Upper Cretaceous Ammonites of California Part I

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Upper Cretaceous Ammonites of California

Part I*

By

Tatsuro MATSUMOTO

Introduction

1. Historical review and purpose of study

The purpose of this paper is to describe the Upper Cretaceous ammonites of California which I studied during my visit to the United States in 1957-1958.

The history of the study of Cretaceous ammonites from this region goes back about a century, but for some reason the Californian ammonites have not been treated as adequately as they ought to have been.

The first governmental reconnaissance in the geology of California was taken in connection with the surveys for the railroad route from the Mississippi to the Pacific (NEWBERRY, 1856; BLAKE, 1858). While many of the collections on this occasion were described in appendices to the report, BLAKE (1858, p. 173) cited for the ammonites only a paper by TRASK (1856), which, however, strangely indicated that the ammonite bearing rocks of the Chico Creek were Tertiary.

The Geological Survey of the State of California was organized soon after the gold rush in 1849. WHITNEY (1865) edited the report of the geological field work and GABB (1864, 1869) was the author of a work on the Cretaceous fossils in two volumes, which contain descriptions of many species of the Ammonoidea. Immediately after the publication of the *Palaeontology of California,* Volume I, CONRAD (1865, 1866) criticised GABB's work, but with little mention of the ammonoid species. Still later STEWART (1927, 1930) published revised descriptions and illustrations of GABB's California Cretaceous and Tertiary type gastropods and lamellibranchs. For GABB's ammonites, however, no paper has been issued which is comparable with these useful and nomenclatorially accurate monographs of STEWART. Still worse is the situation that many of GABB's type ammonites are missing, although some of his illustrated specimens have been discovered in three institutions—the Museum of Paleontology, University of California, the Academy of Natural Sciences, Philadelphia, and the Museum of Comparative Zoölogy at Harvard College.

The United States Geological Survey was established in 1879 and, based on collections made in the course of its geological reconnaissance, WHITE (1885) and STANTON (1893, 1894, 1895, 1896) contributed papers on the paleontology of California. Very few ammonites, however, were described in those papers,

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although the authors made important remarks on stratigraphical problems based on paleontologic evidence.

In the meanwhile MEEK (1862, 1876) described new Cretaceous fossils collected by the North-Western Boundary Commission on Vancouver and Sucia Islands. These included several important species of ammonites, some of which are identical with the Californian species. The collections of the Geological Survey of Canada were described serially by WHITEAVES (1876-1903, 1895) and recently by USHER (1952). Their works are also useful for the study of Californian ammonites, since the faunas are intimately related.

J. P. SMITH (1898, 1899, 1900, 1901, 1905) reported interesting observations on the ontogeny of certain ammonites. The materials for this study were primarily supplied from Californian specimens. His life work was, however, rather in the Triassic cephalopods and no monographic work on the Cretaceous ammonites was attempted by himself or by his successors.

The late Dr. F. M. ANDERSON was a most enthusiastic collector of Cretaceous ammonites from California and Oregon. It is interesting to note that his older monograph (ANDERSON, 1902) was nearly contemporary with YABE's papers on the Cretaceous ammonites of Japan (YABE, 1901-1902, 1903-1904). After accumulating material for three or four decades, ANDERSON (1938) published another paper on the Lower Cretaceous ammonites of California and Oregon, and subsequently prepared a manuscript on the Upper Cretaceous of the same and adjacent regions. Although much delayed, the latter (ANDERSON, 1958) appeared in print quite recently, when I was about to finish the first draft of this paper. Unfortunately the majority of the types of his earlier (1902) descriptions were destroyed in the fire of San Francisco in 1906. Nevertheless the collections in the California Academy of Sciences are great and important, as they contain the types of ANDERSON's later works and also many other specimens.

For some unknown reason ANDERSON gave stratigraphical, instead of paleontological, titles to his three monographs. Furthermore, he published several shorter papers, in which stratigraphic classification and correlation were discussed. All these indeed furnished much valuable information, but the requirements of modern paleontology and stratigraphy were not fully met.

There are five other shorter papers in which Upper Cretaceous ammonites are described. The authors are WARING (1914), HALL and AMBROSE (1916), REAGAN (1924), YABE and SHIMIZU (1921), and ANDERSON and HANNA (1935). Their types are in the collections of Stanford University (for the first three papers), Tohoku University (for the fourth), and California Academy of Sciences (the last). Revisions may be required for them.

In addition to the cartographic works of the U. S. Geological Survey and the Division of Mines, Department of Natural Resources, State of California, a great deal of field work has been undertaken by members (including students) of universities, colleges, and other research or educational organizations, as well as by oil and other economic geologists. The specimens from the various stratigraphic units of many areas have accumulated at these institutions, awaiting careful paleontological study. Although discussion of correlation has been especially active for the last twenty years, there are many unsettled problems and confusion can be found in the published definitions and nomenclature of the stratigraphic units. SCHENCK and MULLER (1941, 1943) took the lead in clearing up fundamentally the confused situation. Only a few papers have dealt with faunal zones in a correct sense.

PACKARD (1916) may be the first, as far as I know, who introduced faunal zones, if not precisely in OPPEL's sense, for the Cretaceous of California. They were based on molluscan species other than ammonites in the Santa Ana Mountains. The same idea was developed by POPENOE (1942), who again depended much on pelecypods and gastropods of southern California, and later extended his work to the Cretaceous of northern California (POPENOE, 1943). The collections of Dr. POPENOE and his associates are large, containing many ammonites, but only small fractions of them were borrowed by ANDERSON for his description. In the recent paper by PECK, IMLAY, and POPENOE (1956) a correlation chart of some Upper Cretaceous sections in California and Oregon was presented, with indication of characteristic ammonites. POPENOE (1957) published another interesting paper on the evolution and biostratigraphic significance of gastropod genus *Biplica*, in which he presented the generic names of associated ammonites on a stratigraphic chart. These two charts depended much on the collections of POPENOE, IMLAY, and their associates, although no monographic descriptions of ammonites followed their papers. On Dr. POPENOE's suggestion, MURPHY attempted zonation of the Lower Cretaceous and his stratigraphic results were published in 1956. I understand that he will eventually publish a refined study of the fossils, including description of ammonites. Incidentally some early Cretaceous ammonites from California and Oregon have already received revised generic names from CASEY (1954), IMLAY (1957), and myself (1955). PACKARD (1956) described an *Engonoceras* from Oregon.

In the meanwhile zonation of the Cretaceous System and descriptions of ammonites have recently advanced in Japan, where one of the standards for the Upper Cretaceous of the Indo-Pacific realm can be established. In fact there was a possibility that certain species were common between California and Japan, and even between the North Pacific and other regions of the world. But, owing to inadequate international exchange of knowledge, identical species often seem to have received different names in different countries. A symposium on the Cretaceous System and its world correlation was held at the XXth International Congress in Mexico (1956). On this occasion papers were read by DURHAM and ALLISON from the American side and by myself from the Japanese side of the North Pacific. Thus the interest in interregional correlations have recently increased.

Under these circumstances Dr. YABE received a letter from Dr. PACKARD, while I received another from Professor SCHENCK of Stanford, suggesting that a visit of a Japanese paleontologist to America was a desirable step in attempting an improvement of our knowledge on the Cretaceous ammonites.

Fortunately the FULBRIGHT program enabled me to visit the United States for this purpose. Of course thirteen months stay is not sufficient for a complete study in both stratigraphic and paleontologic fields. But, owing to the great help of professors and many kind friends, my research work has proceeded reasonably satisfactory. This paper is a report of my study on the ammonites of the Upper Cretaceous of California.

Since taxonomy is fundamental for every field of paleontology and stratigraphy, the systematic descriptions are stressed in this paper. Because my time was limited, I could not consider all the species, but selected those which are represented by a relatively large number of specimens or those which are especially interesting for world problems. Some, if not all, of GABB's and ANDERSON's species are revised in connection with my descriptions. Several of the species from Oregon, Washington (Sucia Island), and British Columbia (Vancouver Island) are also included, so far as they have any connection with the Californian material.

As regards stratigraphy I will describe concisely (in Part III) the local stratigraphy of the ammonite bearing beds. The descriptions will be mostly cited from the already published papers with modification, but new discoveries will be introduced, with the names of the contributors and partly under the joint author names. I will list all the registered localities of Upper Cretaceous and Upper Albian ammonites which have been at my disposal. In addition to the records of localities, the list contains the specific names of my identification and the suggested geological ages. The localities are indicated on the map as far as possible.

In the concluding remarks I will present a summary of the paleontologic results. The results of the stratigraphic correlation and also a summary of the stratigraphic distribution of the described species will be included. Comparisons of the Californian faunas with those of the various provinces of North America, Japan, and other parts of the world will be attempted.

Recently many active geologists have been doing precise geological work in the Cretaceous areas of California and adjacent regions. Collections of ammonites are growing larger and the stratigraphic information is becoming more exact. Paleontological work is in progress on many groups of both mega- and microfossils of the Californian Cretaceous. Studies of Cretaceous ammonites are actively proceeding in various areas of the world. Under these circumstances, I hope that this paper will serve as a step towards a further improvement of knowledge.

2. Material

The material on which this report is based came from various sources. Geographically it extends from Vancouver Island to Baja California, but the majority of the specimens at my disposal were from about 600 localities in California, which are grouped in the following areas of Cretaceous outcrops (Fig. 1):

(1) Hornbrook-Yreka area, Siskiyou County, northern California, which extends to southwestern Oregon

(2) Redding area, Shasta County, northeast side of the Sacramento Valley

(3) Chico Creek and other scattered small areas on east side of the Sacramento Valley; a narrow area around Sutter Butte in the center of the Valley which may be conventionally grouped with them

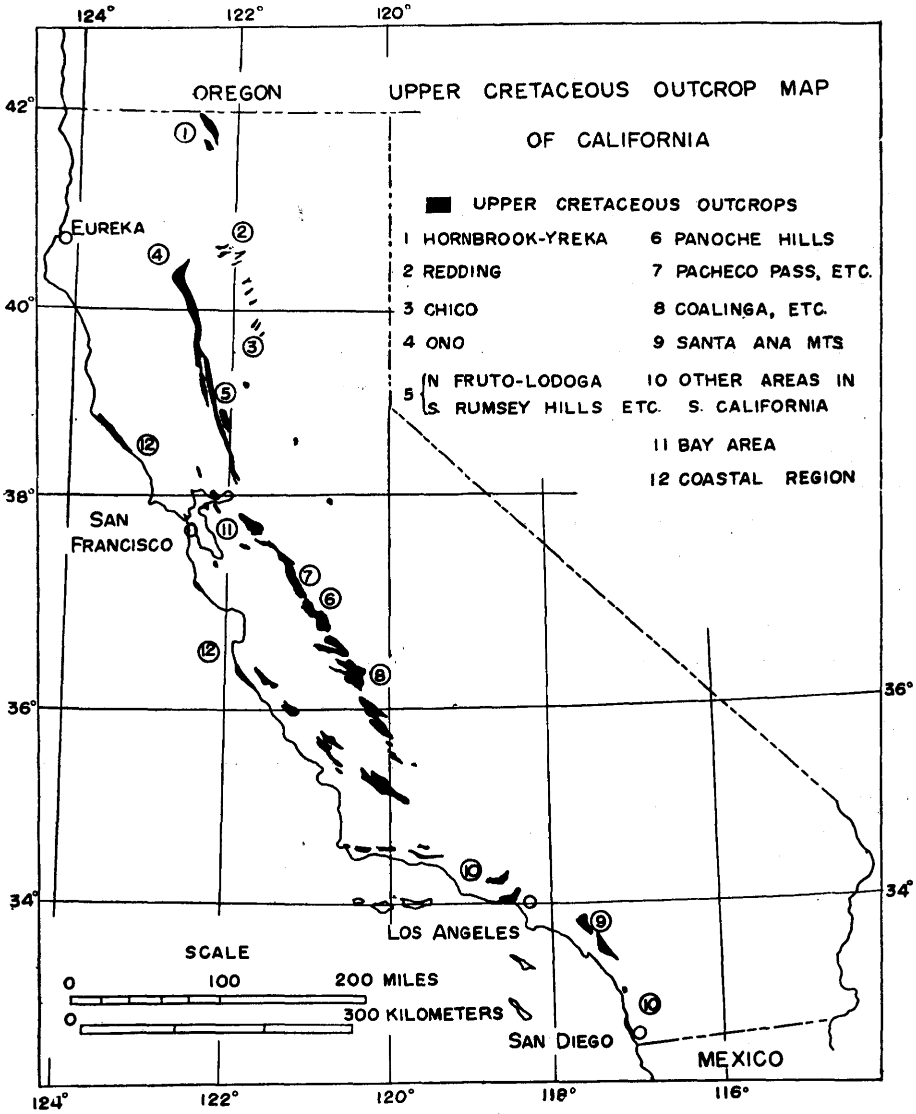


Fig. 1. Map of California showing the Upper Cretaceous outcrops.

(4) Ono area and its extension, northwest side of the Sacramento Valley

(5) Cretaceous area of Fruto and Lodoga Quadrangles in the north to Rumsey Hills and adjacent areas in the south, west side of the Sacramento Valley

(6) Panoche Hills, west side of the San Joaquin Valley

(7) Cretaceous area in Pacheco Pass Quadrangle to the north of Panoche Hills, and its northern extension, west side of the San Joaquin Valley

(8) Coalinga area, covering the localities in Ragged Valley, Joaquin Ridge, Los Gatos Creek, and Walthan Creek, west side of the San Joaquin Valley; other smaller areas in Kings and Kern Counties, southwest side of the San Joaquin Valley which may be regarded as extensions of Coalinga outcrop

(9) Santa Ana Mountains, Orange County, southern California

(10) Other areas in southern California, such as the Santa Monica Mountains near Los Angeles, Simi Hills in Ventura County, Santa Ynez Mountains in Ventura and Santa Barbara Counties, and Point Loma near La Jolla, San Diego County

(11) Scattered localities around the San Francisco Bay, or simply "Bay Area"

(12) A few areas in Mendocino, Sonoma, and Monterey Counties in the Coastal Region

Historically the material goes back to GABB's type specimens, although many of them are missing. I have examined the surviving types of ANDERSON (1902) and almost all of the illustrated types of ANDERSON (1958). The majority of the type ammonites of MEEK (1876) and WHITE (1885) were studied when I visited the U. S. National Museum. Also I had an opportunity of looking at plaster casts of some illustrated types of WHITEAVES (1876-1903) and USHER (1952). The ammonites of WARING (1914), HALL and AMBROSE (1916), YABE and SHIMIZU (1921), and ANDERSON and HANNA (1935) were of course available.

Most of the material of this study lies, however, in the previously undescribed specimens, which have been deposited in various institutions, as well as in the new collections which were obtained during my visit to the United States.

A great number of persons have contributed to the above mentioned collections. Their names are recorded in the description of species and also in the list of localities, so far as they are known. But I should like to mention here the following persons, whose collections are especially valuable in that they have relatively reliable information of the geographic and stratigraphic positions, in that they contain enough number of well preserved specimens for studying the intra- or interspecific variations, or in that some of them are new to California.

Dr. W. P. POPENOE and his collaborators, since 1930, have accumulated a large number of specimens from the Santa Ana Mountains, Simi Hills, the Redding area, the Chico area, Sucia Island and many other scattered localities. The majority of their collections are at present preserved in the University of California at Los Angeles. Mr. J. M. KIRBY, sometimes with Mr. T. H. CROOK, obtained some ammonites on the occasion of his geological field work (1933) in the Rumsey Hills and adjoining areas on west side of the Sacramento Valley. The collections are in Stanford University. In the same university there are valuable collections of Dr. R. E. COOK from Chico Creek and vicinity, made when working for a thesis, and also those of Professor S. W. MULLER and his students from the Coalinga area, Logan Ridge (Lodoga Quadrangle), Mills Creek (east side of the Sacramento Valley), and other localities. Mr. Allan BENNISON collected ammonites and other specimens from many localities on the west side of the San Joaquin Valley. They are preserved partly in the University of California (Berkeley) and partly in the California Academy of Sciences. In the former institution, Professor J. W. DURHAM, Mr. E. C. ALLISON and many students have accumulated specimens from various localities between Vancouver Island and Baja California. Mr. M. V. KIRK, while he was in the University of California, sorted the Cretaceous ammonites of the collections there. His valuable contribution to the collections of ammonites was extended to those of the Paleontological Laboratory, Shell Oil Company at Seattle, where he has accumulated, since 1951, sometimes with his associates, many interesting specimens from the Redding, Chico, Ono, Lodoga (Logan Ridge), Rumsey, and Yreka areas in California, as well as from Alaska. He showed me all the collections of his laboratory and let me borrow the better preserved specimens for further careful studies. The latter were donated to and are now in the type collections of the University of California (Berkeley). Another valuable set of specimens is the collection of Mrs. L. E. and Mr. R. B. SAUL, who have recently done careful field work in Chico Creek under the guidance of Professor POPENOE. The specimens are now in the University of California at Los Angeles.

At present Dr. R. W. IMLAY and Dr. David L. JONES of U. S. Geological Survey are engaged in the study of Mesozoic invertebrates from the West North America. Also Dr. E. L. PACKARD is doing a persistent research work on the collections from Oregon and other areas which he has long since accumulated. Dr. Michael MURPHY and Mr. Peter RODDA, on the suggestion of Professor POPENOE, are doing careful works on the Lower and Upper Cretaceous of Ono and adjacent areas on the northwest side of the Sacramento Valley. By courtesy of Dr. IMLAY, Dr. JONES, Dr. PACKARD, Dr. MURPHY, and Mr. RODDA I had opportunities of looking through their precious collections of the Cretaceous ammonites. These are, however, not included in the description of this paper, since they will eventually be monographed by the respective investigators.

The collections which were obtained during my visit to California are from the following sources:

(a) Panoche Hills and vicinity (Coll. Max B. PAYNE and T. MATSUMOTO; partly with H. G. SCHENCK and J. J. GRAHAM)

(b) Coalinga area (Coll. Max B. PAYNE and T. MATSUMOTO)

(c) Chico Creek and a locality near Pentz (Coll. Stewart CHUBER and T. MATSUMOTO)

(d) Fruto and Lodoga Quadrangles, west side of the Sacramento Valley (Coll. Stewart CHUBER and T. MATSUMOTO)

(e) Redding area (Coll. W. P. POPENOE and T. MATSUMOTO)

(f) Santa Ana Mountains (Coll. W. P. POPENOE, P. RODDA, and T. MATSUMOTO)

(g) Altamont Cut and Arroyo del Valle, Tesla Quadrangle (Coll. H. G. SCHENCK, J. J. GRAHAM, D. L. JONES, and T. MATSUMOTO)

The specimens of the above collections are preserved mostly in Stanford University, but partly in Kyushu University. I had also an opportunity of joining the excursion to Scott Ranch, west of Willows and Putah Creek, southwest side of the Sacramento Valley, held as a paleontologic class work under Professor J. W. DURHAM.

The repositories of the described specimens are as follows, with abbreviations in brackets:

Stanford University, Stanford, California (LSJU.)
University of California, Berkeley, California (UC.)
University of California at Los Angeles, California (UCLA.)
California Institute of Technology, Pasadena, California (CIT.)
University of California, School of Letters and Sciences, Riverside, California (UCR.)
California Academy of Sciences, San Francisco, California (CAS.)
Shell Oil Company, Seattle, Washington (SOC.)
University of Washington, Seattle, Washington (UW.)
United States National Museum, Washington, D. C. (USNM.)
Academy of Natural Sciences, Philadelphia (ANSP.)
Museum of Comparative Zoölogy at Harvard College, Cambridge, Massachusetts (MCZH.)
Geological Survey of Canada, Ottawa, Canada (GSC.)
Tohoku University, Sendai, Japan (GIS.)
Kyushu University, Fukuoka, Japan (GK.)

In connection with the study of the Upper Cretaceous ammonites of California and adjacent areas, the original types or their plaster casts of ammonites from other areas have been studied. Their repositories are, in addition to the above listed institutions, as follows, with abbreviations in brackets:

Denver Laboratory, Stratigraphic and Paleontologic Branch, United States Geological Survey, Denver, Colorado (USGS. Denver)
University of Kansas, Lawrence, Kansas (KU.)
Museum of Paleontology, Michigan University, Ann Arbor, Michigan (MU.)
Bureau of Economic Geology, University of Texas, Austin, Texas (BEG.)
Department of Geology, University of Texas, Austin, Texas (TU.)
Southern Methodist University, Dallas, Texas (SMU.)
Texas Christian University, Fort Worth, Texas (TCU.)
Collection of Mr. J. P. CONLIN, Fort Worth, Texas (JPC.)

University of Alberta, Edmonton, Alberta, Canada (UA.)
British Museum (Natural History), London, England (BM.)
Collection of Mr. C. W. WRIGHT, London, England (CWW.)
Muséum National d'Histoire Naturelle, Paris, France (MNP.)
Ecole de Mines, Paris, France (EMP.)
Geologisches-Palaeontologisches Institut, Universität der Bonn, Germany (GPB.)
South Africa Museum, Cape Tcwn, Union of South Africa (SAM.)
University of Tokyo, Tokyo, Japan (GT.)
Hokkaido University, Sapporo, Japan (GH.)

The above symbols are used for the locality numbers which are registered at the respective institutions.

Some plastotypes and duplicate specimens were donated by the above institutions directly or through Stanford University to Kyushu University, which, in turn, sent some plaster casts of Japanese type ammonites to Stanford University and certain other museums.

Systematic Descriptions

Part A. Baculitids

Family Baculitidae MEEK, 1876

Among many species of the Ammonoidea which have been found in the Upper Cretaceous of California those of the family Baculitidae are relatively abundant, occurring at various levels of the thick series and in various lithofacies of the extensive outcropping area. Sometimes baculitids are found in large numbers even at one locality. The species belonging to this family, thus, seem to be important for interregional as well as local correlation. This is one of the reasons why I put family Baculitidae in the first part of the systematic descriptions.

Baculites LAMARCK, 1799 is an old established genus and taxonomy of the baculitids has been proceeded by a large number of authors, among whom MEEK (1876), NOWAK (1908), SPATH (1926, 1941), REESIDE (1927), COLLIGNON (1931), ELIAS (1933), COBBAN (1951, 1952, 1958), and WRIGHT (*in* MOORE [Editor], 1957) did great contributions. The last two paleontologists are doing very fine and reliable works in the Western Interior region of North America and in Europe. My study has been much encouraged and improved by the two authorities through personal information and instruction which they have kindly given to me.

In our present knowledge the family Baculitidae consist of the following six genera, with the type-species in brackets:

Lechites NOWAK, 1908 [*Baculites gaudini* PICTET and CAMPICHE, 1861]
Sciponoceras HYATT, 1894 [*Hamites baculoides* MANTELL, 1822]

Baculites LAMARCK, 1799 [*Baculites vertebralis* DEFRANCE, 1830]
Eubaculites SPATH, 1926 [*Baculites ootacodensis* STOLICZKA, 1866]
Pseudobaculites COBBAN, 1952 [*Pseudobaculites nodosus* COBBAN, 1952]
Euhomaloceras SPATH, 1926 [*Baculites incurvatus* DUJARDIN, 1837]

The Californian specimens which I have studied are referred to the first four genera. The last two genera seem to represent rather special members, and only a few species of them have been known from limited areas: two species of *Pseudobaculites* in the Western Interior of North America and one species of *Euhomaloceras* from Europe. *Baculites* includes a great number of species, which range in morphological characters to considerable diversities. Although subdivision of genus *Baculites* into several subgenera might not be impossible, most of the species are so intimately connected with one another, that I would not at present propose any new genera or subgenera. Also the relationship of the species among different geographical provinces must be carefully studied before any attempts of splitting genus *Baculites*. The same statement can be extended to *Eubaculites*, which actually does not show so great extent of variability and is not geologically so long-ranged as *Baculites*.

As in many other cases, all the available characters should be taken into consideration for natural and reasonable classification of the Baculitidae. Size, straightness, tapering, and cross section of the shell, mode of lirae, ribs, and tubercles, characters of an aperture, constrictions, and a keel, if present, patterns of sutures, and probably also length of the body chamber are all important. They vary, however, to a certain extent within a species. The observed variation will be described in the descriptions of species as far as possible. The character of the aperture and length of the body chamber are not always known, because of the imperfect preservation, but some of the Californian examples do show interesting features.

As regards morphological terms in the following descriptions I refer to those which are accustomed to be used by many authors and clearly defined in the recently published *"Treatise on Invertebrate Paleontology"* (ARKELL *et al in* MOORE [Editor], 1957), although Harry MUTREI (1956, 1957) sets forth a fundamental revision from an anatomical standpoint. The symbols for the sutural elements are those proposed by WEDEKIND (1916, p. 185-195) and elaborated by SPATH (1923, p. 10). The measurements of the shell are in millimeters.

Straightening of the shell can happen at different epochs in the evolutional history of the Ammonoidea. Thus, Triassic *Rhabdoceras*, Jurassic *Apsorroceras*, and Tithonian-Neocomian *Bochianites* have no direct connection with the Baculitidae, being homoeomorphous offshoots. The Baculitidae themselves are proved to be a monophyletic family. The evidence for this conclusion is at present more definite than was in the date of SPATH (1941, p. 659).

I have not dealt with sufficient material to examine the relationship between *Hamites* and *Lechites*. This has been already discussed by SPATH (1941) in connection with the Gault ammonoids. *Hamites* (?) *glaber* WHITEAVES (1884, p. 213, pl. 24, fig. 2, 2a, 2b) (*Kossmat*, 1895, p. 150, pl. 20, figs. 7a, b) may be the one which can be furnished from the Indo-Pacific region for this problem. SPATH (1941) also discussed at length the intimate connection between *Lechites* and *Sciponoceras* [=*Cyrtochilus* MEEK].

There is some evidence in California to prove the close relationships between *Sciponoceras* and *Baculites*, and between *Baculites* and *Eubaculites*.

In the Upper Cretaceous ammonoids *Ryugasella* WRIGHT and MATSUMOTO, 1953 has a nearly straight shell, but can well be distinguished from any members of the Baculitidae, being better referable to the family Diplomoceratidae. The Californian example of *Ryugasella* will be described in Part II. *Baculites teres* FORBES may be somewhat interrupted from other members of the Baculitidae. There are probable examples of this species in California. Although they have some peculiar features, I describe them temporarily under the generic name *Baculites* with a query.

Genus *Lechites* NOWAK, 1908

Type-species.—*Baculites gaudini* PICTET and CAMPICHE, 1861.

The genus was clearly defined and fully discussed by SPATH (1941, p. 660-662).

Lechites aff. *L. gaudini* (PICTET and CAMPICHE)

Pl. 30, fig. 4a-d

Compare.—

1861. *Baculites gaudini* PICTET and CAMPICHE, *Mat. Paléont. Suisse*, vol. 2, no. 2, p. 112, pl. 55, figs. 5-9, 11.
1941. *Lechites gaudini*, SPATH, *Palaeontogr. Soc.*, 1941, p. 662, pl. 72, figs. 4-7, 9, 10; text-fig. 242 a-g, with synonymy.
1941. *Lechites moreti*, SPATH (*non* BREISTROFFER) (*pro parte*), *Palaeontogr. Soc.*, 1941, p. 665, pl. 72, fig. 8, text-fig. 243 e-k.
1947. *Lechites gaudini* var. *raricostata* BREISTROFFER, *Trav. Lab. Géol. Grenoble*, vol. 26, p. 78.
1951. *Lechites gaudini* var. *raricostatus*, WRIGHT and WRIGHT, *Palaeontogr. Soc.*, 1950, p. 16.

Lectotype of Lechites gaudini (PICTET and CAMPICHE).—The original specimen of PICTET and CAMPICHE, 1861, pl. 55, fig. 5a-c, reproduced by SPATH, 1941, text-fig. 242a-c, designated by SPATH (1941, p. 663).

Material.—The Californian examples at my disposal are a fairly well preserved specimen, UC. Cat. No. 37600, from loc. SOC. K-101 (Coll. M. V. KIRK) (Pl. 30, fig. 4a-d) and three smaller pieces from loc. TM. 201 [=LSJU, 3312], one of which is GK. H7005 and two others are preserved in Stanford University (Coll. M. B. PAYNE and T. MATSUMOTO).

Measurements.—

Specimen	Height	Breadth	(B/H)	Distance	Number of ribs in the distance
UC. 37600	22.0	17.7	(0.80)	40.0	7
	19.3	14.6	(0.75)		
GK. H7005	5.4	4.8	(0.89)	30.0	20
	3.5	3.3	(0.94)		

Description.—The larger fragment (Pl. 30, fig. 4a-d), from loc. SOC. K--101, showing slow tapering, is distinctly higher than broad and nearly elliptical in cross section. It is ornamented with oblique ribs which are of moderate strength on the ventral part but are weakened on the dorsal part. The ribs are nearly as wide as the interspaces on the shell, but are somewhat broader than the latter on the internal mould. Each second or third rib is slightly stronger than others. The last three sutures are well exposed. They are fairly deeply incised and have also minor incisions. All the elements are longer than broad, and especially the stem of the lateral saddle is slender.

One of the smaller specimens, GK. H7005, from loc. TM. 201, showing again slight tapering, is slightly higher than broad and subcircular to elliptical in cross section. It is ornamented with oblique ribs, which are relatively strong, moderately broad, and crowded, being separated by interspaces narrower than the ribs themselves. In this young stage the suture is not deeply incised; the first lateral lobe (L) and the lateral saddle (between L and U) are at first as broad as deep (or high) and tend to be deeper (or higher) than broad later; the internal lobe (I) is nearly as large as the umbilical (or "second lateral") lobe (U).

Another small piece is a fragment similar to the above specimen. In the same nodule of loc. TM. 201, there is another fragment of medium size, in which the cross section is elliptical and the ribs are nearly as broad as or slightly broader than the interspaces. The suture of this specimen of the middle growth-stage is just intermediate between the above-mentioned larger and smaller ones.

Thus all the specimens certainly represent one and the same species.

