Ammonites from the *Buchia* Zones in Northwestern California and Southwestern Oregon

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By RALPH W. IMLAY *and* DAVID L. JONES

JURASSIC (TITHONIAN) AND CRETACEOUS *BUCHIA* ZONES IN NORTHWESTERN CALIFORNIA AND SOUTHWESTERN OREGON

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Some Late Jurassic and Early Cretaceous ammonites date the Buchia *zones and furnish correlations with the Boreal and Tethyan Realms*

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AMMONITES FROM THE *BUCHIA* ZONES IN NORTHWESTERN CALIFORNIA AND SOUTHWESTERN OREGON

By Ralph W. Imlay and David L. Jones

ABSTRACT

Ammonites from the *Buchia*-bearing strata of northwestern California and southwestern Oregon represent the Tithonian stage at the top of the Jurassic and the Berriasian and Valanginian stages at the base of the Cretaceous. These ammonites are associated with various species of the pelecypod *Buchia*, which from oldest to youngest include *B. piochii* (Gabb) and *B.* aff. *B. okensis* (Pavlow) of Tithonian age, *B. uncitoides* (Pavlow) of Berriasian age, *B. pacifica* Jeletzky of early to middle Valanginian age, *B. keyserlingi* (Lahusen) of middle to early late Valanginian age, and *Buchia crassicollis solida* (Lahusen) of late Valanginian age. The ages cited are based primarily on the ammonites present but partly on the similarities of the *Buchia* succession to that in British Columbia and in the Arctic region. As the succession of the species of *Buchia* is similar to that in western Canada, the strata characterized by the species are herein considered assemblage zones in conformity with the usage in Canada.

Ammonites of Tithonian age have been found mostly along the west side of the Sacramento Valley, Calif. They include *Kossmatia* from the lower to middle parts of the *B. piochii* zone, *Parodontoceras* and *Spiticeras* from the upper part of the *B. piochii* zone, and *Substeueroceras*, *Parodontoceras*, *Proniceras*, *Spiticeras*, and *Blanfordiceras* from the *B.* aff. *B. okensis* zone. Of these ammonites, *Kossmatia*, by comparisons with the sequence in Mexico and Argentina, is evidence for a middle Tithonian age, but it occurs also in New Zealand in beds of late Kimmeridgian age and probably also in beds of middle Kimmeridgian age. *Parodontoceras* is good evidence of a middle to late Tithonian age on the basis of its range in Mexico and Argentina. The various ammonites listed from the *B.* aff. *B. okensis* zone are excellent evidence for a late Tithonian age equivalent to the highest Jurassic beds in Mexico and Argentina. An age not older than middle Tithonian for the lowest part of the Jurassic sequence along the west side of the Sacramento Valley is indicated by the absence of species of *Buchia*, such as *B. mosquensis* (Von Buch) and *B. rugosa* (Fischer), which occur in beds of middle Kimmeridgian to middle Tithonian age from the State of Washington northward into Alaska and as high as the *Dorsoplanites panderi* zone (lower middle Volgian) on the Russian platform.

Ammonites of Berriasian age from California and Oregon belong mostly to the subgenera *Spiticeras* (*Negreliceras*) and *S.* (*Spiticeras*) but include also the genus *Neocosmoceras*. The subgenus *Negreliceras* in California ranges through the lower two-thirds of the *Buchia uncitoides* zone and dates that part as not younger than Berriasian.

Ammonites of middle and late Valanginian age are well represented in California and Oregon. That beds of early Valanginian age are present has not been proved faunally. In California, however, some specimens of *Thurmanniceras* in the lower part of the *Buchia pacifica* zone could be dated as early Valanginian on the basis of stratigraphic position. The middle part of the *B. pacifica* zone has furnished species of *Thurmanniceras* and *Kilianella* that, by comparisons elsewhere, suggest a middle Valanginian age. The upper part of the *B. pacifica* zone contains a species of *Tollia* that is similar to a species from the middle Valanginian of East Greenland. The presence of *Tollia* itself is good evidence of an age not younger than middle Valanginian.

The overlying zone of *Buchia keyserlingi* in the Paskenta and Elk Creek quadrangles, California, contains such typical Valanginian ammonites as *Sarasinella*, *Polyptychites*, and *Thurmanniceras*. The last two ammonites in the upper part of the zone are associated with *Crioceratites* and *Neocraspedites*, which in Eurasia are not known in beds older than late Valanginian. The upper part of the zone, therefore, is dated as late Valanginian, but the lower part could be middle Valanginian.

The highest *Buchia* zone, characterized by *B. crassicollis solida* (Lahusen), has furnished diagnostic ammonites only in Oregon. These consist of *Homolsomites* and *Olcostephanus* that by comparisons with species in Eurasia could be either latest Valanginian or earliest Hauterivian. A Valanginian age is favored by the association of these ammonites with *Buchia* and by their stratigraphic position directly below beds containing early Hauterivian ammonites.

The affinities of most of the ammonites of latest Jurassic and earliest Cretaceous ages from California and Oregon are southern or Mediterranean. Only *Tollia* and *Homolsomites* are distinctly Boreal. In addition, the genera *Polyptychites* and *Neocraspedites* range from the Mediterranean to the Arctic but are most common in central and northern Eurasia and are probably not of Mediterranean origin.

Ammonites are rather uncommon in the *Buchia*-bearing sequence of northwestern California and southwestern Oregon except at the very top of the beds characterized by *Buchia pacifica* Jeletzky. Those beds also have furnished a fair variety of pelecypods and gastropods. Elsewhere throughout the sequence the only common fossil is *Buchia* itself.

The ammonites on which this study is based total 454 specimens, of which 57 are assigned a Tithonian age, 103 a Berriasian age, and 294 a Valanginian age. One new genus, *Paskentites* Imlay and Jones, of middle Valanginian age is described herein. New species include *Phylloceras? contrarium* Imlay and Jones, *Proniceras maupinense* Imlay and Jones, *Spiticeras (Negreliceras) stonyense* Imlay and Jones, *Groebericeras? baileyi* Imlay and Jones, and *Neocosmoceras euchrense* Imlay and Jones.

INTRODUCTION

The primary aim of this study is to determine the ages of the *Buchia*-bearing strata in northwestern California and southwestern Oregon by means of the ammonites present. It has been necessary, therefore, to study those ammonites thoroughly, to compare them with similar ammonites elsewhere in the world, and to determine their stratigraphic positions relative to the species of *Buchia* with which they are associated. This has involved a simultaneous study of the characteristics and ranges of the species of *Buchia* in California and Oregon and comparisons of those species with the various species of *Buchia* from western British Columbia described by Jeletzky (1965). That has led in turn to recognition of a number of mappable *Buchia* zones of which some are identical with zones in British Columbia.

This study includes all ammonites of latest Jurassic (Tithonian) and earliest Cretaceous (Berriasian) ages from northwestern California and southwestern Oregon that are available in the California Academy of Sciences, in the Museum of Paleontology at the University of California in Berkeley, and in the laboratories of the U. S. Geological Survey. It includes, also, some Early Cretaceous (Valanginian) ammonites for which new information is available. It does not contain descriptions of many other Valanginian ammonite species that are described by Imlay (1960), although most of those species are mentioned and listed herein. It does contain descriptions and evaluations of most of the Tithonian-Valanginian ammonites described by Anderson (1938, 1945).

The authors are grateful for assistance and loan of specimens to Leo G. Hertlein and G. Dallas Hanna of the California Academy of Sciences at San Francisco, to Wyatt Durham and Joseph H. Peck, Jr., of the University of California at Berkeley, and to Horace G. Richards of the Philadelphia Academy of Natural Sciences.

BIOLOGIC ANALYSIS

The ammonites of latest Jurassic (Tithonian) and earliest Cretaceous (Berriasian and Valanginian) ages that are described herein total 454 specimens. Their distribution by families, subfamilies, genera, and subgenera is shown in table 1. This table shows that the Olcostephanidae include 70 percent and the Berriasellidae 17 percent of the specimens examined. Among the genera studied, *Spiticeras* includes about 24 percent, *Tollia* 44 percent, *Thurmanniceras* 6 percent, and *Neocomites* 7 percent of the 454 specimens. Among these specimens the Tithonian is definitely represented by 55 and questionably by two, the Berriasian by 101 and questionably by two, and the Valanginian by 294. These figures include all ammonites of Tithonian and Berriasian ages but only part of the ammonites of Valanginian age that have been found in northern California and southwestern Oregon. Only those Valanginian ammonites are described herein that have not been described previously (Imlay, 1960), or that have some bearing on correlations and age determinations, or that are better preserved than any found previously.

On the generic and subgeneric level most of the ammonites listed agree in most features with various taxa defined in the "Treatise on Invertebrate Paleontology" (Arkell and others, 1957). Some ammonites that are assigned questionably to *Kilianiceras*, *Aulacosphinctes*, and *Neocosmoceras* are represented by immature fragmentary specimens that do not show enough diagnostic features to place them definitely in their proper genus or subgenus. Other ammonites that are assigned questionably to *Phylloceras*, *Bochianites*, and *Groebericeras* bear features that are not known in those genera but that may not be of more than specific value. Thus *Phylloceras? contrarium* Imlay and Jones, n. sp. has rursiradiate ribs on the upper parts of the flanks and venter, whereas in typical species of *Phylloceras* the ribbing either crosses the venter transversely or arches gently forward. The generic assignment of *Bochianites? glennensis* Anderson is questioned because its venter bears transverse ribs instead of chevron-shaped ribs. The generic assignment of *Groebericeras? bayleyi* Imlay and Jones, n. sp. is questioned because of the presence of umbilical tubercles.

The family Perisphinctidae is represented only by three small immature specimens of *Kossmatia*. These show such characteristic generic features as fairly regular rib branching on the middle third of the flanks, chevronlike arrangement of ribs on the venter, presence of constrictions, and absence of tubercles.

The family Olcostephanidae is represented mostly by the genera *Tollia?* and *Spiticeras*. It also includes a few specimens belonging to *Proniceras*, *Groebericeras?*, *Olcostephanus*, and *Polyptychites*.

In the subfamily Spiticeratinae the identification of *Proniceras* is based on the presence of perisphinctoid

TABLE 1.—*Some ammonite genera in Tithonian, Berriasian, and Valanginian beds in northern California and southwestern Oregon showing biological relationships of the genera, relative numbers available for study, and stages represented*

Family	Subfamily	Genus and subgenus	Number of specimens	Stages
Phylloceratidae	Phylloceratinae	*Phylloceras*	8	T, V
		Phylloceras?	5	T
Lytoceratidae	Lytoceratinae	*Lytoceras*	12	T, V
Bochianitidae	Bochianitinae	*Bochianites?*	1	T?
		Bochianites	15	V
Perisphinctidae	Ataxioceratinae	*Kossmatia*	3	T
Olcostephanidae	Spiticeratinae	*Proniceras*	6	T
		Spiticeras	10	T, B
		S. (Kilianiceras?)	3	B, V
		S. (Negreliceras)	90	B
		Groebericeras?	1	T
	Tolliinae	*Tollia*	200	V
	Olcostephaninae	*Olcostephanus*	1	V
	Polyptychitinae	*Polyptychites*	2	V
Berriasellidae	Berriasellinae	*Blanfordiceras*	3	B
		Substeueroceras	6	T
		Protacanthodiscus	1	T?
		Parodontoceras	9	T
	Himalayitinae	*Aulacosphinctes?*	4	T
	Neocomitinae	*Paskentites* n. gen	8	V
		Thurmanniceras	27	V
		Neocomites	32	V
		Kilianella	3	V
		Sarasinella	2	V
		Neocosmoceras	1	B?
		Neocosmoceras?	1	B?

ribbing on the flanks, a chevronlike rib pattern on the venter, and pronounced forwardly inclined constrictions and on the absence of tubercles and swellings. The subgenus *Spiticeras* differs from *Proniceras* by the presence of acute umbilical tubercles, by rib branching from these tubercles as well as higher on the flanks, and by the ribs on the venter arching forward only gently. In addition, one specimen bears lateral tubercles on its inner whorls, and other specimens bear radial swellings that are prolonged ventrally from the umbilical tubercles. The subgenus *Negreliceras* differs from the subgenus *Spiticeras* by being compressed from early growth stages, by having umbilical tubercles only, by the presence of many weak secondary ribs, and by a tendency for the body chamber to become smooth, particularly on the lower parts of the flanks. The subgenus *Kilianiceras*, doubtfully represented, differs from *Spiticeras* by having much coarser ribbing and two rows of tubercles that persist onto the larger whorls. The genus *Groebericeras* resembles the subgenus *Negreliceras* in having a compressed form and in developing a nearly smooth body whorl but differs by being smoother from an earlier growth stage and by lacking tubercles except possibly on the smallest whorls.

The subfamilies Olcostephaninae and Polyptychitinae are represented respectively by fragmentary specimens of *Olcostephanus* and *Polyptychites* that are typical of those genera and are similar to specimens previously described (Imlay, 1960, p. 203, 204).

The subfamily Tolliinae is represented in the collections studied by the genus *Tollia*. This genus has a compressed and fairly involute shell. The venter may be narrowly rounded or acute on the inner whorls but is moderately rounded on the outer whorls. The ribs on the inner whorls are sharp, fine, bifurcate near the middle, and project slightly forward on the venter. During growth the primary ribs become blunt, prominent, and concave forward, and the secondary ribs arise commonly by twos and threes but in some species by fours and fives. On the largest septate whorls many secondary ribs arise freely on the flanks and a smooth area may develop between the primary and secondary ribs. All ribbing tends to fade on the largest septate whorl preceding the adult body chamber. The adult body whorl is smooth or nearly smooth. Constrictions are common on the internal molds of the septate whorls and on the body whorl. The suture line is characterized by its first lateral lobe being shorter than its ventral lobe.

Within the Tolliinae the genus *Tollia* bears some resemblance to *Homolsomites* (Crickmay, 1930, p. 63; Imlay, 1956, p. 1143–1146; 1960, p. 201; Jeletzky, 1965, p. 39; Shulgina, 1965, p. 81–88). It differs by having a wider and shallower umbilicus, a rounder whorl section, longer primary ribs, fewer secondary ribs per primary rib, less distinct junctions of secondary ribs with the primary ribs, rib branching at only one level, less forward projection of secondary ribs on the venter, loss of ribbing on the venter of the adult body whorl, and a shorter first lateral lobe relative to the ventral lobe.

Tollia differs from *Wellsia* Imlay (1957, p. 275; 1960, p. 205–207; Shulgina, 1965, p. 84) in most of the same features that it differs from *Homolsomites.* In addition it differs by having much stronger primary ribs that branch near instead of above the middle of the flanks and that persist on the flanks to a later growth stage.

The family Berriasellidae is fairly well represented by the subfamilies Berriasellinae, Neocomitinae, and doubtfully by the Himalayitinae. The genera listed under these families in table 1 are all represented by typical specimens except *Aulacosphinctes* and *Blanfordiceras.* The presence of *Aulacosphinctes* is questioned because the specimen is too immature for certain generic identification. The specimens assigned to *Blanfordiceras* are smaller and more compressed than most species of that genus but closely resemble *B. wallichi* (Blanford) (Uhlig, 1910, pl. 29) and *B. acuticosta* Uhlig (1910, p. 201–203, pl. 37, figs. 2a–c) from India and related species from Pakistan (Spath, 1939, p. 45, pl. 6, figs. 10, 13, 14) and Madagascar (Besairie, 1936, p. 136, pl. 11, figs. 17, 18). They also resemble "*Hoplites*" *australis* Burckhardt (1903, p. 64, pl. 11, figs. 9–12) from Argentina, which Arkell and others (1957, p. L352) place in *Blanfordiceras* and Spath (1925, p. 145) assigns to his genus *Pseudoblanfordia.*

The genus *Blanfordiceras* typically has an elliptical to subcircular whorl section that becomes stouter during growth. Its ribs are slightly sigmoidal, are highest near the middle of the flanks, project forward on the shoulders, and terminate in tubercles that border a smooth midventral area. In most species the primary ribs bifurcate near the middle of the flanks; however, in some species the primary ribs on the outer whorls become loosely connected with the secondary ribs, and other secondary ribs arise freely on the upper parts of the flanks. Adorally on the adult body chamber the ventral groove weakens or disappears and the primary ribs become widely spaced. In addition, tubercles or large knots may develop at furcation points near the middle of the flanks on the inflated species. *Blanfordiceras* differs from *Berriasella* by its ribs being more sigmoidal on the flanks, more projected on the venter, highest near the middle of the flanks instead of near the umbilical edge, and much more widely spaced on the body chamber.

The genus *Substeueroceras* is characterized by a moderate to narrow umbilicus, a vertical umbilical wall, a broadly rounded to flat venter on the adult, a lack of constrictions and tubercles, and by fine, generally high flexuous ribs that branch at various heights on the flanks, arch forward on the venter, and tend to disappear or weaken on the adult body whorl. The ribs may be di-, tri-, or bidichotomous, or unbranched, but are not virgatomous. A ventral groove is present on the internal mold but is not present on the adult wherever shell material is preserved. *Substeueroceras* differs from *Kossmatia* by lacking constrictions and by having a broader and flatter venter, finer ribs, irregular rib branching at various heights instead of on the middle third of the flanks, less strongly projected ribs on the middle third of the flanks, less strongly projected ribs on the venter, and a tendency of the ribs to fade out on the adult. Its rib pattern shows more resemblance to that of *Subthurmannia,* but it differs from that genus by lacking constrictions and umbilical tubercles and by its ribs not forking at the umbilical edge.

The assignment of one small specimen from California to *Protacanthodiscus* is based on the presence of biplicate Berriasellid-like ribbing on the flanks, lateral and ventral tubercles, weak umbilical swellings, and a flat, nearly smooth venter.

The genus *Parodontoceras* is characterized by a moderate to narrow umbilicus; by coarse gently flexuous ribs that incline forward on the flanks, bifurcate on the middle third of the flanks, and cross the venter nearly transversely; by the presence of constrictions; and by the absence of a ventral groove on adult whorls. It closely resembles *Berriasella* but differs by being more involute, by having much looser and more variable ribbing, and in particular by lacking a ventral groove on the adult body chamber wherever the shell is preserved. Its inner whorls differ from the inner whorls of *Substeueroceras* by having constrictions, a more marked ventral groove, and less projected secondary ribs. Its outer whorls differ from those of *Substeueroceras* by having much stronger and higher ribs, by fairly regular bifurcation near or above the middle of the flanks instead of bi- or trifurcation at various heights, and by the presence in some species of many single ribs.

The subfamily Neocomitinae is represented by many specimens of *Thurmanniceras* and *Neocomites,* rare specimens of *Kilianella, Sarasinella* and *Neocosmoceras,* and probably also by the new genus *Paskentites.* Of these, *Thurmanniceras* is characterized by having a compressed moderately to fairly evolute shell, constrictions, lateral and ventral tubercles, and gently to strongly flexuous ribs that arise singly at the umbilical edge, bifurcate near the middle of the flanks, and cross the venter transversely with slight or no reduction in strength. Many simple ribs may be present. Its inner whorls have a flattened venter, and its outer whorls a gently rounded venter. It differs from *Neocomites* by having an oblique instead of a vertical umbilical wall, a gently rounded instead of a truncated venter on adult whorls, and by its ribs on adults arising singly at the umbilical edge and forking mostly near the middle of the flanks. It differs, also, by lacking umbilical tubercles and a smooth midventral area except at a very small size.

The genus *Neocomites* is characterized by having an involute compressed shell, flattened flanks, a smooth flat venter that has rather sharp edges, a vertical umbilical wall, umbilical and ventral tubercles only, and rather fine, fairly closely spaced flexuous ribs that incline gently forward on the flanks and cross the venter transversely. These ribs may arise singly or in pairs from small umbilical tubercles, commonly bifurcate again near the middle of the flanks, terminate ventrally on the septate whorls in small obliquely arranged tubercles that border a smooth midventral area, and on the adult body whorl may cross the venter transversely.

The genus *Kilianella* is characterized by having a small evolute shell; an elliptical to suboctagonal whorl section; deep constrictions; a few weak umbilical, lateral, and ventral tubercles; a smooth venter; and strong gently flexuous ribs of which many remain simple. The ribs commonly bifurcate on the middle of the flanks and rarely at the umbilical edge. The ventral terminations of the ribs are commonly broad and fairly strong. Adult specimens of *Kilianella* resemble immature specimens of *Thurmanniceras* but may be distinguished by their ribs being more flexuous and generally much thicker ventrally and by bearing a few umbilical tubercles.

The genus *Sarasinella* resembles *Neocomites* in shape, involution, and ornamentation but differs by having lateral tubercles on its inner whorls, by its umbilical tubercles becoming increasingly stronger on its outer whorl, and by its ribs on the outermost whorls commonly arising in pairs from umbilical tubercles.

The genus *Neocosmoceras* has a wide umbilicus, a polygonal whorl section, and a venter that changes from concave to gently convex during growth. Its ribs are straight and widely spaced on the flanks and are interrupted on the venter. It bears three rows of strong to fairly strong tubercles of which the umbilical and lateral are conical to radially elongate and the ventral are spirally elongate. Its aperture bears prominent lateral lappets. Its outer whorl shows some resemblance to that of *Protacanthodiscus* but differs by the presence of lateral lappets and of spirally arranged tubercles Its inner whorls differ from those of *Protacanthodiscus* by the presence of coarse, simple, widely spaced trituberculate ribs instead of closely to moderately spaced biplicate ribs that bear only lateral and ventral tubercles.

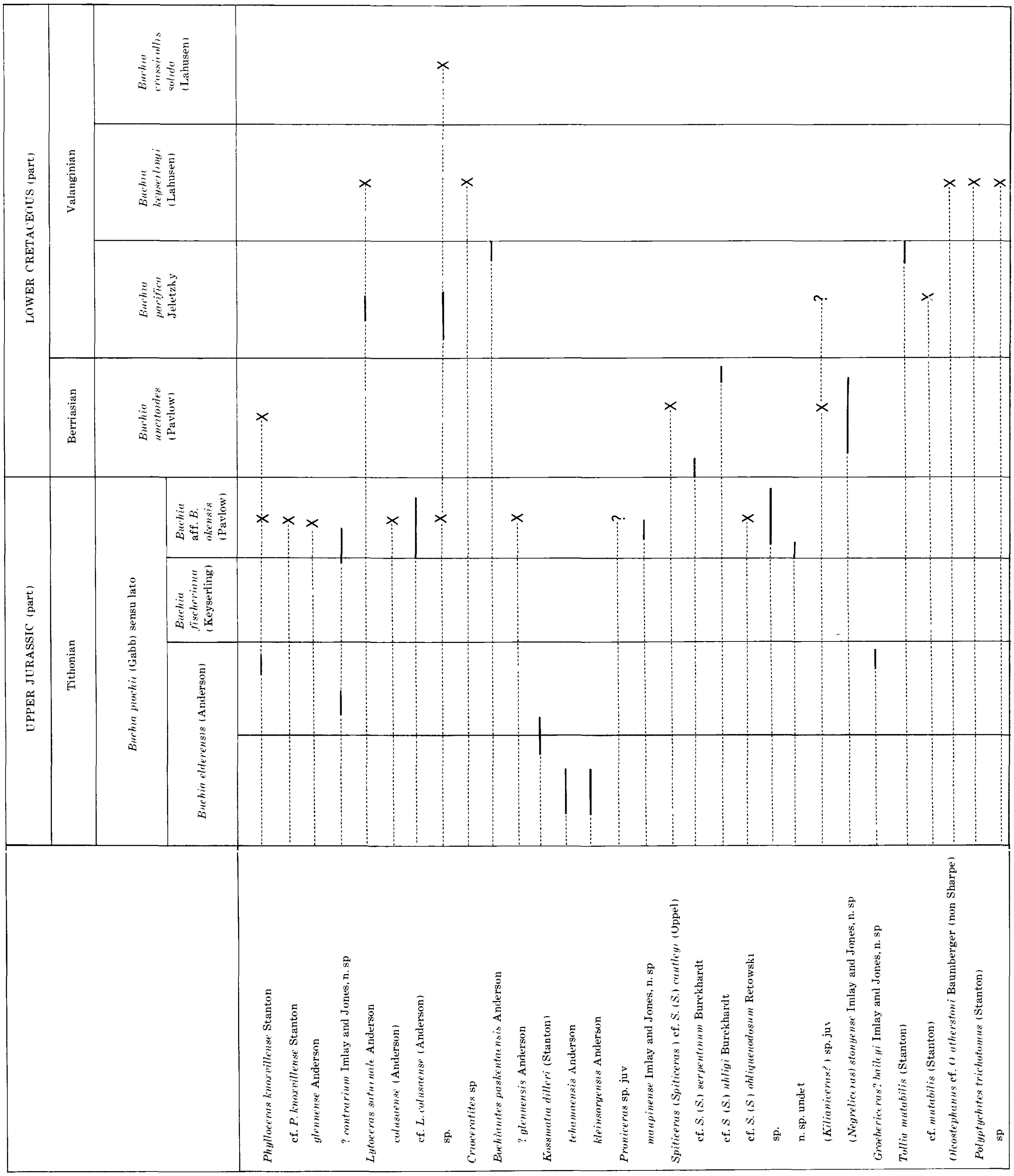
The new genus *Paskentites* is characterized by a compressed shell, evolute coiling, coronate inner whorls resembling *Stephanoceras*, perisphinctoid outer whorls, and strong projection of ribs on the venter.

STRATIGRAPHIC RELATIONSHIPS OF AMMONITES TO BUCHIAS

The stratigraphic positions and ranges of the ammonites described or mentioned herein relative to the species of *Buchia* with which they are associated are shown diagrammatically in figure 1, which summarizes the stratigraphic data presented in detail under the locality descriptions. A stratigraphic arrangement of the most characteristic ammonites relative to the species of *Buchia* is shown in figure 2. These figures do not include certain species of Valanginian age from California and Oregon whose associations with particular species of *Buchia* are uncertain or unknown.

The ammonites of Tithonian age have been found mostly in the Paskenta-Elk Creek area in northwestern California, west of Corning and Orland. In that area the ammonite *Kossmatia* occurs from 4,000 to 5,000 feet above the base of the beds containing *Buchia piochii* (Gabb) and also near the middle of those beds. Considerably higher, but at least 2,000 feet below the base of the beds containing *Buchia* aff. *B. okensis* (Pavlow), occur a few ammonites belonging to *Parodontoceras*, *Groebericeras?*, *Aulacosphinctes?*, and *Phylloceras*. Associated with *B.* aff. *B. okensis* (Pavlow) in the upper 500–1,000 feet of the Jurassic are the ammonites *Phylloceras*, *Lytoceras*, *Proniceras*, *Spiticeras*, *Blanfordiceras*, *Substeueroceras*, *Parodontoceras*, and questionably *Aulacosphinctes*.

The only ammonite of probable Jurassic age found in southwestern Oregon is an immature specimen of *Proniceras* (Mesozoic loc. 2074) that is associated with *Neocosmoceras*, many specimens of *Buchia uncitoides* (Pavlow), and a few specimens of *B. piochii* (Gabb). The specimens of *B. piochii* and *Proniceras* have a slightly different matrix than the other fossils, which suggests that they were obtained from different beds. *Neocosmoceras* could also be late Tithonian in age judging by its stratigraphic distribution in Pakistan


UPPER JURASSIC (part)
LOWER CRETACEOUS (part)
Tithonian
Berriasian
Valanginian
Buchia piochii (Gabb) sensu lato
Buchia elderensis (Anderson)
Buchia fischeriana (Keyserling)
Buchia aff. B. okensis (Pavlow)
Buchia uncitoides (Pavlow)
Buchia pacifica Jeletzky
Buchia keyserlingi (Lahusen)
Buchia crassicollis solida (Lahusen)
Phylloceras knoxvillense Stanton
cf. P. knoxvillense Stanton
glennense Anderson
? contrarium Imlay and Jones, n. sp
Lytoceras saturnale Anderson
colusaense (Anderson)
cf. L. colusaense (Anderson)
sp.
Crioceratites sp
Bochianites paskentaensis Anderson
? glennensis Anderson
Kossmatia dilleri (Stanton)
tehamaensis Anderson
kleinsorgensis Anderson
Proniceras sp. juv
maupinense Imlay and Jones, n. sp
Spiticeras (Spiticeras) cf. S. (S.) cautleyi (Oppel)
cf. S. (S.) serpentinum Burckhardt
cf. S (S.) uhligi Burckhardt
cf. S. (S.) obliquenodosum Retowski
sp.
n. sp. undet
(Kilianiceras?) sp. juv
(Negreliceras) stonyense Imlay and Jones, n. sp
Groebericeras? baileyi Imlay and Jones, n. sp
Tollia mutabilis (Stanton)
cf. mutabilis (Stanton)
Olcostephanus cf. O. atherstoni Baumberger (non Sharpe)
Polyptychites trichotomus (Stanton)
sp

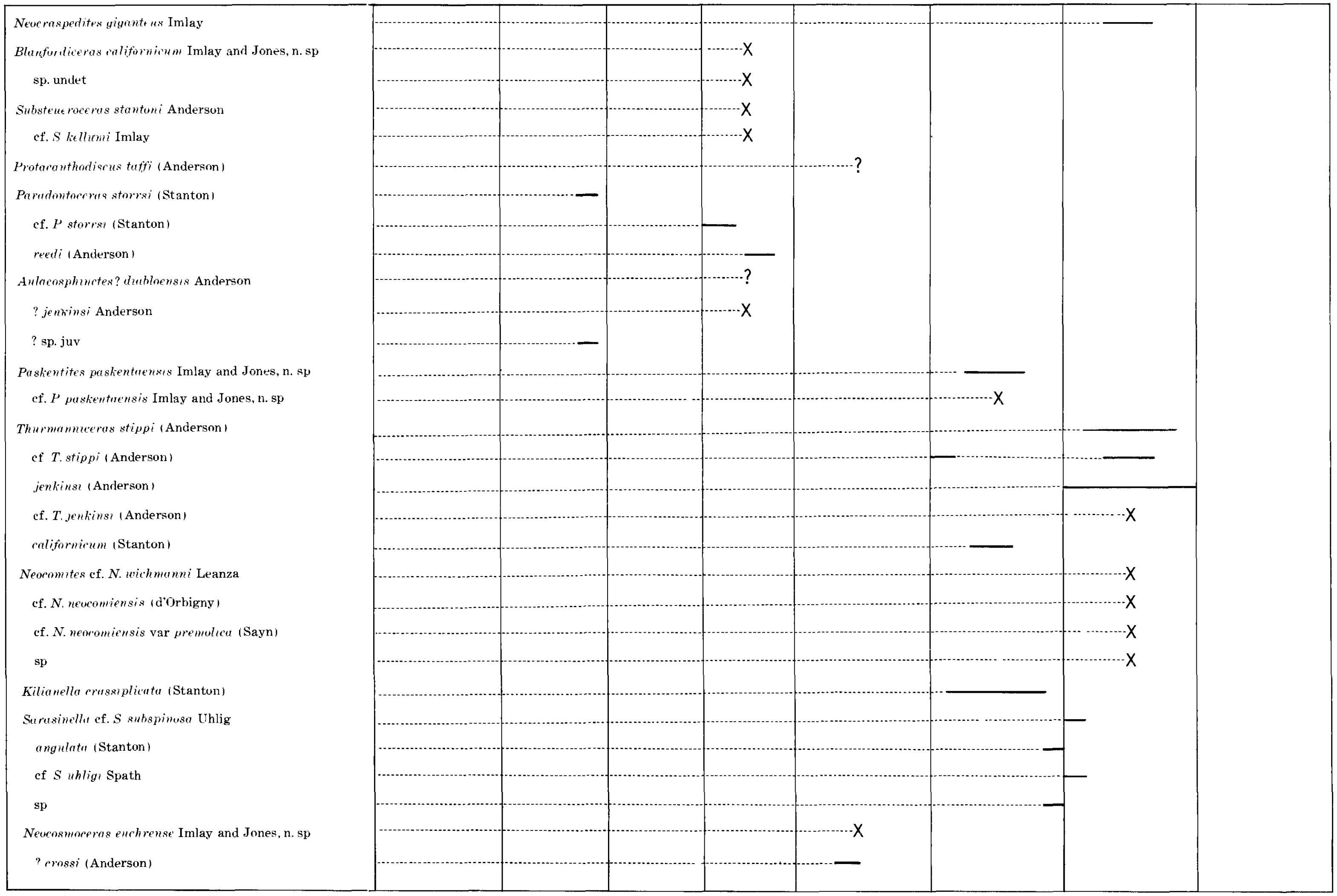


FIGURE 1.—Stratigraphic relationships of ammonites with species of *Buchia*. A question mark (?) indicates that association with a particular species of *Buchia* is uncertain. Black bars show known stratigraphic ranges of the ammonite species within the *Buchia* zones. An × indicates that the exact stratigraphic position or range within the *Buchia* zone is unknown.

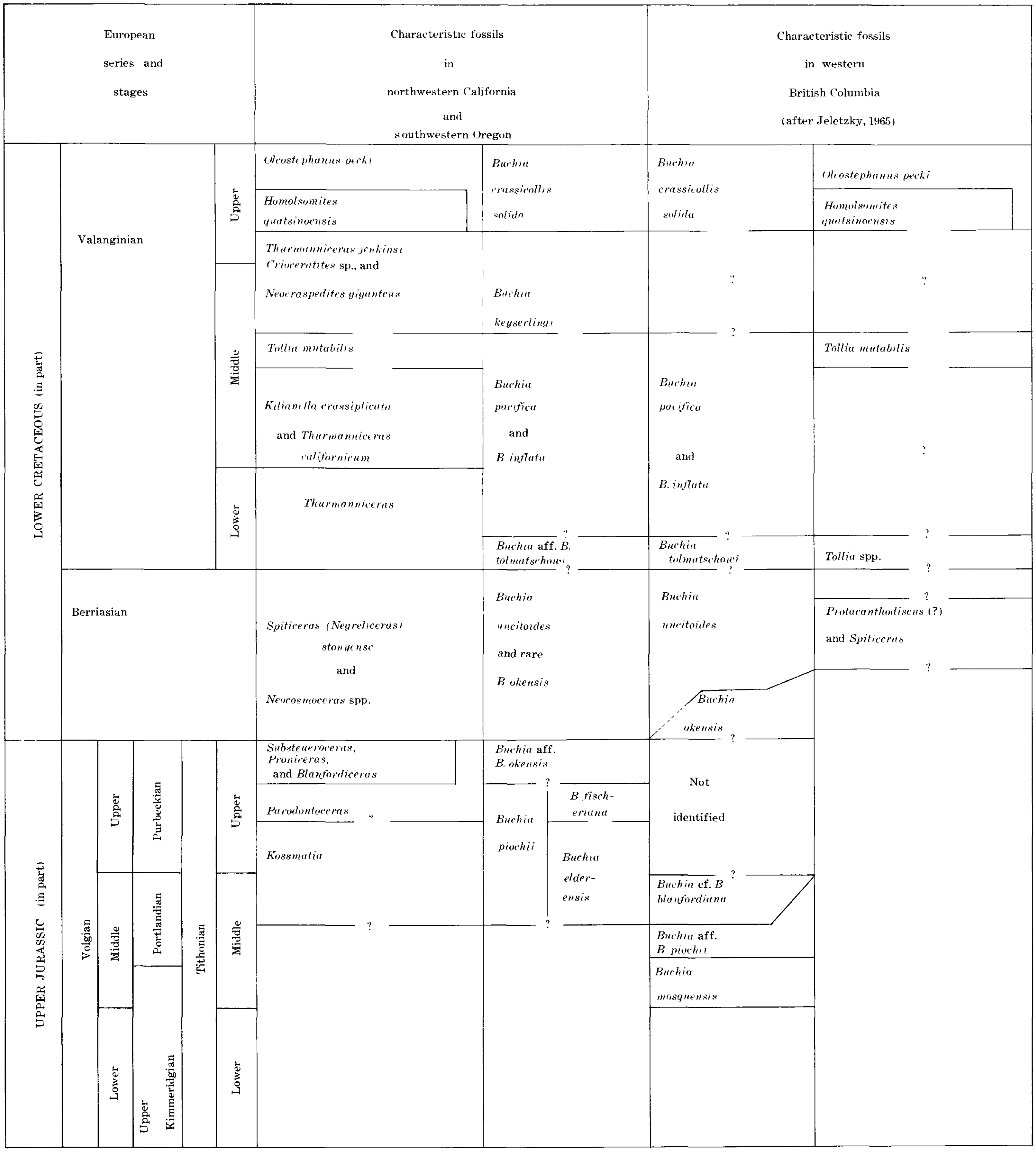


Figure 2.—Correlation of latest Jurassic (Tithonian) and earliest Cretaceous (Berriasian and Valanginian) faunas in California and Oregon.

Characteristic fossils in Mexico (Imlay 1943, 1944, 1952, Erben, 1957)	Characteristic fossils in Argentina (After Windhausen, 1918; Gerth, 1925; Weaver, 1931; Leanza, 1945; Giovine, 1950; Arkell, 1956)	Southern Europe (After Barbier, Debelmas, and Thieuloy, 1965, Enay, 1964; Barthel, 1962)	Russian platform (After Sachs and Shulgina, 1964; Sachs, 1965; Gerasimov and Mikhailov, 1967)	European series and stages					
Rogersites, Olcostephanus, and *Valanginites* (not zoned)	*Olcostephanus curacoensis*, *Rogersites laticostatum*, *Lissonia riveroi* (not zoned)	*Saynoceras verrucosum*	*Dichotomites petschorensis*	Upper	Valanginian				LOWER CRETACEOUS (in part)
			Polyptychites polytychites						
?									
Thurmanniceras, Neohoploceras, Kilianella, and *Polyptychites* (not zoned)	*Neocomites wichmanni* and *Thurmanniceras pertransiens*	*Kilianella roubaudiana*	*Polyptychites michalskii* and *P. Keyserlingi*	Middle					
?			*Temnoptychites hoplitoides*	Lower					
Spiticeras uhligi and *Subthurmannia densestriata*	*Spiticeras damesi* and *Cuyaniceras transgrediens*	*Subthurmannia boissieri*	*Tollia tolli* in Ural Mts.	Berriasian					
?			*Surites stenomphalus* (*Surites spasskensis*)						
Subthurmannia tenochi and *Spiticeras zirkeli*	*Argentiniceras noduliferum* and *Neocosmoceras egregium*	*Berriasella grandis*	? *Riasanites rjasanensis* (*Surites spasskensis*)						
Substeueroceras and *Proniceras* (*Micracanthoceras, Parodontoceras,* and *Hildoglochiceras*)	*Substeueroceras koeneni*	*Berriasella chaperi* (*Virgatosphinctes transitorius*)	? *Craspedites nodiger*	Upper	Tithonian	Purbeckian	Upper	Volgian	UPPER JURASSIC (in part)
			Craspedites subditus						
? *Kossmatia, Durangites,* and *Corongoceras* (*Micracanthoceras, Parodontoceras,* and *Hildoglochiceras*)	*Corongoceras alternans*	*Berriasella delphinensis* (*Virgatosphinctes transitorius*)	*Kachpurites fulgens*						
	Windhausenicera internispinosum		*Epivirgatites nikitini*	Middle		Portlandian	Middle		
? *Pseudolissoceras* and *Subplanites* (*Virgatosphinctes* and *Aulacosphinctoides*)	*Pseudolissoceras zitteli*	*Pseudolissoceras* and *Semiformiceras semiforme*	*Virgatites virgatatus*						
	Virgatosphinctes mendozanus		*Dorsoplanites panderi*			Upper Kimmeridgian			
Mazapilites and *Hybonoticeras* (*Virgatosphinctes* and *Aulacosphinctoides*)	?		*Subplanites pseudoscythicus*	Lower			Lower		
			Subplanites sokolovi						
		Glochiceras lithographicum	*Subplanites klimovi*						

Figure 2.—Continued.

