PALEONTOLOGY AND STRATIGRAPHY OF THE LOWER CHICKABALLY MUDSTONE (BARREMIAN-APTIAN) IN THE ONO QUADRANGLE, NORTHERN CALIFORNIA

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ABSTRACT

The lower Chickabally Mudstone Member of the Budden Canyon Formation is Barremian and probable lowermost Aptian in age. Its lower contact is gradational with the Roaring River Member of the formation, but is bounded above by an angular unconformity at the base of the Huling Member in the Mitchell Creek Area of the Ono Quadrangle. The unconformity is documented by the angular relation of beds in the two members, the thinning section in the lower Chickabally Member from southwest to northeast, and the cutting out of fossil zones in the lower Chickabally Member from south to north.

The unconformity is bracketed by probable lowermost Aptian and middle Aptian strata.

Three faunal assemblages containing elements correlateable with the European middle and upper Barremian are dominated by the genus *Shasticrioceras* whose species serve to subdivide the strata into three biostratigraphic zones: *S. poniente, S. roddai,* and *S. patricki* from top to base. Thirty-five taxa have documented occurrences in the lower Chickabally Member, 33 ammonites and 2 bivalves. Ten new species of the genera ?*Euptychoceras, Ancyloceras, Toxoceras, Toxoceratoides, Heteroceras,* ?*Hemihoplites,* and *Shasticrioceras* are described.

INTRODUCTION

The Chickabally Mudstone is a member of the Budden Canyon Formation (Murphy et al., 1964) of the Great Valley Sequence (Bailey, Irwin and Jones, 1964) which crops out in the Ono Quadrangle in the northern Coast Ranges of California (fig. 1). It is predominantly mudstone with concretionary limestone in beds or nodules, but also contains sandstone lenses and beds, especially in its lower part where it grades laterally and vertically down into the Roaring River Member. The lower Chickabally Member is bounded above by an unconformity at the base of the Huling Member, at least in the northen part of the Quadrangle.

The lower Chickabally Member has yielded fossils that were believed to be entirely of Barremian age (Anderson, 1938; Murphy, 1956; Popenoe et al., 1960) until recently when I suggested (1969, p. 46) that the uppermost strata were lower Aptian in age.

This paper (1) documents the presence of an unconformity at the top of the lower Chickabally Member; (2) discusses the probable lower to middle Aptian age of this discontinuity in the Ono Quadrangle; (3) presents a summary of the biostratigraphy; (4) discusses the age and correlation of the lower Chickabally Member which is believed to range through the upper part of the lower Barremian into the lowest Aptian; and (5) describes the fossils of the lower Chickabally Member.

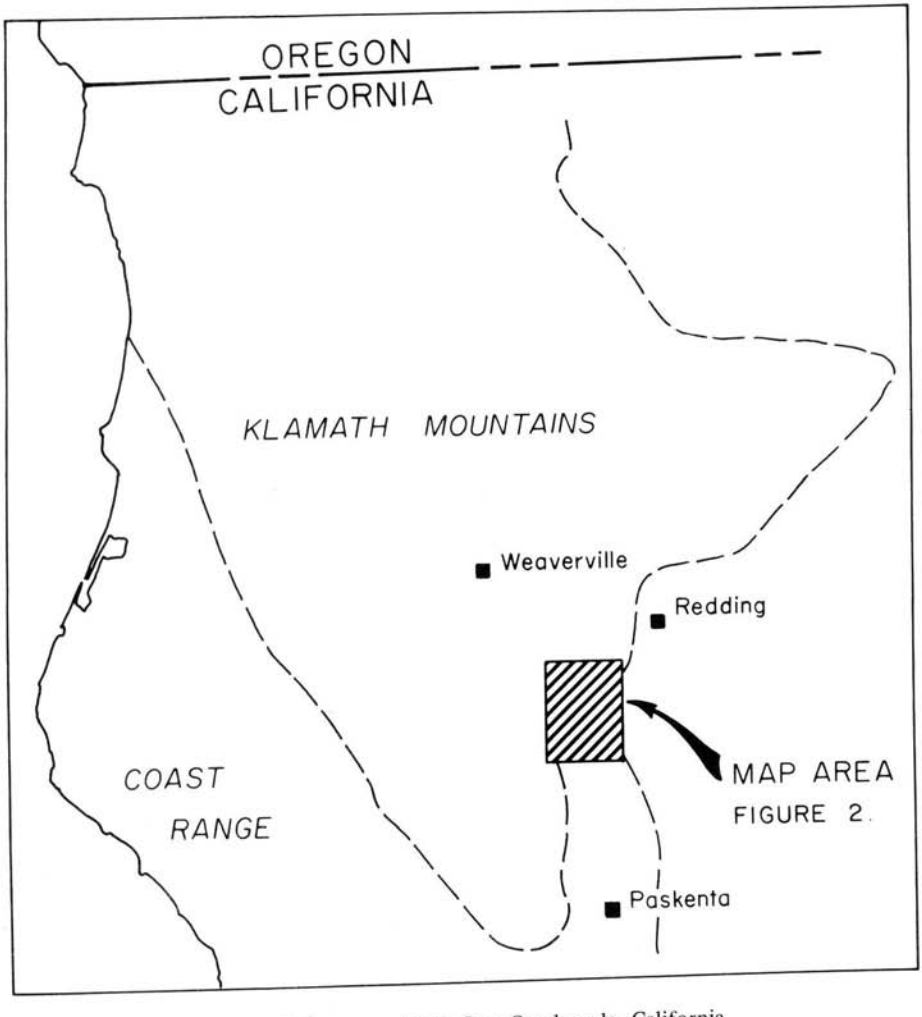

Fig. 1. Index map of the Ono Quadrangle, California

ACKNOWLEDGMENTS

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R. Busnardo, R. Casey, M. Collignon, P. Rawson, J. P. Thieuloy, G. Thomel, and J. Sornay have given me considerable aid in studying the European Barremian ammonites. I am especially indebted to J. A. Jeletzky for discussions concerning the relation of the California and British Columbia Barremian and Aptian faunas.

The unconformity at the top of the Chickabally Member was first suggested by Gary Peterson (1967, p. 864) who discussed the stratigraphic and faunal evidence for it in general terms. The present work was spurred in part by the desire to test his thesis in this region.

Joseph Peck, Museum of Paleontology, University of California, Berkeley, Peter Rodda, California Academy of Sciences, and Louella Saul, University of California, Los Angeles, have generously loaned me a number of type specimens and provided data on the older collections in the region. Mme. S. Taxy-Fabre sent me an excellent photograph of the type of *Eulytoceras phestum* (Matheron).

ABBREVIATIONS AND DEPOSITORIES

UCR - University of California, Riverside
LA or UCLA - University of California, Los Angeles
CAS - California Academy of Sciences, San Francisco
CIT - California Institute of Technology, Pasadena

The depositories for the specimens cited in the text are indicated by the prefix to the specimen number, e.g., UCLA 36217 refers to a specimen in the museum of the Geology Department at the University of California, Los Angeles. Specimens with CIT numbers are now housed in the museum of the Geology Department at the University of California, Los Angeles. Depository for type specimens described below is listed at the end of the section on Systematic Paleontology.

GEOLOGY

The general geology of the Ono Quadrangle and the subdivision of the stratigraphic units found in it have been discussed in two earlier papers (Murphy et al., 1964; Murphy et al., 1969). In those papers the Chickabally Mudstone Member of the Budden Canyon Formation is shown to be a relatively uniform, massive mudstone with a few beds and lenses of sandstone and beds and nodules of concretionary limestone. The upper and lower parts of the member are separated in the northern and central parts of the

quadrangle by the Huling Member, a sandstone tongue that decreases in thickness southwestward and that can be traced through most of the central part of the quadrangle as a distinctive bed of pebbly mudstone 3 to 15 feet thick. The Huling Member apparently lies above an angular unconformity over most of its extent although the angular relationship is documented only in the Mitchell Creek area (pl. 14). Even there, documentation is difficult because of the generally restricted exposure, the influence of numerous minor faults on the attitudes of adjacent beds, the difficulty of distinguishing minor faults from weathered joints, and the paucity of traceable beds.

The critical stratigraphic sections for the purposes of establishing the sequence of faunas also lie principally in the Mitchell Creek area in sections 28 and 33 of T. 30 N., R. 7 W. There, gently dipping strata are exposed in hundreds of small gullies cut a few inches to a few tens of feet into the partially exhumed, pedimented surface that lies between Mitchell Creek and the hills underlain by the Roaring Member sandstones and conglomerates to the northwest. The exposures are excellent in the gullies, in contrast to the interfluves, but the mudstones are so uniform that most horizons are not traceable or recognizable from gully to gully. Lenticular sandstone beds, some with prominent flute casts, and limestone concretion horizons, however, are traceable in some parts of the area and afford a means of correlating some of the sequences measured in the different gully systems. Most of these marker beds are plotted on the map (pl. 15, in pocket) and are noted in the columnar sections (pl. 14, in pocket). No large faults disrupt the strata, but several small ones make it difficult to be sure of the precise succession in some places. Nevertheless, sufficient control is afforded by mappable beds to assess the effect of faulting which I regard as minimal and without serious effect on the measured sections.

Minor Faults

Two sets of minor faults trend through the Mitchell Creek area. One set is oriented about 10 to 30 degrees NW and the other set trends from about N 80° E to N 80° W.

The northwest-trending set is the more easily recognized as it offsets the Huling Tongue a few feet to a few hundred feet in several places. Additional control on the trend and positions of the faults in this set is provided by the mappable beds which strike at approximately right angles to the directions of faulting. Minor gullies in the area and some of the major ones tend to be aligned parallel to this fault direction and thus provide good continuous exposures in a direction almost perpendicular to the strike. The largest offset along this set of faults is about 300 feet on the fault between the Jordan Ranch and the Roaring Road sections. The measured sections parallel this direction of faulting.

The east-west set of faults cuts across the measured sections in various places, but their displacement is small and care has been taken not to

superimpose the adjacent parts of the section on the two sides of one of these small displacements unless the effect of the fault is known. A fault with this orientation whose displacement is unknown is present on Roaring River just west of the Ranch Road. Because of it and other minor faults along Roaring River, the section excellently exposed there is more difficult to interpret and was not used as a primary reference. A left lateral offset along this fault seems to be supported by the occurrence of *Shasticrioceras roddai* n. sp. which was found at UCR locality 642 on strike from the main part of the *S. poniente* local range zone in the Roaring River Road section (see Biostratigraphy).

Unconformity

Evidence for an unconformity between the Chickabally Member and the Huling Member within the northern Ono Quadrangle consists of: (1) progressive truncation of the lower Chickabally strata by the Huling Member from south to north that involves several hundred feet of strata in the Mitchell Creek area; (2) the greatly reduced thickness of strata between the *Hertleinites aguila* fauna (Hauterivian-lowest Barremian, see fig. 2) and the base of the Huling Member when the Mitchell Creek section is compared with the section on the North Fork of Cottonwood Creek farther north; (3) the lack of any fossils of the *Shasticrioceras* faunas north of the Mitchell Creek area although they are relatively common farther south; (4) the markedly different faunas of the upper and lower Chickabally members.

Peterson (1967, p. 867) cited the angular relations and the change of faunas as evidence when he first proposed the presence of an unconformity. I did not agree with his interpretation (Murphy et al., 1969) as there are many angular relations between sets of strata in this quadrangle that have clearly resulted from submarine slumping and sliding. I felt the faunal change could represent a facies change. Detailed mapping of the Mitchell Creek area, however, clearly shows Peterson was correct in suggesting the presence of an unconformity in the northern part of the Ono Quadrangle.

Effect of the Unconformity

The base of the Huling Tongue, a dark brownish weathering, black pebble and cobble conglomerate with a sandy mud matrix, is easily traced by its distinctive lithology along the east side of Mitchell Creek and over the drainage divide northeast into the Bee Creek-North Fork of Cottonwood Creek drainage basin. At its southwestern end (pl. 15, in pocket), it disappears under a cover of soil. As can be seen from the pattern shown by the mappable beds in the lower Chickabally Member, there is a convergence in a northerly direction between them and the Huling Tongue. This is especially shown by the mappable limestone concretion horizon between the Roaring River Road I and Roaring River Road II sections (pl. 15). The strati-

The stratigraphic separation between the horizon and the Huling

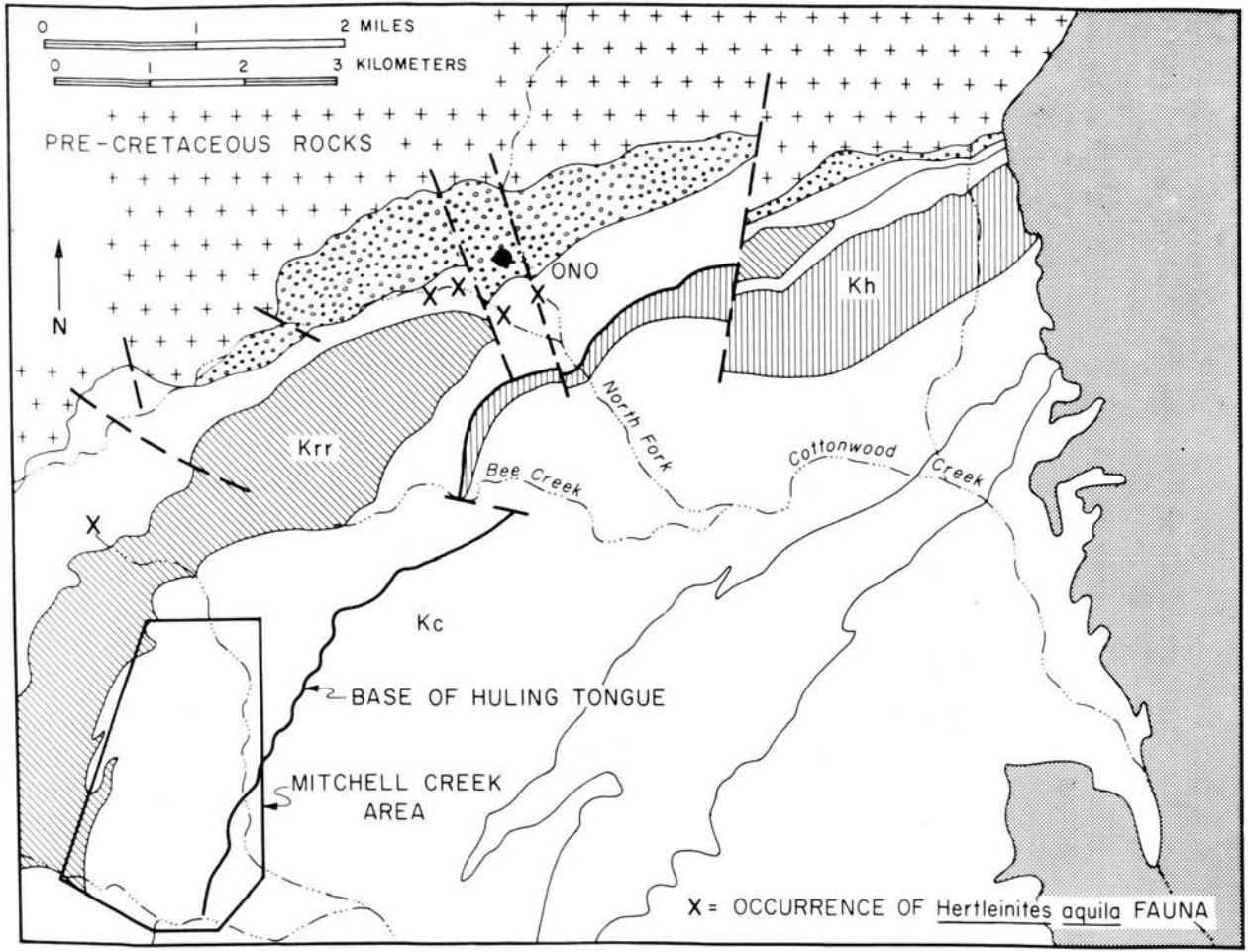

Fig. 2. Map of the northern part of the Ono Quadrangle showing the convergence of the strata bearing the *Hertleinites aguila* fauna with the base of the Huling Tongue between the Mitchell Creek area and the North Fork of Cottonwood Creek. Key: Krr - Roaring River Conglomerate Member; Kh - Huling Tongue; Kc - Chickabally Member; open circles - Rector Member; dense stipple pattern - Tertiary gravel.

Tongue is 160 feet of strata in the Roaring River Road Section I, whereas it is only 65 feet in the Roaring River Road Section II. On the east side of the fault that cuts across the Roaring River Road where it crossed Mitchell Creek, another horizon of limestone concretions is mapped along the east bank of a small gully to a point where it is truncated by the Huling Tongue. In this small area, 15 feet of strata were cut out in a strike distance of 100 feet. These relations are no so easily seen or mapped farther northeast along Mitchell Creek itself. However, the average attitude within the lower Chickabally Member indicates this convergence continues to the northeast for a significant distance, at least into the Bee Creek drainage system. At this rate, the unconformity cuts out about 750 feet of section per mile to the northeast and means that the local range zones of *Shasticrioceras poniente* and *S. roddai* are cut out along Mitchell Creek within the area shown in plate 15 (in pocket). The local range zone of *S. patricki* is probably cut out within two miles to the northeast. This conclusion is supported by the fact that no specimen referrable to the three *Shasticrioceras* faunas (as defined below) has ever been found in the Bee Creek or the North Fork of Cottonwood Creek drainage systems.

The strata below the Huling Member are generally poorly exposed between Mitchell Creek and the North Fork Cottonwood Creek. Reliable attitudes are scarce and no fossils have been recovered. On the North Fork of Cottonwood Creek, however, exposures are excellent, and although faults follow parts of the creek and its tributaries, the stratigraphic thickness of the beds can be reasonably estimated from compilation of direct measurements checked by measurement based on outcrop width and attitudes. The thickness of strata between the uppermost representatives of the *Hertleinites aguila* zone and the Huling Member is between 800 and 1,300 feet. This is much less than at Mitchell Creek where the uppermost fossils representing the *H. aguila* zone are found 2,000-2,500 feet below the Huling Member. These measurements suggest the convergence observed at Mitchell Creek is also present between Mitchell Creek and the North Fork (fig. 2).

In spite of the excellent exposures below the Huling Member along the North Fork of Cottonwood Creek the interval has not yielded fossils diagnostic of any fauna.

The same is true for the rocks below the Huling Member in the area drained by the tributaries of Huling Creek. This also suggests that the zones with *Shasticrioceras* are cut out. Here a large wedge of conglomerate, originally placed in the Huling Member (Murphy, 1956) is correlated with the Roaring River Member by Peterson (1967, p. 868). The conglomerate is separated from the main sandstone body of the Huling Member by a thin mudstone unit. Peterson believes that this mudstone represents the lowest beds of the lower Chickabally Member and that the unconformity has cut even deeper into the underlying units than on the North Fork so that it is virtually resting on the Roaring Member. We adopted Peterson's interpreta-

tion in our report on the Ono Quadrangle (Murphy et al., 1969).

The faunal change across the unconformity is even more complete than reported previously (Murphy, 1956). The only common forms recorded then were *Melchiorites indigenes* and *Pinna pontica.* The former indentification was based on crushed material that I would now prefer to assign questionably to *Barremites* sp. The latter taxon, *Pinna pontica,* has a highly variable morphology and is long ranging. It is present through most of the Lower Cretaceous section in the Ono Quadrangle and is of no aid in distinguishing the different faunas.

Age of the Unconformity

There seems little doubt that this erosional discontinuity occurred within the lower Aptian. The upper Chickabally beds lying immediately above the Huling Member in the Mitchell Creek area have abundant fossils of genera such as *Acanthoplites, Parahoplites, Colombiceras, Eotetragonites, Argonauticeras,* and *Gabbioceras.* These genera indicate a correlation with the Garasian (=Middle Aptian) of France. This fauna is present throughout the quadrangle and shows that sedimentation had probably resumed by the beginning of Gargasian time since several hundred feet of Gargasian-age sediments are present.

The youngest beds below the unconformity are also considered to be lower Aptian (see below) although this correlation is less secure because of the largely provincial nature of lower Aptian faunas in the classical regions in southern France, Germany, and England, as well as those in the Ono Quadrangle. The duration of this period of erosion in the Ono Quadrangle, therefore, is very short.

Interpretation of the Unconformity

Present evidence suggests that the unconformity increases in magnitude northeast of the Mitchell Creek area and dies out to the south of the Mitchell Creek area. Evidence for the northeast part of the quadrangle has been discussed above. South of the Mitchell Creek area in the southern part of the Ono Quadrangle (Murphy, Rodda, and Morton, 1969) and in northern Colyear Springs Quadrangle, 1973; (Jones and Bailey, 1973; Bailey and Jones, 1973) the strata dated as Aptian and those dated as Barremian seem to be parallel and fossils from the interval apparently missing in the Mitchell Creek area are present, particularly the ammonite genus *Deshayesites.*

The above data suggest the unconformity is restricted to the more onshore areas to the east of the present outcrop belt in the subsurface in areas south of the Ono Quadrangle. This would also be expected from interpretation of the structural trends of the Great Valley sequence and the paleocurrent data from Lower Cretaceous sediments on the west side of the Sacramento Valley (Ojakangas, 1968).

BIOSTRATIGRAPHY OF THE LOWER CHICKABALLY MEMBER

Historical Review

Barremian-age strata have been identified in California only in the Ono Quadrangle in Shasta County (Popenoe et al., 1960, p. 1508) and in the adjacent Colyear Springs Quadrangle (Jones and Bailey, 1973). They were originally recognized by Anderson (1938, T. 2) who described almost the entire fauna known to occur in them. His assignment of a Barremian age to these strata was based on the presence of taxa he identified with the genera *Ancyloceras, Acrioceras, Hoplocrioceras,* and *Pulchellia* Anderson, 1938, T. 1, p. 79). Almost all of Anderson's specimens are reported to have come from his Mitchell zone or from California Academy of Sciences locality 1661. The Mitchell zone is interpreted here as an area near Mitchell Creek in Section 28, T. 30 N., R. 7 W. Locality 1661 is on a southwest tributary to Roaring River approximately on strike about a mile to the southwest in the central part of Section 32, T. 30 N., R. 7 W. (pl. 14, in pocket). Anderson believed beds in the latter area to lie below those in the former. Subsequently all these beds were included in the *Shasticrioceras poniente* assemblage zone (Murphy, 1956, p. 2113).

Anderson (1938) mentioned 31 taxa that he believed to have come from what he estimated to be 350 feet of strata between California Academy of Sciences locality 1661 and the top of his Mitchell zone, that is, in the strata we now call the lower Chickabally Member. These are listed in tabular form with reference and remarks (table 1, in pocket).

In addition to the taxa recorded by Anderson, I added three in 1956, *Melchiorites indigenes* Anderson (see discussion under *Barremites*), *Acrotheuthis winslowensis* Anderson, and *Pinna pontica* Anderson. *Acroteuthis aboriginalis* Anderson also shows as being in the *Shasticrioceras poniente* zone in figure 6 of that paper because of a drafting error. It actually occurs at a much lower horizon as can be seen from the map (Murphy, 1956, fig. 4). At the present time two bivalve and thirty-three ammonite taxa occur in the lower Chickabally Member. The belemnites from these strata have not yet been carefully studied and I regard all previous identifications, including my own, as questionable. A fairly large collection of stratigraphically controlled belemnites is now present in the University of California, Riverside collections and is being studied.

Biostratigraphy

The nature of occurrence of the fossils in these strata makes it difficult to amass enough data to assess either the stratigraphic range or the morphologic variation of most of the taxa. It is, therefore, doubly unfortunate that no maps were available to Anderson for plotting collection sites as his generalized and often confusing locality descriptions preclude using his data in biostratigraphic studies of any but the most general nature. The stratigraphic data presented here are based entirely on my own collections made during the period 1951-1971.

Zonation

The subdivision of the faunal sequence in the Chickabally Member is somewhat easier than it was in 1956, but there is still a great deal to be learned of it and many taxa are still to be discovered as each season brings a few more to light. The following, therefore, should be regarded as a preliminary classification of these strata according to their faunal content. At present, it is strictly local and descriptive. I hope that it will provide a framework in which future studies of the biostratigraphy in this region can be placed.

The positions of most fossils that were collected from the measured sections are shown in figure 3 and plate 14 (in pocket). In the upper part of the Roaring River Road section, however, the individual localities were so numerous that many of the localities that yielded *Shasticrioceras poniente* have been grouped together in 15 foot intervals. The localities yielding other taxa are plotted on the chart at their exact stratigraphic positions.

The ammonite faunas are dominated by the species of *Shasticrioceras* and they are the only taxonomic units that can serve for local zonation of these rocks at the present time. All other taxa are too few in number, too poorly preserved, or have too great a stratigraphic range.

Three species of *Shasticrioceras, S. poniente* Anderson, *S. roddai* n. sp., and *S. patricki* n. sp. are abundant enough so that their approximate ranges can be delineated in the Mitchell Creek area. The earliest appearing is *S. patricki* n. sp. which also ranges through the greatest thickness of strata. Its local range zone reaches almost to the lowest occurrence of *S. roddai* n. sp., but the two are not known to overlap. *S. roddai* n. sp. is restricted to about 150 feet of strata. Correlation of the lithologic units in the Jordan Ranch section and the Roaring River Road section indicates that the local range zone of *S. roddai* n. sp. overlaps the base of the local range zone of *S. poniente*, but only slightly. *S. poniente* has been found in the upper 400 feet of the Roaring River Road section to a point about 15 feet below the Huling Tongue. The positions of the other taxa are given in the text in relation to the local range zones of the above species of *Shasticrioceras.*

Fossils that are restricted to the *Shasticrioceras patricki* local range zone in the Mitchell Creek area have been found in other parts of the Ono Quadrangle, but are not known outside northern California with the exception of *Inoceramus colonicus* Anderson and potentially, *Pulchellia* cf. *P. compressissima* (d'Orbigny).

