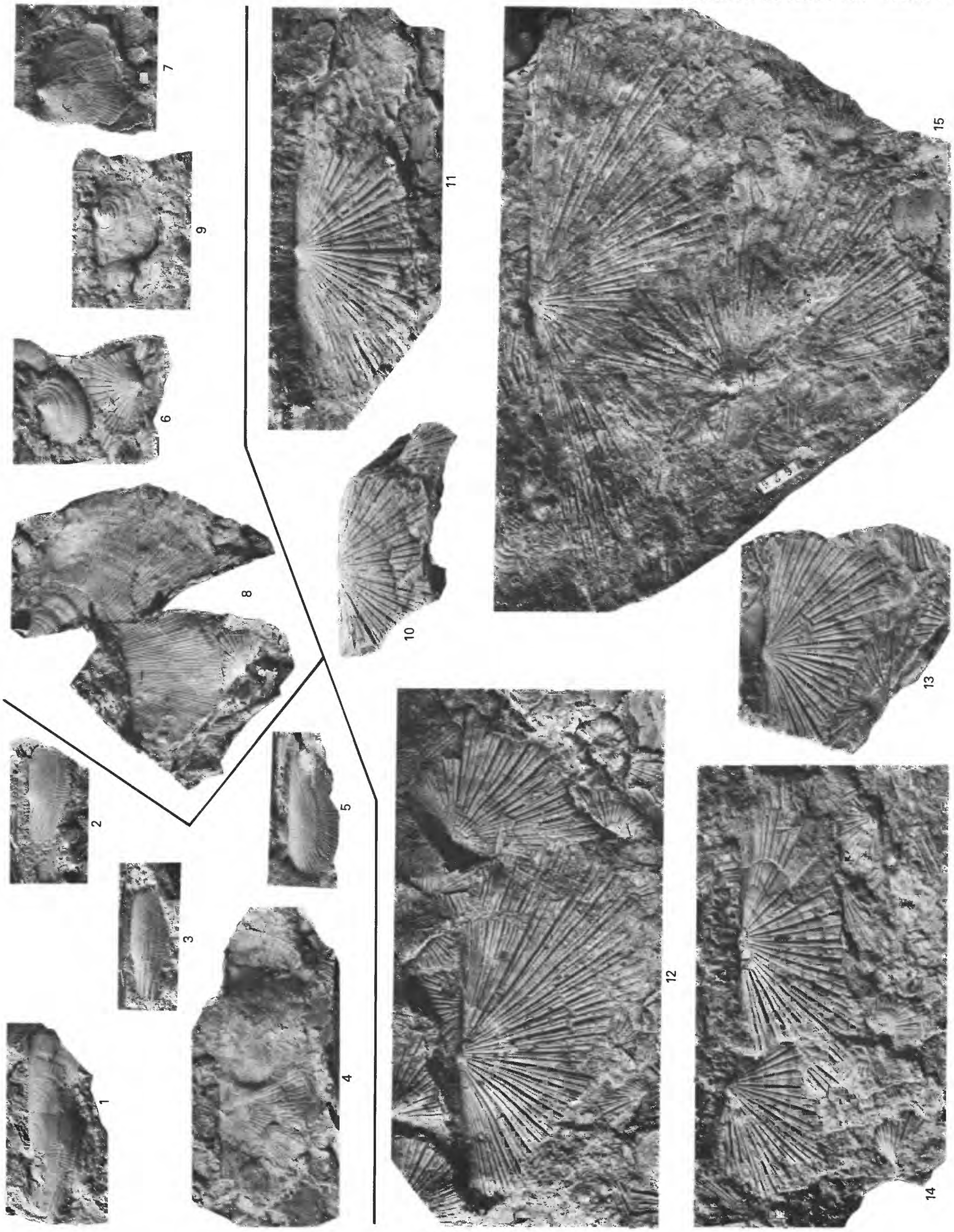
# PLATE 36

[All figures natural size]

FIGURES 1–5. *Daonella* cf. *D. elongata* Mojsisovics (p. 67). Plesiotypes, USGS loc. M968, Meeki Zone.
1. USNM 248952.
2. USNM 248953.
3. USNM 248954.
4. USNM 248955.
5. USNM 248956.

6–9. *Daonella* cf. *D. moussoni* (Merian) (p. 68). Plesiotype, Occidentalis Zone.
6. USNM 248957, USGS loc. M962.
7. USNM 248958, USGS loc. M623.
8. USNM 248959, USGS loc. M145.
9. USNM 248960, USGS loc. M145.

10–15. *Daonella dubia* (Gabb) (p. 68).
10. Lectotype, ANSP 20785, Star Canyon, Humboldt Range, Nev.
11. Plesiotype, USNM 248961, USGS loc. M623, Occidentalis Zone.
12. Plesiotype, USNM 248962, USGS loc. M145, Occidentalis Zone.
13. Plesiotype, USNM 248962, USGS loc. M145, Occidentalis Zone. Same slab as figure 12.
14. Plesiotype, USNM 248964, USGS loc. M145, Occidentalis Zone.
15. Plesiotype, USNM 248965, USGS loc. M145, Occidentalis Zone.