(Fatmi, 1966, table 3), but the genus is generally considered indicative of a Berriasian age (Arkell and others, 1957, p. L358).

The previous record of the late Tithonian genus *Proniceras* at several other localities (Mesozoic locs. 3348, 3349, 25183, 25184) in southwestern Oregon (Imlay and others, 1959, p. 2780) was based mainly on fragments that could belong to the related genus *Spiticeras* of late Tithonian to Berriasian age. Furthermore, the presence of *Buchia uncitoides* (Pavlow) at Mesozoic locs. 3348, 25183, 25184 indicates a Berriasian rather than a Tithonian age. It appears that the Tithonian is represented in southwestern Oregon only by beds containing *Buchia piochii* (Gabb) that crop out from the Dillard area (Imlay and others, 1959, fig. 1 on p. 2771) southwestward to the coast. No occurrence of *Buchia* aff. *B. okensis* (Pavlow) has yet been found in Oregon.

Ammonites of Berriasian age have been found with *Buchia uncitoides* (Pavlow) in a few places in both California and Oregon and have hitherto been interpreted as of Tithonian age. This mistake in age was based mainly on the fact that crushed and immature specimens of *B. uncitoides* are difficult to distinguish from *B. piochii* (Gabb) and that ammonites are not common. In both States the ammonite evidence for a Berriasian age consists of *Neocosmoceras* and *Spiticeras (Negreliceras)*, although both occur rarely in beds of late Tithonian age. Other ammonites associated with *Buchia uncitoides* (Pavlow) include *Spiticeras (Spiticeras)*, *S. (Kilianiceras?)*, and *Phylloceras*. The subgenera *Negreliceras* and *Spiticeras* range throughout most of the lower two-thirds of the beds containing *Buchia uncitoides* (Pavlow) in the area between Elder Creek and Grindstone Creek in northwestern California. In Oregon the stratigraphic positions of these genera have not been determined with respect to the base or top of the beds containing *B. uncitoides* (Pavlow).

Ammonites of Valanginian age are much more common in California and Oregon than are ammonites of Berriasian age or of Tithonian age older than the zone of *Buchia* aff. *B. okensis* (Pavlow). Most of the Valanginian ammonites from California are associated either with *Buchia pacifica* Jeletzky or with *B. keyserlingi* (Lahusen). In Oregon the association of certain Valanginian ammonites, such as *Olcostephanus* and *Homolsomites*, with *B. crassicollis solida* (Lahusen) is well established.

In California the relative positions of the ammonites within the *Buchia pacifica* zone are known mainly for the Paskenta area. Among these ammonites, *Thurmanniceras* cf. *T. stippi* (Anderson) is from the lower 150 feet. *Paskentites* and *Kilianella*, *Lytoceras*, and *Thurmanniceras* are from the middle third. *Kilianella* occurs also about 200 feet below the top. The upper 100–200 contain an abundance of *Tollia mutabilis* (Stanton) and *Bochianites paskentaensis* Anderson along with a few specimens of *Sarasinella.*

In the *Buchia keyserlingi* zone near Paskenta, Calif., *Thurmanniceras jenkinsi* (Anderson) ranges throughout, *T. stippi* (Anderson) ranges through the middle and upper parts, *Neocraspedites* and *Polyptychites* occur near or a little above the middle, and *Sarasinella* occurs near the base. Other ammonites associated with *B. keyserlingi* but of uncertain stratigraphic position because of faulting include *Lytoceras saturnale* Anderson, *Crioceratites* sp., some specimens of *Neocraspedites* and *Polyptychites trichotomus* (Stanton). In addition, *Olcostephanus*, *Neocomites*, and one specimen of *Polyptychites* were obtained from the lower part of the *B. keyserlingi* zone near the South Fork of Cottonwood Creek in the west-central part of the Colyear Springs quadrangle.

In Oregon some of the ammonites of Valanginian age are not associated with *Buchia* in the collections, or the specimens of *Buchia* present are crushed and unidentifiable, or the collections were made over a considerable distance and may contain Buchias from different beds than the ammonites (Mesozoic locs. 4386, 2154). Nonetheless, the ammonites *Spiticeras (Kilianiceras?)* (Mesozoic loc. 24702) and *Sarasinella hyatti* (Stanton) (Mesozoic loc. 4386) are associated with larger crushed Buchias that probably belong to *B. pacifica* Jeletzky. *Sarasinella hyatti* is, also, associated with *B. keyserlingi* at three localities (Mesozoic locs. 4384, 4386, 26405; see Imlay, 1960, p. 187, 188).

The presence of *Buchia keyserlingi* in Oregon is not by itself evidence for correlating the beds in which it occurs with the *Buchia keyserlingi* zone in northwestern California because *B. keyserlingi* in California occurs also with *B. pacifica* Jeletzky and in western British Columbia occurs as low as *B. uncitoides* (Pavlow). Also, in Oregon the position of *Sarasinella hyatti* and *Buchia keyserlingi* at Mesozoic locs. 4384 and 4386 appears to be lower stratigraphically than the beds containing *Tollia mutabilis* (Stanton) and large crushed Buchias at Mesozoic loc. 2154 (Imlay, 1960, p. 173, 174). Evidently the sequence of Buchias and ammonites has not yet been as well established in southwestern Oregon as in California.

In Oregon the zone of *Buchia crassicollis solida* has furnished the ammonites *Olcostephanus pecki* Imlay, *O. popenoi* Imlay, and *Homolsomites quatsinoensis* (Whiteaves) from several hundred feet of beds exposed on the South Umpqua River near Days Creek in Douglas County (Imlay, 1960, p. 184, 185). These were obtained directly beneath beds containing Hauterivian ammonites (Imlay and others, 1959, p. 2775, 2782–2784).

AGES AND CORRELATIONS OF THE AMMONITE FAUNULES

JURASSIC AMMONITES

TITHONIAN AMMONITES FROM THE BUCHIA PIOCHII ZONE

The lower 5,000–6,000 feet of the *Buchia piochii* zone in the Paskenta quadrangle of northwestern California is definitely Late Jurassic age, younger than early Kimmeridgian, as shown by the presence of the ammonites *Kossmatia* and *Durangites*? (Anderson, 1945, p. 981–983; Stanton, 1895, p. 82) from 7,000 to 7,500 feet below the top of the *B. piochii* zone. The age of these beds is probably younger than Kimmeridgian, however, considering the ranges of *Kossmatia* and *Durangites* in Mexico (Imlay, 1939, p. 22, 23), the resemblance of *Buchia piochii* (Gabb) to species near the top of the Jurassic in the Boreal region (Pavlow, 1907, p. 82, 83), and the absence of *Buchia mosquensis* (von Buch) and *B. rugosa* (Fischer). The absence of the last two species in California seems particularly significant because they are common elsewhere in North America in beds of middle Kimmeridgian to middle Tithonian ages (Imlay, 1955, p. 74, 75, 85; 1959, p. 157) and are common in Russia in the Volgian zones of *Subplanites sokolovi* to *Dorsoplanites panderi* inclusive (Gerasimov and Mikhailov, 1967, p. 9, 19, 20). This range is equated by the Russian paleontologists just quoted with the southern English zones of *Subplanites* spp. to *Zaraiskites albani* inclusive (Arkell, 1956, p. 10), which confirms an earlier statement by Spath (1936, p. 166, 167).

The presence of *Durangites*, if verified, would be particularly useful for an age determination, as the genus is known elsewhere near the top of the Jurassic in Mexico (Burckhardt, 1912, p. 143, 205; Imlay, 1939, p. 22, 23, 46–49) and in Cuba (Imlay, 1942, p. 1433, 1436, 1452, pl. 3, figs. 5–7). In Mexico it occurs commonly in association with *Kossmatia*, *Micracanthoceras*, and *Hildoglochiceras* just below beds containing *Substeueroceras*. In California *Durangites* was recorded by Anderson (1945, p. 1001) from CAS loc. 29694, which is 600 feet north of Hull's gate in sec. 35, T. 25 N., R. 7 W., Paskenta quadrangle, and, therefore, at about the same stratigraphic position as two species of *Kossmatia* described by Anderson (1945, pl. 2, figs. 1, 3). Unfortunately, the specimen from California illustrated by Anderson (1945, pl. 2, figs. 4a, b) as *Durangites* is now lost, and a positive generic identification cannot be made from the illustrations.

The presence of *Kossmatia* in California is of considerable age value because the genus occurs in Mexico in abundance near the middle of the Tithonian sequence below beds characterized by *Substeueroceras* and above beds characterized by *Pseudolioceras*, *Subplanites*, and *Aulacosphinctoides* (Burckhardt, 1912, p. 220–222, 1930, table 11 opposite p. 112; Imlay, 1939, p. 22, 23; 1943, p. 538, 539). Likewise, in Argentina, it occurs high in the Tithonian (Krantz, 1928, p. 49) associated with *Aulacosphinctes* and above beds containing *Parodontoceras* and *Corongoceras*, which in turn overlie beds containing *Pseudolissoceras zitteli* Burckhardt. By contrast, in southern Europe and northern Africa *Kossmatia* is reported to range through the entire Tithonian (Mazenot, 1939, p. 129, 130) and its total worldwide range is Kimmeridgian through upper Tithonian (Arkell and others, 1957, p. L323).

The Kimmeridgian age for *Kossmatia* given by Arkell is based on his studies of ammonites from a thick and apparently comfortable sequence exposed on the shore of Kawhia Harbour in New Zealand (Fleming, 1960, p. 264–268; Fleming and Kear, 1960, p. 17–45; Stevens, 1965, p. 22–32, 132–135). At this place *Kossmatia* occurs above the ammonites *Idoceras*, *Subneumayria*, and *Epicephalites* of early Kimmeridgian age and mostly below the ammonite *Aulacosphinctoides* of late Kimmeridgian to middle Tithonian age. It occurs also within the lower part of the local range of *Aulacosphinctoides*. Its age, therefore, at Kawhia Harbour is definitely late Kimmeridgian and, on the basis of stratigraphic position, is partly middle Kimmeridgian.

The upper 4,000–5,000 feet of the *Buchia piochii* zone is definitely middle to late Tithonian in age as shown by the stratigraphic position between occurrences of *Kossmatia* below and *Substeueroceras* above and by the presence of the ammonites *Parodontoceras* and *Spiticeras*. Of these, *Parodontoceras* (Mesozoic loc. 1084), found several thousand feet below the top of the zone, is excellent evidence for an age not older than late middle Tithonian, and *Spiticeras* (Mesozoic loc. 1085), found a few hundred feet below the top of the zone, is evidence of an age not older than late Tithonian. Also, the presence of an ammonite resembling *Groebericeras* (Mesozoic loc. M2024), found about 2,100 feet below the top of the zone, favors an age not older than late Tithonian because that genus has been found only in beds of Berriasian age in Argentina (Leanza, 1945, p. 82).

Only part of the *Buchia piochii* zone of California, as defined herein, is equivalent to beds in western British Columbia and Arctic Canada that supposedly are characterized by *B. piochii* (Gabb) (Jeletzky, 1965, fig. 2 opposite p. 2). Exact equivalence seems unlikely because the specimens of *Buchia piochii* (Gabb) from California, including the type specimen, show scarcely any resemblance to the varieties assigned to that species by Jeletzky (1965, pl. 1, figs. 3–6, 9). Furthermore, the specimens of *Buchia* from the lower part of the *B. piochii* zone in California, described by Anderson (1945, p. 965–967, 973) under the names *B. sollasi* (Pavlow), *B.* sp. A, *B.* aff. *B. mosquensis* (von Buch), and *B. elderensis* (Anderson), all show considerable resemblance to *Buchia* cf. *B. blanfordiana* (Stoliczka) of Jeletzky (1965, pl. 2, figs. 3, 4, 6, pl. 3, figs. 4–8), which in western British Columbia occurs at the top of the Jurassic sequence beneath a disconformity. This comparison indicates that the lower part of the *B. piochii* zone in California is equivalent to the *B.* cf. *B. blanfordiana* zone of western British Columbia and that the upper part of the *Buchia piochii* zone in California may be represented in western British Columbia by the disconformity below the basal Cretaceous zone of *Buchia okensis* as suggested by Jeletzky (1965, p. 17, 18). These correlations, if valid, explain why specimens resembling the holotype of *B. piochii* (Gabb) have not been illustrated from Canada and why the various varieties of *B. piochii* described by Jeletzky have not been found in California.

TITHONIAN AMMONITES FROM THE BUCHIA AFF. B. OKENSIS ZONE

The beds in California that contain *Buchia* aff. *B okensis* (Pavlow) are considered to be of latest Jurassic (late Tithonian) age because they contain the ammonites *Substeueroceras*, *Parodontoceras*, *Blanfordiceras*, *Proniceras*, and *Spiticeras* (*Spiticeras*) and are stratigraphically just beneath a sequence characterized by the pelecypod *Buchia uncitoides* (Pavlow) and the ammonite *Spiticeras* (*Negreliceras*). The presence of of these ammonites is excellent evidence for a Late Jurassic age because *Spiticeras* and *Blanfordiceras* have not been found in beds older than late Tithonian (Djanélidzé, 1922, p. 29, 36), *Proniceras* is characteristic of the upper Tithonian (Djanélidzé, 1922, p. 48, 52), *Parodontoceras* in Mexico (Imlay, 1939, table 3 opposite p. 24; 1942, p. 1433, 1434) and Argentina (Leanza, 1945, p. 91, 92) occurs only in beds of middle to late Tithonian age, and *Substeueroceras* is characteristic of the topmost Jurassic beds in Mexico (Imlay, 1939, table 3 opposite p. 34) and Argentina (Leanza, 1945, p. 91, 92).

Additional evidence for a Late Jurassic age consists of the close resemblance of the species of *Substeueroceras* and *Parodontoceras* in California to species of those genera in Mexico or Argentina. Thus, *Substeueroceras stantoni* Anderson (1945, p. 982, pl. 11, figs. 3, 4, pl. 15, fig. 3) is similar to *S. subquadratum* Imlay (1939, p. 49, pl. 15, figs. 8, 12–15) from Mexico. Another species of *Substeueroceras*, erroneously assigned to *Berriasella storrsi* (Stanton) by Anderson (1945, p. 980, pl. 7, fig. 1) closely resembles *S. kellumi* Imlay (1939, p. 50, pl. 14, figs. 1–4) from Mexico and *S. koeneni* (Steuer) (1897, p. 171, pl. 17, figs. 1–5) from South America. In addition, *Parodontoceras reedi* (Anderson) (1945, p. 978, pl.6, fig. 10, pl. 7, fig. 3) resembles some specimens of *Parodontoceras* from Mexico described as *Berriasella* cf. *B. calistoides* (Behrendsen) by Burckhardt (1906, pl. 19, fig. 9; 1912, pl. 39, fig. 7). It also shows considerable resemblance to the finer variants of *Parodontoceras calistoides* (Behrendsen) from Argentina (Steuer, 1897, pl. 17, figs. 13–16; Leanza, 1945, pl. 5, figs. 5, 6) and could fall within the range of variation of that species.

The *Buchia* aff. *B. okensis* zone has not yet been recognized in southwestern Oregon. Its absence may be due to either a disconformity or a lack of detailed collecting. Likewise, in western British Columbia, the zone has not been recognized and probably is represented by the disconformity beneath the *B. okensis* zone (Jeletzky, 1965, figs. 1 and 2 opposite p. 2, p. 17). The beds in California that contain *Buchia* aff. *B. okensis* (Pavlow) are not equivalent to the *B. okensis* zone in western British Columbia (Jeletzky, 1965, p. 20–26, fig. 1 opposite p. 2) or in northern Alaska (Imlay, 1961, p. 5, 6) because they lack the extremely coarse ribbed variant of *B. okensis* (Pavlow) that occurs in the other areas (Jeletzky, 1965, pl. 4, figs. 1, 19, 20, pl. 5, fig. 7, pl. 6, figs. 1, 2, 4–6, pl. 7, fig. 3; Imlay, 1961, pl. 7, figs. 5, 9, 12, 17–20).

CRETACEOUS AMMONITES

BERRIASIAN AMMONITES FROM THE BUCHIA UNCITOIDES ZONE

The *Buchia uncitoides* zone in California is considered to be mainly of Berriasian age as shown by its stratigraphic position directly above beds containing the latest Tithonian ammonites *Substeueroceras*, *Parodontoceras*, and *Proniceras* and by the presence of *Spiticeras* (*Negreliceras*) and *S.* (*Spiticeras*) throughout the lower two-thirds of the zone. Of these ammonites, the subgenus *Negreliceras* is characteristic of the

Berriasian, is represented by only one species from the upper Tithonian, and is unknown from the Valanginian (Djanélidzé, 1922, p. 48, 49, 51). The subgenus *Spiticeras* ranges from the top of the Tithonian through the Berriasian but no higher (Djanélidzé, 1922, p. 51). On the basis of ammonites, therefore, most of the *Buchia uncitoides* zone in California cannot be younger than Berriasian and is unlikely to be as old as Tithonian. The upper third of the *B. uncitoides* zone, however, has not furnished ammonites and could be younger than Berriasian.

The beds in Oregon that contain *Buchia uncitoides* are similarly dated as Berriasian because of the presence of *Spiticeras* (*Negreliceras*), *S.* (*Spiticeras*), *S.* (*Kilianiceras?*), and *Neocosmoceras*, a genus known mainly from the Berriasian (Mazenot, 1939, p. 179, 182; Wright in Arkell and others, 1957, p. L358). The stratigraphic position of these ammonites within the *Buchia uncitoides* zone in Oregon is not known.

The *Buchia uncitoides* zone is widespread in northwestern California and in southwestern Oregon. In California it directly overlies the *B.* aff. *B. okensis* zone. In Oregon, by contrast, the *B. uncitoides* zone rests directly either on beds containing *Buchia piochii* (Gabb) or on basement rocks. *Buchia uncitoides* (Pavlow) is the characteristic species in the type section of the Riddle Formation exposed on the South Umpqua River near Days Creek. In that section the species ranges upward about 1,000 feet from 20 feet above the basal conglomerate into the third conglomerate (Imlay and others, 1959, p. 2776).

The *Buchia uncitoides* zone in California and Oregon may be correlated approximately with the *Buchia uncitoides* zone in western British Columbia on the basis of having the same characteristic species of *Buchia* and the same genera and subgenera of the ammonite *Spiticeras* (Jeletzky, 1965, p. 27–35, fig. 1 opposite p. 2). That ammonite on the west coast of Vancouver Island (Jeletzky, 1965, pl. 11, figs. 2, 3, 7, pl. 12, figs. 4, 5) ranges from 21 to 128 feet above the base of the *Buchia uncitoides* zone, which is about 270 feet thick, and dates the lower part of the zone as not younger than Berriasian. Additional evidence for a Berriasian age is furnished by a small fragment of an ammonite (Jeletzky, 1965, pl. 11, figs. 4a–d) belonging probably to *Protacanthodiscus* or *Neocosmoceras* that was collected about 167 feet above the base of the zone. The upper 103 feet of the zone has not furnished any ammonites and could be younger than Berriasian.

The *Buchia uncitoides* zone in California differs markedly from that zone in British Columbia by a near absence of *B. okensis* (Pavlow), by a much greater abundance of the ammonite *Spiticeras* (*Negreliceras*), and by its stratigraphic position directly on beds of probable latest Jurassic age. Presumably the lower part of the *B. uncitoides* zone in California is equivalent to the *B. okensis* zone of British Columbia. An alternate explanation would be that the *Buchia okensis* zone in British Columbia is actually of Late Jurassic age and equivalent to the beds in California that contain *Buchia* aff. *B. okensis* (Pavlow). This possibility, however, seems unlikely because in British Columbia *B. okensis* and *B. uncitoides* are associated throughout their range, whereas in California *B.* aff. *B. okensis* (Pavlow) is associated with *B. terebratuloides* (Lahusen) but not with *B. uncitoides* (Pavlow). Also, the *Buchia okensis* zone in British Columbia contains an extremely coarse ribbed variant of *B. okensis* that does not occur in the *B.* aff. *B. okensis* zone in California.

In summation, the *Buchia uncitoides* zone in California and Oregon contains ammonites of Berriasian age. It is correlated with beds in British Columbia that contain both *B. okensis* (Pavlow) and *B. uncitoides* (Pavlow) as well as ammonites of Berriasian age. In both California and British Columbia the upper third of the *B. uncitoides* zone has not furnished ammonites and could be as young as Valanginian.

Correlation of the *Buchia uncitoides* zone in California, Oregon, and British Columbia with the faunal zones in northern Eurasia presents difficulties as discussed by Jeletzky (1965, p. 34, 35). Apparently in northern Eurasia *B. okensis* (Pavlow) ranges from the base of the Cretaceous through the zone of *Surites spasskensis* (Nikitin) (Sachs and others, 1963, p. 61–63, table 7) and is associated with *B. uncitoides* (Pavlow) only at the top of its range (*Surites analogus* subzone). The species *B. uncitoides* (Pavlow) definitely ranges upward through the zone of *Tollia tolli* (Sachs and others, 1963, p. 65), which the Russian paleontologists consider of late Berriasian age, and Jeletzky (1965, p. 34) considered of early Valanginian age. Still higher in the lower or middle Valanginian zone of *Polyptychites michalskii* are recorded *B. uncitoides* (Pavlow and *B.* cf. *B. uncitoides* (Pavlow) (Sachs and others, 1963, p. 67, 68, 70, table 7). These records show that in northern Eurasia the species *B. uncitoides*, if correctly identified, ranges from about middle Berriasian to middle Valanginian.

This apparent discrepancy between the vertical range of *Buchia uncitoides* in northern Eurasia as compared with its range in western Canada has been noted by Jeletzky (1965, p. 34, 35), who suggested that in Eurasia the Berriasian species of *Buchia* may have been reworked into beds of Valanginian age or that the

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Berriasian and Valanginian species of *Buchia* may have been concentrated within a single thin bed as a consequence of extremely slow deposition. It is possible, of course, that *B. uncitoides* in western North America actually ranges into the Valanginian or that it has a slightly different range than in Eurasia. Accurate correlations and age determinations of the *Buchia uncitoides* zone in western North America must await the discovery of well-preserved ammonites in the upper part of the zone.

VALANGINIAN AMMONITES FROM THE BUCHIA PACIFICA ZONE

The age of the *Buchia pacifica* zone in California on the basis of ammonites is probably entirely early to middle Valanginian. Its lower part, about 150 feet above its base, has furnished the ammonite *Thurmanniceras*, whose presence suggests an age not older than Valanginian (Busnardo, LeHegerat and Magne, 1965, p. 27, 32). Its middle part has furnished species of *Thurmanniceras* and *Kilianella* that could be of early Valanginian age but suggest a middle Valanginian age because the species present resemble species of middle Valanginian age known elsewhere (Imlay, 1960, p. 172). Its upper part is definitely Valanginian, as shown by the presence of *Sarasinella*, and is not younger than middle Valanginian, as shown by the presence of *Tollia*. That genus in Russia ranges from the upper part of the zone of *Surites spasskensis* (middle Berriasian) into the zone of *Temnoptychites hoplitoides* (early Valanginian) (Sachs and others, 1963, p. 68, tables 7, 8; Sachs and Shulgina, 1964, table opposite p. 10). A middle Valanginian age for *T. mutabilis* (Stanton) is supported, however, by the resemblance to *T. paucicostata* (Donovan) (1953, p. 110, pl. 23, figs. 1a, b), which occurs in East Greenland in association with the middle Valanginian ammonites *Polyptychites* and *Euryptychites*. A middle Valanginian age is supported, also, by the stratigraphic position of the *B. pacifica* zone below beds that have furnished ammonites of late Valanginian age.

The *Buchia pacifica* zone in southwestern Oregon is represented by the typical *Buchia* species at many localities from Riddle westward to the Pacific coast, but the stratigraphic position of the zone relative to the adjoining *Buchia* zones has not been studied. Furthermore, some of the older collections, such as from Mesozoic loc. 2154 and 2155, were made over distances of about a mile and probably include collections from more than one *Buchia* zone. The *B. pacifica* zone appears to be represented, however, by collections containing *Sarasinella hyatti* (Stanton) (Imlay, 1960, p. 172–174) and *Tollia mutabilis* (Stanton) (Imlay, 1960, p. 174).

The *Buchia pacifica* zone in California and Oregon may be correlated with the *Buchia pacifica* zone in western British Columbia on the basis of having the same species of *Buchia*, of having the same stratigraphic position relative to older species of *Buchia*, and of also containing *Tollia mutabilis* (Stanton) in the upper part of the zone. This species in western British Columbia was obtained only in the Bridge River area and was identified by Jeletzky (1964a, pl. 6, figs. 1, 8, 9; 1965, p. 47, 53, pl. 18, figs. 1, 6, 7) as *Dichotomites* cf. *D. giganteus* (Imlay), a species which was originally described from California as *Neocraspedites giganteus* Imlay (1960, p. 204, pl. 32, figs. 1–6).

Examination of plaster casts of the ammonites from the Bridge River area show that they differ markedly from *N. giganteus* Imlay found in California. They have an oblique instead of a vertical umbilical wall; a gently rounded instead of an abrupt umbilical edge; sharp, narrow primary ribs instead of broad indistinct primary ribs; and less flattened flanks. Furthermore, one specimen (Jeletzky, 1964a, pl. 6, fig. 9b) bears a conspicuous constriction at a size much larger than in any genus of the subfamily Polyptychitinae, which includes both *Dichotomites* and *Neocraspedites* (Wright in Arkell and others, 1957, p. L348). Evidently the ammonites from the Bridge River area do not belong to the same genus or subfamily as *N. giganteus* Imlay.

In contrast the three ammonites from the Bridge River area, British Columbia, illustrated as *Dichotomites* cf. *D. giganteus* (Imlay) by Jeletzky (1965, pl. 16, figs. 1, 6, 7), agree very well in umbilical shape, whorl shape, sharp primary ribbing, fine dense secondary ribbing, and presence of constrictions with *Dichotomites tehamaensis* Anderson (1938, p. 158, pl. 28, fig. 2, pl. 30, fig. 6), which Imlay (1960, p. 201, pl. 28, figs. 18–22) considers to be a finely ribbed variant of *T. mutabilis* (Stanton). Likewise, the specimens from northeast British Columbia illustrated as *Dichotomites* cf. *D. giganteus* (Imlay) by Jeletzky (1964b, pl. 12, figs. 11–13) are similar to *T. mutabilis tehamaensis* (Anderson). They have finer and denser secondary ribs than those on the holotype illustrated by Anderson (1938, pl. 28, fig. 2; Imlay, 1960, pl. 28, figs. 18, 19) but are not much finer ribbed than one specimen illustrated by Imlay (1960, pl. 28, fig. 21).

Considering the close resemblances of these specimens from British Columbia to *T. mutabilis tehamaensis* (Anderson), it is rather strikng that the other variants of *T. mutabilis* have not been found in association as in California. This might be explained as a happenstance of collecting, or perhaps the finely ribbed variant of *T. mutabilis* has a different geographic or stratigraphic range than the normal or the coarsely ribbed variants. Such differences would justify a subspecific rather than varietal rank for *T. mutabilis tehamaensis.*

The ammonites from British Columbia that Jeletzky called *Dichotomites* cf. *D. giganteus* (Imlay) were considered by him (1965, p. 41, 53) to be closely related to *Tollia mutabilis* (Stanton) and to *Olcostephanus quatsinoensis* Whiteaves (1882, p. 82, fig. 1; Jeletzky, 1965, p. 52, 53, pl. 20, figs. 3–5, 14, 15). The last mentioned species was referred by him (1965, p. 41, 53) at one time to *Dichotomites*, but after examination of the type species of *Dichotomites* was assigned on the basis of the suture line to *Homolsomites* (Jeletzky, 1965, footnote on p. 39), which is in the family Craspeditidae rather than in the Olcostephandidae. His final conclusions evidently are close to those presented herein concerning the generic and family assignments of the ammonites from British Columbia under discussion.

The *Buchia pacifica* zone in British Columbia was considered by Jeletzky (1965, p. 47, 48) to be mostly or entirely of middle Valanginian age on the basis of its stratigraphic position between the *Buchia tolmatschowi* zone of probable early Valanginian age and the *B. crassicollis* zone of late Valanginian age. An age not younger than middle Valanginian for the upper part of the *B. pacifica* zone is substantiated by the presence of the ammonite *Tollia.* Whether the lower part of the *B. pacifica* zone in British Columbia is older than middle Valanginian must await the discovery of ammonites in that part. Nonetheless, such an age is favored by the presence of certain ammonites that have been found associated with *B. pacifica* Jeletzky in the upper part of the underlying *B. tolmatschowi* zone.

These ammonites from the *Buchia tolmatschowi* zone in British Columbia have been discussed in detail by Jeletzky (1965, p. 41–43), who concluded that they are probably of early Valanginian age. Stratigraphically the zone could be either late Berriasian or early to middle Valanginian. Faunally its upper part, which contains an association of *Buchia pacifica* Jeletzky and *B. tolmatschowi* (Sokolov), has furnished ammonites that Jeletzky (1965, p. 38) identified as follows:

Neocomites (*Parandiceras*) cf. *N.* (*P.*) *rota* (Spath)
Tollia (*Tollia*) *mutabilis* (Stanton) sensu lato
T. (*T.*) *mutabilis* var. *burgeri* (Anderson)
T. (*T.*) *mutabilis* var. *tehamaensis* (Anderson)
T. (*T.*) *paucicostata* (Donovan)
T. (*T.?*) aff. *T. simplex* (Bogoslovsky)

On the basis of these fossils, the upper part of the *B. tolmatschowi* zone was correlated by Jeletzky (1965, fig. 2 opposite p. 2) with the upper part of the lower Valanginian, although the genus *Tollia* ranges slightly higher. The first four ammonites listed above from the upper part of the *Buchia tolmatschowi* zone were assigned by Jeletzky (1965, p. 43) to the top of the lower Valanginian and were correlated with the *Tollia mutabilis* beds in California (Imlay, 1960, p. 174) on the basis of his identification of *Tollia mutabilis* (Stanton). The last two ammonites listed were considered by Jeletzky (1965, p. 38) as probably a little older than the first two species listed and are assigned an early Valanginian age on the basis of the presence of *Tollia paucicostata* (Donovan) (1953, p. 110, pl. 23, figs. 1a, b). That species in East Greenland, however, was associated with species of *Polyptychites* and *Euryptychites* (Donovan, 1953, p. 102, 110, pl. 20, figs. 4–6, pls. 21 and 22) that are accepted as of middle Valanginian age (Jeletzky, 1965, p. 42, 43; Donovan, 1953, p. 33, 134; Sachs and Shulgina, 1964, table opposite p. 10). Such an age is a little younger than the age that Jeletzky (1965, fig. 1, p. 42, 43) assigned to the upper part of the *B. tolmatschowi* zone, but he suggested that the ammonites from Greenland may represent a mixture of several zones.

Examination by the writers of plaster casts of the ammonites from the *Buchia tolmatschowi* zone of western British Columbia confirms the assignment of most of the ammonites to *Tollia.* Furthermore, the assignment of *Olcostephanus mutabilis* Stanton to *Tollia* (Jeletzky, 1965, p. 39, 40) instead of *Homolsomites* (Imlay, 1960, p. 200, 201) seems reasonable and agrees with the studies of Shulgina (1965, p. 82, 86). Exception is made, however, to the specific identification of four small crushed fragments as *Tollia mutabilis* (Stanton) because the fragments are too poorly preserved for positive identification. Exception is made, also, to the generic identification of one small immature ammonite as *Neocomites* (*Parandiceras*) *cf. N.* (*P.*) *rota* (Spath) (Jeletzky, 1965, pl. 16, figs. 5a, b). The specimen differs from *Neocomites* in the strict sense by lacking umbilical tubercles, by lacking rib branching at the umbilical edge, and by having fairly regular rib branching near the middle of the flanks. Its comparison with *Parandiceras* is not apt because it is much smaller than any illustrated specimen of that genus (Spath, 1939, p. 76–79, pl. 13, figs. 2, 3a–d, pl. 15, figs. 1a, b, pl. 18, fig. 3).

The identification of *Tollia paucicostata* (Donovan) in western British Columbia by Jeletzky (1965, pl. 13, figs. 2, 5, 6, 7, 9, pl. 14, figs. 4–6, 8) is based on 10 laterally crushed ammonites of various sizes. These differ from the holotype of *T. paucicostata* (Donovan) from East Greenland by being appreciably more evolute and by having sparser and coarser ribbing at a comparable size. They differ from *T. mutabilis* (Stanton) (Stanton, 1895, pl. 15, figs. 1–5; Imlay, 1960, pl. 28, figs. 1–22; Jeletzky, 1965, pl. 14, figs. 7a, b, 9, pl. 14, figs. 5a, b) by having coarser and sparser ribbing, a more narrowly rounded venter, and more evolute coiling. The more finely ribbed variants of the Canadian specimens bear ribbing comparable to that on the most coarsely ribbed variant of *T.* (*T.*) *mutabilis* (Stanton) (see Imlay, 1960, pl. 28, figs. 1–4), as noted by Jeletzky (1965, pl. 14, figs. 8a–c). Overall, the Canadian specimens differ appreciably from both *T. paucicostata* (Donovan) and *T. mutabilis* (Stanton) and cannot be used, therefore, for precise correlations with beds containing those species. The presence of the genus *Tollia* itself merely indicates an age not older than middle Berriasian or younger than middle Valanginian.

One other ammonite from Vancouver Island was illustrated by Jeletzky (1965, pl. 13, figs. 8a, b) as *Tollia* (*Tollia?*) aff. *T.* (*T.?*) *simplex* (Bogoslovsky) (1902, p. 138, pl. 14, figs. 6a, b) and compared also with *Surites poreckoensis* Sasonov (1951, p. 60, pl. 1, fig. 2) from Russia. Of these, *T. simplex* (Bogoslovsky) occurs in Russia in the lower part of the *Polyptychites michalskii* zone of early Valanginian age and is listed under the name *Temnoptychites* (Sachs and others, 1963, table 7). The Canadian specimen differs from that species as well as from the species of *Surites* by having less regular rib bifurcation and some simple and intercalated ribs. It could be a coarsely ribbed variant of the Canadian species that Jeletzky refers to *Tollia paucicostata* (Donovan). Similar coarsely ribbed biplicate species of the Tolliinae, as discussed by Jeletzky (1965, p. 42), occur in Russia in beds of middle Berriasian to early Valanginian age.

In summation, the ammonites from the upper part of the *Buchia tolmatschowi* zone in British Columbia do not permit an exact age determination. The presence of the genus *Tollia* itself shows that the zone is not older than middle Berriasian or younger than middle Valanginian (Sachs and others, 1963, p. 64, 65, tables 7, 8). The specimens of *Tollia* that are present either are too fragmentary for specific identification or are different from described species and hence do not permit an age determination closer than that indicated by the genus. The specimen assigned to *Neocomites* differs considerably from that genus and is of little age value. As all these ammonites occur in the lower part of the range of *Buchia pacifica* Jeletzky, they should be older than *Tollia mutabilis* (Stanton), which in California occurs at the top of the range of *Buchia pacifica* and is most probably of middle Valanginian age. On the basis of stratigraphic position, therefore, the *Buchia tolmatschowi* zone is probably at least as old as early Valanginian.

VALANGINIAN AMMONITES FROM THE BUCHIA KEYSERLINGI ZONE

The age of most of the *Buchia keyserlingi* zone in the Paskenta quadrangle in California is definitely Valanginian, as shown by the presence of *Sarasinella* near the base (Mesozoic loc. M3060) and *Polyptychites* about 1,250 feet above the base (Mesozoic loc. M1577). Furthermore, the association of *Neocraspedites*, *Crioceratites*, and *Polyptychites* at one place (Mesozoic locs. 1009, 1087) is good evidence that the beds at that place are of late Valanginian age (Imlay, 1960, p. 172, 174; Wright in Arkell and others, 1957, p. L208, L348), as *Polyptychites* is not known higher than the upper Valanginian and the other genera listed are not known lower. Unfortunately, the association of these three genera is in a faulted area in which the base of the *Buchia keyserlingi* zone cannot be determined. Their occurrence, however, appears to be considerably above the base of that zone and probably in the upper half.

The age of the highest part of the *Buchia keyserlingi* zone in the Paskenta area is not older than late Valanginian or younger than early Hauterivian, as indicated by the association of *Thurmanniceras jenkinsi* (Anderson) with the larger paratype of *Neocraspedites giganteus* Imlay at USGS Mesozoic loc. 1091 (equals 2266 and M1579). The abundance of *Thurmanniceras* at this locality favors a Valanginian age because the genus attained its greatest abundance during the middle Valanginian.

The age of the basal part of the *Buchia keyserlingi* zone in the Paskenta area is not older than late middle Valanginian, as indicated by the superposition of that part on the *Buchia pacifica* zone whose upper part is probably of middle Valanginian age.

The age of the *Buchia keyserlingi* zone in the Colyear Springs quadrangle is likewise definitely Valanginian, as shown by the presence low in the zone of *Olcostephanus*, *Polyptychites*, and *Thurmanniceras* (Imlay, 1960, table 2 on p. 172; Busnardo, LeHegarat, and Magné, 1966, table 6 on p. 27). Among these genera, the first two listed are not known below the Valanginian, *Thurmanniceras* is uncommon below the Valanginian, and *Polyptychites* is not known above the Valanginian. Furthermore, an age not older than middle Valanginian is suggested by the presence of a coarsely ribbed species of *Olcostephanus* similar to *O. atherstoni* Baumberger (non Sharpe). The *Buchia keyserlingi* zone in the Colyear Springs quadrangle cannot represent the latest Valanginian because it is overlain by beds characterized by *Buchia crassicollis* (Keyserling) subspecies *solida* (Lahusen) of late Valanginian age.

In summation, the stratigraphic and faunal evidence concerning the age of the *Buchia keyserlingi* beds in northwestern California shows that those beds are of late middle to early late Valanginian age.