Fossils known to occur in the local range zone of *S. patricki* n. sp. in the Mitchell Creek area are:

?Euptychoceras jordanense n. sp.
?Hemihoplites popenoei n. sp.
Inoceramus colonicus Anderson
Lytoceras sp. 1
Lytoceras sp. 2
Pulchellia cf. *P. compressissima* (d'Orbigny)

Shasticrioceras patricki n. sp.
S. whitneyi Anderson

Fossils that are thus far restricted to the *Shasticrioceras roddai* local range zone in the Mitchell Creek area have also been found abundantly along the Middle Fork of Cottonwood Creek in the Ono Quadrangle, but exposures between Anderson's locality 1661 (pl. 14, in pocket) and the Middle Fork have yielded no fossils diagnostic of these strata.

Fossils that are known to occur in the interval spanned by *S. roddai* in the Mitchell Creek area are:

Ancyloceras elephas (Anderson)
Eulytoceras phestum (Matheron)
Inoceramus colonicus (Anderson)
Lytoceras saturnale (Anderson)
Partschiceras occidentale (Anderson)
Pulchellia *(Heinzia) popenoei* (Anderson)
Shasticrioceras roddai n. sp.
Toxoceras blandi n. sp.

Fossils believed to be restricted to the local range zone of *Shasticrioceras poniente* in the Mitchell Creek area have been collected also from most of the exposures between Mitchell Creek in the northern part of the Ono Quadrangle and Dry Creek in the southern part, a distance of about 10 miles (pl. 14, in pocket). South of Dry Creek, no diagnostic fossils have been found from this zone.

In most of the quadrangle, the strata are either disturbed by faulting or folding and/or the exposures are poor so that it is impossible to measure a section through the entire zone, which is more than 400 feet thick. However, in the area west of Mitchell Creek (Sections 21, 28, 33, T. 30 N., R. 7 W.) good exposures in a relatively fossiliferous area with only minor structural complications have permitted the measurement of two complete sections and one partial one that may serve as a local reference for this part of the column.

Fossils that occur in the local range zone of *S. poniente* are:

?*Anahamulina* sp. 1
?*Anahamulina* sp. 2
Ancyloceras elephas (Anderson)
A. thomeli n. sp.
?*Argvethites* sp.
?*Cheloniceras* sp.
Eulytoceras phestum (Matheron)
?*Shasticrioceras wintunium* (Anderson)
Heteroceras jeletzkyi n. sp.
Inoceramus colonicus (Anderson)
Lytoceras saturnale (Anderson)
Partschiceras occidentale (Anderson)
Phylloceras aff. *P. thetys* (d'Orbigny)
Pinna Pontica (Anderson)
Shasticrioceras poniente (Anderson)
Toxoceras stentor (Anderson)
?*Toxoceratoides greeni* n. sp.

T. cf. *royerianus* (d'Orbigny)
T. sauli n. sp.
?*Toxoceratoides* sp.
Dissimilites sp.

Correlation

The type section for the Barremian Stage is in the French Alps near the villages of Barrême and Angles (Basses Alpes). The section in this region is composed of beds of very fine grained limestone interbedded with shales. Ammonites are common in some of the limestone beds. This facies contrasts strongly with that of northern California and it is not surprising that the dominant elements of the California faunas are not known in France.

Correlation of the northern California section with the type region is not possible with great precision because the ranges of the many taxa are not fully documented in California. In addition, the taxonomic identity of some of the Californian forms remains doubtful.

Busnardo's (1963) study of the type area for the Barremian and his documentation of the detailed stratigraphic succession near Angeles have, however, furnished a standard for comparison. His study makes it possible to confirm the earlier correlations (Anderson, 1938; Popenoe et al., 1960) of most of the *Shasticrioceras*-dominated faunas with the Barremian. However, the uppermost strata in California that bear *Shasticrioceras poniente* also have a fossil of the subfamily Cheloniceratinae that suggests an early Aptian age.

The genera in common to the two regions that seem to provide opportunity for correlation are *Ancyloceras, Argvethites, Barremites, Eulytoceras, Crioceratites, Hemihoplites, Heteroceras, Moutoniceras, Pulchellia,* and *Toxoceras.* Of these, *Barremites, Pulchellia, Heteroceras, Argvethites,* and *Eulytoceras* are probably the most important.

Busnardo's excellently presented and detailed work shows: (1) the lower Barremian of the Angeles section is characterized by the appearance of *Barremites* ss. and followed by *Pulchellia* ss. and *Nicklesia* among others; (2) the upper Barremian has rare *Pulchellia (Heinzia), Hemihoplites, Heteroceras,* and *Eulytoceras phestum.* Busnardo's data indicate the same sequence of morphologies prevails among the pulchelliids in France as shown earlier for Colombia (Bürgl, 1957, p. 133). That is, the pulchelliids of the lower Barremian all have a closed umbilicus and those with an open umbilicus are confined to the upper part of their respective sequences.

The California Barremian probably starts in the *Hertleinites aguila* zone, because *Barremites, Acrioceras, Crioceratites, Moutoniceras,* and *Simbirskites* all occur in it. The *H. aguila* zone lies many hundreds of feet below the local range zone of *Shasticrioceras patricki* n. sp. which contains the earliest of the two species of *Pulchellia* known to occur in California. This species has a closed umbilicus and is similar to *Pulchellia compressisima* d'Orbigny from the Barremian of the area around Castellane, France. Still higher strata have yielded *Pulchellia (Heinzia) popenoei* Anderson, which

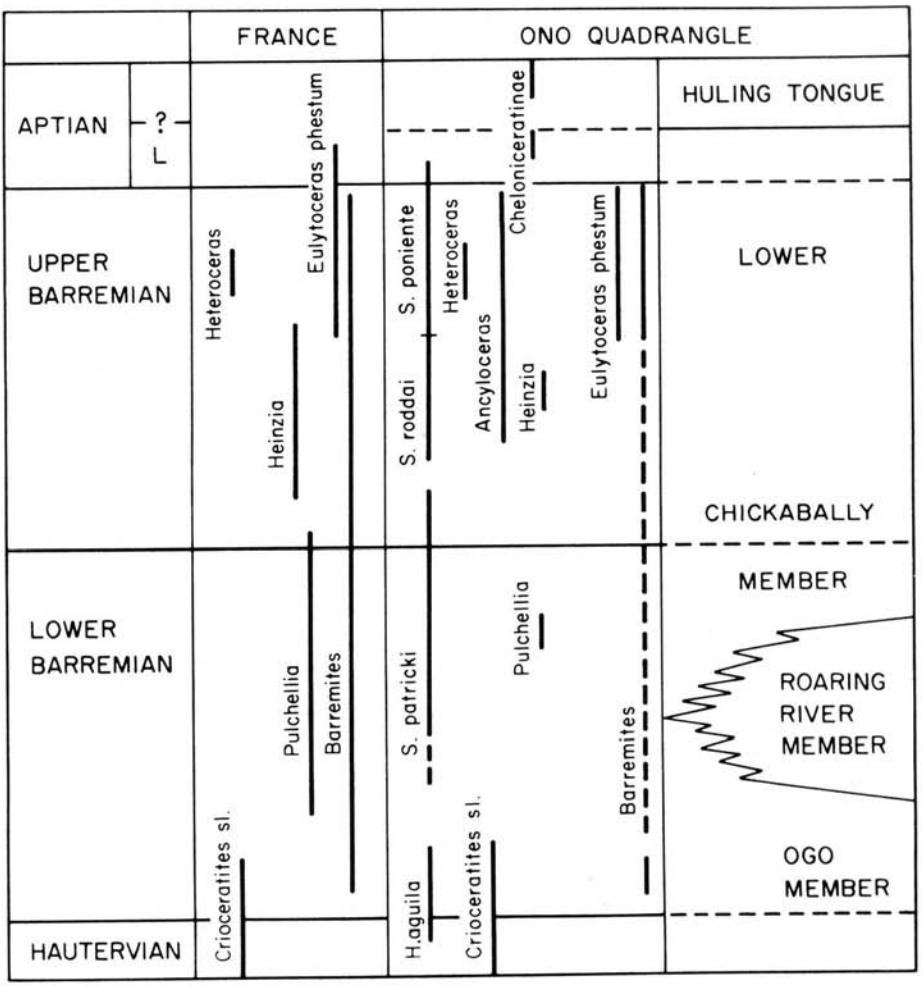

Fig. 4. Correlation of the Barremian ammonite faunas of France and the Ono Quadrangle, California

has a narrow, but open umbilicus. Above *Heinzia* species of *Ancyloceras* become relatively abundant and occur with *Heteroceras, Argvethites,* and *Eulytoceras phestum* (Matheron), all taxa common in the upper Barremian in the Angles section.

The California sequence follows that in the type region in France rather closely and it seems reasonable to correlate the lower two faunas in California with the lower Barremian of France and the upper two California faunas with the upper Barremian as shown in figure 4.

The uppermost strata of the lower Chickabally Member yielded a single specimen of ammonite that must belong to the subfamily Cheloniceratinae. Insofar as is known this group of forms begins in the Aptian. For this reason and because of the lack of other diagnostic forms, the upper beds of the lower Chickabally Member are here considered lower Aptian.

SYTEMATIC PALEONTOLOGY

Phylum MOLLUSCA
Class CEPHALOPODA
Order PHYLLOCERATIDA

Family PHYLLOCERATIDAE Zittel

Only four specimens representing two species of Phylloceratida were recovered during this study. Three of the specimens are assigned to *Partschiceras occidentale* Anderson. The fourth specimen probably belongs to the group of *Phylloceras thetys* (d'Orbigny).

Phylloceras aff. *P. thetys* (d'Orbigny)

(Pl. 1, fig. 3; text figs. 5 and 6)

A single specimen probably belonging to the group of *Phylloceras thetys* was found in the Roaring River Road section in the lower part of the *Shasticrioceras poniente* local range zone. This specimen is similar in inflation, size of umbilicus, and lack of constrictions to specimens of *P. thetys* in the d'Orbigny collection in the Museum National d'Histoire Naturelle, Paris. The California specimen differs in having a moderately sigmoidal ribbing that is moderately prorsiradiate on the outer flank and in having a second lateral saddle (Wright's 1957 terminology) with a trifid termination. It is probably most closely allied morphologically, as well as chronologically, with a paratype of *P. thetys majoricense* Wiedmann from the province of Alicante in Spain, which is similar in the configuration of the ornamentation, but which has higher curvature of the flank. The specimen is slightly crushed and incomplete. At 41mm diameter it has a whorl height of about 22 mm; width 14 mm; umbilicus 3.5 mm.

Genus *Partschiceras* Fucini, 1923

Type species.—*Ammonites partschi* Stur, 1851

Weidmann (1963, p. 229) has reviewed the characters differentiating the genera *Partschiceras* Fucini and *Phyllopachyceras* Spath and concluded that only one generic name, *Partschiceras,* is needed for the classification of this group of phylloceratids. He claims that criteria previously used to separate *Partschiceras* from *Phyllopachyceras,* e.g., diphyllic vs. tetraphyllic saddles and less inflation vs. greater inflation of the test, respectively, cannot be used because these characters overlap in time. Although this does not prove his case, it does suggest that the two stocks did not arise through a process of iterative evolution and adapt similar morphologies because they occupied the same ecologic niche. Rather that the group is more homogeneous than had been supposed.

Pacific Coast species that belong to the genus *Partschiceras* in the sense of Wiedmann are: *Phylloceras occidentale* Anderson, Ph. *sextoni*

Anderson, *Ph. theresae* Anderson, *Ph. trinitense* Anderson, *Ph. shastalense* Anderson, and , probably, *Ph.* cf. *oregonense* Anderson.

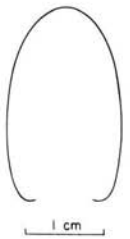

Fig. 5. *Phylloceras* aff. *P. thetys* (d'Orbigny) –cross section of the whorl.

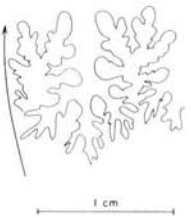

Fig. 6. *Phylloceras* aff. *P. thetys* (d'Orbigny). Camera lucida drawing of the lateral lobe of the suture line.

Partschiceras occidentale (Anderson)

(Pl. 1, figs. 2, 4, and 5; text fig. 7)

Phylloceras occidentale Anderson, 1938, p. 139, pl. 12, fig. 1 only.

The holotype is California Academy of Sciences Type Collection specimen number 8745. It is apparently the only specimen used in Anderson's description of the species although other specimens are mentioned. It is not completely septate contrary to Anderson's statement (1938, p. 139) because the last two centimeters of the test are body chamber. The septate part of the shell is undeformed and the last septum is marked by the white line in fig. 4, pl. 1. The whorl at that point (=46 mm diameter) is 26 mm high and 24 mm wide and the umbilicus is 2.5 mm in width. Anderson's measurements are erroneous. The outer shell of the holotype is not preserved, but the character of the coarse ribbing can still be seen. Ribs arise near the umbilical edge where they may be flexed. They are rectiradiate on the flank and absent on the venter. Some of the coarse ribs split and other ribs intercalate high on the flank. They first appear at about 20 mm diameter and number 19 between that point and the last point where they can be counted, about two-thirds of a whorl later. The fine ornamentation of the external shell is preserved as an external mold in the concretion that contained the specimen and consists of a very fine liration that is inclined adorally at a slightly greater angle than the coarse ornamentation. The umbilicus is bordered on the internal mold by a slight depression that can be seen in fig. 4, pl. 1. This apparently shows on the external shell as well (see fig. 5, pl. 1).

Anderson gave two different versions of the locality for the holotype (1938, p. 140; p. 257) of *P. occidentale* even though he cites the same locality number for them. It is evident from the preservation of the holotype that it did not come from what Anderson referred to in various places in his monograph as the "Barr Zone" or "Barr conglomerate."

Therefore, his second citation on p. 257 "near Barr Zone" is probably better than his first reference "in the Barr Zone" (p. 140). This would put the holotype in the lower Chickabally Member in the same general part of the section that the specimens recovered during this study were found.

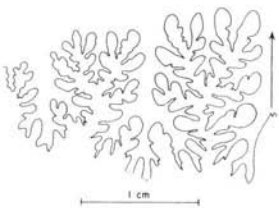

Fig. 7. *Partschiceras occidentale* (Anderson), holotype, C.A.S. Type Collection 8745. Camera lucida drawing of the suture line.

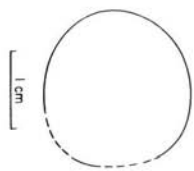

Fig. 8. *Eulytoceras phestum* (Matheron)—cross section of the whorl of UCR specimen 503/1.

Three additional specimens are assigned to this species. Two of them (UCR 189/1, 5181/3) conform to the description of the holotype in having ribbing that is present on the flanks but virtually absent on the venter and in having approximately the expected rib spacing and number. The third specimen (UCR 5189/2) consists of juvenile whorls that only show a suggestion of the ribbing of the adult form. All are deformed. The specimens were found in the Roaring River Road sections and indicate a stratigraphic range including the upper part of the local range zone of *Shasticrioceras roddai* and the lower part of the local range zone of *S. poniente.*

This species is very close to *P. eichwaldi* (Karakash) from the Crimea and to *P. eichwaldi occidentale* Wiedmann from France, Spain and North Africa. The number of ribs and cross sectional dimensions have been cited by Wiedmann (1963, p. 237) as the characteristics diagnosing the subspecies *eichwaldi* ss. and *eichwaldi occidentale.* Neither, however, is known from large samples and the variability remains unassessed. *P. occidentale* (Anderson) differs from both in its larger number of ribs.

Wiedmann's subspecific name *occidentale* is a junior homonym of *P. occidentale* (Anderson).

Order *LYTOCERATIDA*

Suborder LYTOCERATINA

Family LYTOCERATIDAE Neumayr, 1875

Genus LYTOCERAS Suess, 1865

Lytoceras saturnale Anderson

(Pl. 1, figs. 6 and 7; pl. 2, fig. 6)

Lytoceras (Saturnoceras) saturnale Anderson, 1938, p. 145, pl. 13, fig. 1.

Anderson (1938, p. 145) erected this species and made it the type species for his new subgenus *Saturnoceras,* but he neglected to formulate an adequate description of it or to mention any of the localities that specimens other than the holotype came from. The holotype is an extremely large specimen and for that reason it is difficult to compare it with the medium to large size specimens that normally are found in these strata. The characteristic features that seem to set *Lytoceras saturnale* apart from other species of *Lytoceras* are the high rate of increase in diameter of the shell per whorl, the slightly depressed cross section of the whorl, and the configuration of the ribbing which sweeps strongly adorally low on the flank, bends slightly adapically on the outer flank and crossed the venter with no inflection in the early whorls or with a very slight inflection in the later whorls.

As Anderson remarked, this species is similar in growth pattern to *Lytoceras (Argonauticeras) argonautarum* Anderson, but is easily distinguished from that species by its cross section and pattern of ornamentation. *Lytoceras neptunium* Anderson is also close in growth pattern, but its ornamentation has a different configuration and is much finer than *L. saturnale.*

Two specimens are assigned to *Lytoceras saturnale.* The first, UCR 6337/1, is poorly preserved, slightly deformed with a whorl height of 45 mm and width of 63 mm at approximately 110 mm diameter. The second from UCLA 3008 is a whorl fragment with a whorl height/width ration of 0.87 at a whorl height of 34 mm.

The UCR specimen was found in the Roaring River Road section in about the middle of the local range zone of *Shasticrioceras poniente.* The UCLA specimen was collected from an isolated locality on a tributary to Roaring River in the vicinity of Anderson's locality 1661 (see fig. 2). Its probable stratigraphic position is low in the *S. poniente* local range zone or in the *S. roddai* local range zone. This interpretation is supported by the occurrence of a fragmentary specimen from UCR 5189 in the Roaring River Road Auxiliary section that is questionably assigned to *L. saturnale* and which occurs in the *S. roddai* local range zone.

Anderson (1938, p. 146) gave the range of the species as "almost throughout the Paskenta group." The locality of the holotype, given by Gabb (1864, p. 67) as the Bald Hills, however, suggests that the holotype came from much higher strata. The Bald Hills locality precludes its being assigned to the "Paskenta group" as all the area that is within the Bald Hills is underlain by the lower Chickabally Member or higher strata, none of which would have been included in the Paskenta (see fig. 2). This casts doubt on Anderson's interpretation of the range of this species and probably on his interpretation of the species itself. In any case, Anderson's reported occurrence of the species in the Paskenta group needs confirmation before it can be accepted.

Lytoceras spp.

(Pl. 13, fig. 5)

Poorly preserved fragments of several large specimens of *Lytoceras* as well as one or two specifically unidentifiable complete shells have been found. These specimens are referred to in the range chart as *Lytoceras* sp. 1 and *Lytoceras* sp. 2. Both have relatively thick shells with relatively heavy crenulate ribs similar to the ornamentation found in *L. aulaeum.* All occur in the local range zone of *S. patricki.*

Lytoceras sp. 1 has heavy crenulate, slightly sigmoidal, generally rectiradiate ribs similar to the ornamentation found in *Lytoceras aulaeum,* but without the spiral striation of that species.

Lytoceras sp. 2 has prorsiradiate, almost straight ribs lighter in weight than *L.* sp. 1 and it also appears to lack the spiral liration found in *L. aulaeum.*

Genus EULYTOCERAS Spath, 1927

Eulytoceras phestum (Matheron)

(Pl. 2, fig. 3)

Ammonites phestus Matheron, 1878, Pl. C-20, Figs. 5a-5c.
Lytoceras phestus Matheron, Uhlig, 1883, p. 187, Pl. 5, Figs. 1-4, 20.
Lytoceras phestus Matheron, Kilian and Reboul, 1915, p. 21, Pl. 1, Fig. 2.

The California shells assigned to this species are of medium size with evolute whorls and nearly circular cross section, figure 8. Ornamentation consists of slightly flexuous, sharp-crested, weakly crenulate ribs that are evenly spaced and 4 to 5 mm apart on the body whorl. No constrictions or periodic varices are present. The ribs tend to become more closely spaced in the late growth stgaes. Measurements are difficult to obtain because of the preservation. A summary of them is given below:

Specimen	*D in mm*	*H*	*W*	*U*
UCR 682/1	70	25	–	30
UCR 5196/1	55	20	20	22
UCR 6330/1	±48	17	–	–

Mme. Taxy-Fabre, Universite d'Aix-Marseille, has graciously furnished a photograph of the holotype from the Matheron collection in the Museum d'Histoire naturelle de Marseille for comparison. The specimens from California are so close to this specimen and the one figured by Kilian and Reboul (1915, pl. 1, fig. 2) from southeastern France that there seems little doubt that they are the same species. The slight flexure of the ribs and their approximation in the late growth stages are shown in Bedoulian specimens from L'Homme d'Armes quarry near Montelimar and in upper Barremian specimens from Noyers-sur-Jabron and Montagne de Lure that are housed in the Institute Dolomieu collections at Grenoble.

Stratigraphic position and distribution.—The species is reported in

France from the L'Homme D'Armes quarry and from La Bedoule, both in the lower Aptian. Busnardo (1963, T. 1) records it from the Barremian stratotype near Angles, France, in the upper Barremian. In the Mitchell Creek Area it occurs in the *Shasticrioceras roddai* and the lower half of the *S. poniente* local range zones at localities UCR 503, 682; 6330, 5196, 6305, and UCLA 2969.

Family PTYCHOCERATIDAE Meek, 1876

In addition to the taxa described below, a number of specimens have been found that are too fragmentary to describe, but are no doubt members of the Family Ptychoceratidae. Also, Anderson, (1938, p. 219) has reported *Hamulina aldersona* Anderson and *Anahamulina vespertina* Anderson from the Aptian and Valanginian, respectively. The latter has not been discovered during the course of my research so its stratigraphic position is not yet verified. *Hamulina aldersona* occurs in the *Eotetragonites wintunius* zone (Murphy, 1956, fig. 6).

Genus ANAHAMULINA Hyatt, 1900

?*Anahamulina* sp. 1

(Pl. 2, fig. 5)

The general form of the shell is a U-shape with the shaft and hook whorl diverging from one another at a low angle. The ornamentation consists of simple, oblique ribs on the shaft ranging in density from four to six per ten mm. The body chamber is ornamented by simple straight ribs spaced about 3½ per ten mm. The specimen is about 80 mm long and 50 mm wide with a distance of 17 mm between the shaft and hook.

Only about 20 mm of the shaft are septate and this part of the shell is crushed. The L (fig. 9) is the only sutural element that is clearly displayed and is distinctly bifid in form.

Three fragmentary specimens of the body chamber and shaft comprise the material assigned to this taxon. Their preservation is not sufficiently good to warrant the erection of a new specific taxon, and measurements are not meaningful. They occur in a narrow band of strata in the lower part of the *Shasticrioceras poniente* local range zone at UCR localities 5181 and 5192, Roaring River Road section.

Discussion.—Uhlig (1838, p. 217, pl. 13, fig. 6) has figured a very similar form from the Wernsdorfer Schichten which he called "*Hamites (Hamulina)* n. f. ind." ?*Anahamulina* sp. 1 is much coarser ribbed than the fragment of another shell also questionably assigned to *Anahamulina* below.

?*Anahamulina* sp. 2

(Pl. 2, fig. 7)

A single fragment of a shaft about 3 cm long is questionably assigned to *Anahamulina* and is a species distinctly different from ?*Anahamulina* sp. 1

in the weight and inclination of the ornamentation. In this taxon the ribs of the shaft are spaced at about 6 per cm and inclined at about 20 degrees. No tuberculation of the ribs is present on the fragment. The suture shows a distinctly bifid L. The cross section of the shaft is shown in Fig. 10, and measures 16 mm in height and 15 mm wide.

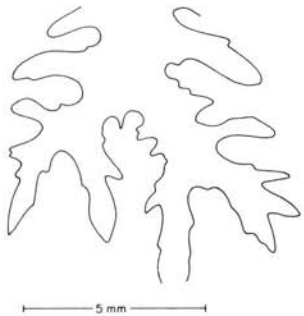

Fig. 9. ?*Anahamulina* sp. 1.–lateral lobe of the suture line.

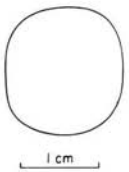

Fig. 10. *Anahamulina* sp. 2.–cross section of the specimen figured on plate 2, figure 7.

?*Anahamulina* sp. 2 was found at UCR 5195 in the lower part of the local range zone of *Shasticrioceras poniente* in the Roaring River Road section.

As nearly as can be compared this fragment is close to the "*Hamites (Hamulina) fumisuginum*" described by Uhlig (1881, p. 214, pl. 13, fig. 2) from the Wernsdorfer Schichten; however, the suture and the cross-sectional shape are unknown in the latter.

Genus EUPTYCHOCERAS Briestroffer, 1952

?*Euptychoceras jordanense* n. sp.

(Pl. 1, fig. 1)

The slightly crushed specimen on which this taxon is based has the general shell form of *Anahamulina,* but is almost entirely smooth. The only ornamentation is a weak, irregular plication on the hook. The shaft is very long and straight. Its cross section is nearly circular but very slightly flattened on the dorsum. The later shaft and hook are deformed, but the recurved limb appears to have been about parallel to the shaft. The suture line has a large trifid L. (fig. 11).