Remarks.—The above described Californian specimens are probably referable to *Lechites gaudini* (PICTET and CAMPICHE), but are not quite identical with its lectotype and other typical examples. The difference is in ribbing. The number of ribs is the same as that of typical examples of *L. gaudini*, being about three in a distance equal to the height (i.e. the longer diameter in cross section) (cf. SPATH, 1941, p. 663), but the ribs in the Californian specimens are somewhat broader and, accordingly, separated by the narrower interspaces than in the typical examples of the species. However, the ribs are never so broad as in *Lechites moreti* BREISTROFFER (1936, p. 66) [=*Baculites gaudini* var. PICTET and CAMPICHE, 1861, p. 112, pl. 55, figs. 10a-d, 11]. The suture is also very different from that of *L. moreti.*

The specimens which have been called *Lechites gaudini* var. *raricostatus* BREISTROFFER (1947, p. 78) [=*Baculites gaudini* PICTET and CAMPICHE, 1861, *pro parte*, p. 112, pl. 55, fig. 8] [=*Lechites moreti*, SPATH, 1941, *pro parte*, p. 665, pl. 72, fig. 8, text-fig. 243 e-k] are very close to the Californian examples in the moderately broad ribs as well as other points, but their ribs are widely spaced, while the ribs of the Californian specimens are rather crowded.

Thus the Californian specimens could represent a new subspecies of *Lechites gaudini* PICTET and CAMPICHE, distributed in the northwestern Pacific region.

The available material, however, is not sufficient for establishing a new subspecies.

Occurrence.—Loc. SOC. K-101, in Huling Creek, about 200 yards upstream from the confluence with North Fork of Cottonwood Creek, Ono Quadrangle, Shasta County, northwest side of the Sacramento Valley; about 10 feet stratigraphically above the conglomerate of loc. SOC. K-102, where *Mortoniceras* (*Deiradoceras*) sp., *Beudanticeras haydeni* (GABB) and *Pachydesmoceras colusaense* (ANDERSON) were obtained. *Desmoceras* (*Pseudouhligella*) sp. (immature of *D.* (*P.*) *dawsoni* WHITEAVES or *D.* (*P.*) *poronaicum* YABE) is associated with *Lechites gaudini* of loc. K-101. Therefore this locality may represent either the Uppermost Albian or Lowest Cenomanian. Another locality, TM. 201 [=LSJU. 3312], Papanatas Canyon of Panoche Hills, Fresno County, west side of the San Joaquin Valley: a sandy calcareous concretion (or boulder?) in the upper part of the Papanatas conglomerate of the Panoche group. Here the species is associated with *Stomohamites* (?) sp. and *Bhimaites* (?) sp., and again its age is either the Upper Albian or Lower Cenomanian.

In Europe typical specimens of *L. gaudini* occur in the Upper Albian, but *L. gaudini* var. *raricostatus* BREISTROFFER is known not only in the Uppermost Albian but also in the Lower Cenomanian (SPATH, 1941, p. 666; WRIGHT and WRIGHT, 1951, p. 16). One of the specimens from the Lower Cenomanian of Madagascar (COLLIGNON, 1929, p. 70, pl. 7, fig. 12) is referable to the same variety (see BREISTROFFER, 1947, p. 78). In India the species was described as occurring in the Lower Ootatoor group (KOSSMAT, 1895, p. 154 [58]). The species has been reported from many other parts of the world, such as Algeria, Madagascar, Zululand, Australia, and Mexico, but in some cases the identification is doubtful. The specimens from the Lower Cenomanian of Japan, listed as *Lechites* cf. *gaudini* (SHIMIZU, 1935, p. 185; MATSUMOTO, 1942, p. 229), have to be reexamined too.

Genus *Sciponoceras* HYATT, 1894

Type-species.—*Hamites baculoides* MANTELL, 1822.

Synonym.—*Cyrtochilus* MEEK, 1876 (non JAKOWLEW, 1875).

Diagnosis.—Straight shell resembling *Lechites*, with prorsiradiate constrictions on the internal mould; section slightly to moderately compressed, subcircular to elliptical. Surface normally with prorsiradiate ribs which may be weakened and in the latest species slightly rursiradiate on the dorsal third. Aperture facing dorsally, with ventral rostrum and in some forms with lateral lappets. Suture similar to that of *Lechites*, with bifid lateral lobes and trifid, small, antisiphonal lobe, complex in some forms but simple in others.

Remarks.—Californian specimens of *Sciponoceras* at my disposal are not so numerous as those of *Baculites*. WRIGHT (personal communication) has notified me that the character of an aperture seems to be important for the specific distinction, but the specimens in satisfactory preservation for this purpose are very rare. I had to depend rather to outlines in cross section, inclination or curvature of constrictions, ribs, and lirae, and patterns of sutures, although they change with growth-stages and show individual variation. The identification is, therefore, rather provisional, waiting for better and more specimens. So far as these characters are concerned, the Californian specimens are referable to the already known species. The new species which ANDERSON (1958) has recently established under *Cyrtochilus* do not seem to stand on sound grounds.

Sciponoceras baculoide (MANTELL)

Pl. 31, fig. 1a–d; Text-fig. 2a, b

1822. *Hamites baculoides* MANTELL, *Fossils of the South Downs*, p. 123, pl. 23, figs. 6, 7.
1842. *Baculites baculoides*, D'ORBIGNY, *Paléontologie française. Terr. Crét.* vol. 1, Céph., p. 562, pl. 138, figs. 8-11.
?1865. *Baculites teres*, STOLICZKA (*non* FORBES), *Pal. Indica*, ser. 3, vol. 1, p. 197, pl. 90, fig. 13.
1872. *Baculites baculoides*, FRITSCH and SCHLOENBACH, *Ceph. böhmischen Kreide*, p. 49, pl. 13, figs. 27, 28, 31.
1876. *Baculites baculoides*, SCHLÜTER, *Palaeontographica*, vol. 24, p. 139. [19], pl. 39, figs. 14, 15; pl. 40, fig. 1.
1876. *Cyrtochilus baculoides*, MEEK, *Rept. U. S. Geol. & Geogr. Surv. Terr.* vol. 9, p. 392.
1894. *Sciponoceras baculoide*, HYATT, *Proc. Amer. Phil. Soc.*, vol. 32 (1893), p. 578.
1895. *Baculites* cf. *baculoides*, KOSSMAT, *Beitr. Pal. Geol. Oesterr.-Ung. Or.*, vol. 9, p. 154 [58].
1896. *Baculites baculoides* ?, CRICK, *Proc. Malac. Soc.*, vol. 2, p. 77, text-figs. A-E.
1907. *Baculites baculoides* PERVINQUIÈRE, *Carte géol. Tunisie*, p. 92, pl. 4, figs. 7a-b, 8a-c; text-fig. 22.
1908. *Baculites* (*Lechites*) *baculoides*, NOWAK, *Bull. Acad. Sci., Cracovie*, 1908, p. 350.
1910. *Baculites baculoides*, PERVINQUIÈRE, *Mém. Soc. Géol. France, Paléont.*, vol. 17, fasc. 2-3, Mém. no. 42, p. 21.
1929. *Baculites baculoides*, COLLIGNON, *Ann. Paléont.*, vol. 18, p. 45 [69], pl. 2 [7], fig. 11, 11a.
1941. *Cyrtochilus baculoides*, SPATH, *Palaeontogr. Soc.*, 1941, p. 661.
1951. *Sciponoceras baculoide*, WRIGHT and WRIGHT, *Palaeontogr. Soc.*, 1950, p. 16.
?1958. *Cyrtochilus major* ANDERSON, *Geol. Soc. Amer.*, *Memoir* 71, p. 189, pl. 38, fig. 6.

Types.—MANTELL (1822) dealt with a number of specimens from the Grey Chalky Marl (Lower Chalk) near Lewes, Sussex, England. The lectotype should be designated by someone who is well acquainted with the English material. Many authors, including HYATT, 1894, who proposed the genus *Sciponoceras*, referred to the better illustrated French specimen of D'ORBIGNY (1842, p. 562, pl. 138, figs. 8-11) as a typical example.

Material.—The Californian specimens before me are not numerous. Several fragmentary specimens in calcareous concretions in the shale at loc. CAS. 34405; several other smaller ones from loc. SOC. K-205 (Coll. M. V. KIRK); another fragment from loc. CAS. 33719; three fragments from loc. UC. A-6458 (no record of collectors).

Measurements.—

Specimen	Height	Breadth	(B/H)	Distance
One of CAS. 34405	{7.4 7.8	6.3 —	(0.85)}	33.0
Another ,,	10.0	8.7	(0.87)	
One from SOC. K-205	{6.1 5.0	5.9 4.7	(0.96) (0.94)}	43.0
Another ,,	5.1	4.7	(0.92)	
One from UC. A-6458	5.7	5.0	(0.88)	

Description.—The shell is small, showing very slow tapering. It is subcircular in cross section, being slightly higher than broad. The surface of the shell is nearly smooth, but with faint prorsiradiate ribs on the ventral half of the adult shell. The periodic constrictions are prorsiradiate and typically moderately frequent but sometimes less so. The apertural margin is preserved on one of the specimens from loc. CAS. 34405. Although the very apex is not preserved, the ventral rostrum is curved dorsally, while the dorsal rostrum is not well developed, and thus the aperture is facing dorsally. There is a collar along the margin, although it is not perfectly preserved on the specimen.

The suture is deeply incised. Lobes and saddles are reversed-trigonal in general outline, with narrow basal stems and expanding branches. Even on the immature whorl, with height of about 5 mm., this diagnostic feature of the suture is shown.

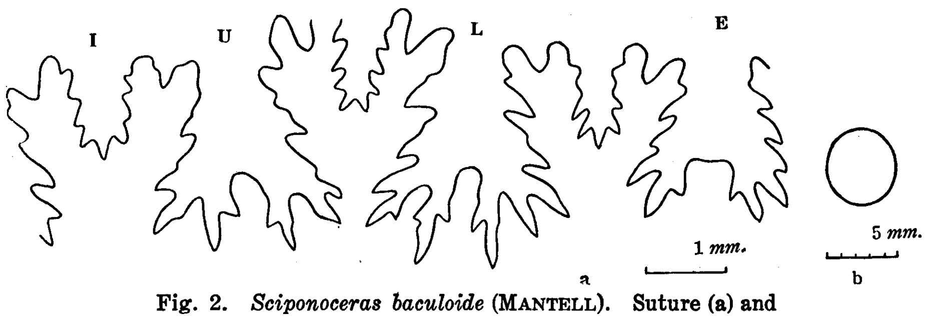


Fig. 2. *Sciponoceras baculoide* (MANTELL). Suture (a) and cross section (b) of an example, from loc. SOC. K-205, at height=5.1, breadth=4.7 mm.

Remarks.—From all the above characters the Californian specimens are referable to *Sciponoceras baculoide* (MANTELL). Although the lectotype has not been designated for this well known species, I follow the authors in Europe, such as D'ORBIGNY (1842), FRITSCH and SCHLOENBACH (1872), SCHLÜTER (1876), CRICK (1896), PERVINQUIÈRE (1907), and WRIGHT and WRIGHT (1951), for the definition of the species.

C. W. WRIGHT (written communication, Sept. 13, 1958) has given me an interesting observation that there are two types of apertures in the so-called *S. baculoide*. Since he has not yet reached the final conclusion, I would not refer his preliminary result, but should like to mention that the aperture of the specimen from loc. CAS. 34405, California, is rather similar to, if not exactly identical with, that described by CRICK (1876, p. 77, text-figs. A-E). The locality CAS. 34405 is recorded as "Hayes Gulch, 2 miles northwest of Gas Point". It should, therefore, be the type locality of "*Cyrtochilus major*" ANDERSON (1958, p. 189, pl. 38, fig. 6), although ANDERSON established the species on a single fragmentary body chamber, in which no aperture and no suture are preserved.

Occurrence.—Loc. SOC. K-205, Roaring River, Ono Quadrangle, northwest side of the Sacramento Valley. From the same locality came another species of ammonite, *Marshallites* n. sp., which occurs in the Cenomanian of Japan. Species from the adjacent localities (SOC. K-204 and SOC. K-206) suggest also the Cenomanian age of loc. SOC. K-205. Loc. CAS. 34405, "Hayes Gulch, 2 miles northwest of Gas Point", Ono Quadrangle, probably Cenomanian, but its stratigraphic position is not accurately known. Loc. UC. A-6458, "Siskiyou Mountains", without further records.

In Japan the species is known in the Cenomanian. In Europe it is widespread in the Cenomanian. Although WRIGHT and WRIGHT (1951, p. 16) recorded its occurrence in the *labiatus* zone (Lower Turonian), C. W. WRIGHT has given me a correction that the *labiatus* zone specimens are *Sciponoceras gracile* (SHUMARD). *S. baculoide* is also known in the "Vraconian" of Tunisia and Algeria (PERVINQUIÈRE, 1907, 1910) and in the Upper Cenomanian of Madagascar (COLLIGNON, 1929). A few specimens which are comparable with the present species were reported from the Lower Ootatoor group of southern India (KOSSMAT, 1895, p. 154 [58]).

Sciponoceras kossmati (NOWAK)

Pl. 31, figs. 2a, b, 3; Text-figs. 4a, b, 5a, b, 6a, b

1895. *Baculites* n. sp. aff. *bohemicum*, KOSSMAT (*non* FRITSCH) *Beitr. Geol. Pal. Oesterr.-Ung. Or.*, vol. 9, p. 154 [58], pl. 19 [5], fig. 18a-d.
1908. *Baculites kossmati* NOWAK, *Bull. Acad. Sci. Cracovie*, 1908, p. 348.
1958. *Cyrtochilus stylus* ANDERSON, *Geol. Soc. Amer., Memoir* 71, p. 188, pl. 11, fig. 5, 5a.

Holotype.—The specimen described and illustrated by KOSSMAT under the heading of *Baculites* n. sp. aff. *bohemicum* (KOSSMAT, 1895, p. 154 [58], pl. 19 [5], fig. 18 a-d). It came from the Lower Trichinopoly group of India (KOSSMAT, 1895, p. 155 [59]).

Material.—The holotype and other examples of *Cyrtochilus stylus* ANDERSON (1958, p. 188, pl. 11, fig. 5, 5a) from locs. CAS. 31097 and CAS. 31131. Three fragmentary specimens from loc. CAS. 33706 (Coll. A. S. HUCY) (Pl. 31, figs. 2, 3).

Measurements.—

Specimen	Height	Breadth	(B/H)	Distance
Holotype of *stylus*	9.0 5.4	7.5 4.8	(0.83) (0.88)	55.0
Smaller specimen from CAS. 33706	5.4 5.0	4.8 4.3	(0.88) (0.86)	20.0
Larger specimen from CAS. 33706	6.2 5.3	4.9 4.5	(0.79) (0.84)	26.0

Description.—The Californian examples listed above have slow tapering, subcircular to thick elliptical cross section, and nearly smooth external surface. Their constrictions are less frequent and less oblique than that of *S. baculoide*. They show sigmoidal curvature on the flank, although this feature may be variable. The suture is moderately incised; its element is reversed trapezoidal in general outline. The body whorl is not preserved and, accordingly, the aperture is unknown.

Remarks.—Since the original type is a single, imperfect specimen from India, this species is rather indefinite. Although I have not seen the holotype, from the description and illustration of KOSSMAT (1895) and also NOWAK's remarks (1908), the distinction of this species from other better known species may be written as follows.

S. kossmati (NOWAK) is allied to *S. baculoide* (MANTELL), but the former has nearly smooth shell and often gently sigmoidal constrictions, while the latter has oblique ribs and constrictions. The elements of the suture of the former are not so deeply incised and not so triangular in outline as those of the latter. In this respect *S. kossmati* (NOWAK) is close to *S. gracile* (SHUMARD) (Text-fig. 3a, b), but is distinguished by narrower and more deeply incised saddles, than that species. While the external saddle is much broader than the lateral saddle in *S. gracile*, the former is nearly as broad as and somewhat lower than the latter in *S. kossmati*. The general outline of the sutural elements is reversed trapezoidal in *S. kossmati*, but is rectangular in *S. gracile* and also in *S. bohemicum*. Thus in the character of the suture, *S. kossmati* (NOWAK) is intermediate between *S. baculoide* (MANTELL) and *S. gracile* (SHUMARD) or *S. bohemicum* (FRITSCH). Criterion might be found in the character of the aperture, which, however, has not yet been known in this species.

Occurrence.—Loc. CAS. 33706, Arroyo del Valle, 1 mile south of aquaduct, from a calcareous conglomerate. The stratigraphic position of this conglomerate

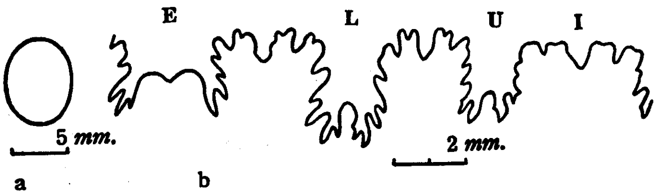
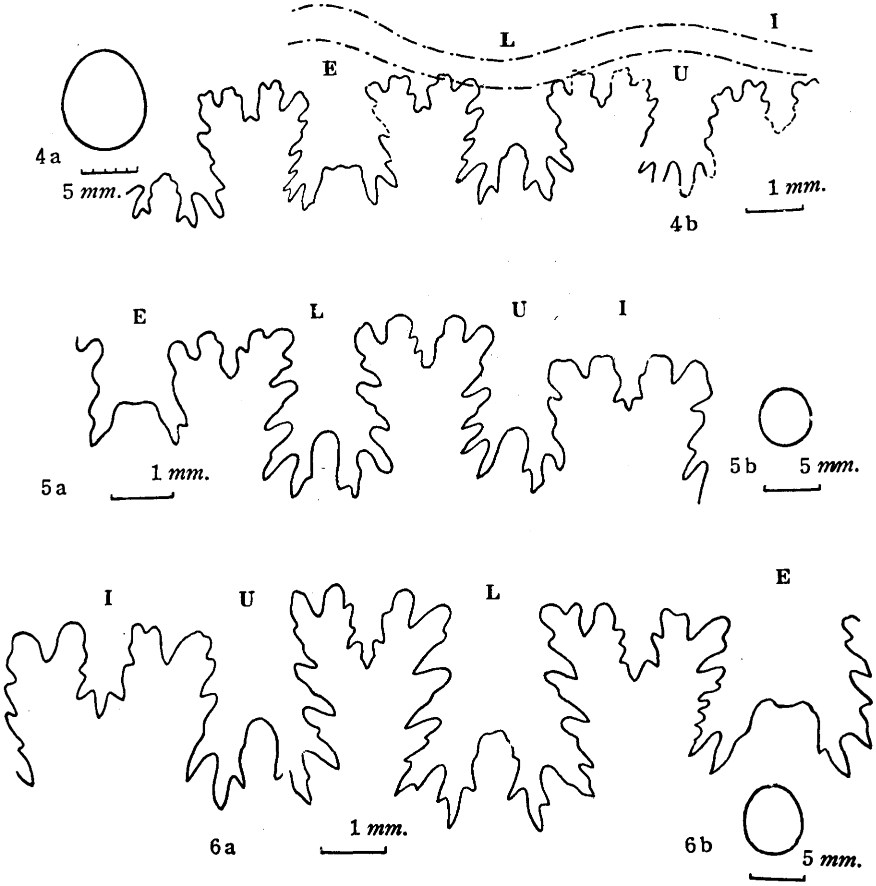


Fig. 3. *Sciponoceras gracile* (SHUMARD). Cross section (a) and suture (b), at height=7.6, breadth=5.6 mm., of an example, GK. H 9185, from loc. USGS. Mes. loc. 23062, Greenhorn limestone, north flank of Black Hills Uplift, Montana (W. A. COBBAN Coll.).



Figs. 4–6. *Sciponoceras kossmati* (NOWAK).

4. Cross section (a), with height=9.0, breadth=7.5 mm., and suture (b), at height=5.4, breadth=4.8 mm., of the holotype of *Cyrtochilus stylus* ANDERSON, from loc. CAS. 31097. Broken lines indicate the constriction.

5. Suture (a) and cross section (b) of an example, at height=5.1, breadth =4.5 mm., from loc. CAS. 33706, Arroyo del Valle.

6. Suture (a) and cross section (b) of another example, from loc. CAS. 33706, at height=6.2, breadth=4.9 mm. The same specimen is illustrated on Pl. 31, fig. 2a, b.

is uncertain, although it was presumed as the lower part of the Upper Cretaceous in this area (as understood from the writing on the label). Loc. CAS. 31097, the type locality of *Cyrtochilus stylus* ANDERSON, Dry Creek, Ono Quadrangle, northwest side of the Sacramento Valley; CAS. 33719, Garzas Creek, west side of the San Joaquin Valley, where Lower Turonian *Kanabiceras* cf. *K. septemseriatum* (CRAGIN) and *Inoceramus labiatus* SCHLOTHEIM are associated. Although further collection is needed, the existence of *S. kossmati* (NOWAK) in the Cretaceous of California is worth recording.

Sciponoceras aff. *S. bohemicum* (FRITSCH)
Pl. 30, figs. 2a-c, 3a, b; Pl. 31, fig. 4; Text-figs. 7a, b, 8-11

Compare.—

1872. *Baculites faujassi* LAMARCK var. *bohemica* FRITSCH *in* FRITSCH and SCHLOENBACH, *Ceph. der böhm. Kreideformat.*, p. 49, pl. 13, figs. 23-25, 29, 30.
1874. *Baculites baculoides*, GEINITZ (*non* MANTELL), *Palaeontographica*, vol. 20, p. 195, pl. 35, figs. 17-21.
1876. *Baculites* cf. *bohemicus*, SCHLÜTER, *Palaeontographica*, vol. 24, p. 140, pl. 39, figs. 1-5.
1895. *Baculites bohemicus*, JAHN, *Jahrb. K. K. geol. Reichsanst.*, vol. 45, p. 136, pl. 8, figs. 7, 8.
1896. *Baculites bohemicus*, WOODS, *Quart. Jour. Geol. Soc. London*, vol. 52, p. 76, pl. 2, figs. 9, 10.
1908. *Baculites* (*Lechites*) *bohemicus*, NOWAK, *Bull. Acad. Sci. Cracovie*, 1908, p. 348, 350.
1951. *Sciponoceras bohemicum*, WRIGHT and WRIGHT, *Palaeontogr. Soc.*, 1950, p. 16.

Types.—FRITSCH established the name *bohemica* on a number of syntypes. No subsequent authors have designated the lectotype. I have not seen the original specimens from Bohemia, but had an opportunity of studying the hypotypes of WOODS (1896) and WRIGHT and WRIGHT (1951) from the Chalk Rock of England.

Material.—The Californian specimens here described are as follows: UCLA. 28848 (Pl. 30, fig. 2a-c; Text-fig. 8), from loc. CIT. 1069; UCLA. 28849 (Text-fig. 7), from loc. CIT. 1069; UCLA. 28850-28852, from loc. CIT. 1062; UCLA. 28853 (Pl. 30, fig. 3a, b), from loc. CIT. 1070, representing a body whorl; UCLA. 28854 (Pl. 31, fig. 4; Text-fig. 9), from loc. CIT. 979; UCLA. 28855 (Text-fig. 11) and other fragments from loc. CIT. 79. All came from the upper sandy part of the Baker Canyon member, Santa Ana Mountains (Coll. W. P. POPENOE; W. P. POPENOE & G. H. ANDERSON; B. N. MORE).

Measurements.—

Specimen	Height	Breadth	(B/H)	Distance
UCLA. 28848	7.6 6.5	5.8 5.0	(0.76) (0.71)	25.0
UCLA. 28849	5.9	4.5	(0.76)	
UCLA. 28851	7.4	5.5	(0.74)	
UCLA. 28853	16.1 13.8	11.5 9.0	(0.71) (0.65)	75.0
UCLA. 28854	5.5	4.4	(0.80)	
UCLA. 28855	12.4	9.2	(0.74)	

Description.—The shell is relatively small; the largest example of the body chamber is 16.1 mm. in height, but other specimens are smaller than that. Tapering is very slow. The section is almost elliptical. The periodic constrictions are very weak on all the examined specimens, being hardly discernible on the dorsal part. The ribs are generally weak, although variable in strength by individuals. They are more distinct on the ventral area and adjacent part of the flank than on the dorsal area. Those along the constrictions are slightly stronger than others. The ribs and constrictions are prorsiradiate on the flank,

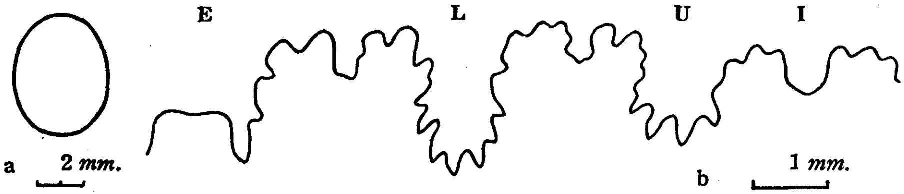
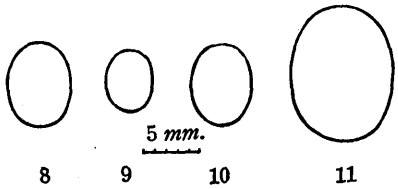


Fig. 7. *Sciponoceras* aff. *S. bohemicum* (FRITSCH). Cross section (a) and suture (b) of an example, UCLA. 28849, from loc. CIT. 1069, top of Baker Canyon member, Santa Ana Mountains.



Figs. 8–11. *Sciponoceras* aff. *S. bohemicum* (FRITSCH). Cross sections of the four specimens: UCLA. 28848 (fig. 8) (see Pl. 30, fig. 2a–c), from loc. CIT. 1069; UCLA. 28854 (fig. 9), from loc. CIT. 979; UCLA. 28851 (fig.10), from loc. CIT. 1062; UCLA. 28855 (fig. 11), from loc. CIT. 79, all at or near top of Baker Canyon member, Santa Ana Mountains.

moderately but not strongly projected on the venter, and broadly curved forward on the dorsum, showing a shallow sinus on the dorsolateral part. No specimens before me are complete enough to show the aperture.

The suture is simple, having small and shallow dentation in addition to bifurcation. The saddles are much broader than the lobes; that between E and L is the broadest.

Remarks.—In all the characters the Californian specimens here described are almost certainly assigned to *Sciponoceras bohemicum* (FRITSCH). Among several species of *Sciponoceras*, *S. bohemicum* (FRITSCH) of the Upper Turonian is the closest to the Coniacian species of *Baculites* in the elliptical, instead of subcircular, section, weakness of ribs, slight forward curve of the ribs on the dorsal area, and simple (or simplified) suture. The fact was briefly mentioned by WRIGHT (*in* MOORE [Editor], 1957, p. L 218), who personally gave me further detailed information of the British species of *Sciponoceras*.

In the form represented by the Californian specimens the weakness of the constrictions is constant and diagnostic, just as in the one represented by the Japanese Upper Turonian specimens. Whereas in the European specimens, as was noticed by FRITSCH (1872) and WOODS (1896), the constrictions are sometimes fairly well-marked, but sometimes indistinct. WRIGHT (a letter to me dated Jan. 14, 1958) observes that "the constrictions are beginning to weaken in *S. bohemicum*." It may be suggested that the Californian and Japanese specimens, in which the constrictions are always very weak, could be separated at least subspecifically from the typical European examples of *S. bohemicum* (FRITSCH). Until the European specimen, especially the types from the Bohemian Cretaceous, are carefully examined, I temporarily call the Californian (and Japanese) specimens *Sciponoceras* aff. *S. bohemicum* (FRITSCH).

It should be noted here that *Baculites fairbanksi* ANDERSON (1902, p. 92, pl. 10, fig. 194; *non* pl. 7, figs. 152, 153) could possibly be a synonym of the present species, because the recorded type locality strongly suggests the Baker Canyon sandstone and the illustrated suture is as simple as that of the present species. Unfortunately ANDERSON's original specimens were lost (presumably in the fire of 1906) and two other figures (pl. 7, figs. 152, 153) indicated under his same specific name do not show the elliptical section, weak ribbing and simple suture of *Sciponoceras bohemicum,* but rather suggest *Baculites anceps* LAMARCK, the latter of which could be expected to be found in the higher level (*Metaplacenticeras*-bearing beds) of the same Santa Ana Mountains. In these circumstances we have to disregard the specific name *fairbanksi,* until we can confirm that its topotypes could be distinguished from either of *Sciponoceras bohemicum* (FRITSCH) and *Baculites anceps* LAMARCK.

Occurrence.—The described specimens came from the localities CIT. 1069, CIT. 1062, CIT. 1070, CIT, 979, and CIT. 79, all of which belong to the upper or uppermost part of the Baker Canyon member of the Santa Ana Mountains. The species is frequently associated with *Subprionocyclus neptuni* (GEINITZ).

In Japan the examples of the same species occur in the Upper Turonian, ranging from the subzone of *Subprionocyclus neptuni* (GEINITZ) to that of *Reesidites minimus* (HAYASAKA and FUKADA).

In Europe *Sciponoceras bohemicum* (FRITSCH) has been described as occurring in the Upper Turonian, frequently associated with *Subprionocyclus neptuni* (GEINITZ).

Genus *Baculites* LAMARCK, 1799

Type-species.—*Baculites vertebralis* DEFRANCE, 1830 (designated by MEEK, 1876).

Diagnosis.—WRIGHT's description (*in* MOORE [Editor] 1957, p. L 218) is adequate, but for a point about sutures. There are fairly great diversities in complexity of sutures in both *Sciponoceras* and *Baculites.*

Remarks.—A gradual transition occurs from Upper Turonian *Sciponoceras* to Coniacian *Baculites.* The situation is well exemplified by the Japanese material, between *Sciponoceras* aff. *S. bohemicum* (FRITSCH) and *Baculites yokoyamai* TOKUNAGA and SHIMIZU. The details should be described in the monographic descriptions of the Japanese species. In California there are examples of *Sciponoceras* aff. *S. bohemicum* (FRITSCH), as described above. *Baculites yokoyamai* is very rare in California, being represented by a few, poorly preserved specimens, but there is a closely allied species, *B. schencki* n. sp. to be described below.