In western British Columbia a distinct zone dominated by *Buchia keyserlingi* has not been recognized. Failure to recognize the zone may be related to a lack of exposures on the west coast of Vancouver Island (Jeletzky, 1965, p. 44, 49) and to the presence of volcanic rocks in the Harrison Lake area between the zones of *B. pacifica* and *B. crassicollis* (Jeletzky, 1965, p. 49, fig. 4 on p. 65). Nonetheless, an association of *B. pacifica* with *B. crassicollis* in the basal beds of the *B. crassicollis* zone in western Canada (Jeletzky, 1965, p. 49, 51) suggests that a distinct zone of *B. keyserlingi* is truly absent and that *Buchia pacifica* is overlain directly by *B. crassicollis.*

VALANGINIAN AMMONITES FROM THE BUCHIA CRASSICOLLIS SOLIDA ZONE

The age of the *Buchia crassicollis solida* zone is latest Valanginian because it contains the highest Buchias found in the Pacific Coast region, because its characteristic *Buchia* species is common in Eurasia in the upper part of the Valanginian (Jeletzky, 1965, p. 54), because it directly underlies beds containing early Hauterivian ammonites on the South Umpqua River near Days Creek, Oregon (Imlay and others, 1959, p. 2775; Imlay, 1960, p. 175), and because at the same locality near Days Creek it is associated with the ammonites *Olcostephanus* and *Homolsomites.*

Of these ammonites, *Olcostephanus* is represented by *O. pecki* Imlay (1960, p. 202, 203, pl. 29, figs. 1–5, 7–9, pl. 30, fig. 7), a species which closely resembles *O. jeannoti* (d'Orbigny) (1841, p. 188, pl. 56, figs. 3–5) from the latest Valanginian and early Hauterivian of France. *Homolsomites* is represented by the species *H. quatsinoensis* (Whiteaves) (formerly referred to *H. stantoni* McLellan by Imlay, 1960, p. 201, pl. 27), which is similar to *H. bojarkensis* Shulgina (1965, p. 84, pl. 1–4, pl. 5, fig. 2) from northern Siberia. This latter species is considered to be of early Hauterivian age by the Russian paleontologists because it overlies beds containing *Dichotomites* Shulgina (1965, p. 83), which in their stratigraphic scheme is defined as marking the uppermost Valanginian (Sachs and others, 1963, table 8). Nonetheless, the association of *H. bojarkensis* Shulgina with *Buchia crassicollis* (Keyserling) and *B. sublaevis* (Keyserling, but not with any ammonites of definite Hauterivian age (Sachs and others, 1963, tables 7, 8), suggests that the early Hauterivian age of *Homolsomites* in Siberia is not well established.

The characteristic ammonites of the *Buchia crassicollis solida* zone in Oregon have not been found in northern California but are associated with *B. crassicollis solida* in northwestern Washington (Imlay, 1960, p. 175, pl. 27, figs. 1–13; Jeletzky, 1965, p. 54, pl. 20, figs. 2, 5–7, pl. 21, figs. 4, 9, 10) and in western British Columbia (Jeletzky, 1965, p. 52, pl. 20, figs. 3, 4, 13–15, pl. 21, fig. 11). In these areas north of California *Homolsomites quatsinoensis* (Whiteaves) has been found only in the lower part of the *Buchia crassicollis solida* zone (Imlay and others, 1959, fig. 2 on p. 2775; Jeletzky, 1965, p. 52).

Buchia crassicollis solida (Lahusen) has been found in California only in the Colyear Springs quadrangle north of the Elder Creek fault. In southwestern Oregon the species is widespread from the Riddle area westward to the coast. On the South Umpqua River near its junction with Days Creek, east of Riddle, the subspecies ranges through 330 feet of beds comprising units 2–4 of the published section (Imlay and others, 1959, p. 2775, 2782) of the Days Creek Formation. Its lowest occurrence in this section is only 65 feet above the highest occurrence of *Buchia uncitoides* (Pavlow). Unless a disconformity is present, that 65 feet must correspond to the *B. pacifica* and *B. keyserlingi* beds of northwestern California.

Beds characterized by *Buchia crassicollis solida* (Lahusen) have been found in western British Columbia in the Quatsino Sound area of Vancouver Island and in the Harrison Lake area (Jeletzky, 1965, p. 47). At Quatsino Sound such beds rest unconformably on Middle Jurassic intrusive igneous rocks. At Harrison Lake they are underlain by volcanic rocks that in turn are underlain by beds containing *Buchia pacifica* Jeletzky (1965, fig. 4 on p. 65).

COMPARISONS OF AMMONITES WITH OTHER AMMONITE FAUNULES

The ammonite faunule of latest Jurassic (Tithonian) age in California and Oregon is dominated by genera that are characteristic of the Mediterranean (Tethyan) region and of South America as far south as Argentina but that are unknown in the Arctic region. Such genera include *Kossmatia*, *Parodontoceras*, *Substeueroceras*, *Proniceras*, *Groebericeras?*, *and Spiticeras*. All of them are represented by species that closely resemble or are possibly identical with species in Mexico or in Argentina. None of them are known north of Oregon with the possible exception on Vancouver Island of one small crushed berriasellid ammonite that shows a little resemblance to immature forms of *Substeueroceras* (Jeletzky, 1965, p. 18, pl. 2, fig. 5). None are related even on the family level to ammonites of latest Jurassic age in northern Canada (Jeletzky, 1966, p. 3–23, 43).

The Tithonian of California is represented also by several specimens of *Blanfordiceras* in association with small Buchias that probably belong to *B. piochii* (Gabb). These were obtained at a spot very near beds characterized by *B.* aff. *B. okensis* (Pavlow) and should be of late Tithonian age. This occurrence is interesting paleogeographically because the genus hitherto has been found definitely only in India, Pakistan, Indonesia, and Madagascar in beds of Tithonian or probable Tithonian age and questionably in Argentina in beds of Berriasian age. The presence of *Blanfordiceras* in California, therefore, is far north of all other known occurrences.

Other ammonite genera present in the highest Jurassic beds in California and Oregon include *Phylloceras* and *Lytoceras*. These were once considered to be characteristic of the Mediterranean region because they are common in Jurassic beds of that region, become uncommon northward in central Europe, and are uncommon in the Arctic region of Eurasia (Ortmann, 1896, p. 265; Haug, 1907, p. 119; Spath, 1932, p. 151, 152). Both genera are now known, however, to be fairly common in Jurassic beds bordering the Pacific Ocean (Fleming, 1960, p. 267; Sato, 1962, p. 58; Imlay, 1953b, p. 59, 60; 1955, p. 78), and hence their presence in California and Oregon does not signify that they are of southerly origin. Rather, their absence in the Jurassic of the western interior of the United States (Imlay, 1953a, p. 12), their scarcity in central Europe, and their abundance in lands bordering the Mediterranean Sea and the Pacific Ocean favors the suggestion made by Spath (1932, p. 151, 152) that they were pelagic organisms and were not adapted to live in the shallow epicontinental seas.

All the ammonites of Berriasian age in California and Oregon belong to genera and subgenera of distinct Mediterranean affinities. These include *Spiticeras*, *S.* (*Negreliceras*), *S.* (*Kilianiceras?*), *Neocosmoceras*, and *Protacanthodiscus*. All species of these genera are similar to species in the Mediterranean region including Mexico. Some are also similar to species from Vancouver Island in western British Columbia (Jeletzky, 1965, p. 33, pl. 11, figs. 2–4, 6, 7, pl. 12, figs. 5, 6), but none are similar even generically to ammonites in the Arctic region of Canada (Jeletzky, 1964b, pls. 1–4) and northern Eurasia (Sachs and others, 1963, tables 7, 8). Comparisons with northern Alaska cannot be made because Berriasian ammonites have not yet been found there, except for one specimen of *Phylloceras* (Imlay, 1961, p. 55, pl. 12) whose age is determined by its association with *Buchia okensis* (Pavlow). Likewise, comparisons with southern and southwestern Alaska cannot be made because of the lack of ammonites, although the presence of *Buchia uncitoides* (Pavlow) indicates that the Berriasian is represented there.

The ammonites of Valanginian age in California and Oregon, as discussed previously (Imlay, 1960, p. 181, 182), bear strong affinities with those of the Mediterranean (Tethyan) region and some affinities also with ammonites of central and northern Eurasia. Genera characteristic of the Mediterranean region include *Crioceratites*, *Olcostephanus*, *Thurmanniceras*, *Neocomites*, *Sarasinella*, *Kilianella*, and *Acanthodiscus*. Genera characteristic of the Arctic region include *Homolsomites* and *Tollia* (Shulgina, 1965; Jeletzky, 1964b, table 1; 1965, fig. 2 opposite page 2; Sachs and others, 1963, tables 7, 8). Ammonites that range from the Mediterranean to the Arctic include *Bochianites*, *Polyptychites*, and *Neocraspedites;* of these, the last two genera listed are reported most commonly from central and northern Eurasia. Also, present in the Valanginian of the Pacific Coast are a few representatives of *Phylloceras* and *Lytoceras*, which, as previously discussed, are not necessarily of Mediterranean origin. It is evident, therefore, that the Valanginian ammonite fauna in California and Oregon contains an association of genera derived from both southerly and northerly directions but that the genera of Mediterranean affinities predominate.

In summation, in California and Oregon the ammonite genera of Tithonian and Berriasian ages are entirely of southern or Mediterranean origin except for *Phylloceras* and *Lytoceras;* the ammonites of Valanginian age are mostly of southern origin, but include two genera that are characteristic of the Arctic region and several genera that could have come from the Arctic region, the Mediterranean region, or areas in between.

These facts are significant from ecological and correlative viewpoints because the ammonites are associated with the pelecypod *Buchia*, which numerically is much more common than the ammonites and clearly is of northern derivation (Jeletzky, 1965, p. 57; Imlay, 1965, p. 1034). Furthermore, *Buchia* in California and Ore-

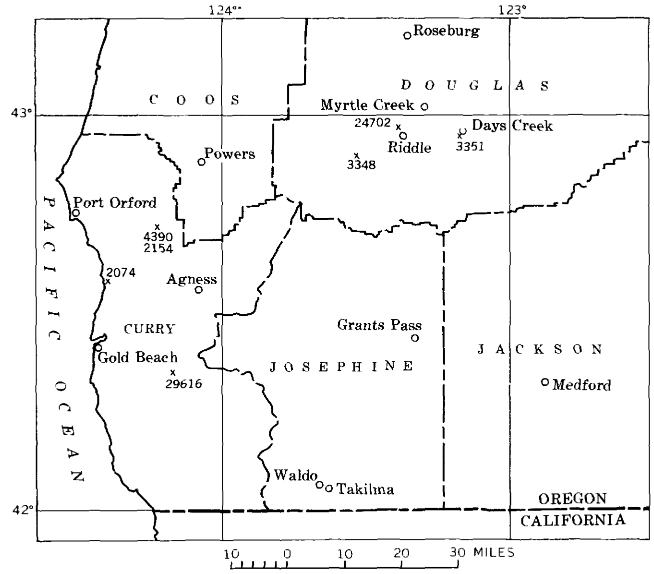

FIGURE 3.—Index map of ammonite localities in the *Buchia* beds of southwestern Oregon. Numbers on map show positions of fossil localities given in table 2 and in locality descriptions.

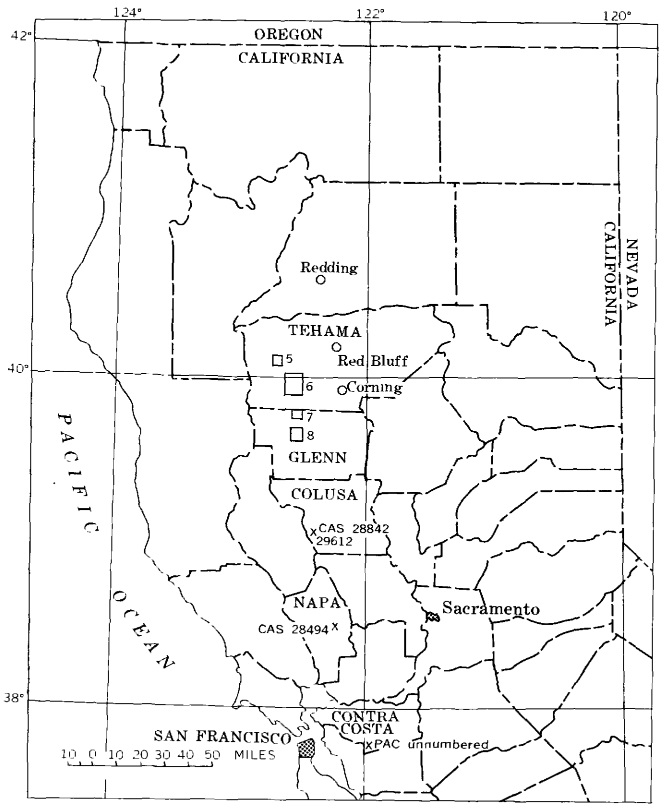

FIGURE 4.—Index map of ammonite localities in the *Buchia* beds of northwestern California. Rectangles numbered 5–8 show areas covered by figures 5–8, which are detailed index maps of ammonite localities.

gon is represented by a succession of intergrading species that is nearly identical with a succession in western British Columbia (Jeletzky, 1965, p. 17–55) and contains some species in common with successions of *Buchia* in Alaska, northern Canada, Greenland, and northern Eurasia. Evidently the latest Jurassic and earliest Cretaceous succession of ammonites and *Buchia* in California and Oregon will be useful in correlating the diverse molluscan assemblages of those ages in the Arctic and Mediterranean regions.

GEOGRAPHIC DISTRIBUTION

The occurrences of the Tithonian, Berriasian, and Valanginian ammonites from California and Oregon described herein are shown by State and locality in table 2 and in figures 3–8. Detailed descriptions of the individual localities are given in the following table. Abbreviations used include UC for the University of California Museum of Paleontology at Berkeley, CAS for the California Academy of Sciences, USNM for U.S. National Museum, and USGS Mesozoic loc. for U.S. Geological Survey Mesozoic locality.

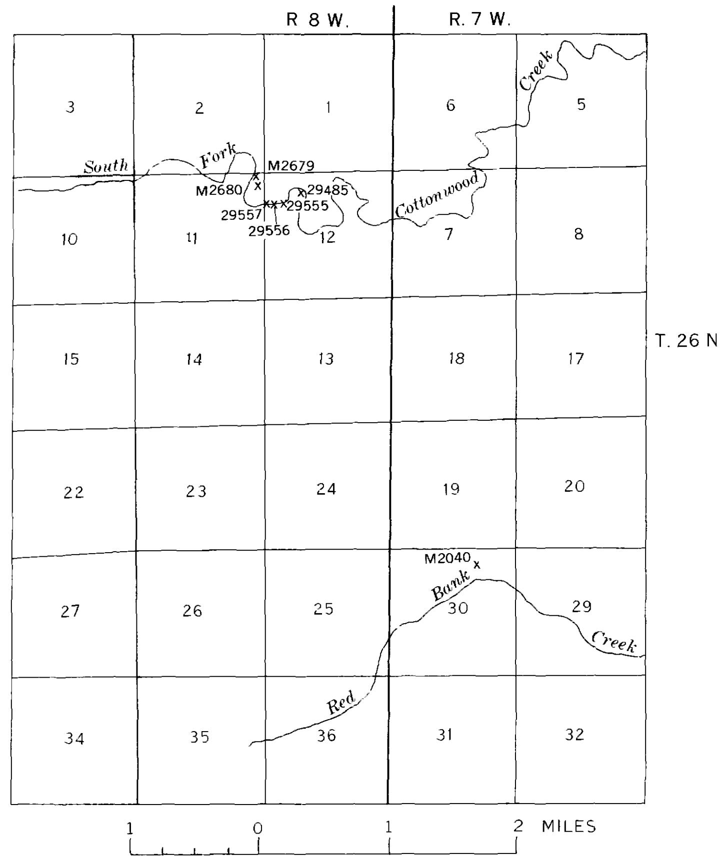

FIGURE 5.—Detailed index map of ammonite localities in west-central part of the Colyear Springs quadrangle, California. Numbers on map show positions of fossil localities given in table 2 and in locality descriptions.

TABLE 2.—*Geographic distribution of ammonites in the uppermost Jurassic (Tithonian)*

	Oregon							California																											
	Douglas County			Curry County				Tehama County																											
	3351	24702	3348	4390	2154	2074	29616	M2679	M2680	29557	29556	29555	29485	M2040	666	M2025	UC-B-5091	UC-B-5092	UC-B-5093	UC-B-5094	M2024	29558	29489	M3082	M3083	M3084	1009	1087	CAS unnumbered	M3092	1088	UC-2605	1003	1084	29591
Phylloceras knoxvillense Stanton	X																					X											X	X	
cf. *P. knoxvillense* Stanton																			X																
glennense Anderson																																			
?contrarium Imlay and Jones, n. sp.																							X												
Lytoceras saturnale Anderson																												X							
colusaense (Anderson)																																			
cf. *L. colusaense* (Anderson)																			X																
sp.																		X																	
Crioceratites sp.																											X								
Bochianites paskentaensis Anderson																																			
?glennensis Anderson																																			
Kossmatia dilleri (Stanton)															X																				
tehamaensis Anderson																																			
kleinsorgensis Anderson																													X						
Proniceras sp. juv.						X																													
maupinense Imlay and Jones, n. sp.																																			X
Spiticeras (*Spiticeras*) cf. *S.* (*S.*) *cautleyi* (Oppel)			X																																
cf. *S.* (*S.*) *serpentinum* Burckhardt																																			
cf. *S.* (*S.*) *uhligi* Burckhardt																														X					
cf. *S.* (*S.*) *obliquenodosum* Retowski																																			
sp.																	X						X												
n. sp. undet.																																			
(*Kilianiceras*?) sp. juv.		X	X																																
(*Negreliceras*) *stonyense* Imlay and Jones, n. sp.			X													X																			
Groebericeras? *baileyi* Imlay and Jones, n. sp.																					X														
Tollia mutabilis (Stanton)				X	X																														
cf. *T. mutabilis* (Stanton)																																			
Olcostephanus cf. *O. atherstoni* Baumberger (non Sharpe)									X		X	X	X																						
Polyptychites trichotomus (Stanton)							X																					X							
sp.												X																							
Neocraspedites giganteus Imlay																											X	X							
Blanfordiceras californicum Imlay and Jones, n. sp.																																			
sp. undet.																																			
Substeueroceras stantoni Anderson																																			
cf. *S. kellumi* Imlay																																			
Protacanthodiscus taffi (Anderson)																																			
Parodontoceras storrsi (Stanton)																																	X	X	
cf. *P. storrsi* (Stanton)																							X												
reedi (Anderson)																				X															
Aulacosphinctes? *diabloensis* Anderson																																			
?jenkinsi Anderson																																			
?sp. juv.																																	X		
Paskentites paskentaensis Imlay and Jones, n. sp.																																			
cf. *P. paskentaensis* Imlay and Jones, n. sp.																																			
Thurmanniceras stippi (Anderson)																										X									
cf. *T. stippi* (Anderson)																								X											
jenkinsi (Anderson)					X																				X						X				
cf. *T. jenkinsi* (Anderson)														X																					
californicum (Stanton)																																			
Neocomites cf. *N. wichmanni* Leanza								X	X																										
cf. *N. neocomiensis* (d'Orbigny)									X																										
cf. *N. neocomiensis* var. *premolica* (Sayn)									X																										
sp.										X			X																						
Kilianella crassiplicata (Stanton)																																			
Sarasinella cf. *S. subspinosa* Uhlig																																			
angulata (Stanton)																																			
cf. *S. uhligi* Spath																																X			
sp.																																			
Neocosmoceras euchrense Imlay and Jones, n. sp.						X																													
?crossi (Anderson)																																			

and Lower Cretaceous Buchia *beds of northwestern California and southwestern Oregon*

California—Continued																																																					
Tehama County—Continued																																			Glenn County															Colusa County		Napa County	Contra Costa County
29592	1085	M3096	5339	CAS unnumbered	29595	1091	2266	M1579	M1577	M1578	29594	29588	29589	29597	29596	1010	M3061	1093	M3060	M3059	M3058	29593	29598	29487	UC-A-2921	UC-B-5085	M4066	CAS 28667	29505	UC-A-2925	1001 (=1095)	CAS 144	CAS 33502	M1580	29493	M4053	UC-B-5120	CAS 28037	M1574	M2253	M3030	M1575	M2605	M2599	CAS near 28037	M2604A	M2598	M703	2286	29612	CAS 28842	CAS 28494	Philadelphia Academy Sciences unnumbered
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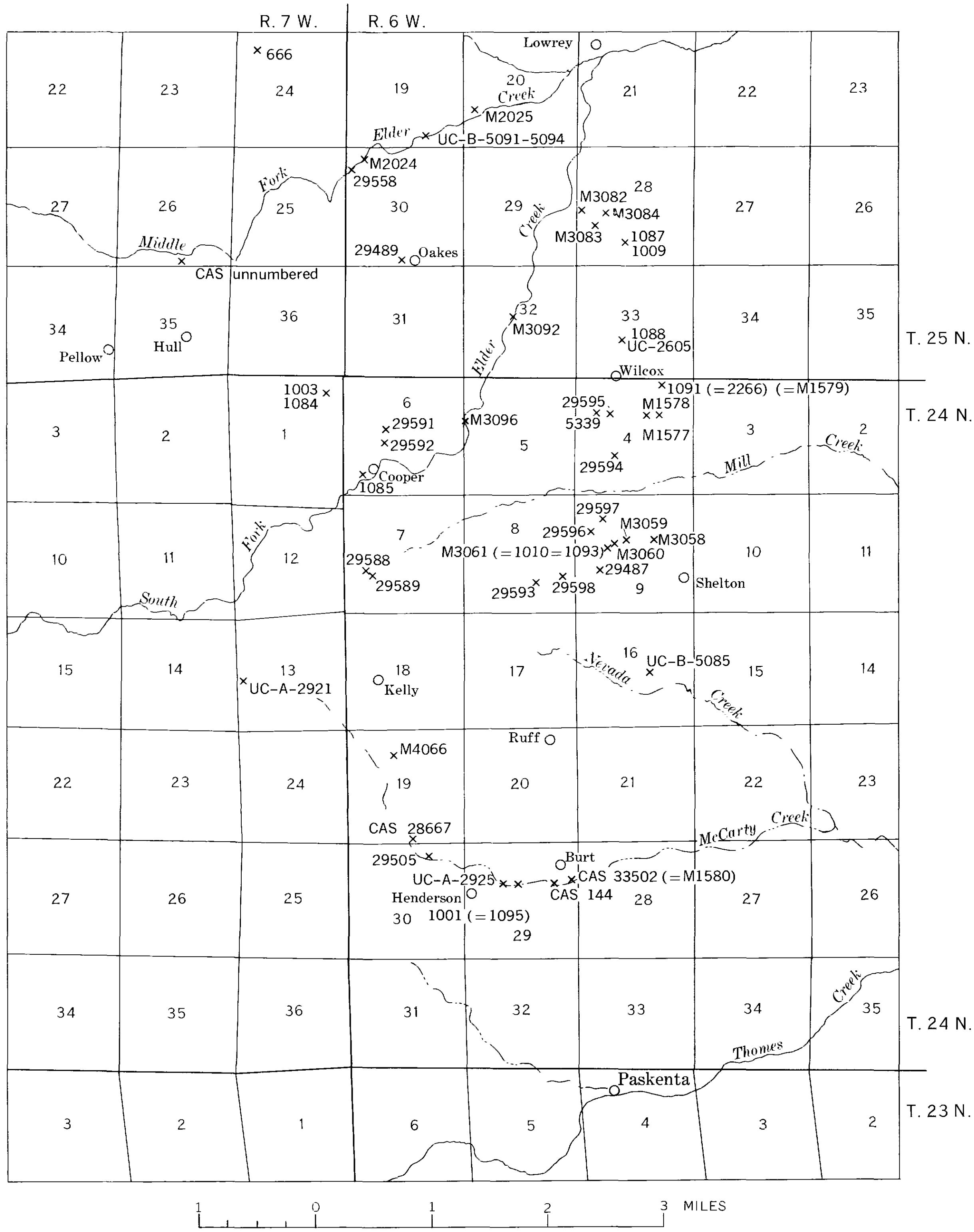

Figure 6.—Detailed index map of ammonite localities in the Paskenta area, California. Numbers on map show positions of fossil localities given in table 2 and in locality descriptions.

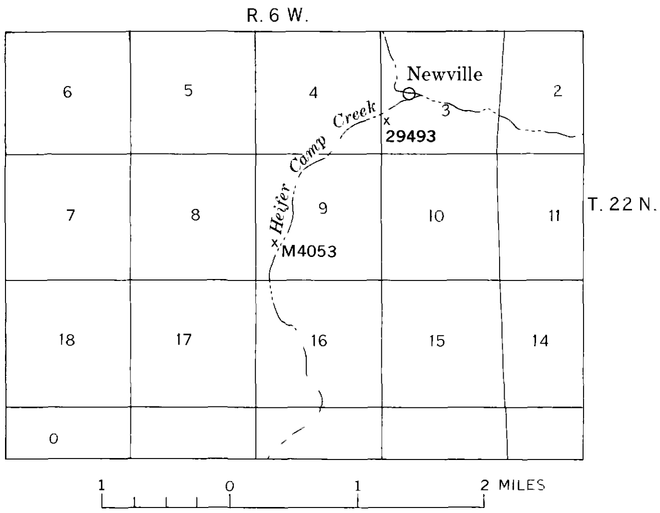

Figure 7.—Detailed index map of ammonite localities near Newville, Calif. Numbers on map show positions of fossil localities given in table 2 and in locality descriptions.

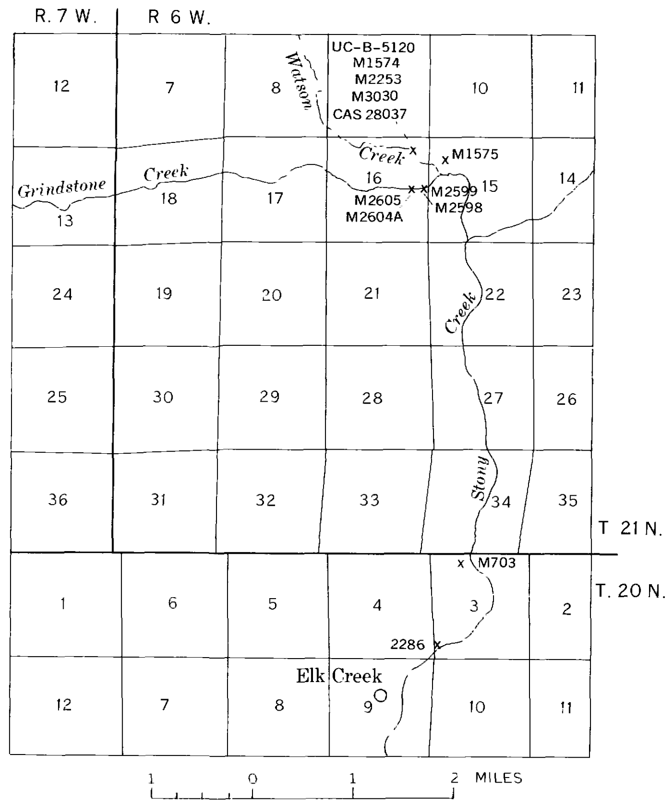

Figure 8.—Detailed index map of ammonite localities in the Elk Creek area, California. Numbers on map show positions of fossil localities given in table 2 and in locality descriptions.

Special attention is called to the fact that the descriptions of CAS locs. 28037 and 29694 as recorded by F. M. Anderson prior to 1945 are not in line with data shown on the more recently published topographic sheets of the Elk Creek and Paskenta quadrangles. The localities, when plotted on these quadrangles with reference to ranch houses, bridges, or natural features as described by Anderson, are in different sections, or different parts of sections, from those described by Anderson. These differences apparently mean that Anderson did not have adequate base maps. Such a lack is shown especially on a map of the Paskenta area published by him in 1933 (Anderson, 1932, fig. 2 on p. 314) in which the positions of the ranch house are related to the drainage pattern as shown on the 1952 Paskenta quadrangle, but are not so related to section lines. Accordingly, the locality descriptions published herein (unnumbered table) include revisions as well as the original descriptions.

Descriptions of some Upper Jurassic and Lower Cretaceous fossil localities in northwestern California and southwestern Oregon

USGS Mesozoic locs.	Collector's field Nos.	Localities of other institutions	Collector, year of collection, description of locality, stratigraphic assignment, and age
3351	6761		Diller, J. S., and Storrs, James, 1905. On South Umpqua River ½ mile above mouth of Days Creek, Douglas County, Oreg. Tithonian. *Buchia uncitoides* zone.
24702			Rice, Claude, 1898?. From Wilson Creek near Riddle, Oreg. Valanginian.
3348	6738		Diller, J. S., and Storrs, James, 1905. Mouth of Iron Mountain Creek on Cow Creek, 1 mile north of Nichols station, Douglas County, Oreg. Berriasian.
4390	S-9		Storrs, James, 1907. ⅓ mile below forks of Elk River, Curry County, Oreg. Valanginian.
2154	5446		Diller, J. S., 1900. Elk River between the forks and the mouth of Blackberry Creek, SE¼ sec. 14, NW¼ sec. 23, NE¼ sec. 22, T. 33 S., R. 13 W., Agness 15-min quad., Curry County, Oreg. Valanginian.
2074	6015		Diller, J. S., and Storrs, James, 1899. On beach north of mouth of Euchre Creek, sec. 5, T. 35 S., R. 14 W., Port Orford quad., Curry County, Oreg. Tithonian? and Berriasian. *Buchia uncitoides* and *B. piochii* zones.
29616			Aalto, Kenneth, 1967. From northeast bank of Southeast flowing tributary of Windy Creek, 1 mile N. 94° E. of Snow Camp Lookout, T. 37 S., R. 12 E., Collier Butte 15-min quad., Curry County, Oreg. Valanginian.

Descriptions of some Upper Jurassic and Lower Cretaceous fossil localities in northwestern California and southwestern Oregon—Continued

USGS Mesozoic locs.	Collector's field Nos.	Localities of other institutions	Collector, year of collection, description of locality, stratigraphic assignment, and age
M2679	64–JCS–32		Jones, D. L., 1964. East slope of a small knoll on west bank of South Fork of Cottonwood Creek at boundary line between secs. 2 and 11, 500 ft west of SE. cor. sec. 2, T. 26 N., R. 8 W., Colyear Springs 15-min quad., Tehama County, Calif.
M2680	64–JCS–33		Jones, D. L., 1964. East bank of Cottonwood Creek, 300 ft west and 650 ft south of NE. cor. sec. 11, T. 26 N., R. 8 W., Colyear Springs 15-min quad., Tehama County, Calif.
29557	67–JCS–4		Jones, D. L., 1967. North side of South Fork of Cottonwood Creek directly north of junction with Quail Creek and 800 ft west of and 100–200 ft stratigraphically below Mesozoic loc. 29556. Valanginian.
29556	67–JCS–3		Jones, D. L., 1967. North side of South Fork of Cottonwood Creek about 400 ft due west of Mesozoic loc. 29555. Valanginian.
29555	67–JCS–2		Jones, D. L., 1967. North side of South Fork of Cottonwood Creek at southwestend of hairpin loop, 1,000 ft east and 1,350 ft south of NW. cor. sec. 12, T. 26 N., R. 8 W., Colyear Springs 15-min quad., Tehama County, Calif. Valanginian. Probably *Buchia keyserlingi* zone.
29485	66–JIJ–5		Jones, D. L., and Imlay, R. W., 1966. South side of South Fork of Cottonwood Creek at north end of hairpin loop, 1,350 ft east and 670 ft south of NW. cor. sec. 12, T. 26 N., R. 8 W., Colyear Springs quad., Tehama County, Calif. Valanginian.
M2040	265		Bailey, E. H., 1963. On Sunflower Trail on north bank of Red Bank Creek, 1,200 ft west and 600 ft south of NE. cor. sec. 20, T. 26 N., R. 7 W., Colyear Springs 15-min quad., Tehama County, Calif. Valanginian.
666	2463		Diller, J. S., 1889. On ridge about 3 miles directly west of the Lowrey Ranch house. Probably in the north-central part of sec. 24, T. 25 N., R. 7 W., Tehama County, Calif. Tithonian. Probably from 6,000–7,000 ft below top of *Buchia piochii* zone.
M2025	246		Bailey, E. H., 1963. Recollected by Imlay, R. W., 1965. North side of Middle Fork of Elder Creek at spillway from a pond, 1,052 ft east and 1,900 ft north of SW. cor. sec. 20, T. 25 N., R. 6 W., Colyear Springs 15-min quad., Tehama County, Calif. Berriasian. About 2,000 ft above base of *Buchia uncitoides* zone.
		UC–B–5091	Young, Gerald C., 1957. Middle Fork of Elder Creek, on south side, 10 ft east of junction with small tributary from south, about 570 ft stratigraphically below a massive sandstone, SE¼NE¼ SW¼SE¼ sec. 19, T. 25 N., R. 6 W., Colyear Springs 15-min quad., Tehama County, Calif. Late Tithonian.
		UC–B–5092	Young, G. C., 1957. Middle Fork of Elder Creek, 40 ft east of junction with small tributary from south, 550 ft below base of massive sandstone, SE¼NE¼ SW¼SE¼ sec. 19, T. 25 N., R. 6 W., Colyear Springs 15-min quad., Tehama Calif. Late Tithonian. *Buchia* aff. *B. okensis* (Pavlow) zone.
		UC–B–5093	Young, G. C., 1957. Middle Fork of Elder Creek, about 105 ft downstream from junction with small tributary from south, 80 ft stratigraphically above UC–B–5091, and 490 ft stratigraphically below a massive sandstone, SE¼ NE¼ SW¼SE¼ sec. 19, T. 25 N., R. 6 W., Colyear Springs 15-min quad., Tehama County, Calif. Late Tithonian.
		UC–B–5094	Young, G. C., 1957. About 205 ft downstream from point where tributary enters the Middle Fork of Elder Creek from south, 105 ft stratigraphically above UC–B–5093 SE¼NE¼ SW¼SE¼ sec. 19, T. 25 N., R. 6 W., Colyear Springs 15-min quad., Tehama County, Calif. Late Tithonian. From upper few hundred feet of Jurassic sequence.
M2024	244		Bailey, E. H., 1963. South side of Middle Fork of Elder Creek, 1,000 ft east and 450 ft south of NW. cor. sec. 30, T. 25 N., R. 6 W., Colyear Springs 15-min quad., Tehama County, Calif. Tithonian. About 2,100 ft below top of *Buchia piochii* zone.
29558	67–JCS–8		Jones, D. L., 1967. Middle Fork of Elder Creek, 450 ft E. and 300 ft south of NW. cor. sec. 30, T. 25 N., R. 6 W., Paskenta 15-min quad., Tehama County, Calif. Tithonian. About 2,300 ft below top of *Buchia piochii* zone.
29489	66–JIJ–9		Jones, D. L., and Imlay, R. W., 1966. From thin interbeds of graywacke and mudstone containing limestone concretions exposed in creek bed 300 ft southwest of Oakes Ranch house (abandoned), 2,500 ft west of SE. cor. and just north of south line of sec. 30, T. 25 N., R. 6 W., Paskenta 15-min quad., Tehama County, Calif. Late Tithonian. *Buchia* aff. *B. okensis* (Pavlow) zone.
M3082	65–JCS–30		Jones, D. L., 1965. South side of road from Paskenta to Red Bluff, 800 ft southeast of BM 870 near South Fork of Elder Creek, 400 ft east and 2,000 ft south of NW. cor. sec. 28, T. 25 N., R. 6 W., Paskenta 15-min quad., Tehama County, Calif. Valanginian. *Buchia keyserlingi* zone.
M3083	65–JCS–31		Jones, D. L., 1965. On south side of road to Red Bluff, 1,100 ft east and 1,750 ft north of SW. cor. sec. 28, T. 25 N., R. 6 W. Paskenta 15-min quad., Tehama County, Calif. Valanginian. *Buchia keyserlingi* zone.
M3084	65–JCS–32		Jones, D. L., 1965. On top of small knoll 600 ft north of road and 800 ft northeast of Mesozoic loc. M3083, 1,700 ft east and 2,150 ft south of NW. cor. sec. 28, T. 25 N., R. 6 W., Paskenta 15-min quad., Tehama County, Calif. Valanginian. *Buchia keyserlingi* zone.

Descriptions of some Upper Jurassic and Lower Cretaceous fossil localities in northwestern California and southwestern Oregon—Continued

USGS Mesozoic locs.	Collector's field Nos.	Localities of other institutions	Collector, year of collection, description of locality, stratigraphic assignment, and age
1009(=1087)	15		Diller, J. S. and Storrs, James, 1893. About halfway between the Lowrey and Wilcox ranch houses, on hill about 500 ft east of road in south-central part of sec. 28, T. 27 N., R. 6 W., Paskenta 15-min quad., Tehama County, Calif. Valanginian. *Buchia keyserlingi* zone.
		CAS unnumbered.	Anderson, F. M., and Rist, R. L., 1937(?). Middle Fork of Elder Creek about 1 mile east of the Kleinsorg chromite mine and 1 mile south of the Soledad ranch house, sec. 26, T. 25 N., R. 7 W., Paskenta 15-min quad., Tehama County, Calif. Tithonian.
M3092	65–JCS–40		Jones, D. L., 1965. South Fork of Elder Creek, 2,400 ft east and 2,500 ft south of NW. cor. sec. 32, T. 25 N., R. 6 W., Paskenta 15-min quad., Tehama County, Calif. Berriasian. Near base of upper third of *Buchia uncitoides* zone which is about 5,500 ft thick.
1088	91		Diller, J. S., Stanton, T. W., and Storrs, James, 1893. About ½ mile east of road and ¾ mile north of the Wilcox Ranch house, north-central part of sec 33, T. 25 N., R. 6 W., Tehama County, Calif. Valanginian. Near base of *Buchia keyserlingi* zone.
		UC–2605	P______, F. L., year unknown. About 2¼ miles south of Lowrey's house, ½ mile north of Wilcox's house, and 800 ft east of road. Probably about same place as USGS Mesozoic loc. 1088, Tehama County, Calif. Valanginian.
1003			Same as loc. 1084.
1084	86		Storrs, James, and Stanton, T.W., 1893. From sandstone 1 mile northwest of Cooper's Ranch house. Probably in NE¼ sec. 1, T. 24 N., R. 7 W., Paskenta 15-min quad., Tehama County, Calif. Same as loc. 1003. Tithonian. Probably 2,000–3,000 feet below the top of the *Buchia piochii* zone.
29591	I67–10–23B		Imlay, R. W. and Ross, Wm. O., 1967. About ⅓ mile north-northeast of Ray Borellos ranch house (formerly Cooper's), about 150 ft east of road, and 200 ft stratigraphically below conglomerate on east side of valley. South-central part of SE¼NW¼ sec. 6, T. 24 N., R. 6 W., Paskenta 15-min quad., Tehama County, Calif. Late Tithonian. Probably near middle of *Buchia* aff. *B. okensis* zone.
29592	I67–10–23C		Imlay, R. W., 1967. About ¼ mile south of loc. 29591 at same stratigraphic position, north-central part NE¼SW¼ sec. 6, T. 24 N., R. 6 W., Paskenta 15-min quad., Tehama County, Calif. Late Tithonian.
1085	87		Storrs, James, and Stanton, T. W., 1893. Near South Fork of Elder Creek just west of Cooper's house in NE. cor. SW¼SW¼ sec. 6, T. 24 N., R. 6 W., Paskenta 15-min quad., Tehama County, Calif. Late Tithonian. Near top of *Buchia piochii* zone.
M3096	65–JCS–41		Jones, D. L., 1965. East bank of South Fork of Elder Creek, 300 ft east and 2,000 ft south of NW. cor. sec. 5, T. 24 N., R. 6 W., Paskenta 15-min quad., Tehama County, Calif. Berriasian. A little below middle of *Buchia uncitoides* zone which is about 5,500 ft thick.
5339	24		Storrs, James, 1908. ⅓ mile west of Wilcox ranch house in NW¼ sec. 4, T. 24 N., R. 6 W., Tehama County, Calif. Valanginian. Near middle of *Buchia pacifica* zone.
		CAS unnumbered.	Anderson, F. M., about 1930. About 5 miles north of Paskenta and ½ mile south of the Wilcox (now Schuchart) ranch house near center of NW¼ sec. 4, T. 24 N., R. 6 W., Paskenta 15-min quad., Tehama County, Calif. Probably same place as Mesozoic loc. 29595. Valanginian. At top of *Buchia pacifica* zone.
29595	I67–10–17B		Imlay, R. W. and Ross, Wm. O., 1967. Near top of hill on south slope, 1,700 ft east and 1,750 ft south of NW cor. sec. 4, T. 24 N., R. 6 W., Paskenta 15-min quad., Tehama County, Calif. Valanginian. At top of *Buchia pacifica* zone.
1091	94		Stanton, T. W., Diller, J. S., and Storrs, James, 1893. About ½ mile east of Wilcox Ranch house in NE¼NW¼NE¼ sec. 4, T. 24 N., R. 6 W., Tehama County, Calif. Same as locs. 2266 and M1579. Valanginian. About 1,550 ft above base of *Buchia keyserlingi* zone.
2266	536		Stanton, T. W., 1900. Same as loc. 1091.
M1579	62–P–4		Jones, D. L., and Imlay, R. W., 1962. North of north tributary to Mill Creek, 1,200 ft west and 500 ft south of NE. cor. sec. 4, T. 24 N., R. 6 W., Paskenta 15-min quad., Tehama County, Calif. Same as USGS Mesozoic loc. 1091 and 2266. Valanginian. About 1,550 ft above base of *Buchia keyserlingi* zone.
M1577	62–P–2		Jones, D. L., and Imlay, R. W., 1962. Near north tributary to Mill Creek, 1,600 ft west and 1,900 ft south of NE. cor. sec. 4, T. 24 N., R. 6 W., Paskenta 15-min quad., Tehama County, Calif. Valanginian. About 1,250 ft above base of *Buchia keyserlingi* zone.
M1578	62–P–3		Jones, D. L., and Imlay, R. W., 1962. Near north tributary to Mill Creek, 1,800 ft west and 1,900 ft south of NE. cor. sec. 4, T. 24 N., R. 6 W., Paskenta 15-min quad., Tehama County, Calif. Valanginian. About 1,075 ft above base of *Buchia keyserlingi* zone.
29594	I–67–10–17A		Ross, W. O., and Imlay, R. W., 1967. Near top of hill on south slope 1,800 ft east and 1,700 ft north of SW. cor. sec. 4, T. 24 N., R. 6 W., Paskenta 15-min quad., Tehama County, Calif. Valanginian. At top of *Buchia pacific* zone.