*DAONELLA*

## PLATE 37

[All figures natural size]

FIGURES 1–3. *Daonella* cf. *D. moussoni* (Merian), (p. 68). Plesiotypes, Occidentalis Zone.

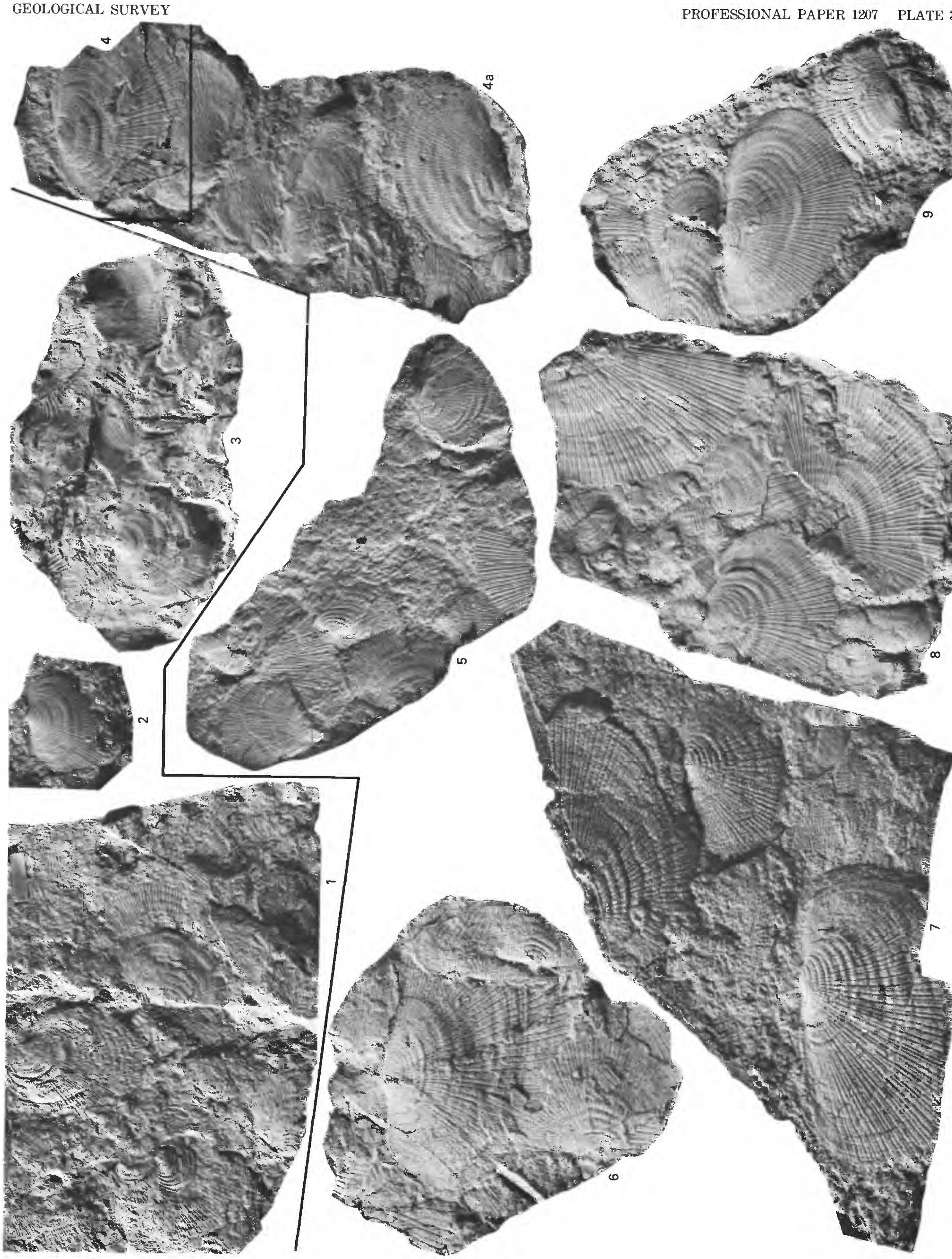
1. USNM 248966, USGS loc. M909.
2. USNM 248967, USGS loc. M146.
3. Latex impression, USNM 248968, USGS loc. M623.

4–9. *Daonella rieberi* n. sp. (p. 68). Subasperum Zone.

4. Latex impression of holotype, USNM 248969, USGS loc. M147.

4a. Latex impressions of paratypes, USNM 248970, USGS loc. M147.

5. Latex impression of paratype, USNM 248971, USGS Mesozoic loc. M3094.
6. Latex impression of paratype, USNM 248972, USGS loc. M908.
7. Paratype, USNM 248973, USGS loc. M911.
8. Latex impression of paratype, USNM 248974, USGS loc. M911.
9. Latex impression of paratype, USNM 248975, USGS loc. M911.