In addition to the above two there are in the Lower Senonian of California two other allied Indo-Pacific species, *B. boulei* COLLIGNON and *B. capensis* WOODS.

These Lower Senonian species have simple sutures, with massive saddles and shallow minor incisions. They are not much apart from *Sciponoceras bohemicum* in sutures, size, and cross section. These Indo-Pacific species can be well distinguished from the Lower Senonian species of the Western Interior, but the differentiations in the two regions do not seem to be significant. The latter group of species may also be proved to be direct or indirect descendants of the world wide *Sciponoceras bohemicum* of the Upper Turonian.

In the Upper Senonian (Campanian and Maestrichtian) of California there are more diversities. A general evolutional trend can be recognized from a relatively simple to a complex suture. *Baculites chicoensis* TRASK of the Lower (to Middle ?) Campanian has a suture which is more complex than that of *B. yokoyamai* or its allies of the Lower Senonian. Its complexity is, however, moderate and the suture of *B. occidentalis* MEEK of the Upper Campanian is still more advanced. *B. rex* ANDERSON of the Maestrichtian (*plus* ? Uppermost Campanian) has the most complex suture among the Californian baculitid species, with deeply incised elements and a narrowed lateral lobe. The suture of the last species is nearly as complex as that of *B. complex* SAY. In fact a similar, but not identical, evolutional change of sutures are generally recognized in the species of the Western Interior province, as COBBAN (1951, 1958, and also oral communication) indicates. But the courses in the two provinces differ in detail and are probably parallel.

Even in the Pacific province the actual lineages of the species do not seem to be simply straight. Sometimes several species with sutures of dissimilar patterns occur in almost the same stage, if not at the same locality. Such a comparison can be done among *B. inornatus* MEEK, *B. occidentalis* MEEK, and *B. anceps* LAMARCK. Again, species with simple or simplified (?) sutures, e.g. *B. columna* MORTON, occur in the beds of late age. The situation is still more complicated, when size, tapering, cross section, ribbing, and keel are added to be taken into consideration. Thus, for instance, the keel or keel like siphonal elevation appears more than once, as seen in *B. kirki* n. sp. (Santonian), *B. chicoensis* TRASK, and *B. occidentalis* MEEK. These three species of successive geological ages do not necessarily show continuous change in all the morphological characters. *Eubaculites* is proved to have been derived from one of them, *B. occidentalis* MEEK.

So far as the available records are concerned, some of the Senonian species of California, e. g. *B. schencki* n. sp. and *B. chicoensis* TRASK, seem to be endemic, while others, e. g. *B. inornatus* MEEK and *B.* aff. *B. anceps* LAMARCK, are specifically indistinguishable from, or closely allied to, the European or other extra Californian species. Thus the faunal relations among different geographical provinces seem to be complicated too.

There is much to be done for correct understanding of the natural history of *Baculites*. There may be two or more main branches within *Baculites*, but it is at present rather difficult to state clearly what species belong to which subgroup. Until the whole picture can be figured out, and especially until the position of *B. vertebralis* LAMARCK, the type species, in the whole group can be well settled, it is not advisable to subdivide subgenera within *Baculites* or to separate other new genera from *Baculites*. From the same reason I would not propose any new generic names for *Baculites columna* MORTON and *Baculites teres* FORBES, although they have peculiar features, as will be described below in detail.

Baculites schencki sp. nov.

Pl. 32, figs. 1a-c, 2a-c, 3a, b, 4a, b, 5a-c, 6a-c; Text-figs. 12a, b, 13a-c, 14a, b, 15-21, 22a, b, 23a-c, 24, 25

Material.—On examining a large number of specimens, I designated the types as follows:

Holotype, UCLA. 28830 (Pl. 32, fig. 2a-c; Text-fig. 12a, b), from loc. CIT. 1034, Member IV of the Redding area (Coll. W. P. POPENOE & D. SCHARF).

Paratypes, UCLA 28831 (Pl. 32, fig. 1a-c; Text-fig. 17) and UCLA. 28832 (Pl. 32, fig. 3a, b), from loc. CIT. 1244, Member VI (?) of the Redding area (Coll. W. P. POPENOE); USLA. 28828 (Pl. 32, fig. 4a, b; Text-fig. 13a-c), UCLA. 28829 (Pl. 32, fig. 5a-c; Text-fig. 14a, b), and UCLA. 28841 (Pl. 32, fig. 6a-c; Text-fig. 15) from the same locality as the holotype (Coll. W. P. POPENOE & SCHARF); UCLA. 28800 (Text-fig. 16) and UCLA. 28801, from loc. CIT. 1008, lower part of Member V of the Redding area (Coll. W. P. POPENOE & D. SCHARF); GK. H 7006 (Text-fig. 23a-c) and LSJU. 8576 (Text-fig. 24), from loc. LSJU. 3315 [=TM. 210], Lower Marlife formation of the Panoche group in Panoche Hills (Coll. M. B. PAYNE & T. MATSUMOTO); two better preserved specimens, UC. 35769 and UC. 35770, (Text-figs. 18, 19) among seven, from SOC. K-220, Member IV of the Redding area (Coll. M. V. KIRK, presented from SOC., Seattle, to UC., Berkeley); GK. H 7009 from TM. 1001 [=LSJU. 3310], basal member of the Chico formation in Chico Creek (Coll. S. CHUBER & T. MATSUMOTO); a specimen (UCLA.) from loc. CIT. 1014 and another (Text-fig. 20) from loc. UCLA. 3617, basal member of the Chico formation in Chico Creek (Coll. W. P. POPENOE & D. SCHARF; R. B. SAUL); a specimen from loc. UC. A-5179, Rumsey Hills (Coll. T. M. CROOK); LSJU. 8952 (Text-fig. 25) and LSJU. 8953 (Text-fig. 22a, b), from loc. LSJU. 2004, Funks shale of Rumsey Hills (Coll. J. M. KIRBY & T. M. CROOK); LSJU. 8954 and LSJU. 8955, from loc. LSJU. 2001, Funks shale of Rumsey Hills (Coll. J. M. KIRBY & T. M. CROOK); UC. 31506 (Text-fig. 21), from loc. UC. A-5179, Rumsey area (Coll. T. M. CROOK).

Associated with the above specimens there are many other less completely preserved ones which are comparable with the present species.

Measurements.—

Specimen	Height	Breadth	(B/H)	Distance
UCLA. 28830	7.5	5.5	(0.73)	33.0
	5.1	3.8	(0.74)	

UCLA. 28828	8.9	7.2	(0.80)	30.0
	6.2	5.1	(0.82)	
UCLA. 28829	10.9	7.9	(0.72)	
UCLA. 28841	10.0	7.8	(0.70)	30.0
	8.2	6.2	(0.75)	
UCLA. 28800	11.7	9.0	(0.76)	50.0
	8.8	6.6	(0.75)	
UCLA. 28831	11.0	7.8	(0.70)	28.0
	8.5	6.2	(0.72)	
UCLA. 28832	9.2	6.7	(0.72)	26.0
	7.3	5.4	(0.73)	
GK. H 7006	15.0	10.0	(0.67)	60.0
	11.5	8.0	(0.69)	
LSJU. 8576	15.5	12.0	(0.77)	
Loc. CIT. 1014	16.0	10.8	(0.67)	
Loc. UCLA. 3617	12.5	9.0	(0.72)	30.0
	10.3	7.4	(0.71)	
UC. 35769	8.4	6.5	(0.77)	35.0
	6.4	4.7	(0.73)	
UC. 35770	11.4	8.8	(0.77)	30.0
	9.0	6.7	(0.74)	
UC. 31506	11.5	—		25.0
	9.0	6.2(+)	(0.68)	
	7.5	5.1	(0.68)	
LSJU. 8953	9.8	7.3	(0.74)	
LSJU. 8952	14.4	10.5	(0.72)	

Diagnosis.—The shell is relatively small, showing rapid tapering. The section is higher than broad and oval (i.e. egg-shaped), being much more narrowly rounded on the siphonal area than on the antisiphonal area and gently inflated on the flank.

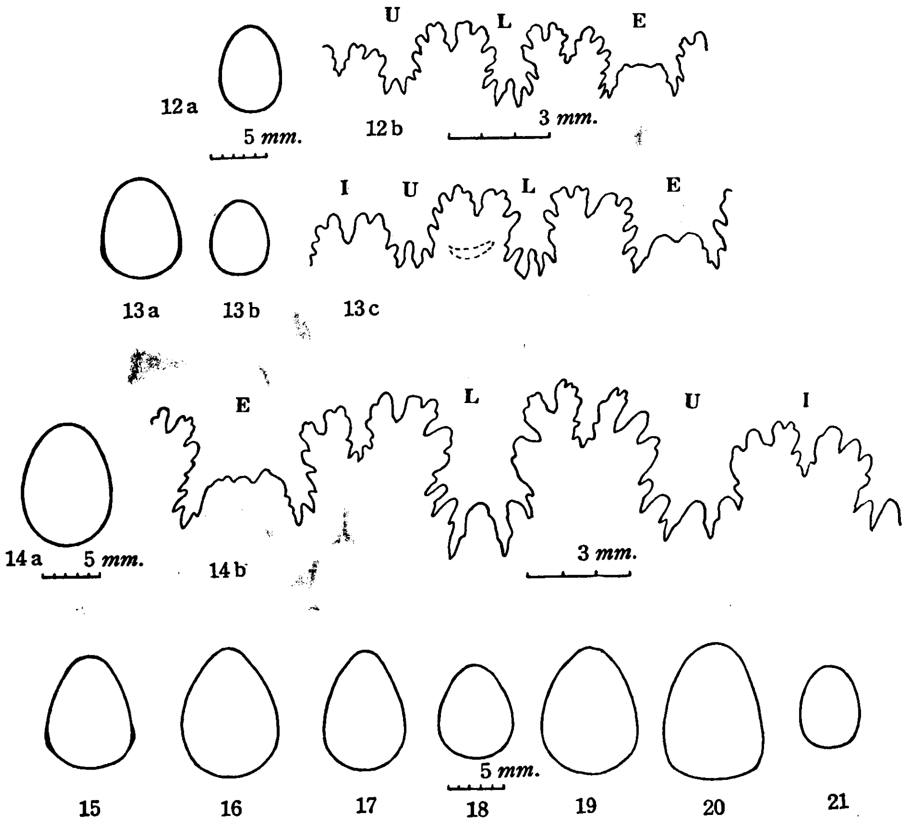
In the typical examples short crescentic nodes are feebly developed on the dorsolateral part. They are moderately spaced, but the distance sometimes varies. The nodes are sometimes fairly strong but occasionally almost obsolete. From the nodes weak riblets run obliquely forward towards the venter, where they show prominent projection; the forward curve of the riblets on the dorsal part is broad and less pronounced. There are also several riblets and lirae on the untuberculate interspaces. On the body chamber the nodes and riblets are so much weakened that the surface is nearly smooth or only laevigate.

The suture is simple. The saddles are broad, subquadrate and subequally bifid; the saddle between E and L is slightly broader than or nearly as broad as the one between E and U; the antisiphonal saddle is smaller and lower than the other two. E is very wide and moderately deep; L is narrow, deep, and nearly symmetric; U is slightly wider but shallower than L and asymmetric; I is extremely small and narrow. The minor dentations are small and rather shallow.

Variation.—A considerable number of specimens from one and the same formation exemplifies a wide extent of variation of this species. Tapering is generally rapid, but is somewhat slowed in the adult body chamber. The slowed tapering occurs in a few specimens (e.g. UCLA. 28832, Pl. 32, fig. 3a, b) even in the septate part.

The cross section is typically oval but sometimes modified. In some specimens the flanks and antisiphonal side are more flattened than in the normal ones, resulting in a subtrigonal whorl section, with the maximum breadth in the dorsal part. Other specimens tend to have an approximately elliptical cross section. Examples are shown in the Text-figures 12-25.

The ornament shows remarkable variation. In the typical form, as seen in the holotype and several of the paratypes, the dorsolateral nodes are weakly



Figs. 12–21. *Baculites schencki* n. sp.

12. Cross section (a) and the last suture (b), at height=7.5, breadth=5.5 mm., of the holotype, UCLA. 28830, from loc. CIT. 1034, Member IV of Redding area.

13. Cross sections (a, b), at height=8.9, breadth=7.2 mm. and height=6.2, breadth=5.1 mm., and the last third suture (c), at height=6.2, breadth=5.1 mm., of a paratype, UCLA. 28828, from loc. CIT. 1034. The dotted crescent indicates the dorsolateral tubercle.

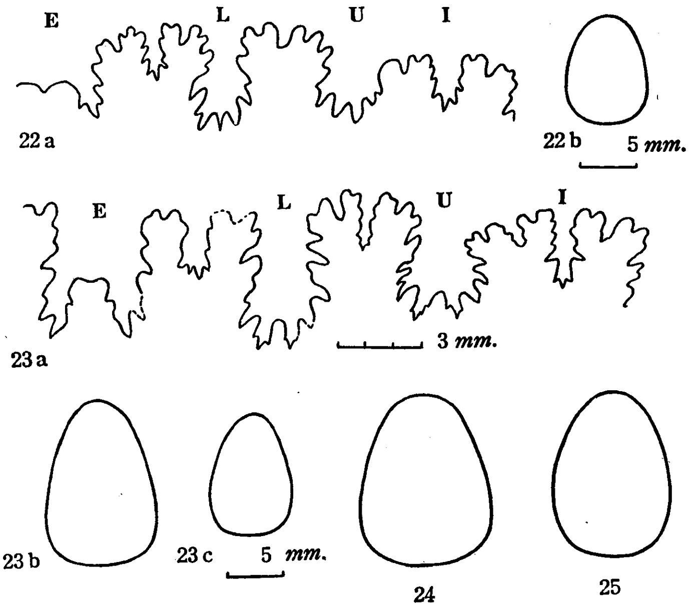
14. Cross section (a) and suture (b), at height=10.9, breadth=7.9 mm., of a paratype, UCLA. 28829, from loc. CIT. 1034.

15–21. Cross sections of various examples: ULCA. 28841 (fig. 15), from loc. CIT. 1034; UCLA. 28800 (fig. 16), from loc. CIT. 1008, lower part of Member V; UCLA. 28831 (fig. 17), from loc. CIT. 1244, Member VI (?); UCLA. 35769 (fig. 18), from loc. SOC. K-220; UCLA. 35770 (fig. 19), from loc. SOC. K-220, Member IV of the Redding area; an example (fig. 20), from loc. UCLA. 3617, basal member of the Chico formation, Chico Creek; UC. 31506 (fig. 21), from loc. UC. A-5179, Funks shale (?) of Rumsey Hills.

developed in the middle growth-stage, becoming still fainter on the late growth-stage. The early growth-stages, with heights below 5 mm., are nearly free from the nodes. Another paratype, UCLA. 28841, from the type locality, and several other examples have, however, moderately strong nodes, whereas still another set of specimens, e.g. UCLA. 28829, from the same type locality, and also several others, are only very faintly tuberculate or nearly smooth. There is gradation between the nearly smooth variant and the fairly strongly tuberculate ones. Some of the variants are illustrated on Plate 32.

The suture also shows variation in its minor details, such as the breadth and general outline of the saddles and the degree of slight asymmetry of the bifurcated saddles on both sides of L. As the shell grows, the relative height of the saddles and depth of the lobes increase. Again the Text-figures 12-14, 22, and 23 illustrate the facts.

Remarks.—This species is closely related to certain other Lower Senonian species of *Baculites* of the Indo-Pacific region. One is *Baculites yokoyamai* TOKUNAGA and SHIMIZU (1926, p. 195, pl. 22, fig. 5a, b, pl. 26, fig. 11), which is common in the Lower Senonian (especially Coniacian) of Japan, and another is *Baculites*



Figs. 22-25. *Baculites schencki* sp. nov.

22. Suture (a) and cross section (b), at height=9.8, breadth=7.3 mm., of a paratype, LSJU. 8953, from loc. LSJU. 2004, Funks shale of Rumsey Hills.

23. The last third suture (a), at height=13.5 mm., and cross sections (b, c), at height=15.0, breadth=10.0 and at height=11.5, breadth=8.0 mm., of a paratype, GK. H7006, representing a variety with a subtrigonal section, from loc. TM. 210 [=LSJU. 3315], Lower member of Marlife formation, Panoche group, Panoche Hills.

24. Cross section of another specimen, LSJU. 8576, from loc. LSJU. 3315.

25. Cross section of an example, LSJU. 8952, from loc. LSJU. 2004, Funks shale of Rumsey Hills.

besairiei COLLIGNON (1931, p. 37, pl. 5, figs. 6, 6a, 7, 7a, 8, 8a, 9; pl. 9, fig. 16), which occur abundantly in the Lower Senonian of Madagascar. These two are probably synonymous. They are distinguished from the present species by their very slow tapering, nearly elliptical cross section, and almost smooth to weakly semicostate surface, which has no tubercles at all. Among the species of *Baculites*, *B. yokoyamai-B. besairiei* is closest to the preceding species, *Sciponoceras* aff. *S. bohemicum* (FRITSCH). In the Japanese succession the former occurs just above the latter. In California the succession of species is not so perfectly recorded as in Japan. The uppermost part of the Baker Canyon member, in which *S.* aff. *S. bohemicum* occurs, is overlain by the poorly fossiliferous Holtz shale. No example of *B. yokoyamai* has been found in the latter member. Probable, but slightly doubtful, examples of *B. yokoyamai* in California are, in my observation, the one from loc. SOC. K-54, Member IV of the Redding area (Coll. KENNELL & ROBINS) and others from loc. UC. A-6621 of the Ortigalita Peak area (Text-fig. 26a, b). Their localities are too much isolated to inspect their relation to the specimens of *Sciponoceras* aff. *S. bohemicum,* while in the same Member IV of the Redding area and the approximately equivalent Lower Marlife formation of the Panoche group *Baculites schencki* occurs. Thus, *B. yokoyamai,* if existent, seems to be very rare in California. It should be noted, however, that the extreme variety of *B. schencki* approaches to *B. yokoyamai.* The example is a specimen, UC. 31506 (Text-fig. 21), from loc. UC. A-5179, in which tapering is relatively slow, the cross section tends to be relatively elliptical, and the dorsolateral nodes are very feebly developed on a limited portion of the whorl.

A variety of *B. schencki* with dorsolateral tubercles of moderate intensity, as represented by UCLA. 28828 (Pl. 32, fig. 4a, b; Text-fig. 13a-c) and UCLA. 28841 (Pl. 32, fig. 6a-c; Text-fig. 15), is allied to *Baculites boulei* COLLIGNON (to be described below) and *Baculites brevicosta* SCHLÜTER (1876, p. 141 [21], pl. 39, figs. 9, 10). The latter two have stronger dorsolateral tubercles and slower tapering than *B. schencki.* In *B. brevicosta* the nodes are crowded and the cross section is trigonal. A variety of *B. schencki* with subtrigonal section is fairly similar to *B. brevicosta.* Unfortunately the suture has not been illustrated for the typical examples of *B. brevicosta* from the upper part of the Emscher-Mergel of Germany. SCHLÜTER (1876, p. 141 [21] footnote, pl. 39, fig. 8) mentioned and illustrated an interesting specimen from the Emscher-Mergel, which has an oval cross section and smooth surface. This is close to a smoothish variety of *Baculites schencki,* as represented by LSJU. 8752 (Funks shale), LSJU. 3315, GK. H 7009, and others (basal member of the type Chico formation).

Occurrence.—Abundant at localities CIT. 1034 and SOC. K-220, Member IV of the Redding area; fairly common at loc. CIT. 1244, which is doubtfully referred by POPENOE to Member VI (?) of the Redding area, but possibly Member IV or V in my opinion; less common at loc. CIT. 1008, lower part of Member V of the same area. At the type locality (CIT. 1034) *Peroniceras shastense* ANDERSON and *Prionocycloceras californicum* (ANDERSON) are associated, indicating the Coniacian. Also found at localities LSJU. 3310 [=TM. 1001], CIT. 1014 and UCLA. 3617, basal member of the Chico formation in the type section of Chico Creek, east side of the Sacramento Valley; locs. LSJU. 2001, LSJU. 2004, and UC. A-5179, Funks shale of the Rumsey Hills, W. Sacramento Valley; LSJU. 3315 [=TM. 210], LSJU. 3316 [=TM. 31], and LSJU. 3136 [cf.], sandstone beds intercalated in the Lower Marlife shale of the Panoche group, Panoche Hills, west side of the San Joaquin Valley.

To sum up the species is common in the Lower Senonian, especially Coniacian, of California.

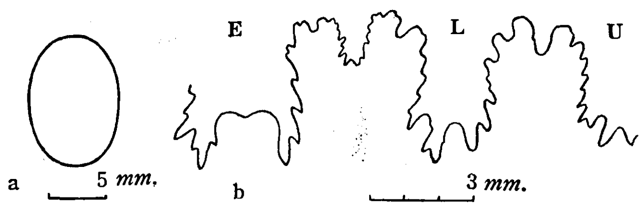


Fig. 26. *Baculites* aff. *B. yokoyamai* TOKUNAGA and SHIMIZU
Cross section (a), at height=11.5, breadth=8.1 mm., and suture (b) at height =8.5 mm., of an example, from loc. UC. A-6621, Ortigalita Peak Quadrangle.

Baculites boulei COLLIGNON

Pl. 32, fig. 7a-c; Pl. 33, figs. 4a-c, 5a, b, 6a-d, 7a, b;
Text-figs. 27a, b, 28-32

1907. *Baculites vagina*, BOULE, LEMOINE, & THEVENIN (*non* FORBES), *Ann. Pal.*, vol. 2, p. 65, pl. 15, fig. 3, 3a.

1931. *Baculites boulei* COLLIGNON, *Ann. Géol. Serv. Mines, Madagascar*, fasc. 1, p. 35, pl. 5, fig. 2, 2a; pl. 9, fig. 14.

Type.—COLLIGNON established this species on nine syntypes. The illustrated one among them (COLLIGNON, 1931, pl. 5, fig. 2, 2a; pl. 9, fig. 14) is designated here as the lectotype. The type locality is, according to COLLIGNON, Mahagaga, northern part of Madagascar.

Material.—The Californian examples which I refer to this species are as follows:

UCLA. 28833 (Pl. 33, fig. 4a-c; Text-fig. 28) and UCLA. 28834 (Pl. 32, fig. 7a-c; Text-fig. 27a, b), from loc. CIT. 1008, lower part of Member V (Coll. W. P. POPENOE & D. SCHARF). Many other specimens from the same locality are referable to the present species.

UCLA. 28836 (Pl. 33, fig. 6a-d; Text-fig. 30) and UCLA. 28835 (Pl. 33, fig. 7a, b; Text-fig. 31), from loc. CIT 1007, Member IV (Coll. W. P. POPENOE & D. SCHARF). Many other specimens from the same locality are also referable to the present species.

UCLA. 28802 (Text-fig. 29)—UCLA. 28804, from loc. CIT. 1006, lower part of Member V of the Redding area (Coll. W. P. POPENOE & D. SCHARF).

UCLA. 28857, from loc. CIT. 1005, lower part of Member V (Coll. W. P. POPENOE & D. SCHARF); many other fragmentary specimens.

LSJU. 8577 (Pl. 33, fig. 5a, b; Text-fig. 32) and LSJU. 8578, from loc. LSJU. 3350, Holtz shale member of the Santa Ana Mountains (Coll. NISBELL).

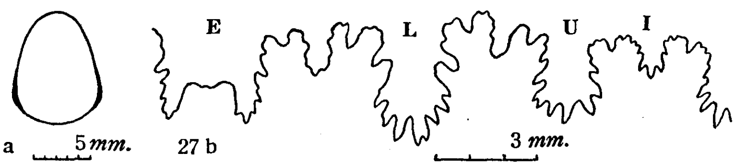
Other comparable specimens from loc. CIT. 1282 and CIT. 1285, Member V of the Redding area (Coll. L. NELSON & V. CHURCH; C. W. AHLROTH); loc. SOC. K-54, upper part of Member IV of the same area (Coll. KENNEL & ROBINS).

Measurements.—

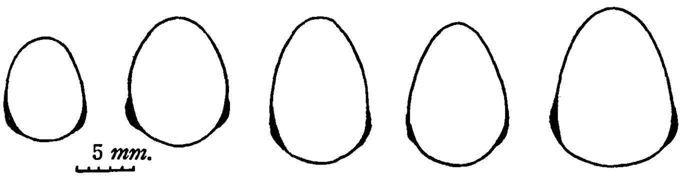
Specimen	Height	Breadth: Costal	Breadth: Interc.	(B/H)	Distance
UCLA. 28833	9.6	7.5 ;	7.0	(0.78 ; 0.73)	45.0
	7.3	5.5		(0.75)	
UCLA. 28834	10.2		7.5	(0.73)	30.0
	8.0		6.0	(0.75)	
UCLA. 28835	12.8		9.0	(0.70)	70.0
	8.6		6.3	(0.73)	
UCLA. 28836	16.0		11.2	(0.70)	45.0
	13.0		9.0	(0.69)	
UCLA. 28802	11.5		9.3	(0.80)	
UCLA. 28857	6.8		4.8	(0.70)	
LSJU. 8577	14.0	11.7 ;	11.0	(0.83 ; 0.78)	50.0
	11.0		8.6	(0.78)	

Diagnosis.—The shell is relatively small, with slow tapering. The section is higher than broad, and oval to subelliptical, with the siphonal more narrowly rounded than the antisiphonal area. The maximum breadth is somewhat on the antisiphonal side of the mid-flank.

On the dorsolateral part there are normally strong crescentic nodes or short



27 a 27 b



28 29 30 31 32

Figs. 27–32. *Baculites boulei* COLLIGNON

27. Cross section (a) and the last suture (b), at height = 10.2, breadth = 7.5 mm., of an example, UCLA. 28834, from loc. CIT. 1008, lower part of Member V, Redding area.

28–32. Cross sections of various examples: UCLA. 28833 (fig. 28), from loc. CIT. 1008; UCLA. 28802 (fig. 29), from loc. CIT. 1006, Member V, Redding area; UCLA. 28836 (fig. 30) and UCLA. 28835 (fig. 31), from loc. CIT. 1007, Member IV, Redding area; LSJU. 8577 (fig. 32), from loc. LSJU. 3350, Holtz shale, Santa Ana Mountains.

but thick, arcuate ribs, which fade at the middle of the flank into the weak riblets. There are also intercalatory riblets. These riblets are developed on the siphonal half of the shell, being oblique on the flank and projected strongly on the venter. They are often so weak that they are only discernible under oblique lighting. The antisiphonal extensions of the major ribs quickly fade out, showing less pronounced forward curve on the dorsum. The tubercles or major, short ribs are moderately spaced, but the distance is occasionally irregular. Also the intensity of the tubercles varies irregularly. The nodes themselves are usually crescentic, but sometimes fairly rounded. The shells in the early growth-stage below 7-5 mm. in height are devoid of nodes.

The suture is simple. The saddles are broad, subquadrate to subrectangular in general outline, and subequally bifid. E is wide; L is narrow and deep; U is shallower than L; I is very small. The minor dentations are small and shallow.

Remarks.—*Baculites boulei* COLLIGNON is closely related to *Baculites schencki* n. sp., described just above. Typical examples of the two species are well distinguished. The former shows slower tapering and has thicker, stronger, and more distant dorsolateral nodes than the latter. Although the cross section is essentially oval in both species, it tends more frequently to be subelliptical in *B. boulei* than in *B. schencki*, while in the latter it tends often to be subtrigonal. There is, however, variation in these characters, and, accordingly, there are a few intermediate specimens. No significant difference is recognized in the sutures of the two species. Although the stratigraphical ranges of the two species overlap within the Lower Senonian, as represented by Member IV and V of the Redding area, *B. schencki* occurs abundantly in the lower part and is rare in the upper, while *B. boulei* is relatively common in the upper part. Even if the two species occur in the same member, their localities are usually isolated, the fossils being rarely intermingled.

As COLLIGNON (1931) already pointed out, *B. boulei* is closely allied to *B. besairiei* COLLIGNON [≑ *B. yokoyamai* TOKUNAGA & SHIMIZU]. The criteria for distinction are the dorsolateral tubercles in the former and comparatively elliptical section in the latter. Again there is variation in these features. The dorsolateral nodes are occasionally very weak and relatively elliptical section is also found in *B. boulei*. In slow tapering and in the characters of the suture, the two species are quite similar.

Baculites schencki is intimately related to *B. yokoyamai* [≑ *B. besairiei*], as has been already remarked.

Under these circumstances, it might be suggested that all the "species" in discussion could be ranked as subspecies within one species. The subspecies might be differentiated geographically and also in slight different stratigraphical levels. To prove clearly this possibility, however, the material at my disposal is not satisfactory. For the time being I treat *B. boulei* COLLIGNON as an allied but distinct species from *B. schencki* n. sp. and from *B. yokoyamai* TOKUNAGA and SHIMIZU or from *B. besairiei* COLLIGNON.

Baculites brevicosta SCHLÜTER (1876, p. 141 [21], pl. 39, figs. 9, 10) has short, crescentic ribs on the dorsolateral part, but its section is subtrigonal, having a subacute venter and its short ribs are more crowded than in *B. boulei* COLLIGNON.

Baculites asperoanceps LASSWITZ (1904, p. 16, pl. 3 [15]. fig. 1a, 1b), from the Santonian (?) of Texas, likewise has crescentic ribs on the septate part, but its ribs are thicker, larger, and more numerous than in *B. boulei,* and on the adult body chamber become as strong and rounded as the tubercles of *B. asper* MORTON. Sutures were not illustrated for the original types of *B. asperoanceps* and *B. brevicosta,* and cannot at present be compared exactly with that of *B. boulei.*

The specimens from Zululand (South Africa) and Madagascar which were described under *Baculites* cf. *asperoanceps* LASSWITZ by SPATH (1921, p. 259, pl. 24, fig. 4, 4a) and by COLLIGNON (1931, p. 22, pl. 3, fig. 7, 7a) are probably better referable to *Baculites boulei* COLLIGNON, being, however, rather transitional between *B. boulei* and *B. capensis* WOODS (described below). In California too there are a few examples of such an intermediate form, as represented by UCLA. 28857, from loc. CIT. 1005.