This species is not close to "*Ptychoceras*" *natrice* Anderson, the only other species of the genus described from these strata. It appears to be a form intermediate between *Anahamulina* and *Ptychoceras,* like *Anahamulina* in shell shape; like *Ptychoceras* in ornamentation and suture.

The specimen was found low in the Jordon Ranch section (UCR 5123) and thus is probably about middle Barremian in age. This locality is in the lower part of the *Shastcrioceras patricki* local range zone.

The species is known from only a single specimen (UCR 5123/1). It is named for the site of the Jordan Ranch, now destroyed by fire.

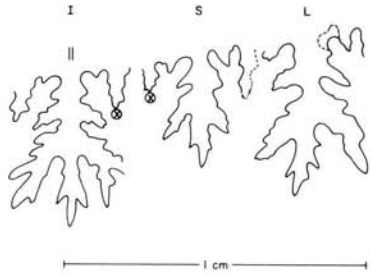

Fig. 11. ?*Euptychoceras jordanense* n. sp.—partial suture line. X marks a similar position on successive suture lines.

Suborder AMMONITINA

Family PULCHELLIIDAE Hyatt

Genus PULCHELLIA Uhlig, 1883

Two species, *Pulchellia* cf. *P. compressissima* and *P. (Heinzia) popenoei* Anderson have been found in superpositional sequence in northern California. These occurrences have an importance out of proportion to the small number of specimens that have been found because they seem to enable the French Barremian strata to be correlated with the middle part of the Barremian sequence as it is developed in northern California. This conclusion is based on the works of Bürgl (1956) and of Busnardo (1963) and is discussed under the section heading of correlation.

Pulchellia cf. *P. compressissima* (d'Orbigny)

(Pl. 2, fig. 4)

This taxon is represented by a single specimen that is small and crushed, but which retains enough of the characters of ornamentation and shape to compare it favorably with d'Orbigny's species. The shell is completely involute and about 27 mm maximum diameter. The ornamentation consists of broad, rounded ribs that are present only on the outer part of the flank and venter and that have clavae at the ventral shoulder. The entire surface is faintly striated with growth lines.

The d'Orbigny collection at the Museum National d'Histoire Naturelle, Paris, contains about 20 specimens from southeastern France that are assigned to this species. D'Orbigny's register lists 12 specimens from Robion, 7 from Escragnolles, and 3 from Barrême. There is considerable variation between the individuals from these localities, especially with respect to the density and coarseness of the ribbing and apparently in the ontogenetic stage where the ribs begin. Most of the smaller specimens show smooth inner flanks similar to the illustrated figure (d'Orbigny, 1842, pl. 61, figs. 4, 5)

and broad plications toward the periphery. This is the morphology with which I am comparing the California specimen and the morphology that d'Orbigny apparently considered typical of the species.

Stratigraphic position.—Busnardo (1963, table 1) gives the range of *P. compressissima* as the middle part of the lower Barremian in the stratotype near Angles in southeastern France. The California specimen seems to fall in the same position in the faunal sequence, that is, above the earliest Barremian strata characterized by the appearance of *Barremites* ss. and below *Pulchellia* with an open umbilicus (=*Pulchellia popenoei*). The California specimen was found in the Mitchell Creek I Section at UCR locality 5142.

Subgenus HEINZIA Sayn, 1890

I am following Bürgl (1956) and Busnardo (1963) in recognizing the subgenus *Heinzia* as it is a useful taxonomic category for the discussion of Barremian biostratigraphy.

Pulchellia (Heinzia) popenoei Anderson

(Pl. 2, fig. 2; pl. 6, figs. 3 and 4)

The shell is of small to medium size, discoidal, with about 90 percent involution. The whorl section is suboval with a flattened venter that is bordered by ventro-lateral clavi terminating the ribs. The ribs are sinuous, simple, or branching, or intercalated with branching or intercalation occurring at the midpoint of the flank. They widen broadly toward the periphery and have prominent growth lines superimposed. The suture has an asymmetrical L with several auxiliaries in the suspensive lobe.

Stratigraphic position and distribution.—Relatively few specimens of this species have been recovered in the Mitchell Creek area and no others have been reported from the Pacific Coast of North America. According to Anderson (1938, p. 197), the holotype and three other examples were found on Roaring River by W. P. Popenoe and D. W. Scharf upstream about a quarter of a mile from the "Millsap Road" (presumably this is the road that runs through the Mitchell Creek area from north to south and connects with the Ono-Platina highway at the north edge of the map shown on pl. 15, in pocket). In addition, several specimens were found in the Jordan Ranch section at approximately the same horizon, as nearly as can be determined. All of the specimens from the Jordan Ranch section were found in the lower part of the local range zone of *Shasticrioceras roddai* at UCLA locality 3060.

Anderson's measurements of the holotype UCLA 36217 (CIT 3468) at 57 mm diameter are: whorl height 32 mm, width 17 mm, umbilicus 5.5 mm. My measurements of this specimen are the same except for the umbilicus which is 4 mm from one umbilical seam to the other. The specimen figured here has the same umbilical diameter at only 37 mm diameter.

Suborder ANCYLOCERATINA

Family ANCYLOCERATIDAE

Genus ANCYLOCERAS d'Orbigny, 1842

Ancyloceras elephas Anderson

(Pl. 9, fig. 2)

Ancyloceras elephas Anderson 1938, p. 209, pl. 64, figs. 1, 2; pl. 66, fig. 1.

The shell is large to very large with ancylocerid coiling. The spire is unknown. The cross section of the shaft is nearly circular in the early part (fig. 12), expanded laterally in the later part of the shaft and the hook, but tapers rapidly to end in a compressed oval aperture only about half the size of the cross section at the top of the hook. The ornamentation of the shaft consists of fine ribs spaced at about two to three mm apart. Six symmetrically disposed, large spine bases are superimposed on each fifth or sixth rib and cover two to three ribs. The ribs are generally distinct between the spine bases. The inclination of the ribs to the shaft axis varies from about 75 to 90 degrees. The ribs are coarser on the early part of the hook and continue to form at least to the crest of the hook. On the flank, the ribs are less strongly developed and die out between the second and third large plications of the hook. A marked change in character of the tubercle occurs between the last septate part of the shell and the body chamber. The ribs disappear gradually and very large tubercles (?spine bases) mounted on heavy distant plications develop. The plications have lateral tubercles on the early part of the hook. On the later part of the hook the plications are narrower and more continuous and with ventral tubercles in addition to the lateral ones. Near the aperture the plications are more approximate. The diameter of the aperture becomes progressively more constricted with growth of the recurved limb of the hook. A large fragment of the shaft, UCR 5404/1, is 76 mm in height and 72 mm in width.

Comparison.—This species differs from others in California, except *Toxoceras stentor* and *Ancyloceras durrelli,* by the round cross section of the shaft (fig. 12) and the continuous development of the spines on the shaft. The character of the ribbing and the way the spines are mounted on the ribs differentiates it from European species: viz. the spines are not mounted on larger periodic ribs with smaller ribs between them, but cover two or three of the smaller ribs themselves. It is difficult to state the differences between *A. elephas* and *A. durrelli* as *A. durrelli* is based on two fragments which may not be conspecific. The "paratype" (Anderson, 1938, pl. 68, fig. 1) has a different cross section than the holotype at the top of the shaft. The "paratype," however, is slightly deformed. If the paratype is also *A. durrelli,* the differences between the species are marked. *A. durrelli* is not transversely inflated on the hook and the change in ornamentation is abrupt between the shaft and the hook in contrast to *A. elephas.* See *Toxoceras stentor* for comparison.

Range.—The species is known from the *Shasticrioceras roddai* and the *S. poniente* local range zones. A relatively small number of specimens is known and only a few of them are accurately placed in measured sections. During this study, fragmentary specimens have been recovered from UCLA localities 2983 and 2985, and UCR localities 5129, 6338, and 5404. One specimen from UCR 6347/3 is questionably assigned to this species.

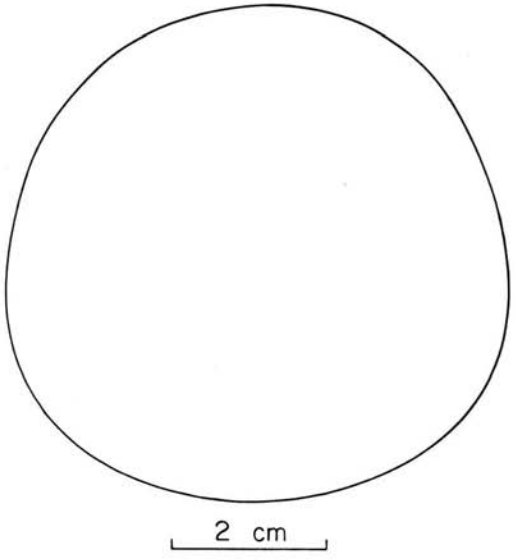

Fig. 12. *Ancyloceras elephas* Anderson—cross section of the whorl of UCR specimen 5404/1.

Ancyloceras thomeli n. sp.

(Pl. 3, figs. 1 and 5; pl. 11, figs. 1 and 2)

The shell is large; the coiling ancylocerid with a slightly arched shaft and oval to elliptical cross section. The spire is ornamented with fine, weakly flexed ribs, nearly rectiradiate except at the outer and inner edges of the flank. Two large lateral tubercles are spaced at 4 to 6 rib intervals. They are superimposed over two ribs at the inner and outer thirds of the flank. Smaller lateroventral tubercles are present on each rib. The tubercles are lost on the early part of the shaft and the ribbing becomes prorsiradiate. The adoral part of the shaft again shows pairs of lateral tubercles that are progressively more prominent as the shell increases in size. As the lateral tubercles reappear, the ribbing gradually becomes obscure and is not present on the flanks of the hook. The ribbing on the venter extends, though more weakly developed, to the position of the first large lateroventral tubercles of the plicate ribs of the hook. Most of the hook is ornamented only by large tubercles mounted on plications of the shell at the dorsolateral, ventro-lateral, and latero-ventral positions.

Comparison.—*A. thomeli* n. sp. is similar in ornamentation and coiling

pattern to *A. audouli* (Astier), the type species of the subgenus *Audouliceras* Thimel, 1964, from southeastern France. The principal differences are that *A. audouli* has much finer and more closely spaced plications on the hook and the fine ribs of the shaft also ornament parts of the hook, whereas they die out on the hook of *A. thomeli.* Also the spire of *A. thomeli* tapers much less rapidly than that of *A. audouli* which, according to Thomel (personal communication) is grounds for excluding the California form from *Audouliceras.*

Of the California species, *A. thomeli* differs from *A. elephas* in having an oval vs. a round cross section, and in lacking the large blister-like spine bases that are present on every fifth or sixth rib of the shaft of *A. elephas.* It is similar to *A. elephas* in the marked lateral expansion of the later part of the shaft and early part of the hook and the subsequent reduction in cross sectional area in the late part of the hook. It differs from *A. ajax* Anderson, which it otherwise closely resembles, in having the tubercles develop gradually on the flank of the late shaft, whereas in *A. ajax* the change in ornamentation is abrupt. *A. ajax* also apparently lacks tubercles on the late part of the spire that are present in *A. thomeli. A. durelli* differs from *A. thomeli* in having a rounded cross section of the shaft, and no tubercles on the shaft. The paratype of *A. durrelli* figured by Anderson (1938, pl. 69, fig. 1), which may not be conspecific with the holotype because of the apparent difference in cross sectional shape of the shaft, differs from *A. thomeli* in having an abrupt change from ribbing to plication on the shaft and in not developing ventral tubercles on the plications until the hook is almost completed.

Range.—Only four specimens have been identified as belonging to this species. Two of them collected at UCLA 2982 and UCR 6338/5 occur just below the mappable limestone bed in the middle part of the Roaring River Road Section I in about the middle of the local range zone of *Shasticrioceras poniente.* One specimen was collected at UCR 5405 on Roaring River at a horizon that probably falls within the *Shasticrioceras roddai* local range zone as developed in the Mitchell Creek area. The locality of the remaining specimen cannot be placed in the column accurately.

Genus INDETERMINATE

"Shasticrioceras" inflatum Anderson

(Pl. 5, fig. 4)

Shasticrioceras inflatum Anderson, 1938, p. 204, pl. 56, fig. 3; not pl. 56, fig. 4.

This species is known only from the holotype which is a fragment of about one-quarter of a whorl (C. A. S. Type Collection No. 8933). The fragment is completely septate, so no estimate of its maturity is possible. The whorl section is subtrapezoidal with a venter that is slightly tabulate. The ribs are prorsiradiate, slightly biconcave as in *Shasticrioceras,* but irregular in

weight and spacing and with tubercles at the ventral shoulder. The suture has an ancylocerid lateral lobe with a narrow trunk.

The small specimen figured with the holotype is not part of the same specimen as can be seen from its much different ornamentation in which the ribs are coarser at a smaller diameter, show no indication of flattening on the venter, or of having any latero-ventral clavae or bullae of any kind. Also the adoral end of the small specimen is a weathered surface whereas the adapical end of the holotype is a broken surface.

Anderson reports these specimens from C. A. S. Locality 1347. Even so the precise locality and horizon are not known because he gives nine separate locality descriptions from four separate zones for this locality number (Anderson, 1938).

Discussion.—The suture of the holotype suggests that the species should be assigned to an ancylocerid genus rather than a hemihoplitid genus. The style of ribbing, and coiling, though perhaps similar to that found in *Shasticrioceras,* is also common in ancylocerid genera in the spire. The species which seems closest is "*Crioceras*" *aequicostatum* var. *subtilis* figured by von Koenen (1902, pl. 30, fig. 3).

The small specimen is probably a fragment of a species of *Heteroceras.* The holotype may be part of an *Ancyloceras* spire, or possibly, it belongs in the genus *Toxoceras.*

Genus DISSIMILITES Sarker, 1954

Dissimilites sp.

(Pl. 7, figs. 5 and 6)

Two fragments of body chambers referable to this genus were recovered during the present study. One (UCR 5188/2, fig. 13) was collected in the lowest part of the *S. poniente* local range zone in the Roaring River Road Section II. The other (UCR 5193/1) was collected from an area near the Middle Fork of Cottonwood Creek where it was associated with *Shasticrioceras roddai* n. sp. An additional specimen, questionably assigned to this genus because of its preservation, was found at UCR locality 5417.

These specimens are reported here as evidence of faunal similarity and connection of the California province with the Tethyan region during the Barremian.

Genus TOXOCERAS d'Orbigny, 1842

Type species.—*Toxoceras requienianus* d'Orbigny, 1842

D'Orbigny created this genus for forms that were slightly to strongly, but uniformly arcuate in coiling style, but which never formed a spiral coil. He included all such Neocomian-age shells regardless of their ornamentation. The type species has major ribs with two pairs of tubercles with minor ribs between them. The other species included by d'Orbigny in his genus ranged from trituberculate forms to non-tuberculate forms. Some have since been made the types of other genera: *t. royerianus* = *Toxoceratoides* Spath; *T. obliquatus* = *Hemiaculites* Hyatt; *T. moutonianus* = *Moutoniceras* Sarkar.

Wright (1957, p. L208, L212) has suppressed *Toxoceras* in favor of *Crioceratites*; *Toxoceratoides* in favor of *Hamiticeras*; and *Moutoniceras* in favor of *Hemibaculites. Toxoceratoides* is discussed below (p. 62).

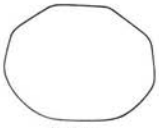

Fig. 13. *Dissimilites* sp.—cross section of a UCR specimen 5188/2.

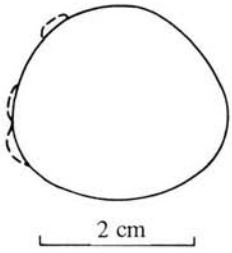

Fig. 14. *Toxoceras stentor* (Anderson)—cross section of UCR specimen 694/1.

Hemibaculites has been cited by Anderson (1938) as occurring in California, but Casey (1961, p. 70) has since included all of Anderson's species in his genus *Lithancylus. Hemibaculites* Hyatt is, as Sarkar (1954, p. 159) has pointed out, a *nomen dubium* because it is based on a non-diagnostic specimen. For this reason, I follow Sarkar and use his genus *Moutoniceras* for the non-tuberculate members of d'Orbigny's *Toxoceras. The coiling* style is so different between *Toxoceras* and *Crioceratites* that is seems reasonable to keep *Toxoceras* as a separate taxon, especially since most workers now separate from *Crioceratites* several genera that are more similar to it than *Toxoceras*, e.g. *Paracrioceras, Emericiceras*. Sarkar included *Toxoceras nodosus* d'Orbigny (Boule, 1937, pl. 5, fig. 7) in *Moutoniceras,* but with a query. This species has ventro-lateral tubercles and lacks the adoral inflection of the ribs on the venter characteristics of the type species. It also has faint lateral tubercles and is, thus, close to the type species of *Toxoceras* in which it is retained here. *T. requienianus* and *T. nodosus* form a morphological gradation to which the California forms grouped in *T. blandi* would form a third step.

Toxoceras stentor (Anderson)

Pseudocrioceras stentor Anderson, 1938, p. 206, pl. 61, figs. 1, 1a.
Pseudocrioceras stentor Anderson, Murphy, 1956, fig. 6.

The shell is large with a rounded cross section that is flattened on the dorsum (fig. 14). The coiling is in an open plane spiral with the whorls probably not touching. Ornamentation consists of 6 to 8 fine ribs that are between low, broad ribs surmounted with 3 pairs of symmetrically placed spines. The spines, generally not preserved, are represented by large blister-like swellings covering the ribs. The suture is Ancylocerid with a slightly asymmetrically trifid L. A small fragment measured 25 mm high and 26 mm wide.

Comparison.—This species may be confused with the shaft fragments of *Ancyloceras elephas* Anderson. The known specimens differ in curvature

of the conch, by the character of the large ribs, and by the slightly different cross section which tends to be more flattened dorsally in *Toxoceras stentor*. All known fragments have about the same amount of curvature regardless of size.

Stratigraphic position.—Only 4 small fragments of this species were found during the present investigation. Fortunately, two of them were found in the Roaring River Road Section I and give a range that extends from the *Shasticrioceras roddai* local range zone to the middle of the *S. poniente* local range zone. Specimens have been recovered form UCLA 2983 and at UCR locality 694.

Toxoceras blandi n. sp.

(Pl. 4, fig. 1; pl. 3, fig. 2; pl. 7, fig. 3)

This taxon is known from several fragments of a large, moderately curved *Toxoceras* with the general style of ornamentation found in the type species. The cross-sectional shape is like an oval with the flattened venter accentuated by ventro-lateral spinose tubercles (fig. 15). The ornamentation consists of slightly sinuous primary ribs with an occasional secondary rib intercalated from the dorsum. The suture is ancylocerid in general pattern with a deep, narrow, somewhat asymmetrically trifid L. The holotype is UCLA specimen number 48340. The specimen measures 35 mm in whorl height and 25 mm in width at the fracture plane in its middle part.

Comparison.—This taxon most closely resembles *T. nodosus* d'Orbigny. It differs from that species and the type species in lacking lateral tubercles and in having ventro-lateral tubercles on every rib that reaches the venter.

Stratigraphic position.—Two specimens assigned to this species (UCR 5194/1, 5196/2) occur in the middle of the local range zone of *Shasticrioceras roddai* n. sp. in the Jordan Ranch section of the Mitchell Creek area. The holotype was found on Roaring River at UCLA locality 2984, probably in the same zone.

Genus TOXOCERATOIDES Spath, 1924

Type species.—*Toxoceras royerianus* d'Orbigny

Casey (1961, p. 77) resurrected Spath's genus for a group of forms that are characterized by an ancyloceratid type of ornamentation and that have labeceratid coiling. I agree with Casey that a taxon is needed for this distinctive group of species.

Several species of hooked ammonites that more or less resemble the group of *Toxoceras royerianus* d'Orbigny, as exemplified by the neotype, have been found in California in the middle part of the section exposed in the Mitchell Creek area. Anderson described one of them as *"Acrioceras" starrkingi*. The holotype of *starrkingi* and other Californian specimens discussed below resemble *Toxoceratoides* in the weight of the ribbing, the

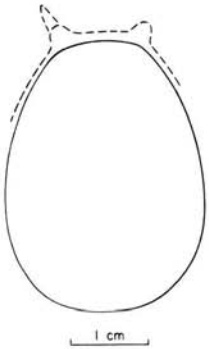

Fig. 15. *Toxoceras blandi* n. sp.–cross section of the holotype, UCLA locality 2984.

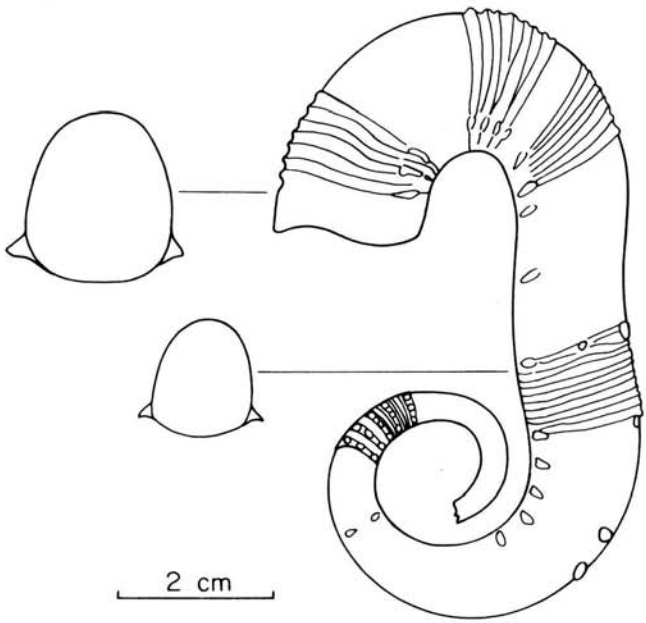

Fig. 16. Sketch of *Acrioceras tabarelli*. The whorls of the spire in *Acrioceras tabarelli*, the type species of *Acrioceras*, have ribs with three pairs of tubercles separated by 2-4 finer ribs without tubercles. The early, septate part of the shaft is similarly ornamented, but the smaller ribs reach 11 in number. After the midpoint on the shaft all the shaft ribs are small, lack lateral and ventral tubercles, but some are bundled together at the dorso-lateral angle where irregularly spaced bullae are developed. The ribs gradually get coarser and the bullae more closely spaced until the hook is complete.

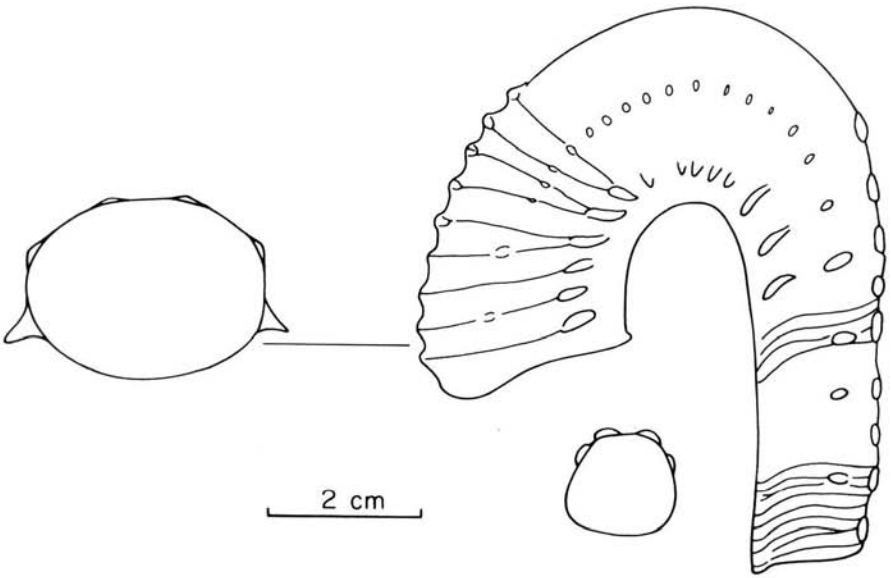

Fig. 17. *Toxoceratoides starrkingi* (Anderson), lateral view. This species and other California specimens of this general group lack the early ontogenetic stages of the spire. *T. starrkingi* differs from *A. tabarelli* in possessing coarser ribbing that is tuberculate only on the venter of the adapical part of the shaft. Near the adoral end of the shaft poorly developed lateral and dorso-lateral bullae are prominent and spinose whereas the other two pairs are faint or absent. *T. starrkingi* also has a more inflated cross section of the shaft and especially of the hook.

ontogenetic development of the ornamentation, and the cross section of the shaft and hook. None of these specimens, however, shows any part of the spire, so it is impossible to say whether or not the coiling stype was labeceratid, as inferred by Casey (1961, p. 79) for *Toxoceratoides*, or ancyloceratid as in *Acrioceras*. The differences between *Acrioceras tabarelli*, type species of *Acrioceras* and *Toxoceratoides starrkingi* are diagrammatically shown in figures 16 and17. This comparison supports their assignment to *Toxoceratoides* rather than *Acrioceras.*

Toxoceratoides cf. *Toxoceratoides royerianus* (d'Orbigny)

(Pl. 2, fig. 1; pl. 4, fig. 2)

For synonymy of *Toxoceratoides royerianus* (d'Orbigny), see Casey, 1961, p. 78.