Descriptions of some Upper Jurassic and Lower Cretaceous fossil localities in northwestern California and southwestern Oregon—Continued

USGS Mesozoic locs.	Collector's field Nos.	Localities of other institutions	Collector, year of collection, description of locality, stratigraphic assignment, and age
29588	I67-10-13A		Imlay, R. W., 1967. Maupin Flat, east-central part NW¼SW¼ sec. 7, T. 24 N., R. 6 W., Paskenta 15-min quad., Tehama County, Calif. Late Tithonian. Near base of zone of *Buchia* aff. *B. okensis*.
29589	I67-10-13B		Ross, W. O., 1967. Maupin Flat, a little southeast and about 150 ft higher stratigraphically than loc. 29588. SE¼NW¼SW¼ sec. 7, T. 24 N., R. 6 W., Paskenta 15-min quad., Tehama County, Calif. Late Tithonian. *Buchia* aff. *B. okensis* zone.
29597	I67-10-20C		Imlay, R. W., 1967. On west slope of hill about 200 ft east of dry gulch that drains north into Mill Creek, 1,250 ft east and 1,050 ft south of NW. cor. sec. 9, T. 24 N., R. 6 W., Paskenta 15-min quad., Tehama County, Calif. Valanginian. About 200 ft below top of *Buchia pacifica* zone.
29596	I67-10-20A		Ross, W. O., 1967. About 750 ft east and 1,650 ft south of NW. cor. sec. 9, T. 24 N., R. 6 W., Paskenta 15-min quad., Tehama County, Calif. Valanginian. Near base of upper third of *Buchia pacifica* zone.
1010	16 and 17		Diller, J. S., and Storrs, James, 1893. About ½ mile northwest of Shelton's Ranch houses in NW¼ sec. 9, T. 24 N., R. 6 W., Tehama County, Calif. Valanginian.
M3061	65-I-4		Imlay, R. W., 1965. Top of knoll at elevation of 1,157 ft, about ½ mile south of Mill Creek, 1,500 ft east and 2,400 ft south of NW. cor. sec. 9, T. 24 N., R. 6 W., Paskenta 15-min quad., Tehama County, Calif. Valanginian. At top of *Buchia pacifica* zone. Same as USGS Mesozoic locs. 1010 and 1093.
1093	Sta 96		Diller, J. S. and Storrs, James, 1893. About ½ mile northwest of Shelton's ranch house in NW¼ sec. 9, T. 24 N., R. 6 W., Tehama County, Calif. Valanginian. Same spot as Mesozoic loc. 1010 and M3061.
M3060	65-I-3		Imlay, R. W., 1965. Just south of crest of ridge about ½ mile south of Mill Creek and at base of northeast end of a prominent knoll, 1,750 ft east and 2,000 ft south of NW. cor. sec. 9, T. 24 N., R. 6 W., Paskenta 15-min quad., Tehama County, Calif. Valanginian. In lower 200 ft of *Buchia keyserlingi* zone.
M3059	65-I-2		Imlay, R. W., 1965. On hill ½ mile south of Mill Creek, 2,200 ft east and 2,000 ft south of NW. cor. sec. 9, T. 24 N., R. 6 W., Paskenta 15-min quad., Tehama County, Calif. Valanginian. About 450 ft above base of *Buchia keyserlingi* zone.
M3058	65-I-1		Imlay, R. W., 1965. On hill ½ mile south of Mill Creek, 1,900 ft west and 2,000 ft south of NE. cor. sec. 9, T. 24 N., R. 6 W., Paskenta 15-min quad., Tehama County, Calif. Valanginian. About 1,530 ft above base of *Buchia keyserlingi* zone.
29593	I67-10-16B		Ross, W. O. and Imlay, R. W., 1967. In gully 400 ft north and 1,400 ft west of SE. cor. sec. 8, T. 24 N., R. 6 W., Paskenta 15-min quad., Tehama County, Calif. Valanginian. In lower 150 ft of the *Buchia pacifica* zone.
29598	I67-10-20D		Ross, W. O., 1967. About 500 ft west and 1,700 ft north of SE. cor. sec. 8, T. 24 N., R. 6 W., Paskenta 15-min quad., Tehama County, Calif. Valanginian. About top of lower third of *Buchia pacifica* zone.
29487	66-JIJ-7		Jones, D. L., 1966. About ¾ mile south of Mill Creek and ¼ mile south of loc. M3061, 1,150 ft east and 2,000 ft north of SW. cor. sec. 9, T. 24 N., R. 6 W., Paskenta 15-min quad., Tehama County, Calif. Valanginian. Top of *Buchia pacifica* zone.
		UC-A-2921	Rist, R. L., 1937. In west-central part of sec. 13, T. 24 N., R. 7 W., 950 ft west of road to Pellow's Place just over saddle in first ridge, Paskenta 15-min quad., Tehama County, Calif. Tithonian. About 4,000 ft, above fault contact of Jurassic *Buchia*-bearing beds with Franciscan rocks and about 5,000 ft below top of *B. piochii* zone.
		UC-B-5085	Young, Gerald C., 1957. In tributary to Nevada Creek, NW¼NE¼NW¼SE¼ sec. 16, T. 24 N., R. 6 W., Paskenta 15-min quad., Tehama County, Calif. Valanginian. About 2,450 ft stratigraphically above base of *Buchia keyserlingi* beds.
M4066	66-JBP-15		Jones, D. L. and Bailey, E. H., 1966., 500 ft west of road to Maupin Flat, 2,500 ft east and 1,700 ft south of NW. cor. sec. 19, T. 24 N., R. 6 W., Paskenta 15-min quad., Tehama County, Calif. Berriasian. About 1,300 ft above base of *Buchia uncitoides* zone which is about 5,500 ft thick.
		CAS 28667	Taff, J. A. and Cross, C. M., 1936. From McCarty Creek, south side of SE¼ sec. 19, T. 24 N., R. 6 W., Mount Diablo meridian, Tehama County, Calif. Berriasian?
29505	PL1599		Warren, John, 1965. On McCarty Creek, 1,600 ft west and 550 ft south of NE. cor. sec. 30, T. 24 N., R. 6 W., Paskenta 15-min quad., Tehama County, Calif. Berriasian. About base of upper third of *Buchia uncitoides* zone and about 2,000 ft below base of *B. pacifica* zone.
		UC-A-2925	Rist, R. L., 1937. McCarty Creek, 625 ft west of wooden bridge between Burt's and Henderson's ranch houses, NW¼ sec. 29, T. 24 N., R. 6 W., Paskenta, 15-min quad., Tehama County, Calif. Valanginian. About 500 ft above base of *Buchia pacifica* zone.

Descriptions of some Upper Jurassic and Lower Cretaceous fossil localities in northwestern California and southwestern Oregon—Continued

USGS Mesozoic locs.	Collector's field Nos.	Localities of other institutions	Collector, year of collection, description of locality, stratigraphic assignment, and age
1001	6 and 7		Diller, J. S., and Storrs, James, 1893. ½ mile east of Henderson's house on upper road leading from Paskenta to Lowrey's Ranch. NW¼ sec. 29, T. 24 N., R. 6 W., Tehama County, Calif. Valanginian. Middle of *Buchia pacifica* zone.
1095	98		Diller, J. S. and Storrs, James, 1893. Same as loc. 1001.
		CAS 144	Collector unknown. From south bank of McCarty Creek opposite Burt's Ranch house in NE¼ sec. 29, T. 24 N., R. 6 W., Tehama County, Calif. Valanginian. *Buchia keyserlingi* zone.
		CAS 33502	Anderson, F. M., about 1930. 1,200 ft southeast of Burt's Ranch House in McCarty Creek in NE¼ sec. 29, T. 24 N., R. 6 W., Tehama County, Calif. Valanginian. *Buchia keyserlingi* zone.
M1580	62–P–5		Jones, D. L. and Imlay, R. W., 1962. McCarty Creek, 300 ft west and 1,800 ft south of NE. cor. sec. 29, T. 24 N., R. 6 W., Paskenta 15-min quad., Tehama County, Calif. Valanginian. About 1,000 ft above base of *Buchia keyserlingi* zone.
29493	66–JIJ–13		Jones, D. L. and Imlay, R. W., 1966. From unnamed eastern tributary of Heifer Camp Creek, ¼ mile above junction with the North Fork of Stony Creek, 250 ft east and 1,400 ft north of SW. cor. sec. 3, T. 22 N., R. 6 W., Paskenta 15-min quad., Glenn County, Calif. Tithonian. Within 1,000 ft of the top of the *Buchia piochii* zone.
M4053	66–JBP–4a		Jones, D. L. and Bailey, E. H., 1966. On Heifer Camp Creek, 850 ft east and 1,150 ft north of SW. cor. sec. 9, T. 22 N., R. 6 W., Paskenta 15-min quad., Glenn County, Calif. Tithonian. About 5,000 ft below top of *Buchia piochii* zone.
		UC–B–5120	Dondanville, Richard F., 1957. Watson Creek, 320 ft east of bridge on road from Elk Creek to Chrome and 430 ft north of a small cemetery, NW¼SE¼NE¼NE¼ sec. 16, T. 21 N., R. 6 W., Elk Creek 15-min quad., Glenn County, Calif. Late Tithonian.
		CAS 28037	Anderson, F. M. and Jenkins, H. O. 1934. Also, Anderson, F. M., Taff, J. A., and Cross, C. M., 1936. Recorded in Calif. Acad. Sci. locality book as 6½ miles north of Winslow bridge in SE¼SW¼ sec. 10, T. 21 N., R. 6 W., Mount Diablo meridian, western Glenn County, Calif. The fossils were obtained, however, mostly from 400 ft of beds exposed on and near Watson Creek east of bridge on road from Elk Creek to Newville (Anderson, 1945, p. 942). This locality in the Elk Creek quadrangle (1957 ed.) is in the NE¼NE¼ sec. 16, T. 21 N., R. 6 W., or about ½ mile west-southwest of the location given in the record book. Late Tithonian. Upper 400–500 ft of Jurassic beds.
M1574	62–EC–1		Jones, D. L., and Imlay, R. W., 1962. On Watson Creek 550 ft west and 800 ft south of NE. cor. sec. 16, T. 21 N., R. 6 W., Elk Creek 15-min quad., Glenn County, Calif. Late Tithonian. About same stratigraphic position as M2253 and UC–B–5120.
M2253			Jones, D. L., 1964. On Watson Creek northeast of road, 500 ft northwest of cemetery, 600 ft west and 700 ft south of NE. cor. sec. 16, T. 21 N., R. 6 W., Elk Creek 15-min quad., Glenn County, Calif. Late Tithonian. *Buchia* aff. *B. okensis* zone.
M3030	65–W–7		Jones, D. L., 1965. On Watson Creek 293 ft southeast of bridge which is 1,100 ft west and 800 ft south of NE. cor. sec. 16, T. 21 N., R. 6 W., Elk Creek 15-min quad., Glenn County, Calif. Late Tithonian. *Buchia* aff. *B. okensis* zone.
M1575	62–EC–2		Jones, D. L., and Imlay, R. W., 1962. Just north of junction of Watson Creek and Grindstone Creek, 900 ft east and 1,400 ft south of NW. cor. sec. 15, T. 21 N., R. 6 W., Elk Creek 15-min quad., Glenn County, Calif. Valanginian.
M2605	Grindstone 64–12.		Jones, D. L., 1964. On south bank of Grindstone Creek, 775 ft west of east line of sec. 16, T. 21 N., R. 6 W., Elk Creek 15-min quad., Glenn County, Calif. Tithonian. Within a few feet of top of *Buchia piochii* zone just below zone of *B.* aff. *B. okensis*.
M2599	Grindstone 64–6.		Jones, D. L., 1964. On south bank of Grindstone Creek, 450 ft west of east line of sec. 16, T. 21 N., R. 6 W., Elk Creek 15-min quad., Glenn County, Calif. Late Tithonian. About base of upper third of *Buchia* aff. *B. okensis* zone which is 450 ft thick.
		CAS near 28037.	Anderson, F. M., year unknown. From 1,200 ft west of iron bridge across Grindstone Creek. Probably near line of secs. 15 and 16, T. 21 N., R. 6 W., Elk Creek 15-min quad., Glenn County, Calif. Tithonian or Berriasian.
M2604A	Grindstone 64–11A.		Jones, D. L., 1964. On south bank of Grindstone Creek, 560 ft west of east line of sec. 16, T. 21 N., R. 6 W., Elk Creek 15-min quad., Glenn County, Calif. Late Tithonian. A little below middle of *Buchia* aff. *B. okensis* zone.
M2598	Grindstone 64–5		Jones, D. L., 1964. On south bank of Grindstone Creek, 300 ft west of east line of sec. 16, T. 21 N., R. 6 W., Elk Creek 15-min quad., Glenn County, Calif. Berriasian. Within a few feet of base of *Buchia uncitoides* zone.
M703			Chuber, Stewart, 1957 or 1958. 2,050 ft east and 500 ft south of NW. cor. sec. 3, T. 20 N., R. 6 W., Elk Creek 15-min quad., Glenn County, Calif. Valanginian. *Buchia pacifica* zone.

Descriptions of some Upper Jurassic and Lower Cretaceous fossil localities in northwestern California and southwestern Oregon—Continued

USGS Mesozoic locs.	Collector's field Nos.	Localities of other institutions	Collector, year of collection, description of locality, stratigraphic assignment, and age
2286	554		Stanton, T. W., 1900. On east bank of Stony Creek about ½ mile northeast of town of Elk Creek in SW. cor. sec. 3, T. 20 N., R. 6 W., Glenn County, Calif. Berriasian. From 425 ft of greenish-gray sandstone. *Buchia uncitoides* zone.
29612	RWS-65-23		Rich, E. I., 1965. From sandstone bed in Bear Creek near culvert across road, 1½ miles north of turnoff to Wilbur Springs, 100 ft west and 2,400 ft south of NE. cor. sec. 16, T. 14 N., R. 5 W., Wilbur Springs 15-min quad., Colusa County, Calif. Valanginian.
		CAS 28842	Taff, J. A. and Cross, C. M., 1937. Limestone ledges in gully 50–100 ft east of Bear Creek road, 1 mile north of Wilbur Springs bridge and 1⅓ miles above mouth of Sulphur Creek, SW. cor. sec. 15, T. 14 N., R. 5 W., Mount Diablo meridian, Colusa County, Calif. Tithonian?
		CAS 28494	Griffith, Mr., 1935. From an oil prospect tunnel near highway in bluff on east side of Capell Creek, near center of east half of sec. 29, T. 8 N., R. 3 W., Mount Diablo meridian, Napa County, Calif. Tithonian.
		Philadelphia Academy Sciences unnumbered.	Gabb, W. M., 1860? Bagley Creek near Mount Diablo, Contra Costa County, Calif.

SYSTEMATIC DESCRIPTIONS

Family PHYLLOCERATIDAE Zittel, 1884
Genus PHYLLOCERAS Suess, 1865

Phylloceras knoxvillense Stanton

Plate 2, figures 4–11

Phylloceras knoxvillense Stanton, 1896, U.S. Geol. Survey Bull. 133, p. 72, pl. 14, figs. 1–3 (not fig. 4). [Imprint 1895.]
Phylloceras knoxvillense Stanton. Anderson, 1945, Geol. Soc. America Bull., v. 56, p. 976, pl. 11, fig. 5.
Phylloceras capellense Anderson, 1945, idem, p. 977, pl. 4, fig. 8.

This species is characterized by having very fine, closely spaced, gently flexuous ribs that are extremely fine and dense near the umbilicus but coarsen a little ventrally and on the venter are slightly wider than the interspaces. The shell also bears faint radial folds that become stronger adorally. The internal mold bears pronounced constrictions at diameters as much as 70 millimeters.

The holotype is entirely septate and has a diphyllic first lateral saddle and a triphyllic second lateral saddle (Stanton, 1895, pl. 14, fig. 3). At a maximum diameter of 112 mm, its whorl height is 66 mm and its whorl thickness is 34 mm. Associated fragments indicate that the species attained a much larger size and developed fairly strong radial folds.

The assignment of this species to *Phylloceras* rather than *Calliphylloceras* is based on the presence of radial folds and a triphyllic second lateral saddle.

Types.—Holotype, USNM 23083; hypotype, USNM 158803; hypotype, CAS 8716 and 8735.

Occurrences.—In California at USGS Mesozoic locs. 1084 (equals 1003), 29558, and 29589 and CAS locs. 28037 and 28494. In Oregon the species is represented at Mesozoic loc. 3351. The holotype and the specimen from Oregon are associated with *Buchia piochii* (Gabb). The holotype was obtained, along with the holotype of *Parodontoceras storrsi* (Stanton), several thousand feet below the top of the range of *B. piochii.* The plesiotype figured by Anderson (1945, pl. 11, fig. 5) was obtained at CAS loc. 28037 near the top of Jurassic and probably above the range of *B. piochii.*

Phylloceras glennense Anderson

Plate 1, figures 9, 10

Phylloceras glennense Anderson, 1945, Geol. Soc. America Bull., v. 56, p. 976, pl. 11, figs. 1, 2.

This species, judging by the holotype, differs from *P. knoxvillense* Stanton by having a stouter whorl section and by its ribs being coarser, sparser, more flexuous, and grouped in more prominent radial folds. It differs also, according to Anderson (1945, p. 976), by a lack of constrictions. This reported difference is questioned, however, because constrictions in *Phylloceras* are confined to the internal mold, which is not known on *P. glennense* Anderson.

P. glennense Anderson shows some resemblance to *P. appeninicum* Canavari in Burckhardt (1906, p. 106, pl. 28) from beds of early Tithonian age in Mexico but lacks strong folds on the lower parts of its flanks.

Type.—Holotype, CAS 8720.

Occurrence.—In California at CAS loc. 28037.

Phylloceras? contrarium Imlay and Jones, n. sp.

Plate 1, figures 1–8

This species is represented by five small septate specimens and by one large fragment of which less than half is septate. Some shell material is preserved on all the specimens.

The shell is highly involute and compressed. The small specimens are elliptical in section, much higher than wide, and attain their greatest thickness a little below and middle of the flanks. The large specimen is subtrapezoidal in section and attains its greatest thickness at about the top of the lower fourth of the flanks. The flanks slope gently to the umbilicus and to the venter, which is narrowly arched. The body chamber is possibly partly represented by the adoral part of the largest specimen.

The small specimens bear very fine ribs that are faint near the umbilicus and that are slightly stronger ventrally. They trend almost radially near the umbilicus, curve strongly forward on the lower third of the flanks, recurve backward gradually on the middle third of the flanks, and then curve backward more strongly on the upper third of the flanks and on the venter. The ribs on the venter are distinctly arched backward or adapically. In addition, the flanks, near their middle, bear faint widely separated forwardly arched folds that either fade out high on the flanks or pass into some of the ribs on the venter. Constrictions are not present.

The largest specimen bears broad, faint, rather closely spaced flexuous ribs that likewise arch adapically on the venter. In addition, some broad, low, widely separated folds are present on the middle of the flanks. The rib arrangement, therefore, is the same as on the small specimens.

The specimen shown on plate 1, figures 1–3, at a diameter of 51 mm has a whorl height of 34 mm and a whorl thickness of 19 mm.

The suture line, as exposed on one immature specimen, has tetraphyllic first and second lateral saddles.

This species is difficult to place generically. The absence of constrictions shows that it belongs in the subfamily Phylloceratinae rather than in the Calliphylloceratinae. The presence of folds on the flanks favors an assignment to *Phylloceras*, but the presence of tetraphyllic saddles is against such an assignment. The adapically arched ribs on the venter is not characteristic of any genus of the Phylloceratinae but is possibly only a specific characteristic.

Types.—Holotype, USNM 158804; paratypes, USNM 158805–158807.

Occurrences.—In California at USGS Mesozoic locs. M2605, M4053, 29489, and 29493. The species is associated with *Buchia piochii* (Gabb) at all localities except 29489, where it is associated with a Jurassic variant of *B. okensis* (Pavlow).

Family LYTOCERATIDAE Neymayr, 1875
Genus LYTOCERAS Suess, 1865

Lytoceras colusaense (Anderson)

Plate 2, figures 1–3

Aulacosphinctes? colusaensis Anderson, 1945, Geol. Soc. America Bull., v. 45, p. 980, pl. 13, figs. 1, 2.

?*Lytoceras* aff. *L. liebigi* (Oppel). Anderson, 1945, idem, p. 977, pl. 14, fig. 1.

?*Lytoceras* aff. *L. exoticum* Oppel. Anderson, 1945, idem, p. 977, pl. 14, fig. 2.

The genus *Lytoceras* is represented by a few septate fragments from the highest Jurassic beds exposed on the west side of the Sacramento Valley. One of the fragments, named *Aulacosphinctes? colusaensis* Anderson (1945, p. 980, pl. 13, figs. 1, 2), is assigned to *Lytoceras* because of the presence of radially trending crinkled growth lines that are characteristic of the genus. Other fragments include *Lytoceras* aff. *L. liebigi* Oppel of Anderson (1945, p. 977, pl. 14, fig. 1) and *L.* aff. *L. exoticum* Oppel of Anderson (1945, p. 977, pl. 14, fig. 2). Of these, the last named consists of two small whorls that bear very fine and dense growth lines. *L.* aff. *L. liebigi* Oppel consists of one medium-sized septate whorl whose adoral end bears widely spaced fine lines as on *L. colusaense* (Anderson) and whose adapical end bears fine, dense lines, as on *L.* cf. *L. exoticum* Oppel. These resemblances suggest that only a single species is represented by the three specimens described by Anderson. Nonetheless, the fragmentary condition of the three specimens precludes a definite specific diagnosis, or even comparisons with such early Cretaceous (Neocomian) species as *Lytoceras aulaeum* Anderson (1938, p. 146, pl. 14, figs. 1–4; Stanton, 1895, pl. 13, fig. 11; Imlay, 1960, p. 195) and *L. saturnale* Anderson (1945, p. 145, pl. 13, fig. 1; Imlay, 1960, p. 195).

Type.—Holotype, CAS 10446.

Occurrences.—*L. colusaense* (Anderson) is from CAS loc. 28842. *L. aff. L. liebigi* Oppel and *L.* aff. *L. exoticum* are from CAS loc. 28037. Other fragments of *Lytoceras* have been found near the top of the Jurassic sequence at USGS Mesozoic locs. M1574, M2253, and M2604A, which are at or near CAS loc. 28037 and at UC loc. B–5092. *L. colusaense* (Anderson) is probably represented at USGS Mesozoic loc. 29588 and UC loc. B–5093 near the top of the Jurassic.

Family BOCHIANITIDAE Spath, 1922
Genus BOCHIANITES Lory, 1898

Bochianites? glennensis Anderson

Plate 1, figures 11, 12

Bochianites sp. Hanna and Hertlein, 1941, California Div. Mines Bull. 118, p. 168, fig. 22 on p. 169.

Bochianites glennensis Anderson, 1945, Geol. Soc. America Bull., v. 56, p. 984, pl. 7, fig. 2.

This species as based on the holotype has a nearly straight shaft, an ovate cross section, and weak to moderately strong annular ribs that become slightly stronger ventrally, incline forward on the flanks, and cross the venter transversely without reduction in strength.

In lateral view this species appears to be a typical representative of *Bochianites*, but the ribbing on its venter differs markedly by being transverse instead of projecting strongly forward. It differs from *Protancyloceras* in the same manner but also is much straighter and lacks a ventral furrow. In regard to ventral ribbing it resembles *Hamulina*? *rosariensis* Imlay (1942, p. 1457, pl. 9, figs. 1–11, pl. 12, fig. 1), the type species of *Vinalesphinctes* (Thieuloy, 1966, p. 287, fig. 2 on p. 288) from middle Tithonian beds in Cuba. It differs from that species, however, by being much larger and by having finer, less regular, and more strongly inclined ribbing.

One possibility concerning the generic status of *B.*? *glennensis* Anderson is that it actually was collected from a different locality than reported and represents some Cretaceous ptychoceratid such as *Anahamulina* of middle Hauterivian to Barremian age. Such a possibility is favored by the presence of a weak constriction that is most pronounced on the venter. The species differs from *A. wilcoxi* Imlay (1960, p. 200, pl. 25, figs. 2, 56) from Hauterivian beds in California by having coarser ribbing and an elliptical instead of a circular whorl section. Comparable coarsely ribbed species of *Anahamulina* have been described by Uhlig (1883, pl. 13, figs. 2–7) from Barremian beds in the Carpathian Mountains. Evidently the generic identification of *B.*? *glennensis* Anderson must await the discovery of additional specimens that show the development of the species and whose stratigraphic position is certain.

Type.—Holotype, CAS 5959.

Occurrence.—In California at CAS loc. 28037.

Bochianites paskentaensis Anderson

Plate 1, figures 13–15

Bochianites paskentaensis Anderson, 1938, Geol. Soc. America Spec. Paper 16, p. 167, pl. 29, fig. 10.

The species has a straight shaft, an ovate cross section that is slightly higher than wide, faint annular ribs that become slightly stronger ventrally, and very widely spaced constrictions that are bordered by low broad swellings. Both ribs and constrictions cross the dorsum transversely, incline forward on the flanks, and arch forward on the venter. The suture line appears to be identical with that on the genotype species (Arkell and others, 1957, p. L206).

Types.—Holotype, CAS 8790; hypotypes, USNM 161184 and 161185.

Occurrences.—In California at USGS Mesozoic locs. M3061 and 29595 at top of beds containing *Buchia pacifica* Jeletzky. The holotype (CAS unnumbered locality) was obtained one-half mile south of the Wilcox Ranch house at about the same place as Mesozoic loc. 29595.

Family PERISPHINCTIDAE Steinmann, 1890
Genus KOSSMATIA Uhlig, 1907

Kossmatia dilleri (Stanton)

Plate 3, figures 5–7

Hoplites dilleri Stanton, 1896, U.S. Geol. Survey Bull. 133, p. 82, pl. 18, figs. 6, 7. [Imprint 1895.]

Kossmatia dilleri (Stanton). Burckhardt, 1912, Inst. Geol. Mexico Bd. 29, p. 32.

Kossmatia dilleri (Stanton). Imlay, 1943, Jour. Paleontology, v. 17, p. 537.

The species is represented only by the holotype, which is a small septate internal mold that retains some shelly material and consists of four immature whorls.

The shell is compressed and discoidal. The outermost whorl embraces about one-third of the preceding whorl. The whorls are rounded in section, are broader than high at the adapical end of the outer whorl but become higher than broad adorally. During growth the flanks likewise change from highly convex to gently convex, and the venter changes from broadly rounded to moderately rounded. The umbilicus is moderately wide. The umbilical wall is vertical at its base and rounds evenly into the flanks. The body chamber is unknown.

The ornamentation consists of sharp, moderately spaced primary ribs and slightly less sharp, rather closely spaced secondary ribs. The primary ribs begin low on the umbilical wall, incline slightly forward on the flanks, and pass into two or three secondary ribs between the middle and the upper third of the flanks. Wherever a primary rib passes into three secondary ribs, two of the secondary ribs arise a little higher than the other. The furcation points are elevated but are not tuberculate. The secondary ribs project strongly forward on the upper parts of the flanks and on the venter and have a chevronlike arrangement along the midline of the venter. This arrangement is interrupted by a midventral groove on the internal mold, but the ribs persist across the venter wherever shelly material is preserved.

The holotype at a diameter of 31 mm has a whorl height of 12 mm, a whorl thickness of 11 mm, and an umbilical width of 11 mm.

Comparisons of the described species of *Kossmatia* from California with those from elsewhere in the world are difficult to make because the descriptions of the California species are based on small immature specimens whereas the descriptions of most species are based on large adult specimens. Nonetheless, *K. dilleri* (Stanton) shows considerable resemblance in its rib pattern to the specimens of *K.* aff. *K. victoris* (Burckhardt) (1906, p. 132, 133, pl. 36, figs. 7–9) from the Mazapil area, Mexico. It differs mainly by having somewhat finer and denser ribbing. In that respect, it shows more resemblance to the holotype of *K. victoris* (Burckhardt) (1906, p. 131, pl. 36, figs. 1–6).

Type.—Holotype, USNM 21573.

Occurrence.—In California at USGS Mesozoic loc. 666, which is recorded as about 3 miles directly west of Lowrey's Ranch house and is shown on a 1890 edition of the Red Bluff quadrangle as 3⅓ miles slightly south of west of Lowrey's house. This location is definitely south of the easterly trending fault zone near the North Fork of Elder Creek and is in the middle third of the Jurassic *Buchia*-bearing beds which appear to be about 3 miles thick. It seems probable that the occurrence of *Kossmatia* at Mesozoic loc. 666 is a little higher stratigraphically than the other specimens of *Kossmatia* described by Anderson (1945, p. 981, 982) and reillustrated herein, although it occurs on or near the same sandstone ridge as those species.

Kossmatia tehamaensis Anderson

Plate 3, figures 1, 2

Kossmatia tehamaensis Anderson. Hanna and Hertlein, 1941, California Div. Mines Bull. 118, p. 168, figs. 12 and 16 on p. 169. (Name not valid because of lack of description.)

Kossmatia tehamaensis Anderson, 1945, Geol. Soc. America Bull., v. 56, p. 981, pl. 2, figs. 1a–c.

This species is represented only by the holotype, which is a small septate internal mold consisting of 3½ whorls.

The shell is discoidal and compressed. The outermost preserved whorl is subquadrate in section, wider than high, and embraces about one-third of the preceding whorl. The flanks on the inner whorls are gently convex and on the outermost whorl are nearly flat. The venter on the outermost whorl is fairly narrow and nearly flat. The umbilicus is moderately wide. The umbilical wall is vertical at its base, rounds evenly into the flanks on the inner whorls and rather abruptly on the outer whorl. The body chamber is unknown.

The inner whorls exposed in the umbilicus bear fine forwardly inclined primary ribs, some of which bifurcate below the line of involution. The outermost septate whorl bears fairly sharp primary ribs that begin on the umbilical wall and incline gently forward on the lower part of the flanks. Most of these primary ribs bifurcate below or near the middle of the flanks, but some remain simple. The furcation points are not elevated. The secondary ribs are slightly weaker than the primary ribs. All ribs on the upper third of the flanks project strongly forward and form a broad chevronlike pattern on the venter. A smooth groove is present along the midline of the venter on the internal mold. One pronounced constriction is present near the adoral end of the outer whorl. This constriction is bordered adorally by fairly fine and dense ribbing.

The holotype at a diameter of about 48 mm has a whorl height of about 18 mm, a whorl thickness of 13 mm, and an umbilical width of 17 mm.

This species differs from *K. dilleri* (Stanton) by its ribs branching mostly below instead of above the middle of the flanks, by the furcation points not being elevated, by its secondary ribs arising mostly in twos instead of twos and threes, and by the presence of more simple ribs. It was compared by Anderson (1945, p. 981) with *K.* aff. *K. victoris* (Burckhardt) (1906, pl. 36, figs. 10–12, 15), but its ribs branch much lower on the flanks.

Type.—Holotype, UC 5956.

Occurrence.—In California at UC loc. A–2921. The holotype is reported to have been obtained about 4,575 feet above the base of the Jurassic *Buchia*-bearing beds (Anderson, 1945, p. 1001) and at about the same stratigraphic position as *K. kleinsorgensis* Anderson (1945, p. 982).

Kossmatia kleinsorgensis Anderson

Plate 3, figures 3, 4

Kossmatia kleinsorgensis Anderson, 1945, Geol. Soc. America Bull., v. 56, p. 982, pl. 2, fig. 3.

This species, based on one small fragment, differs from *K. dilleri* (Stanton) and *K. tehamaensis* Anderson by having much higher, sharper, and more widely spaced ribs at a comparable size and by the presence of a linguiform sinus along the midline of the venter. Some of the primary ribs remain simple, but most of them divide into two secondary ribs a little below the middle of the flanks. The furcation points are elevated but are not tuberculate.

This species greatly resembles some small immature specimens of *K. pectinata* Burckhardt (1912, p. 134, pl. 34, figs. 4, 6, 8, 9) from northern Mexico, but its ribs project forward much more strongly on the venter.

Type.—Holotype, CAS 8711.

Occurrence.—In California from about 1 mile east of the Kleinsorg chromite mine near the Middle Fork of Elder Creek and about 4,000 feet above the lower contact of the Jurassic *Buchia*-bearing beds (Anderson, 1945, p. 982, 1001). This location should be in, or near, the SE¼ sec. 26, T. 25 N., R. 7 W., Paskenta quadrangle.

Family OLCOSTEPHANIDAE Haug, 1910
Genus PRONICERAS Burckhardt, 1919

Proniceras sp. juv.

Plate 3, figures 9, 10

One small internal mold, consisting of parts of four whorls, bears ribbing similar to that on immature specimens of *Proniceras* from Mexico figured by Burckhardt (1921, pl. 16, figs. 5, 7, 13, 15) and to that on immature specimens of *P. jacobi* (Djanélidzé (1922, p. 59, pl. 1, figs. 5a, b, 6a, b, 9) from southern Europe.

The coiling is fairly evolute. The whorls are stout, wider than high, depressed ovate, and are thickest below the middle of the flanks. The flanks are gently convex and curve evenly into a moderately rounded venter. The umbilical wall is vertical at the base, is fairly high, and rounds rather abruptly into the flanks.

The primary ribs are high and strong. They trend radially on the umbilical wall, incline forward slightly on the flanks, and then divide near, or a little below the middle of the flanks into pairs of slightly weaker secondary ribs. A few primary ribs remain simple. The secondary ribs incline forward on the flanks and form forwardly arched chevrons on the venter. The ribs on the internal mold are partially interrupted by a smooth band along the midline of the venter, and most of them are offset with respect to ribs on the opposite side of the midline. The interspaces on the internal molds are a little wider than the ribs. Each of the outer whorls bears a pronounced forwardly inclined constriction. Tubercles are not present.

This specimen is assigned to *Proniceras* rather than *Spiticeras* because of the idoceratoid character of its ribbing and the complete lack of tubercles or swellings.

Figured specimen.—USNM 158808.

Occurrence.—In Oregon at USGS Mesozoic loc. 2074 in association with *Neocosmoceras euchrense* Imlay, and Jones, n. sp., *Buchia uncitoides* (Pavlow), and some specimens of *B. piochii* (Gabb). These were obtained along a beach and may have been obtained from more than one bed.

Proniceras maupinense Imlay and Jones, n. sp.

Plate 3, figures 8, 11–16

This species is represented by five internal molds and one external mold. Some of these bear shelly material.

The shell is fairly evolute and moderately compressed. Its whorls are subovate in section, a little wider than high, become wider during growth, are thickest a little below the middle of the flanks, and overlap from ¼ to ⅓ of the preceding whorl. The flanks are gently convex and become more convex during growth. The venter is moderately to broadly arched. The umbilicus is fairly wide and shallow. The umbilical wall is fairly low, vertical at its base, and rounds evenly into the flanks. The body chamber occupies nearly a complete whorl but is incomplete.

The inner whorls exposed in the umbilicus bear sharp, fairly high moderately spaced forwardly inclined primary ribs and several deep constrictions per whorl. The outermost septate whorl similarly bears sharp primary ribs that extend to the middle of the flanks. From each of them arise two or three much weaker secondary ribs that incline forward on the upper parts of the flanks, arch strongly forward on the venter, and are slightly weakened along the midventral line. A few secondary ribs arise freely on the upper third of the flanks, which bear about three secondary ribs for each primary rib.

Adorally on the largest preserved whorls the primary ribs become higher and more widely spaced, but vary somewhat in height and spacing from one specimen to another. These ribs pass just below midflank into three or four much weaker secondary ribs that arch forward on the venter. Adjacent bundles of secondary ribs are generally separated by single ribs that arise freely on the upper third of the flanks. All whorls bear several pronounced forwardly inclined constrictions.

The smaller specimen illustrated at a diameter of 23 mm has a whorl height of 8 mm, a whorl thickness of 9 mm, and an umbilical width of 9 mm. The other specimens illustrated have been slightly compressed and cannot be measured accurately.

The suture line has a large and long ventral lobe, a much smaller and shorter trifid first lateral lobe, a very short trifid second lateral lobe, and two auxiliary lobes of which the first is largest and is inclined obliquely to the other lobes. The suspensive lobe descends rather steeply to the umbilicus. The first lateral saddle is fairly large and is irregularly bifid.

This species is characterized by having moderate to fairly strong but nontuberculate primary ribs and numerous, rather fine secondary ribs. It shows some resemblance in side view to *Proniceras* aff. *P. aguilerae* Burckhardt (1919, p. 46; 1921, pl. 15, fig. 13) from the latest Jurassic of Mexico but has a stouter whorl section and finer and denser secondary ribs. It also resembles *Proniceras gracile* Djanélidzé (1922, p. 76, pl. 2, figs. 6, 7a, b) from the latest Jurassic of France in ribbing but appears to be less evolute and much stouter.

Types.—Holotype, USNM 161186; paratypes, USNM 161187–161189.

Occurrences.—In California at USGS Mesozoic locs. 29589, 29591, and 29592 in association with *Buchia* aff. *B. okensis* (Pavlow).