*DAONELLA*

## PLATE 38

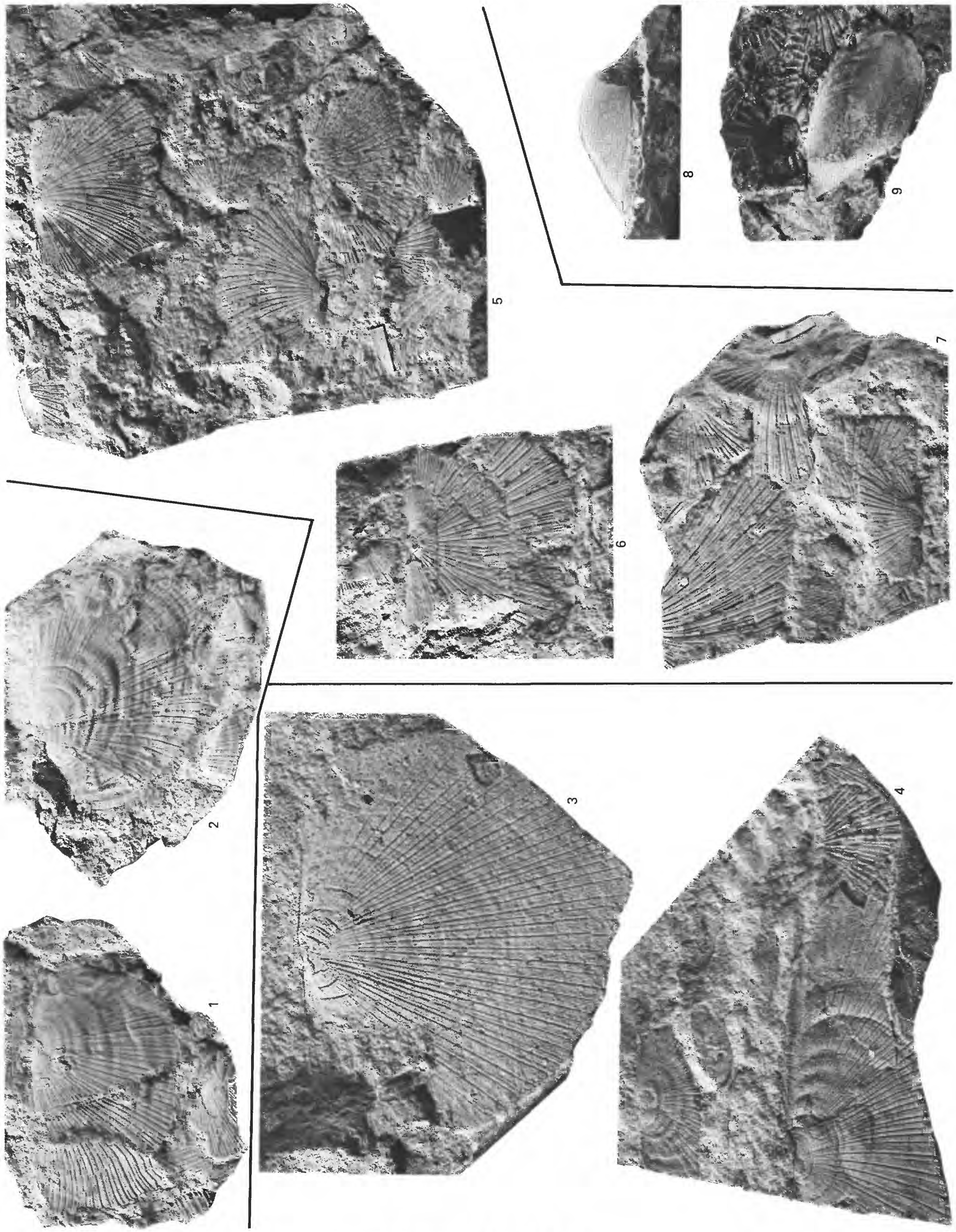
[All figures natural size]

FIGURES 1–2. *Daonella rieberi* n. sp. (p. 68). Paratypes, USGS loc. M908, Subasperum Zone.
1. Latex impression, USNM 248976.
2. Latex impression, USNM 248977.

3–4. *Daonella* n. sp. ex aff. *D. indica* Bittner (p. 69). Plesiotypes, USGS Mesozoic loc. M3095, upper Ladinian.
3. USNM 248978.
4. USNM 248979.

5–7. *Daonella* cf. *D. lommeli* (Wissman) (p. 69). Plesiotypes, USGS loc. M907, upper Ladinian.
5. USNM 248980.
6. USNM 248981.
7. USNM 248982.

8–9. *Pteria? obesus* (Gabb) (p. 66). Holotype?, ANSP 30791, original locality description vague but probably from Humboldt Range, Nev.




*DAONELLA* AND *PTERIA?*

U.S. GOVERNMENT PRINTING OFFICE: 676-041/15 — 1983