The shell is of medium size, probably with labeceratid coiling. The ornamentation of the specimen is similar to that found in the neotype of *T. royerianus* as figured in Casey (1961, p. 79, fig. 30a-c). The main differences are that the California specimen has less oblique ribbing on the shaft, the ribs on the hook are more distant and the specimen is somewhat larger and more expanded in the hook (fig. 18). The variation that occurs in various specimens assigned to *T. royerianus* in the museum collections in France shows that there is a variation in the size and curvature of the shaft, and in the inclination and number (usually one, rarely two) of the

intermediate ribs on the shaft, and in the prominence of the tubercles. Most of these specimens are fragments of the shaft and it is very possible that a number of species exist with this general type of ornamentation. Therefore, it is considered prudent to wait for additional information on the variability of both the California and French forms before positive identification is made.

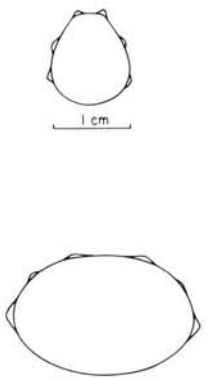

Fig. 18. *Toxoceratoides* cf. *T. royerianus* (d'Orbigny)—cross sections of the shaft and hook of UCR specimen 5181/4.

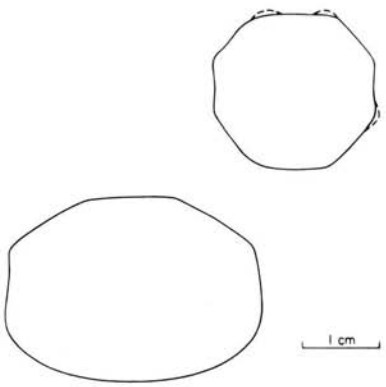

Fig. 19. *Toxoceratoides saulae* n. sp.—cross section of the hook and shaft of the holotype, UCR specimen 6347/2.

The California specimen, UCR 5181/4, was found in Roaring River Road Section I in the Mitchell Creek area. This locality is low in the *Shasticrioceras poniente* local range zone and of Barremian age.

Toxoceratoides saulae n. sp.

(Pl. 4, figs. 4 and 6)

The shell is of medium size and known from a single specimen of a partial shaft and early hook. The late part of the shaft is ornamented by fine, sharp ribs in groups of one or two alternating with coarse, broader trituberculate ribs. The ribs cross the dorsum with a slight adoral curvature and almost undiminished in weight. They are very slightly prorsiradiate on the flanks, and have a slight adoral curvature on the venter. The shaft is nearly round in cross section (fig. 19) but with slightly flattened venter, dorsum and flanks. The hook is laterally expanded to one and a half times the diameter of the shaft while approximately maintaining its height. The ribs on the hook are narrow and sharp-crested, arise in pairs at spinose bullae low on the flank, rise nearly straight to an angular ventral shoulder where bullae are developed, are arched gently adorally on the venter, and bear weakly developed ventral bullae. The suture in not known.

The holotype is UCR 6347/2. The species is named for Louella Saul.

Comparison.—This species is much larger than any known from Europe.

It differs from all other species known from California in its very low prorsiradiate inclination of the ribs. It is closest in form to *T.* cf. *T. royerianus* and to *T. corae* n. sp. From *T. corae* it differs in having a round vs. an oval cross section of the shaft, more closely placed tubercles on the shaft, in expanding the body chamber laterally to a greater degree, and in being smaller. From *T.* cf. *T. royerianus* it differs, in addition to the inclination of the ribbing, mainly in being larger.

Stratigraphic position.—The specimen was found in the middle part of the local range zone of *Shasticrioceras poniente* in the Roaring River Road section in the Mitchell Creek area.

Toxoceratoides starrkingi (Anderson)

(Pl. 4, figs. 3 and 5)

Acrioceras starrkingi Anderson, 1938, p. 207, pl. 59, fig. 4, not *Ancyloceras (Acrioceras)* aff. *starrkingi* Anderson, Jeletzky, 1964, pl. 19, fig. 2.

Anderson's description of this species is generally good, but in some respects it is misleading. The holotype (1938, pl. 59, fig. 4) is obviously reconstructed as the shaft is separated from the hook by plaster. What is not obvious is that the original position of the shaft as shown by the external mold was 2 mm closer to the hook near the proximal end and 4 mm closer to the hook at the distal end. This change makes the hook and shaft almost parallel. If the fossil were portrayed as it was found, half of the plaster in the reconstruction would have to be removed.

The tuberculation of the flanks is difficult to see in Anderson's figure. It begins about 1 cm from the adapical end of the shell and is irregularly developed on the following part of the shaft. Dorso-lateral bullae appear on the adoral part of the shaft. (see fig. 17). Ventral tubercles are present the entire length of the shaft.

Comparison.—*T. starrkingi* differs from all European and Californian species, except *T. greeni* n. sp. described below, in the possession of fine, closely spaced ribs that have a pronounced adoral inclination on the lower flank. It differs from *T. greeni* n. sp. in the form of the ventral tuberculation of the shaft, in being smaller, and in the much more closely spaced ribbing on the hook. The species figured by Jeletzky (1964, pl. 19, fig. 2) is not close to *T. starrkingi* as shown by the different configuration of the ornamentation on the shaft, the alternating heavier and lighter ribs on the shaft, and the greater rate of taper of the shaft. It should be described as a new species. See below for comparison with *T. corae* n. sp.

Range and distribution.—The precise horizon of Anderson's specimen is unknown. During the present investigation, two specimens that probably belong to this species were found in isolated localities in the southern part of the Ono Quadrangle. One of them near the Middle Fork of Cottonwood Creek and the other on Corral Gulch at UCR localities 5406 and 505,

respectively. The species probably occurs in the local range zone of *Shasticrioceras roddai* as species from that part of the column predominate in localities in those areas.

Toxoceratoides corae n. sp.

(Pl. 5, figs. 1 and 5)

The shell is of medium size and known only from fragmental specimens of the shaft and hook. The shaft is ornamented by fine gently arched ribs, with tubercules on the venter in the early part of the shaft, joined by lateral tubercles on the mid shaft and by latero-dorsal tubercles on the late part of the shaft. The tubercles tend to cover two or three of the small ribs. The hook is ornamented by narrow, rounded ribs that arise at the edge of the dorsum, bear a short, bullate spine low on the flank, then branch in doublets or triplets on the early part of the hook, but remain single distally. These ribs also bear small lateral and ventral bullae. The holotype is UCR 505/26.

Comparison.—*T. corae* n. sp. is similar to *T. starrkingi* in size and ornamentation. It differs form that species in having dorso-lateral tubercles rather than bullae, in being slightly larger, in having less taper to the shaft, and in having the ventral tubercles spaced farther apart. *T. greeni* is easily distinguished by the different ornamentation of the venter of the shaft. *T. royerianus* and similar forms are much smaller, and they have the tubercles mounted on large ribs with smaller ribs between.

Stratigraphic position.—The holotype was found with a specimen of *Shasticrioceras poniente* on Corral Gulch in the southern part of the Ono Quadrangle. A fragmentary specimen tentatively referred to this species (UCR 5186/2) occurs in the lower part of the *S. poniente* local range zone in Roaring River Road Section I. Another fragmentary specimen was found just below the bridges across Roaring River at about the same stratigraphic position. This specimen was found very close to locality UCR 642 which yielded *S. roddai*, but their precise relationships cannot be established stratigraphically because of a small shear zone of unknown displacement. From these three occurrences it appears that the species occurs in the lower beds of the *S. poniente* local range zone and perhaps in the upper part of the *S. roddai* local range zone.

This position in the stratigraphic section and its morphologic similarity to *T. starrkingi* suggest an evolutionary relationship, with *T. starrkingi* giving rise to T. *corae.*

The species is named for Cora Rodrick.

?*Toxoceratoides greeni* n. sp.

(Pl. 5, figs. 2, 3, 6)

The shell is of medium size and is known from the hook and partial shaft. The shaft is ornamented by fine, adorally inclined ribs that are tuberculate

at the ventral shoulder, no lateral tubercles can be seen on the shaft of the holotype, but the specimen is not well preserved in this part of the shell. The cross section of the shaft is subtrapezoidal (fig. 20). The shaft ornamentation gives way abruptly on the hook to more distant, high, sharp-crested ribs that arise in pairs or singly at spinose umbilical tubercles and trend straight across the venter. They have very light bullae laterally and on the venter. Between the ventral bullae the ribs are slightly sulcate. The hook is nearly equant in cross section. It measures 31.5 mm high and 35 mm wide at the crest of the hook and on the recurved portion as well. The holotype is from UCLA locality 2968. The suture is not known.

Fig. 20. *Toxoceratoides greeni* n. sp.—cross section of the shaft of the holotype from UCLA locality 2968.

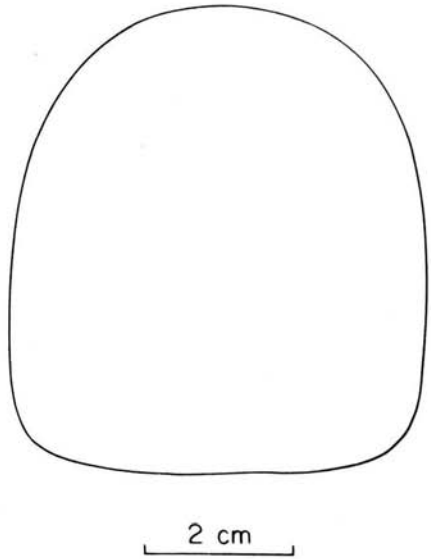

Fig. 21. *Heteroceras jeletzkyi* n. sp.—cross section of the hook of UCR specimen 6340/3.

Comparison.—This species is larger than other Californian species and has a much finer ribbing in proportion to its size. The size, shape, and ornamentation of the shaft easily distinguish it from species of *Toxoceratoides* and the character of the ornamentation of the hook separates it from such genera as *Lithancylus* and *Acrioceras* which it resembles in shaft ornamentation.

Besides the holotype one other specimen, UCR 5184/2, is questionably assigned to ?*T. greeni* n. sp. This specimen is alike in size and general ornamentation of the shaft and hook, but the tuberculation of the venter of the shaft is different in having small tubercles that are irregularly spaced in contrast to medium-sized tubercles that seem to be present on every rib of the holotype.

Range and distribution.—The locality of the holotype is on Roaring River on strike with the main fossiliferous zone of the Roaring River Road section which essentially is equivalent to the lower part of the local range zone of *Shasticrioceras poniente*. There are several small faults in the area, however, their effect in unknown. The specimen from UCR 5184 was found in the Jordan Ranch section at about 1225 feet. It occurred above specimens of *S. roddai* in that section and its horizon is correlated with the lowest part of the *S. poniente* local range zone in the Roaring River section. The inferred range, therefore, is from the lowest part of the local range zone of *S. poniente* to its middle part.

The species is named in memory of Lamar Green.

Toxoceratoides sp. 1

(Pl. 6, figs. 1, 2, 11)

This taxon is known from a single shell judged to be too poorly preserved to serve as a reference specimen, but which is distinctive enough to establish the presence of a separate taxon of *Toxoceratoides* high in the *Shasticrioceras poniente* local range zone and probably lowermost Aptian in age. It has the general style of ornamentation of the hook that is present in *T.* cf. *T. royerianus* and *T. saulae* n. sp. described above, but the hook does not expand laterally as it does in those species. The upper part of the shaft is nearly circular in cross section and is ornamented with simple, slightly adorally inclined ribs that are bullate at the edge of the dorsum where they arise, at ventral shoulder, and on the venter. The ribs of the preserved part of the shaft are relatively widely spaced and sharp crested when compared with the shaft ribs of other species in the genus. A part of the last septum is preserved, but the character of the suture is not distinguishable.

The figured specimen comes from UCR locality 5131 near the top of Roaring River Road Section I.

?*Toxoceratoides* sp.

(Pl. 3, fig. 6; pl. 6, figs. 5 and 6)

This taxon is known from three fragmental specimens, two of which come from the same stratigraphic interval. The locality of the third specimen is unknown. Based on the two specimens from known locality this species has the general style of shaft ornament that is present in *T. greeni* n. sp. described above, but the ribs on the venter are bullate rather than tuberculate, they cross the venter subdued and with an adorally concave flexure. The ribs of the hook are not so prominent as in *T. greeni* and the spinose bullae at the edge of the dorsum are not developed. The shaft is subtrapezoidal in cross section and the hook though deformed appears to have had and oval cross section. The species is easily distinguished from other Californian forms by the high inclination of the ribbing and cross sectional shape of the shaft.

The third specimen is generally similar to the two described above,

but shows the development of the bullae that may have been spinose on the hook. This specimen is of particular interest because it shows muscle scars on the internal mold. Unfortunately, it was picked up in a gravel deposit and its stratigraphic position is unknown. The presence of muscle scars is rare in ammonites and has been described from only a handful of specimens. The muscle scars on this shell are of the same shape as those described by Jones (1961, p. 502) in *Diplomoceras notabile* Whiteaves. They are arranged in that species so that the dorsal pair of scars is positioned slightly adapically to the single ventral scar. In the specimen described here, the reverse is true. The ventral scar is much more difficult to recognize and would not have been noticed if the dorsal scars had not been so well preserved. Each of the scars seems to have been underlain by a layer of shelly material that is analogous to the myostracum found in some bivalve shells and each of the dorsal scars is bordered by a hairline impression on the internal mold. The cross section measures 28.5 mm high and 24.5 mm wide at the position of the muscle scar; at the top of the hook it is 31 mm high and 32 mm wide.

Stratigraphic position.—The two specimens from known localities occur in the lower part of Roaring River Road Section II (UCR 5185) and near the Jordan Ranch Section (UCR 81), respectively. Their position is in the lowest part of the local range zone of *S. poniente*.

Family HETEROCERATIDAE Hyatt

Genus HETEROCERAS d'Orbigny

The genera *Heteroceras* and *Colchidites* differ from one another primarily in the orientation of the helix, but also in the tightness of coiling of the spire and in the number of volutions in the spire. The specimens recovered from the Mitchell Creek Area, Ono Quadrangle, California, show only a suggestion of the helix, but none of them shows the tight initial coil of *Colchidites*. For this reason, the better preserved forms from California are assigned to the genus *Heteroceras*. The taxa in which the spire is unknown are assigned to ?*Heteroceras*.

Heteroceras jeletzkyi n. sp.

(Pl. 7, fig. 4)

The shell is large with heteroceratid coiling and subquadrate cross section (fig. 21). The spire consists of an initial helix followed by a single volution in the plane of the adult coiling. Only a single specimen partially preserves the distal part of the helix which shows strong, simple, oblique ribs about equal in width to the interspaces between them. The remainder of the spire is ornamented with coarse, simple adapically inclined, straight to slightly arched ribs on the earlier part of the whorl that weaken and become more approximate on the last part of the spire. The shaft is curved and ornamented similarly, but some secondary ribs are intercalated or branch from

the primary ribs. On the hook the ribs are large, rectiradiate, sharp, simple, and widely spaced. There is no trace of tubercles or bullae at any stage. The suture is typical for the genus with a long, narrow, symmetrically trifid L in the center of the flank; the saddle of the E is deeply cleft. The holotype is UCR specimen 6338/1.

Discussion.—This species is close to the figured specimens of several species found in France and Georgia (USSR). It differs from *H. astieri* d'Orbigny (Kilian, 1888, pl. 21, fig. 1) in having more irregular and finer ribbing and a loosely coiled spire. In this last respect, however, the specimens at the Institut Dolomieu, Grenoble, show variation from specimens with the coils of the spire touching the helix to specimens with the coils of the helix and spire distinctly separated. The species *H. leenhardti* is similar in coiling style, but the ribbing pattern is different and finer on the spire, though the two are similar on the shaft.

Rouchadzé (1933, 1938) has figured several heterocerids that are similar in coiling and ornamentation to the Californian specimens. Of these, the closest are assigned to the genera *Colchidites* or *Argvethites*. The species *Colchidites longus* Rouchadzé (1933, p. 14, fig. 6) and *C. kakabadzei* Rouchadzé (1948, pl. 6, fig. 4) are similar to *H. jeletzkyi* n. sp. in ornamentation and coiling style, but the California species is larger.

Stratigraphic position.—All specimens assigned to the species come from a narrow band of strata no thicker than 10 feet in the middle part of the local range zone of *Shasticrioceras poniente* as developed in the Roaring River Road section. One specimen, somewhat smaller than the others (UCR 5146/60), was found about 30 feet higher and is questionably assigned to the species.

?*Heteroceras* sp.

(Pl. 13, fig. 1)

A single specimen (UCLA 2999) consisting of the body chamber and last septum was found in the middle part of the local range zone of *Shasticrioceras poniente.* This is approximately the same stratigraphic horizon and the specimens of *Heteroceras jeletzkyi* n. sp. described above, but this shell is distinguished by its much smaller size. The ornamentation is similar on all parts of the shell and consists of simple, sharp-crested, adorally inclined ribs spaced about 8 to 10 mm apart. They encircle the shell, but are somewhat reduced on the dorsum. The suture is not known.

Several additional fragments of shafts that could belong to this species are present in my collections but they cannot be compared with this shell as they do not represent the same growth stage.

Genus ARGVETHITES Rouchadzé, 1933

?*Argvethites* sp.

(Pl. 6, Figs 7-10)

A single fragmentary specimen consisting of the last turn of the spire and

early part of the shaft is assigned questionably to *Argvethites*. The specimen is doubtless a heteroceratid, as ornamentation of the earliest preserved part of the shell is obliquely asymmetrical and the shell has a slight curvature that indicates the earlier parts were coiled in a helix. The shell is ornamented by sharp-crested, spaced, simple ribs that differ in curvature on the two flanks. On one flank they are concave adorally, while on the other they are convex adorally. They cross the venter more or less obliquely. The ribs are well developed on the dorsum and cross it without interruption. Some ribs have a pair of tubercles on the venter, but these are irregularly developed. Some of the pairs of tubercles are joined by a double rib across the center on the early part of the shaft. This is apparently modified on the later part of the shaft as the last pair of tubercles preserved are joined by a single rib. There is also irregular development of bullae on the upper flank. The orientation of the helix is not known, but the non-helicoid part of the spire is very short (about 2 cm) and is connected to the rather straight shaft by a sharp, knee-like bend. The suture is not known.

Discussion.—This species is most similar in its style of coiling to the specimen figured by Kilian (1889, pl. 3, fig. 2) as *Heteroceras astieri* d'Orbigny. Kilian's specimen, however, according to his description, does not have ventral tubercles. If there is variability with respect to the tuberculation in this species, my specimen should probably be considered conspecific. Kilian's specimen came from the upper Barremian of southeastern France. The only specimen of this type in my collection (UCR 6361/1) was found in Roaring River Road Section I in the middle part of the local range zone of *Shasticrioceras poniente* and apparently in the upper Barremian of California.

Family HEMIHOPLITIDAE Spath

Genus HEMIHOPLITES Spath, 1924

?*Hemihoplites popenoei* n. sp.

(Pl. 8, figs. 1-5)

The assignment of this species to *Hemihoplites* probably will not be accepted by some workers; however, it has the general whorl shape, simple, ribbing, and suture characteristics that place it at least in the Family Hemihoplitidae. I regard it as a rather late development of the genus.

The shell is large, evolute with the successive whorls barely in contact in the early whorls; slightly separated later. The cross section of the whorl is subtrapezoidal at all growth stages preserved. The ribs are simple with all ribs extending from the middle of the umbilical wall across the flank and venter. The ribs are sharp crested with broader interspaces, slightly sinuous, but nearly straight on the lower flank and with a moderate adoral inflection on the outer flank. Spinose tubercles are present on each rib at the latero-ventral shoulder in young stages. The later whorls may have bullae at this position, but the preservation is too poor to be sure. The

ribs trend straight across the venter and are somewhat reduced on the venter on the last whorl. The suture is characterized by an L with a broad trunk and asymmetrically bifid or trifid termination that is similar to that found in the genus *Shasticrioceras*. The holotype is UCR 6308/1.

Comparison.—The only close forms to this species are some undescribed shells of the same genus from the lower part of the Barremian section near the village of Ono. The species could be confused with some *Tropaeum* species on the basis of its ornamentation, but the suture is much different than that found in *Tropaeum*.

Stratigraphic position.—The holotype is the only specimen known and was found at UCR locality 6308 in the Jordan Ranch section in the middle of the local range zone of *Shasticrioceras patricki* n. sp. It is named for Professor Willis P. Popenoe.

Genus SHASTICRIOCERAS Anderson, 1938

Type species.—*Shasticrioceras poniente* Anderson, 1938 (subsequent designation by Wright, 1957, p. L208

The shell is medium to very large, evolute, with whorls barely touching or crioceratitid coiling at all growth stages. The whorl section is subtrapezoidal in the early whorls becoming more inflated in the adult stages, with flattened venter and slightly impressed to rounded dorsum. The ornamentation consists of simple, more or less sinuous or biconcave ribs that may be intercalate or branch on the flanks, but generally do not; the ribs and interspaces are about equal in the early stages of development; clavi or tubercles are present at the ventral shoulder. The adult suture has an asymmetrical L that has a short, broad trunk; U is not undercut by elements of L or I.

The distinctive characters of *Shasticrioceras* are its loose coiling, simple ribbing with ventral tuberculation, and the character of the lateral lobe of the suture (see Anderson, 1938, pl. 56, fig. 1).

Anderson (1938, p. 203) assigned his genus to the Family Hemihoplitidae because of the character of the suture and ornamentation. An assignment close to *Hemihoplites* seems more reasonable than Wright's (1957, p. L208) subsequent classification of it in the Ancyloceratidae because of its whorl shape and stratigraphic position, as well as the characters cited by Anderson. Wright was probably mislead by Anderson's (1938, p. 203) interpretation which claimed that the many fragmental, uncoiled shells commonly associated with *S. poniente* were the uncoiled parts of the *Shasticrioceras* conch. No known specimen of the species originally placed in the genus by Anderson (1938, pp. 203-205) shows any such relationship.

The concept of the genus *Shasticrioceras* was based on species collected from the Lower Cretaceous strata near Ono, in Shasta County, California. Anderson included four species in it (1938, pp. 204-205); *S. poniente*,

S. hesperum, S. whitneyi, and *S. inflatum.* All Anderson's species except *s. whitneyi* are reported to have come from his Mitchell Zone which he assigned to the Barremian (1938, table 2). The stratigraphic position of *S. whitneyi* is given as "a few hundred feet below the Mitchell zone." Thus all the taxa referred by Anderson to the genus came from the Mitchell Creek area as described here (figs. 2 and 3). In the present study of this fauna, *S. hesperum* is regarded as a subjective synonym of *S. poniente* and *S. inflatum* is regarded as a taxon of dubious affinity, not closely related to *Shasticrioceras.*

Since Anderson's paper, very few additional references have been made to the genus or its species. Most of these citations deal with fragmentary specimens whose place in the classification of ammonites is either still uncertain, or they are so incompletely preserved they are difficult to evaluate. These are discussed below.

(1) Matsumoto (1947, p. 19) figured a specimen that he identified as *S.* cf. *S. poniente* and described a second specimen as a new species, *S. nipponicum,* or as a new variety, *S. hesperum* var. *nipponicum.* The two specimens are very small and apparently not well preserved and thus difficult to relate to their supposed California relatives. Matsumoto compared his new species to the small shells identified by Anderson as juveniles of his species. (Anderson, 1938, pl. 67, figs. 4 and 5, and pl. 68, fig. 3). Although additional verification of Anderson's identification of the juvenile shells is needed, it appears reasonable and is tentatively accepted here. Also, I believe that the amount of variability that this species shows in the earlier stages would easily allow the specimens of Matsumoto to be included in the concept of the species *S. poniente.*

(2) In 1956, I referred two specimens to *Shasticrioceras* sp. ind. The one cited from UCLA locality 2976 probably belongs to *S. patricki,* described below. The specimen from UCLA 2786 is a fragment of a *Moutoniceras*-like form with respect to its coiling and differs from *Shasticrioceras* also in having a narrow, deep symmetrically trifid L. I exclude it from *Shasticrioceras.*

(3) Imlay (1960, p. 198, pl. 25, figs. 7,10) referred a fragmental specimen of a hetermorph collected by Stanton from the North Fork of Cottonwood Creek near Ono, California, to *S.* aff. *S. whitneyi.* I have since found a similar specimen at or near the same locality. These specimens are only slightly coiled, and differ from typical *Shasticrioceras* in having a rounded dorsum, an ellipitcal cross section, no spines, no tubercles or clavi, an adorally convex inflection of the ribs across the venter, and a narrow deep, almost symmetrically trifid L. I believe they belong in the genus *Moutoniceras.*

(4) Doyle (1963, p. 575, pl. 78, figs. 1-3) described a short fragment of a slightly coiled form found at Speeton, in east Yorkshire, England, as *Shasticrioceras anglicum.* I exclude this species from the genus *Shasti-*

crioceras, predominatly because it is virtually uncoiled, but also because of the differences in the suture line which is consistent in form in the species from California assigned to the genus. Also the character of the ventral spines is different and its stratigraphic position is much different with no known intermediates. Doyle compared it most favorably with *S. whitneyi* which is also a fragment, but which shows relatively strong curvature when compared with "*S.*" *anglicum*. Doyle's statement that *Shasticrioceras* ranges into the lower Barremian is based on the specimens discussed under items (2) and (3) above. These specimens have also been excluded from the genus *Shasticrioceras*. It is possible that Casey's suggestion (Doyle, 1963, p. 576) that they Speeton form belongs to an as yet unnamed genus is correct or that it is close to the group of forms, as yet poorly known, classified as *Moutoniceras*.

Age.—Thus constituted the genus ranges through the middle and upper Barremian and possibly into the lowest Aptian in California.