Genus SPITICERAS Uhlig, 1903

Spiticeras (Spiticeras) cf. S. (S.) cautleyi (Oppel)

Plate 3, figures 23, 24

One laterally crushed specimen is represented by an internal mold that retains some shell material and by part of an external mold. The shell is highly evolute and apparently compressed. The whorl section is probably elliptical and is higher than wide. The flanks are gently convex, and the venter appears to be narrowly rounded. The umbilicus is wide. The umbilical wall is low, gently inclined, and rounds gradually into the flanks. The adult body chamber occupies about three-fourths of a whorl and terminates in a prolonged lateral lappet.

The ornamentation of the innermost whorls is not well preserved, but at one place the penultimate septate whorl bears umbilical tubercles from which branch pairs of ribs that incline forward. The septate part of the ultimate whorl bears weak radially trending primary ribs on the umbilical wall, radially elongate tubercles at the base of the flanks, and fairly sharp forwardly inclined ribs on the flanks. The secondary ribs arise singly or in pairs from the umbilical tubercles, and some bifurcate again near the middle of the flanks.

Body chamber ornamentation consists of umbilical tubercles, of radial swellings from those tubercles, and of fine secondary ribs that outnumber the tubercles about 4 to 1. The ribs branch by twos and threes at various heights below the middle of the flanks, and some branch again near the middle. Some arise freely near the middle. All ribs incline strongly forward on the venter. Near the adapical end of the body chamber most rib branching occurs low on the flanks just above the tubercles. Adorally, however, some of the tubercles are prolonged ventrally as strong radial swellings of variable lengths, and consequently the position of rib branching varies from low on the flanks to near the middle. All whorls bear from three to four forwardly inclined constrictions.

The specimen is so crushed and distorted that accurate measurements cannot be made. The suture line is too poorly preserved for tracing.

The Oregon specimen greatly resembles the holotype of *Spiticeras cautleyi* (Oppel) (1863, p. 279, pl. 78, fig. 1a, b; Uhlig, 1903, pl. 12, figs 1a–c) in its wide umbilicus, compressed whorl shape, pattern of ornamentation, and presence of lateral lappets. It differs mainly by being only about half as large and by some of its umbilical tubercles being prolonged ventrally as fairly prominent swellings. It likewise resembles *S. eximius* (Uhlig) (1903, p. 126, pl. 18, figs. 3a–d), but is much smaller and bears much stronger ribs on the lower parts of the flanks of the adult body whorl.

Figured specimen.—USNM 158809.

Occurrence.—In Oregon at USGS Mesozoic loc. 3348 associated with *Spiticeras (Negreliceras)* and *Buchia uncitoides* (Pavlow).

Spiticeras (Spiticeras) spp.

Plate 3, figures 17, 18, 20

The subgenus *Spiticeras* is represented in California by a number of fragmentary crushed specimens that may be compared to various described species. One distorted external mold (pl. 3, fig. 20) resembles *Spiticeras serpentinum* Burckhardt (1912, p. 180, pl. 43, figs. 7, 9, 10, 13, 16) from beds of Berriasian age near San Pedro del Gallo in northern Mexico in having evolute coiling and strong ribs that arise in pairs from prominent umbilical tubercles. Another specimen (pl. 3, fig. 18), consisting of both external and internal molds, resembles the outer whorl of *S. uhligi* Burckhardt (1912, p. 173, pl. 41, fig. 5, pl. 42, figs 1, 3–5) from the same beds in Mexico in having prominent radially elongate umbilical tubercles from which pass two or three broad ribs that branch again near the middle of the flanks. A third specimen (pl. 3, fig. 17), consisting of an internal mold that retains some shell material, resembles *S. obliquenodosum* Retowski (1893, pl. 9, fig. 18; Djanélidzé, 1922, pl. 20, figs. 3a, b, pl. 21, fig. 6) in having evolute coiling, strong constrictions, and fairly acute umbilical tubercles from which pass bundles of three to five weak, closely spaced ribs. The bundling of the ribs at the umbilical tubercles distinguish this specimen from similarly finely ribbed species of the subgenus *Negreliceras*, such as *S.* (*N.*) *negreli* (Matheron) (Djanélidzé, 1922, pl. 18, figs. 1, 2).

Figured specimens.—USNM 158810–158812.

Occurrences.—In California *Spiticeras* cf. *S. serpentinum* Burckhardt occurs at USGS Mesozoic loc. M2598, *S.* cf. *S. uhligi* Burckhardt at Mesozoic loc. M3092, and *S.* cf. *S.* obliquenodosum Retowski at Mesozoic locs. M1574 and M2253. Associated pelecypods include *Buchia uncitoides* (Pavlow) at Mesozoic locs. M2598 and M3092 and a Jurassic variant of *B. okensis* (Pavlow) at Mesozoic locs. M1574 and M2253.

Spiticeras (Spiticeras?) n. sp. undet.

Plate 3, figures 22, 25

Two laterally crushed internal molds that retain some shell material probably represent a new species. The smaller specimen is nonseptate and probably represents the adapical part of a body chamber. The larger specimen shows parts of the septate whorls, most of the body chamber, and a lateral lappet; on this specimen the coiling is evolute and the umbilicus is wide and shallow.

The septate whorls, as exposed in the umbilicus, bear strong, nearly radial fairly widely spaced primary ribs that are slightly swollen on the umbilical edge and bear small tubercles near the middle of the flanks. From these tubercles pass pairs of slightly weaker secondary ribs that incline gently forward on the flanks and on the venter. Adorally on the outermost septate whorl the tubercles disappear from the flanks, and the umbilical swellings become slightly stronger. Several constrictions are present on the septate whorls.

The body chamber bears long, low moderately spaced primary ribs that are weakly swollen on the umbilical edge, incline slightly forward on the flanks, and bifurcate at various heights on the middle third of the flanks. The secondary ribs are a little weaker than the primary ribs and incline forward more strongly. Many of the secondary ribs bifurcate again above the middle of the flanks. Adorally on the body chamber the secondary ribs become finer, more closely spaced, and outnumber the primary ribs about 4 to 1.

These specimens probably belong to the subgenus *Spiticeras* rather than to the subgenus *Kilianiceras* considering that bituberculation is weakly developed on the inner whorls and does not persist onto the outermost septate whorl. The persistence of long primary ribs onto the body chamber, however, favors an assignment to *Kilianiceras*. The loss of lateral tubercles at an early stage of development is similar to that on *S. burckhardti* Djanélidzé (1922, p. 192; Burckhardt, 1912, p. 175, pl. 43, figs. 1, 2, 6, 8), but that species has much finer and denser secondary ribs on its inner whorls and does not have long primary ribs on its largest whorl.

The California species is characterized by its evolute coiling, by bituberculate perisphinctoid ribbing on its inner septate whorls, by early loss of lateral tubercles, and by the presence on the body chamber of fairly long primary ribs that divide on the middle third of the flanks into many weak secondary ribs.

Figured specimen.—USNM 158813.

Occurrence.—In California at USGS Mesozoic loc. M2605 asociated with *Buchia piochii* (Gabb).

Subgenus KILIANICERAS Djanélidzé, 1922

Spiticeras (Kilianiceras?) sp. juv.

Plate 3, figures 19, 21

Three small laterally crushed, evolute ammonites from Oregon represent the inner whorls of a species possibly belonging to the subgenus *Kilianiceras* as shown by the presence of bituberculate ribs on the middle whorl of one ammonite. The outer whorls of these ammonites bear fairly strong, radially trending primary ribs that divide into two or three secondary ribs on the upper part of the flanks. The ornamentation is similar in plan to that on the inner whorls of *S.* (*K.*) *damesi* (Steuer) in Leanza (1945, pl. 15, fig. 4) and *S.* (*K.*) *gigas* Leanza (1945, pl. 19, fig. 3) but differs by being much weaker.

Figured specimen.—USNM 158814.

Occurrences.—In Oregon at USGS Mesozoic locs. 3348 and 24702. It is associated with *Buchia uncitoides* (Pavlow) at loc. 3348 and *B.* cf. *B. pacifica* Jeletzky at loc. 24702.

Subgenus NEGRELICERAS Djanélidzé, 1922

Spiticeras (Negreliceras) stonyense Imlay and Jones, n. sp.

Plate 4, figures 1–22

This species is represented by about 90 specimens of which 63 are internal molds from USGS Mesozoic loc. 2286. Most of the other specimens retain some shell material. Nearly all specimens are crushed laterally or distorted.

The shell is compressed and fairly evolute. The whorls are elliptical in section, a little higher than wide, overlap from 1/4 to 2/5 of the preceding whorl, and attain their greatest thickness near or a little below the middle of the flanks. The flanks are gently convex but become less convex during growth, and on the body chamber their lower parts become somewhat flattened. The venter is moderately to narrowly arched. The umbilicus is shallow and fairly wide. The umbilical wall is low, nearly vertical at its base, and rounds evenly into the flanks. The body chamber occupies about four-fifths of a whorl. The aperture, wherever preserved, is marked by prolonged lateral lappets. All specimens in which the aperture is preserved bear lateral lappets.

The ribs on the inner septate whorls are fine to moderately fine, are generally as wide as the interspaces, begin near the line of involution, are radial on the umbilical wall, incline forward on the flanks, form chevrons on the venter, and are slightly reduced in strength along the midventral line. Most of the primary ribs divide on the middle third of the flanks into two or three slightly weaker secondary ribs, but some primary ribs remain undivided. A few ribs arise freely on the flanks.

Adorally on the outer septate whorls the ribs become less strongly inclined forward on the flanks, less strongly arched on the venter, and do not form ventral chevrons. In addition, the primary ribs become more widely spread and on most specimens develop weak radially elongate swellings on the umbilical edge. Most of the primary ribs divide on the middle third of the flanks into two or three secondary ribs. Some secondary ribs branch above the middle of the flanks. Some ribs arise freely on the flanks.

Adorally on the adult body whorl the ribs weaken appreciably on the finely ribbed specimens and little or none on the moderately ribbed specimens. In general, the primary ribs weaken more than the secondary ribs. Weak radially elongate swellings on the umbilical edge are present on some adult body chambers and absent on others. Some specimens near the aperture develop striae, others bear indistinct broad radial undulations, and still others bear fairly strong ribs.

The ribbing of this species varies considerably in strength, in spacing, and in the number of secondary ribs per primary rib. Most larger septate and adult whorls bear fine to very fine densely spaced ribs and from three to four secondary ribs per primary rib. About one-sixth of the larger septate and adult whorls bear moderately fine and moderately spaced ribs and from 2½ to 3 secondary ribs for each primary rib. All variations between these extremes are present.

Accurate measurements cannot be made because of lateral crushing of incomplete preservation. Likewise, the suture line cannot be traced in detail.

Two or three weak constrictions occur on each septate whorl. On some specimens the lateral lappet is preceded by a weak constriction or furrow.

This species resembles *Spiticeras* (*Negreliceras*) *paranegreli* Djanélidzé (1922, p. 108–112, pl. 6, figs. 1a–c, 2, 3a–c; pl. 12, figs. 5a–c; pl. 22, figs. 1a–c) in size, evolution, tuberculation, ribbing, and in range of variation. It differs from *S. paranegreli*, however, by having consistently stronger primary ribs on all its variants and hence less of a tendency toward effacement of ribbing during growth. As a consequence, the most finely ribbed variant of the California species has only slightly weaker ribbing than the most coarsely ribbed variant of *S. paranegreli* Djanélidzé (1922, pl. 6, fig. 2).

The finely ribbed variant of the species from California likewise resembles *S.* (*Negreliceras*) *planissimum* Djanélidzé (1922, p. 113, 114, pl. 4, figs. 10a, b) but has somewhat stronger primary ribs and less distinct umbilical tubercles, or swellings. It differs from *S*? *proteus* (Retowski) (1893, p. 252, pl. 10, figs. 3a, b, 4) by having finer ribbing on its inner whorls and more secondary ribs per primary rib on its body whorl.

Types.—Holotype, USNM 158815; paratypes, USNM 158816–158833.

Occurrences.—In California at USGS Mesozoic loc. M2025, M3096, M4066, 2286 and 29505. In Oregon at Mesozoic loc. 3348. It is associated with *Buchia uncitoides* (Pavlow) at all localities except M4066 where it is associated with *B. okensis* (Pavlow) and with *B.* cf. *B. uncitoides* (Pavlow).

Genus GROEBERICERAS Leanza, 1945

Groebericeras? baileyi Imlay and Jones, n. sp.

Plate 5; plate 6, figures 1, 2, 5, 6, 8–11; plate 15

This species is represented by one entirely septate specimen that includes both internal and external molds. The outer two septate whorls are fragmentary and are crushed laterally. The shell is large for the genus, discoidal, compressed, moderately evolute, and becomes more evolute during growth. The innermost exposed septate whorls embrace about three-fifths of the preceding whorl. The outermost septate whorl embraces about two-fifths of the preceding whorl. The whorls are elliptical in section, much higher than wide, and become higher during growth. The flanks are nearly flat in their lower half and converge gently above into a narrowly arched venter. The umbilicus is shallow, moderate in width, and becomes slightly wider during growth. The umbilical wall is low, steep, and rounds fairly abruptly into the flanks. The body chamber is not preserved.

The ribs on the innermost septate whorls up to a whorl diameter of about 30 mm are fairly strong, slightly wider than the interspaces, and mostly simple, although a few bifurcate low on the flanks. The ribs begin on the upper part of the umbilical wall, are slightly swollen on the umbilical edge, trend radially on the lower part of the flanks, incline slightly forward on the upper part of the flanks, and arch forward on the venter. They are slightly reduced in strength along the midventral line, and some are slightly offset with respect to the ribs on the opposite side of the venter.

At whorl diameters from about 30 to 110 mm the umbilical swellings during growth gradually develop into weak radially elongate tubercles. From these pass pairs of low ribs that incline slightly forward on the flanks, are generally faint near the tubercles, and become stronger and broader ventrally. Other ribs arise freely, or by branching, on the middle third of the flanks. All the ribs arch forward on the venter and form weak chevrons along the midventral line. At a diameter of 110 mm the ribs on the venter outnumber the tubercles about 3 to 1.

During subsequent growth the ornamentation decreases considerably in strength. The elongate tubercles gradually become indistinct blunt swellings. The ribs become very broad, low, widely spaced and less commonly branched. The third from the largest septate whorl bears many unbranched ribs, and the next two larger septate whorls at a diameter greater than about 220 mm bear only simple unbranched ribs. Such ribs on the largest septate fragment measure from 15 to 18 mm from crest to crest.

Each whorl is also marked by three to four forwardly inclined constrictions. These are fairly deep on the smallest exposed whorl and are weak on all the other whorls.

The holotype at a diameter of 109 mm has a whorl height of 42 mm, an estimated whorl thickness of 28 mm, and an umbilical width of 35 mm. The third from the largest septate whorl has a maximum diameter of about 250 mm and is probably only slightly compressed. The outer two septate whorls are too crushed for measurements, but their very presence suggests that the complete ammonite had a diameter several times larger than 250 mm.

The suture line is poorly exposed and cannot be described accurately.

The characteristics of *Groebericeras*? *baileyi* show that it belongs in the subfamily Spiticeratinae (Arkell and others, 1957, p. L345) but that it differs somewhat from any described genus or subgenus of that subfamily. Its innermost whorls resemble those of *Proniceras*, but it develops a much higher, more compressed whorl section, much coarser ribbing, and attains a much larger size. It differs from large specimens of the subgenus *Spiticeras*, as illustrated by Djanélidzé (1922, pl. 14, fig. 1, pl. 16, fig. 1, pl. 17), by lacking lateral tubercles on its inner whorls and by having a more compressed whorl section and fewer branching ribs. It differs from large specimens of *S.* (*Kilianiceras*) (Steuer, 1897, pl. 6, figs. 1, 4, pl. 15, fig. 1; Leanza, 1945, pl. 16, figs. 1, 2, pl. 19, figs. 3, 4, 8; Djanélidzé, 1922, pls. 8–10) by lacking lateral tubercles and by having weaker umbilical tubercles and flatter flanks. It resembles *S.* (*Negreliceras*) (Djanélidzé, 1922, pl. 5) in whorl shape and in the presence of weak umbilical tubercles, but differs by having considerably fewer and broader secondary ribs that do not tend to fade out on the lower parts of the flanks. Its outer whorls greatly resemble those of *Groebericeras bifrons* Leanza (1945, p. 82, pl. 17, figs. 2, 5; pl. 18, fig. 1, pl. 19, figs. 1, 2, 7) from basal Cretaceous beds in Argentina in size, whorl shape, abrupt umbilical edge, and sparseness of ribbing. That genus as defined, however, lacks umbilical tubercles, has weaker ribbing on the lower parts of the flanks, and has a more narrowly rounded venter.

Overall, *Groebericeras*? *baileyi* Imlay and Jones, n. sp. shows more resemblance to *Groebericeras* than to the other taxa listed above, and thus it could belong to that genus. A positive generic determination is not possible, however, because *Groebericeras* is to date represented only by a single species whose immature growth stages have not been illustrated and whose range of variation is unknown.

Groebericeras? *baileyi* Imlay and Jones, n. sp. is named in honor of Edgar H. Bailey of the U.S. Geological Survey who collected the type specimen.

Type.—Holotype, USNM 158834.

Occurrence.—In California at USGS Mesozoic loc. M2024 in association with *Buchia piochii* (Gabb) about 2,000 feet below the top of beds containing *Buchia piochii* (Gabb) and probably a thousand feet more below the top of the Jurassic.

Genus TOLLIA Pavlow, 1914

Tollia mutabilis (Stanton)

Plate 7, figures 1, 2, 4–12; plate 8, figures 1–10

Olcostephanus (*Simbirskites*) *mutabilis* Stanton, 1896, U.S. Geol. Survey Bull. 133, p. 77–78, pl. 15, figs. 1–5 [Imprint 1895.]

Subcraspedites? *mutabilis* (Stanton). Spath, 1923, Geol. Soc. London Quart. Jour., v. 79, pt. 3, no. 313, p. 303.

Dichotomites mutabilis (Stanton). Anderson, 1938, Geol. Soc. America Spec. Paper 16, p. 160.

Dichotomites tehamaensis Anderson, 1938, idem., p. 158, pl. 28, fig. 2, pl. 30, fig. 6.

Dichotomites gregerseni Anderson, 1938, idem, p. 158, 159, pl. 28, figs. 3, 4.

Dichotomites burgeri Anderson, 1938, idem, p. 159, pl. 28, fig. 5.

Homolsomites mutabilis (Stanton). Imlay, 1956, Jour. Paleontology, v. 30, no. 5, p. 1144, 1145.

Homolsomites mutabilis (Stanton). Imlay, 1960, U.S. Geol. Survey Prof. Paper 334–F, p. 200, 201, pl. 28, figs. 1–22.

Tollia (Tollia) mutabilis (Stanton). Jeletzky, 1965, Canada Geol. Survey Bull. 103, p. 38, 39, pl. 14, figs. 3, 7, 9, pl. 15, figs. 1, 3, 5:

The collections in hand contain nearly 200 septate specimens of this species from the Paskenta area, California. Most are from the same spot as the holotype (USGS Mesozoic loc. 1093), and the others were obtained within 1½ miles at the same stratigraphic position. All specimens are somewhat crushed laterally, but some are only slightly deformed.

The septate specimens are discoidal and moderately compressed. The whorl section is subelliptical, a little higher than wide, and thickest at about the top of the lower third of the flanks. The flanks are weakly convex and converge slightly ventrally. The venter is narrowly to moderately arched and apparently becomes broader during growth. The umbilicus is fairly narrow, its wall is fairly low, steep, and rounds evenly into the flanks. The body chamber is not preserved on any specimen from the Paskenta area, but is probably represented on one crushed adult ammonite from the Wilbur Springs area, California. On this ammonite (pl. 7, figs. 13, 14) the body chamber occupies a complete whorl and terminates simply. The aperture is preserved only on the venter.

The internal molds of the septate whorls bear from five to seven forwardly inclined constrictions per whorl.

The ribbing on the septate whorls inclines forward on the flanks, arches forward considerably on the venter, and is highly variable in strength, density, and in number of secondary ribs per primary rib. The primary ribs incline backward on the umbilical wall, incline forward on the lower part of the flanks, and divide near the midflank into two to four weaker secondary ribs that incline forward more strongly than the primary ribs. In addition, some secondary ribs arise freely on the flanks at or above the zone of furcation. During growth the primary ribs tend to become even stronger relative to the secondary ribs, and on some specimens they acquire a pinched appearance. All ribs weaken near the adoral end of the largest septate specimens (Jeletzky, 1965, pl. 14, fig. 9; Imlay, 1960, pl. 28, fig. 18).

The high variability in ribbing that is characteristic of this species was discussed by Stanton (1895, p. 77) and Imlay (1960, p. 201), who concluded that the variations were not of specific importance even though the extreme variants were strikingly different from each other. Additional fossils obtained recently from the type locality show clearly that the variants grade into each other and are associated with each other in the same beds.

The suture line is characterized by having long, nearly symmetrical lobes and by having auxiliary lobes trending nearly straight or ascending slightly to the umbilical seam. The first lateral lobe on the holotype (Imlay, 1969, pl. 28, fig. 11) is a little longer than the ventral lobe. On two smaller specimens shown herein (pl. 7, figs. 5, 7; pl. 8, fig. 6), however, the first lateral lobe is a little shorter than the ventral lobe.

Olcostephanus mutabilis Stanton was assigned by Jeletzky (1965, p. 38, 39) to *Tollia* rather than *Homolsomites* because its outer septate whorls are subelliptical instead of subtriangular in cross section, its umbilicus is wider and shallower at all growth stages, its ribs branch mostly by twos and threes at only one level, its primary ribs are longer and coarser during early and middle growth stages, and the auxiliary lobes of its suture line ascend feebly instead of strongly to the umbilical seam.

Similar conclusions regarding *Olcostephanus mutabilis* Stanton were reached independently by Shulgina (1965, p. 82)on the basis of studies of new species of *Homolsomites* from northern Siberia. Although she did not assign *O. mutabilis* Stanton to *Tollia*, she showed clearly that it did not belong to *Homolsomites*. Furthermore, she said its characteristics fitted those of *Tollia* rather than *Homolsomites* except that its first lateral lobe was as long as or a little longer than its ventral lobe.

The presence of a long, slender first lateral lobe on *Olcostephanus mutabilis* Stanton was also noted by Jeletzky (1965, p. 40) but was not considered by him to be of sufficient importance to bar assignment of that species to *Tollia*. He noted in particular that *Tollia anabarensis* (Pavlow) (1914, p. 27, pl. 4, figs. 3a, b), which he considered typical of the genus, has a fairly long and slender first lateral lobe similar to that on *O. mutabilis*. This comparison is not fully apt because on the holotype of *T. anabarensis* the first lateral lobe is actually shorter than the ventral lobe according to Shulgina (1965, p. 85), who noted that Pavlow (1914, p. 28) stated the opposite.

Nonetheless comparison of the suture lines of *O. mutabilis* Stanton, as herein illustrated, with the suture lines of species of *Tollia* from Siberia (Voronetz, 1962, figs. 24–26, p. 67–70) supports Jeletzky's assignment. On all the Siberian species the first lateral lobe is shorter than the ventral lobe, but this relationship varies considerably, and on such species as *T. pakhsaensis* Voronetz (1962, fig. 24) the lobes are almost equal in length. On the Siberian species, also, the suture lines are much more frilled (Pavlow, 1914, pls. 12, figs. 1a, 2c, 3, pl. 13, fig. 2; Voronetz, 1962, p. 67, 68, 70, pls. 31, 32, 33, 37 in part) than the suture lines of *O. mutabilis*, but this difference probably reflects the small size and immaturity of the California specimens on which the sutures are traceable. It appears, therefore, that *O. mutabilis* cannot reasonably be excluded from *Tollia* on the basis of its suture line.

The assignment of *Olcostephanus mutabilis* Stanton to *Tollia* made by Jeletzky (1965, p. 39, 40) assumes that the species in the adult develops a smooth, narrowly umbilicate body chamber marked only by constrictions. Unfortunately only one such specimen has been found in California, and it is much crushed and broken and is not associated with other specimens typical of the species. Its probable identity with *O. mutabilis* Stanton, however, is indicated by the penultimate whorl (pl. 7, figs. 13, 14) bearing ribs that are similar in strength and mode of branching to those on the coarsely ribbed variants of that species. Its assignment to *Tollia* seems reasonable, but a definite specific assignment must await the discovery of better preserved specimens. It follows that the assignment of *O. mutabilis* Stanton to *Tollia* needs substantiation by the discovery of better preserved specimens that show the characteristics of the adult.

Tollia mutabilis (Stanton) closely resembles and may include *Dichotomites gregerseni* Anderson var. *paucicostata* Donovan (1953, p. 110–112, pl. 23, figs. 1a, b) from Greenland. That variety was considered by its author to differ from *D. gregerseni* Anderson (1938, pl. 28, figs. 3, 4) only by having a slightly smaller umbilicus and fewer ribs. It now appears, on the basis of abundant material from California, to have ribbing of intermediate coarseness between the typical variant of *T. mutabilis* (Stanton) (Imlay, 1960, pl. 28, figs. 5–10) and *T. mutabilis* var. *crassicostata* Imlay (1960, pl. 28, figs. 1–4). It definitely has much weaker and denser ribbing than a specimen from California that Jeletzky (1965, pl. 14, fig. 3) identified as *T. paucicostata* (Donovan) but which appears to be a large septate narrowly umbilicate example of *T. mutabilis* var. *crassicostata* Imlay. The specimens from British Columbia that Jeletzky (1965, p. 38, pl. 13, figs. 2, 5–7, 9, pl. 14, figs. 4–6, 8) identified with *T. paucicostata* (Donovan) are considerably more evolute than that species and have sparser and higher primary ribs at a comparable size. They differ from *T. mutabilis* var. *crassicostata* mainly by being appreciably more evolute.

Types.—For previously listed types see Imlay (1960, p. 201). Other types illustrated herein are as follows: Hypotypes of *T. mutabilis* (Stanton), USNM 161194–161198; hypotypes of *T. mutabilis crassicostata* Imlay, USNM 161199–161202; hypotypes of *T. mutabilis burgeri* (Anderson), USNM 161190–161192.

Occurrences.—In Oregon at USGS Mesozoic locs. 2154 and 4390. In California at USGS Mesozoic locs. 1010 (equals 1093 and M3061), 29487, 29594, and 29595 at or near the top of the *Buchia pacifica* beds in the northeastern part of the Paskenta quadrangle. These occurrences in California are in fairly resistant nearly vertical beds, packed with buchias, that crop out as vertical ledges on the tops of a series of small hills that extend north-northeast from the northeast corner of sec. 20, T. 24 N., R. 6 W., to the south-central part of sec. 33, T. 25 N., R. 6 W. The adult ammonite herein compared with *Tollia mutabilis* (Stanton) was obtained at USGS Mesozoic loc. 29612 in the Wilbur Springs quadrangle, California.

Genus OLCOSTEPHANUS Neumayr, 1875

Olcostephanus cf. O. atherstoni Baumberger (non Sharpe)

Plate 8, figure 15; plate 9, figures 1–3, 6–10

This species is represented by six deformed and crushed specimens that show the various growth stages. The shell is stout and moderately involute. The adult body whorl, preserved on the largest specimen, is crushed laterally, but its whorl section appears to be depressed ovate and much wider than high. On the small septate specimens the whorls overlap almost to the umbilical tubercles; the umbilical wall is low, nearly vertical, and rounds evenly into the flanks; the flanks are gently convex; and the whorl section is probably higher than wide. The adult body chamber occupies about three-fourths of a whorl. The aperture on the internal mold is marked by a deep constriction that is preserved only on the lower part of the flanks.

The ribs on the small septate specimens (pl. 9, figs. 7, 8) are fairly sharp, high, and are moderately spaced. The primary ribs are strong, trend nearly radially on the umbilical wall, and terminate ventrally in prominent radially elongate tubercles on the umbilical edge. From the tubercles pass two or three slightly weaker secondary ribs that incline forward on the flanks and cross the venter transversely. A few ribs arise freely on the flanks above the zone of tuberculation, and this results in about three secondary ribs for each primary rib. All secondary ribs become slightly broader and lower ventrally. Each whorl is also marked by two or three deep forwardly inclined constrictions.

On a larger septate whorl (pl. 9, figs. 1, 3, 6), the ornamentation differs by being somewhat coarser. The tubercles are larger and more prominent, the secondary ribs are higher and more widely spaced, and the constrictions are more conspicuous and generally followed or preceded by a prominent flare.

The ornamentation of the adult body whorl is not well preserved but apparently becomes coarser and sparser adorally. Secondary ribs outnumber ribs about 4 to 1.

The suture line cannot be traced, and accurate measurements cannot be made.

The adult outer whorl of this specimen is similar in size and coarseness of ornamentation to the large outer whorls of *Olcostephanus curacoensis* Weaver (1931, p. 427, pl. 49, pl. 50, fig. 328; Leanza, 1945, pl. 20, fig. 3) from Argentina, but apparently has fewer secondary ribs per primary rib. Close comparisons cannot be made, however, because the inner whorls of the Argentina species have not been illustrated or described.

The adult outer whorl of the California species differs from the holotype of *O. atherstoni* (Sharpe) from South Africa as illustrated by Spath (1939, pl. 20, figs. 4a, b) by having more prominent tubercles and fewer secondary ribs per tubercle. In these respects it shows more resemblance to the large specimens of *O. atherstoni* (Sharpe) from Switzerland as identified by Baumberger (1907, figs. 114–116 on p. 44, pl. 23, figs. 1a, b) but apparently has a less depressed whorl section.

The small specimens of the California species also bear ribbing similar to that on small specimens of *O. atherstoni* (Sharpe) in Baumberger (1907, pl. 21, figs. 3a, b, pl. 24, figs. 4a, b, 5) but apparently are more widely umbilicate. Their general appearance as regards both umbilical width and ribbing matches more closely with an ammonite described by Spath (1939, p. 28, pl. 19, figs. 3a, b) as *O.* cf. *O. madagascariensis* (Lemoine). They differ, however, by having much flatter flanks.

Figured specimens.—USNM 158835–158838.

Occurrences.—USGS Mesozoic locs. M2680, 29485, 29555, and 29556.

Genus POLYPTYCHITES Pavlow, 1892

Polyptychites sp.

Plate 7, figure 3; plate 9, figures 4, 5

The genus *Polyptychites* is represented by three specimens from two localities. The smallest specimens are fairly involute and have a rounded whorl section, weak primary ribs, rather closely spaced umbilical tubercles, fine dense secondary ribs, and deep constrictions that are preceded by a prominent flare. The secondary ribs arise from the tubercles by twos and threes, and some ribs branch again on the flanks.

The larger specimen is fairly evolute and has a rounded whorl section, fairly strong primary ribs on the umbilical wall, a row of prominent acute tubercles at the umbilical edge, fairly sharp secondary ribs, and three deep forwardly inclined constrictions of which one is preceded by a prominent flare. The secondary ribs arise from the tubercles by threes. A few secondary ribs bifurcate again low on the flanks. Two inner whorls, partly exposed in the umbilicus, also bear prominent tubercles and sharp ribs.

The larger specimen differs from the small by being more evolute and by having much coarser tubercles and ribs. It closely resembles the smallest cotype of *Polyptychites keyserlingi* (Neumayr and Uhlig) (1881, pl. 27, fig. 3) from Germany but appears to be more evolute and to have slightly weaker ribbing. In strength of ribbing and tubercles it shows even more resemblance to *P.* cf. *P. keyserlingi* (Neumayr and Uhlig) as illustrated by Jeletzky (1964b, p. 18, pl. 6, fig. 5) from beds of middle Valanginian age in northeastern British Columbia.

Figured specimens.—USNM 158839, 158840.

Occurrences.—In California at USGS Mesozoic loc. M1577 in association with *Thurmanniceras jenkinsi* (Anderson) and at Mesozoic loc. 29555 in association with *Olcostephanus* and *Buchia* cf. *B. keyserlingi* (Lahusen).

Polyptychites trichotomus (Stanton)

Plate 8, figures 11–14

Olcostephanus (Polyptychites) trichotomus Stanton, 1896, U.S. Geol. Survey Bull. 133, p. 78, pl. 16, fig. 1. [Imprint 1895.]

Dichotomites trichotomus (Stanton). Anderson, 1938, Geol. Soc. America Spec. Paper 16, p. 159.

Polyptychites trichotomus (Stanton). Imlay, 1960, U.S. Geol. Survey Prof. Paper 334–F, p. 204, pl. 31, figs. 13, 15.

This species, in addition to the holotype, which is much crushed and distorted, is now represented by a fairly well-preserved internal mold that is only slightly compressed laterally. On the basis of both specimens the species may be redescribed.

The shell is compressed and moderately involute. The whorls are subovate in section and a little higher than wide. The flanks are flattened below and converge slightly above to a rather narrowly rounded venter. The umbilicus is moderate in width. The umbilical wall is vertical, fairly low, and rounds evenly into the flanks. The body chamber occupies about four-fifths of a whorl and is incomplete.

The septate inner whorls, as exposed in the umbilicus of the holotype, bear fairly strong, forwardly inclined primary ribs that are not tuberculate near the umbilicus. The body whorl bears fairly strong virgatomous ribbing. The primary ribs are weak and trend radially on the umbilical wall, recurve at the edge of the umbilicus, are strong and forwardly inclined on the lower third of the flanks, and divide at from ¼ to ½ of the height of the flanks into two appreciably weaker secondary ribs. Generally the adapical rib of each pair curves adapically and then divides again on the middle third of the flanks into secondary ribs that recurve slightly adorally. All secondary ribs are of about equal strength, become slightly broader on the venter, and either cross the ventor transversely or arch gently adorally.

The suture line cannot be traced. The hypotype at a diameter of 73 mm has a whorl height of 26 mm, a whorl thickness of 25 mm, and an umbilical width of 27 mm.

This species differs from most species of *Polyptychites* by being compressed, by lacking umbilical tubercles or swellings, and by lacking rib furcation near the umbilicus. Its rib pattern greatly resembles that of *P. ramulicosta* Pavlow (1892, p. 481, pl. 8 (5), figs. 10a, b, pl. 15 (8), figs. 6a, b) from the middle Valanginian of England and *P. densicosta* (Pavlow) (1914, p. 26, pl. 5, figs. 3a–c) from the middle Valanginian of Russia, but it is more evolute and compressed than those species. It is distinguished from similar compressed species of *Dichotomites* (compare V. Koenen, 1902, pl. 3, figs. 6, 7, 10, pl. 47, figs. 1, 2, pl. 53, figs. 1, 2) by lacking fairly regular bifurcation from umbilical swellings or tubercles.

Types.—Holotype, USNM 23090; hypotype 161193.

Occurrences.—USGS Mesozoic locs. 1087 and 29616.

Family BERRIASELLIDAE Spath, 1922
Genus BLANFORDICERAS Cossman, 1907

Blanfordiceras californicum Imlay and Jones, n. sp.

Plate 10, figures 1–5, 10

This species is represented by two specimens, each of which includes both internal and external molds.

The shell is compressed and moderately evolute. The whorls are higher than wide and subquadrate in section but become subovate on the body chamber. The flanks are flattened in their lower half and converge slightly above toward the venter. The venter is flattened along its midline and is moderately narrow. The umbilicus is moderately wide and shallow. The umbilical wall is low, is vertical at its base, but rounds evenly into the flanks. The body chamber occupies about three-fifths of a whorl, begins at a diameter of about 35 mm, and bears small lateral lappets.

The septate whorls bear high, narrow fairly widely spaced primary ribs that begin near the line of involution, incline slightly forward on the flanks, bifurcate at various heights on the middle third of the flanks, and are generally swollen at the point of furcation. A few primary ribs remain simple, and a few secondary ribs arise freely on the upper third of the flank. The secondary ribs incline forward more strongly and are weaker than the primary ribs; they terminate ventrally in radially elongate tubercles that bound a narrow smooth area along the midline of the venter. Secondary ribs outnumber primary ribs slightly more than 2 to 1. The innermost septate whorls bear two or three constrictions per whorl.

On the body chamber the primary ribs remain high and narrow but become more flexuous and more widely and variably spaced. They incline slightly forward on the lower third of the flank, recurve slightly near the middle, and then pass into pairs of weaker secondary ribs. The secondary ribs near their furcation points continue the same curvature as the primary ribs and then recurve abruptly and incline forward on the margin of the venter. All ribs cross the venter of the body chamber with only a slight reduction in strength wherever the shell is preserved. On the internal mold, however, the ribs bound a smooth area along the midline of the venter. Near the aperture many primary ribs remain simple. The lateral lappet is preceded by a single strong rib that curves forward a little below the middle of the flanks.

The small paratype at a diameter of 33 mm has a whorl height of 13 mm, a whorl thickness of 11.5 mm, and an umbilical width of 12 mm. On the holotype at a diameter of 41 mm, the dimensions are 15.5, 13.5, and 15 mm respectively. Most of the body chamber of the holotype has been crushed laterally and cannot be measured.

The suture line is characterized by the ventral lobe being distinctly shorter than the first lateral lobe, which is long and slender and has two prominent lateral branches. The second lateral lobe is much smaller and shorter than the first and is obliquely inclined. The auxiliary lobes are small, obliquely inclined, and descend steeply to the umbilicus. The first lateral saddle is fairly wide and unsymmetrically divided by a secondary lobe so that the larger part is on the ventral side. The second lateral saddle is bifid, symmetrical, and much narrower than the first. In general appearance this suture is remarkably similar to that of *Blanfordiceras wallichi* (Gray) (Uhlig, 1910, pl. 29, fig. 3b), the genotype species. It differs mainly by having a slightly shorter ventral lobe, a slightly lower second lateral saddle, and a more obliquely inclined second lateral lobe.

This species is assigned to *Blanfordiceras* rather than *Berriasella* because its secondary ribs project strongly forward on the margins of the venter, its ventral groove persists onto the adult body chamber, and its ribs become rather widely spaced on the body whorl. It is much smaller, however, than most described species of *Blanfordiceras*, and it bears a lateral lappet, a feature which has not been mentioned in the description of any species of *Blanfordiceras*. Among described species of *Blanfordiceras* it resembles *B. acuticosta* Uhlig (1910, p. 201, pl. 37, figs. 2a–c) from India in most features but differs by having slightly more flexuous ribbing and narrow saddles. Its rib pattern closely resembles that of *B. wallichi* (Gray) (Uhlig, 1910, p. 186, pl. 29) and *B. rotundidoma* Uhlig (1910, p. 189, pl. 83, figs. 1a, b, 2a, b), but it is much smaller and probably more compressed than these species.

Another similar appearing species is *Hoplites australis* Burckhardt (1903, p. 64, pl. 11, figs. 9–12; Leanza, 1945, p. 48, pl. 10, figs. 1–4) from the Berriasian of Argentina. This species was designated by Spath (1925, p. 145) as the type of *Pseudoblanfordia* but was placed by Wright (in Arkell and others, 1957, p. L352) in *Blanfordiceras*. It differs from the species herein described mainly by its ribs being much straighter and more widely spaced, its saddles much broader, its first lateral lobe much shorter and broader, and its auxiliary lobes less steeply inclined.

The California species is also similar in coiling and coarseness of ribbing to the European Berriasian species *Berriasella picteti* (Jacob in Kilian) as figured by Mazenot (1939, pl. 2, figs. 1a, b, 2a, b) but is distinguished by its sigmoidal ribbing.

Types.—Holotype, UC 10099; paratype, UC 10100.

Occurrence.—In California at UC loc. B-5120 associated with *Buchia uncitoides* (Pavlow) and an undescribed species of *Inoceramus* that has been found elsewhere in northern California associated with *B. uncitoides*.