Occurrence.—Localities CIT. 1008, CIT. 1006, CIT. 1005, CIT. 1282 and CIT. 1285, lower part of Member V of the Redding area; loc. CIT. 1007 and SOC. K-54, Member IV of the Redding area, northeast Sacramento Valley. Loc. LSJU. 3350, Holtz shale member of the Santa Ana Mountains.

The species is not rare in California, if not so abundant as *Baculites schencki.* In Madagascar it is represented by less numerous specimens than *Baculites besairiei* COLLIGNON (COLLIGNON, 1931), both occurring in the probable Lower Senonian.

Baculites capensis WOODS

Pl. 33, figs. 1a-d, 2a-c, 3a, b; Pl. 45, figs. 1a-d, 2a-d, 3a-d, 4a-d;
Text-figs. 33a, b, 34a, b.

1906. *Baculites capensis* WOODS, *Ann. South Afr. Mus.*, vol. 4, pt. 7, no. 12, p. 342, pl. 44, figs. 6a, b, 7a, b.
?1907. *Baculites vagina,* BOULE, LEMOINE, & THEVENIN (*non* FORBES), *Ann. Paléont.*, vol. 2, p. 65, pl. 15, fig. 3.
1921. *Baculites capensis,* SPATH, *Ann. South Afr. Mus.*, vol. 12, pt. 7, no. 16, p. 257, pl. 24, figs. 6, 7.
?1931. *Baculites* aff. *capensis,* COLLIGNON, *Ann. Géol. Serv. Mines, Madagascar,* fasc. 1, p. 22, pl. 3, fig. 6.
1936. *Baculites capensis,* VENZO, *Pal. Italica,* vol. 36, p. 116 [58].
1936. *Baculites capensis* var. *umsinensis* VENZO, *Pal. Italica,* vol. 36, p. 116 [58], pl. 10 [6], fig. 13a, b.
1958. *Baculites buttensis* ANDERSON, *Geol. Soc. Amer., Memoir* 71, p. 191, pl. 49, fig. 6, 6a, 6b.
1958. *Baculites* aff. *capensis* ANDERSON, *Geol. Soc. Amer., Memoir* 71, p. 192, pl. 48, fig. 8, 8a.

Types.—WOODS established this species on several syntypes. The one with septate part, if it exists, should be selected as the lectotype. As I have not seen the actual specimens of the syntypes, I hesitate to give here a designation. SPATH's (1921) hypotypes are considered reliable, since he had opportunities of comparing his specimens with WOODS'.

Material.—GK. H 7010 (Pl. 45, fig. 4a-d), GK. H 7011 (Text-fig. 33a, b), GK. H 7012 (Pl. 45, fig. 3a-d), GK. H 7013, GK. H 7014 (Pl. 45, fig. 2a-d), GK. H 7015 (Pl. 45, fig. 1a-d), and GK. H 7016-7019, from loc. TM. 14 [=LSJU. 3320] (Coll. T. MATSUMOTO); GK. H 7023-7026, from loc. TM. 11 [=LSJU. 3319] (Coll. H. G. SCHENCK, J. J. GRAHAM, M. B. PAYNE & T. MATSUMOTO); many other specimens from the same localities as above; GK. H 7020-7022, from loc. TM. 1007 [=LSJU. 3304] (Coll. S. CHUBER & T. MATSUMOTO), and many other fragmentary specimens from the same locality (Coll. S. CHUBER & T. MATSUMOTO); LSJU. 8565 (Pl. 33, fig. 1a-d), LSJU. 8564 (Pl. 33, fig. 2a-c; Text-fig. 34a, b) and several other fragmentary specimens, from loc. LSJU. 2880 (Coll. R. E. COOK); UCLA. 28838 (Pl. 33, fig. 3a, b), and other specimens from locs. UCLA. 3627, UCLA. 3630, and UCLA. 3633 (cf.) (Coll. L. E. & R. B. SAUL); a large number of specimens from locs. CIT. 1260 (Coll. W. P. POPENOE) and UCLA. 3784 (Coll. W. P. POPENOE and Victor CHURCH); specimens from loc. CAS. 31289 described by ANDERSON (1958, p. 192, pl. 48, fig. 8, 8a) as *Baculites* aff. *B. capensis* WOODS; holotype of *Baculites buttensis* ANDERSON (1958, p. 191, pl. 49, fig. 6, 6a, 6b) from loc. CAS. 27835 (Coll. J. A. TAFF, G. D. HANNA, & C. M. CROSS); ? several fragments comparable with the present species, from loc. UCLA. 3374 (Coll. W. P. POPENOE).

Measurements.—

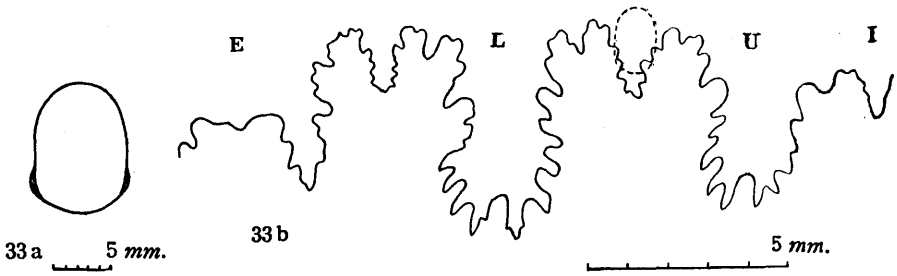
Specimen	Height	Breadth	(B/H)	Distance	Interval between tubercles ant. post.
GK. H 7010	15.1 14.4	11.0 10.3	(0.73) (0.71)	40.0	19.0/16.0/14.5/11.5
GK. H 7012	12.8 10.5	9.2 8.2	(0.71) (0.78)	30.0	10.7/12.5/10.5
GK. H 7013	9.7 8.7	7.7 6.7	(0.79) (0.77)	20.0	10.0/7.5/9.5
GK. H 7014	9.4 9.0	7.2 6.8	(0.76) (0.75)	25.0	10.0/9.8/7.5
GK. H 7015	8.4 7.8	6.2 5.4	(0.74) (0.70)	25.0	11.5
GK. H 7016	6.5	5.0	(0.77)		6.9/4.3/5.0
GK. H 7018	7.2 6.7	5.6 4.8	(0.78) (0.71)	20.0	7.8/6.7
GK. H 7020	10.5 9.4	8.0 6.7	(0.76) (0.71)	25.0	11.0/11.4
GK. H 7023	8.1 7.5	6.0 5.4	(0.74) (0.72)	20.0	10.5/10.0/8.5
GK. H 7026	7.0 6.0	5.3 4.5	(0.75) (0.75)	15.0	6.5/5.8/5.5
LSJU. 3565	10.0 8.5	7.4 6.0	(0.74) (0.70)	25.0	10.5/11.5/8.5
LSJU. 3564	9.5 7.0	7.0 5.3	(0.72) (0.75)	40.0	11.2/9.5/10.2/11.5
LSJU. 3566	7.0 5.1	5.5 3.8	(0.77) (0.74)	35.0	6.7/3.7/4.8/3.8/5.3/5.8/no tub.

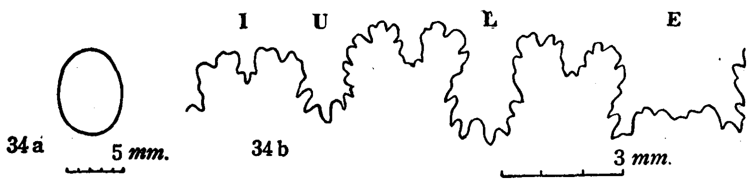
One from loc. UCLA. 3627	9.3 7.0	7.0 5.3	(0.75) (0.75)	50.0	8.0/14.5/12.2/13.9/7.8
Another from UCLA. 3627	9.0 6.0	7.5 —	(0.83) —	40.0	9.5/8.0/7.5/8.0
Another from UCLA. 3627	9.3 8.3	6.5 5.8	(0.69) (0.69)	22.0	13.4/10.0
One from loc. UCLA. 3784	19.5 17.0	— 13.5	— (0.79)	50.0	14+/17.0/20.0
One from loc. CIT. 1260	16.5 14.8	11.8 10.5	(0.71) (0.71)	40.0	12.7/11.9

Diagnosis.—The shell shows extremely slow tapering, having nearly parallel sided outline in lateral, siphonal and antisiphonal views. It is much higher than broad, elliptical in cross section, with only slightly convex, or flattened, nearly parallel, flanks, moderately rounded venter, and broadly rounded dorsum. In some cases even a shallow depression is discernible along the median line of the flank.

There is a row of tubercles along the dorsolateral shoulder. They are much apart from one another and typically, but not always, elongated in parallel to the elongated axis of the shell.

The suture is simple, with a number of relatively shallow incisions, which give rise to minute, roundish branches of saddles. The external and lateral saddles are almost equally broad, bifid, and subrectangular in general outline. The two lateral lobes are much narrower than the lateral saddle between them. The external lobe (E) is broad; the antisiphonal lobe (I) is very small; the first lateral lobe (L) is the deepest of all.





Figs. 33, 34. *Baculites capensis* Woods.

33. Cross section (a) and the last suture (b) of an example, GK. H7011, from loc. TM. 14 [=LSJU. 3320], lower part of the Upper Marlife shale of Panoche Hills.

34. Cross section (a) and suture (b), at height=7.8, breadth=5.5 mm., of an example, LSJU. 8564, from loc. LSJU. 2880, upper part of the lower half of the Chico formation in Chico Creek.

Variation.—The species varies little in shell-form; thus the very slow tapering, elliptical cross section, with flattened sides, and the proportion of breadth and whorl, mostly ranging from 7/10 to 8/10, are characteristic of the species. The shallow depression on the mid-flank, which was regarded as a specific character by WOODS, are not always discernible, but may be a character which never occurs in many other species of *Baculites*. Anyhow, a number of Californian examples do show this character as WOODS' South African types do.

Another point of which WOODS stressed the importance is the elongation of the tubercles in parallel to the axis of the shell. Examining a great number of specimens from one and the same bed in California, I have noticed that this character is again inconstant. Even on the same individual some tubercles are elongated in parallel to the axis of the shell but others are not. In some specimens that kind of tubercle occurs more frequently than others. In an extreme example (e.g. GK. H 7012, Pl. 45, fig. 3a-d) the rounded, strong nodes like those of *Baculites asper* MORTON (1834, p. 43, pl. 1, figs. 12, 13; pl. 13, fig. 2) are developed, but that specimen cannot be specifically separable from other coexisting unmistakable examples of *B. capensis* WOODS.

Very faint riblets are sometimes discernible, extending from the tubercles or isolated on the ventral part. They never become as distinct as those of *Baculites asperiformis* MEEK (1876, p. 405, pl. 39, fig. 10a, d).

The young shell has no tubercles. The tubercle first appears where the height (i.e. the longer diameter of the section) is about 6 mm. in Californian examples before me, but about 8 mm. in South African examples (SPATH, 1921, p. 257).

The distance between the tubercles is variable, as the figures in the measurements clearly indicate. In many cases it is as long as, or somewhat longer than the height of the cross section, but there are many exceptions. It does not always increase regularly with growth, although in average it does so.

The simple suture as described above is characteristic of the species, but varies to some extent. For instance, the external saddle is sometimes slightly broader than the lateral one, but in some other cases as broad as, or even slightly narrower than the latter. The difference, however, is little. The rough outline of the elements is usually subrectangular, but on some specimens slightly trapezoidal or inverse trapezoidal.

Remarks.—*Baculites capensis* WOODS has close affinity with *Baculites yokoyamai* TOKUNAGA and SHIMIZU (1926, p. 195, pl. 22, fig. 5a, b; pl. 26, fig. 11) or *Baculites besairiei* COLLIGNON (1931, p. 37, pl. 5, figs. 6, 6a, 7, 7a, 8, 8a, 9; pl. 9, fig. 16) in its very slow tapering, elliptical cross section, and type of suture. Still closer is *B. boulei* COLLIGNON (1931, p. 35, pl. 5, fig. 2, 2a; pl. 9, fig. 14) (p. 118 of this paper), which has distant, arcuate tubercles. This is possibly an intermediate form between typical *B. yokoyamai*-*B. besairiei* and *B. capensis*. To trace the actual lineage, careful zonal collection (in some suitable place in South Africa) is necessary. In California there are very few examples of *B. yokoyamai* or *B. besairiei*, but its ally *B. schencki* n. sp. occurs abundantly. This species differs from *B. besairiei* and *B. capensis* in its fairly distinct tapering and nonelliptical cross section, although it has a tendency to acquire dorsolateral tubercles, and includes an extremely rare variant of subelliptical cross section. *B. boulei* occurs also in California (see the preceding description). Here the three species, *B. schencki, B. boulei,* and *B. capensis* are nearly contemporary, but their stratigraphic positions of the maximum abundance are arranged in ascending order.

Similarity between *B. capensis* WOODS and the nearly contemporary *B. asper* MORTON is probably a parallelism between the entirely separated biogeographic provinces. The former has much more compressed whorl, thinner tubercles, and narrower saddles of sutures than the latter (see REESIDE, 1927a, p. 4, pl. 1, figs. 19-24; pl. 2, figs. 1-5; REESIDE, 1927b, p. 13, pl. 10, figs. 9-12; pl. 11, figs. 5-13; ? figs. 14-16).

A few body chambers of *B. capensis* WOODS from California are slightly arcuate. This may not be accidental, because the siphonal side is always convex. The feature, together with the distant dorsolateral tubercles, recalls to us *Euhomaloceras incurvatus* (DUJARDIN) (1837, p. 232, pl. 17, fig. 17; D'ORBIGNY, 1842, p. 564, pl. 139, figs. 8-10; SCHLÜTER, 1876, p. 142, pl. 39, figs. 6, 7; pl. 40, fig. 3; SPATH, 1926, p. 80). The suture of that species has broader lobes and more numerous minor incisions than that of *B. capensis,* but the difference is not so great as SPATH (1921, p. 258) considered. The resemblance between the two species, as already pointed out by WOODS (1906, p. 342), may not be superficial. To clarify the true relationship, we need better material of intermediate forms.

Occurrence.—Locs. TM. 14 [=LSJU. 3320] and TM. 11 [=LSJU. 3319], lower part of the Upper Marlife formation of Panoche group, Panoche Hills, west side of the San Joaquin Valley; locs. TM. 1007 [=LSJU. 3304], LSJU. 2880, CAS. 27835, UCLA. 3627, UCLA. 3630, and UCLA. 3666 (cf.), upper part of the lower half of the Chico formation in the type area, Chico Creek, east side of the Sacramento Valley (*Inoceramus naumanni* YOKOYAMA occurs in this unit). Locs. UCLA. 3374 and CIT. 1260, Redding area, which are referred to member IV of Popenoe. From another locality, UCLA. 3373, not far from UCLA. 3374, came a fragment of ammonite referable to *Texanites kawasaki* (KAWADA); also loc. UCLA. 3784, Member V (?) (possibly Member IV) of the Redding area. Loc. CAS. 31289, northwest of Rumsey, southwest side of the Sacramento Valley. Close to this locality, from loc. CAS. 31209, *Peroniceras* sp. is known.

WOODS' originals came from the 20 feet thick beds exposed in Pondoland, South Africa, in which *Texanites soutoni* (BAILY) and *T. stangeri* (BAILY) occur. Therefore they are most probably Santonian. SPATH's examples from Umtamvuna River, Natal and Umkwelane Hill, Zululand, South Africa were referred by him to the Upper Senonian, but his age assignment is doubtful, because *Texanites stangeri* (BAILY) was reported from the first area and *Pseudoschloenbachia umbulazi* (BAILY), *etc.* from the second. The association suggests rather Santonian and Lowest Campanian. BOULE, LEMOINE, and THEVENIN'S comparable specimen from Madagascar may be late Coniacian, because "*Barroisiceras nicklesi* GROSSOUVRE" was described by them (1907, p. 45, pl. 11, fig. 2, 2a) from the same bed.

In Japan the species is rare, but a few examples were obtained from the probable Santonian of Hokkaido.

Baculites lomaensis ANDERSON

Pl. 34, figs. 1a-c, 2a-c; Text-figs. 35-38, 39-41.

?1941. *Baculites* sp., STEPHENSON, *Univ. Texas Pub.*, no. 4101, p. 407, pl. 76, figs. 7, 8.

1958. *Baculites lomaensis* ANDERSON, *Geol. Soc. Amer., Memoir* 71, p. 191, pl. 48, figs. 5, 5a, 6.

Holotype.—CAS. type coll. (ANDERSON, 1958, pl. 48, fig. 5) (Text-fig. 39 of this paper) from loc. CAS. 2361, Joaquin Rock Quadrangle, west side of the San Joaquin Valley, as originally designated.

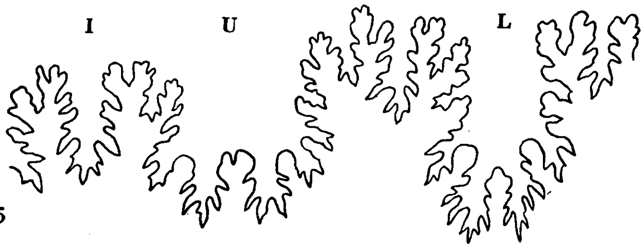
Material.—In addition to the holotype and paratypes of ANDERSON, the following is a list of examples of this species which I have examined:

LSJU. 8614 (Pl. 34, figs. 1a-c, 2a-c; Text-fig. 41), LSJU. 8615, LSJU. 8616 (Text-fig. 38), LSJU. 8617, LSJU. 8618 (Text-fig. 40), LSJU. 8619-8623, and a large number of specimens, from loc. LSJU. 1631 (Coll. S. W. MULLER & REINHARDT); LSJU. 8624 (Text-fig. 35), LSJU. 8625 (Text-fig. 36), LSJU. 8626 (Text-fig. 37), and a number of specimens, from loc. LSJU. 1629 (Coll. S. W. MULLER & REINHARDT); a large number of specimens from locs. CAS. 31593 [=CAS. 2361, the type locality] (Coll. C. C. CHURCH), CAS. 28304 (Coll. J. A. TAFF & C. M. CROSS), and CAS. 463 (Coll. F. M. ANDERSON). A probably referable specimens from loc. CAS. 1173 (Coll. L. G. HERTLEIN).

Measurements.—

Specimen	Height	Breadth (costal)	(B/H)	Breadth (intercostal)	(B′/H)	Distance
Holotype	13.0	9.3	(0.71)	8.5	(0.65)	
Paratype 1	10.2 8.8	7.9 —	(0.77)	6.5 —	(0.64)	27.5
Paratype 2	8.5 5.0	6.3 4.0	(0.74) (0.80)	5.5 —	(0.65) —	60.0
LSJU. 8614	10.5 7.6	7.8 5.4	(0.74) (0.71)	7.1	(0.67)	30.0
LSJU. 8615	8.8	6.9	(0.78)	6.1	(0.69)	
LSJU. 8618	11.5	9.0	(0.78)	7.7	(0.67)	
LSJU. 8619	10.5	7.8	(0.74)	7.2	(0.68)	
LSJU. 8625	9.5	7.4	(0.78)	6.6		
LSJU. 8626	7.0 4.4			5.1 3.7	(0.72) (0.84)	25.0

Diagnosis.—The shell is small, being about 15 mm. in height (i.e. longer diameter) in the probable adult stage. Tapering is rapid in the earlier growth-stages, gradually becoming slow in the later. The section is trigonal, higher than broad, broadest in the dorsal (i.e. antisiphonal) part, flattened on the dorsal area, subangular at the dorsolateral shoulder, slightly convex on the



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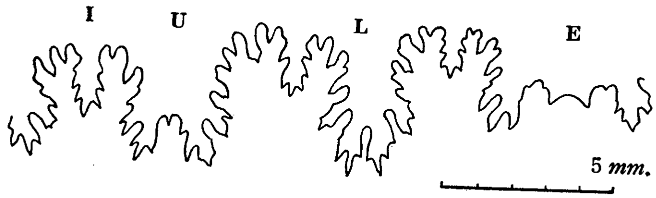

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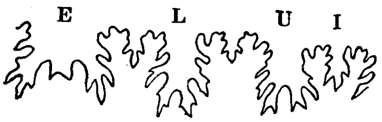

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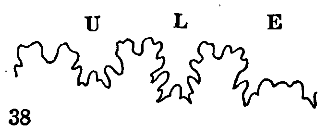

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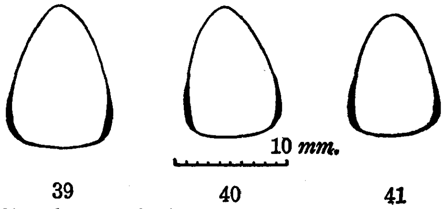
Figs. 35–38. *Baculites lomaensis* ANDERSON. Sutures at different growth-stages.
35. Suture, at height=13.0 mm., of a probably adult shell, LSJU. 8624, from loc. LSJU. 1629, Coalinga area.
36. Suture, at height=9.5, breadth (costal)=7.4 mm., of a shell of probably middle growth-stage, LSJU. 8625, from loc. LSJU. 1629.
37. Suture, at height=5.5, breadth=4.5 mm., of a young shell, LSJU. 8626 from loc. LSJU. 1629.
38. Suture, at height=4.2mm., of a young shell, LSJU. 8616, from loc. LSJU. 1631, Coalinga area.

flanks, which are remarkably convergent, and very narrowly arched or almost fastigate on the siphonal area. In early growth-stages, with heights of 3-7 mm., the shell is relatively broad, inflated on the sides, rounded on the antisiphonal area, and subtrigonal in section.

The young shell is smooth up to a height of about 5 mm.; then widely spaced, weak nodes are developed on the flank near the dorsolateral shoulder; finally in the later growth-stages these nodes become strong and crescentic, extending to arcuate, short ribs on the flank and also sometimes to faint ribs on the dorsal area. The arcuate ribs fade out on the siphonal area, where very weak, numerous riblets or striae are sometimes discernible, forming sharp chevrons. On the dorsal area the weak ribs and growth-lines show very broad convexity and occasionally obtuse chevrons.

The suture is moderately incised; the saddles are broad and subrectangular in general outline. The saddle between L and U is somewhat broader than the one between L and E, except in the very young stage. The stem of L is much narrower than those of the adjacent saddles. At the bottom of L the secondary



Figs. 39-41. *Baculites lomaensis* ANDERSON.

39. Cross section of the holotype, a body chamber, from loc. CAS. 2361, Coalinga area.

40. Cross section of an example, LSJU. 8618, from loc. LSJU. 1631, Coalinga area.

41. Cross section of another example, LSJU. 8614, from loc. LSJU. 1631.

branches are moderately deep; the top of the median minor saddle is distinctly lower than the tops of the adjacent, lateral, minor saddles. These three minor saddles are nearly of equal size and end at the phylloid terminals. U is broader and much more asymmetric than L. The antisiphonal saddle is lower and smaller than other saddles. I is narrow, but becomes fairly deep in the later growth-stage. In the latest growth-stage minute incisions are added to all the secondary divisions of the elements, resulting in a fairly ornate suture.

Variation.—Rapid tapering changes to slower tapering at different growth-stages in different individuals. In many specimens the trigonal section is slightly inequilateral, the one side being more flattened than the other.

The strength and spacing of the crescentic nodes are fairly regular, but occasionally much weaker ones occur at shorter intervals. The weak riblets and striae on the siphonal area are variable; thus the siphonal area is sometimes nearly smooth and sometimes weakly corrugated.

The asymmetry of the external and lateral saddles in this species is not so constant as SPATH (1921, p. 260) mentioned in connection with *B. brevicosta* SCHLÜTER and its allies. In some specimens the siphonal portion of the external saddle is smaller than the internal branch, but in others they are almost of equal size, or the former is slightly smaller than the latter. The subrectangular, general outline of the saddles is sometimes modified to inverse trapezoidal, owing to the deep cut by the branches of the lobes.

Remarks.—*Baculites lomaensis* ANDERSON is closely allied to *Baculites brevicosta* SCHLÜTER (1876, p. 141 [21], pl. 39, figs. 9, 10) in the trigonal cross section, crescentic nodes (or short ribs) on the flank near the dorsolateral shoulder, subacute siphonal area, which is sometimes weakly corrugated. The distinction between the two species is that the former has more widely spaced nodes, more flattened antisiphonal area, and probably more advanced type of suture than the latter.

SCHLÜTER established *B. brevicosta* for the specimens from "Oberen Emscher-Mergel" of Westfalia (Germany), which is probably Lower Santonian. Unfortunatly no illustration has been shown for the sutures of SCHLÜTER's types. In the Indo-Pacific area, several specimens have been referred or compared to this European species. As regards the representative from Zululand, SPATH (1921, p. 260, pl. 24, fig. 5, 5a) described (but not illustrated) the suture as relatively simple and similar to that of *B. capensis* WOODS. The age of this Pondoland example is probably Santonian, as judged from the associated species. COLLIGNON (1931, p. 34, pl. 5, fig. 1, 1a; pl. 9, fig. 13) described a few examples from the Senonian of Mahagaga, Madagascar. His illustrated suture is very similar to that of *B. besairiei* COLLIGNON of the same area. That type of suture is characteristic to the Coniacian-Santonian species of California, as described above (see *B. schencki* n. sp., *B. capensis* WOODS, and *B. boulei* COLLIGNON).

B. lomaensis ANDERSON follows essentially the same pattern of suture as *B. yokoyamai* TOKUNAGA and SHIMIZU, *B. besairiei* COLLIGNON, *B. schencki* n. sp., *B. capensis* WOODS, and probably *B. brevicosta* SCHLÜTER, of earlier ages. In detail, however, there is a difference which should not be overlooked. In the former species the suture is more deeply incised, has more numerous minute frills, and has at the bottom of L the median minor saddle located more distinctly below the lateral ones than in the latter group of species.

In spite of the resemblance of *B. lomaensis* ANDERSON to *B. brevicosta* SCHLÜTER, there is some gap both stratigraphically and geographically between the two species. I have not seen any examples of these types of *Baculites* in the Cretaceous of India and Japan. In California the occurrence of *B. lomaensis* is rather isolated. One of the extreme varieties of *B. schencki* n. sp. (see description of p. 113) of the Lower Senonian is fairly close to *B. brevicosta,* but no intermediate forms between that species and *B. lomaensis* of the lowest Maestrichtian (or ? higher Campanian) have been found in the intervening part of the stratigraphic succession.

As a possible ancestor of *B. lomaensis,* a strongly costate variety of *B. anceps* LAMARCK (see the next description) can be taken into consideration. This may be stratigraphically reasonable, but again no intermediate form has been found in California.

Another possible source of migration may be in the Gulf Coast region through somewhere in Mexico (?). In fact, *Baculites* sp. (USNM. 77251) of STEPHENSON, (1941, p. 406, pl. 76, figs. 7, 8), from the Neylandville marl of Navarro group of Texas, is almost indistinguishable from *B. lomaensis* ANDERSON, although the former has slightly thicker section than the latter. STEPHENSON's specimen is described as being related to *B. carinatus* MORTON, from the Prairie Bluff chalk of Alabama.

I have noticed that *B. lomaensis* ANDERSON is similar to one of the new species from the middle part of the Pierre shale in Western Interior, which COBBAN is going to establish. This may be a parallel development.

ANDERSON (1958, p. 192) compared *B. lomaensis* with *Eubaculites vagina* (FORBES) as its nearest ally. There seems to be no direct relationship between the two, although the trigonal section with a flattened dorsum and subangular dorsolateral shoulders may be accounted unusual for normal *Baculites.*

Occurrence.—Locs. CAS. 2361, CAS. 31593, CAS. 28304, CAS. 463, LSJU. 1631, LSJU. 1629, all from the "Ragged Valley shale" of Coalinga and Joaquin Rock Quadrangles of West San Joaquin Valley. The species seems to form a local subzone, along with the associated ammonites, *Solenoceras* sp., *Nostoceras* sp., *Damesites hetonaiensis fresnoensis* (ANDERSON), *Hauericeras rembda* (FORBES), *Pachydiscus subcompressus obsoletus* MATSUMOTO, etc. · The assemblage suggests the Lower Maestrichtian but may be the Uppermost Campainan.

ANDERSON (1958, p. 191) mentioned the occurrence of this species at Point Loma, near La Jolla, San Diego County (Coll. A. W. FAIRBANKS), but I could not see FAIRBANKS' specimens. There are some examples in the subsequent collection from Point Loma (e.g. loc. CAS. 1173).

The closely allied, or possibly identical, example of Texas came from the Neylandville marl of Navarro group. From the same formation a good many representatives of *Solenoceras*, *Nostoceras*, and *Pachydiscus* (*s.s.*) are known.

Baculites aff. *B. anceps* LAMARCK

Pl. 34, fig. 3a-d; Pl. 35, fig. 1a-d; Text-figs. 42a, b, 43

Synonym.—

?1902. *Baculites fairbanksi* ANDERSON (*pro parte*), *Proc. Calif. Acad. Sci.*, ser. 3, vol. 2, no. 1, p. 92, pl. 71, figs. 152, 153 (*non* pl. 10, fig. 194).

1915. *Baculites chicoensis*, WARING (*non* TRASK), *Calif. Min. Bureau Bull.*, 69 (1914), map, fig. 6.

?1932. *Baculites* n. sp. (?), NOMLAND and SCHENCK, *Univ. Calif. Publ. Geol. Sci.*, vol. 21, no. 4, p. 46, fig. 4.

?1958. *Baculites fairbanksi*, ANDERSON, *Geol. Soc. Amer.*, *Memoir* 71, p. 190, pl. 48, fig. 4, 4a; pl. 49, fig. 4, 4a.

Compare.—

1822. *Baculites anceps* LAMARCK, *Hist. anim. sans vertéb.*, vol. 7, p. 648.