Shasticrioceras poniente Anderson

(Pl. 10, figs. 1, 2, 6; pl. 11, figs. 5, 7)

Shasticrioceras poniente Anderson, 1938, p. 204, pl. 57, figs. 1, 2; pl. 67, figs. 4, 5; not pl. 57, fig. 3.
Shasticrioceras hesperum Anderson, 1938, p. 204, pl. 56, figs. 1, 2; pl. 68, fig. 3.
Shasticrioceras cf. *S. poniente* Anderson, Matsumoto, 1947, p. 19.
Shasticrioceras hesperum nipponicum Matsumoto, 1947, p. 19.

The shell is large, discoidal, with closely approximate whorls in all known growth stages. The cross section of the whorl is subtrapezoidal at all known stages, generally with slightly or moderately inflated flanks (fig. 22). Ribbing is simple, biconcave to sigmoidal at all known stages, but rarely a rib will branch or be intercalated on the flank. Ribs are sharply rounded on the lower half of the flank with their heights greater on the inner flank than on the outer. The ribs are continuous and straight across the venter and bear prominent clavate tubercles on the ventral shoulders that give a tabulate form to the venter. The suture is typical of the genus.

The critical characters by which the species is distinguished are as follows: (1) the simple, sigmoidal or biconcave rib with clavi at the ventral shoulder, (2) the rate of growth of the spire, (3) the flattening and broadening of the rib as it approaches the periphery, (4) the inclination of the ribbing, and (5) the cross section of the whorl. Holotype is C.A.S. Type Collection specimen 8905.

Discussion.—Some statements in Anderson's description of the species are probably interpretative as no specimens have been found to show that they are descriptive. For example, there is no known specimen that shows a final uncoiled, straightened arm; the whorls are in contact in the later stages; the ribs do not tend to become straighter with increasing size. Fragments of shells with characteristics mentioned by Anderson occur in the

area where he obtained most of his specimens, but they are demonstrably parts of different taxa, some of which are described in this paper.

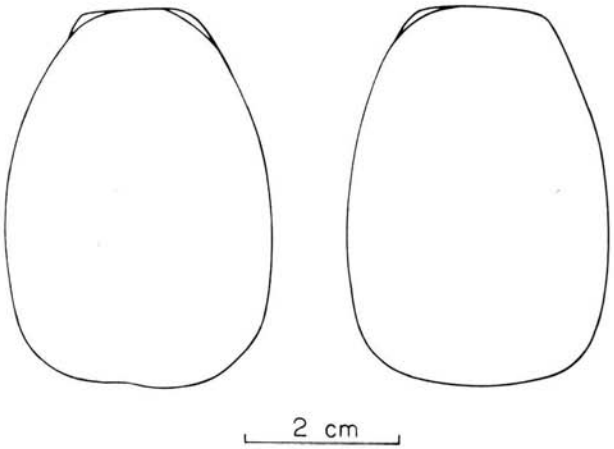

Fig. 22. *Shasticrioceras poniente* Anderson—cross section of two fragmental specimens of approximately equal diameter.

Shasticrioceras hesperum Anderson was erected on the basis of its fine ribbing on the juvenile whorls and the widely and irregularly spaced ribs on the living chamber of the last whorl in the holotype as compared with the holotype of *S. poniente*. Of over a hundred specimens that are in my collection from the general area where Anderson obtained the holotypes of *S. poniente* and *S. hesperum*, only one is similar to *S. hesperum* in having widely spaced ribs on the body whorl. However, this specimen has the normal density of ribs on the younger whorls rather than the very fine ribbing of the holotype of *S. hesperum*. Other shells that have very fine ribbing on the younger whorls have normal adult ribbing. For these reasons I regard *S. hesperum* as an extreme variant of *S. poniente*.

The graph (fig. 23) shows the measurements of about thirty specimens of *S. poniente* and contrasts them with the measurements of other members of the genus insofar as the preservation of the latter permit it. In the case of *S. whitneyi* the diameter was obtained by reconstructing the whorl based on the curvature in the holotype.

Stratigraphic range and distribution.—Most of the known specimens assigned to *S. poniente* are from the Roaring River Road section in the Mitchell Creek area because of the excellent exposures there. This part of the section is generally poorly exposed south of Roaring River, but a small number of specimens have been recovered from various isolated localities as far south as Dry Creek in the southern part of the Ono Quadrangle. Northeast of the Mitchell Creek area the range zone of *S. poniente* is cut out by an unconformity.

The local range zone of *S. poniente*, as determined from the Roaring

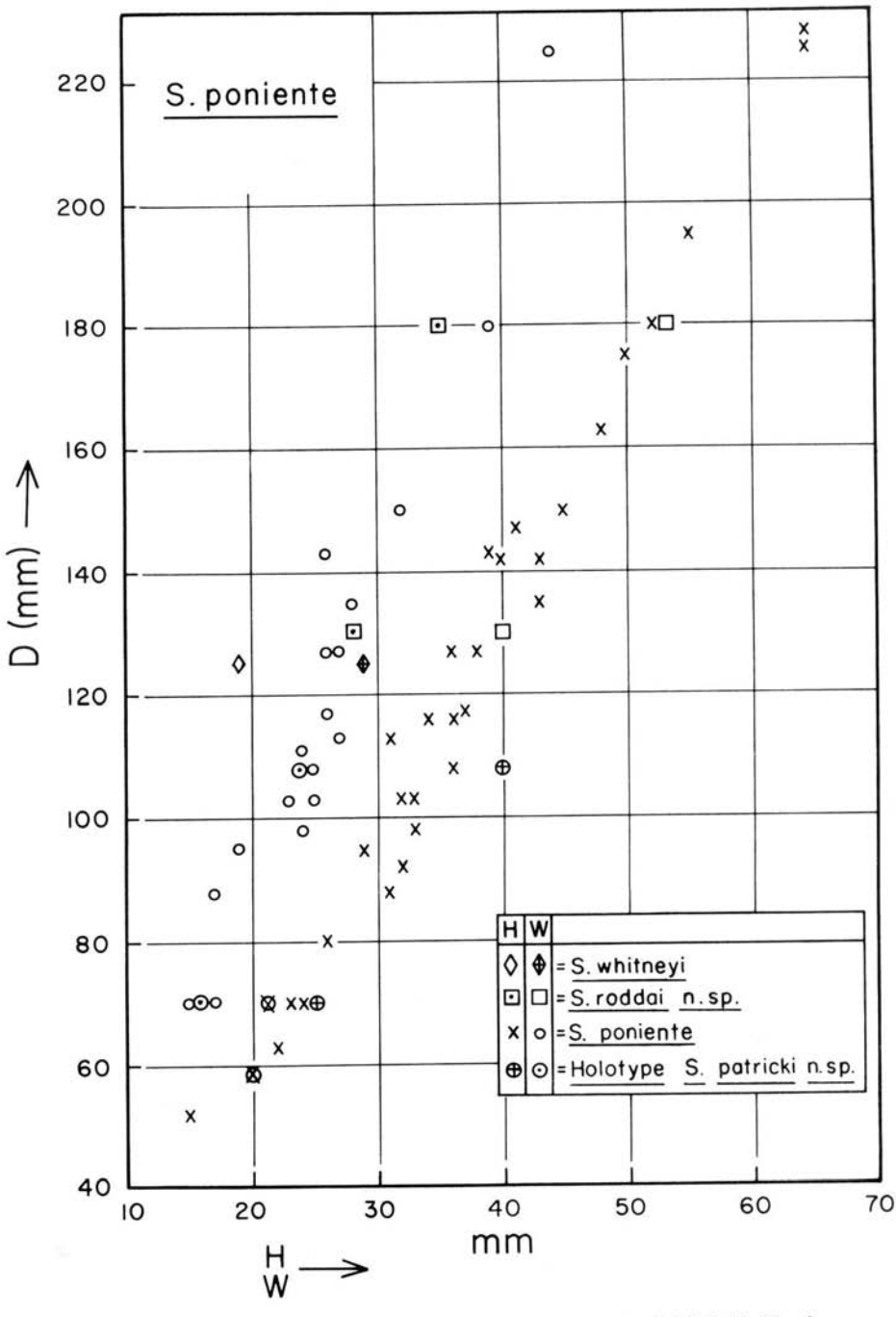

Fig. 23. Measurements of specimens of *Shasticrioceras* from the Chickabally Member, Ono Quadrangle.

River Road section, is uppermost Barremian and probably also lowest Aptian. The reasons for this assignment are given in the section on correlation. As presently understood, it barely overlaps in its lower part with the local range zone of *S. roddai* n. sp. The last recorded occurrence is about 15 feet below the Huling Tongue in the Roaring River Road section. The immediately succeeding fauna is not known.

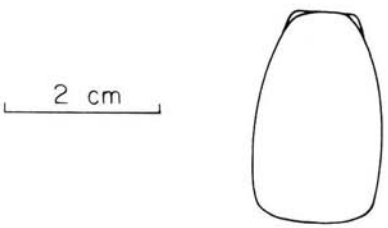

Fig. 24. *Shasticrioceras whitneyi* Anderson—cross section of the holotype.

Shasticrioceras whitneyi Anderson

(Pl. 3, fig. 4; pl. 9, figs. 3, 4, 6, 7)

Shasticrioceras whitneyi Anderson, 1938, p. 205, pl. 58, fig. 1.

The shell is of moderate size and coiling is probably normal for the genus, but no specimens are known that show its exact nature. The holotype is the largest fragment known and is deformed. The cross section of the whorl is subtrapezoidal, slightly inflated (fig. 24). The ribs are simple, prorsiradiate, straight to slightly biconcave; they cross the venter in a straight or slightly adorally convex line and bear a pair of clavate tubercles on the ventral shoulder. The ribs are generally continuous on the dorsum as well as the exterior sides, but a few ribs arise by intercalation of the flanks; rarely a rib branches. The suture is typical for the genus with a broad-necked, asymmetrically bifid L. (pl. 9, fig. 7).

Discussion.—This species is known from the holotype and three other smaller fragments (UCLA 3057 and UCR 5142/1, 6323/1). The small specimen cited by Anderson (1938, p. 205) has not been found in the collections of the California Academy of Sciences. The species has the characteristics of the genus with respect to the ribbing and tuberculation, coiling and suture. It differs from the type species and the holotype of *S. hesperum* in its distinctly different rate of growth (see fig. 23). I cannot distinguish the "broad grooves" that cross the flanks mentioned in Anderson's original description (1938, p. 205).

Range.—Anderson indicates that this specimen was found at California Academy of Sciences locality 1653 in the lower part of the section exposed near the old Jordan Ranch house, however, on a later page (p. 303) he gives the locality as number 1347. The first citation is probably the correct one and it corresponds to data for the fragments mentioned above in UCLA

and UCR collections. These strata, however, are much below any possible reconstruction of where California Academy of Sciences locality 1661 is located, not near that horizon as Anderson states (p. 205).

Specimens assigned to the species here come from the low and middle parts of the local range zone of *S. patricki.*

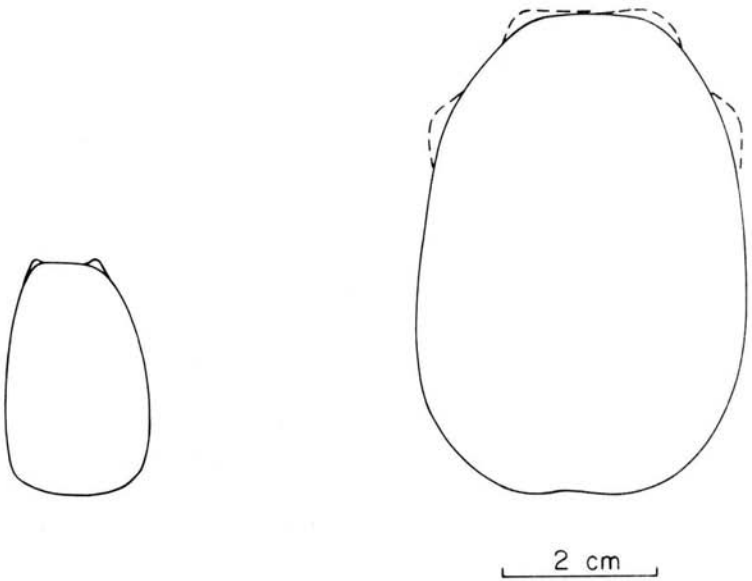

Fig. 25. *Shasticrioceras roddai* n. sp.–cross section of the whorl of UCR specimen 696/1.

Shasticrioceras roddai n. sp.

(Pl. 12, figs. 1-5)

The shell is very large, discoidal, with normal coiling for the genus, whorls are barely in contact. The cross section of the whorl is oval with a somewhat flattened dorsum in some specimens, but it may appear polygonal if the section cuts through the ribs (fig. 25). Early ontogeny unknown. Ribbing is biform. The earliest parts of the conch that are known have simple, biconcave ribs with interspaces about equal in size with rounded tubercles at the ventral shoulders. At about 200 mm diameter the ribs become more distant, and develop bullate lateral and umbilical tubercles in addition to the ventral ones. The suture is similar to the suture of *S. poniente* with a lateral lobe that has three asymmetrically disposed major accessory lobes and a broad trunk. Holotype is UCR 5212/1.

Comparison.–S. roddai n. sp. differs from all species assigned to *Shasticrioceras* in the possession of lateral tubercles on shells of large size (more than 200 mm diameter). It is difficult, however, to separate from *S. poniente* in juvenile shells that do not show the lateral bullae. The width between the ventral tubercles in *S. roddai* is less in fairly large specimens

and the tubercles also tend to be less clavate, but these characters are difficult to use in material that is not well preserved. I have only one specimen of *S. roddai*, UCLA 3005, that shows the character of the whorl at diameters less than 100 mm. The ribs of this specimen tend to be sharper, a little less regular in weight on the upper flank and narrower on the venter than those in *S. poniente*, thus indicating that the earlier growth stages in *S. roddai* generally differ from those of *S. poniente* in having a narrower venter, generally more sharply crested ribs, with more rounded tubercles than in *S. poniente.*

Range and distribution.—This species occurs in the Jordan Ranch and Roaring River Road section and falls between the local range zones of *S. patricki* below and *S. poniente* above. Its lowest occurrence, UCR 6326, Jordan Ranch section, is based on three tiny fragments of a shell that show the distant ribbing and bullae of the large *S. roddai*. Its uppermost occurrence is at UCR 696, also in the Jordan Ranch section.

This species is much more widely distributed in the Ono Quadrangle than any of the other members of the genus, although specimens are usually fragmentary. Even so, it is known from a much smaller number of specimens than *S. poniente*. It has been found fairly abundantly near the Middle Fork of Cottonwood Creek in the southern part of the Quadrangle as well as in the Mitchell Creek area. This species is named for Peter U. Rodda.

Shasticrioceras patricki n. sp.

(Pl. 7, figs. 1, 2; pl. 10, figs. 3-5)

The shell is large, discoidal with successive whorls just in contact. The cross section of the shell is subtrapizoidal with flattened dorsum and venter and slightly inflated flanks (fig. 26). The ornamentation is of biconcave ribs, somewhat irregular in weight and spacing, and with a small clavus or tubercle at the ventral shoulder. Most ribs traverse the entire flank and cross the venter in a straight line, but many arise by intercalation on the flank. Rarely, the ribs branch. The suture has the typical form for the genus. Holotype is UCR 5128/1.

Comparison.—This species differs from *S. poniente* principally in expanding its diameter more per volution, and also in its generally finer ribbing, its greater H/W ratio at equivalent diameters, somewhat straighter ribs on the lower flank, and in having many intercalated ribs. The holotype of *S. hesperum* (= *S. poniente*) is the closest variant of *S. poniente* to *S. patricki*. It differs from *S. patricki* in having distinctly more curvature of the ribs on the lower flank, in having few, if any, intercalated ribs, and in having a smaller H/D ratio at equivalent diameters. *S. patricki* differs from *S. whitneyi* in expanding its diameter much more per volution, has a higher H/D ratio, and is generally more compressed in cross section.

Range and distribution.—*S. patricki* n. sp. is known from a number of localities, but so far only in the Mitchell Creek area. It occurs 150 feet above the base of the Jordan Ranch section and intermittently through approximately the overlying 800 feet of strata. The highest occurrence is at UCR 5139, but this locality is not in a measured section and its exact position is in question. The highest level in measured sections is at UCLA locality 3014 and UCR locality 5190. Its local range zone is believed to correlate approximately with the upper part of the lower Barremian because of the presence of *Pulchellia* cf. *P. compressissima* and because of its stratigraphic position between faunas of lower and upper Barremian. This species is named for M. Patrick Murphy who found the holotype.

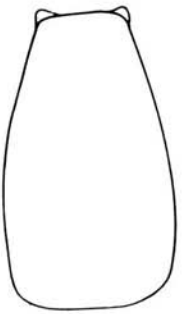

Fig. 26. *Shasticrioceras patricki* n. sp. — cross section of the whorl of specimen UCR 5128/1.

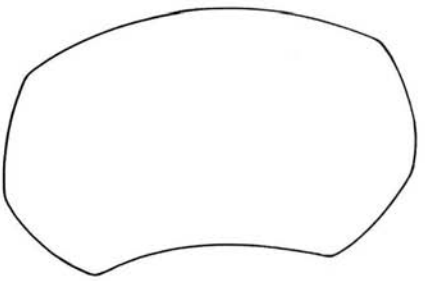

Fig. 27. ?*Cheloniceras* sp.—cross section of the whorl of the specimen figured in plate 11, figures 3, 4, and 6.

?*Shasticrioceras wintunium* (Anderson)

(Pl. 9, figs. 1 and 5)

Hoplocrioceras wintunium Anderson, 1938, p. 202, pl. 60, figs. 3, 4.

The shell is small to medium size, discoidal with the successive whorls barely in contact. The cross section of the whorl is subtrapezoidal with somewhat inflated flanks. The ornamentation of the early whorls is of sigmoidal to biconvex, usually simple ribs, but with some branching primary ribs. The ribs are bullate to tuberculate on the ventral shoulder, somewhat reduced on the venter and trending straight across it. At about 50 mm diameter the ribs become more distant and intercalate ribs are developed on the inner and outer flanks. The ribs on the venter of the body whorl are still slightly reduced. The suture is typical for the family with a large, asymmetrically trifid L. The holotype is California Academy of Sciences Type specimen number 8900.

Comparison and discussion.—The abrupt change in ornamentation between the penultimate and the last whorl of the conch in combination with other shell characters and the suture make this species unique.

Anderson assigned the species to the genus *Hoplocrioceras* Spath and inferred from the deformed portion of the body whorl that the species had an uncoiled stage. In my opinion, no support for this interpretation exists in the specimens presently known. They are all normally coiled in a plane spiral.

Stratigraphic position.—Anderson reports this species from California Academy of Sciences locality 1661 (see fig. 2). He recorded it associated with *Shasticrioceras poniente* and *Inoceramus colonicus.* His data agree with mine in placing this species in the lower part of the local range zone of *S. poniente.* The two specimens of the species found during the present study were found together at locality UCR 5481 in Roaring River Road Section I, Mitchell Creek area.

Family DOUVILLEICERATIDAE Parona and Bonarelli

Subfamily CHELONICERATINAE Spath

Genus CHELONIERAS Hyatt, 1903

?*Cheloniceras* sp.

(Pl. 11, figs. 3, 4, and 6)

This taxon is known from a single fragment, about 6 cm long, of a large whorl that is completely septate. The cross section of the whorl is depressed with a reniform shape (fig. 27). It measures about 60 mm wide at and 35 mm high. It is ornamented with heavy simple ribs that arise at the umbilical seam, are adapically inclined on the umbilical wall which they cross in an arc to the rounded angulation at the umbilical edge. They are then straight, rectiradiate, or slightly rursiradiate to the ventral shoulder where they thicken at low, broad bullae and then cross the venter in an arc that is adorally concave. The suture is well preserved and is douvilleiceratid in general pattern. It differs from normal douvilleiceratid sutures in that the inner branch of the extremely wide lateral lobe is larger and deeper than the outer branch and the accessory saddle that separates them is almost as large as the first lateral saddle. The lateral lobe is very deep.

Discussion.—This shell is unusual in the development of the lateral lobe and in the adorally concave pattern of the ribs on the venter. Its affinity is greatest with the genus *Cheloniceras*, but it is apparently an early and previously underscribed species.

Stratigraphic position and age.—The specimen was found near the top of the Roaring River Road section (UCR 5130) in the upper part of the *Shasticrioceras poniente* local range zone. There is no fossil in this part of the section that can be used to correlate these beds to sections outside California. Its stratigraphic position about 100 feet above the last *Heteroceras* and below beds containing the *Eotetragonites wintunius* fauna dictates that the age must be either uppermost Barremian or lower Aptian. In 1969

(p. 46) I suggested that the uppermost part of the *Shasticrioceras poniente* local range zone might be Aptian based on the sequence of faunas in the Mitchell Creek area. The presence of a species certainly closely allied to *Cheloniceras* supports, but does not prove, the contention that these beds are lowermost Aptian. According to Casey (1961, p. 594) the earliest *Cheloniceras* occurs in the *Deshayesites deshayesi* zone of the lower Aptian of England. He includes two other zones below the *D. deshayesi* zone in the Aptian as well. In western Europe the *D. deshayesi* zone is either regarded as the basal zone of the Aptian (as in France and Bulgaria) or it is underlain by one or two zones that are also included in the Aptian as in England (Sornay, 1968, p. 10). Based on the present interpretations in Europe, therefore, it is possible that these beds are the same age as lowermost Aptian of the Isle of Wight. The members of the family, like *Paraspiticeras*, which occur in the Barremian seem more distantly related to this shell than the members of the genus *Cheloniceras* and so I have tentatively assigned these beds to the Aptian.

Family DESMOCERATIDAE Zittel

Genus BARREMITES, Kilian, 1913

?*Barremites* sp.

(Pl. 13, fig. 3)

Three crushed and deformed specimens that are morphologically similar to species of *Barremites* from France and the Crimea were found in the upper beds of the Chickabally Member. I listed one of them as *Melchiorites indigenes* Anderson in 1956. This form has the angular umbilical edge, constrictions with collars and very light ribbing developed between the constrictions that is characteristic of some species of *Barremites.* It is very close to the California species *Melchiorites indigenes*, the main difference being that the constrictions are broader and more prominent on the flanks, they tend to have greater curvature on the venter, and the intermediate ribbing is less regular. The genera *Barremites* and *Melchiorites* are difficult to interpret. I have chosen to put the specimen in *Barremites* because of the steep wall of the umbilicus, the moderately angular umbilical edge, and the subquadrate cross section of the whorl.

The specimens are of little use stratigraphically because of their poor preservation. The reason for reporting them here is that they indicate a relationship with the tethyan faunas rather than those of northern Europe and also to demonstrate that the Family Desmoceratidae is represented in the California Barremian.