Blanfordiceras sp. undet.

Plate 10, figures 6–9

Another species of *Blanfordiceras* is possibly represented by the internal and external mold of a single individual.

The shell is moderately evolute and compressed. The whorls are higher than wide and subquadrate in section. The outermost septate whorl embraces about two-fifths of the preceding whorl. The flanks are flattened below and converge slightly above. The venter is flattened and fairly narrow. The umbilicus is moderately wide and shallow. The umbilical wall is low, steeply inclined, and rounds evenly into the flanks. The body chamber is probably represented in part by about one-fourth of a nonseptate whorl that terminates adorally in a sigmoidal curve suggestive of an aperture. A lateral lappet is not evident. The inner whorls are septate to a diameter of at least 54 mm, which is only half a whorl adapical from the apparent aperture.

The septate whorls bear sharp, moderately spaced ribs. The primary ribs begin near the line of involution, incline gently forward on the flanks, recurve slightly near the middle of the flanks, bifurcate on the middle third of the flanks, and are generally strongest at or just below the furcation points. Some primary ribs remain simple, and some secondary ribs arise freely on the upper third of the flanks or are indistinctly connected with the primary ribs. In places simple primary ribs alternate with short intercalated secondary ribs. The secondary ribs are weaker than the primary ribs, incline forward more strongly, and pass ventrally into radially elongate swellings that bound a depressed area along the midline of the venter. The ribbing on the middle of the venter at a diameter of about 36 mm is considerably reduced but at a diameter of about 45 mm is only faintly reduced. The innermost whorls bear two or three weak constrictions per whorl.

The fragment that probably represents part of the body chamber bears high sharp, widely spaced sigmoidal ribs. Some of the primary ribs bifurcate near the middle of the flanks, and others remain simple. The secondary ribs are broader than but nearly as high as the primary ribs, incline forward on the flanks, arch forward on the venter, and are only faintly reduced in strength along the midline of the venter.

The septate part of the specimen illustrated at a diameter of about 34 mm has a whorl height of 14 mm, an estimated whorl thickness of about 11 mm, and an umbilical width of 11 mm. At a diameter of about 45 mm the same dimensions are 18, 14 and 13 mm.

The suture line cannot be traced.

This specimen differs from *B. californicum* Imlay and Jones, n. sp. by having appreciably weaker and more closely spaced ribs, by attaining a larger size, and by being slightly more compressed. Its association with that species suggests that it is only a finely ribbed variant, but that cannot be proven on the basis of only one specimen. It is much finer ribbed than any described species of *Blanfordiceras* from India but only slightly less than *B. molinensis* Burckhardt (1903, p. 66, pl. 11, figs. 13–17) from the Berriasian of Argentina.

Its ribbing is more sigmoidal than in the genus *Berriasella*, although it bears some resemblance to *Berriasella oppeli* (Kilian) (Mazenot, 1939, pl. 3, figs. 1–7) and to *B. calisto* (d'Orbigny) (Mazenot, 1939, pl. 4, figs. 6–12).

Figured specimen.—UC 10101.

Occurrence.—In California at UC loc. B–5120 associated with *B. californicum* Imlay and Jones, n. sp. and *Buchia uncitoides* (Pavlow).

Genus SUBSTEUEROCERAS Spath, 1923

Substeueroceras stantoni Anderson

Plate 10, figures 11–18

Substeueroceras stantoni Anderson, 1945, Geol. Soc. America Bull., v. 56, p. 982, pl. 11, figs. 3, 4; pl. 15, fig. 3.

This species has a subquadrate whorl section, a flattened venter, fairly evolute coiling, and high, thin, slightly flexuous ribs that are much narrower than the interspaces. The primary ribs incline slightly forward on the flanks and bifurcate a little above the middle of the flanks. The secondary ribs incline forward slightly on the upper parts of the flanks and cross the venter nearly transversely. They are considerably reduced in strength along the midventral line.

Substeueroceras stantoni Anderson is nearly identical in side view with *S. subquadratum* Imlay (1939, p. 49, pl. 15, figs. 8, 12–15) from the highest Jurassic beds in northern Mexico. It has a flatter venter and a more distinct ventral furrow, and its ribs are not inflected forward as much on the middle of the flanks. It differs from *S. alticostatum* Imlay (1939, p. 51, pl. 15, figs. 1–7) from Mexico in the same respects but is also much finer ribbed. All these species are represented only by small immature specimens. None of them show the loose ribbing that is typical of the adult whorl of *Substeueroceras*. The differences between the immature and adult whorls is illustrated by *Substeueroceras intercostatum* (Steuer) (1897, p. 172, pl. 22, figs. 1–5). In that species one immature specimen (Steuer, 1897, pl. 22, figs. 4, 5) at its adapical end bears fairly regular rib furcation similar to that on *S. stantoni* Anderson. Adorally on the same specimen, however, as well as on an adult whorl (Steuer, 1897, pl. 22, figs. 1, 2), the ribbing gradually becomes loose and rib furcation occurs at various heights on the flanks.

Anderson's assignment of the California species to *Substeueroceras* seems reasonable because of the presence of very high and thin ribs similar to those on small specimens of *Substeueroceras* from Mexico (Burckhardt, 1906, pl. 40; Imlay, 1939, pl. 15, figs. 1–9, 12–15).

Types.—Holotype, CAS 10452; paratypes CAS 10453–10456.

Occurrence.—In California at CAS loc. 28037.

Substeueroceras cf. S. kellumi Imlay

Plate 10, figures 19, 20

Berriasella storrsi (Stanton). Anderson, 1945, Geol. Soc. America Bull., v. 56, p. 980, pl. 7, fig. 1.

The specimen described by Anderson is a laterally crushed, septate internal mold that retains a few fragments of shelly material. The outer whorl overlaps about one-fourth of the preceding whorl. Before being crushed the specimen probably had a high subquadrate whorl section and flattened flanks. The venter is gently rounded. The umbilical wall is low, vertical, and rounds rather abruptly into the flanks.

The ribs are fine, moderately spaced, and inclined gently forward on the flanks and are strongest on the venter. They are inflected slightly forward near the middle of the flanks and are arched gently forward on the venter. Some of the ribs are weakly swollen near the umbilicus, but none is tuberculate. Furcation occurs at various heights on the flank from near the umbilicus to considerably above the middle. Some ribs bifurcate at two levels. Many secondary ribs are indistinctly connected with the primary ribs. The ribs are not thinned along the midline of the venter. Constrictions are not present.

This specimen is assigned to *Substeueroceras* rather than *Parodontoceras* because its ribs branch irregularly at various heights on the flanks instead of regularly at or above the middle of the flanks, because its ribs are fine instead of coarse on the larger septate whorls, and because it lacks constrictions.

The California specimen closely resembles *S. lamellicostatum* (Burckhardt) (1912, p. 167, pl. 40, figs. 1–4, 6) and *S. kellumi* Imlay (1939, p. 50, pl. 14, figs. 1–4) from the highest Jurassic beds in Mexico. It differs from both species by being less involute and by having finer ribbing on its outer septate whorl. Its ribs do not arch forward nearly as strongly on the venter as on *S. disputabile* (Castillo and Aguilera) (1895, p. 14, pl. 14). Fine dense ribbing similar to that on the California specimen occurs also on a number of fragments of *Substeueroceras* figured by Burckhardt (1906, pl. 39, figs. 1, 2; 1912, pl. 39, fig. 11; pl. 40, figs. 5, 7–10; pl. 48, figs. 1–4).

The California specimen in comparison with species from South America greatly resemble *Substeueroceras koeneni* (Steuer) (1897, p. 45, pl. 17, figs. 1–5; Leanza, 1945, pl. 7, fig. 4), but differs by having a wider umbilicus and less flexuous ribs that are less projected forward on the upper parts of the flanks. In these respects it shows more resemblance to *S. fasciatum* (Steuer) (1897, p. 46, pl. 18, figs. 1–3), but appears to have slightly sharper ribbing and lower points of rib branching. It differs from *S. permulticostatum* (Steuer) (1897, p. 56, pl. 23, figs. 1, 2) by having a narrower umbilicus and more widely spaced ribbing. *S. steueri* (Gerth) (1925, p. 86, pl. 5, figs. 4, 4a) develops coarser ribs on its outer whorl.

The California specimen probably shows more resemblance to *S. fasciatum* (Steuer) than to any other South American species listed. That species, however, was considered by Gerth (1925, p. 83) to be no more than a variety of *S. koeneni* (Steuer). Such a relationship was disputed by Leanza (1945, p. 28).

Overall, the California specimen probably shows greater resemblance to *S. kellumi* Imlay than to any other described species of *Substeueroceras*. Its finer ribbing may merely reflect the difference between ribbing preserved on an internal mold and the ribbing preserved on the original shell as on the holotype of *S. kellumi*. The greater involution of *S. kellumi* appears to be the only important difference.

Figured specimen.—CAS 10463.

Occurrence.—CAS loc. 28037.

Genus PROTACANTHODISCUS Spath, 1923

Protacanthodiscus taffi (Anderson)

Plate 6, figures 3, 4, 7

Aulacosphinctes taffi Anderson, 1945, Geol. Soc. America Bull., v. 56, p. 979, pl. 7, figs. 4a, b.

?*Distoloceras* sp. Anderson, 1945, idem, p. 983, pl. 14, fig. 4.

This species is represented by internal and external molds of the holotype, which is an immature specimen that has been slightly compressed laterally.

The shell is discoidal, compressed, and moderately involute. The outermost preserved whorl is subquadrate in section, is a little higher than wide, and embraces about two-fifths of the preceding whorl. The flanks are convex near the adapical end of the outer whorl, but adorally their lower part becomes flattened and their upper part converges toward the venter. The venter is moderate in width and is flat. The umbilicus is fairly narrow and deep. The body chamber is unknown.

An inner whorl, exposed in the umbilicus, bears sharp, fairly widely spaced ribs that terminate in prominent lateral tubercles at the line of involution. The outermost whorl bears sharp, moderately spaced, forwardly inclined primary and secondary ribs and lateral and ventral tubercles. The primary ribs arise on the upper part of the umbilical wall, incline slightly forward to the middle of the flanks, and then generally pass into pairs of lower, broader secondary ribs that incline forward more strongly. Some rather weak secondary ribs arise freely along the zone of furcation. The furcation points are marked by fairly strong radially elongate tubercles. All secondary ribs terminate ventrally in tubercles that are nearly conical, are fairly closely spaced, and are slightly weaker than the lateral tubercles. Weak radially elongate umbilical swellings are present on the adoral end of the holotype. The venter is nearly smooth or is marked by faint transverse ribbing.

The holotype at a diameter of 20 mm has a whorl height of 8 mm, a whorl thickness of 7(?) mm, and an umbilical width of 5.5 mm.

Protacanthodiscus taffi (Anderson) is recorded from the same place as the following species:

- *Distoloceras* sp. (Anderson, 1945, p. 979, pl. 14, fig. 4)
- *Protacanthodiscus* sp. (Anderson, 1945, p. 962)
- *Lytoceras* aff. *L. exoticum* Oppel (Anderson, 1945, p. 980)
- *Inoceramus stantoni* Anderson (1945, p. 961, pl. 15, fig. 2)
- "*Aucella*" *fischeri* d'Orbigny var. (Anderson, 1945, p. 962)
- "*A.*" *stantoni* Pavlow (Anderson, 1945, p. 980)

Of these species, *Distoloceras* sp. (now probably lost) is similar in side view to *Neocosmoceras euchrense* Imlay and Jones, n. sp., described herein, and *Inoceramus stantoni* Anderson (not Sokolov) shows some resemblance to *I. ovatus* Stanton (1895, p. 47, pl. 4, fig. 15).

The age of the faunule on the basis of the species of "*Aucella*" should be latest Jurassic (late Tithonian) rather than Berriasian, provided Anderson's identifications are correct. An age not younger than Berriasian is indicated by the presence of *Protacanthodiscus*, a genus not known above the Berriasian. A Berriasian age is indicated by an ammonite that possibly represents the Berriasian genus *Neocosmoceras*. An age near the boundary of the Jurassic and Cretaceous is indicated by the presence of an *Inoceramus* resembling *Inoceramus ovatus* Stanton, whose holotype was found (Mesozoic loc. 1086) in association with *Buchia* aff. *B. okensis* (Pavlow) and *B. terebratuloides* (Lahusen) (Pavlow, 1907, p. 60, 83) of latest Jurassic age.

"*Aulacosphinctes*" *taffi* Anderson is assigned to *Protacanthodiscus* rather than *Neocosmoceras* because it has biplicate *Berriasella*-like ribs instead of simple ribs. Its small size, however, indicates that it is an immature form and precludes any meaningful comparisons with the much larger specimens of *Protacanthodiscus* that have been described.

Type—Holotype, CAS 8709 and 8709a (external mold).

Occurrence.—In California CAS loc. 28037 according to Anderson (1945, p. 979). The holotype, however, was obtained on Grindstone Creek, 1,200 feet west of the iron bridge, whereas most of the specimens from loc. 28037 were obtained from nearby Watson Creek. Also, the holotype of *Inoceramus stantoni* Anderson (not Sokolov) (Anderson, 1945, p. 961) from the same spot on Grindstone Creek was reported by Anderson (1945, p. 961) to be from "a horizon very near that of loc. 28037 (Calif. Acad. Sci.) not far to the north."

All the specimens mentioned by Anderson as being obtained from 1,200 feet west of the iron bridge (now washed away) on Grindstone Creek are referred to herein, under the locality descriptions, as "near CAS loc. 28037."

Genus PARODONTOCERAS Spath, 1923

Parodontoceras storrsi (Stanton)

Plate 12, figures 11, 16–18

Hoplites storrsi Stanton, 1896, U.S. Geol. Survey Bull. 133, p. 79, 80, pl. 17, figs. 1, 2; pl. 18, fig. 5. [Imprint 1895.]

?*Berriasella* cf. *B. storrsi* (Stanton). Burckhardt, 1912, Inst. Geol. México Bol. 29, p. 162, pl. 39, figs. 8–10.

Not *Berriasella storrsi* (Stanton). Anderson, 1945, Geol. Soc. America Bull., v. 56, p. 980, pl. 7, fig. 1.

This species is represented in available collections only by the holotype, which consists of a fairly large septate internal mold that shows parts of two whorls and retains some shell material.

The shell is discoidal, compressed, and moderately involute. The whorls are subquadrate, much higher than wide, and embrace about half of the preceding whorl. The flanks are flattened, subparallel in their lower third, and convergent toward the venter in their upper two-thirds. The venter is nearly flat. The umbilicus is moderate in width. The umbilical wall is low, very steep, and rounds evenly into the flanks. The body chamber is unknown.

The ribbing on the adapical end of the outermost preserved septate whorl is fairly sharp, moderately spaced, and gently flexuous. The primary ribs begin on the upper part of the umbilical wall, incline slightly forward on the lower two-fifths of the flanks, then recurve and generally bifurcate at or just above the middle of the flanks into equally strong secondary ribs. A few ribs remain simple. The secondary ribs arch forward gently on the upper parts of the flanks, thicken a little on the margins of the venter, cross the venter transversely, and on the internal mold are reduced in strength along the midventral line. The interspaces are about twice as wide as the primary ribs.

Adorally on the outermost septate whorl both primary and secondary ribs become slightly broader, the interspaces become narrower, and the secondary ribs become a little thicker on the margins of the venter. Most primary ribs bifurcate a little above the middle of the flanks, but a few remain simple. Rarely a secondary rib arises freely near the middle of the flanks. Secondary ribs outnumber primary ribs about 2 to 1. Four weak constrictions are present on the outermost septate whorl.

The holotype has been crushed slightly laterally but at a maximum diameter of 110 mm has a whorl height of 48 mm, a whorl thickness of 30 mm, and an umbilical width of 35 mm.

The suture line (Stanton, 1895, pl. 17, fig. 1) is characterized by a strongly retracted suspensive lobe and by a first lateral lobe that is much longer than the ventral lobe.

One specimen from Mexico described by Castillo and Aguilera (1895, p. 38, pl. 11, fig. 2) as *Hoplites calisto* (d'Orbigny) var. was considered by Stanton (1895, p. 80) to be closely related to *Parodontoceras storrsi*. It differs from that species, however, by being much more evolute and by having considerably coarser and sparser ribbing. Another specimen from Mexico described as *Berriasella* cf. *B. storrsi* (Stanton) by (Burckhardt, 1912, p. 162, pl. 39, figs. 8–10) is too poorly preserved for close comparisons with the holotype of *P. storrsi*, but apparently has a much stouter whorl section.

P. storrsi (Stanton) also shows some resemblance to *P. calistoides* (Behrendsen) (1891, p. 402, pl. 23, figs. 1a, b) from the highest Jurassic of Argentina, but differs from the holotype of that species by being more involute and by having much finer and denser ribbing. In these respects it shows more resemblance to the finer ribbed variants of *P. calistoides* (Behrendsen) illustrated by Steuer (1897, pl. 17, figs. 13–16) and Leanza (1945, pl. 5, figs. 5, 6) but appears to have more closely spaced and more flexuous ribs, fewer unbranched and intercalated ribs, and a more compressed subquadrate whorl section. Overall it differs from *P. calistoides* in much the same ways as it differs from *P. reedi* (Anderson).

Parodontoceras storrsi (Stanton) is much more involute than any of the described species of *Parodontoceras* from southern Europe. In rib pattern and whorl shape, however, it resembles *P. paramacilenta* Mazenot (1939, p. 127, pl. 20, figs. 1–3, pl. 21, fig. 1) from beds of early Berriasian age.

Type.—Holotype, USNM 23092.

Occurrence.—In California at USGS Mesozoic loc. 1084 associated with *Buchia piochii* (Gabb) from 2,000 to 3,000 feet below the top of the range of that species.

Parodontoceras cf. P. storrsi (Stanton)

Plate 12, figures 7, 8, 10

Two small specimens closely resemble the smallest exposed septate whorl of the holotype of *Parodontoceras storrsi* (Stanton) (1895, p. 79, pl. 17, figs. 1, 2) in amount of involution and fineness of ribbing. They are appreciably more involute and finer ribbed than specimens of *P. reedi* (Anderson) (1945, p. 978, pl. 6, fig. 10, pl. 7, fig. 3) at a comparable size.

Figured specimen.—USNM 161204.

Occurrence.—In California at USGS Mesozoic loc. 29489 associated with *Buchia* aff. *B. okensis* (Pavlow) in the lower part of its range. This occurrence is at least several hundred feet lower stratigraphically than that of *P. reedi* (Anderson) obtained about 1 mile to the north at UC loc. B–5094 and is several thousand feet higher than the occurrence of the holotype of *P. storrsi* (Stanton).

Parodontoceras reedi (Anderson)

Plate 11, figures 1–11, plate 12, figures 9, 12

Aulacosphinctes reedi Anderson, 1945, Geol. Soc. America Bull., v. 56, p. 978, pl. 6, fig. 10; pl. 7, fig. 3.

Aulacosphinctes watsonensis Anderson, idem, pl. 11, fig. 6 (not described).

This species, as herein interpreted, is represented by six septate internal molds of which some retain a little shell material.

The shell is discoidal, compressed, and evolute. The whorls are subquadrate in section, higher than wide, become higher during growth, and embrace about one-fourth of the preceding whorl. The flanks are flattened and subparallel. The venter is moderate in width and gently convex to nearly flat. The umbilicus is wide. The umbilical wall is low, steep, and rounds evenly into the flanks. The adult body chamber is not known.

The ribs on the smallest whorls (pl. 11, figs. 4, 5) up to a diameter of about 22 mm are sharp and moderately spaced. The primary ribs are radial on the umbilical wall, incline slightly forward on the flanks, recurve just above the middle of the flanks, and then bifurcate. The secondary ribs incline forward on the flanks and venter, are slightly reduced in strength along the midventral line, and are nearly as strong as the primary ribs.

The ribs on the next larger whorl (pl. 11, figs. 2, 3, 8) up to a diameter of about 60 mm are similar to those just described. They differ, however, by forking both above and below the middle of the flanks, by arching forward only slightly on the venter, and by not being reduced in strength along the midline of the venter except on the internal mold.

On the next larger septate whorl (pl. 11, figs. 7, 9), as represented by the holotype, the primary ribs are sharp, variably spaced, generally considerably narrower than the interspaces, and incline slightly forward to the middle third of the flanks. Bifurcation occurs at various heights but mostly on the middle third of the flanks and mostly below the middle. Some primary ribs remain simple. Some secondary ribs arise freely near the middle of the flanks, and some forked secondary ribs are indistinctly connected with the primary ribs. All secondary ribs incline forward gently on the upper parts of the flanks and cross the venter nearly transversely. Secondary ribs outnumber the primary ribs about 2 to 1 and are about as strong as the primary ribs.

On still larger septate whorls (pl. 11, figs. 1, 6, 10, 11) the ribbing on the flanks varies considerably in strength from weak to coarse, and many ribs do not fork. The interspaces vary considerably in width and on the lower parts of the flank are from two to three times wider than the primary ribs. The character of the ribbing on the adult body chamber is unknown. All septate whorls bear six or seven forwardly inclined constrictions.

Accurate measurements cannot be made because of poor preservation.

The suture line has a very broad unequally bifid first lateral saddle, a fairly narrow irregularly trifid second lateral saddle, a long irregularly trifid first lateral lobe that is considerably longer than the ventral lobe, and a suspensive lobe that descends fairly abruptly to the umbilicus. The appearance of the suture line is similar to that of *Parodontoceras calistoides* (Behrendsen) as figured by Steuer (1897, pl. 17, fig. 15), which differs by having a shorter first lateral lobe and an evenly descending supensive lobe.

This species is characterized by its evolute coiling, irregular bifurcation, and the presence of many simple ribs on its larger septate whorls. *Parodontoceras storrsi* (Stanton), redescribed herein, is much more involute, has fewer simple ribs, and rib furcation occurs somewhat higher on the flanks. Also, its suture line has a broader first lateral saddle and a more strongly retracted suspensive lobe.

Parodontoceras reedi (Anderson) in rib pattern resembles some specimens from the highest Jurassic beds in Mexico described by Burckhardt (1906, p. 139, pl.

39, fig. 6; 1912, p. 162, pl. 39, fig. 7; 1921, pl. 19, fig. 9) as *Berriasella* cf. *B. calistoides* Behrendsen, but it is more evolute and develops looser ribbing. It has much weaker ribbing than *Parodontoceras bifurcatum* (Castillo and Aguilera) (1895, p. 42, pl. 20, fig. 1) and slightly weaker and denser ribbing than a specimen described as *Hoplites calisto* (d'Orbigny) by Castillo and Aguilera (1895, p. 38, pl. 11, fig. 2). That specimen was considered by Stanton (1895, p. 80) and Burckhardt (1930, p. 80) to be related to *Hoplites storrsi* Stanton.

P. reedi (Anderson) shows considerable resemblance to the finer ribbed variants of *P. calistoides* (Behrendsen) from the highest Jurassic beds in Argentina as figured by Steuer (1897, pl. 17, figs. 13–16) and Leanza (1945, pl. 5, figs. 5, 6). Similarities include degree of involution, rib pattern, and presence of many simple and intercalated ribs. *P. reedi* is appreciably finer ribbed, however, than the holotype of *P. calistoides* (Behrendsen) (1891, p. 402, pl. 23, figs. 1a, b) but could be within the range of variation of that species, which according to Krantz (1928, p. 24) and Leanza (1945, p. 42) varies greatly in umbilical width, in shape, and in coarseness of ribbing. It is possible, therefore, that the California specimens herein called *P. reedi* (Anderson) may eventually be referred to *P. calistoides* (Behrendsen) when more complete and better preserved specimens are available for comparisons.

Compared with species of *Parodontoceras* from southern Europe (Mazenot, 1939, pl. 20, figs. 1–4; pl. 21, figs. 1, 6–9; pl. 22, figs. 1–3, 5, 6), *P. reedi* (Anderson) shows great resemblance in coiling and rib pattern to *P. ponticum* (Retowski) (1893, p. 256, pl. 10, fig. 9; Mazenot, 1939, p. 131, pl. 21, figs. 9a, b) from beds of early and middle Berriasian age. It differs mainly by having more unbranched ribs, furcation of ribs generally lower on the flanks, and a stouter whorl section. Both species greatly resemble *P. calistoides* (Behrendsen), but according to Mazenot (1939, p. 132), *P. ponticum* (Retowski) differs by lacking a midventral furrow. In reality *P. calistoides* (Behrendsen) also lacks a ventral furrow wherever the shell is preserved on the venter according to Leanza (1945, p. 41, 42).

Types.—Holotype, CAS 8715; holotypes, USNM 158845–158847 and UC 10097, 10098. The holotype of *Aulacosphinctes watsonensis* Anderson is CAS 8714.

Occurrences.—In California at CAS loc. 28037, UC loc. B–5094, USGS Mesozoic loc. M2253, M2599, and M3030. It is associated with a Jurassic variant of *Buchia okensis* (Pavlow) at all these localities or was collected within a few feet of that species.

Genus AULACOSPHINCTES Uhlig, 1910

Aulacosphinctes? sp. juv.

Plate 12, figures 1, 2

One small ammonite has fairly evolute coiling, a low rounded whorl section, and strong perisphinctoid ribbing. The ribs begin low on the umbilical wall, incline gently forward on the flanks, and arch weakly forward on the venter. The primary ribs are strong and fairly high, and most of them bifurcate near the middle of the flanks. The secondary ribs are slightly weaker than the primary ribs, and generally the adoral rib of each pair is in direct line with the primary rib. All secondary ribs terminate abruptly at a narrow, smooth area along the midline of the venter on the internal mold and also wherever shell material is preserved. The furcation points of the ribs are slightly swollen. Tubercles are not present. Interspaces are about twice as wide as the ribs. Constrictions are not present.

This ammonite shows all the features characteristic of *Aulacosphinctes*, but it is too small and immature for a positive generic identification. It was considered by Stanton (1895, p. 82) to be a small specimen of *Hoplites dilleri* Stanton (now referred to *Kossmatia*), but it has much coarser ribbing than that species at a comparable size.

Figured specimen.—USNM 23229.

Occurrence.—In California at USGS Mesozoic loc. 1003 in association with *Buchia piochii* (Gabb) and the holotypes of *Parodontoceras storrsi* (Stanton) and *Phylloceras knoxvillense* Stanton.

Aulacosphinctes? diabloensis Anderson

Plate 12, figure 3

Aulacosphinctes diabloensis Anderson, 1945, Geol. Soc. America Bull., v. 56, p. 980, pl. 2, fig. 2.

The holotype is a small, fragmentary, and immature specimen. It is fairly evolute and has a rounded whorl section. The characteristics of the venter are unknown. The flanks bear sharp moderately spaced radially trending primary ribs of which most bifurcate high on the flanks into slightly lower and broader secondary ribs. The furcation points are slightly swollen. Constrictions are not evident.

The specimen is not well enough preserved for a definite generic determination. Its ribbing does not match with any of the small perisphinctoid ammonites described herein under *Aulacosphinctes?*, *Parodontoceras*, or *Substeueroceras*.

Type.—Holotype, Philadelphia Acad. Sci. collection; plastoholotype, CAS 8710.

Occurrence.—In California from Bagley Creek near Mount Diablo, Contra Costa County.

Aulacosphinctes? jenkinsi Anderson

Plate 12, figures 5, 6

Aulacosphinctes jenkinsi Anderson, 1945, Geol. Soc. America Bull., v. 56, p. 979, pl. 13, figs. 3a, b.

This species is represented by two crushed external molds. It is characterized by fairly evolute coiling and by high, thin, slightly flexuous, widely spaced ribs that bifurcate near the middle of the flanks and incline gently forward high on the flanks. The characteristics of the venter are unknown. Tubercles are not present at the furcation points.

The ribbing of this species resembles that on *Substeueroceras stantoni* Anderson (1945, p. 982, pl. 11, figs. 3, 4, pl. 15, fig. 3) but is a little stronger and much more widely spaced at a comparable size. The ribbing is likewise similar to that on the inner whorls of *Substeueroceras santarosanum* (Burckhardt) (1906, p. 124, pl. 35) and of *Parodontoceras bifurcatum* (Castillo and Aguilera) (1895, p. 42, pl. 20, fig. 1). It is more flexuous than is typical of *Aulacosphinctes*, but without knowledge of the venter an assignment to that genus cannot be ruled out.

Type.—Holotype, CAS 8712; paratype, CAS 8713.

Occurrence.—In California at CAS loc. 28037.

Genus PASKENTITES Imlay and Jones, n. genus

This genus has a compressed, widely umbilicate shell that becomes more compressed and less widely umbilicate during growth. Its inner whorls are characterized by having high widely spaced primary ribs that bear tiny conical tubercles near the ventral margin. From these pass pairs of much weaker secondary ribs that project strongly forward on the venter. Its outer septate whorls are characterized by loss of tubercles, weakening of primary ribs, development of biplicate perisphinctoid ribbing, strong projection of secondary ribs on the venter, and a chevronlike rib pattern on the venter. A ventral groove is absent on septate whorls of medium to large size. *Paskentites paskentaensis* Imlay and Jones, n. sp. is designated as the type species of the genus.

The coronate inner whorls of *Paskentites* greatly resemble the adult whorls of the genus *Hemispiticeras* Spath (1925, p. 144) from the upper Tithonian of Argentina (Steuer, 1897, p. 154, pl. 8, figs. 1–4) but are a little more evolute and have more strongly projected secondary ribs. The perisphinctoid ribs on the outer whorls resemble those on the Late Jurassic genus *Kossmatia* (Arkell and others, 1957, p. L353) but are less dense and are less branched. The early Hauterivian genus *Speetoniceras* (Arkell and others, 1957, p. L349; Pavlow, 1886, pls. 1, 2) resembles *Paskentites* in appearance and in development, but its ribs branch lower on the flanks and project less strongly on the venter. The Tithonian genus *Windhauseniceras* Leanza (1945, p. 22; 1949, p. 239–242) has coronate inner whorls and perisphinctoid outer whorls as does *Paskentites*, but its ribs branch somewhat lower on the flanks and cross the venter transversely.

Paskentites paskentaensis Imlay and Jones, n. sp.

Plate 13, figures 11–17

This species is represented by eight specimens of which most are fragmentary and crushed laterally.

The coiling is highly evolute. The whorls are subquadrate in section, are higher than wide except possibly on the smallest inner whorls, and become higher during growth. The flanks are gently rounded on the small inner whorls but are flattened on the middle and outer whorls. The venter is narrowly rounded on the largest septate whorl and is probably moderately to narrowly rounded on the smaller whorls. The umbilicus is wide. Its wall is low, steep, and rounds evenly into the flanks. The body chamber is unknown but is possibly represented in part by the adoral one-fourth of the outermost whorl of the holotype.

On the small inner septate whorls the primary ribs are high, narrow, and fairly widely spaced. They begin near the line of involution, incline forward slightly on the flanks, are highest on the lower part of the flanks, weaken a little just above the middle of the flanks, and then terminate in small conical tubercles on the margin of the venter. From these tubercles arise pairs of low broad ribs that incline strongly forward on the venter. The midline of the venter is poorly exposed, but appears to be marked by a groove on one specimen at a diameter of about 18 mm. Several weak constrictions are present on each whorl.

On the middle and large septate whorls the primary ribs adorally gradually become lower, the tubercles weaker, and the points of rib furcation somewhat lower on the flanks. On the largest known septate whorl (pl. 13, figs. 16, 17) the primary ribs are low, narrow, moderately spaced, incline slightly forward, are slightly swollen low on the flanks, and are nontuberculate. They pass at about three-fifths of the height of the flanks into pairs of weaker secondary ribs that incline strongly forward and form chevrons along the midline of the venter. A few secondary ribs arise freely on the upper parts of the flanks between the tubercles. The midline of the venter does not bear a groove. The largest septate whorls bear several weak constrictions.

The holotype at a diameter of about 110 mm has a whorl height of 31 mm and an umbilical width of 55 mm. The suture line cannot be reproduced or described.

The features of this species do not fit those of any previously described genus. Its inner whorls in side view greatly resemble those of *Hemispiticeras steinmanni* (Steuer) (1897, p. 28, pl. 8, figs. 1–4) from the latest Jurassic of Argentina (Gerth, 1925, p. 124, 128). Its middle and outer septate whorls differ, however, by gradual loss of tuberculation, by becoming compressed laterally, and by the strong forward projection of secondary ribs on the venter. The inner whorls of the California species likewise resemble the small septate whorls of *Spiticeras* (*Kilianiceras*) gigas Leanza (1945, p. 74, 75, pl. 19, figs. 3, 4) from the upper Berriasian of Argentina. Its outer septate whorls differ, however, from comparable-sized whorls on the Argentina species by having weaker and sparser ribbing, by losing the ventrolateral tubercles at a smaller size, and by lacking umbilical tubercles.

Type.—Holotype, USNM 161205; paratypes. USNM 161206–161208.

Occurrences.—In California at USGS Mesozoic locs. 29596, 29598, and questionably at M703 in association with *Buchia pacifica* Jeletzky. South of Mill Creek it occurs in the middle third of *Buchia pacifica* beds and is associated with *Kilianella crassiplicata* (Stanton) at Mesozoic loc. 29596.

Genus THURMANNICERAS Cossman, 1901

Thurmanniceras stippi (Anderson)

Plate 13, figures 7–9

Neocomites stippi Anderson, 1938, Geol. Soc. America Spec. Paper 16, p. 166, pl. 29, fig. 2.

Thurmanniceras stippi (Anderson), Imlay, 1960, U.S. Geol. Survey Prof. Paper 334–F, p. 216, pl. 39, figs. 1–5, 8–10.

Recognition of this species is a little difficult because the holotype is a fragmentary, crushed internal mold on which the ribbing is indistinctly shown and because well-preserved specimens have not been found at the type locality (CAS loc. 144) on McCarty Creek, Calif. Recently, however, one fairly well-preserved fragment (pl. 13, fig. 7) bearing ribbing similar to that in the holotype has been found (USGS Mesozoic loc. M3059) about 3 miles northeast of the type locality at a similar stratigraphic position. An associated small ammonite (pl. 13, fig. 9) that bears similar ribbing appears to be an immature form of the same species.

Thurmanniceras stippi (Anderson), as interpreted by these specimens, is characterized by a compressed whorl section, a moderately wide umbilicus, a steeply inclined umbilical wall, and fairly coarse gently flexuous ribs. All ribs begin singly near the umbilicus, and about two-thirds of them bifurcate on the middle third of the flanks. On the small whorls the ribs terminate ventrally in tubercles that bound a smooth midventral area. On the large whorls the ribs are slightly swollen ventrally but continue across the venter with only slight reduction in strength. Constrictions are present on the small whorls.

This species differs from *T. californicum* (Stanton) (1895, p. 76, 77, pl. 15, figs. 5, 6; Imlay, 1960, p. 214, pl. 39, figs. 11–15), which occurs at a lower stratigraphic level associated with *Buchia pacifica* Jeletzky, by its ribs being sharper, more flexuous, and more distinctly forked. It differs from *T. jenkinsi* (Anderson) (1938, p. 165, pl. 29, fig. 1; Imlay, 1960, pl. 40, figs. 1, 2, 6, 7, 9) by its ribs being much coarser, more widely spaced, less flexuous, and not fasciculate.

Thurmanniceras stippi (Anderson) has been collected only in beds characterized by *Buchia keyserlingi* (Lahusen), above the range of *B. pacifica* Jeletzky and mostly below *T. jenkinsi* (Anderson). The holotype of *T. stippi* (Anderson) was recorded (Anderson, 1938, p. 166) from the south bank of McCarty Creek opposite Burt's Ranch house in the NE¼ sec. 29, T. 24 N., R. 6 W., Paskenta quadrangle. The holotype of *T. jenkinsi* (Anderson) was recorded (Anderson, 1932, p. 322; 1938, p. 165) about 1,000 feet higher on the same creek. Similarly *T. jenkinsi* was found (Mesozoic loc. M3058) about 1,080 feet higher than *T. stippi* (Mesozoic loc. M3059) in the hills one-half mile south of Mill Creek in the central and east-central parts of sec. 9, T. 24 N., R. 6 W. Both species are recorded together, however, a little farther north about one-half mile east of the Wilcox Ranch house in the NE¼ sec. 4, T. 24 N., R. 6 W. (USGS Mesozoic locs. 1091, M1579). Still farther north near the road in sec. 28, T. 25 N., R. 6 W., *T.* cf. *T. stippi* (Anderson) was found (Mesozoic loc. M3082) in beds that appear to underlie an occurrence of *T. jenkinsi* (Anderson) (Mesozoic loc. 3083). These last occurrences, however, are in a zone of faulting, and consequently the apparent superposition of beds may not be real.

Types.—Holotype, CAS 10465; hypotypes, USNM 129836, 129837a, b, 158848, 158849.

Occurrences.—In California at USGS Mesozoic loc. 1091, M3059, and M3084 and CAS loc. 144. Fragments resembling immature forms of this species occur as Mesozoic locs. M1580, and M3082. The species is associated with *Buchia keyserlingi* (Lahusen) at all these localities. In addition, a fragment of *Thurmanniceras* (pl. 13, fig. 10) similar to *T. stippi* (Anderson) was found at Mesozoic loc. 29593 near the base of the beds containing *Buchia pacifica.*

Thurmanniceras jenkinsi (Anderson)

Plate 13, figures 1–6

For synonymy and descriptions see Imlay, 1960, p. 215–216, pl. 40, figs. 1, 2, 6, 7, 9.

This species is characterized by a compressed whorl section, by flattened flanks, and by its ribs being fairly thick, low, very closely spaced, strongly flexuous, and fasciculate. Some small specimens from a single locality are ilustrated herein to show the ribbing of the species and to supplement the illustrations previously published.

Types.—Holotype, CAS 8775; hypotypes, USNM 23223, 129859, 129860, and 158850.

Occurrences.—In California at CAS loc. 33502, UC loc. B–5085, and USGS Mesozoic locs. 1088, 1091, M1575, M1577, M1578, M1579, M3058, M3083, and probably also M2040. In Oregon at Mesozoic loc. 2154. In California the species occurs in the beds characterized by *Buchia keyserlingi* (Lahusen). Its highest known occurrence in California is near Nevada Creek in the Paskenta quadrangle (UC loc. B–5085) about 2,450 feet above the top of the *Buchia pacifica* beds and about 680 feet below an occurrence of *Hertleinites pecki* Imlay (UC loc. B–5089) (Imlay, 1960, p. 208, pl. 43).

Genus NEOCOMITES Uhlig, 1905

Neocomites cf. N. wichmanni Leanza

Plate 14, figures 1–15

cf. *Neocomites wichmanni* Leanza, 1945, La Plata Univ. Nac. Mus. Anales, new ser., Paleontologia, sec. A, no. 1, p. 61, pl. 12, figs. 2, 3.

This species is represented by 30 fragmentary molds of which most have been crushed. The shell before crushing was probably discoidal, compressed, and moderately evolute. One small specimen (pl. 14, figs. 14, 15) has a whorl section that is considerably higher than wide. One larger specimen (pl. 14, figs. 2–4) at its apparently undeformed adoral end is subquadrate in section and only slightly higher than wide. On this specimen the outermost preserved whorl embraces nearly half of the next inner whorl and has a vertical umbilical wall.