1842. *Baculites anceps*, D'ORBIGNY, *Paléont. franç.*, *Terr. crét.*, vol. 1, p. 564, pl. 139, figs. 1-7.

1861. *Baculites anceps*, BINKHORST, *Monogr. gastérop. et céphalop. craie supér. Limbourg*, p. 42, pl. 5d. fig. 3a-d.

?1873. *Baculites fuchsi*, REDTENBACHER, *Abb. geol. Reichsanst.*, vol. 5, no. 5, p. 134, pl. 30, fig. 15.

1876. *Baculites anceps*, SCHLÜTER, *Palaeontographica*, vol. 24, p. 145, pl. 40, fig. 2.

1889. *Baculites anceps*, GRIEPENKERL, *Palaeont. Abh.*, vol. 4, p. 106, pl. 11 (44), fig. 2.

?1891. *Baculites valognensis* BÖHM, *Palaeontographica*, vol. 38, p. 50, pl. 1, fig. 13a, b.

1908. *Baculites anceps* var. *valognensis*, NOWAK, *Bull. Acad. Sci. Cracovie*, 1908, p. 335, text-figs. 1-4; 6a, 7a, 7b, 9.

1951. *Baculites anceps*, WRIGHT and WRIGHT, *Palaeontogr. Soc.*, 1950, p. 16.

Types.—There is an unsettled situation regarding the types of *Baculites anceps*. C. W. WRIGHT (a letter to me dated March 24, 1958) says as follows: "The description of *Baculites anceps* by LAMARCK, 1822 is inadequate and the interpretation of this species must be based on the description and figures of

D'ORBIGNY, 1842. An application will eventually have to be made to I C Z N to give preference to the name *anceps* over *dissimilis* DESMAREST, 1816 and to designate the original of D'ORBIGNY'S figure as holotype of *anceps*." Someone who is well acquainted with the European specimens will take the necessary procedure. For the time being I describe the Californian form in comparison witn the European one as represented by D'ORBIGNY'S specimens (1842, p. 564, pl. 139, figs. 1-7) and also by others which are regarded identical with D'ORBIGNY'S (see above list of synonymy).

Material.—The Californian examples which I describe under this heading are as follows:

LSJU. 8561 (Pl. 34, fig. 3a-d), LSJU. 8556 (Pl. 35, fig. 1a-d), LSJU. 8560 (Text-fig. 43), LSJU. 8557-8559, and LSJU. 8562-8563, from loc. LSJU. 1840, with which many other less perfectly preserved specimens are associated (Coll. J. P. SMITH)

LSJU. 8555 (Text-fig. 42a, b) and many other specimens from loc. LSJU. 2734 (Coll. L. W. FUNKHOUSER)

"LSJU. 1775" (1-4) Arroyo del Valle (Coll. S. W. MULLER)

"LSJU. 37193" (no record of collection)

LSJU. 184 (WARING, 1915, fig. 6) (Coll. A. T. SCHWENNESEN & C. A. WARING)

? LSJU. 618 (NOMLAND & SCHENCK, 1932, fig. 4) (Coll. REICHE, ROGERS & SCHENCK)

Specimens from loc. CAS. 31245 (Coll. S. MCCOY)

Measurements.—

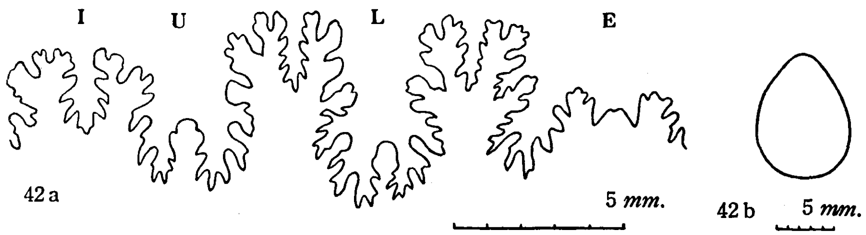
Specimen	Height	Breadth	(B/H)	Distance	Remarks
LSJU. 8555	11.3	8.3	(0.73)		
LSJU. 8556 (near aperture)	15.8	10.8	(0.68)		second. compressed (?)
LSJU. 8558	13.3 11.1	9.2 8.3	(0.69) (0.74)	25.0	
LSJU. 8559	10.5 8.7	7.7 6.2	(0.73) (0.71)	20.0	
LSJU. 8561	12.2 10.0	9.0 7.7	(0.73) (0.77)	45.0	
LSJU. 8562	16.4 14.2	12.4 9.8	(0.75) (0.69)	35.0	
LSJU. 8563	12.4	9.2	(0.74)		
LSJU. 184	10.4 7.0	7.7 5.2	(0.74) (0.74)	40.0	
"LSJU. 37193"	13.7	9.7	(0.70)		subelliptical section
"LSJU. 1775"	26.3	18.5	(0.70)		"

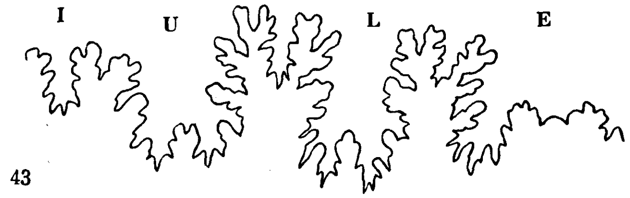
Description.—The shell is of moderate size. The height in cross section is usually about 15 mm. in the probable adult shell, but it reaches 26 mm. in the largest known example. Tapering is rather slow, but is moderate in some specimens.

The cross section is normally oval, with the siphonal area much more narrowly rounded than the antisiphonal. In some specimens, e.g. LSJU. 8577, the narrowing of the siphonal area is not so distinct as in the normal examples, and in the extreme case, as in the specimens "LSJU. 37193" and one of "LSJU. 1775", the cross section is subelliptical. In a few specimens a very faint depression is discernible on the ventrolateral part, but, this could be a result of secondary deformation.

The shell is normally ornamented with arcuate ribs of moderate intensity and density. In many specimens the ribs cross the siphonal area with a projection, forming, however, a rounded curve over the siphon itself but, without showing acute chevrons. In a few specimens, as in LSJU. 8559, they fade out quickly towards the venter, and no ribs perceptibly cross the siphonal area. The ribs cross the antisiphonal area with a broadly rounded curve, being somewhat weakened. There is variation in the intensity and density of the ribs. On the flanks of many specimens the ribs are separated by interspaces which are somewhat wider than the ribs themselves. On some others, as on LSJU. 8559, the ribs are crowded, being separated by interspaces as narrow as the ribs, although some of the ribs are normally spaced. Occasionally the ribs are very distant, but the distance may be narrowed even on one and the same specimen. In addition to the major ribs faint riblets and lirae are sometimes discernible.

The suture is moderately incised. The first lateral lobe (L) and the saddles on both sides of it are subrectangular in general outline and nearly equally bifid. The median minor saddle at the bottom of L is slightly larger than the adjacent lateral minor-saddles. The top of the former is nearly as high as those of the latter, but the relative height may vary to some extent. The second





Figs. 42, 43. *Baculites* aff. *B. anceps* LAMARCK.
42. Suture (a) and cross section (b), at height=11.3, breadth=8.3 mm., of an example, LSJU. 8555, from loc. LSJU. 2734, Arroyo del Valle.
43. Suture, at height=9.3 mm., of another example, LSJU. 8560, Arroyo del Valle.

lateral lobe (U) is broader but shallower than L, and asymmetric. The external lobe (E) is the broadest, but shallower than L. The antisiphonal lobe (I) is smaller than other lobes, but relatively not so small as in many other species of Lower Senonian *Baculites*. It has normally seven lobules. Generally minor incisions are moderately deep and sharp in the later growth-stages. The aperture is preserved in one example, LSJU. 8556 (Pl. 35, fig. 1a-d). The ventral projection is long but not sharp. The margin is bordered by a shallow collared constriction.

Remarks.—From all the characters described above the Californian species under consideration is most closely related to and possibly identical with *Baculites anceps* LAMARCK as defined by D'ORBIGNY (1842, p. 564, pl. 139, figs. 1-7). Unfortunately there is unsettled situation as regards the holotype (or syntypes) and nomenclature of this famous species, and I have not dealt with enough number of European specimens to give a clear cut solution.

So far as D'ORBIGNY's description and illustration are regarded as representing the typical form of *Baculites anceps*, there are significant differences between the Californian and the typical European forms. In the former the siphonal area is not so acute as in the latter. The siphonal prolongation of the ribs or lirae in the latter is farther forward than in the former. According to C. W. WRIGHT (loc. cit., 1958) no ribs cross the keel-like acute portion of the siphonal area in the European examples of *B. anceps*. In many of the Californian examples the ribs are much weakened on the ventrolateral portion, but cross the siphonal area again with slightly increased intensity. Only in a small number of specimens of California do the ribs fade out on the siphonal area. On examining the plaster casts of two of D'ORBIGNY's original specimens (Coll. No. 7204) and also several actual specimens from "Calcaire à *Baculites*" of Manche, which Dr. J. SORNAY kindly sent to me, I have noticed some variation within the French examples. Most of them have the characters of the "European form" as mentioned above, but one of them before me does show the characters which most of Californian specimens have.

The illustration of the suture by D'ORBIGNY (1842, pl. 139, fig. 7) is too

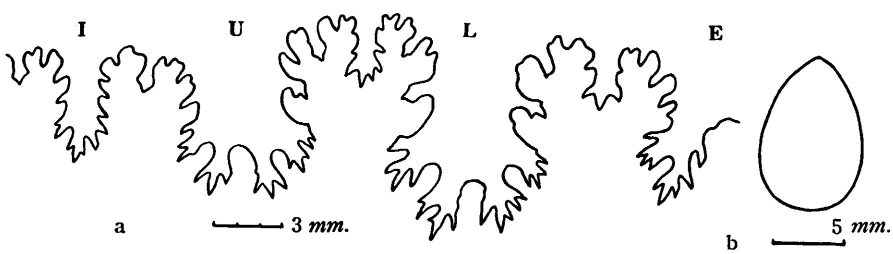


Fig. 44. *Baculites anceps* LAMARCK. Suture (a) and cross section (b), at height =22.0, breadth=14.5 mm., of a French specimen, from "craie à *Baculites* du Cotentin", Fresville near Valognes (Manche) (Coll. Muséum National d'Histoire Naturelle, Paris). (one of the seven specimens on loan by courtesy of Dr. J. SORNAY).

sketchy, apparently showing massive elements and simplified type of suture. The illustrations by BÖHM (1891, pl. 1, fig. 13a) and by NOWAK (1908, text-figs. 2, 3) for the specimens from Valogne (Manche), and also for NOWAK's variety *leopoliensis* (1908, text-figs. 5-10), show that the suture of European *B. anceps* is essentially similar to that of the Californian form, although it varies considerably. This can be confirmed by comparing the Californian specimens with the French ones before me (Text-fig. 44a, b). If sutures of corresponding size are taken, the European examples generally show more massive (broadly subquadrate) saddles as compared with the high subrectangular ones of California. But the exceptional specimen of France, which I have just mentioned in connection with the characters of the siphonal area and ribbing, has nearly the same type of suture as the normal Californian examples.

Baculites anceps var. *leopoliensis* NOWAK (1908, p. 328, pl. 14, figs. 1-11, text-figs. 1-4 of p. 329, text-figs. 5-10 of p. 331) has a blunt-pentagonal cross section in its large, later stages. According to C. W. WRIGHT (loc. cit., 1958), in *leopoliensis* as in the Californian examples, the lirae or striae cross the siphonal area and are not so projected as in typical *anceps*.

SCHLÜTER (1876, p. 145) mentioned that the specimens from northern Germany do not show so acute siphonal side as D'ORBIGNY's.

On studying one of the specimens from Arroyo del Valle, California as well as many European ones, C. W. WRIGHT (letter of March 24, 1958) has suggested to me that all the forms under discussion would reasonably be grouped as one species, *Baculites anceps* LAMARCK, being subspecifically separated in some such way as follows:

B. anceps anceps [=*B. anceps* var. *valognensis*], with acute venter: Lower Maestrichtian

B. anceps leopoliensis, with bluntly pentagonal section: Upper Campanian

B. anceps hochstetteri, with oval section (? including the Californian form): ? Middle Campanian

I quite agree with his opinion in a general way, but there is a questionable point, as WRIGHT himself put a query, as regards *Baculites hochstetteri* LIEBUS (1902, p. 119, pl. 6, figs. 4-6; text-fig. 2) from the Upper Cretaceous of the Carpathians. This is not quite identical with the Californian form in its moderate tapering, fine and regular subcostae, and deeply incised, complex suture, being closer to *Baculites rex* ANDERSON to be described below. Also it is doubtful whether the Carpathian and Californian species are contemporary or not.

Even if the subspecific separation of the Californian form from *B. anceps anceps* is warranted, a question remains regarding its nomenclature. Besides *B. hochstetteri*, there are at least two already published names which should be taken into consideration. One is *Baculites fuchsi* REDTENBACHER (1873, p. 134, pl. 30, fig. 15) from the Alpine Gosau beds. The illustration is so close to some of the Californian examples, that the identity is strongly suggested. For this species of REDTENBACHER, however, no suture has been illustrated and there is no reliable record of the geological age. BRINKMANN (1935, p. 9), in his revised list of the ammonites from the Gosau beds, did not quote *B. fuchsi,* but gave *B. anceps* under the Maestrichtian fauna of Krampen. *B. anceps* of REDTENBACHER (1873, p. 133, pl. 30, fig. 13) is too poorly preserved and has too strong ribs for a typical *B. anceps,* as SCHLÜTER (1876, p. 145) already pointed out. This can, however, fall within the variation of *B. anceps,* as is suggested by one of D'ORBIGNY's specimen, the plaster cast of which has been sent to me from Dr. J. SORNAY. Until I get satisfactory information of the Alpine form for exact comparison with the Californian one, I hesitate to use *fuchsi* for the subspecific name. The other name to be considered is *Baculites fairbanksi* ANDERSON, 1902. He gave two incongruent illustrations. One of them (1902, pl. 7, figs. 152, 153) seems to be an example of the Californian *Baculites anceps* here described, but the other (1902, pl. 10, fig. 194) shows a much simpler suture, reminding us that of *Sciponoceras* aff. *S. bohemicum* (FRITSCH) described above. ANDERSON's original types (syntypes) were unfortunately destroyed in the fire of 1906 and his recent description (ANDERSON, 1958, p. 190, pl. 48, fig. 4, 4a; pl. 49, fig. 4, 4a) mainly depends upon his old one, with an additional specimen from loc. CAS. 228, Sucia Island. In the type Silverrado Canyon there are two fossiliferous parts of entirely different ages. One is Upper Campanian *Metaplacenticeras*-bearing beds in the Pleasant sandstone and the other is Upper Turonian *Subprionocyclus*-bearing beds at or near the top of the Baker Canyon sandstone. From the former, as in Arroyo del Valle, specimens of *B. anceps* group can well be expected, but in the available collections I found no good example, while from the latter, as already described, *Sciponoceras* aff. *S. bohemicum* was obtained. Under these circumstances I cannot at present adopt ANDERSON's *fairbanksi* for the suggested subspecies of California.

For the time being, I describe the Californian form under the heading *Baculites* aff. *B. anceps* LAMARCK, with a strong suggestion that it would be subspecifically separated from the typical European form of *B. anceps,* but hardly separable as a distinct species.

In California no species has been found which could be the direct ancestor of *Baculites* aff. *B. anceps* LAMARCK. WRIGHT (loc. cit., 1958) suggested me *B. hochstetteri* LIEBUS as a possible origin, but its suture is as much advanced as *B. rex* ANDERSON which is later than *B.* aff. *B. anceps* in California. I suggest as a possible origin a form like *Baculites bailyi* WOODS (1906, p. 341, pl. 44, fig. 5) [=*B. sulcatus* BAILY (*pro parte*), 1855, p. 457, pl. 11, fig. 5a, b (*non* 5c)], because that species is subelliptical-suboval in section, tapering slowly, ornamented with inconspicuous ribs of arcuate curvature, and is characterized by moderately incised sutures, being fairly close in many respects to *B.* aff. *B. anceps* of California. That African species can morphologically and stratigraphically link *Baculites* aff. *B. anceps* of California with *B. yokoyamai* TOKUNAGA and SHIMIZU-*B. besairiei* COLLIGNON of the Lower Senonian. In Japan there is a species of *Baculites* which is close to or possibly identical with *B. bailyi* WOODS in the probable Upper Santoinan-Lower Campanian, above the upper limit of the range of *B. yokoyamai,* while *B.* aff. *B. anceps* is found in the Upper Campanian.

Occurrence.—Localities LSJU. 1840, LSJU. 2734, and several others in Arroyo del Valle, Alameda County, Bay Area. The specimens occur abundantly along with *Metaplacenticeras pacificum* (SMITH).

Baculites sp. of NOMLAND and SCHENCK (1932, p. 46, fig. 4), which REESIDE considered as a member of *B. anceps* group, is probably comparable with the Californian form here described. It came from loc. LSJU. 929, the slate unit in the vicinity of Slate Hotsprings, Monterey County.

In Europe *Baculites anceps,* including its so-called varieties or possible subspecies, is said to range from the middle of Campanian to the lower part of Maestrichtian. Further study is necessary for more accurate age determination of each of the various subgroups of subspecific rank and for their clearer definition.

Baculites rex ANDERSON

Pl. 31, fig. 5a-d; Pl. 34, fig. 5; Pl. 39, figs. 1a-c, 2a-c, 3; Pl. 40, fig. 1a-c;
Text-figs. 45a, b, 46a-c, 47, 48a-c, 49a, b, 50-52

1958. *Baculites rex* ANDERSON, *Geol. Soc. Amer., Memoir* 71, p. 191, pl. 49, fig. 2.

Holotype.—The illustrated specimen of ANDERSON (1958, pl. 49, fig. 2), from loc. CAS. 28325, Crow Creek, West San Joaquin Valley, as originally designated. This is unfortunately poorly preserved and no other specimens were associated with it at the same locality.

Material.—In addition to the holotype, I refer to the present species a fairly large number of specimens from California, some of which are better preserved than the holotype. The examples are as follows:

Four specimens from loc. CAS. 31401 [=31567], (Coll. W. S. KNOUSE) (Pl. 31, fig. 5a-d; Text-figs. 45-47)

GK. H 7034 (Text-fig. 48a-c) and GK. H 7035 (Text-fig. 49a, b), from loc. TM. 204 A [=LSJU. 3329 A], (Coll. M. B. PAYNE & T. MATSUMOTO); GK. H 7036 (Pl. 39, fig. 1a-c) and GK. H 7037 from loc. TM. 507 [=LSJU. 3345], (Coll. M. B. PAYNE & T. MATSUMOTO)

LSJU. 8598 (Pl. 34, fig. 5) and LSJU. 8599, from loc. LSJU. 3329 A [=TM. 204 A], (Coll. M. B. PAYNE & T. MATSUMOTO)

LSJU. 8612 and LSJU. 8613, from loc. LSJU. 2227

LSJU. 8596 (Text-fig. 50a, b) and LSJU. 8597 (Pl. 39, fig. 2a-c; Text-fig. 52) from loc. LSJU. 3347 (?) (Coll. H. HANNIBAL & A. W. AMBROSE)

LSJU. 8600 (Pl. 39, fig. 3) and several others, from loc. LSJU. 2795, (Coll. J. G. MARKS)

UC. 37604 from loc. UC. A-4890 (Coll. Bud OGLE, Geol. 102B class, 1949)

UC. 37603, UC. 37605, (Pl. 40, fig. 1a-c; Text-fig. 51) and several others, from loc. UC. A-4959 (Coll. Paleo. 137 class, 1949)

Several specimens, from loc. UC. A-7234, (Coll. Geol. 118 class, 1951, Paleo.

117 class, 1958)

Other examples from loc. LSJU. 3357 (Coll. D. L. JONES & T. MATSUMOTO); loc. LSJU. 3358 (no record of the collector); loc. LSJU. 3359, (Coll. S. W. MULLER *et al*), loc. LSJU. 3346 [= TM. 506] (Coll. M. B. PAYNE & T. MATSUMOTO)

Possibly referable specimens from loc. UCLA. 2415, Santa Ana Mountains (Coll. L. E. SAUL)

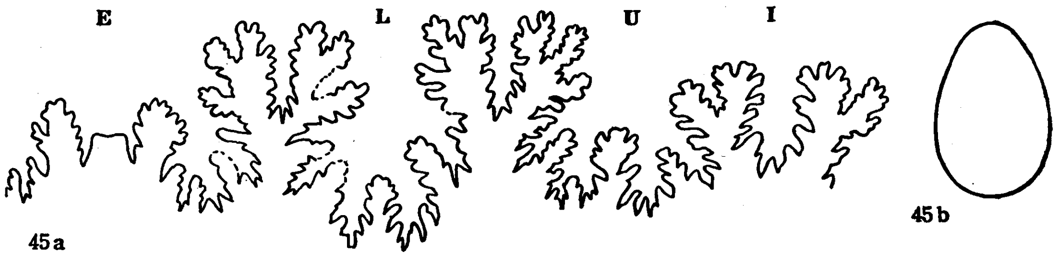
Measurements.—

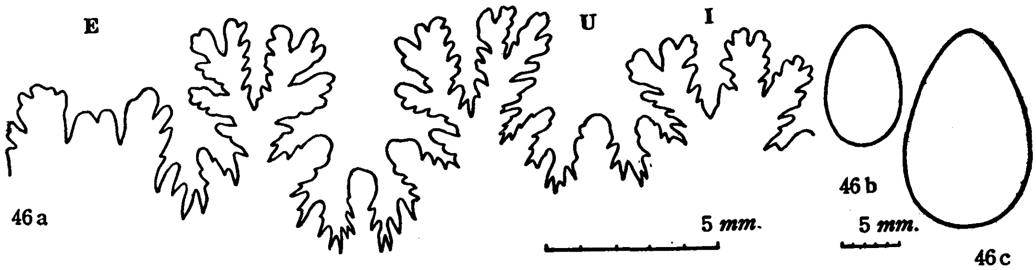
Specimen	Height	Breadth	(B/H)	Distance	Remarks
One from CAS. 31401	17.1	11.1	(0.65)	c. 70	
	10.5	7.0	(0.66)		
Another ,, ,,	17.0	11.0	(0.65)	50.0	
	12.3	9.0	(0.70)		
LSJU. 8596	17.8	12.4	(0.70)	45.0	
	13.5	10.0	(0.73)		
LSJU. 8597	33.0	19.1	(0.58)	105.5	secondarily compressed (?)
	15.6	11.3	(0.73)		
LSJU. 8612	35.5	20.6	(0.58)	75.0	,,
	32.0	17.0	(0.53)		
GK. H 7034	10.0	7.5	(0.75)		
GK. H 7035	6.0	4.6	(0.75)		
GK. H 7036	10.5	7.9	(0.75)	50.0	
	5.4	4.3	(0.79)		
GK. H 7037	12.2	9.9	(0.81)	60	
	5.9	4.8	(0.81)		
One from UC.A-4890	19.9	13.2	(0.66)		
One from UC.A-7234	15.4	12.8	(0.83)		
UC. 37605	35.0	25.5	(0.73)	82.0 } 112	length of body whorl
	28.0	20.3	(0.72)	30.0	
	25.0	18.0	(0.72)	42.0	
	21.5	15.7	(0.73)		
Another from UC.A-4959	14.5	10.5	(0.72)	30.0	
	11.3	8.4	(0.74)		
Another ,, ,,	12.5	9.0	(0.72)	28.0	
	10.0	7.3	(0.73)		
Another ,, ,,	26.8	19.5	(0.72)		
Another ,, ,,	41.0	31.5	(0.77)	100	unusual form
	35.5	26.5	(0.74)		
One from UCLA. 2415	13.8	10.3	(0.74)		,,

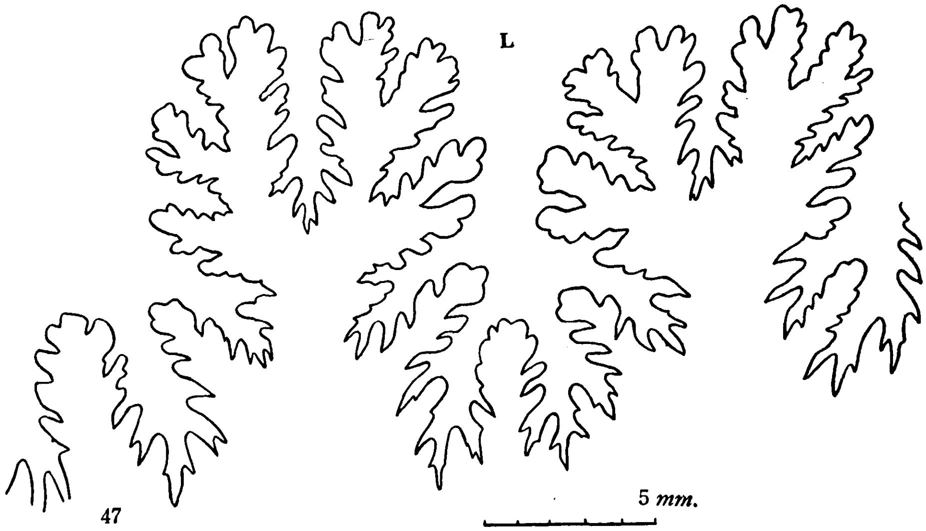
Diagnosis.—The shell is rapidly tapering, straight or sometimes gently arcuate, growing to a large size; the largest known example slightly exceeds 60 mm. in height (i.e. longer diameter in cross section). The section is higher than broad; the proportion of height and breadth is 10: 7.3 in average but varies considerably. It is egg-shaped, the siphonal area being much more narrowly rounded than the antisiphonal; the flanks are gently inflated, with the maximum breadth at somewhat below mid-flank.

The surface is almost smooth, but very weak riblets and lirae are sometimes discernible. They show a deep sinus on the flank, strongly incline forward on the ventrolateral part, and then cross the venter with pronounced projection and also sometimes with increased intensity; they are very feeble on the dorsum, showing a broad convexity.

An indistinct, shallow constriction may be developed along the apertural margin.







Figs. 45-47. *Baculites rex* ANDERSON.

45. The last suture (a) and cross section (b), at height=15.4, breadth=10.2 mm., of a specimen from loc. CAS. 31567 [=CAS. 31401], back from Antelope valley, Kern County.

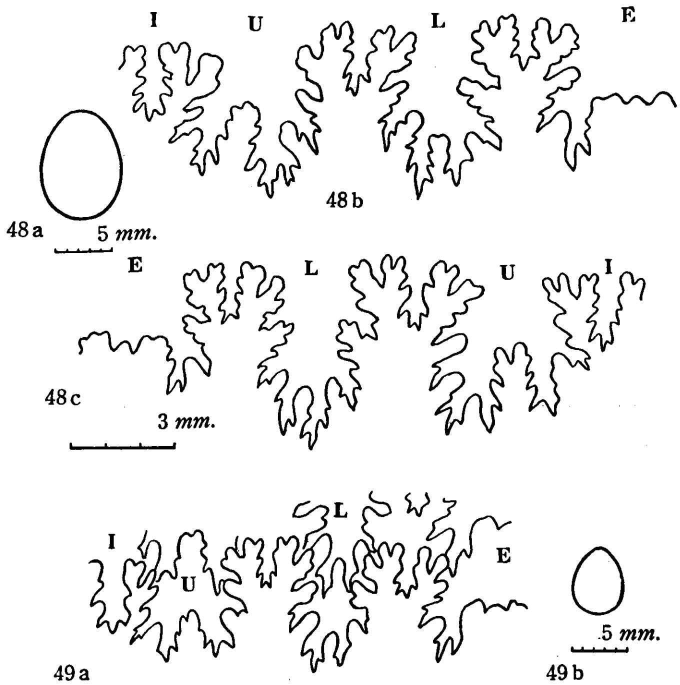
46. Suture (a), at height=13.0 mm., and two cross sections (b, c), at height=10.5, breadth=7.0, and height=17.5, breadth=11.1 mm., of another specimen, from loc. CAS. 31567.

47. Lateral lobe and adjacent part of the suture, at height=26 mm., of another specimen from loc. CAS. 31567.

The suture is complex, very deeply incised, and ornate. The saddles are nearly symmetrically bifid. In the late growth stages their stems are narrowed by the deep incision of the lobules. L is again typically symmetric, but in some case modified; the median minor saddle at its bottom is lower than and tends to be overhung by the adjacent lateral minor saddles. L is deep and in more or less late growth-stages narrowed by the laterally streched branches of the saddles. U is broader and shallower than L; its branches are expanded. I is relatively larger than those of many other species of *Baculites*, being nearly as deep as the height of the saddles on oth sides of it.

Variation.—The specimens which I have examined are mostly straight, but a few specimens, e.g. LSJU. 8597 (Pl. 39, fig. 2a-c) and the one from loc. CAS. 31567 (Pl. 31, fig. 5a-d), are broadly arcuate, being convex on the ventral area, as in the case of *Euhomaloceras*.

The oval section is more or less compressed. There is a very narrowly oval example, with proportion less than 0.6, which looks like the cross section of *Baculites compressus* SAY (1821, p. 41; HALL and MEEK, 1854, p. 400, pl. 5, fig. 2, pl. 6, figs. 8, 9), but this is probably due to secondarly compression.



Figs. 48, 49. *Baculites rex* ANDERSON.

48. Cross section (a) and sutures (b, c) on both sides of a specimen, at height=9.7, breadth=7.3 mm., GK. H7034, from loc. TM. 204 [=LSJU. 3329], Marca shale of the Moreno formation, Panoche Hills.

49. Suture (a) and cross section (b), at height=6.0, breadth=4.6 mm., of a young specimen, GK. H7035, from loc. TM. 204 [=LSJU. 3329].

A few other specimens tend to be subelliptical, but these are rather unusual.

Tapering of the shell is relatively rapid, but tends to be slowed on the adult body chamber. Again the degree of tapering varies to some extent by individuals.