	UCLA Locality	*UCLA Type Number*
P. popenoei	3060	48338
A. thomeli	2798	48339
T. blandi	2984	48340
S. whitneyi	3057	48341
T. greeni	2968	48342
S. patricki	3014	48343
S. poniente juv.	2980	48344
S. roddai	3005	48345
?*Heteroceras* sp.	2999	48346
Barremites sp.	2983	48347

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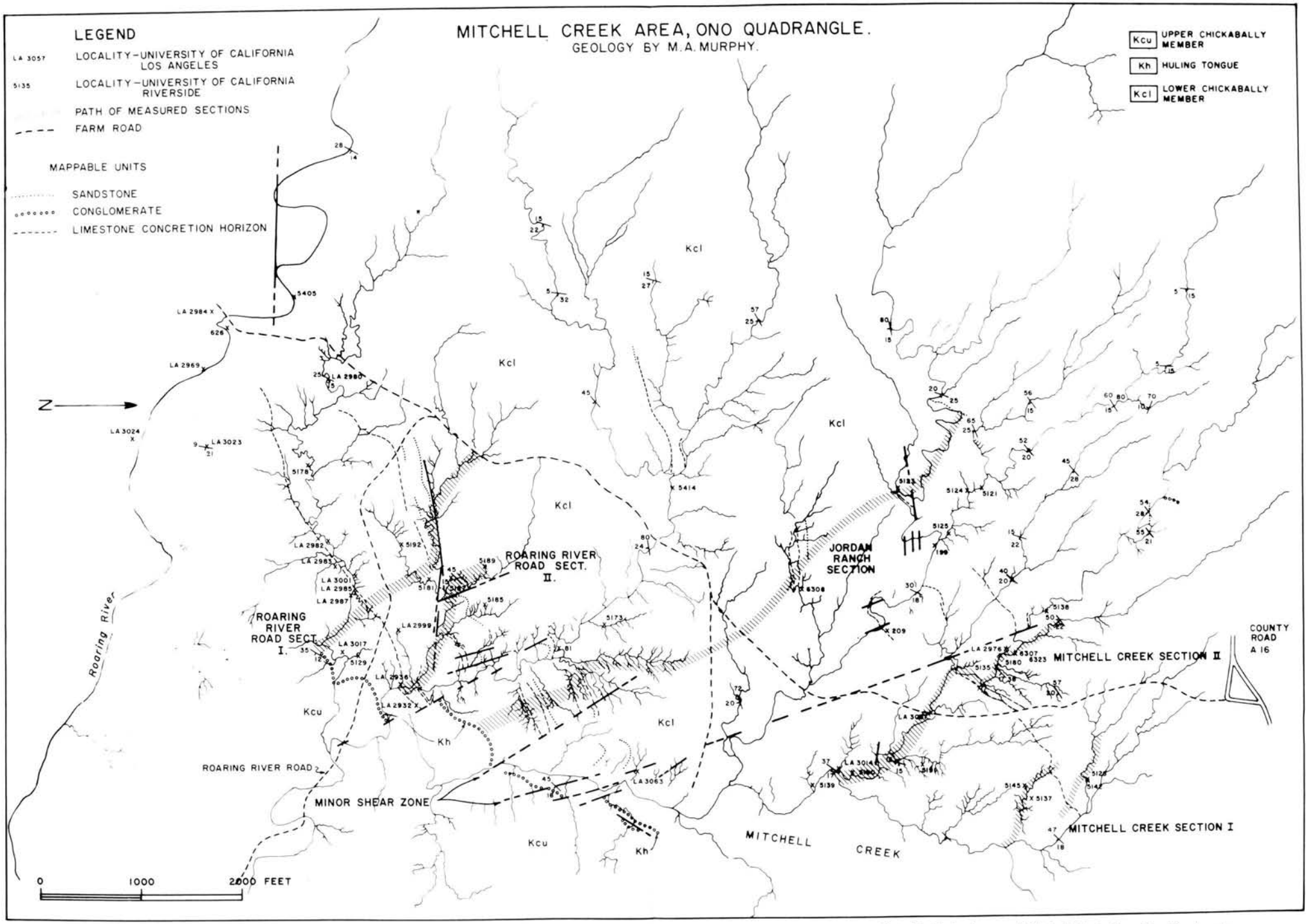
TABLE I

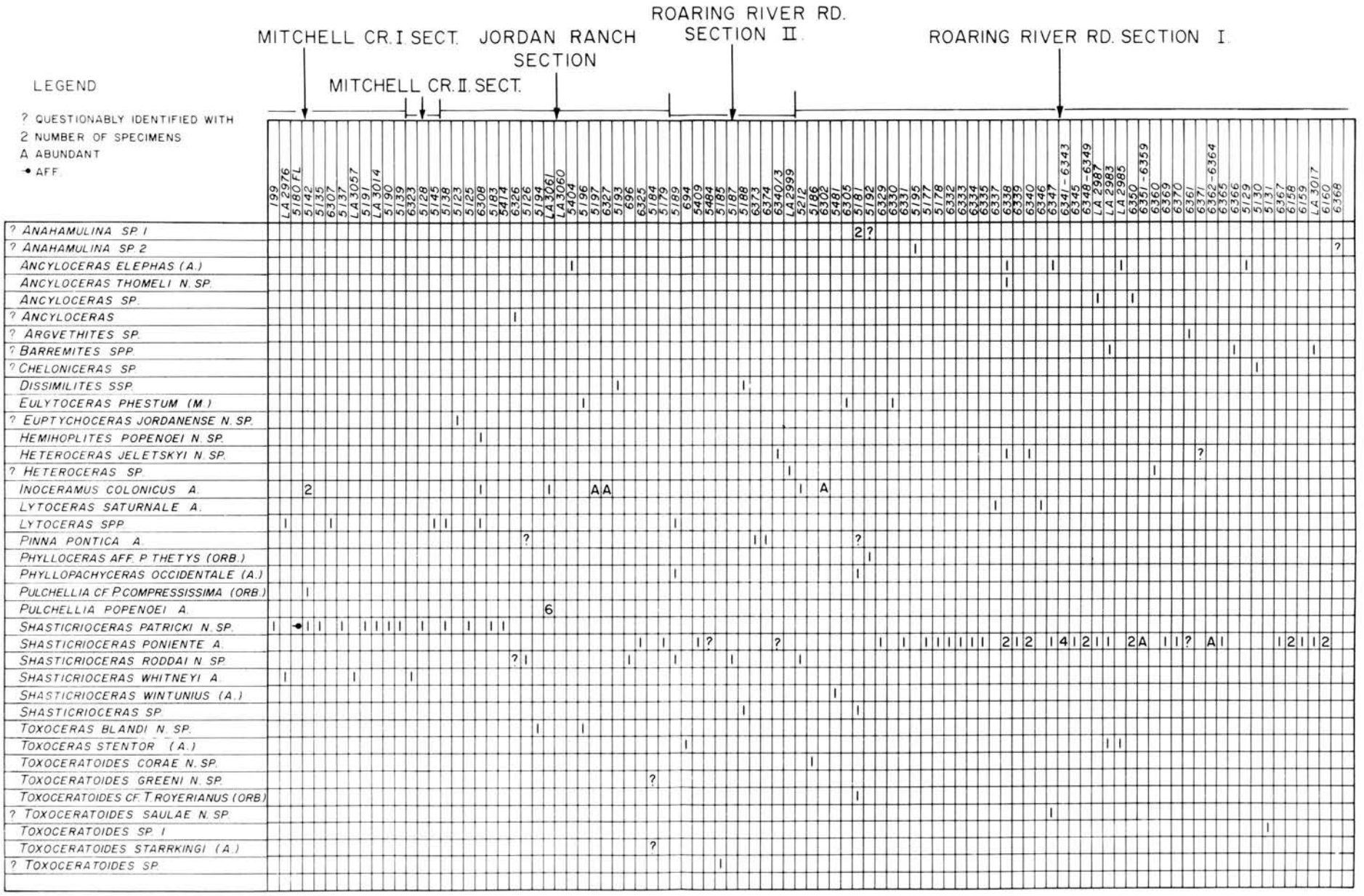
TAXON	ANDERSON'S NOMENCLATURE	REFERENCE*	REMARKS
1.	Acroteuthis divergens Anderson	p. 229, 325	This species has not been found during this study.
2.	A. impressa Gabb	p. 65, 225 T.2, T.3	This species may be present in these strata but the belemnites have not yet been studied.
3.	A. mitchelli Anderson	p. 228, T.2	Ditto
4.	A. shastensis Anderson	p. 65 T.3	In T.3 Anderson puts this species in the Hauterivian. Anderson identified a specimen from Popenoe's collection (CIT 967) as this species. It came from Roaring River, probably in the lower part of the lower Chickabally Mem.
5.	Ancyloceras ajax Anderson	p. 204	Not found during this study.
6.	A. attrox Anderson	p. 65, 210 T.2	On p. 210 Anderson reports this species associated with Parahoplitoides cerrosensis. The locality reported would be low in the Chickabally Mem., not Aptian as reported. Association with P. cerrosensis is unnatural.
7.	A. durrelli Anderson	p. 65, 211 T.2	Not found during this study. May be impossible to identify because of the fragmentary nature of the holotype. Paratype may not be conspecific with the holotype.
8. A. elephas Anderson	A. elephas Anderson	p. 65, 209 T.2	Occurrence confirmed.
9. ?Colombiceras cerrosensis (Anderson)	Parahoplitoides cerrosensis Anderson	p. 210	A middle or upper Aptian form.
10.	Hibolites cigarroides Anderson	p. 100	Not found during this study.
11. nomen nudum	Hoplocrioceras whitneyi Anderson	p. 65	Probably an uncorrected early MS name for Shasticrioceras whitneyi Anderson.
12. ?Shasticrioceras wintunium (Anderson)	Hoplocrioceras wintunium Anderson	p. 203 T.2	Occurrence confirmed.
13. nomen nudum	Hoplocrioceras wyntoonium Anderson	p. 65	Probably a spelling variation on H. wintunium.
14. Inoceramus colonicus Anderson	Inoceramus colonicus Anderson	p. 65, 100 T.2	Occurrence confirmed
15. I. colonicus Anderson	Inoceramus ovatoides Anderson	p. 65, 100 T.2	I believe I. ovatoides is a synonym of I. colonicus.
16. Lithancylus nauplius (Anderson)	Hemibaculites nauplius Anderson	p. 65, 221 T.2	Casey (1961, p. 70) puts all the species of Hemibaculites described by Anderson in Lithancylus. Not found during this study.
17. Lithancylus neleus (Anderson)	Hemibaculites neleus Anderson	p. 65, T.2	Ditto. T.2 and p. 65 probably erroneously refer this species to the "Barremian Mitchell Zone" as p. 222 specifies an Aptian horizon for the species.
18. nomen nudum	Lytoceras cf. L. argonautarum Anderson	p. 65	No figured specimen. No specimen in the C.A.S. collection with this label.
19. nomen nudum	Parahoplitoides cf. P. cerrosensis Anderson	p. 222	No figured specimen. No specimen in the C.A.S. collection with this label.
20. Partschiceras occidentale Anderson	Phylloceras occidentale Anderson	p. 65, 100, 140, T.2	Anderson lists this species above and below the lower Chickabally Member, but gives no record within it. I have found the species in the lower Chickabally Member only.
21. Partschiceras sextoni (Anderson)	Phylloceras sextoni Anderson	p. 140	Not found during this study.
22. nomen nudum	Pseudocrioceras indopacificum Anderson	p. 203	Probably an uncorrected early MS name for Pseudocrioceras stentor Anderson.
23.	Ptychoceras natrice Anderson	p. 65, 218 T.2	Not found during this study.
24. Pulchellia (Heinzia) popenoei Anderson	Pulchellia popenoei Anderson	p. 65, 197 T.2	Occurrence confirmed.
25. Shasticrioceras poniente Anderson	Shasticrioceras hesperum Anderson	p. 65, 204 T.2	Occurrence confirmed. Considered a synonym of S. poniente Anderson.
26. Shasticrioceras poniente Anderson	Shasticrioceras poniente Anderson	p. 65, 204 T.2	Occurrence confirmed.
27. Shasticrioceras whitneyi Anderson	Shasticrioceras whitneyi Anderson	p. 205	Occurrence confirmed.
28.	Terebratula durrelli Anderson	p. 95	Not found during this study.
29.	Shasticrioceras inflatum Anderson	p. 205	Not found during this study. This species not referable to Shasticrioceras.
30. Toxceras stentor (Anderson)	Pseudocrioceras stentor Anderson	p. 65, 206 T.2	Occurrence confirmed.
31. Toxoceratoides starrkingi (Anderson)	Acrioceras starrkingi Anderson	p. 207	Occurrence confirmed.

* Reference is to page or table number in F. M. Anderson, G.S.A. Sp. Paper 16, 1938.



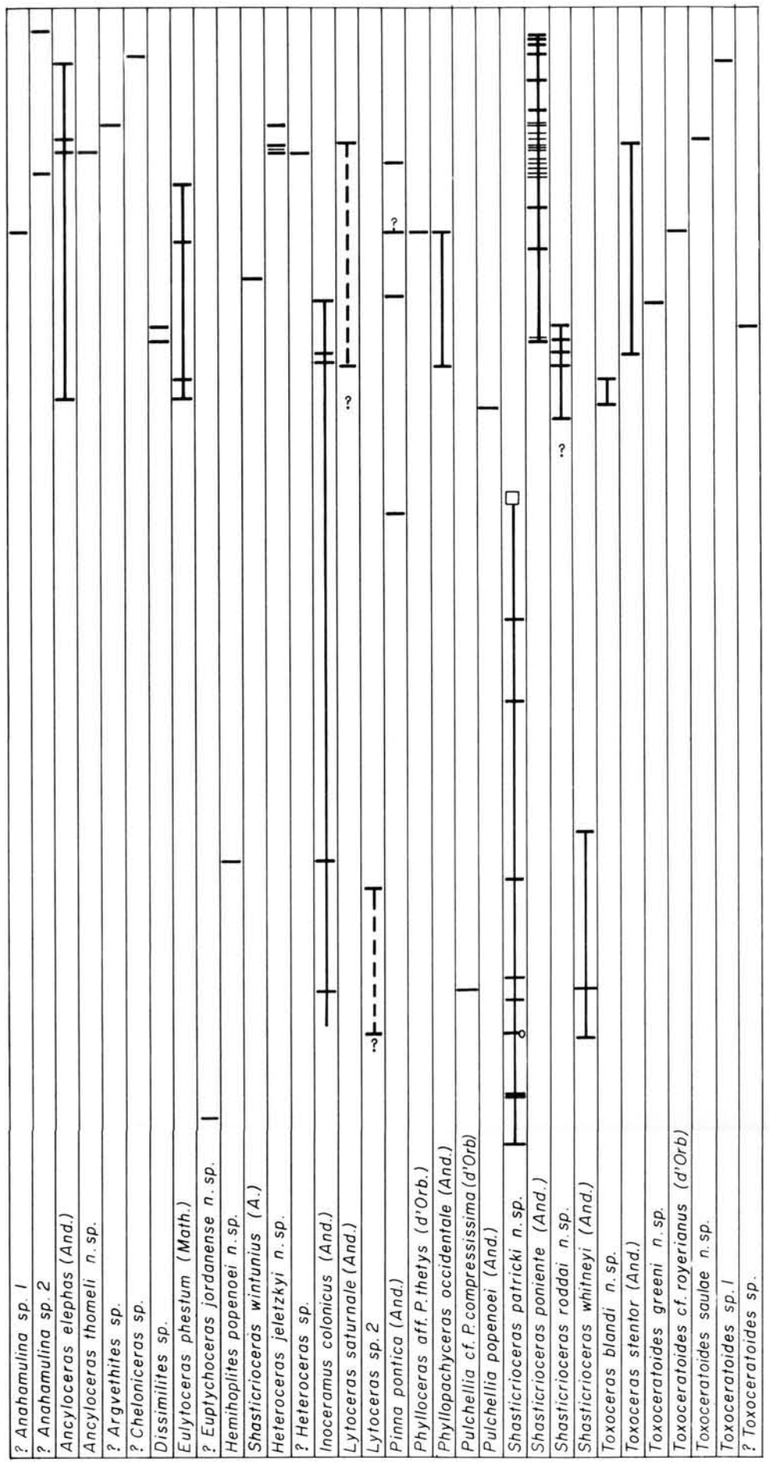
To accompany Michael A. Murphy, "Paleontology and Stratigraphy of the Lower Chickabally Mudstone (Barremian-Aptian) in the Ono Quadrangle, Northern California," Univ. Calif. Publ. Geol. Sci. Vol. 113.

Plate 15. Geologic map of Mitchell Creek Area, Ono Quadrangle.



To accompany Michael A. Murphy, "Paleontology and Stratigraphy of the Lower Chickabally Mudstone (Barremian-Aptian) in the Ono Quadrangle, Northern California," Univ. Calif. Publ. Geol. Sci. Vol. 113.

Fig. 3. Distribution and abundance of fossil taxa, Mitchell Creek Area, Ono Quadrangle.



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? QUESTIONABLY IDENTIFIED WITH
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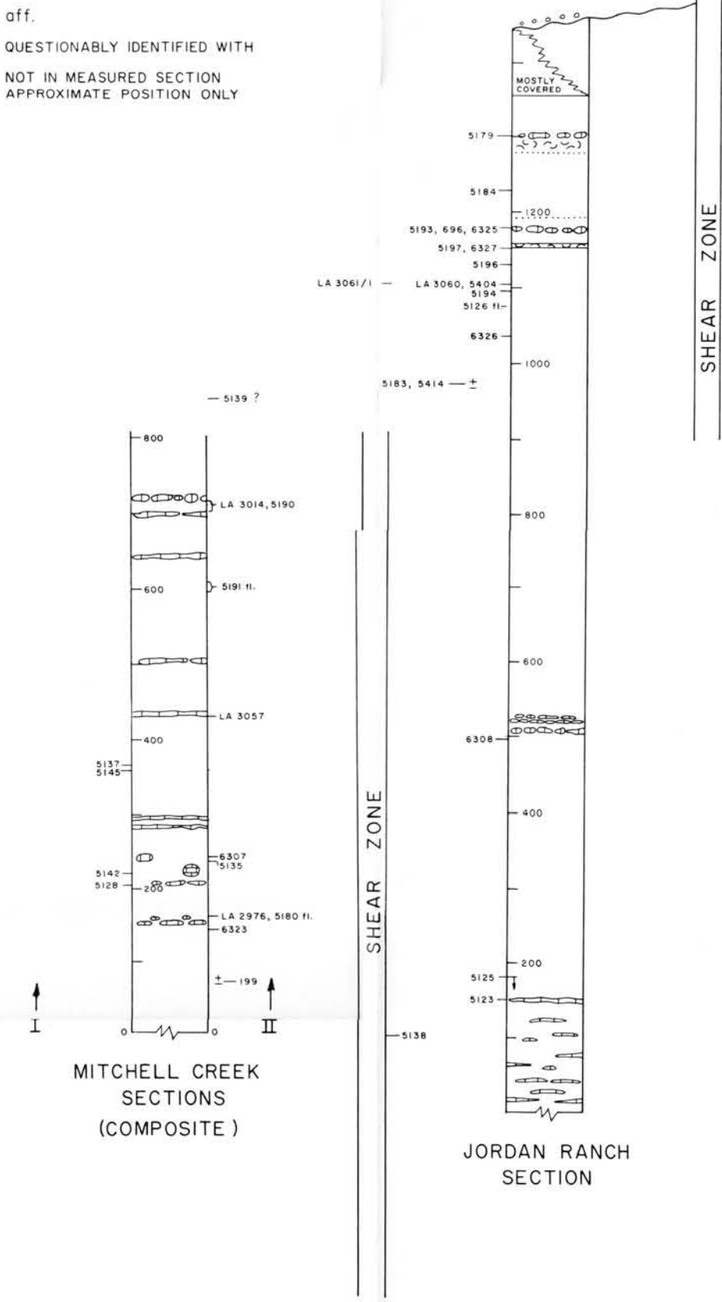
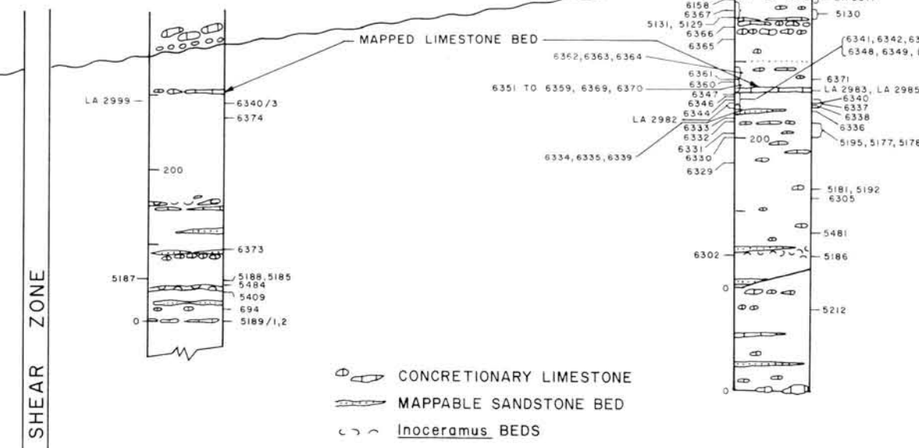


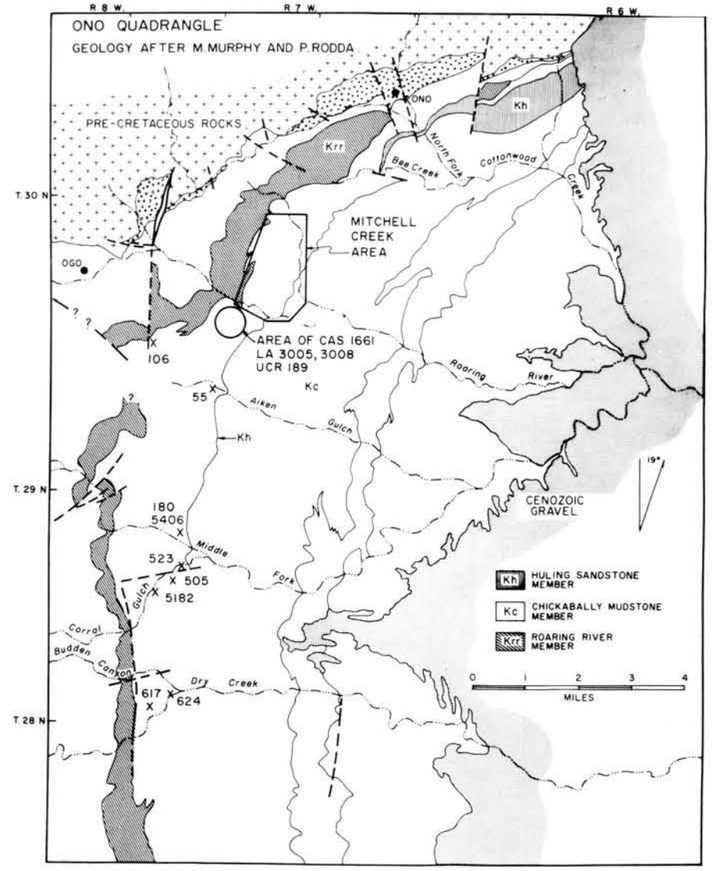
MITCHELL CREEK SECTIONS (COMPOSITE)

JORDAN RANCH SECTION



ROARING RIVER ROAD SECTION II.

ROARING RIVER ROAD SECTION



MAP, COLUMNAR SECTIONS, AND RANGE CHART FOR MITCHELL CREEK AREA, ONO QUADRANGLE, CALIFORNIA.

To accompany Michael A. Murphy, "Paleontology and Stratigraphy of the Lower Chickabally Mudstone (Barremian-Aptian) in the Ono Quadrangle, Northern California," Univ. Calif. Publ. Geol. Sci. Vol. 113.

Plate 14. The map shows the general geology and distribution of the members of the Budden Canyon Formation discussed in this paper. Numbers are University of California, Riverside, museum collection numbers. The Mitchell Creek Area is shown in detail in figure 3.

The range chart and columns are placed with respect to one another so that occurrences on the range chart are horizontally opposite the locality numbers on the columar sections. The two Mitchell Creek sections are represented on the opposite sides of a single column with mappable beds between them represented traversing the column. No mappable beds have been traced across the shear zones so the relative positions of the columns on different sides of them are approximate except for the bed above the unconformity which is traced. The unconformity is represented by the wavy line at the top of the sections. Some locality numbers are set out from the columns indicating that their relative positions were projected into the measured section and are approximate.

PLATE I

(All figures natural size)

Fig. 1. ?*Euptychoceras jordanense* n. sp. Lateral view of the holotype, UCR specimen number 5123/1.

Figs. 2, 4, 5. *Phyllopachyceras occidentale* (Anderson). 2. Ventral view of the holotype CAS Type specimen number 8745. 4. Lateral view of the same. 5. Lateral view of UCR specimen number 5181/3.

Fig. 3. *Phylloceras* aff. *P. thetys* (d'Orbigny). Lateral view of UCR specimen number 5192/2.

Figs. 6, 7. *Lytoceras saturnale* Anderson. Lateral view of two parts of UCR specimen number 6337/1.

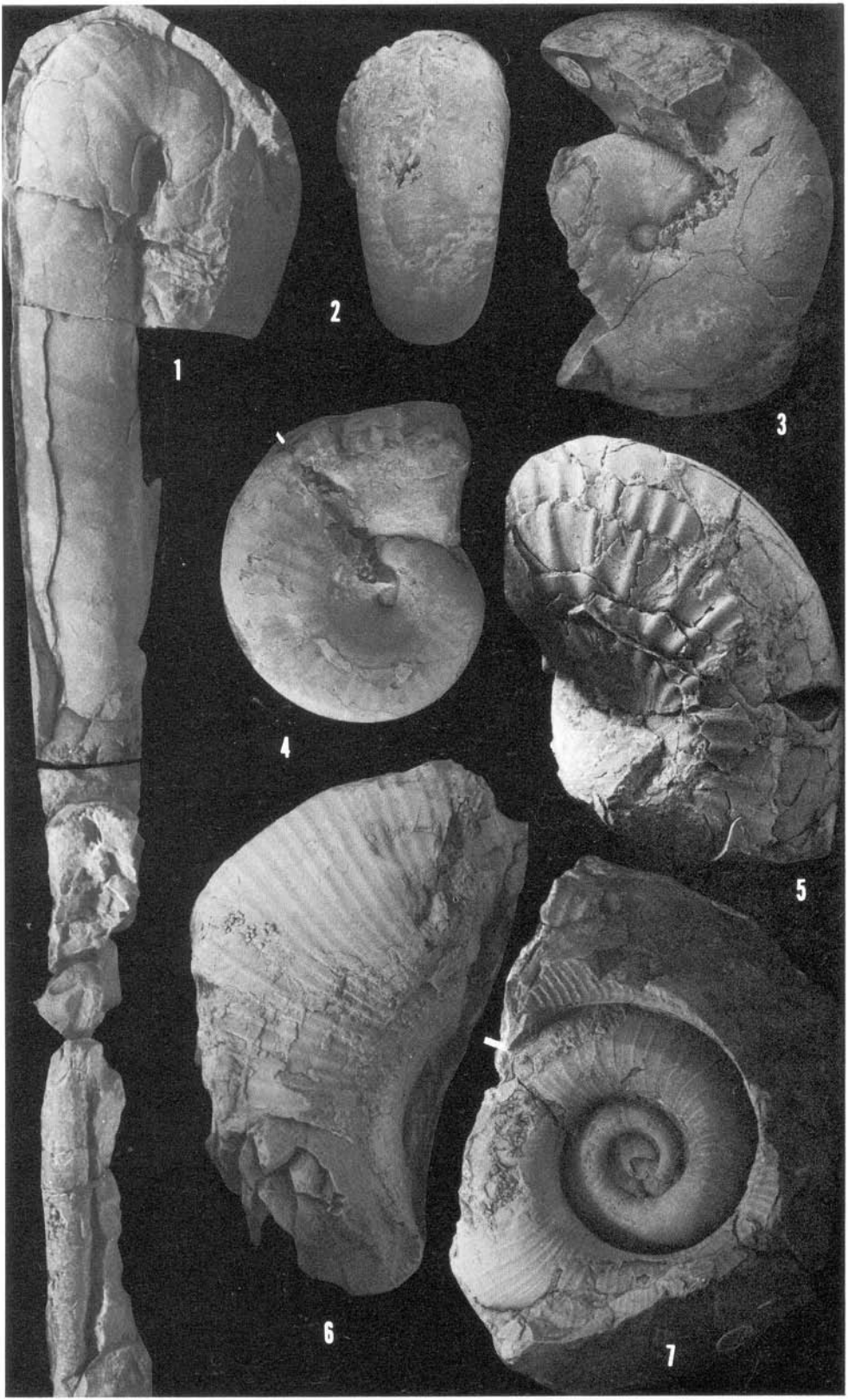

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PLATE 2

(All figures natural size except fig. 4)

Fig. 1. *Toxoceratoides* cf. *T. royerianus* (d'Orbigny). Ventral view of UCR specimen number 5181/4.