The ribs on the small specimens are high, narrow, moderately spaced, are inclined forward on the flanks, and become stronger ventrally. Some begin on the umbilical wall, and others begin low on the flanks. Many of the ribs are swollen radially on the umbilical edge. Forking of the ribs is common at the umbilical edge and on the middle third of the flanks, but many ribs remain simple. Some secondary ribs arise freely on the flanks, and others are indistinctly connected with the longer ribs or with the umbilical swellings. All ribs terminate ventrally in the acute tubercles that incline forward and that, on the internal mold, border a smooth midventral area. The interspaces are a little wider than the ribs.

During growth the ribs on the flanks become somewhat coarser, more closely spaced, and more flexuous. On the largest preserved septate whorls the primary ribs on the umbilical wall are high, thin, widely spaced, are radially arranged, and terminate on the umbilical edge in weak radially elongate tubercles. From these tubercles arise pairs of ribs, or less commonly single ribs that are sharp, flexuous, and become slightly stronger ventrally. Some ribs fork again on the middle half of the flanks.

Other ribs arise freely at various heights on the flanks. All ribs are slightly swollen and are inclined forward on the margins of the venter but are not tuberculate ventrally. The midventral area on the internal mold bears weak, forwardly arched continuations of the ribs.

This species is assigned to *Neocomites* rather than *Subthurmannia* because of the presence of a vertical umbilical wall and the lack of constrictions. It differs from species of *Thurmanniceras* by having a vertical umbilical wall, umbilical tubercles, rib branching at the umbilical edge, and by lacking constrictions. It bears a general resemblance to *Neocomites wichmanni* Leanza (1945, p. 61, pl. 12, fig. 2, 3) from Valanginian beds in Argentina in having strongly flexuous, fairly closely spaced ribs and a fair number of simple ribs, but appears to have slightly coarser ribs on its inner whorls. Its general appearance is also similar to that of the typical variant of *N. neocomiensis* (d'Orbigny) (Sayn, 1907, pl. 3, figs. 10, 11), but it has fewer furcating ribs on the flank and is probably more involute.

Figured specimens.—USNM 158841 a and b, 158842 a–e.

Occurrences.—USGS Mesozoic loc. M2679 and M2680.

Neocomites cf. N. neocomiensis (d'Orbigny)

Plate 14, figure 16

One ammonite is represented by a nearly undeformed internal mold. It has a high subquadrate whorl section, a flat venter, and flat flanks that converge slightly toward the venter. The outer whorl embraces about half of the preceding whorl. The umbilical wall on the inner whorls is low, vertical, and rounds evenly into the flanks. On the outer whorl the umbilical wall becomes high, vertical, and rounds abruptly into the flanks. The outermost half whorl is nonseptate. The aperture is unknown. The ribs are fine and rather closely spaced. They begin on the upper part of the umbilical wall, trend radially to the umbilical edge, and incline slightly forward on the flanks in a gently flexuous manner. They are distinctly swollen on the umbilical edge of the outermost half whorl. Most ribs bifurcate low on the flanks a little above the umbilical edge, and some bifurcate again above the middle of the flanks. Some ribs remain simple, and some arise freely low on the flanks. All ribs terminate ventrally in tubercles that on the internal mold border a smooth midventral area.

At a diameter of 39 mm, the whorl height is 18 mm and the umbilical width is 11 mm.

This ammonite differs from *N.* cf. *N. wichmanni* Leanza, with which it is associated, by having somewhat finer ribbing, a wider umbilicus, less distinct umbilical tubercles at a comparable size, and by rib branching occurring a little above instead of at the umbilical edge. In these respects it shows more resemblance to a finely ribbed variant of *N. neocomiensis* (d'Orbigny) figured by Sayn (1907, pl. 3, figs. 5a, b) as var. *subtenuis*, but has fewer furcating ribs on the upper parts of the flanks. The typical variant cf. *N. neocomiensis* (d'Orbigny) as figured by Sayn (1907, pl. 3, figs. 10, 11) apparently has slightly coarser and more flexuous ribbing.

Figured specimen.—USNM 158843.

Occurrence.—USGS Mesozoic loc. M2680. The species is possibly represented also at Mesozoic locs. 29485 and 29557.

Neocomites cf. N. neocomiensis (d'Orbigny) var. premolica (Sayn)

Plate 14, figures 17–19

One species is represented by the internal and external molds of a single specimen which has been compressed laterally. It has high flattened flanks, a narrow flattened venter, and a low, vertical umbilical wall. The outer whorl overlaps about three-fifths of the next inner whorl. The ribs are fairly high, moderately spaced, and gently flexuous. Most ribs arise on the umbilical wall and bifurcate at various heights on the middle third of the flanks. A few ribs remain simple. On the adoral fourth of the outer whorl all ribs are swollen at the umbilical edge, and some ribs arise in pairs from the umbilical swellings. All ribs terminate ventrally in forwardly inclined tubercles that border a smooth midventral area. The ribs are not swollen at their furcation points on the flanks.

This species is assigned to *Neocomites* rather than *Thurmanniceras* because of a lack of constrictions and because the ribs bifurcate at various heights on the middle third of the flank instead of at a uniform height above the middle of the flanks. Its ribbing is comparable with that of some of the most coarsely ribbed variants of *Neocomites neocomiensis* (d'Orbigny) figured by Sayn (1907, pl. 3, figs. 4, 7, 8) as var. *premolica* and is appreciably coarser and less flexuous than the typical variant of that species (Sayn, 1907, pl. 3, figs. 11a, b).

Figured specimen.—USNM 158844.

Occurrence.—USGS Mesozoic loc. M2680.

Genus KILIANELLA Uhlig, 1905

Kilianella crassiplicata (Stanton)

Plate 14, figures 27–31

For synonymy and descriptions see Imlay, 1960, p. 218, pl. 42, figs. 1–5, 7.

The close resemblance of this species to *Kilianella roubaudi* (d'Orbigny), as discussed previously (Imlay, 1960, p. 218), is strongly supported by the discovery of several additional specimens. Two of these (pl. 14, figs. 29, 31) bear ribbing comparable in coarseness with some specimens figured by Sayn (1907, pl. 6, figs. 10a, b and 14). Another specimen (pl. 14, fig. 30) bears somewhat finer, sharper, and denser ribbing closely similar to that on another specimen of *K. roubaudi* figured by Sayn (1907, pl. 6, fig. 9). Apparently *K. crassiplicata* (Stanton) differs from *K. roubaudi* (d'Orbigny) mainly in having a more compressed whorl section.

Kilianella crassiplicata (Stanton) has been found at four stratigraphic positions within the beds characterized by *Buchia pacifica* Jeletzky. Its lowest occurrence (UC A–2925) is about at the top of the lower fourth of those beds, or about 550 feet above their base. Its highest occurrence (USGS Mesozoic loc. 29597) is about 200 feet below their top. The specimen herein shown on plate 14, figure 31, (USGS Mesozoic loc. 29596) was collected about 650 feet below the top of the *B. pacifica* beds, or about at the base of their upper third. The other specimens described previously were obtained near the middle of the *B. pacifica* beds.

Types.—Holotype, USNM 23094; hypotypes, USNM 129684, 161210, 161211; hypotype, UC 10095.

Occurrences. — USGS Mesozoic locs. 1001, 5339, 29596, 29597; UC loc. A–2925.

Genus SARASINELLA Uhlig, 1905

Sarasinella cf. S. subspinosa Uhlig

Plate 12, figures 13–15

This species is represented by one specimen that includes a fairly complete external mold and part of an internal mold. Some shell material is preserved. The internal mold is septate and undeformed at its adapical end and is crushed at its adoral end. It apparently represents part of a body chamber.

The shell is discoidal, moderately compressed, and fairly evolute. The whorls are ovate in section, probably a little higher than wide, and overlap about one-third of the preceding whorl. The flanks are gently convex and round evenly into the umbilical wall and venter. The venter is slightly flattened. The umbilicus is fairly wide. The umbilical wall is fairly low and steep at its base.

The innermost whorl, as exposed in the umbilicus, bears sharp widely spaced radially trending ribs of variable strength. Some of the strongest ribs bear lateral tubercles just below the line of involution. On the succeeding whorl the ribs are widely spaced, are alternately strong and weak, and the strong ribs bear both weak umbilical tubercles and prominent lateral tubercles. On the outermost septate whorl the ribs on the flanks are sharp, fairly widely spaced, and highly variable in strength. About every third or fourth rib is much stronger than the intervening ribs and bears prominent umbilical and lateral spines. The weaker intervening ribs are not tuberculate on the flanks, but some are slightly swollen on the lower part of the flanks near the zone of umbilical tubercles. Pairs of ribs arise from some of the unbilical spines. The characteristics of the ribs on the venter of the internal whorls are unknown.

On the outermost nonseptate half whorl the ribbing adorally becomes less sharp, nearly uniform in strength, and more flexuous. About every third or fourth rib bears a high conical umbilical spine from which branch a pair of ribs. A few of these ribs and a few of the intervening ribs bifurcate again between the middle and the upper fourth of the flanks. None of the ribs bears lateral tubercles, but all bear radially elongate ventral tubercles of slightly unequal strength that border a midventral furrow. The midventral area is marked by weak continuations of the ribs wherever the shell is preserved on the venter, but is fairly smooth on the internal mold.

This species bears ribbing on its outer whorl similar to that on *Sarasinella subspinosa* (Uhlig) (1910, p. 239, pl. 90, figs. 4a–c; Spath, 1939, pl. 16, figs. 2a, b) but has much coarser ribbing on its inner whorls. It is more involute and has coarser ribbing than *S. uhligi* Spath (1939, p. 99, pl. 12, fig. 5, pl. 14, figs. 1a, b, pl. 21, figs. 5, 6) at a comparable size. *S. chichalensis* Spath (1939, p. 101, pl. 21, figs. 3, 4) has much coarser and sparser ribbing.

Figured specimen.—USNM 158852.

Occurrence.—In California at USGS Mesozoic loc. M3060 in association with *Buchia keyserlingi* (Lahusen) about 100 feet above beds containing *Tollia mutabilis* (Stanton) and the highest occurrence of *Buchia pacifica* Jeletzy.

Sarasinella cf. S. uhligi Spath

Plate 12, figure 4

One ammonite fragment has a fairly high vertical umbilical wall, a rounded umbilical edge, flattened flanks, and fairly strong forwardly inclined ribs of which most arise in pairs from umbilical tubercles. Generally the adoral branch of each pair forks again on the middle third of the flank, and generally the furcation point is swollen or weakly tuberculate. The ribs become slightly swollen and project forward on the margin of the venter.

The fragment has a rib pattern similar to that on the larger septate whorls of *Sarasinella uhligi* Spath (1939, p. 99, pl. 14, figs. 1a, b, pl. 21, fig. 5a). Its ribbing also resembles that on *S. campylotoxa* Uhlig (1902, p. 49, pl. 4, figs. 1–3; Sayn, 1907, pl. 4, fig. 12) but appears to be less flexuous and to fork less commonly on the flanks.

Figured specimen.—UC 10096.

Occurrence.—In California at US loc. 2605. This locality should be near USGS Mesozoic loc. 1088 and either in the top of the *Buchia pacifica* beds or in the basal part of the *Buchia keyserlingi* beds.

Genus NEOCOSMOCERAS Blanchet, 1922

Neocosmoceras euchrense Imlay and Jones, n. sp.

Plate 14, figures 23–26

?*Distoloceras* sp. Anderson, 1945, Geol. Soc. America Bull., v. 56, p. 983, pl. 14, fig. 4.

One internal mold, retaining some shell material, shows parts of three whorls and has been slightly compressed laterally.

The shell is discoidal, compressed, and highly evolute. The whorls are subquadrate in section, are a little higher than wide, become higher during growth, and embrace about one-fourth of the preceding whorl. The flanks are flattened. The venter is flat on the inner septate whorls and is only slightly convex on the body chambers. The umbilicus is wide. The umbilical wall is gently inclined and rounds evenly into the flanks. The body chamber is represented by three-fifths of a whorl and is probably nearly complete, as indicated by the presence of forwardly arched flank ribs at the adoral end of the specimen. Such ribs are suggestive of the basal parts of lateral lappets.

The ornamentation on the smallest whorl consists of strong simple, unbranched ribs and of radially elongate lateral and ventral tubercles. The ribs begin near the umbilicus, incline slightly forward on the flanks, and terminate ventrally along a smooth mid-ventral area. They are strong, high, and moderately spaced on the lower part of the flanks below the lateral tubercles and are a little lower, broader, and rather closely spaced on the upper part of the flanks.

The ornamentation on the next larger whorl consists mostly of simple, very widely spaced, nearly radial ribs and of prominent rounded lateral and ventral tubercles. The ribs begin weakly on the umbilical wall, are swollen at the umbilical edge, are fairly high and narrow on the lower parts of the flanks below the lateral tubercles, and are somewhat lower and weaker on the upper parts of the flanks. The ventral tubercles border a smooth midventral area.

The ornamentation on the outer whorl consists of strong widely spaced umbilical and ventral tubercles, of weak widely spaced lateral tubercles, and of irregularly spaced weak to fairly weak, slightly flexuous ribs. The umbilical tubercles are round, the lateral tubercles are round to radially elongate and become weaker adorally, and the ventral tubercles are spirally elongate. The ventral tubercles are merely the bases of prominent ventral spines of which one is preserved in the matrix. Most ribs arise singly from the umbilical tubercles, a few arise in pairs from the umbilical tubercles, and still others arise freely on the flanks. A few ribs bear a weak lateral tubercle. Some ribs terminate in the ventral tubercles, and other ribs terminate freely high on the flanks or between the ventral tubercles. The ventral tubercles generally mark the termination of two adjoining ribs that may or may not arise as a pair from an umbilical tubercle. The venter is nearly smooth except for broad undulations connecting the ventral tubercles. Faint flexuous striae are present on the flanks and the venter.

The specimen at a diameter of 62 mm has a whorl height of 25 mm, a whorl thickness of 20 mm, and a probable umbilical width of 21 mm. The whorl section before compression was probably a little thicker.

This species from Oregon is assigned to *Neocosmoceras* rather than *Protacanthodiscus* because of the presence of coarse unbranched widely spaced trituberculate ribs on its small septate whorls, of prominent widely spaced spirally elongate tubercles on the venter of its body chamber, and of forwardly arched flank ribs suggestive of lateral lappets at the adoral end of the body chamber. *Protacanthodiscus*, by contrast, has closely to moderately spaced biplicate ribs on its inner whorls; it does not develop umbilical tubercles until it attains a fairly large size; its ventral tubercles on the adult body chamber are generally moderately to closely spaced and are arranged radially or tangentially; and its body chamber terminates simply instead of bearing lateral lappets.

Neocosmoceras euchrense Imlay and Jones, n. sp. is similar in side view to *Distoloceras* sp. of Anderson (1945, p. 983, pl. 14, fig. 4), which is recorded from 1,200 feet west of the iron bridge across Grindstone Creek, Glenn County, Calif. Unfortunately the specimen was not described and now appears to be lost. It was found at the same locality as *Protacanthodiscus taffi* (Anderson), redescribed herein, and could be an adult of that species.

N. euchrense differs from most species of *Neocosmoceras* by having somewhat weaker ornamentation and a more compressed whorl section. It shows some resemblance to a plesiotype of *N. sayni* (Simionescu) illustrated by Mazenot (1939, pl. 28, figs. 9a, b) but has less evolute coiling, weaker tubercles, and finer ribs. It differs from *N. perornatus* (Retowski) (1893, p. 270, pl. 12, fig. 5) by having stronger tubercles and slightly weaker ribs. Its outermost septate whorl has much stronger ribbing than the fragmentary probable holotype of *N.? crossi* (Anderson) illustrated herein.

Type.—Holotype, USNM 158851.

Occurrence.—In Oregon from outcrops along a beach at USGS Mesozoic loc. 2074 in association with *Proniceras* sp. juv., abundant *Buchia uncitoides* (Pavlow), and a few specimens of *B. piochii* (Gabb). The two species of *Buchia* are preserved in a slightly different colored matrix, which suggests that they were collected from different beds.

Neocosmoceras? crossi (Anderson)

Plate 14, figures 20–22

Protacanthodiscus crossi Anderson, 1945, Geol. Soc. America Bull., v. 56, p. 984.

This species was not illustrated by Anderson, but one fragment of a whorl in the California Academy of Sciences fits the description fairly well, is from the correct locality, and is labeled "apparently holotype."

The whorl fragment is subquadrate in section and is a little wider than high. It is characterized by the presence of widely spaced ventral and lateral tubercles and by widely spaced weak ribs. The ventral tubercles are prominent and spirally elongate. The lateral tubercles are weak and radially elongate. The flanks are almost smooth but bear variably weak forwardly inclined ribs of which some are connected with the lateral and ventral tubercles. The venter is even smoother than the flanks but bears faint traces of ribs and striae. The umbilical edge and wall are not preserved. The dorsum bears the imprint of the venter of an inner whorl. This venter has a smooth midventral area and many low, broad, evenly spaced ribs that terminate ventrally in conical ventral tubercles. Evidently the venter of the inner whorl has much denser and more regular ribbing and tuberculation than the venter of the outer whorl.

The holotype of *P.? crossi* Anderson is too fragmentary to warrant a positive generic identification, although the presence of prominent widely spaced, spirally arranged ventral tubercles suggests an assignment to *Neocosmoceras* rather than *Protacanthodiscus*. Also it shows some resemblance to the outermost septate whorl of the specimen of *Neocosmoceras* from Oregon described herein.

Type.—Holotype, CAS 10448.

Occurrence.—In California at CAS loc. 28667.

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INDEX

[Italic page numbers indicate both major references and descriptions]

PLATES 1–15

PLATE 1

[All figures natural size unless otherwise indicated]

FIGURES 1–8. *Phylloceras? contrarium* Imlay and Jones, n. sp. (p. B28).

1–3. Paratype, USNM 158806 from USGS Mesozoic loc. M2605. Shows adapically inclined ribbing on the upper parts of the flanks.

4. Suture line (× 2) of paratype, USNM 158807 from USGS Mesozoic loc. 29489. Suture line drawn at diameter of 30 mm and whorl height of 19 mm.

5. Lateral view of small nearly smooth paratype, USNM 158805 from USGS Mesozoic loc. M2605.

6–8. Cross section and ventral and lateral views of holotype, USNM 158804 from USGS Mesozoic loc. 29493. Ventral view is oriented with adoral end down.

9, 10. *Phylloceras glennense* Anderson (p. B28).

Holotype CAS 8720 from CAS loc. 28037.

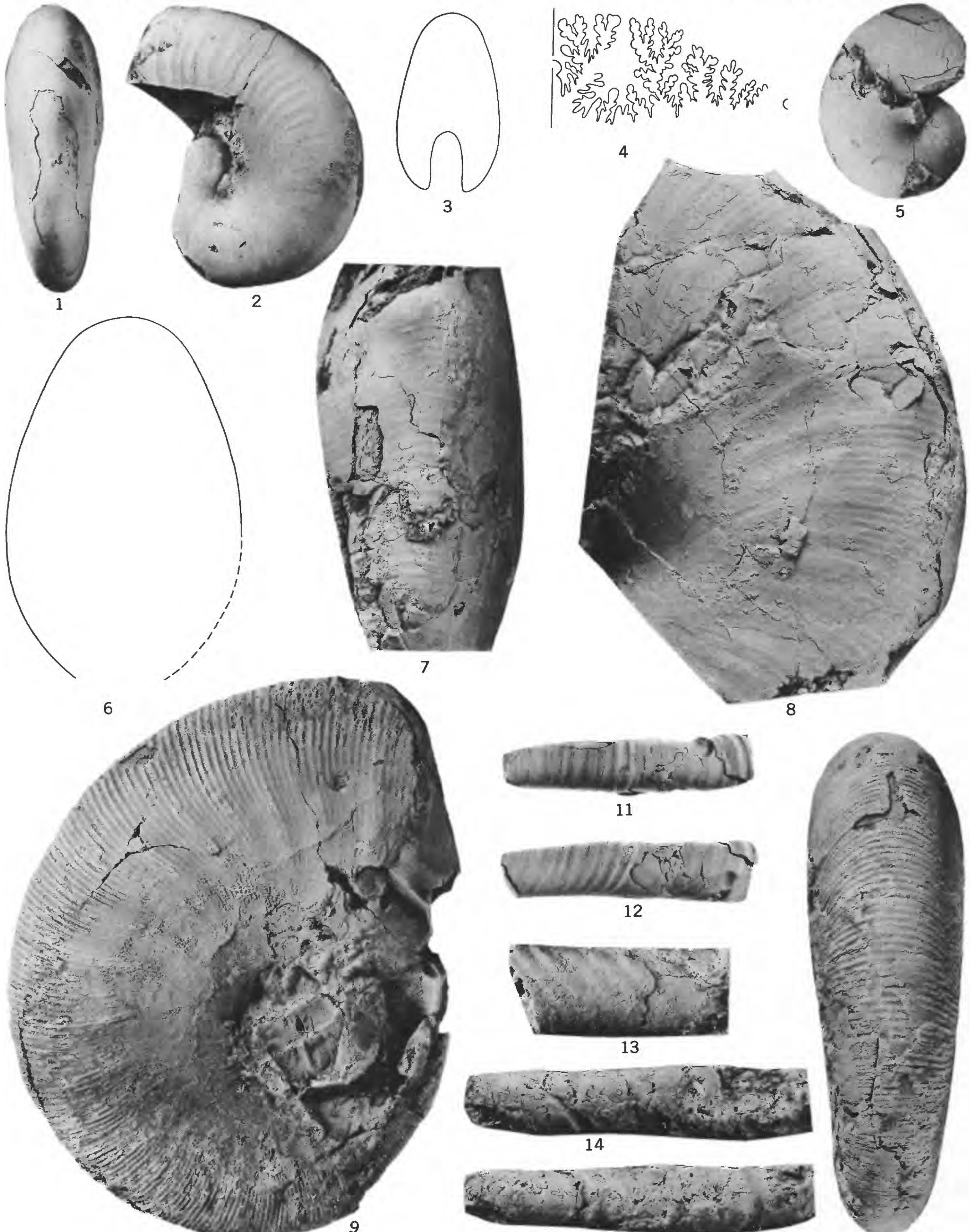
11, 12. *Bochianites? glennensis* Anderson (p. B30).

Ventral and lateral views of holotype, CAS 5959 from CAS loc. 28037. Generic assignment is questioned because ribs cross venter transversely.

13–15. *Bochianites paskentaensis* Anderson (p. B30).

13. Lateral view of a large nonseptate fragment of hypotype, USNM 161185 from USGS Mesozoic loc. 29595. Adoral end is on left.

14, 15. Lateral and ventral views (× 2) of hypotype, USNM 161184 from USGS Mesozoic loc. 29595. Adoral end is on right.



PHYLLOCERAS, PHYLLOCERAS?, *BOCHIANITES*?, AND *BOCHIANITES*

PLATE 2

[All figures natural size]

FIGURES 1–3. *Lytoceras colusaense* (Anderson) (p. B29).

1. Holotype, CAS 10446 from CAS loc. 28842.
2. Hypotype, CAS 10462 from CAS loc. 28037. Described by Anderson (1945, p. 977) as *Lytoceras* aff. *L. exoticum* Oppel.
3. Hypotype, CAS 10461 from CAS loc. 28037. Described by Anderson (1945, p. 977) as *Lytoceras* aff. *L. liebigi* (Oppel).

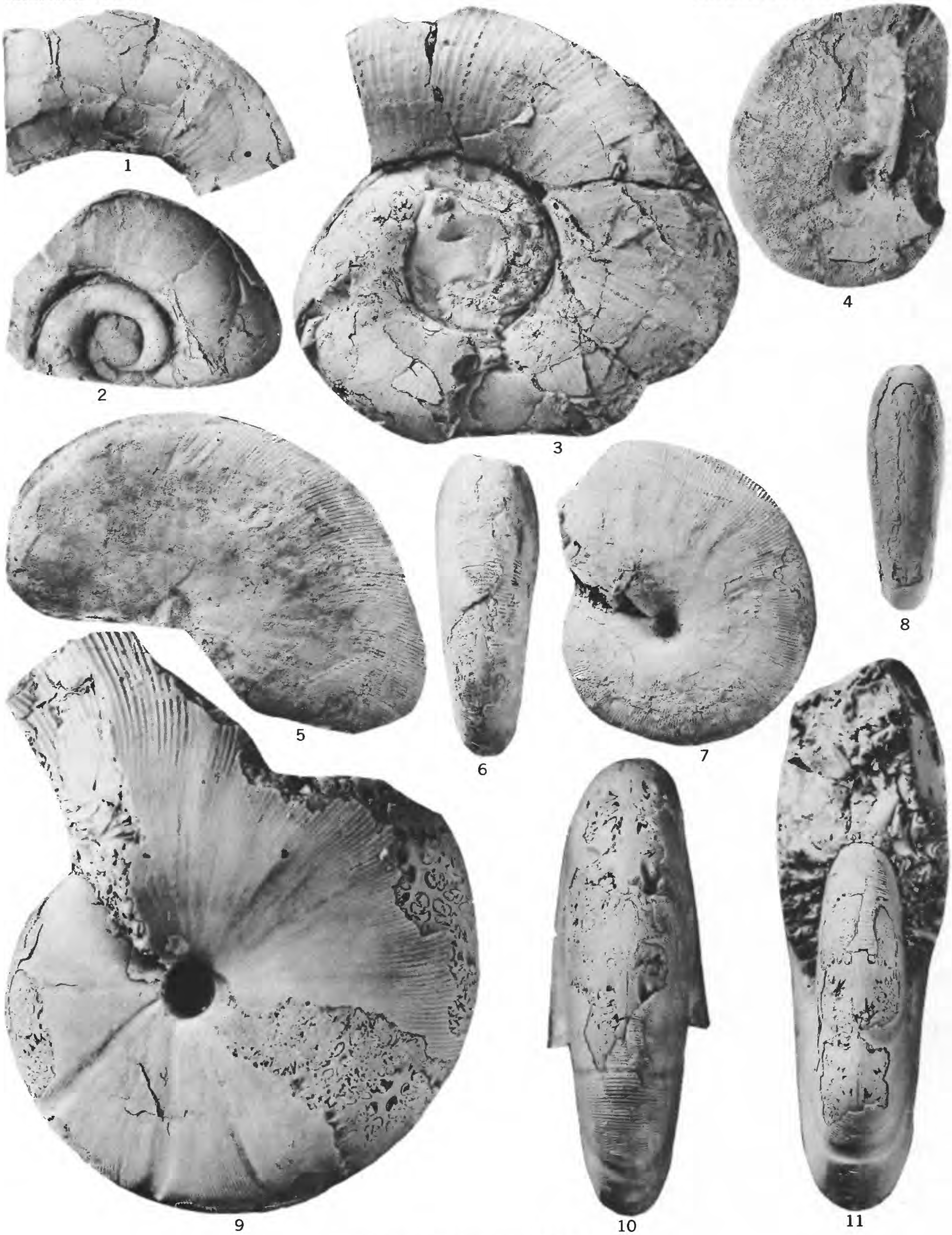
4–11. *Phylloceras knoxvillense* Stanton (p. B28).

4, 8. Hypotype, CAS 8735 from CAS loc. 28037.

5. Hypotype, CAS 8716 from CAS loc. 28494. Described by Anderson (1945, p. 977) as holotype of *P. capellense* Anderson.

6, 7. Hypotype, USNM 158803 from USGS Mesozoic loc. 29558.

9–11. Holotype, USNM 23083 from USGS Mesozoic loc. 1084.



LYTOCERAS AND *PHYLLOCERAS*

PLATE 3

[All figures natural size unless otherwise indicated]

FIGURES 1, 2. *Kossmatia tehamaensis* Anderson (p. B31).
Holotype, UC 5956 from UC loc. A–2921.

3, 4. *Kossmatia kleinsorgensis* Anderson (p. B31).
Holotype, CAS 8711 from CAS unnumbered locality 1 mile east of the Kleinsorg mine in sec. 26, T. 25 N., R. 7 W., Paskenta quadrangle, California.

5–7. *Kossmatia dilleri* (Stanton) (p. B30).
Holotype, USNM 21573 from USGS Mesozoic loc. 666.

8, 11–16. *Proniceras maupinense* Imlay and Jones, n. sp. (p. B32).
8. Rubber imprint of external mold of paratype, USNM 161189 from USGS Mesozoic loc. 29592.
11, 12. Holotype, USNM 161186 from USGS Mesozoic loc. 29589.
13, 14. Lateral view and suture line (× 4) (drawn at whorl height of 8 mm) of paratype USNM 161187 from USGS Mesozoic loc. 29589.
15, 16. Internal mold with some shell adhering and rubber imprint of external mold of paratype, USNM 161188 from USGS Mesozoic loc. 29591.

9, 10. *Proniceras* sp. juv. (p. B32)
Ventral and lateral view (× 2) of specimen, USNM 158808 from USGS Mesozoic loc. 2074.

17. *Spiticeras* (*Spiticeras*) cf. *S.* (*S.*) *obliquenodosum* Retowski (p. B33).
Laterally crushed internal mold with some shell adhering of specimen, USNM 158812 from USGS Mesozoic loc. M2253.

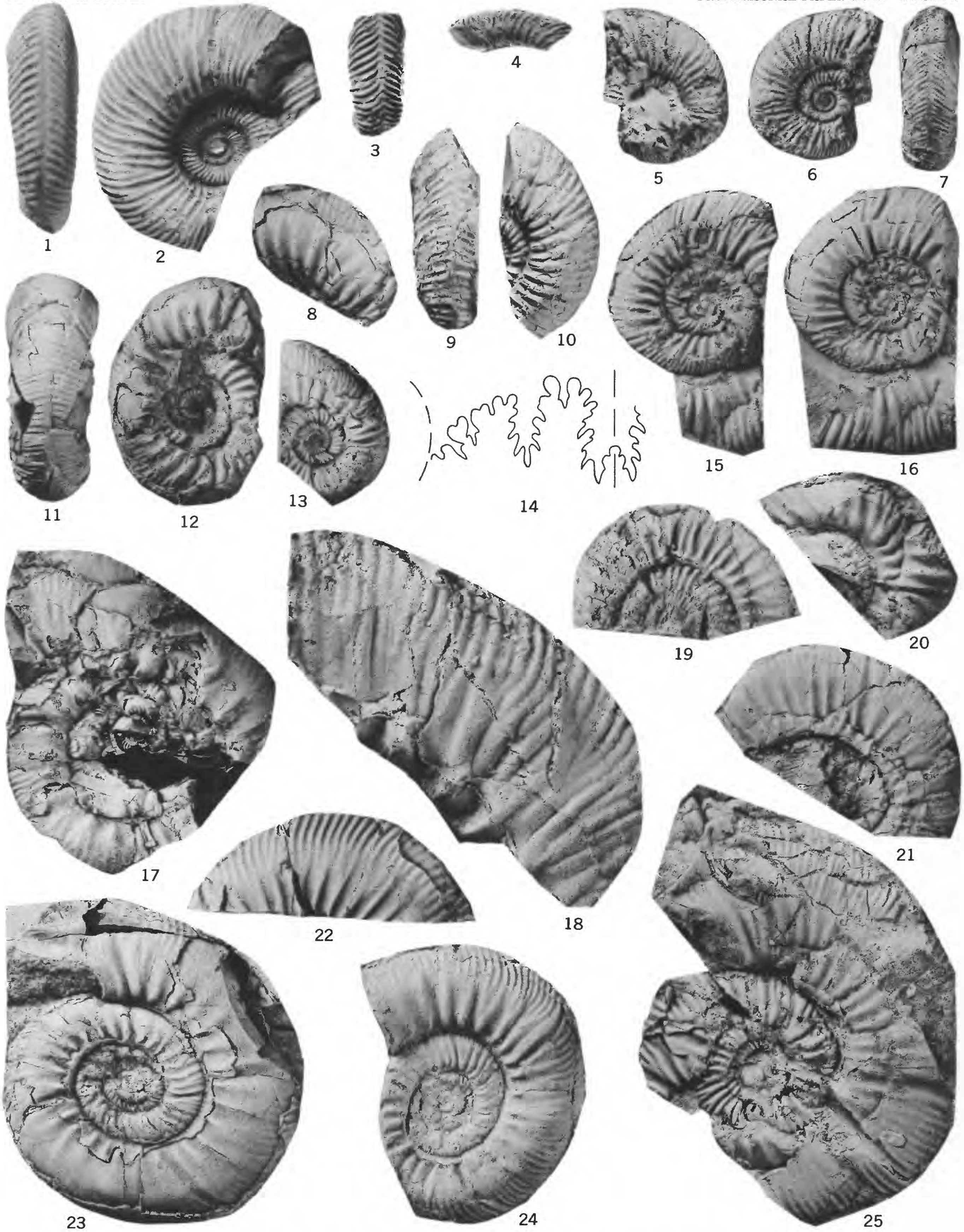
18. *Spiticeras* (*Spiticeras*) cf. *S.* (*S*). *uhligi* Burckhardt (p. B33).
Rubber imprint of external mold of specimen, USNM 158811 from USGS Mesozoic loc. M3092.

19,21. *Spiticeras* (*Kilianiceras*?) sp. juv. (p. B34).
Lateral views of internal molds of specimens, USNM 158814 from USGS Mesozoic loc. 24702.

20. *Spiticeras* (*Spiticeras*) cf. *S.* (*S*). *serpentinum* Burckhardt (p. B33).
Rubber imprint of external mold of specimen, USNM 158810 from USGS Mesozoic loc. M2598.

22,25. *Spiticeras* (*Spiticeras*?) n. sp. undet. (p. B34).
Laterally crushed internal molds retaining some shell material. Note lateral lappet in figure 25. Specimens, USNM 158813 from USGS Mesozoic loc. M2605.

23,24. *Spiticeras* (*Spiticeras*) cf. *S.* (*S*). *cautleyi* (Oppel) (p. B33).
23. Internal mold with some shell adhering. Specimen, USNM 158809 from USGS Mesozoic loc. 3348.
24. Rubber imprint of external mold of same specimen shown in figure 23.



KOSSMATIA, *PRONICERAS*, *SPITICERAS*, AND *S*. (*KILLIANICERAS*?)

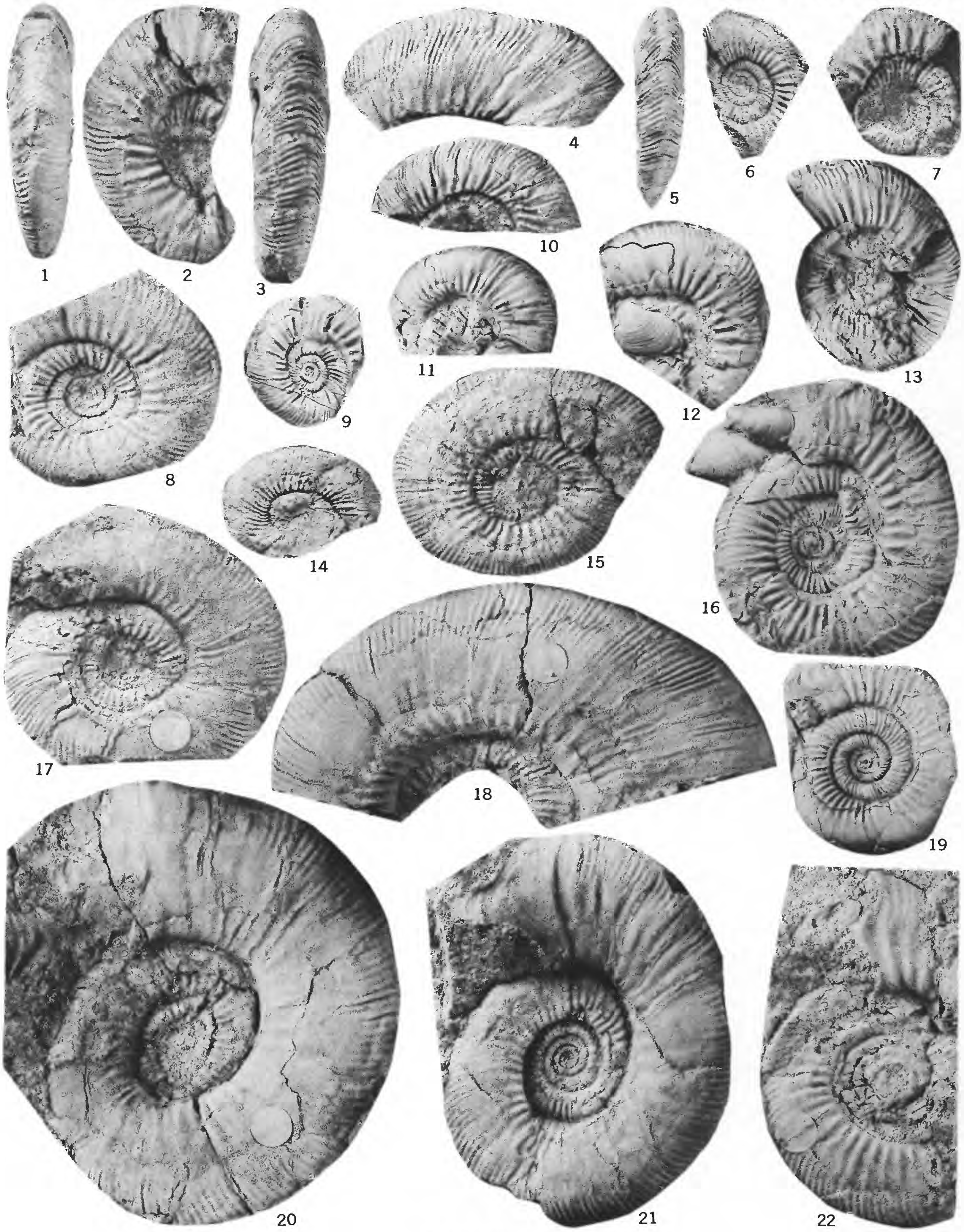
PLATE 4

[All figures natural size]

FIGURES 1–22. *Spiticeras* (*Negreliceras*) *stonyense* Imlay and Jones, n. sp. (p. B34).

1, 2. Ventral and lateral views of paratype, USNM 158826.
3, 4. Ventral and lateral views of paratype, USNM 158822.
5, 10. Paratype, USNM 158823.
6. Paratype, USNM 158820.
7. Paratype, USNM 158825.
8. Paratype, USNM 158818.
9. Paratype, USNM 158827 from USGS Mesozoic loc. 3348.
11. Paratype, USNM 158833 from USGS Mesozoic loc. M4066.
12. Paratype, USNM 158831 from USGS Mesozoic loc. M4066.
13. Paratype, USNM 158832 from USGS Mesozoic loc. M4066.
14. Paratype, USNM 158829 from USGS Mesozoic loc. M2025.
15. Paratype, USNM 158819.
16. Paratype, USNM 158828 from USGS Mesozoic loc. 29505.
17. Paratype, USNM 158817.
18. Paratype, USNM 158821.
19. Paratype, USNM 158830 from USGS Mesozoic loc. M3096.
20. Paratype, USNM 158816.
21. Holotype, USNM 158815.
22. Paratype, USNM 158824.

All specimens shown in figures 1–8, 10, 15, 17, 18, 20–22 are from USGS Mesozoic loc. 2286.



SPITICERAS

PLATE 5

[Figure reduced to four-fifths natural size]

Groebericeras? *baileyi* Imlay and Jones, n. sp. (p. B35).

Rubber imprint (× 4/5) of external mold of holotype, USNM 158834 from USGS Mesozoic loc. M2024. Other views of same specimen are shown on plate 6, figures 1, 2, 5, 6, 8–11.

GROEBERICERAS?