The complex pattern of suture is very diagnostic of the present species. Although it follows the above described details, slight modification occurs in some specimens. Not infrequently the details are not the same between the sutures on the left and right sides. For instance, one of the minor saddles at the bottom of L on one side is unusually shorter than the other, resulting in slight asymmetry of L, but at the bottom of L on the other side the normal symmetry is kept. Again the antisiphonal saddles on both sides of I are sometimes of unequal size and differ in the details of minor incisions. These facts are illustrated in the text-figures.

Existence of the feeble constriction along the apertural margin of the adult body chamber, as seen on a specimen, UC. 37605 (Pl. 40, fig. 1a-c), is not necessarily unusual for *Baculites*, because I have seen the same feature in *Baculites* aff. *B. anceps* LAMARCK. The aperture itself is not curved and does not face dorsally, being different from that of *Sciponoceras*. Periodic constrictions of *Sciponoceras* type on the course of growth are not normally found in the present species, as well as in other species of *Baculites*, but there are

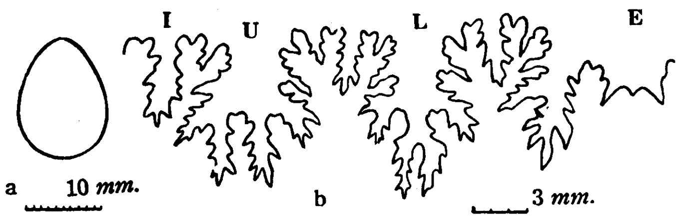
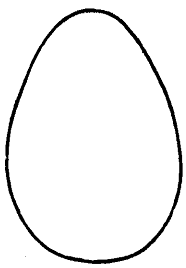
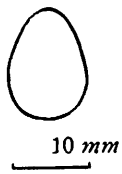


Fig. 50. *Baculites rex* ANDERSON. Cross section (a), at height=16.0, breadth =12.0 mm., and suture (b), at height=14.0 mm., of a specimen, LSJU. 8596, from loc. LSJU. 3347, "Black Mountain".





51 52

Figs. 51, 52. *Baculites rex* ANDERSON. Cross sections near the anterior end of the body chamber of an example, UC. 37605 (fig. 51) (Pl. 40, fig. la-c), from loc. UC. A-4959, and the young part of another example, LSJU. 8597 (fig. 52) (Pl. 39, fig. 2a-c), from loc. LSJU. 3347 (?).

several exceptional specimens in the collections of UC. (Paleo. Class 117, 1958), from locality UC. A-7234, where I also visited. Many small, probably immature specimens have been obtained there. They are best referabl to the present species in shell-form, ornament, and suture. Strange to say, several of them show indistinct and rather irregular constrictions, which are parallel to the riblets and lirae. Also on a few examples among them the riblets become coarser than on the normal ones.

As the specific name (*rex*=king) indicates, the species reaches a large size and is the largest among the Californian baculitids, if not so large as *Baculites grandis* HALL and MEEK and its ally of Western Interior and Gulf Coast. In some cases, as in the Moreno shale of Panoche Hills, a number of specimens so far obtained at one locality are all small; even the specimen which preserves the body chamber is of moderate size. In our present state of knowledge, it is hard to decide whether the fact means variation in size or indicates ecological difference between immature and mature shells. In fact, the largest example was found in a sandstone formation along with other relatively large specimens (loc. LSJU. 2795).

Remarks.—Among the species of *Baculites* from California, this species has the most complex type of suture. The pattern is similar to that of *Baculites compressus* SAY as figured by MEEK (1876, p. 400, pl. 20, fig. 3a-c). *B. compressus* SAY, from the relatively upper part of the Pierre shale in the Western Interior, has, however, much more compressed whorl and slower tapering than the present species. In the relatively narrowly oval section, rapid tapering, complex suture, and nearly smooth surface, with some ventral riblets, *B. rex* ANDERSON is similar to *Baculites gregoriensis* COBBAN (1951, p. 820, pl. 118, figs. 1-5; text-figs. 8-13), from the Gregory member and equivalents of the Pierre shale, but is distinguished by the details of the suture. In the former the median minor saddle at the bottom of L is lower and overhung by the adjacent lateral minor saddles, while in the latter the three elements are nearly of equal height, the constricted state of L occurring only above the main lateral branch. *B. gregoriensis* is in average more compressed than *B. rex*.

In the details of suture *Baculites rex* ANDERSON is closely allied to *Baculites hochstetteri* LIEBUS (1902, p. 119, pl. 6, figs. 4-6; text-fig. 2) from the Upper Cretaceous of the Carpathians. That European species is, however, somewhat indefinite, because it was established for small, fragmentary specimens and because its geological age has not yet been precisely fixed. So far as LIEBUS' original description is concerned, the Carpathian species has narrow, subelliptical cross section, and regular, fine ribs. NOWAK's magnified reproduction (1906, text-figs. 10, 10a, 11) is not well understandable in that he exaggerated the acute siphonal side for one of LIEBUS' apparently deformed specimens (1902, pl. 6, fig. 5). C. W. WRIGHT, however, has recently suggested to me (in a letter dated March 25, 1958) the intimate relation of *Baculites hochstetteri* with *Baculites anceps* LAMARCK, as NOWAK (1906, p. 344) once considered.

In California there is a possible subspecies of *Baculites anceps,* which I have described above under the heading of *Baculites* aff. *B. anceps* LAMARCK. That species, as is shown in the succession of Arroyo del Valle of the Bay area, occurs in the beds slightly below the level where *B. rex* is obtained. Morphologically, however, there is no gradual transition between the two, because *Baculits* aff. *B. anceps* has arcuate ribs of moderate intensity and evidently less complex type of suture. Although *Baculites hochstetteri* could be considered as a possible connecting form between the two, the paleontological and stratigraphical evidences available at present are not sufficient for leading a definite conclusion. The Californian example of *Baculites* aff. *anceps* has less acute siphonal area, where the ribs show less pronounced projection than the typical form of *B. anceps*. Some of the specimens of *B. rex,* as shown in the illustration (Pl. 40, fig. 1a-c), have reminiscent of the same feature, although the ribs themselves are extremely weak. Thus it is probably reasonable to search the origin of *B. rex* ANDERSON in the Californian subgroup of *B. anceps,* although the actual connecting form has not yet been perfectly confirmed. One would then conclude that *Baculites rex* had no direct connection with the stock of *Baculites gregoriensis-Baculites compressus* of the Western Interior Province, but was in parallel relation with that group, although the ultimate origin might be common.

Occurrence.—The type locality is CAS. 28325, Crow Creek, Stanislaus County, west side of the San Joaquin Valley; its stratigraphic position is not precisely recorded, but called "probably Joaquin formation". Other localities are LSJU. 3329 A [=TM. 204 A], and LSJU. 3327 [=TM. 3], type exposures of Marca shale of the Moreno formation, Panoche Hills, west side of the San Joaquin Valley; LSJU. 3345 [=TM. 507], Ragged Valley shale, slightly higher than the beds of *Baculites occidentalis* MEEK, and (?) LSJU. 3346 [=TM. 506], Brown Mountain sandstone, and also LSJU. 3369, of doubtful stratigraphic position, all in or adjacent to Los Gatos Creek, northwest of Coalinga, west side of the San Joaquin Valley; UC. A-4890, Reef Ridge, west side of the San Joaquin Valley; CAS. 31401 [=31567], LSJU. 3358, and UC. A-4959, shale unit, back of Antelope plain, southwest San Joaquin Valley; LSJU. 2227, in Cholame Quad., back in the range, west of San Joaquin Valley; LSJU. 2785, Debris Dam sandstone of the Santa Barbara Mountains; UCLA. 2415, *Pseudophyllites* bearing sandstone of the Santa Ana Mountains; LSJU. 3347, "Black Mountain" of a doubtful area, but possibly of Ragged Valley shale of Joaquin Ridge, west side of the San Joaquin Valley; LSJU. 3357, sandstone unit, top member of the Cretaceous in the succession of Arroyo del Valle, Bay area; UC. A-7234, west of Willows, far apart higher than the top of Guinda sandstone, west side of the Sacramento Valley.

The specimens from the Marca shale and Ragged Valley shale cannot be specifically separated, although no examples of this species have been found in Tierra Loma shale, in which *Eubaculites ootaçodensis* was obtained. Therefore, *Baculites rex* is fairly long ranged. So far as available evidence is concerned, it occurs above *Baculites* aff. *B. anceps-Metaplacenticeras pacificus* in Arroyo del Valle and also above *Baculites occidentalis* MEEK in Los Gatos Creek. Its geological range is probably all through the Maestrichtian and could possibly go down to the highest part of the Campanian.

Baculites kirki sp. nov.

Pl. 43, figs. 1a-c, 2a-c, 3a-c; Text-figs. 53a, b, 54-57, 58a, b

Material.—Holotype, UC. 35693, from loc. SOC. K-229 (Coll. M. V. KIRK) (Pl. 43, fig. 1a-c; Text-fig. 53a, b). Paratypes UC. 34871 (Pl. 43, fig. 2a-c) and UC. 34872 from the same locality as the holotype (Coll. M. V. KIRK); also UCLA. 28805 (Text-fig. 58a, b), 28806a (Text-fig. 55), 28806b (Text-fig. 56), 28809 (Text-fig. 57), 28813, 28814, and 28827 (Pl. 43, fig. 3a-c), from loc. CIT. 1006 (Coll. W. P. POPENOE & D. SCHARF, 1931). Many other comparable specimens from loc. CIT. 1006 are also available (UCLA.).

Measurements.—

Specimen	Height	Breadth	(B/H)	Distance
Holotype (UC. 35693)	10.5 9.2	7.5 6.6	(0.71) (0.71)	30.0
UC. 34871	10.7	7.5	(0.71)	
UCLA. 28805	11.3 8.0	7.0 5.4	(0.62) (0.67)	—
UCLA. 28806	12.0	7.8	(0.65)	
UCLA. 28806 b	12.0	8.2	(0.68)	
UCLA. 28809	9.4	7.1	(0.75)	
UCLA. 28813	7.4 6.2	5.5 4.2	(0.74) (0.67)	22
UCLA. 28814	6.9 5.4	4.9 3.5	(0.71) (0.64)	28
UCLA. 28827	8.2 5.5	6.0 3.7	(0.73) (0.67)	48
UCLA. —	10.0	7.0	(0.70)	
UCLA. —	9.5	6.5	(0.68)	

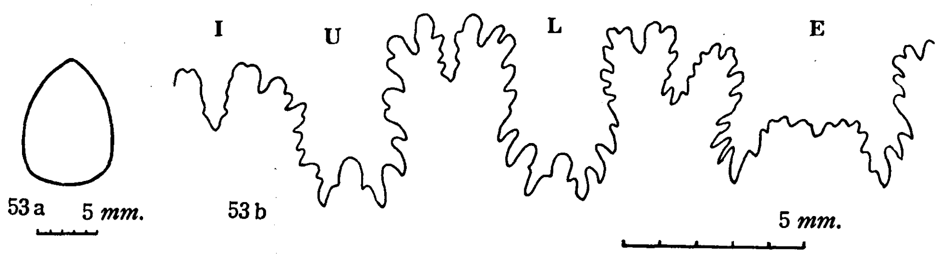
Diagnosis.—The shell is small, showing slow tapering. The section is higher than broad. A small, rounded keel is developed on the siphonal line of the shell. It is less distinct on the internal mould, sometimes resulting in fastigate venter. The main part of the flank is only slightly inflated on the body chamber, but somewhat inflated on the septate part. The dorsal part is rounded, but on the body whorl there are subangular shoulders between the dorsal part and the flattened flanks. Thus the adult section looks like an outline of a small boat in plane view.

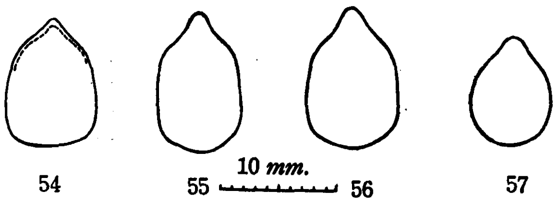
The surface of the shell is nearly smooth, but with very weak riblets and indistinct striae, which show a sinus on the dorsolateral part, a broad convex curve on the dorsal part, and a prominent projection on the ventral part, forming chevrons on the mid-venter.

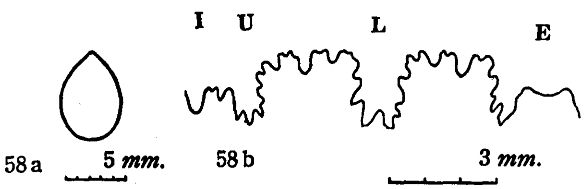
The suture has minute incisions of less acuteness, leaving roundish terminals to the subdivisions. The saddles and lobes are subrectangular in general outline. The former is relatively broad on the young shell, but becomes high on the adult whorl. The antisiphonal lobe (I) is extremely small. Thus the suture is as simple as in many Lower Senonian *Baculites*.

Variation.—A fairly large number of specimens from one stratigraphic units (lower part of Member V of the Redding area) show a certain extent of variation. The proportion of breadth and height varies from 6:10 to 8:10. Generally the flanks are more flattened on the adult shell than on the immature. Even in the immature stage, however, flanks are only gently inflated on some shells and moderately inflated on others. Also the keel varies in prominence by individuals, although it is rather small and rounded on the external surface of the shell.

The holotype and two other specimens, from loc. SOC. K-229, of the upper part of Member V have less rounded dorsal part than many specimens, from loc. CIT. 1006, of the lower part of Member V. If the difference would be confirmed to be constantly kept between the two different levels, subspecific speration could be justified. The available number of specimens from the higher







Figs. 53-58. *Baculites kirki* sp. nov.

53. Cross section (a) of the internal mould and suture (b), at height=10.5, breadth=7.5 mm., of the holotype, UC. 35693, from loc. SOC. K-229, upper part of Member V, Redding area. See Pl. 43, fig. 1a-c.

54-57. Cross sections of the paratypes: UC. 34871 (fig. 54) (internal mould shown by a dotted line), from loc. SOC. K-229 (see Pl. 43, fig. 2a-c); UCLA. 28806a (fig. 55), UCLA. 28806b (fig. 56) and UCLA. 28809 (fig. 57), from loc. CIT. 1006, lower part of Member V, Redding area.

58. Cross section (a) and suture (b), at height=7.3, breadth=5.0 mm., of a young shell, paratype, UCLA. 28805, from loc. CIT. 1006.

level is at present so small and the morphological difference is so slight, that for the time being I record the fact under the heading of variation.

Remarks.—At first sight this species resembles *Eubaculites* (?) *simplex* (KOSSMAT) [=*Baculites vagina* FORBES var. *simplex* KOSSMAT, 1895, p. 156 [60], pl. 19 [5], figs. 13a, b, 14a-c], from the Arialoor group of India, but has rounded antisiphonal area and no distinct ribs. KOSSMAT's original material consisted only of three fragments. Their sutures have not been illustrated nor described. SPATH (1953, p. 46) regarded this Indian species as intermediate between *Baculites* and *Eubaculites*. Similarly the present species could be regarded as another intermediate example. It never shows, however, the angular edges of the keel and strong ribs of the typical examples of *Eubaculites* [e.g. *E. vagina* (FORBES) and *E. ootacodensis* (STOLICZKA)]. Its simple suture is the same type as that of certain species of *Baculites* of the same and also the subjacent beds. From these facts I am inclined to conclude that the present species is more intimately related to the Lowr Senonian species of *Baculites* than to the Maestrichtian species of *Eubaculites*.

Occurrence.—Loc. SOC. K-229, in a sandstone of Hooten Gulch, upper part of Member V of POPENOE in the Redding area; this is the type locality where the holotype and two paratypes were obtained along with *Pseudoschloenbachia* n. sp. (?) aff. *P. boulei* (BASSE). Another locality is CIT. 1006, in calcareous concretion of the lower part of Member V of POPENOE in the Redding area, where a large number of more or less fragmentary specimens, including several paratypes, were obtained along with *Baculites boulei* COLLIGNON and *Inoceramus* cf. *I. cordiformis* SOWERBY.

From the stratigraphic position and associated species, the geological age of the present species is best assigned to the Santonian (both the early and late parts). This is the earliest record of any keeled *Baculites*.

Baculites chicoensis TRASK

Pl. 36, fig. 2a-d; Pl. 37, fig. 1a-d; Text-fig. 59a-d, 60a, 61a, b, 62a, b, 63a, b

1856. *Baculites chicoensis* TRASK, *Calif. Acad. Nat. Sci., Pr.*, vol. 1, p. 92, pl. 2, fig. 2, 2A.
1864. *Baculites chicoensis*, GABB (*pro parte*), *Palaeont. Calif.*, vol. 1, p. 80, pl. 14, fig. 27b; ? pl. 17, fig. 27, 27a (*non* pl. 14, fig. 29, 29a).
1940. *Baculites chicoensis*, SCHENCK and KEEN, *Calif. Fossils for the Field Geologist*, p. 23, pl. 17, fig. 6A.
1940. *Baculites chicoensis*, TAFF, HANNA, and CROSS, *Bull. Geol. Soc. Amer.*, vol. 51, p. 1321, pl. 1, figs. 3, 4.
1958. *Baculites chicoensis*, ANDERSON, *Geol. Soc., Amer., Mem.* 71, p. 190, pl. 48, fig. 1, 1a, 1c (*non* 1b, 1d); Pl. 60, fig. 3, 3a, 3b.

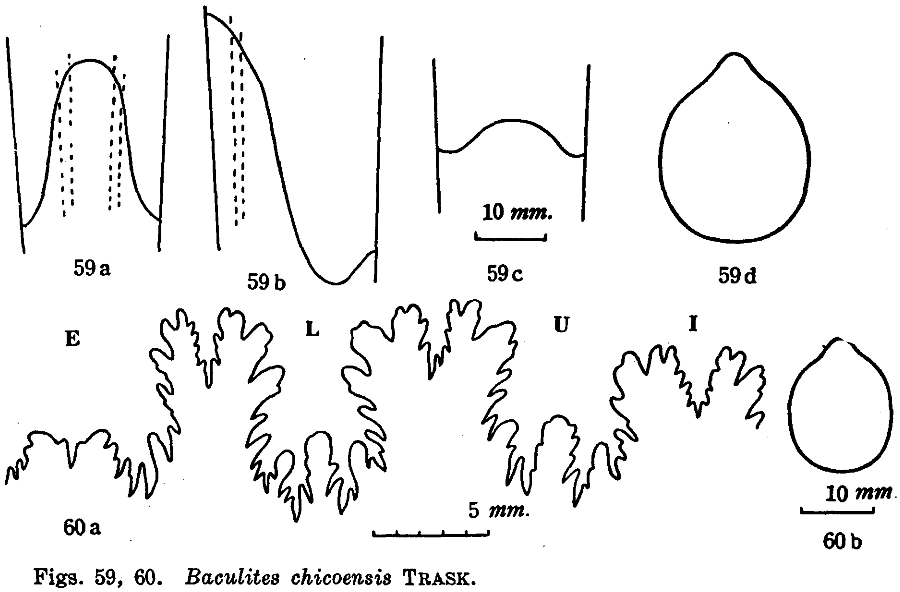
Types.—TRASK's original specimen (specimens ?) is (are ?) lost (see TAFF, *et al*, 1940, p. 1321). TAFF, HANNA, and CROSS (1940, p. 1321) designated two specimens, CAS. 5786 and 5787, from loc. CAS. 27838, Chico Creek, as "neosyntypes". They are, however, unofficial neotypes and represent only body chambers. While the character of suture is important for distinguishing species of *Baculites*, the two specimens do not show a complete suture. Thus the selection by TAFF *et al* is proved to have been made unwisely. I challenge here to select the better preserved specimen, LSJU. 8537, from loc. 2609, Chico Creek (Coll. R. E. COOK) (Pl. 36, fig. 2a-d; Text-fig. 60a, b). An application will be made to the International Commission on Zoological Nomenclature to reject the two specimens, CAS. 5786 and 5787, and uphold LSJU. 8537 as the neotype of *Baculites chicoensis* TRASK.

Material.—A great number of specimens from the Chico area, among which following are better preserved examples.

LSJU. 8537 (the proposed neotype), 8538 (Pl. 37, fig. 1a-d; Text-fig. 59a-d), and 8539-8551 (Text-figs. 61-63), from loc. LSJU. 2609; LSJU. 8568-8571 from loc. LSJU. 2882; LSJU. 8552, from loc. LSJU. 2883 (all Coll. R. E. COOK)

CAS. 5952 (HANNA and HERTLEIN, 1943, Text-fig. 61-21) from loc. CAS. 27838 (Coll. TAFF, HANNA, & CROSS)

A number of well-preserved specimens from locs. UCLA. 3637, UCLA. 3638, UCLA. 3639, UCLA. 3647 (Coll. L. E. & R. B. SAUL)



Figs. 59, 60. *Baculites chicoensis* TRASK.

59. Curvature of a growth-line on the venter (a), side (b), and dorsum (c), and cross section (d) of a long specimen, LSJU. 8538, from loc. LSJU. 2609, upper half of the Chico formation in Chico Creek. The same specimen is illustrated on Pl. 37, fig. 1a-d. The dotted lines indicate the position of the shallow grooves.

60. The last third suture (a) and cross section (b), at height=18.5, breadth =14.1 mm., of a neotype, LSJU. 8537, from loc. LSJU. 2609. See also Pl. 36, fig. 2a-d.

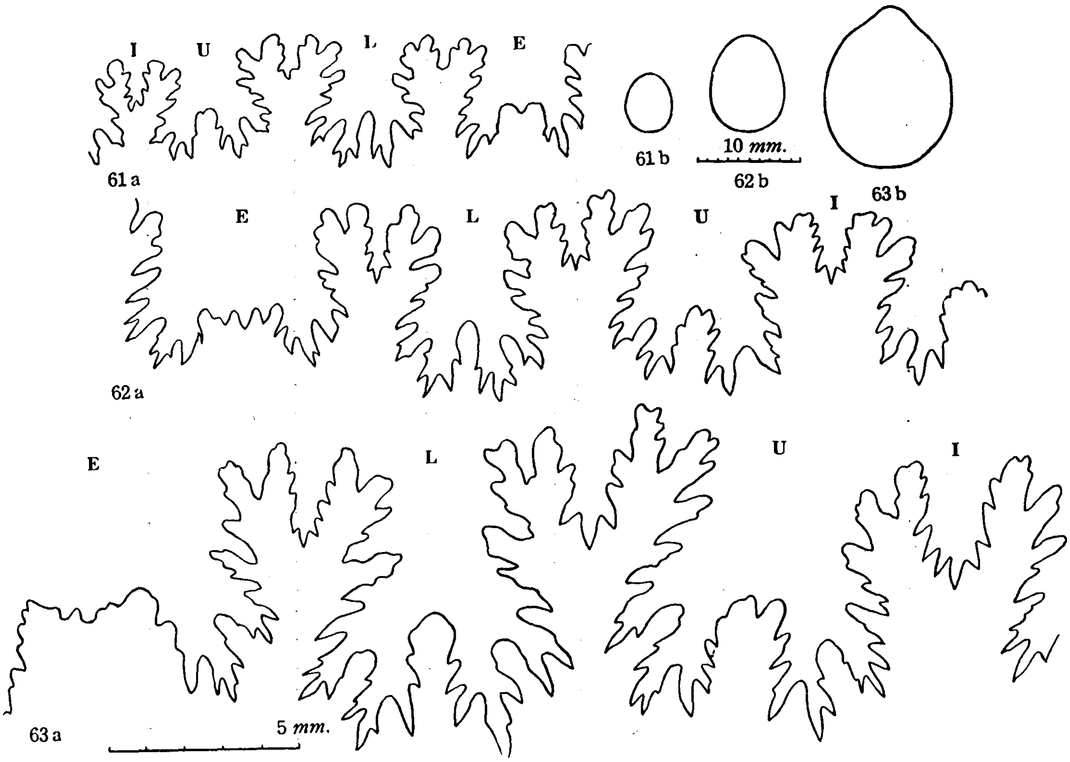
Measurements.—

Specimen	Remarks	Height	Breadth	(B/H)	Distance
LSJU. 8537 (neotype)	(body chamber)	22.5 21.5	18.0 16.9	(0.80) (0.78)	35.0
	(intern. mould of sept. part)	18.5	14.2	(0.77)	55.0
LSJU. 8538	(body chamber)	25.4 23.0	20.8 19.3	(0.81) (0.84)	90.0
	(intern. mould of sept. part)	21.5	16.9	(0.78)	120.0
LSJU. 8542	(body chamber)	22.5 19.1	16.6 14.3	(0.73) (0.74)	70.0
LSJU. 8543	(intern. mould of sept. part)	17.5	13.5	(0.77)	
LSJU. 8541	(" ")	13.1 10.0	9.5 7.6	(0.72) (0.76)	50.0
LSJU. 8545	(septate part)	11.5 8.0	9.0 6.5	(0.78) (0.81)	40.0
LSJU. 8546	(septate part)	8.5 5.0	6.0 4.3	(0.70) (0.86)	30.0
LSJU. 8547	(" ")	7.7 4.2	6.2 3.6	(0.80) (0.85)	30.0
LSJU. 8548	(" ")	9.0	7.4	(0.82)	
LSJU. 8549	(intern. mould)	9.3	7.2	(0.77)	
CAS. 5786	(body chamber)	18.0 15.0	13.3 11.5	(0.74) (0.76)	50.0
CAS. 5787	(body chamber)	18.0 15.2	13.1 11.5	(0.72) (0.75)	65.0
CAS. 5786	(body chamber)	18.0 15.0	13.3 11.5	(0.74) (0.76)	50.0
CAS. 5787	(body chamber)	18.0 15.2	13.1 11.5	(0.72) (0.75)	65.0
UCLA. 28817	(septate part)	17.0 13.0	13.0 10.5	(0.76) (0.80)	50.0
Another from loc. UCLA. 3637	(" ")	11.0 8.1	8.8 6.7	(0.80) (0.82)	37.0

Diagnosis.—The tapering of the shell is fairly rapid in the earlier growth-stages, and slow in the later. The shell can attain moderate size; the largest example is slightly over 25 mm. in height (i.e. longer diameter) and at least 130 mm. in length of the body chamber. The cross section is oval, being somewhat higher than broad and broadest at the point slightly below (i.e. dorsally from) the mid-flank. The flanks are moderately inflated; the dorsal area is broadly rounded; the ventral area narrowly rounded. In the later growth-stages, a low elevation is developed on the mid-venter, being bordered on its both sides by very shallow grooves, thus forming a blunt ventral keel.

The surface of the shell is nearly smooth, but with faint striae and growth-lines. On the body chamber, weak riblets are occasionally discernible along with the striae. These ornaments show a deep sinus on the dorsal half of the flank, a strong projection on the venter, and a much weaker projection on the dorsal area.

The suture is finely and fairly deeply incised, especially so in the later growth-stages. The external lobe is broader and shallower than the lateral lobes; the siphonal saddle low and broad; the external saddle (between E and L) relatively narrow; the lateral saddle (between L and U) slightly higher than



Figs. 61-63. *Baculites chicoensis* TRASK.

61. Suture (a) and cross section (b), at height=5.5, breadth=4.7 mm., of a specimen, LSJU. 8550, from loc. LSJU. 2609, Chico formation in Chico Creek.

62. Suture (a) and cross section (b), at height=9.3, breadth=7.2 mm., of a specimen, LSJU. 8549, from loc. LSJU. 2609.

63. Suture (a) and cross section (b), at height=15.8, breadth=12.4 mm., of a specimen, LSJU. 8541, from loc. LSJU. 2609.

others. The first lateral lobe (L) is nearly as deep as, but narrower than, the second lateral lobe (U). The former is symmetrically bifid; the latter rather asymmetrically so. The antisiphonal lobe (I) is very small, sitting on the united antisiphonal saddles, as if it was a divide of one saddle. All the elements (except I) are inverse trapezoidal in general outline, forming a dovetail. The median divide at the bottom of L is fairly large, being higher than the lateral divides on both sides of it. This difference in size and height of divides is still more distinct at the bottom of U.

Variation.—Tapering is rapid in the earlier growth-stages, but is slowed down in the later.

The section is egg-shaped, but the proportion of breadth and height varies from 7.0/10 to 8.6/10; being changeable even at different growth-stages of the same individual. The height of the siphonal elevation or depth of furrows varies to some extent by individuals, but an angular keel never occurs.

The stems of the external and lateral saddles are much narrowed in some cases (e.g. on the specimen, LSJU. 8541, Text-fig. 63a), but broad in others (e.g. LSJU. 8537, Text-fig. 60a). The essential character of the suture described in the above diagnosis is common throughout the various specimens.

Remarks.—The specific name, *Baculites chicoensis* TRASK, was listed frequently by previous authors, but in many cases the identification is doubtful. I restrict the species as defined above. The specimens which I have seen outside the Chico area (except those from Redmont Cut, near Altamonta, Alameda County) are not referable to *B. chicoensis.*

In the Chico area *B. chicoensis* TRASK occurs stratigraphically above *B. capensis* WOODS. There is, however, no direct relationship between the two, because the latter has tubercles and many other differences from the former. The closest ally of *B. chicoensis* TRASK is *B. bailyi* WOODS (1906, p. 341, pl. 44, fig. 5) [=*Baculites sulcatus* BAILY, 1855, p. 457 (*partim*), pl. 11, fig. 5a, b (*non* fig. 5c)]. This species has an indistinct keel-like elevation, the same curvature of growth striae, and the same type of suture as *B. chicoensis,* but shows very slow tapering. The originals and other examples of *B. bailyi* WOODS were obtained in South Africa from a series of strata in which *Texanites* and *Pseudoschloenbachia,* as well as *B. capensis* WOODS, occur. Therefore the age of *B. bailyi* WOODS is probably Santonian. I know examples of *Baculites* aff. *B. bailyi* WOODS, that came from the probable Santonian-Lower Campanian of Japan. Thus the ancestor of *B. chicoensis* TRASK can be sought in such species as *B. bailyi* WOODS, which has the ultimate origin probably in such species as *B. yokoyamai* TOKUNAGA and SHIMIZU or *B. besairiei* COLLIGNON. *Baculites rectus* MARSHALL (1926, p. 154, pl. 19, fig. 1; pl. 32, figs. 9, 10) from the Senonian (probably Campanian) of New Zealand was regarded by the author himself as closely allied to *B. chicoensis* TRASK. This may be true in some respects, but there is a doubt in his description of suture. He seems to have confused the first lateral lobe with the second; otherwise the suture is dissimilar. A specimen of WRIGHT's collection (*in* SPATH, 1953, pl. 7, fig. 3) from New Zealand shows the suture which is fairly similar to that of *B. chicoensis.* The New Zealand species has, according to MARSHALL's description, no sign of siphonal keel at any growth-stage. The specimens of *B.* aff. *rectus* MARSHALL described by SPATH (1953, p. 19, pl. 7, fig. 2a-c) from the Upper Senonian of Antarctica have also elliptical sections.