Fig. 2. *Pulchellia* (*Heinzia*) *popenoei* Anderson. Lateral view of UCLA specimen number 48338 from UCLA locality 3060.

Fig. 3. *Eulytoceras phestum* (Matheron). Lateral view of UCR specimen number 5196/1.

Fig. 4. *Pulchellia* cf. *P. compressissima* (d'Orbigny). Lateral view of UCR specimen number 5142/4. 2x natural size.

Fig. 5. ?*Anahamulina* sp. 1. Lateral view of UCR specimen number 5181/1.

Fig. 6. *Lytoceras saturnale* Anderson. Ventral view of UCR specimen number 6337/1 figured on plate 1.

Fig. 7. ?*Anahamulina* sp. 2. Lateral view of a shaft fragment from UCR locality 5195.

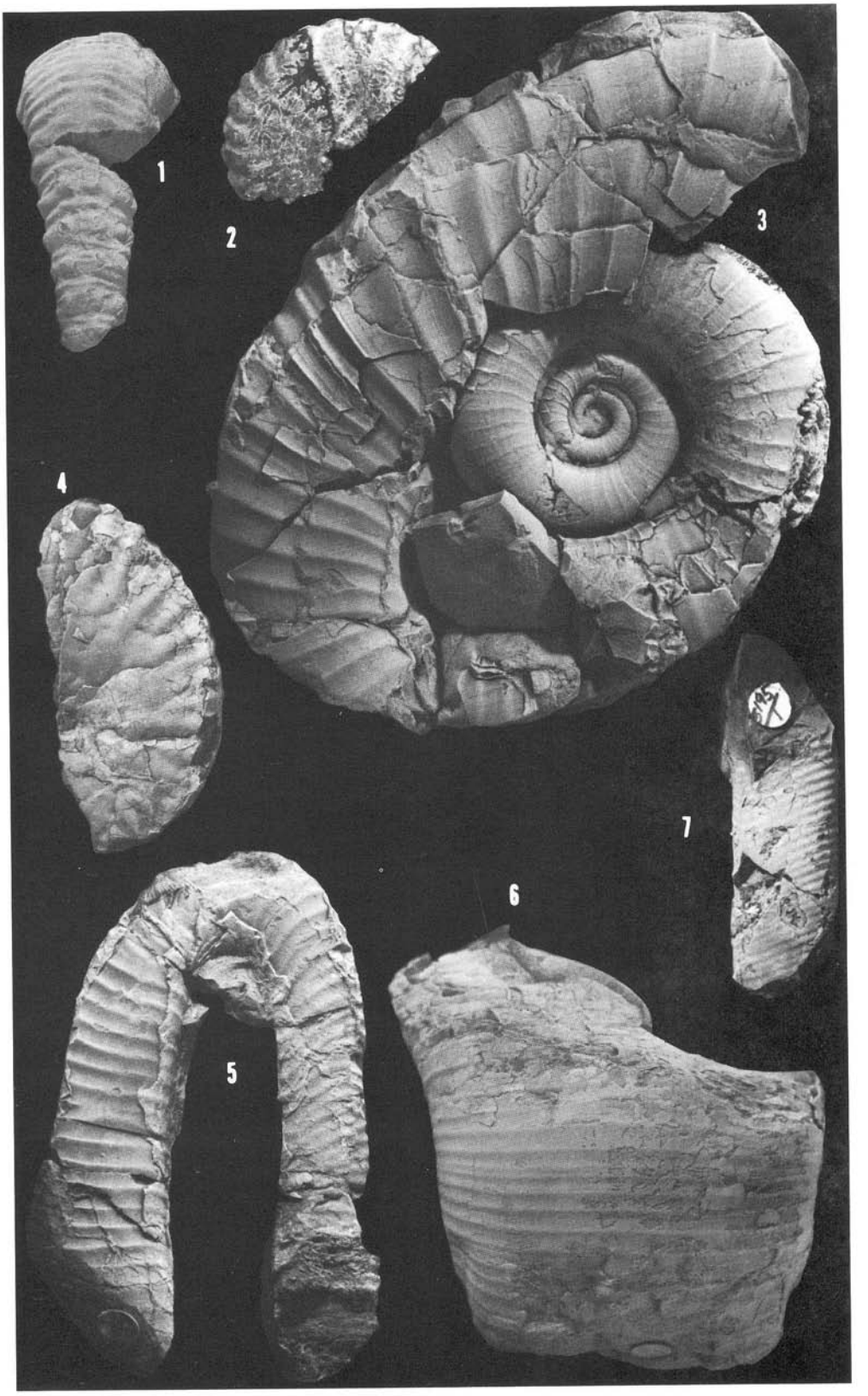
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PLATE 3

(All figures natural size except figs. 1 and 5)

Figs. 1, 5. *Ancyloceras thomeli* n. sp. Lateral view of the holotype of which the center section of the shaft was crushed and almost destroyed x ½. UCLA specimen number 48339.

Fig. 2. *Toxoceras blandi* n. sp. Suture line showing the lateral lobe of the holotype. UCLA specimen number 48340 from UCLA locality 2984.

Fig. 3. ?*Shasticrioceras wintunius* (Anderson). Lateral view of UCR specimen number 5481/1.

Fig. 4. *Shasticrioceras whitneyi* Anderson. Ventral view of UCLA specimen number 48341 from locality UCLA 3057.

Fig. 6. ?*Toxoceratoides* sp. Lateral view of UCR specimen number 6328/1 showing the muscle scar at the dorsolateral position.

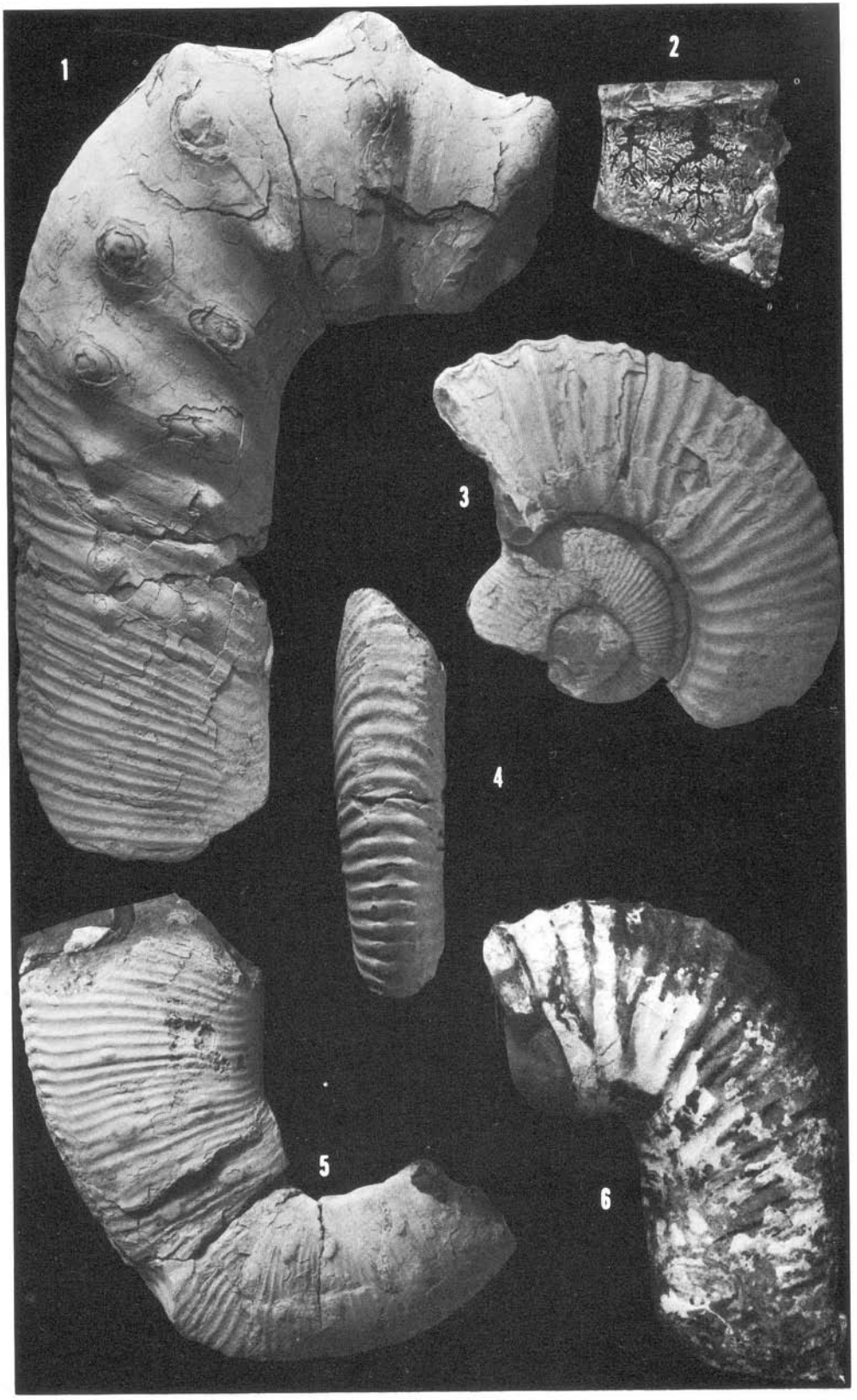
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PLATE 4

(All figures natural size)

Fig. 1. *Toxoceras blandi* n. sp. Lateral view of the holotype, UCLA specimen number 48340.

Fig. 2. *Toxoceratoides* cf. *T. royerianus* (d'Orbigny). Lateral view of UCR specimen number 5181/4.

Fig. 3, 5. *Toxoceratoides starrkingi* (Anderson). 3. Lateral view of the holotype, CAS type collection number 8847. 5. Ventral view of the same.

Fig. 4, 6. *Toxoceratoides saulae* n. sp. 4. Ventral view of the holotype, UCR specimen number 6347/2. 6. Lateral view of the same.

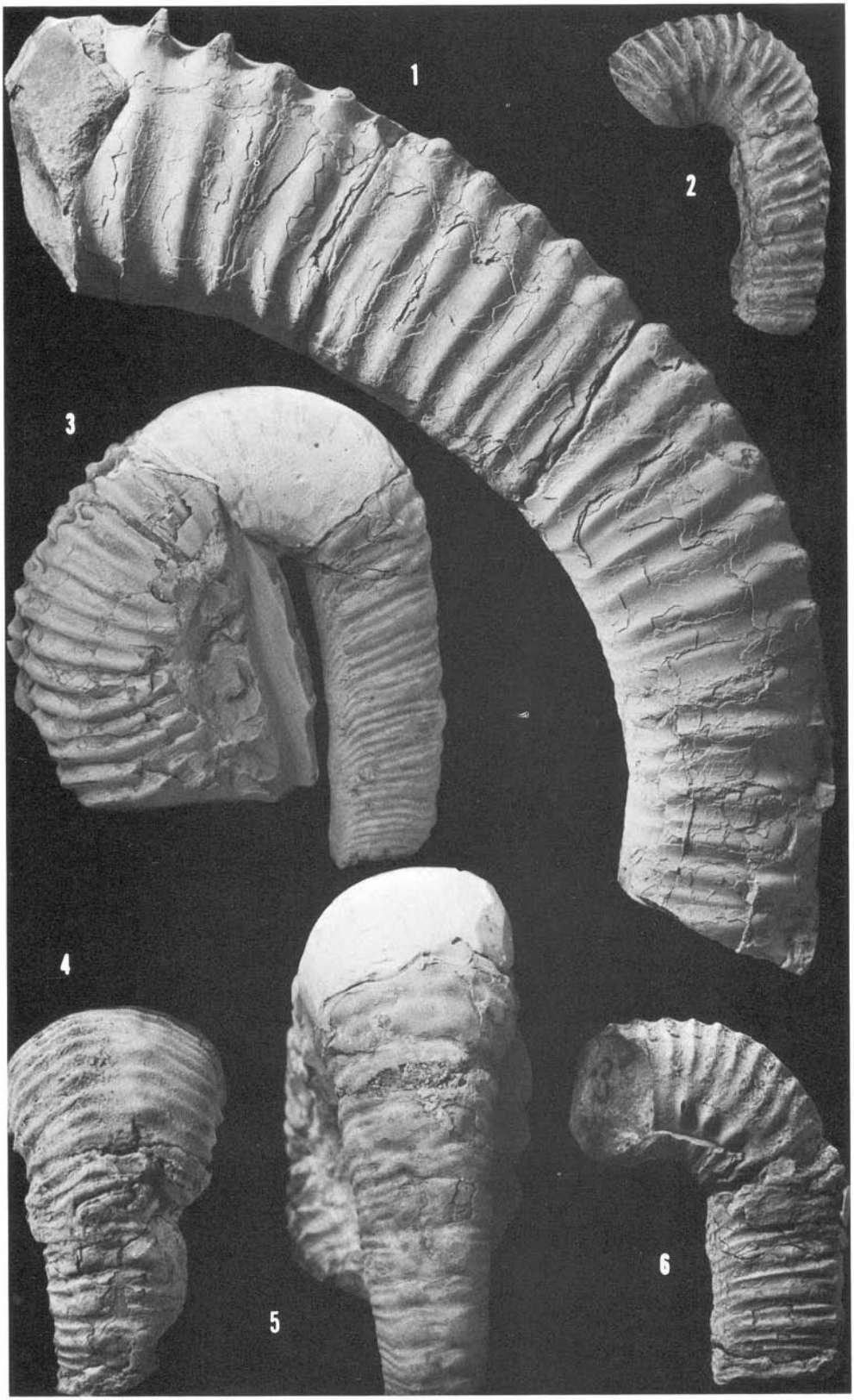
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PLATE 5

(All figures natural size)

Fig. 1, 5. *Toxoceratoides corae* n. sp. 1. Lateral view of the holotype, UCR specimen number 505/26. 5. Ventral view of the same.

Figs. 2, 3, 6. ?*Toxoceratoides greeni* n. sp. 2. Ventral oblique view of the holotype, UCLA specimen number 48342 from UCLA locality 2968. 3. Ventral view of the early hook and late shaft of same. 6. Lateral view of the same. Arrow shows the direction of photo in figure 2.

Fig. 4. "*Shasticrioceras*" inflatum Anderson. Portion of the holotype, CAS type collection specimen number 8933 showing the lateral lobe of the suture.

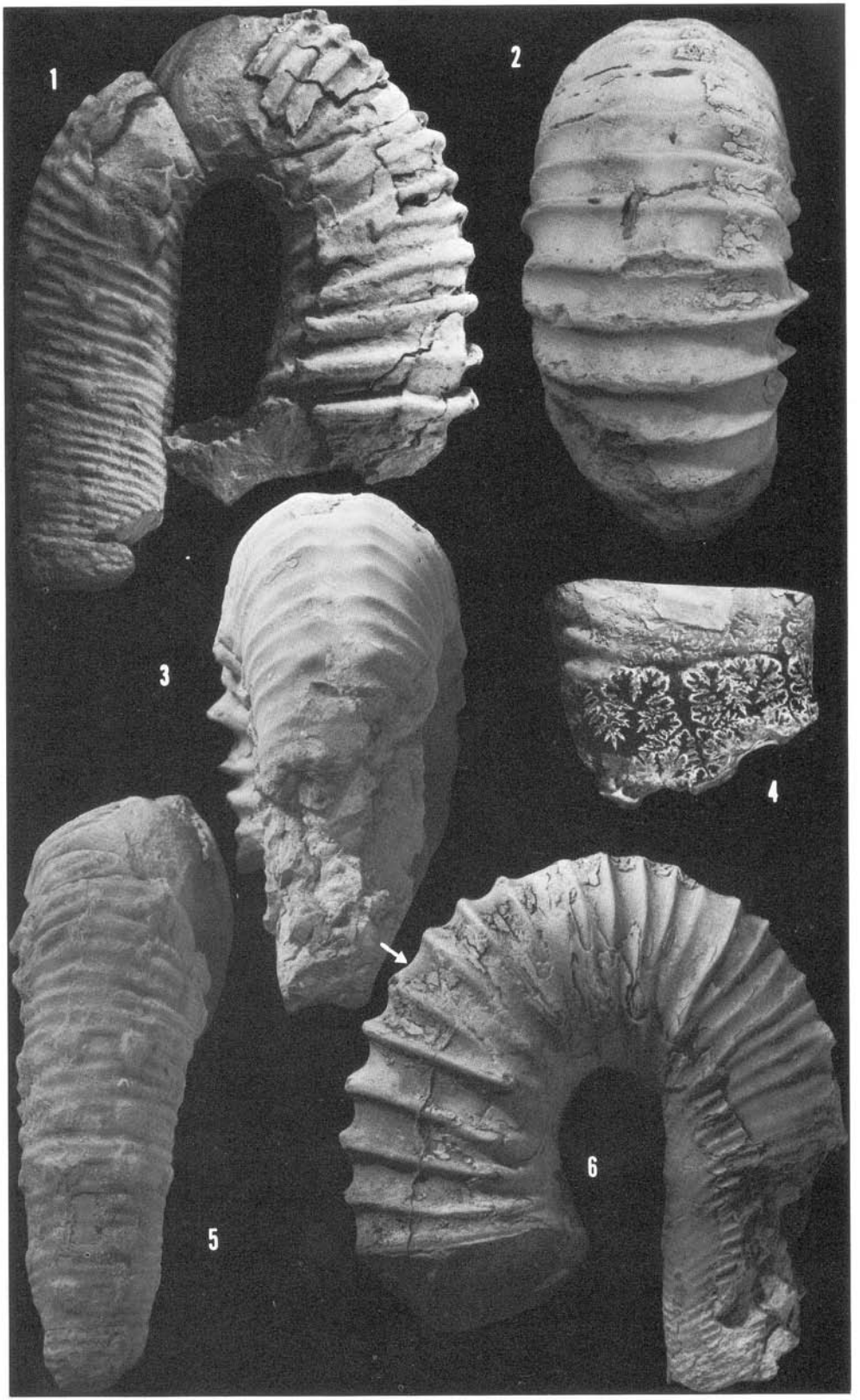
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PLATE 6

(All figures natural size)

Figs. 1, 2, 11. *Toxoceratoides* sp. 1. 1 and 11. Lateral views of UCR specimen number 5131/1. 2. Ventral view of same.

Figs. 3, 4. *Pulchellia* (*Heinzia*) *popenoei* Anderson. Lateral and ventral views of UCLA specimen number 48338 from UCLA locality 3060.

Figs. 5, 6. ?*Toxoceratoides* sp. Lateral and ventral views of UCR specimen number 5185/1.

Figs. 7, 8, 9, 10. ?*Argvethites* sp. 7. Ventral view of the shaft. 8. Ventral view of the spire. 9 and 10. Lateral views to show the asymmetrical character of the ornamentation of the spire. UCR specimen number 6361/1.

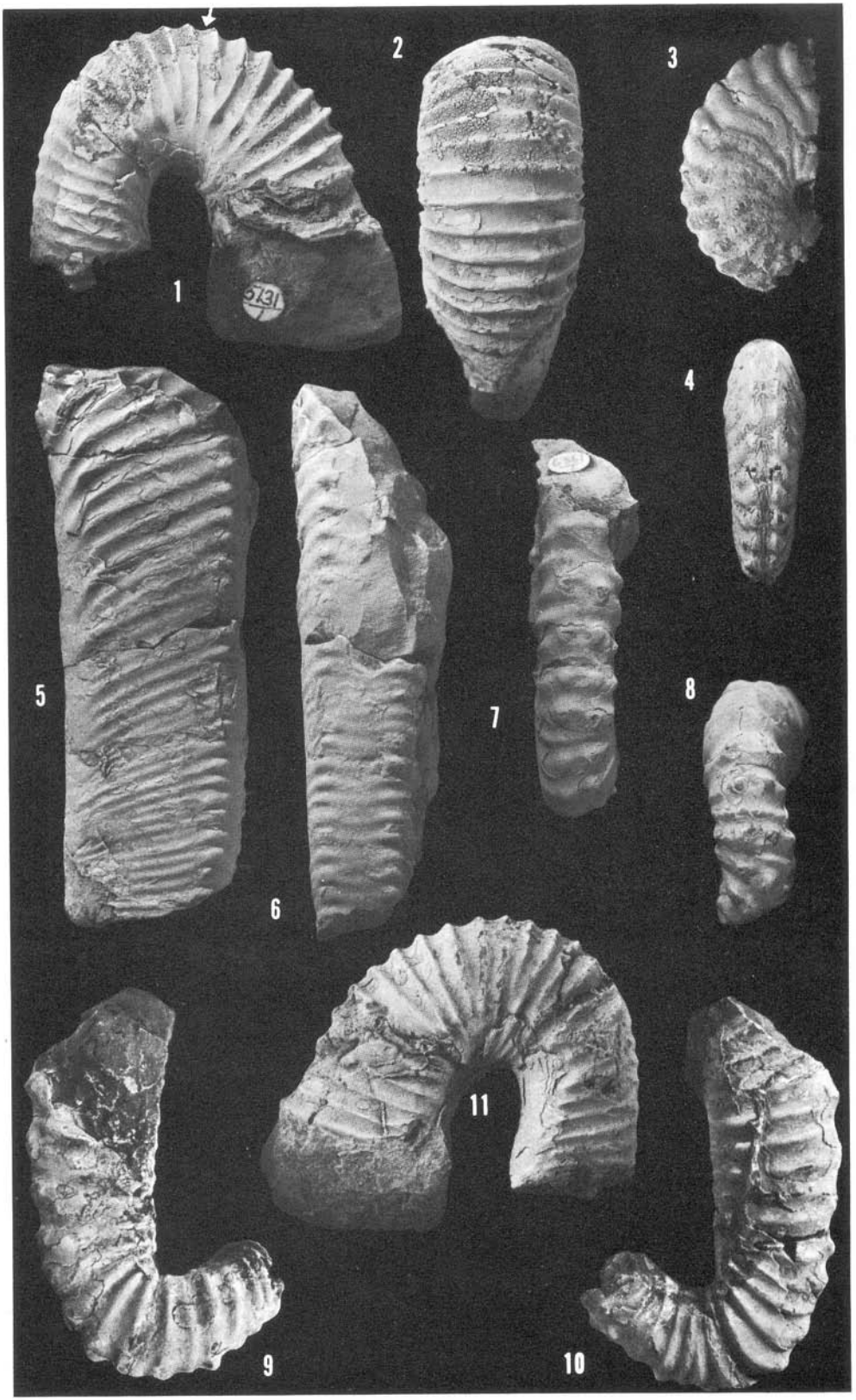
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PLATE 7

(All figures except fig. 4 are natural size)

Figs. 1, 2. *Shasticrioceras patricki* n. sp. 1. Lateral view of UCLA specimen number 48343 from locality UCLA 3014.

Fig. 3. *Toxoceras blandi* n. sp. Ventral view of the holotype, terminal half of the specimen, UCLA specimen number 48340.

Fig. 4. *Heteroceras jeletzkyi* n. sp. Lateral view of the holotype, UCR specimen number 6338/1.

Figs. 5, 6. *Dissimilites* sp. 5. Lateral view of UCR specimen number 5188/1. 6. Ventral view of the same.