PLATE 6

[Figures natural size unless otherwise indicated]

FIGURES 1, 2, 5, 6, 8–11. *Groebericeras*? *baileyi* Imlay and Jones, n. sp. (p. B35).

1, 5, 6, 11. Cross section, ventral, lateral, and apertural views of moderately small septate whorls of holotype, USNM 158834 from USGS Mesozoic loc. M2024.

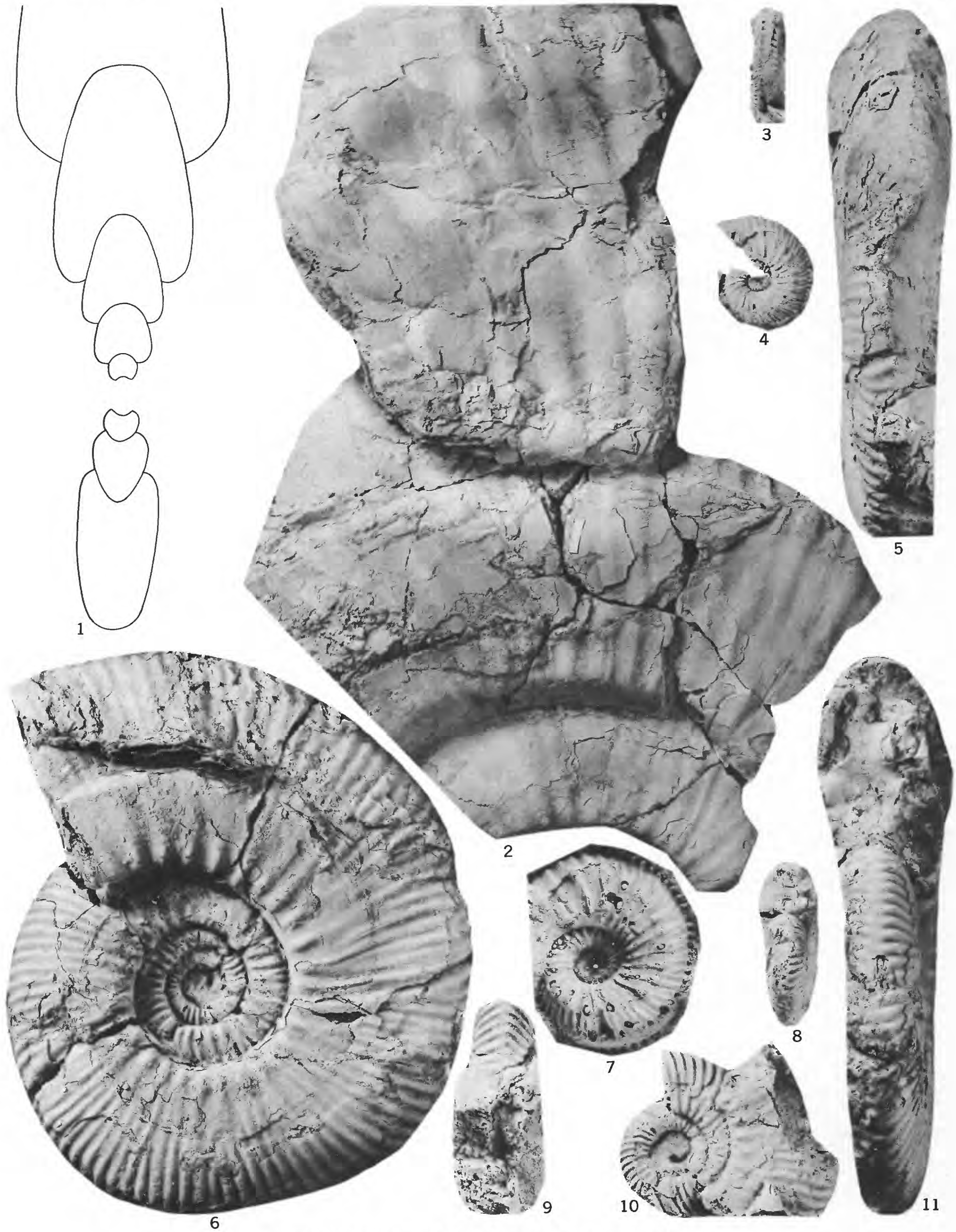
2. Outer septate whorls of holotype (× ½). The smallest whorl is next larger than the outermost shown in figure 6. The largest whorl is the same as the fragmentary outermost whorl shown on plate 5.

8–10. Apertural, ventral, and lateral views of smallest whorls of holotype. Chevron arrangement of ribs present on venter.

3, 4, 7. *Protacanthodiscus taffi* (Anderson) (p. B43).

3, 4. Ventral and lateral views of holotype.

7. Lateral view of rubber imprint of external mold of holotype, CAS 8709 from CAS locality on Grindstone Creek near CAS loc. 28037.



GROEBERICERAS? AND *PROTACANTHODISCUS*

PLATE 7

[Figures natural size unless otherwise indicated]

FIGURES 1, 2, 4–12. *Tollia mutabilis mutabilis* (Stanton) (p. B36).

1. Hypotype, USNM 161196 from USGS Mesozoic loc. M3061.
2. Hypotype, USNM 161195 from USGS Mesozoic loc. M3061.

4–7. Hypotype, USNM 161198 from USGS Mesozoic loc. 29594. Suture line (× 2) drawn at diamter of 26 mm and whorl height of 12 mm. Figure 7 (× 3), an enlargement of figure 4, shows details of suture line.

8. Hypotype, USNM 161194 from USGS Mesozoic loc. M3061.
9. Lectotype, USNM 23089a from USGS Mesozoic loc. 1010.

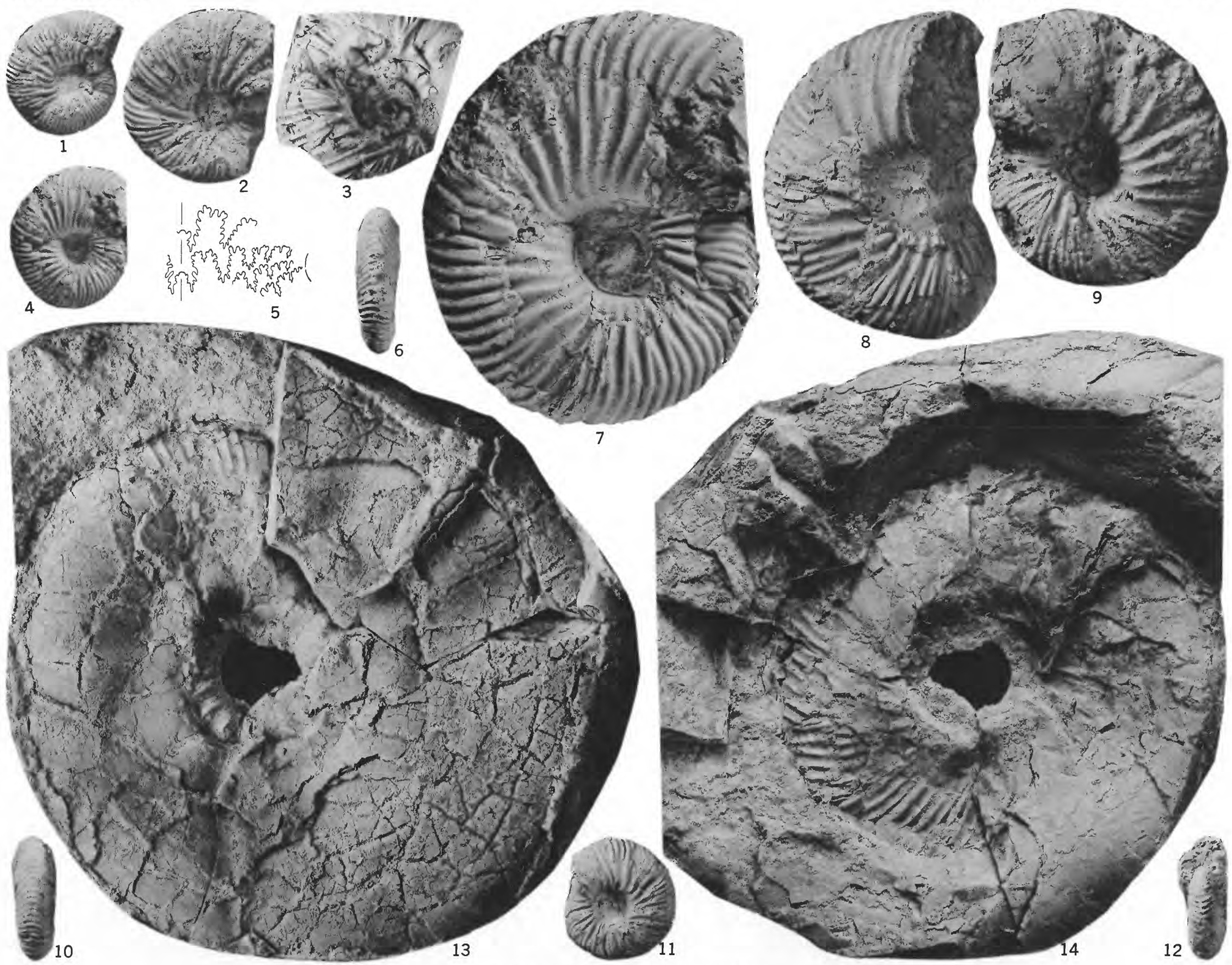
10–12. Hypotype, USNM 161197 from USGS Mesozoic loc. M3061.

3. *Polyptychites* sp. (p. B39).

Lateral view of specimen, USNM 158839 from USGS Mesozoic loc. M1577.

13, 14. *Tollia* cf. *T. mutabilis* (Stanton) (p. B37).

Lateral views of crushed and broken specimen, USNM 161203 from USGS Mesozoic loc. 29612. Shows complete body chamber. In figure 13 the adoral end of body chamber is missing on the flank but not on the venter.



TOLLIA AND POLYPTYCHITES

PLATE 8

[Figures natural size unless otherwise indicated]

FIGURES 1–5. *Tollia mutabilis crassicostata* Imlay (p. B38).

1. Hypotype, USNM 161199 from USGS Mesozoic loc. M3061.
2. Paratype, USNM 129692 from USGS Mesozoic loc. 1010.
3. Hypotype, USNM 161201 from USGS Mesozoic loc. M3061.
4. Hypotype, USNM 161200 from USGS Mesozoic loc. M3061.
5. Hypotype, USNM 161202 from USGS Mesozoic loc. M3061.

6–10. *Tollia mutabilis burgeri* (Anderson) (p. B36).

6, 7. Suture line (× 2) and lateral view of hypotype, USNM 161192 from USGS Mesozoic loc. M3061. Suture line measured at diameter of 30 mm and whorl height of 13.5 mm.

8, 9. Ventral and lateral views of hypotype, USNM 161191 from USGS Mesozoic loc. M3061.

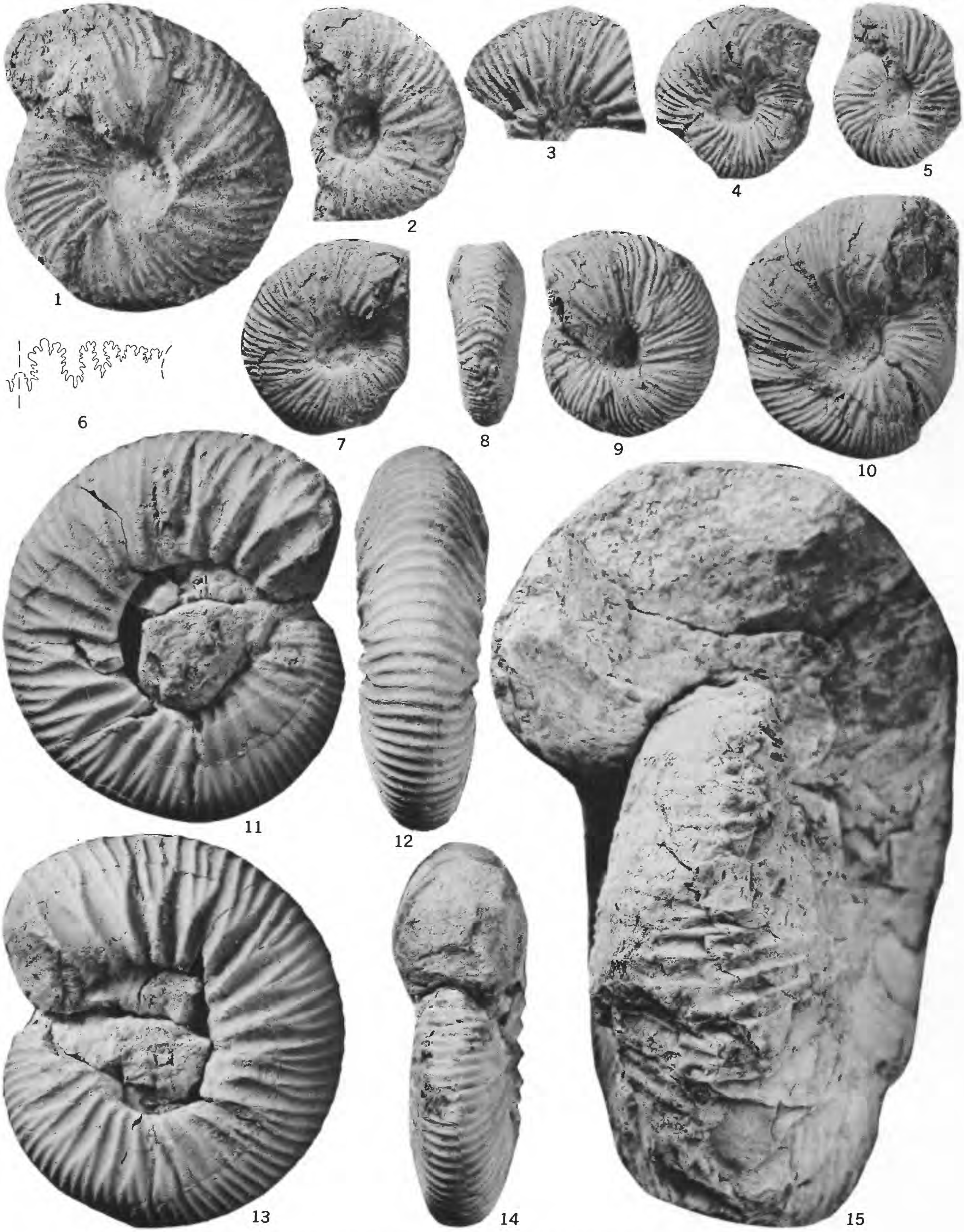
10. Hypotype, USNM 161190 from USGS Mesozoic loc. M3061.

11–14. *Polyptychites trichotomus* (Stanton) (p. B39).

Lateral, ventral, and apertural views of hypotype, USNM 161193 from USGS Mesozoic loc. 29616.

15. *Olcostephanus* cf. *O. atherstoni* Baumberger (non Sharpe) (p. B38).

Apertural view of specimen, USNM 158835 from USGS Mesozoic loc. 29556. Other views on plate 9, figures 1–3, 6–10.



TOLLIA, POLYPTYCHITES, AND *OLCOSTEPHANUS*

PLATE 9

[All figures natural size unless otherwise indicated]

FIGURES 1–3, 6–10. *Olcostephanus* cf. *O. atherstoni* Baumberger (non Sharpe) (p. B38).

1, 3, 6. Apertural, ventral, and lateral views of specimen, USNM 158836 from USGS Mesozoic loc. 29555.

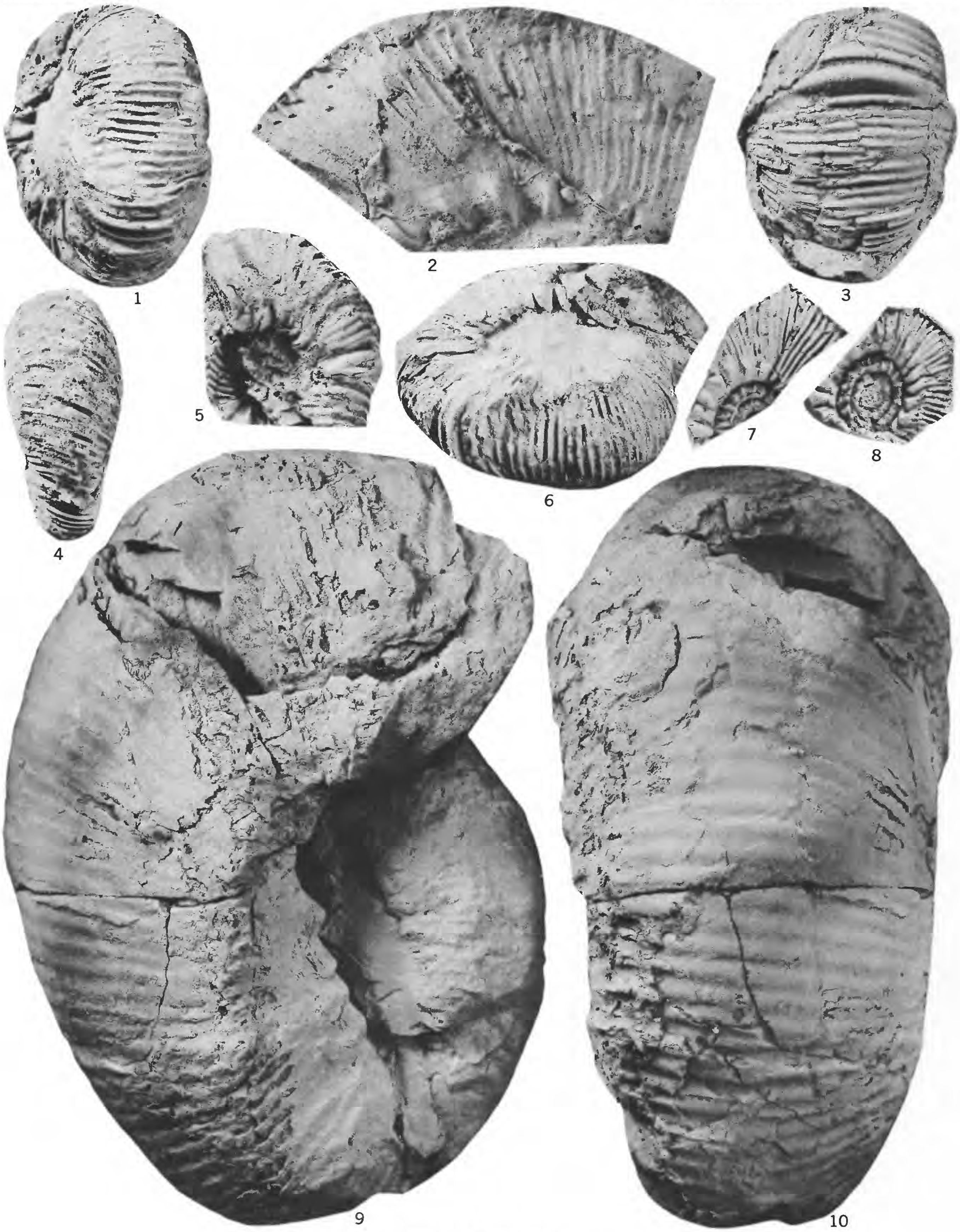
2. Lateral view of rubber imprint of external mold, USNM 158838 from USGS Mesozoic loc. 29485.

7, 8. Rubber imprints of external molds, USNM 158837 from USGS Mesozoic loc. M2680.

9, 10. Lateral and ventral views of specimen, USNM 158835 from USGS Mesozoic loc. 29556. Apertural view is shown on plate 8, figure 15.

4, 5. *Polyptychites* sp. (p. B39).

Ventral and lateral views (× 2) of specimen, USNM 158840 from USGS Mesozoic loc. 29555.



OLCOSTEPHANUS AND *POLYPTYCHITES*

PLATE 10

[Figures natural size unless otherwise indicated]

FIGURES 1–5, 10. *Blafordiceras californicum* Imlay and Jones, n. sp. (p. B40).

1, 2, 10. Ventral and lateral views and suture line (× 4) drawn at whorl height of 8.5 mm. Paratype, UC 10100 from UC loc. B–5120.

3, 4. Ventral and lateral views of internal mold of holotype, UC 10099 from UC loc. B–5120.

5. Rubber imprint of external mold of holotype, UC 10099 from UC loc. B–5120.

6–9. *Blanfordiceras* sp. undet. (p. B41).

6, 7. Lateral and ventral views of largest specimen, UC 10101 from UC loc. B–5120. Outermost one-fourth whorl is nonseptate.

8, 9. Ventral and lateral views of rubber imprint of external mold of inner whorls of same specimen shown in figures 6 and 7.

11–18. *Substeueroceras stantoni* Anderson (p. B42).

11–13. Lateral and ventral views of paratype, CAS 10454 from CAS loc. 28037. Figure 12 is a rubber imprint of an external mold.

14. Lateral view of paratype, CAS 10453 from CAS loc. 28037.

15, 16. Ventral and lateral view of holotype, CAS 10452 from CAS loc. 28037.

17, 18. Lateral and ventral views of paratype, CAS 10456 from CAS loc. 28037.

19, 20. *Substeueroceras* cf. *S. kellumi* Imlay (p. B42).

Lateral and ventral views of specimen described by Anderson (1945, p. 980) as *Berriasella storrsi* (Stanton). Specimen, CAS 10463 from CAS loc. 28037.

BLANFORDICERAS AND *SUBSTEUEROCERAS*

PLATE 11

[All figures natural size]

FIGURES 1–11. *Parodontoceras reedi* (Anderson) (p. B45)

1. Lateral view of holotype of *Aulacosphinctes watsonensis* Anderson (1945, p. 1010). CAS 8714 from CAS loc. 28037.

2–5. Hypotype, USNM 158845 from USGS Mesozoic loc. M2599. The specimen shown in figures 4 and 5 are the inner whorls of the same specimen shown in figures 2 and 3.

6. Hypotype, USNM 158846 from USGS Mesozoic loc. M2253. Suture line shown on plate 12, figure 9.

7, 9. Ventral and lateral views of holotype of *Aulacosphinctes reedi* Anderson (1945, p. 978), CAS 8715 from CAS loc. 28037.

8. Hypotype, USNM 158847 from USGS Mesozoic loc. M3030. View of rubber imprint of external mold.

10. Hypotype, UC 10097 from UC loc. B–5094. Suture line shown on plate 12, figure 12.

11. Hypotype, UC 10098 from UC loc. B–5094.

PARODONTOCERAS

PLATE 12

[Figures natural size unless otherwise indicated]

FIGURES 1, 2. *Aulacosphinctes*? sp. juv. (p. B46).
Figured specimen (× 2), USNM 23229 from USGS Mesozoic loc. 1003.

3. *Aulacosphinctes*? *diabloensis* Anderson (p. B46).
Holotype, CAS 8710 from Bagley Creek near Mount Diablo, Calif.

4. *Sarasinella* cf. *S. uhligi* Spath (p. B51).
UC 10096 from UC loc. 2605.

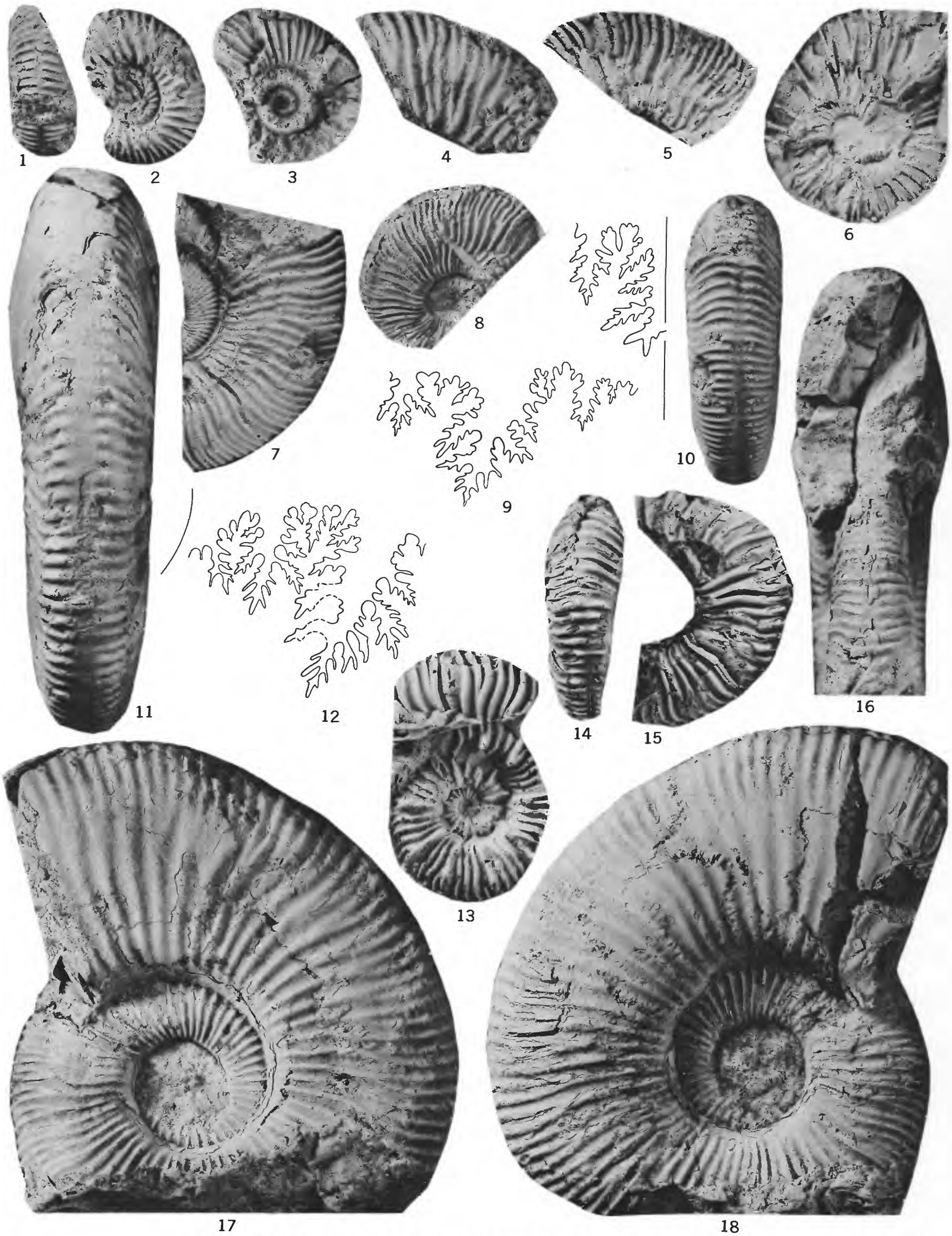
5, 6. *Aulacosphinctes*? *jenkinsi* Anderson (p. B47).
5. Paratype, CAS 8713 from CAS loc. 28037.
6. Holotype, CAS 8712 from CAS loc. 28037.

7, 8, 10. *Parodontoceras* cf. *P. storrsi* (Stanton) (p. B45).
Figured specimens, USNM 161204 from USGS Mesozoic loc. 29489. Figure 10 is ventral view of specimen shown in figure 7.

9, 12. *Parodontoceras reedi* (Anderson) (p. B45).
9. Suture line (× 1½) of hypotype, USNM 158846 from USGS Mesozoic loc. M2253. Same specimen shown on plate 11, figure 6.
12. Suture line (× 1⅓) of hypotype, UC 10097 from UC loc. B-5094. Same specimen shown on plate 11, figure 10.

11, 16–18. *Parodontoceras storrsi* (Stanton) (p. B44).
Ventral, apertural, and lateral views of holotype, USNM 23092 from USGS Mesozoic loc. 1084.

13–15. *Sarasinella* cf. *S. subspinosa* Uhlig (p. B50).
Ventral and lateral views of specimen, USNM 158852 from USGS Mesozoic loc. M3060 Figure 13 is from a rubber imprint of an external mold.



AULACOSPHINCTES?, *SARASINELLA*, AND *PARODONTOCERAS*

PLATE 13

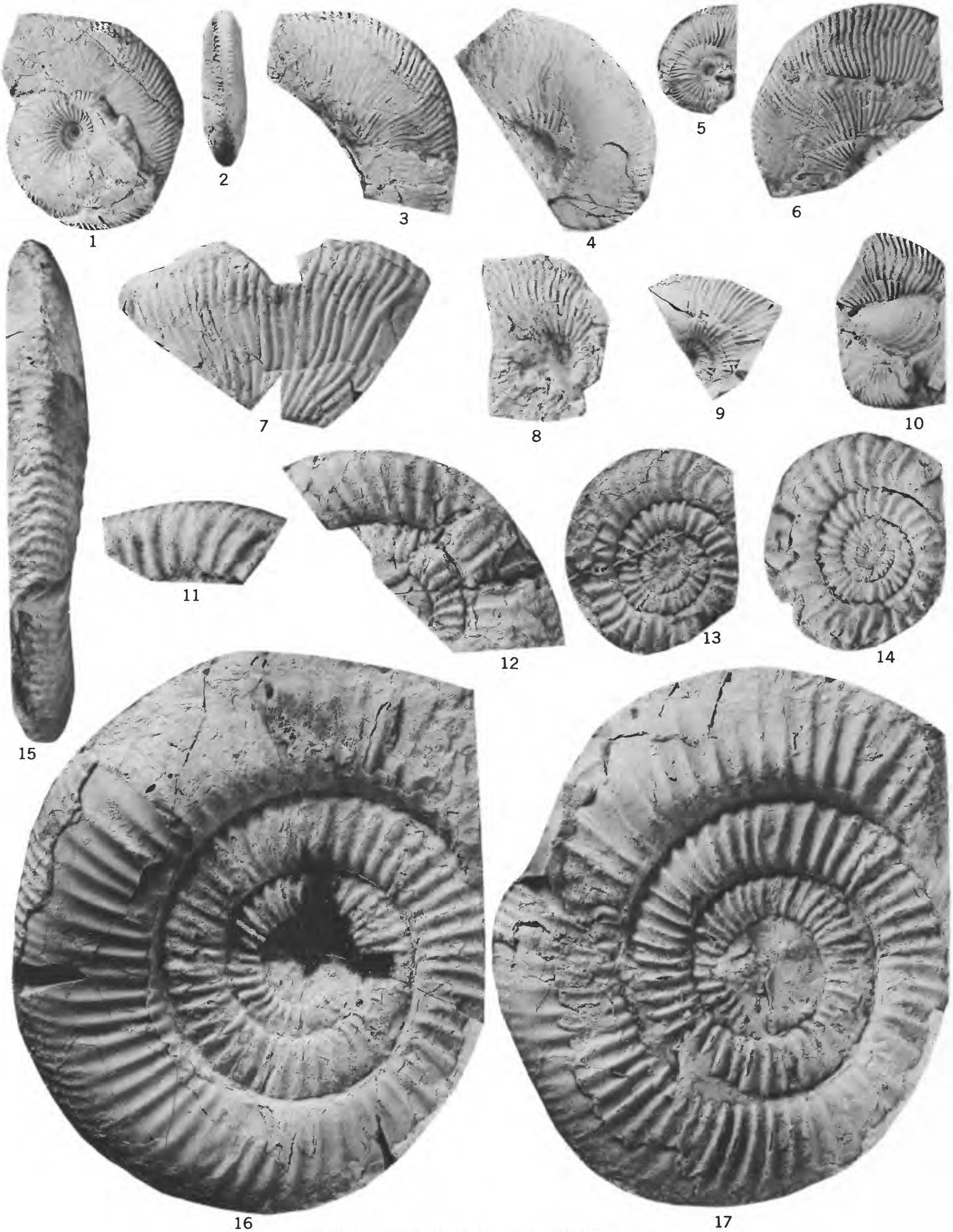
[All figures are natural size]

FIGURES 1–6. *Thurmanniceras jenkinsi* (Anderson) (p. B49).
Hypotypes USNM 158850 from USGS Mesozoic loc. M1577. Figure 2 is ventral view of specimen shown in figure 1.

7–9. *Thurmanniceras stippi* (Anderson) (p. B48).
7, 9. Hypotypes, USNM 158849 from USGS Mesozoic loc. M3059.
8. Hypotype, USNM 158848 from USGS Mesozoic loc. M3084.

10. *Thurmanniceras* cf. *T. stippi* (Anderson) (p. B48).
Figured specimen, USNM 161209 from USGS Mesozoic loc. 29593.

11–17. *Paskentites paskentaensis* Imlay and Jones, n. sp. (p. B47).
11. Paratype, USNM 161208 from USGS Mesozoic loc. 29596.
12. Paratype, USNM 161206 from USGS Mesozoic loc. 29596.
13, 14. Paratype, USNM 161207 from USGS Mesozoic loc. 29596. Figure 13 is from a rubber imprint of an external mold.
15–17. Ventral and lateral views of holotype USNM 161205 from USGS Mesozoic loc. 29598. Figure 17 is from a rubber imprint of an external mold.



THURMANNICERAS AND *PASKENTITES*

PLATE 14

[Figures natural size unless otherwise indicated]

FIGURES 1–15. *Neocomites* cf. *N. wichmanni* Leanza (p. B49).

1. Rubber imprint of laterally crushed external mold, USNM 158841a from USGS Mesozoic loc. M2679.

2–4, 6, 7. Vertically crushed internal mold, USNM 158842a from USGS Mesozoic loc. M2680. Figures 6 and 7 are from rubber imprints of interior whorls that bear umbilical tubercles.

5, 10. Lateral views of laterally compressed internal mold of a single specimen, USNM 158842b from USGS Mesozoic loc. M2680.

8, 9. Lateral and ventral views of a laterally compressed internal mold, USNM 158842c from USGS Mesozoic loc. M2680.

11, 12. Lateral and ventral views of a laterally compressed specimen, USNM 158841b from USGS Mesozoic loc. M2679.

13. Lateral view of internal mold, USNM 158842d from USGS Mesozoic loc. M2680.

14, 15. Lateral and ventral views of internal mold, USNM 158842e from USGS Mesozoic loc. M2680.

16. *Neocomites* cf. *N. neocomiensis* (d'Orbigny) (p. B49).

Figured specimen, USNM 158843 from USGS Mesozoic loc. M2680.

17–19. *Neocomites* cf. *N. neocomiensis* var. *premolica* Sayn (p. B50).

Figured specimen, USNM 158844 from USGS Mesozoic loc. M2680. Figure 17 is from a rubber imprint of an external mold. Figures 18 and 19 are from an internal mold.

20–22. *Neocosmoceras*? *crossi* (Anderson) (p. B52).

Ventral, lateral, and dorsal views of holotype, CAS 10448 from CAS loc. 28667. Note imprint of two rows of ventral tubercles on the dorsam.

23–26. *Neocosmoceras euchrense* Imlay and Jones, n. sp. (p. B51).

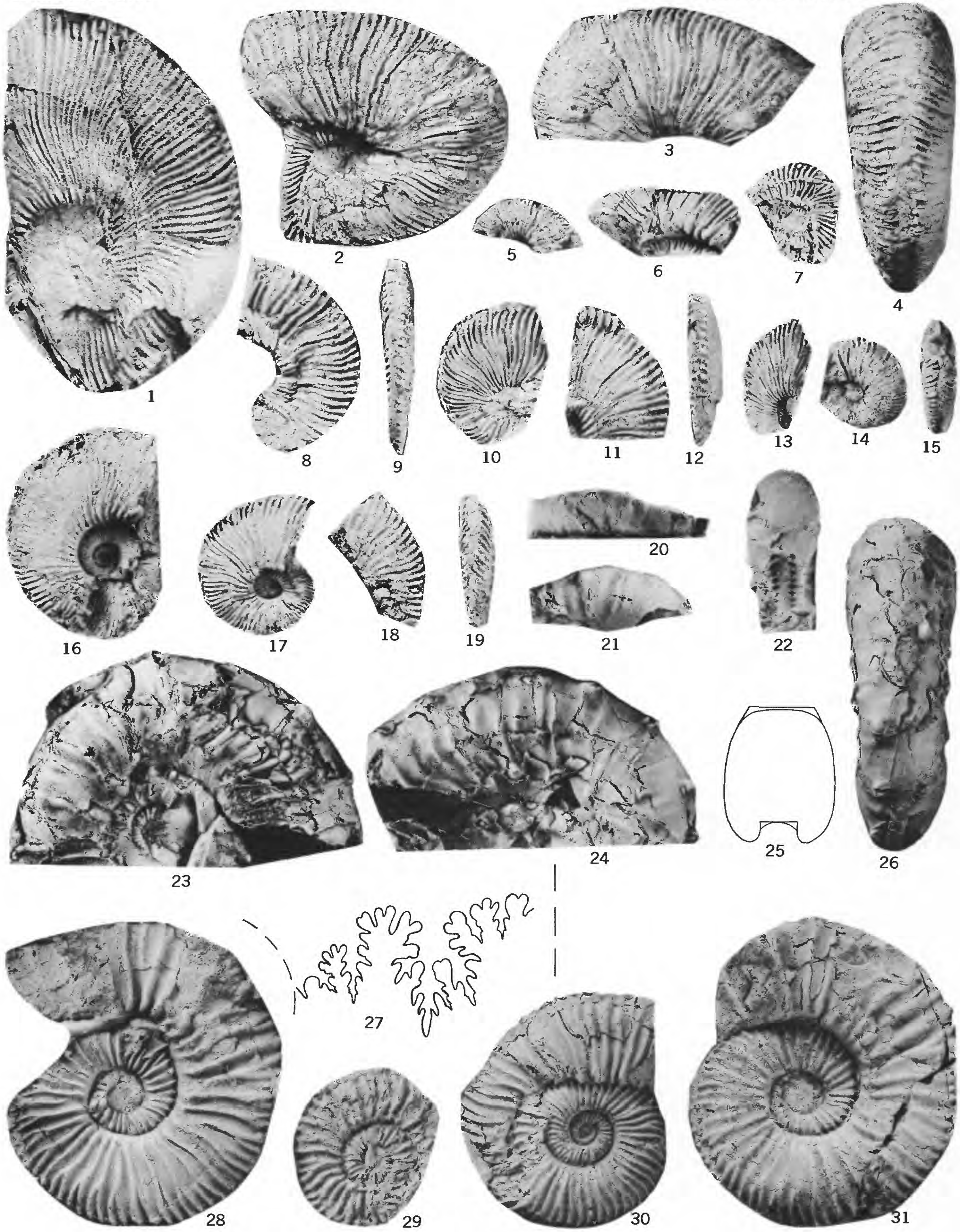
Lateral and ventral views and cross section of holotype, USNM 158851 from USGS Mesozoic loc. 2074.

27–31. *Kilianella crassiplicata* (Stanton) (p. B50).

27, 28, 31. Hypotype, USNM 161210 from USGS Mesozoic loc. 29596. Figure 28 is from a rubber imprint of an external mold. Figure 31 is from an internal mold. Suture line (× 4) was drawn at whorl height of 13 mm.

29. Hypotype, UC 10095 from UC loc. A–2925.

30. Hypotype, USNM 161211 from USGS Mesozoic loc. 29597.



NEOCOMITES, *NEOCOSMOCERAS*?, *NEOCOSMOCERAS*, AND *KILIANELLA*

PLATE 15

[Figure is natural size]

Groebericeras? *baileyi* Imlay and Jones, n. sp. (p. B35).

Lateral view of five septate whorls of holotype, USNM 158834 from USGS Mesozoic loc. M2024. The outermost whorl is the continuation of the innermost whorl shown on plate 6, figure 2, but is oriented nearly 180° from that figure. The next inner whorl shown on plate 15 is the same as the outermost whorl shown on plate 6, figure 6, but is oriented nearly 90° from that figure.

GROEBERICERAS?

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