There is a very interesting similarity of the sutures between *Baculites chicoensis* TRASK and *Sciponoceras kossmati* (NOWAK) (see text-figures). Of course there is no direct connection between the two species, which are different in many points and geologically much separated. The similarity, however, may not be accidental but have some meaning in the evolutional history of the family Baculitidae.

Occurrence.—Locs. LSJU. 1806 a, LSJU. 2609, LSJU. 2883, CAS. 27838, UCLA. 3648, UCLA. 3647, UCLA. 3645, UCLA. 3644, UCLA. 3643, UCLA. 3642, UCLA. 3641, UCLA. 3639, UCLA. 3638, UCLA. 3637, UCLA. 3636, UCLA. 3632, UCLA. 2406, CIT. 1041, CIT. 1183, UC. A-4654, UC. A-4655, SOC. K-179, SOC. K-

180, SOC. K-181, SOC. K-182, TM. 1010 [=LSJU. 3301], TM. 1013 [=LSJU. 3298], TM. 1014 [=LSJU. 3297], TM. 1016 [=LSJU. 3296], TM. 1017 [=LSJU. 3294], all in Chico Creek, upper half of the Chico formation in the type area; loc. SOC. K-199, Little Chico Creek; LSJU. 2882, CIT. 1040, SOC. K-185, CAS. 27837, Big Butte Creek; locs. CIT. 1012, CAS. 1125, UC. A-963, UC. A-6588, TM. 1000 [=LSJU. 3293], SOC. K-186, etc. in Dry Creek near Pentz Ranch; both approximately corresponding to upper part of the Chico formation in the type section of Chico Creek, east side of the Sacramento Valley.

Comparable specimens have been recently discovered by SCHENCK, GRAHAM, JONES, and me at loc. LSJU. 3356 [=TM. 701], Redmont Cut of Western Pacific Railroad, east of Altamont, Tesla Quadrangle of Bay Area.

In many cases the species is associated with *Submortoniceras chicoense* (TRASK).

Baculites occidentalis MEEK

Pl. 35, figs. 2a-d, 3a-d; Pl. 36, fig. 1a-d; Pl. 41, fig. 1a-d; Pl. 42, fig. 1a-c, 2a-c; Text-figs. 64, 65a, b, 66, 67-71

1857. *Baculites ovatus* (?), MEEK (*non* SAY), *Trans. Albany Inst.*, vol. 4, p. 48.
1862. *Baculites occidentalis* MEEK, *Proc. Acad. Nat. Sci., Philadelphia*, vol. 13, p. 316.
1876. *Baculites occidentalis*, MEEK, *Bull. U. G. Geol. Geogr. Surv. Terr.*, vol. 2, no. 4, p. 366, pl. 4, fig. 1, 1a, 1b.
1879. *Baculites occidentalis*, WHITEAVES, *Mesozoic Fossils*, vol. 1 pt. 2 p. 115.
?1935. *Baculites occidentalis*, ANDERSON and HANNA, *Proc. Calif. Acad. Sci.*, 4th ser., vol. 23, no. 1, p. 24, pl. 8, figs. 3, 4.
1952. *Baculites occidentalis*, USHER (*pro parte* ?), *Geol. Surv. Canada, Bull.* 21, p. 98, pl. 28, fig. 1 (?), pl. 31, fig. 19; text-fig. 4.

Types.—MEEK established this species on several syntypes. At least three of them are now preserved in the U. S. National Museum under the same number, USNM. 1363: two fragmentary body chambers (Pl. 42, figs. 1a-c, 2a-c; Text-figs. 67, 68) and another poorly preserved specimen. The one with the illustrated suture (MEEK, 1876, pl. 4, fig. 1b) is unfortunately missing, but cannot be regarded as having been lost. Although the longer piece of the two body chambers (MEEK, 1876, pl. 4, fig. 1, 1b) might be good enough for the lectotype, I still hesitate to designate so, because it shows no suture. We have to search for the original specimen of MEEK's illustration of the suture. MEEK's specimens came from "Komooks, Vancouver Island".

Material.—A large number of specimens of California are referable to this species. The relatively well preserved examples are as follows:

LSJU. 8553 (Pl. 41, fig. 1a-d; Text-figs. 64, 70), LSJU. 8602, LSJU. 8603 (Text-fig. 69), etc. from loc. LSJU. 3344 (Coll. B. NATERA)

LSJU. 8554 (Pl. 35, fig. 3a-d; Text-fig. 71), LSJU. 8609 (Pl. 35, fig. 2a-d), and many others, from loc. LSJU. 1630 (Coll. S. W. MULLER); many from loc. LSJU. 1628 (Coll. MULLER & REINHARDT)

GK. H 7030 (Pl. 36, fig. 1a-d; Text-fig. 65a, b) from loc. TM. 509C; many others from locs. LSJU. 3343C [=TM. 509C] and LSJU. 3342 [=TM. 505] (Coll. M. B. PAYNE & T. MATSUMOTO)

A specimen from loc. SOC. K-82 (Coll. M. V. KIRK)

Several specimens from loc. CAS. 28305 (Coll. J. A. TAFF, G. D. HANNA, C. C. CHURCH, & C. M. CROSS)

Specimens from locs. CAS. 2362 and CAS. 2367

A specimen, probably referable to this species, from locs. CAS. 33693 and CAS. 26878

Measurements.—

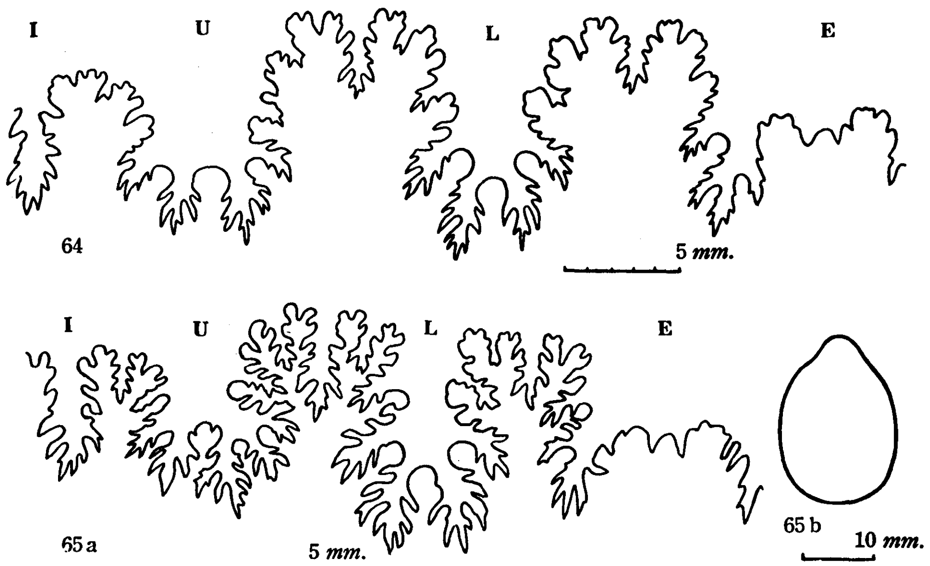
Specimen	Height	Breadth	(B/H)	Distance
USNM. 1363 (longer fragment)	33.5 31.3	24.0 20.8	(0.71) (0.66)	65.0
USNM. 1363 (shorter ″)	36.0 34.0	26.2 23.0	(0.73) (0.66)	65.0
LSJU. 8553	29.0 22.2	19.7 15.3	(0.68) (0.68)	95.0
LSJU. 8602	34.2	25.9	(0.75)	
LSJU. 8603	27.0	19.0	(0.70)	
LSJU. 8554	18.5 13.6	13.5 9.3	(0.73) (0.68)	40.0
LSJU. 8610	7.9	6.2	(0.78)	
LSJU. 8611	5.0 2.6	4.0 2.3	(0.80) (0.88)	12.0
GK. H 7030	23.8 19.5 18.0	17.9 13.7 12.5	(0.75) (0.70) (0.69)	45.0 20.0
GK. H 7031	14.7 11.7	10.5 8.3	(0.71) (0.70)	35.0
One from Soc. K-82	14.6	10.5	(0.71)	
UC. 36118 for comparison	35.3 28.8	22.0 15.4	(0.62) (0.53)	100.0

Diagnosis.—The shell attains a moderate size, the largest height of the section being less than 50 mm. Tapering is fairly rapid in the early growth-stage, moderate in the middle, and very gradual in the late stage. The section is egg-shaped in the earlier growth-stages; it later becomes subtrigonal pear-shaped, with the addition of shallow grooves on both sides of the narrowly rounded siphonal area, subangulation of the laterodorsal shoulder, tendency towards flattening of the antisiphonal (i.e. dorsal) area, and also that of the dorsal half of the flanks. The maximum breadth is at about one third of the height from the dorsum.

The surface of the shell is nearly smooth, but for obscure undulations and lines of growth, which show a deep, but not sharp, sinus on the sides, prominent, long rostrum (i.e. siphonal projection), and broadly convex, short, antisiphonal projection.

The suture is fairly finely incised, but the stems of both the saddles and lobes are not narrow. At the bottom of the lateral lobe (L), the top of the median, minor saddle is below the tops of the adjacent lateral, minor saddles. The saddles on both side of L are nearly of equal size, squarish in general outline, and subsymmetrically bifid; the antisiphonal saddle is much smaller than others. The umbilical lobe (U) (or "second lateral lobe") is wide and asymmetric; the antisiphonal lobe (I) is smaller than other lobes but nearly as deep as, or only slightly shallower than the height of the antisiphonal saddles.

Variation.—Change of shell-form with growth described above is remarkable. This change occurs at a speed that varies between individuals. I have not seen enough specimens from the type locality ("Komooks") and adjacent areas in Vancouver Island. According to USHER (1952, p. 98; text-fig. 4), the section changes rapidly from ovate in early stages to subtrigonal in middle and later stages. He did not describe the shallow grooves on both sides of the siphonal



Figs. 64, 65. *Baculites occidentalis* MEEK.
64. Suture, at height=26.5, breadth=17.5 mm., of a specimen, LSJU. 8553, from loc. LSJU. 3344, Coalinga area. See also Pl. 41, fig. la-d.
65. Suture (a), at height=19.0 mm., and cross section (b), at height=23.3, breadth=17.3 mm., of a specimen, GK. H7030, from loc. TM. 509c [=LSJU. 3343 c], Coalinga area. See also Pl. 36, fig. la-d.

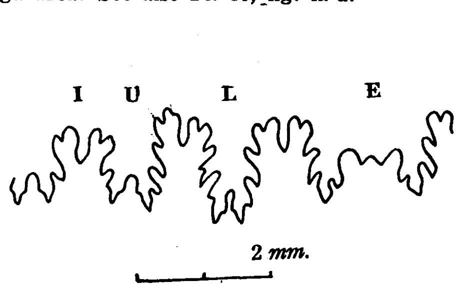
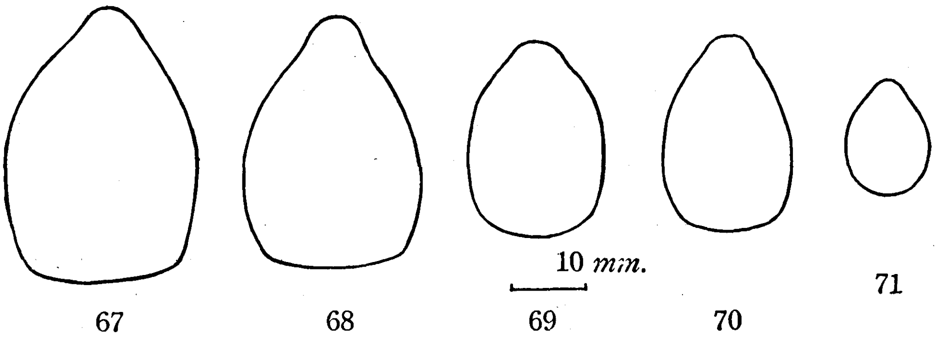


Fig. 66. *Baculites occidentalis* MEEK. Suture of a young shell, LSJU. 8611, from loc. LSJU. 1630, Coalinga area.



Figs. 67-71. *Baculites occidentalis* MEEK. Cross sections of various examples: Two of MEEK's syntypes, USNM. 1363 (figs. 67, 68 from "Komooks, Vancouver Island" (see Pl. 42, fig. 1a-c, fig. 2a-c); three Californian examples. LSJU. 8603 (fig. 69) and LSJU. 8553 (fig. 70) (see also Pl. 41, fig. 1a-d), from loc. LSJU. 3344, and LSJU. 8554 (fig. 71) (Pl. 35, fig. 3a-d), from loc. 1630, Coalinga area.

area, while that character is distinctly discernible on the two adult parts among MEEK's types (see Text-figs. 67, 68 of this paper). This is, however, again variable in intensity and stage of appearance.

Now the Californian examples which I have examined show mostly a slow change of outline. In other words, the sections in the middle growth-stage still keep the ovate outline, while the subtrigonal section, with subangular dorsolateral shoulder, appears at the very latest stage of growth. The very shallow grooves and low, keel-like elevation of the siphonal area, as those of MEEK's original specimens, are discernible in more or less late stages of the Californian examples. Thus the pear-shaped section is not so distinctly shown as in MEEK's types.

If these differences are taken into account, the Californian examples could be separated subspecifically from the typical form of the type area. For the final conclusion of subspecific separation, we have to compare more carefully, perhaps by statistical analysis, the material of the different areas and also to examine by subzonal collecting the change of characters with geological age. In our present knowledge, there is no positive evidence to prove the significant difference in geological age between the forms of Vancouver Island and California.

USHER (1952, p. 98, 99) described at length the variation in ribbing. This is acceptable in principle, because in the specimens at my disposal there is a variation from a nearly smooth example to a weakly costate one, in the latter of which the ribs are better discernible at or near the bottom of their lateral sinus. I have not seen, however, any example in California which has as strong ribs as the illustration of USHER (1952, pl. 28, fig. 1) (GSC. 5952). That figure recalls us rather *Baculites anceps* LAMARCK.

The suture is variable in depth of incisions, breadth of stems of saddles, and other minor details. Its diagnostic features as described above are kept constant.

Remarks.—This species is interesting in that it represents just an intermediate stage from *Baculites* to *Eubaculites.* While typical examples of *Eubaculites* in the probable Maestrichtian of the Indo-Pacific region have angular edges and a flat top of the siphonal keel, a flattened dorsum, and angular dorsolateral shoulders, this species has a rounded, blunt, keel-like siphonal elevation, a less remarkably flattened dorsum, and subangular dorsolateral shoulders only in the relatively later growth-stages.

Baculites chicoensis TRASK (see the preceding description) appears to be the next earlier species along the line of this evolutional trend. It has, likewise, a blunt, keel-like elevation on the antisiphonal area of the shell of later growth-stages. *B. occidentalis* MEEK is less inflated on the sides, accordingly, has smaller proportion of breadth and height in average than *B. chicoensis* TRASK, ranging from 6.5/10 to 7.5/10 as compared with 7.0/10 to 8.6/10 of the latter. The variations in this character overlap and in the young shells below the diameter of 8 mm. there is almost no difference of shell-form between the two species. In the later stages of growth the sides are more convergent and a keel-like elevation has broader top in the former species than in the latter.

In *B. chicoensis* TRASK the shell is nearly smooth, except for growth-lines and faint riblets, the latter only discernible at a late growth-stage; this ornament shows a deep lateral sinus, narrowly rounded at the bottom. In *B. occidentalis* MEEK the ribs are developed somewhat more distinctly than in *B. chicoensis* TRASK, although they are not strong; they show a deep lateral sinus, which is more broadly rounded at the bottom than in *B. chicoensis* TRASK. In *Eubaculites ootacodensis* (STOLICZKA) and its related species the lateral ribs are still more distinct and more broadly arcuate than in *B. occidentalis* MEEK.

The two species, *B. occidentalis* and *B. chicoensis,* differ in sutures. The median minor saddle at the bottom of L is as small as and lower than the adjacent lateral, minor saddles in *B. occidentalis,* but the former is larger and higher than the latter in *B. chicoensis.* In correlation with this the posterior part of L is narrowed in *B. occidentalis,* but it is expanded in *B. chicoensis.* The general outline of the saddle is squarish and massive in *B. occidentalis,* while it is inverse-trapezoidal and rather slender in *B. chicoensis.* In the typical species of *Eubaculites* the suture has broader and more massive elements than in *B. occidentalis* MEEK, being rather of reduced type. Its relative position of minor saddles at the bottom of L is nearly the same as that of *B. occidentalis* MEEK.

In summation, it is still difficult to prove that *B. chicoensis* TRASK is a direct ancestor of *B. occidentalis* MEEK. The former may be a parallel offshoot of earlier age, which showed a tendency towards *Eubaculites*-like character, being perhaps a dead-end, while the latter can well be regarded as an ancestor of *Eubaculites.*

A single example from Santa Catarina, Baja California, described by ANDERSON and HANNA (1935, p. 24, pl. 18, figs. 3, 4: UC. 36118 from loc. UC. A-444) shows a high trigonal section, with dorsolateral angulation and a flattened dorsum. This could be separated from the typical *B. occidentalis* MEEK being closer to *Eubaculites*. There are intermediate specimens, in the collection of W. P. POPENOE from San Antonio del Mar, Baja California, which connect the typical *B. occidentalis* with the form of ANDERSON and HANNA.

Occurrence.—Localities LSJU. 1630, LSJU. 3342 [=TM. 505], LSJU. 3343B, C [=TM. 509B, C], LSJU. 3344, CAS. 2362, and CAS. 28305, all from the lower part of "Ragged Valley shale" of Coalinga area, west side San Joaquin Valley; loc. CAS. 33693, Mt. Diablo Quad., Bay region (possibly referable specimens); loc. CAS. 2367, Ortigalita Peak Quadrangle, west side San Joaquin Valley. Comparable or doubtfully referable specimens came from locs. CAS. 33722, Orestimba Quad., CAS. 26878, Carbona Quad., west side San Joaquin Valley and CAS. 31366, NW. Kern Co., southwest side San Joaquin Valley.

According to USHER (1952, p. 99) the species occurs in the Cedar District and Lambert formations of the Nanaimo group, British Columbia, but I have not examined his specimens.

From the associated species and also the stratigraphic position the geological age is considered as Upper Campanian. Slight difference of age may exist between this species and other species of "Upper Campanian" *Baculites*, since they do not always occur associated with each other. Further study is required for this point.

Baculites inornatus MEEK

Pl. 38, fig. 1a-c, Pl. 43, fig. 5a-c; Text-figs. 72a, b, 73a-d, 74-79

1862. *Baculites inornatus* MEEK, *Proc. Acad. Nat. Sci., Philadelphia*, vol. 13, p. 316.
1876. *Baculites chicoensis* ?, MEEK (*non* TRASK), *Bull. U. S. Geol. Geogr. Surv. Terr.*, vol. 2, no. 4, p. 364, pl. 4, fig. 2, 2a, 2b, 2c.
1879. *Baculites chicoensis*, WHITEAVES, (*pro parte*), *Mesozoic Fossils*, vol. 1, pl. 2, p. 114.
1903. *Baculites chicoensis*, WHITEAVES, (*pro parte*), *Mesozoic Fossils*, vol. 1, pt. 5, p. 339.
?1935. *Baculites inornatus*, ANDERSON and HANNA, *Proc. Calif. Acad. Sci.*, 4th ser., vol. 23, no. 1, p. 24, pl. 8, figs. 1, 2.
1952. *Baculites chicoensis*, USHER (*pro parte*), *Geol. Surv. Canada, Bull.* 21, p. 96, pl. 26, figs. 1-4; pl. 31, fig. 18; text-fig. 3.
1958. *Baculites inornatus*, ANDERSON, *Geol. Soc. Amer. Memoir* 71, p. 190, pl. 48, figs. 2, 2a, 3.

Types.—Three of MEEK's original specimens are preserved in the U. S. National Museum, with numbers USNM. 1257, 1258 and 1259. MEEK's figured specimens are missing, but these three specimens are parts of the syntypes and match the original description of MEEK (1862). One of them, USNM. 1259, is here designated as the lectotype and is illustrated (Pl. 43, fig. 5a-c; Text-fig. 72a, b). It came, together with other syntypes, from "Sucia Island, Washington".

Material.—In California the species is not known so abundantly as in Sucia Island. The following is a list of the examples:

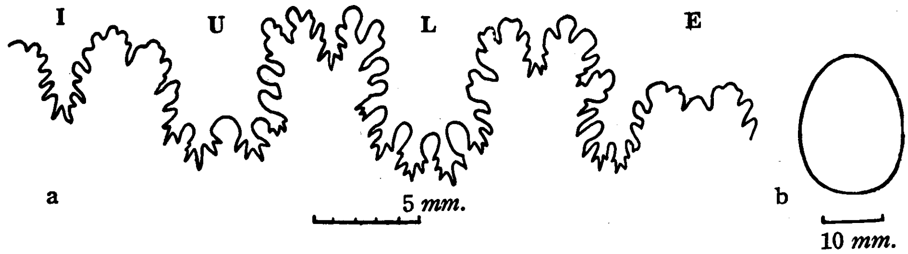


Fig. 72. *Baculites inornatus* MEEK. Suture (a) and cross section (b), at height=22.5, breadth=15.9 mm., of the lectotype, USNM. 1259, from Sucia Island. See Pl. 43, fig. 5a-c.

Three specimens, measured below (see also Text-fig. 77), and another larger body chamber, from loc. CAS. 33709 (no record of collector).

A specimen showing well preserved sutures, from locs. CAS. 29086 (Coll. B. L. CLARK) and CAS. 31245 (Coll. S. McCOY)

Specimens LSJU. 8606-8608, and other comparable fragments from loc. LSJU. 3197, and also from loc. LSJU. 1628 (Coll. S. W. MULLER & REINHARDT)

Specimens from locs. CIT. 83 (Coll. B. N. MOORE), CIT. 983, and CIT. 1060 (Coll. W. P. POPENOE), now preserved at UCLA., and those from loc. CAS. 699

Several specimens from locs. UC. 2135 (Coll. E. M. BUTTERWORTH), and UC. A-7581 (Paleo. 137 class, 1951)

In addition to MEEK's syntypes, I have seen a large number of specimens from Sucia Island by subsequent collecting: UW. 43040 from loc. "UW. D5" (Coll. V. S. MALLORY); UW. 43037, 43038, etc. from loc. UW. A67; UW. 13283

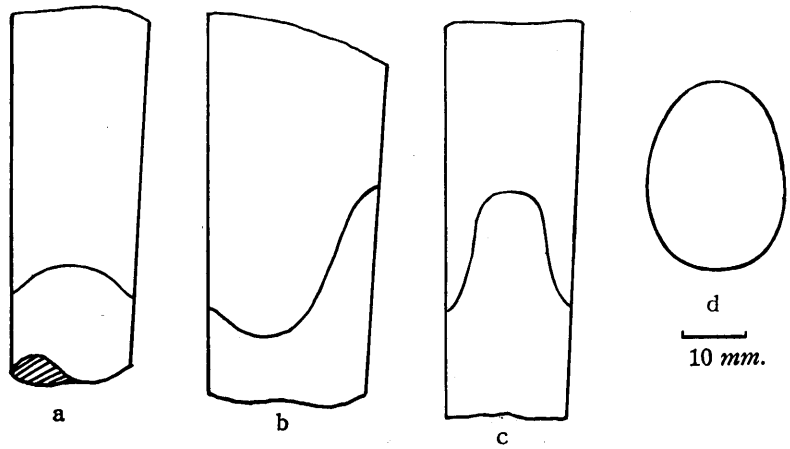


Fig. 73. *Baculites inornatus* MEEK. Curvature of a growth-line on the dorsum (a), side (b), and venter (c) and cross section (d) of one of Meek's syntypes, USNM. 1257, from Sucia Island, Washington.

A-D, etc. from loc. UW. A 142 (Coll. MALLORY, WHEELER, & KEAN); LSJU. "27228" (general no.) from "Puget Sound"; LSJU. "2821" from "loc. 118, Sucia Is." (J. P. SMITH Coll.); specimens from loc. LSJU. 1860 (Coll. F. L. COLE); figured specimens of ANDERSON (1958, p. 190, pl. 48, figs. 2a, 3) from loc. CAS. 228; specimens from locs. UC. A-4528, UC. A-4533, UC. A-4470 (Coll. J. W. DURHAM); UC. 2208, UC. 2209, UC. 2210, UC. 2211 (Coll. E. L. PACKARD ?).

E. C. ALLISON has recently collected and kindly provided me for study a large number of specimens of this species from a limited thickness of strata in Baja California; locs. UC. B-5326, UC. B-5323, UC. B-5321, UC. B-5320, UC. B-5323, UC. B-5325, and UC. A-4580. Two of them are illustrated in this paper (Pl. 38, fig. 1a-c; Text-fig. 74).

Measurements.—

Specimen	Height	Breadth	(B/H)	Distance
USNM. 1259 (lectotype)	22.5 18.5	15.9 12.9	(0.71) (0.70)	60.0
USNM. 1257	29.8 25.6	22.2 18.8	(0.74) (0.73)	50.0
USNM. 1258	27.0	19.8	(0.70)	
LSJU. 27228	39.1 32.8	27.2 21.3	(0.69) (0.65)	145.0
LSJU. 2821 A	40.0	27.5	(0.69)	
LSJU. 2821 B	26.7	20.3	(0.76)	
UW. 43040	25.3 21.4	17.5 15.3	(0.69) (0.71)	60.0
UW. 43037 (costal) (intercostal)	21.0 19.5 18.3	16.5 14.1 13.3	(0.78) (0.72) (0.72)	*c.* 50
One of UC. 2208	28.8 23.0	20.2 16.5	(0.70) (0.71)	60.0
ANDERSON, 1958, pl. 48 f. 2 (costate)	21.3 17.8	16.7 14.4	(0.78) (0.80)	45.0
One from CAS. 33709	21.0	14.4	(0.66)	
Another " "	17.2	12.4	(0.72)	
Another " "	13.2	9.2	(0.70)	
LSJU. 8606	13.1	10.1	(0.77)	
LSJU. 8607	16.4	13.2	(0.80)	
LSJU. 8608	25.5	20.5	(0.80)	
One of UC. B-5326	48.0 44.5	33.8 32.3	(0.70) (0.72)	90
One from UC. B-5321	32.9 27.2	23.3 19.9	(0.71) (0.73)	85
One from UC. B-5323 (costal) (intercostal)	36.8 35.9 31.3	28.5 26.5 23.7	(0.77) (0.73) (0.75)	80
One from CIT. 1060	14.5 10.5	10.5 8.3	(0.72) (0.79)	40

Diagnosis.—The shell is of medium size, the maximum diameter of the section being about 50 mm. Tapering is gradual; the body chamber of the adult is almost parallel sided, but moderate tapering occurs sometimes in the young stage. The section is higher than broad, and nearly elliptical; the ventral area is somewhat more narrowly rounded than the dorsal area. The growth-lines indicate a sinus of moderate depth on the sides, a long linguiform rostrum on the ventral area, and a short and broad projection on the dorsal area; the ventral projection is not acute but moderately rounded at its top, the dorsal projection very broadly arcuate, and the bottom of the sinus broadly concave.

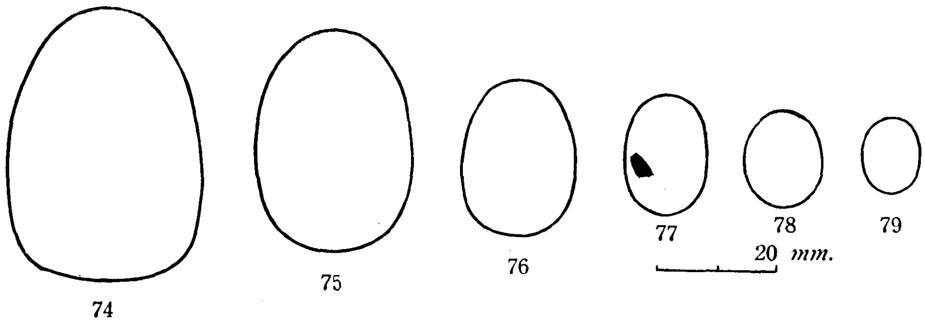
The surface of the shell is typically smooth, except for the growth-lines. It is, however, occasionally ornamented with widely spaced, blunt, broad, lateral undulations and also with numerous, weak corrugation on the siphonal area.

The saddles and lobes of the suture (except for I) are broad, squarish, and massive; the incisions are fine but not deep, giving rise to phylloid terminals to the minor saddles. The saddles on both sides of L are of subequal size, or the external one is slightly narrower and lower than the internal one; they are nearly symmetrically bifid. The three minor saddles at the bottom of L are equally small, the median one being slightly lower than the top of the lateral, minor saddles. The antisiphonal lobe (I) is relatively narrow and small; the antisiphonal saddles are lower than lateral saddles.

Variation.—A large number of specimens from a limited area and a limited stratigraphic range of Sucia Island and Baja California clearly show the extent of variation of this species. The Californian examples are within this variation.

Tapering is generally slow. Moderate tapering sometimes occurs in the young shell, and in still rare cases, even persists to the shell of middle growth-stage, e.g. of 25 mm. in heights of cross section.