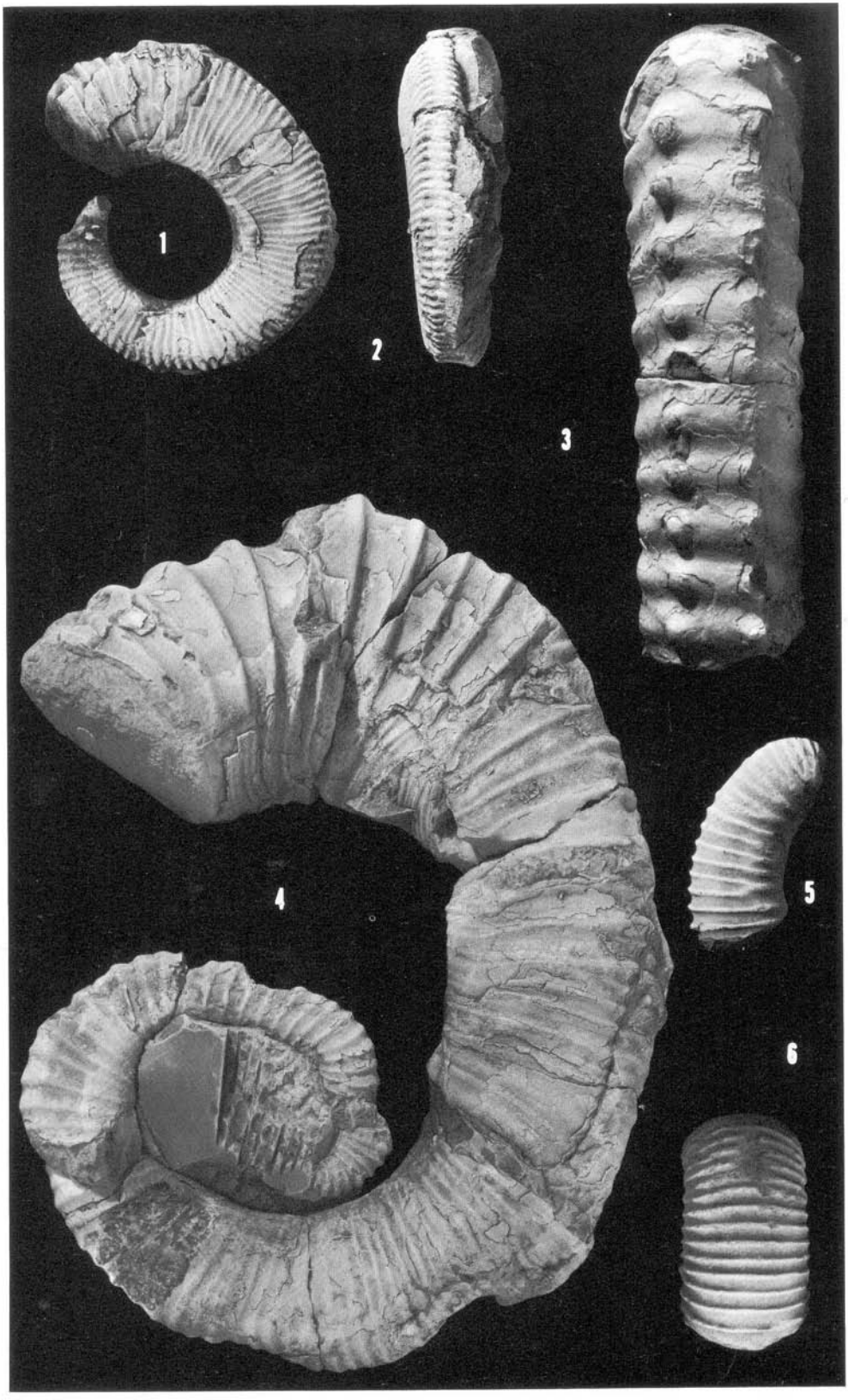
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PLATE 8

(All figures natural size)

Figs. 1-5. ?*Hemihoplites popenoei* n. sp. 1 and 2. Lateral view of the holotype, UCR specimen number 6308/1. The whorls were separated during preparation. They were separated by 1 to 2 mm of matrix when found. The white line indicates their relative positions before separation during preparation. 3 and 4. Ventral views of the outer and inner whorls, respectively. White arrows indicate the direction of ventral views, 3 and 5, respectively.

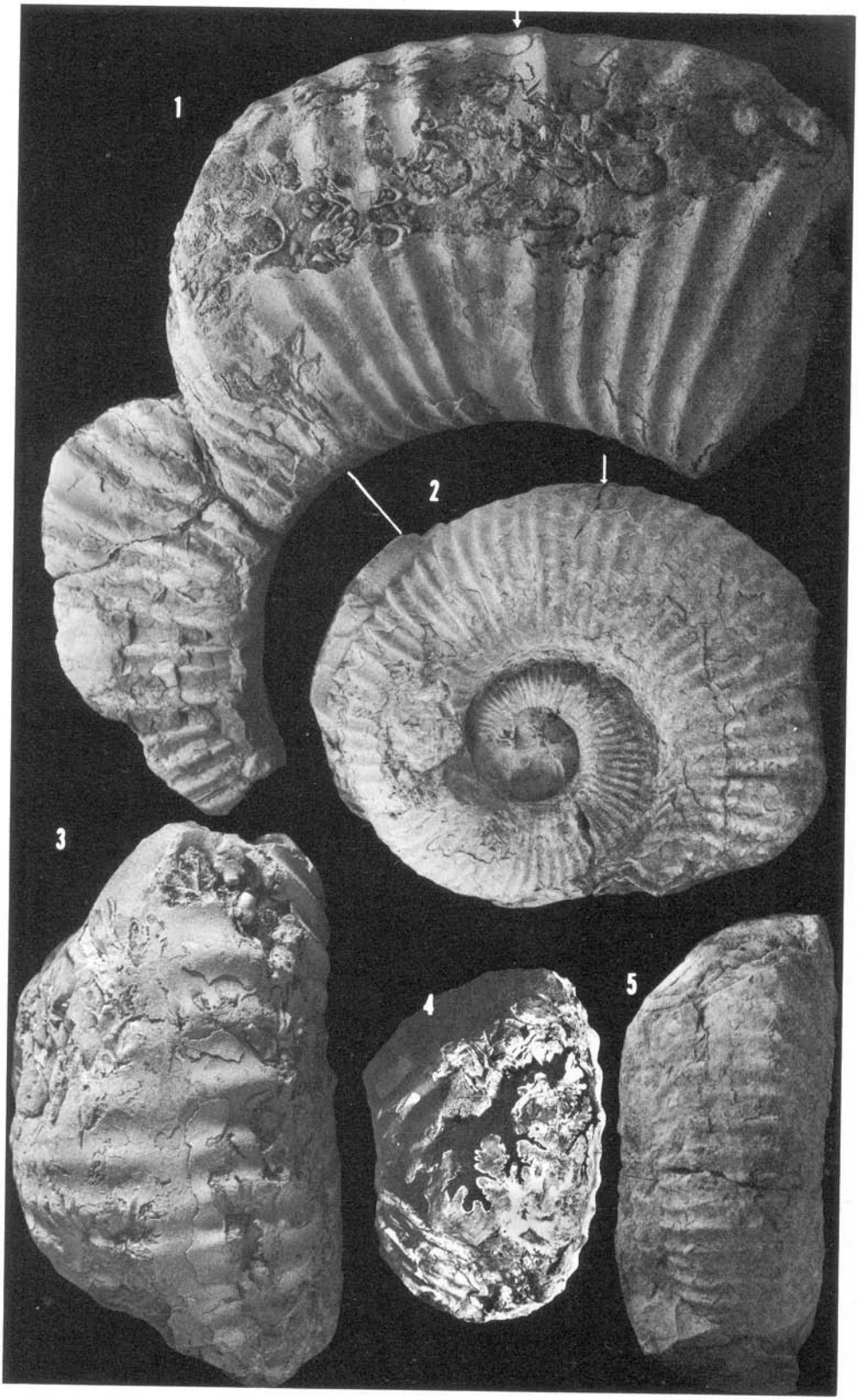
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PLATE 9

(All figures natural size except as noted)

Figs. 1, 5. ?*Shasticrioceras wintunius* (Anderson). 1. Lateral view of the holotype, CAS type collection specimen number 8900. White arrow indicates direction of view in figure 5. Half arrow indicates location of enlarged suture figured at lower right of specimen. 2. Ventral view of the same specimen.

Fig. 2. *Ancyloceras elephas* Anderson. Lateral view of shaft of UCR specimen number 5404/1 showing spine bases (x ½).

Figs. 3, 4, 6, 7. *Shasticrioceras whitneyi* Anderson. 3. Lateral view of UCLA specimen number 48341 from UCLA locality 3057. 4, 6, 7. Views of the holotype, CAS type collection specimen number 8932.

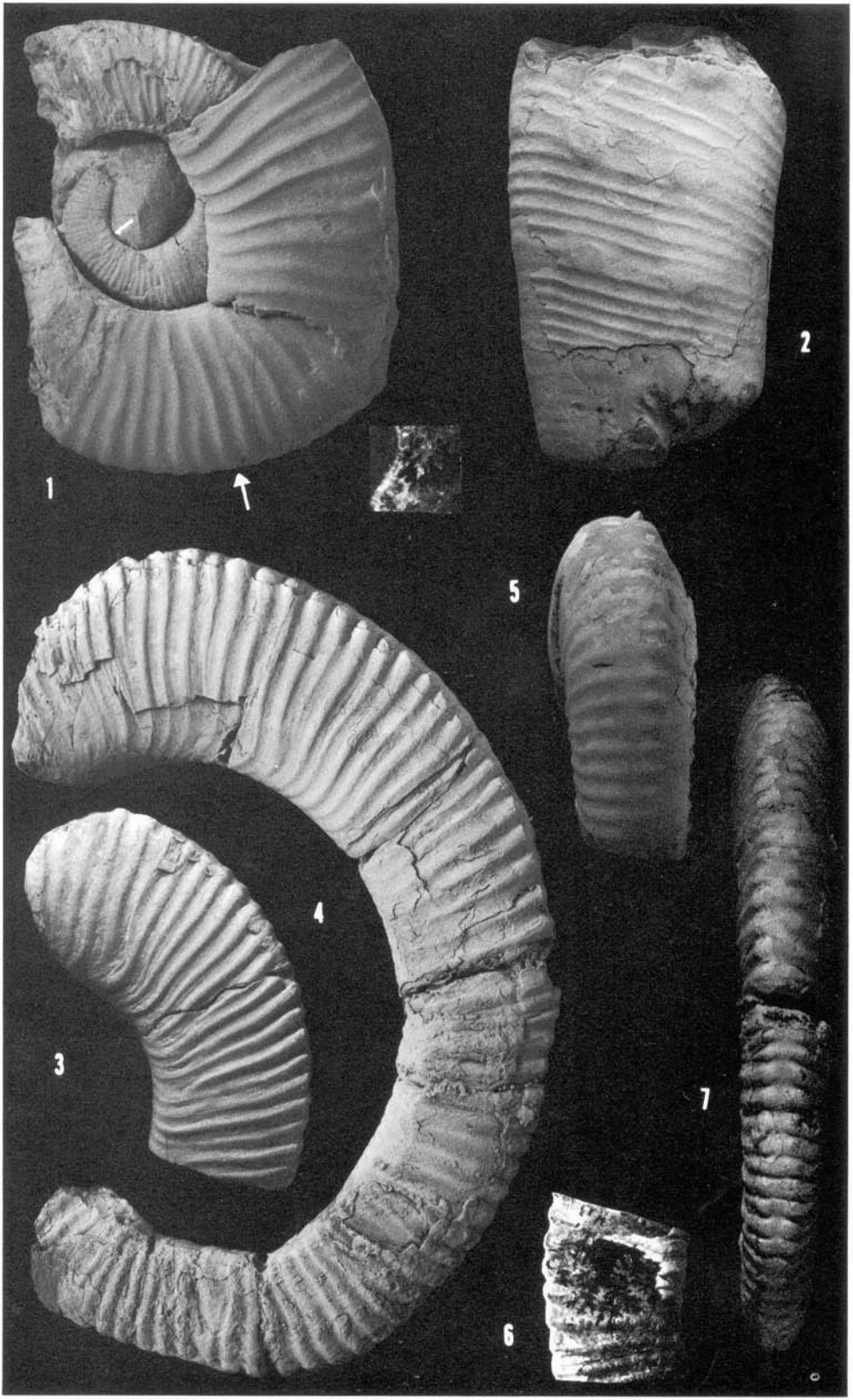
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PLATE 10

(Figures natural size except figs. 1 and 6)

Figs. 1, 2, 6. *Shasticrioceras poniente* Anderson. 1. Lateral view of UCR specimen number 6343/1, x ½. 2. Lateral view of juvenile specimen (UCLA specimen number 48344 from UCLA locality 2980) showing the sulcate nature of some of the ribs in the early ontogeny. 6. Suture line, x ½, UCR specimen number 6331/1.

Figs. 3, 4, 5. *Shasticrioceras patricki* n. sp. 3 and 4. Ventral and lateral view of the holotype, UCR specimen number 5128/1. 5. Suture line of UCR specimen number 5414/1.

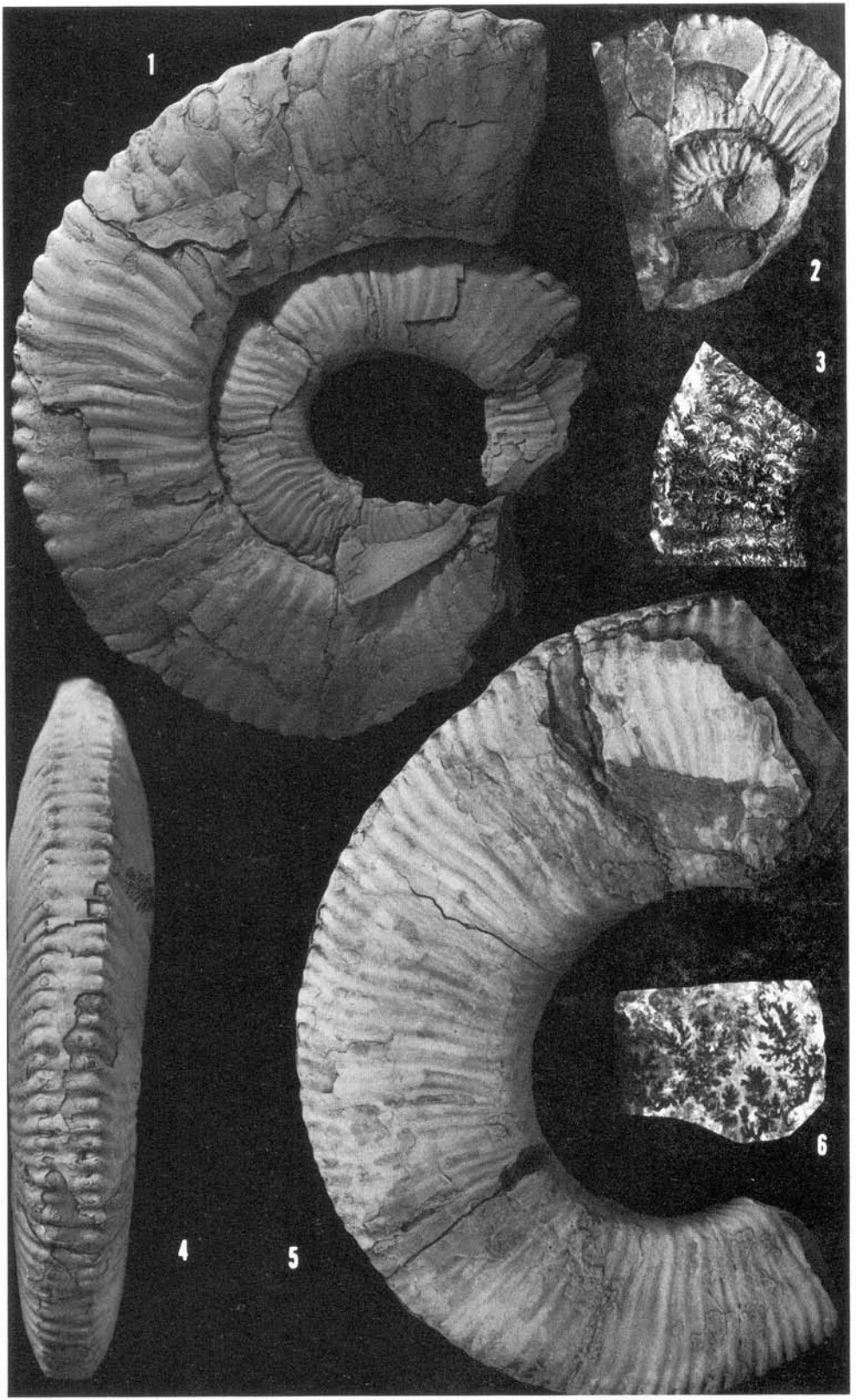
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PLATE 11

(Natural size except as noted)

Figs. 1, 2. *Ancyloceras thomeli* n. sp. Ventral view of the holotype, UCLA specimen number 48339 from UCLA locality 2798. x ½.

Figs. 3, 4, 6. ?*Cheloniceras* sp. 3 and 4. Lateral and ventral views of UCR specimen number 5130/1. 6. Suture of same specimen reduced to ½ size.

Figs. 5, 7. *Shasticrioceras poniente* Anderson. 5. Ventral view of UCR specimen number 6359/2 to show character and spacing of the clavae. 7. Suture of UCR specimen number 6340/2 showing the nature of the lateral lobe. Both x ½.

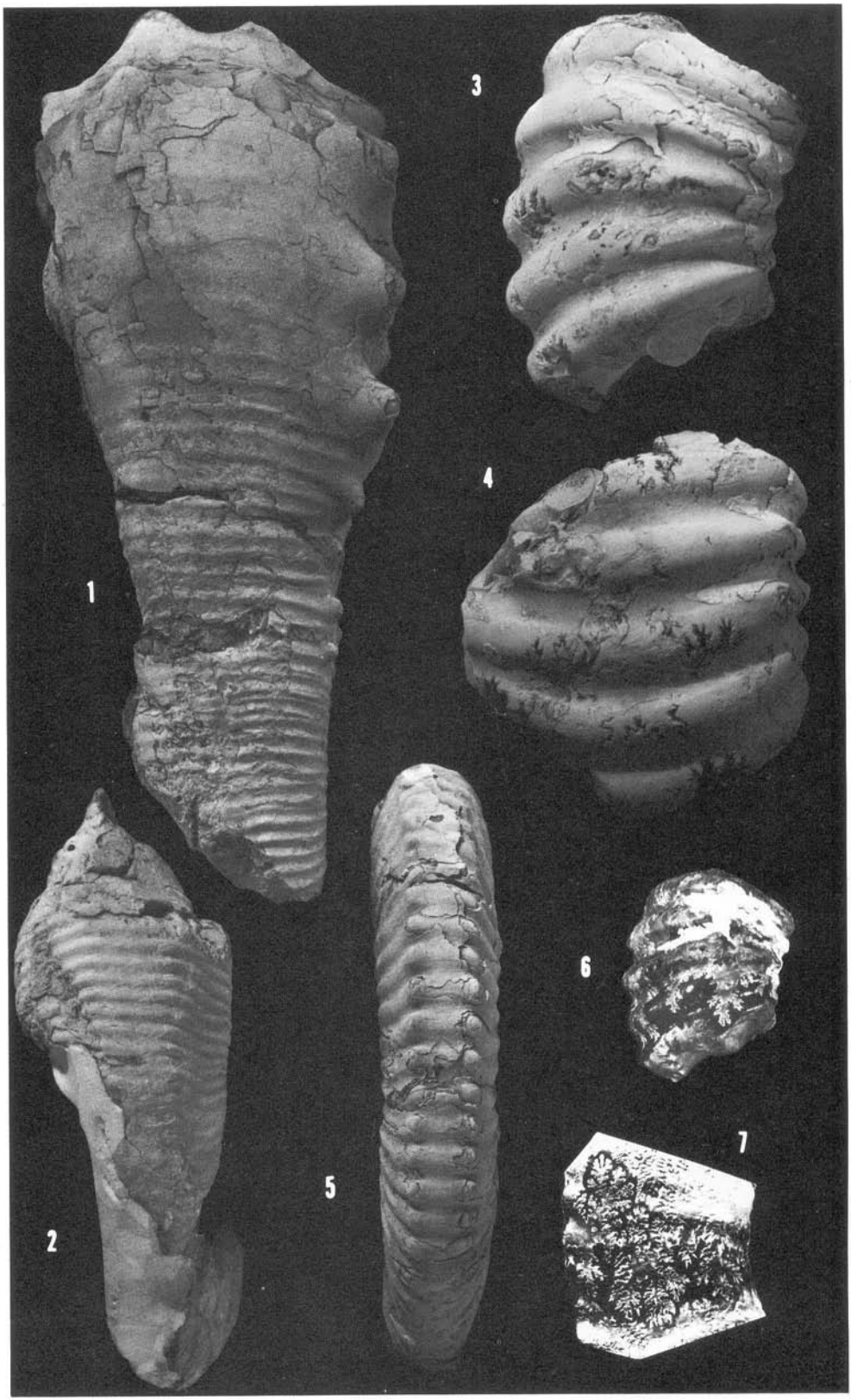
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PLATE 12

(All figures except fig. 5 are one-half size)

Figs. 1-5. *Shasticrioceras roddai* n. sp. 1. Lateral view of the holotype, UCR specimen number 5212/1. 2 and 3. Ventral and lateral view of UCLA specimen number 48345 from UCLA locality 3005, which shows the intermediate ribbing better than the holotype. 4. Suture line of UCR specimen 696/1 showing the characteristic *Shasticrioceras* lateral lobe. 5. Ventral view of the inner whorl of specimen in figs. 2 and 3. (x 1).

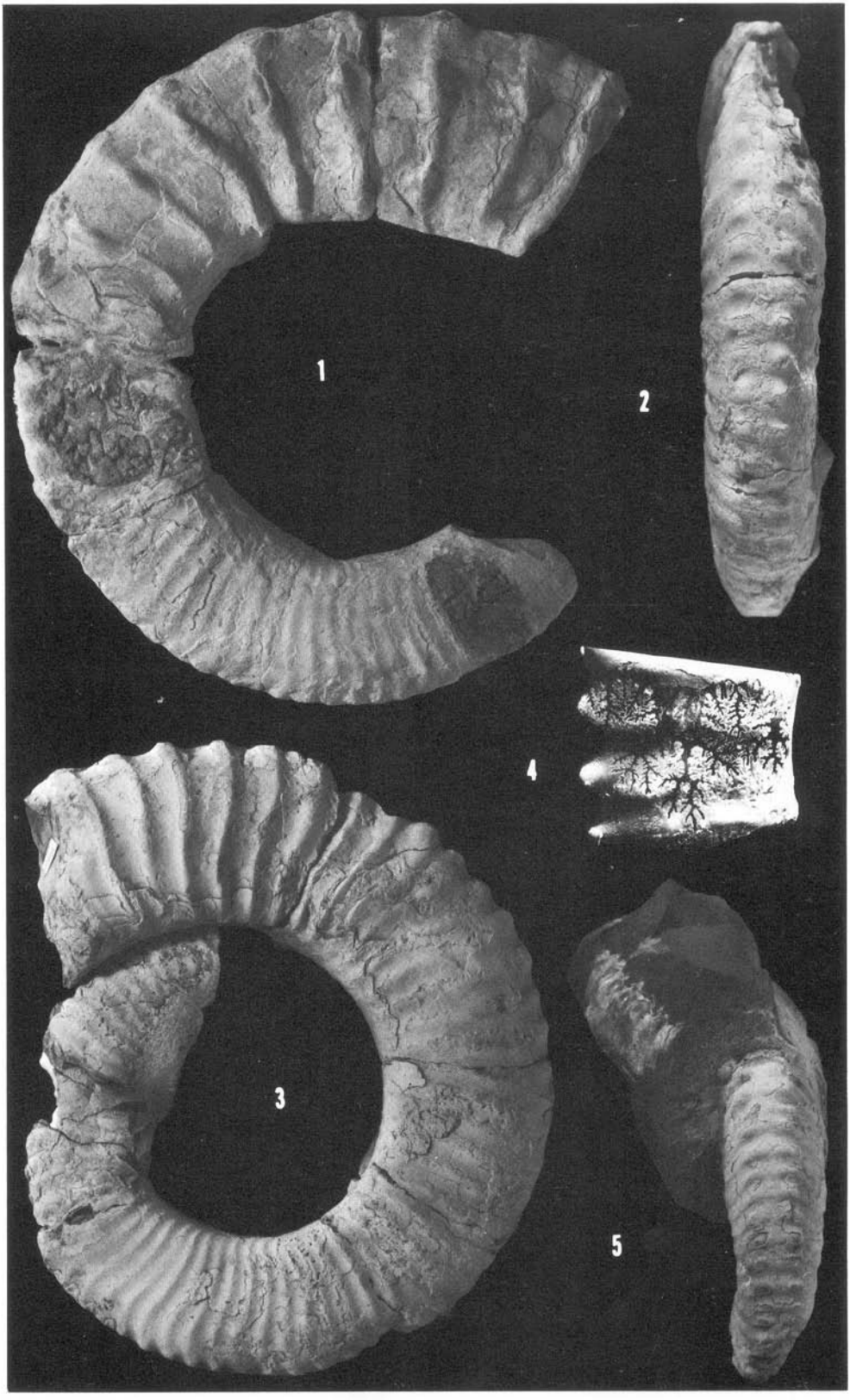
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PLATE 13

Figs. 1, 2. ?*Heteroceras* sp. Lateral and ventral views of UCLA specimen number 48346 from UCLA locality 2999 (x ¾). The white arrow on figure 1 indicates the direction of the camera in figure 2.

Fig. 3. *Barremites* sp. Lateral view of UCLA specimen number 48347 from UCLA locality 2983 (x 1).

Fig. 4. *Shasticrioceras patricki* n. sp. Lateral view of UCR specimen number 5191/1.

Fig. 5. *Lytoceras* sp. Lateral view of UCR specimen number 5182/1. This specimen is probably conspecific with *Lytoceras* sp. 1.


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Errata

Paleontology and Stratigraphy of the Lower Chickabally Mudstone (Barremian-Aptian) in the Ono Quadrangle, Northern California

by M. A. Murphy

Page No.	Line No.	Should read (corrections are underlined)
7	7	.....are not so easily....
17	32	Road II section.....
	23	....height/width ratio of
18	18	...late growth stages. Measurements
20	last	....part of the Shasticrioceras.....
25	2	-ceras Thomel, 1964.....
26	next to last	....genera: T. royerianus
	last	obliquatus = Hemibaculites
27	3	is discussed below (p. 28).
30	3	....the coiling type was
32	10	Section I in the .....
33	15	....It differs from
35	3	Section I which is....
	8	....in the Roaring River Road sections.
	21	arise, at the ventral....
37	29	....River Road Section I. one...
41	11	that the Speeton form....
44	1	River Road Sections....
46	11	....River Road sections

Plate	Line No.	
1	3	Partschiceras occidentale
7	7	....number 5188/2. ....
10	heading	(Figures natural size except 1 and 3)
	1	Figs. 1,2,3
	4	ontogeny. 3. Suture....
	6	Figs. 4,5,6. Shasticrioceras patricki n. sp.
		4 and 5. Ventral....
	7	....5128/1. 6. Suture....
14	right hand section	Roaring River Road Section I
14	line 4 of explanation	detail in pl. 15.