The proportion of height and breadth of the section varies from 6.5/10 to 8.0/10. The roughly elliptical section is sometimes modified to ovate, the siphonal side more narrowly rounded than the antisiphonal. The form with ovate section and considerable tapering apparently approaches *B. occidentalis* MEEK, although the two species are distinguished by their sutures. A set of specimens from loc. U.C. A-8580, Baja California, especially show this tendency; some of them have faint depressions on both sides of the narrowly rounded



Figs. 74-79. *Baculites inornatus* MEEK. Cross sections of various examples: a large specimen (fig. 74) from loc. UC. B-5326, Baja California; a specimen, LSJU. 27228 (general coll.) (fig. 75) from Puget Sound, Sucia Island; one of Meek's syntypes, USNM. 1258 (fig. 76) from Sucia Island; an example (fig. 77) from loc. CAS. 33709, Texas Flat, near Folsom, California; two young shells, LSJU. 8607 (fig. 78) and LSJU. 8606 (fig. 79), from loc. LSJU. 3197, Coalinga.

siphonal area. They seem to represent an intermediate shell-form between the two species, but the partly exhibited last sutures indicate rather of *inornatus* type. Whether the resemblance is superficial or genetic should be carefully examined.

Concerning sutures, the diagnostic features described above are kept fairly constantly. In a few exceptional examples, however, again an approach to the pattern of *B. occidentalis* MEEK is discernible. A specimen from loc. CAS. 33709 (Folsom), for instance, exhibits a suture in which the two lateral minor saddles are considerably higher than the median minor saddle at the bottom of L. This specimen has an egg-shaped cross section, but other specimens from the same locality have an elliptical section and typical *inornatus* type of suture. This may be an extreme case of variation, but accidental admixture of a few specimens of *B. occidentalis* with many of *B. inornatus* might have happened. The true situation should be examined through careful field observation.

MEEK's syntypes and many other specimens are nearly smooth on the surface of the shell, except for growth-lines and weak, siphonal corrugation. Some specimens have distant, broad and low costae on the sides, as shown in the illustration (Pl. 38, fig. 1a-c). They occur in the same bed as the smooth ones and there is complete gradation between the two kinds of ornaments. Therefore, they cannot be separated as distinct species.

Remarks.—From the above description *B. inornatus* MEEK could be regarded as a possible ally of *B. occidentalis* MEEK, but careful stratigraphic, as well as paleontological analysis is required for a final conclusion. So far as the available evidence is concerned, the former species is longer ranged than the latter, appearing slightly earlier. They occur frequently in the same formation, but not at the same locality, except for a few doubtful cases.

Attention should be paid to the close affinity of the present species with certain extra-Pacific ones. A species of the lower part of the Navarro group of the Gulf Coast region, described under the name of *Baculites claviformis* STEPHENSON (1941, p. 403, pl. 1; pl. 77, figs. 6-8; pl. 78, figs. 1-6), is closely allied to *B. inornatus* MEEK, especially to the bluntly costate variety, in shell-form, ornament, and general pattern of suture. The difference is the much larger size and the more minute incisions of the suture in the Gulf Coast species. In other words the former is slightly more advanced and possibly of slightly later geological age than the latter. *B. claviformis* STEPHENSON and the contemporary *Baculites undatus* STEPHENSON (1941, p. 405, pl. 79, figs. 5-10) (which may represent a variety of the same species) are closely allied to, or possibly identical with, the well known species of the Western Interior, *Baculites grandis* HALL and MEEK (1854, p. 402, pl. 6, fig. 10; pl. 7, figs. 1, 2; pl. 8, figs. 1, 2) MEEK, 1876, p. 398, pl. 33, fig. 1a-c; text-fig. 53).

Baculites vertebralis LAMARCK (1801, p. 103) (see SCHLÜTER, 1876, p. 143, pl. 39, figs. 11-13; pl. 40, figs. 4, 5, 8) from the Upper Senonian (Upper Campanian—Lower Maestrichtian ?) of Europe is again allied to *Baculites inornatus*

MEEK, in the slow tapering, nearly elliptical cross section, smoothish surface, and the general pattern of the suture. I have not seen enough of the European specimens, but from the descriptions and figures by SCHLÜTER (1876, with synonyms), and NOWAK (1908, p. 350, pl. 14, fig. 8; text-fig. 12), that species has more compressed whorl and less deeply and more minutely incised sutures than this species. The illustration of the former shows the rectangular antisiphonal saddles, which are distinctly separated by the antisiphonal lobe even on the young whorl. The two antisiphonal saddles of the latter altogether form a dome-like outline, subdivided by the antisiphonal lobe, which is small at least in the young. Whether this difference is actual or just a matter of method of drawing is not clear. The species from the Lower Maestrichtian of Palestine and Egypt, which was described under *Baculites vertebralis* (PICKARD, 1929, p. 444, pl. 9, figs. 5-8; text-figs. 3-6; GRECO, 1915, p. 114, pl. 15, figs. 2, 3), has the same type of antisiphonal suture as *B. inornatus* MEEK. In other respects this Middle East species is indistinguishable from *B. vertebralis* LAMARCK of Europe. PICKARD pointed out the variability of the shell form, calling the form with ovate cross section *B. vertebralis* var. *ovatus* SAY (PICKARD, 1922, p. 446), and the one with thick section *B. vertebralis* var. *syriacus* CONRAD (PICKARD, 1929, p. 445, pl. 9, figs. 9, 10). The variation is similar to that of *B. inornatus* MEEK. Another contemporary species, *B. palestinensis* PICKARD (1929, p. 438, pl. 10, figs. 1-7; text figs. 1, 2) from Palestine, is similar to the costate variety of *B. inornatus* MEEK, although its costae seem to be strong. My comparison with the Middle East species has been done only from the description and illustration. Direct comparison of the actual specimens should be done some day.

Occurrence.—Loc. 33709, near Folsom, E. Sacramento Valley; locs. CAS. 29086, Contra Costa Co., Bay Area; CAS. 31245, Arroyo del Valle, Alameda Co. (associated with *Metaplacenticeras*), Bay Area; locs. LSJU. 3197 and LSJU. 1628 of Coalinga Quadrangle, west side San Joaquin Valley (associated with *Inoceramus subundatus* MEEK); loc. UC. A-7581, Reef Ridge Quadrangle, west side San Joaquin Valley; locs. CIT. 83, CIT. 983, CIT. 1060, Santa Ana Mountains, top of Holtz shale, southern California; loc. CAS. 699, St. Monica Mountain, southern California.

Doubtfully referable specimen came from loc. CAS. 33695, upper part of the upper half of Marlife formation, Panoche group (associated with *Pachydiscus buckhami* USHER, *Pachydiscus* cf. *ootacodensis* (STOLICZKA)), west side San Joaquin Valley.

The species is abundant in Sucia Island, from where MEEK's types were obtained. USHER referred the formation there to his Cedar District formation; the information from University of Washington (through Prof. MALLORY) indicates the Haslam formation. According to USHER the species occurs in Vancouver Island (including Sucia and Little Sucia Islands) in the Haslam, Lambert, and Cedar District formations.

The occurrence in Baja California will be described in detail by E. C. ALLISON.

Baculites columna MORTON

Pl. 30, fig. 1a-c; Pl. 34, fig. 4a-c; Pl. 43, fig. 4a-c; Text-figs. 80a, b, 81

1834. *Baculites columna* MORTON, *Synopsis of the organic remains of the Cretaceous group of the United States*, p. 44, pl. 19, fig. 8.
1905. *Baculites columna*, JOHNSON, *Acad. Nat. Sci. Philadelphia Proc.*, vol. 57, p. 27.
1941. *Baculites columna*, STEPHENSON, *Univ. Texas Publ.*, no. 4101, p. 405, pl. 76, figs. 1-4.
1951. *Baculites* cf. *fairbanksi*, BROWN (*non* ANDERSON) *in* PAYNE, *State Calif., Dept. Nat. Res., Div. Mines, Special Report* 9, p. 27 (listed only).

Types.—MORTON's figured type seems to be missing (JOHNSON, 1905). The type locality is at "Prairie Bluff, Alabama River, Wilcox County, Alabama". I examined the collection of the Academy of Natural Sciences of Philadelphia, but failed to find any reliable record for the designation of the lectotype. For the time being I follow the definition by STEPHENSON (1941), who illustrated a fairly well-preserved specimen, a hypotype, USNM. 77248, from locality close to the type locality.

Material.—The Californian specimens which I refer to this species are as follows:

LSJU. 8572, LSJU. 8573 (Pl. 30, fig. 1a-c), LSJU. 8574, and LSJU. 8575 (Pl. 34, fig. 4a-c), all from loc. LSJU. 2251 (Coll. R. C. BROWN, S. W. MULLER, H. G. SCHENCK & M. B. PAYNE)

Two figured specimens (Pl. 43, fig. 4a-c; Text-fig. 80a, b, 81) and several other fragmentary pieces from loc. UC. A-4684 (Coll. Dept. Paleont. UC. 103 Class, 1948)

I had an opportunity of studying STEPHENSON's specimens (USNM. 77248, 77429, etc.) from Alabama and Texas.

Measurements.—

Specimen	Height	Breadth	(B/H)	Distance	Number of ribs within the measured distance	Number of ribs within the (distance of average height)
USNM. 77248	8.4	7.0	(0.83)	40	11	(2.1)
USNM. 77249	7.1	6.3	(0.88)	16	5	(2.2)
LSJU. 8573	10.1 9.0	7.8(+) 7.0	(0.77) (0.77)	25	8	(3.0)
LSJU. 8572	7.5 6.0	5.8 4.5	(0.77) (0.75)	25	8	(2.1)
LSJU. 8575	6.8 5.0	5.3 3.9	(0.77) (0.78)	15	8	(3.1)
Larger one of UC. A-4684	12.0 10.5	10.0 9.2	(0.83) (0.87)	15	3	(2.3)
Medium ,, ,, ,,	6.5	5.0	(0.77)			
Smaller ,, ,, ,,	3.4	3.0	(0.88)			

Diagnosis.—The shell is small and shows slow tapering. The section is higher than broad and nearly elliptical, with the venter slightly more narrowly rounded than the dorsum.

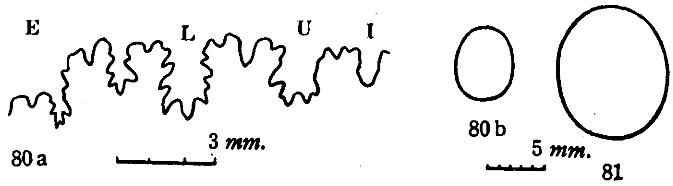
The shell is ornamented with widely spaced ribs of moderate intensity, which start from the thickest point near the dorsolateral shoulder, run obliquely forward on the main part of the flank, and cross the venter with projection and undiminished strength; the extensions of the ribs to the antisiphonal area are weakened and show less pronounced forward curve on the dorsum.

The suture is simple, with shallow minor incisions. The saddles are broad, the one between E and L being the broadest. They are symmetrically bifid. The lobes are much narrower than the saddles, but their stems are not constricted.

Variation.—Although the specimens at my disposal are only about a dozen, they indicate a certain extent of variation. Tapering of the shell is generally slow, but a few young specimens (e.g. LSJU. 8575) show moderate tapering. The proportion of breadth and height varies between 7.5/10 and 8.8/10.

The ribs are more or less widely spaced. The number of ribs within the distance of height ranges from 2 to 3. The strength of the ribs may vary to some extent. At a point near the dorsolateral shoulder on the flank the ribs are generally arcuate, but on some relatively large specimens, they are bent rather abruptly, forming obtuse chevrons.

Remarks.—This species is very peculiar in that it is apparently similar to *Sciponoceras bohemicum* (FRITSCH) (see description of p. 109) of much earlier geological age. This may be the reason why the specimens from loc. LSJU. 2251 were once misidentified as *Baculites fairbanksi* ANDERSON (PAYNE, 1951, p. 27), which can be included in *Sciponoceras bohemicum* (FRITSCH). *Baculites columna* MORTON has no constrictions, which *Sciponoceras* has. In this respect, the species looks like *Lechites gaudini* (PICTET and CAMPICHE) (especially the variety *raricostatus* BREISTROFER) (see description of p. 102) of still earlier age. This is of course a superficial resemblance, because *Lechites* has a different pattern of suture and simple oblique ribs. Anyhow the resemblance is very interesting, because it happened between the species of almost two end members of the long ranged family Baculitidae.



Figs. 80, 81. *Baculites columna* MORTON.
80. Suture (a) and cross section (b), at height=6.5, breadth=5.0 mm., of a specimen from loc. UC. A-4684, Volta area.
81. Cross section of another specimen, UC. 36440, from loc. UC. A-4684. See also Pl. 43, fig. 4a-c.

The aperture of *B. columna* MORTON has not yet been found. It should be different from that of *Sciponoceras* and *Lechites.* The oblique ribs cross the venter with considerable forward, subacute curve, but their projection is not so remarkable as that of the apertural margin of other Senonian *Baculites.* Unfortunately the preservation is not good enough to see the growth-lines. One of the specimens (Pl. 43, figs. 4a-c), however, shows on the venter slight traces of the growth-lines, which are nearly as strongly projected as those of the typical examples of *Baculites,* cutting obliquely the ribs. There is no peculiarity in the curvature of the dorsal ornament.

In the elliptical section, slow tapering, and simple suture *B. columna* MORTON is apparently allied to Lower Senonian *B. besairiei* COLLIGNON (1931, p. 37, pl. 5, figs. 6, 6a, 7, 7a, 8, 8a, 9; pl. 9, fig. 16) and *B. yokoyamai* TOKUNAGA and SHIMIZU (1926, p. 195, pl. 22, fig. 5a, b; pl. 26, fig. 11). There is considerable gap of geological age between the former species and the latter two, which differ in ornaments. I have not seen any species which could be the direct ancestor of *B. columna* MORTON.

Occurrence.—Not rare in California; loc. LSJU. 2251; calcareous sandstone at the top of the Panoche group in type Panoche Hills, west side of the San Joaquin Valley; loc. UC. A-4684, Volta Quadrangle, adjacent to the north of Panoche Quadrangle, west side of the San Joaquin Valley; the calcareous sandstone of this locality, which is called "Garzas formation" and is used to be referred to Moreno group, is, in my opinion, a probable equivalent of a part of the Uhalde formation, top member of the Panoche group. From the same locality, UC. A-4684, *Baculites* (?) aff. *B. teres* (FORBES) was obtained. LSJU. 2251 has *Diplomoceras* sp. and *Glyptoxoceras* sp. Many other molluscan shells are contained in the sandstone of the two localities.

According to STEPHENSON (1941) the species occurs in the Prairie Bluff chalk of Alabama and Corsicana marl of Navarro group of Texas, both of which are referred to the Maestrichtian.

Baculites (?) aff. *B. teres* FORBES

Pl. 45, figs. 5a-d, 6a-c; Text-figs. 82a-c, 83

Compare.—

1846. *Baculites teres* FORBES, *Trans. Geol. Soc. London,* 2nd ser., vol. 7, p. 115, pl. 10, fig. 5a, b.
1865. *Baculites teres,* STOLICZKA, *Mem. Geol. Surv. India, Pal. India,* ser. 3, vol. 1, p. 197, pl. 90, fig. 12, 12a, 12b (*non* fig. 13).
1895. *Baculites teres,* KOSSMAT, *Beitr. Pal. Geol. Oesterr.-Ung. Or.,* vol. 9, p. 155 [59].

Holotype of *B. teres* FORBES.—BM. C. 51152, from the Valudayur beds of Pondicherry, southern India (Coll. KAYE & CUNLIFFE), a plaster cast of which has been sent to Kyushu University by courtesy of Dr. M. K. HOWARTH of the British Museum (Natural History).

Material.—The Californian specimens which I describe under this heading are as follows:

The figured specimens, UC. 33521 (Pl. 45, fig. 5a-d, Text-fig. 82a-c) and UC. 33522 (Pl. 45, fig. 6a-c, Text-fig. 83), and a large number of fragmentary pieces, from loc. UC. A-4684 (Coll. UC. Paleo. 103 class, 1948)

Several fragmentary specimens, from loc. UC. A-7234 (Coll. UC. Geol. 118 class, 1951; Paleo. 117 class, 1958)

Measurements.—

Specimen	Height	Breadth	(B/H)	Distance
UC. 33521	5.5 4.2	5.3 3.9	(0.96) (0.93)	22.0
UC. 33522	6.5	5.8	(0.89)	
BM. C. 51152	8.0	7.5	(0.94)	

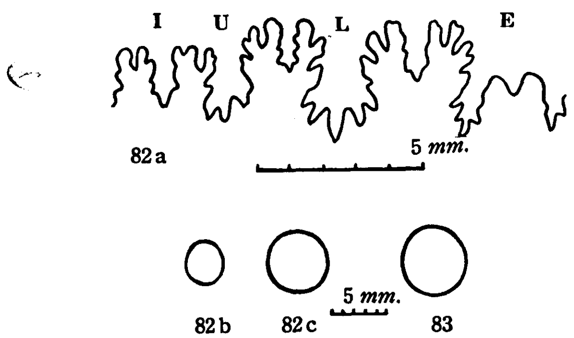
Description.—The shell is rather small, showing slow tapering. The section is subcircular, with height only slightly larger than breadth.

The surface is weakly ornamented with fine lirae or subcostae, which are prorsiradiate on the main part of the flank, moderately projected on the venter, with a rounded curvature, prorsiradiate on the dorsolateral part, and much weakened and slightly projected on the dorsum with a broad curve. Some ribs are occasionally stronger than others, being accompanied with indistinct grooves.

There is a collar at the base of the apertural margin, which, in turn, is somewhat enlarged as compared with the main part of the body chamber (see Pl. 45, fig. 6a-c). The outline of the very margin is not known.

The suture is simple, with relatively shallow minor incisions. The saddles are massive, rather plump in general outline, and almost symmetrically bifid. The one between E and L is the broadest. The lobes, except E, are narrower than the adjacent saddles, but their stems are not particularly narrowed.

Remarks.—From the above described characters the Californian specimens under consideration are almost certainly referred to *Baculites teres* FORBES (1846,



Figs. 82, 83. *Baculites* (?) aff. *B. teres* (FORBES).
82. Suture (a) and two cross sections (b, c) of a Californian example, UC. 33521, from loc. UC. A-4684, Volta area. See Pl. 45, fig. 5a-d.
83. Cross section of another specimen, UC. 33522, from loc. UC. A-4684, See Pl. 45, fig. 6a-c.

p. 115, pl. 10, fig. 5a. b; STOLICZKA, 1865, p. 197, pl. 90, fig. 12, 12a, 12b; KOSSMAT, 1895, p. 155 [59]). Unfortunately no suture has been illustrated nor described for this Indian species. The suture figured by STOLICZKA (1865, pl. 90, fig. 13b) is not for this species from Valudayur beds, but probably for a certain species of *Sciponoceras* from the Ootatoor group. FORBES (1846) mentioned obsolete longitudinal striae, which seem to me to be a matter of preservation, and was denied by STOLICZKA. Such a feature is not recognized in the Californian specimens. Until these doubtful points can be clarified by the study of the topotypes from India, I cannot conclude the precise identity.

This species is peculiar in that the lirae or subcostae are not so strongly projected on the venter as in normal species of *Baculites,* in that they are oblique on the main part of the flanks, with a shallow sinus near the dorsolateral edge, and in that the cross section is subcircular, instead of compressed elliptical or oval. All these features, together with indistinct constriction-like grooves, give a superficial similarity between this species and geologically much earlier species of *Sciponoceras*. In the curvature of ribs and also in the pattern of sutures, the present species is closely allied to nearly contemporary *Baculites columna* MORTON (see the preceding description), but the latter has distinctly stronger and much more distant ribs and more elliptical section. The establishment of a new genus or subgenus might be suggested for these two species, which have certain peculiar features as compared with normal *Baculites*. But I hesitate to do such a new proposal, until their relations with *B. vertebralis* DEFRANCE, the type species, can be clarified. Actually, among the hitherto known species from California, *B. inornatus* MEEK, which is closely allied to *B. vertebralis,* has some affinity with *B. columna* in the elliptical, instead of egg-shaped, section and with *B. teres* in the weak ornaments, the relatively shallow sinus of the lirae, and with both of the two in the tendency to have simplified sutures, although it may not be a direct ancestor of them.

Occurrence.—Loc. UC. A-4684, Volta Quadrangle, the so-called "Garzas sandstone", west side San Joaquin Valley. From the same locality *Baculites columna* MORTON was also obtained (see the preceding description). Loc. UC. A-7234, in limestone west of Willows, west side Sacramento Valley, far apart higher than the top of Guinda sandstone, and considerably higher than the localities of *Baculites inornatus* MEEK. From the same locality *Baculites rex* ANDERSON was obtained. Although only the two localities have been known, the specimens occur fairly commonly in the rocks.

The original locality in India is, according to KOSSMAT (1895), Valudayur beds of Pondicherry. This is probably referred to the Lowest Maestrichtian or somewhere near the boundary of Campanian and Maestrichtian.

Genus *Eubaculites* SPATH, 1926

Type-species.—*Baculites ootacodensis* STOLICZKA, 1866 (by original designation).

Generic diagnosis.—The shell is of moderate size, or fairly large. The cross section is "pear-shaped", with a tabulated ventral keel and a flattened dorsum. The dorsal half or two-thirds of the flank is ornamented with broadly arcuate, or nearly straight, strong ribs or bullae, which fade out on the remaining ventral part of the flanks. Indistinct tubercles may develop at the ends of the ribs. The elements of the suture are broad and massive, with numerous minute frills. The character of the apertural margin is not well known.

Remarks.—SPATH (1926, p. 80) has reasonably introduced this generic names, and further made clear the scope of the genus (SPATH, 1940, 1953). As he remarked, the species of *Eubaculites* have been known in the Upper Senonian of southern India, western Australia, and Chile. He strongly doubted the identification of *B. vagina* FORBES by the French paleontologists for the Malagasy specimens, although the distribution of *Eubaculites* to that region could be expected, as he considered. I have no positive comments on the Malagasy specimens, which I have not studied.

Incidentally the species which are referred to *Eubaculites* were all old established, as indicated in the following list:

Baculites vagina FORBES, 1846
B. lyelli D'ORBIGNY, 1848
B. ornatus D'ORBIGNY, 1848
B. ootacodensis STOLICZKA, 1865
B. simplex KOSSMAT, 1895

A few Californian examples of *Eubaculites* were already illustrated (though inadequately) by GABB (1864) under the misidentified specific name, *Baculites chicoensis* (*non* TRASK). Now I have sufficient confirmation for the representatives of *Eubaculites* occurring in California.

The Californian material is, furthermore, important in that it furnishes us with some evidence for concluding the derivation of *Eubaculites* from such species as *Baculites occidentalis* MEEK. This has been discussed in the description of that species.

The five species of *Eubaculites* listed above are closely allied to one another, so that even a question remains whether they are all distinct species or some of them should better be regarded as variants or subspecies of a smaller number of species. In view of the considerable variability of certain minor characters, it is unwise to split the well defined *Eubaculites* into more genera or subgenera, unless some new diagnostic, instead of insignificant, characters would be recognized from fresh materials.

Eubaculites ootacodensis (STOLICZKA)

Pl. 43, fig. 6; Pl. 44, figs. 1a, b, 2a-c, 3a-d; Text-figs. 84a, b, 85a, b

1864. *Baculites chicoensis*, GABB (*non* TRASK) (*pro parte*), *Pal. Calif.*, vol. 1, p. 80, pl. 14, fig. 29, 29a (*non* pl. 17, fig. 27, 27a; pl. 14, fig. 27b).
1865. *Baculites vagina* var. *ootacodensis* STOLICZKA, *Mem. Geol. Surv. India, Pal. Indica*, ser. 3, vol. 1, p. 199, pl. 90, fig. 14,

Ung. Or., vol. 9, p. 157 [61], pl. 19 [5], fig. 15a, b, 16a-c.

1922. *Baculites vagina* var. *otacodensis*, COTTREAU, *Ann. Pal.*, vol. 11, p. 72, pl. 9, fig. 11, 11a, 11b.

1940. *Eubaculites otacodensis*, SPATH, *Jour. Royal Soc. W. Australia*, vol. 26, p. 49, pl. 1, fig. 3a, b; text-fig. 1b.

Types.—Unfortunately I have not seen the original specimens of STOLICZKA (1865) and KOSSMAT (1895). The lectotype should be selected from STOLICZKA's specimens through careful study of the Indian material. SPATH's (1940) hypotypes are not in the British Museum, but in the University of West Australia. In the collections of Stanford University there are examples of the present species, LSJU. 8642 (Pl. 44, fig. 3a-d; Text-fig. 85a, b) and two others from loc. LSJU. 3184 and LSJU. 8643 (Pl. 43, fig. 6; Pl. 44, fig. 1a, b) and four others from loc. LSJU. 3186, from the Upper Cretaceous of West Australia, which are associated with the same type of faunule as that SPATH (1940) once reported. They are useful for understanding *E. ootacodensis* (STOLICZKA), although they were not type specimens of previous authors.

Material.—The Californian material is rather poor in preservation and in number of specimens. There are, at any rate, examples listed as follows:

UC. 12116 [= "Calif. Geol. Surv. 52"] (Pl. 44, fig. 2a-c), one of the originals of *Baculites chicoensis* var. of GABB (*non* TRASK) (1864, pl. 14, fig. 29), from "Martinez"

Another specimens, in the collection of the Academy of Natural Sciences of Philadelphia, of *Baculites chicoensis* var. of GABB (1864, pl. 14, fig. 29a ?), from "Martinez"

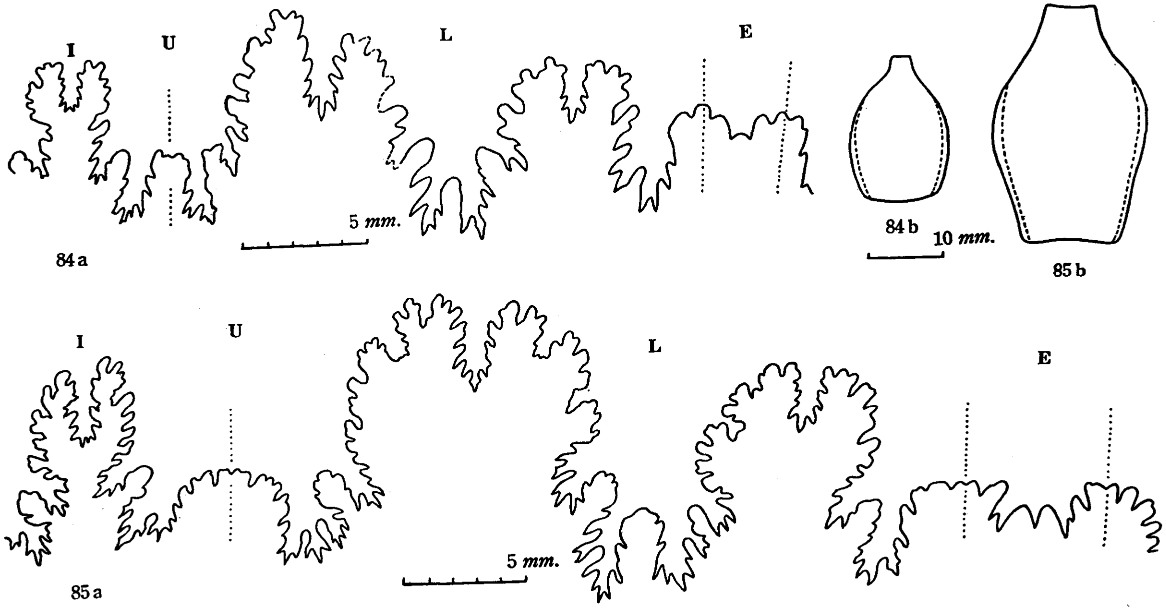
LSJU. 8627, from loc. LSJU. 3362, and LSJU. 8628 and 8629, from loc. LSJU. 3363, crushed specimens

Several crushed specimens from loc. UC. B-4163

Measurements.—

Specimen	Height	Breadth (costal)	(B/H)	Breadth (intercostal)	(B′/H)	Distance	Number of ribs within the measured distance	Number of ribs within the (distance of average height)
LSJU. 8642 from loc. LSJU. 3184	31.8 27.0	20.5 17.0	(0.64) (0.63)	18.0 14.6	(0.56) (0.54)	95	8	(2.3)
Another ,, ,,	27.3	15.3	(0.56)			45	4	(2.4)
Another ,, ,,	24.5 19.5	12.5 10.9	(0.51) (0.56)			10.5	10(?)	(2.1)
LSJU. 8643 from loc. LSJU. 3186	22.8 19.5	14.8 12.0	(0.65) (0.61)			50	6	(2.5)
Another ,, ,,	26.5 22.5	18.5 14.5	(0.67) (0.64)	16.3	(0.61)	60	6	(2.4)
Another ,, ,,	23.0 15.2	14.2 10.2	(0.61) (0.67)			90	15	(3.2)
UC. 12116	18.8	13.0	(0.64)			50	7	(2.6)
ANSP.	18.0 11.5	12.0 7.3	(0.66) (0.63)			55	9	(2.4)

Diagnosis.—The shell is of moderate size, typically showing slow tapering.



Figs. 84, 85. *Eubaculites ootacodensis* (STOLICZKA).

84. Suture (a) and cross section (b) of a Californian example, UC. 12116, from Martinez [=*Baculites chicoensis* GABB, 1864, Pl. 14, fig. 29]. See Pl. 44, fig. 2a-c.

85. Suture (a) and cross section (b) of a West Australian example, LSJU. 8642, from loc. LSJU. 3184. See Pl. 44, fig. 3a-d.

The section is pear-shaped, higher than broad, broadest near the mid-flank, considerably inflated on the lateral ribs, flattened on the interspaces of the ribs, convergent on the ventral half of the flanks, flattened on the top of the siphonal keel, which has angular edges, subangular at the laterodorsal shoulder, and flattened, or sometimes slightly concave, on the dorsum, which is approximately two thirds as narrow as the maximum breadth of the whorl.

Strong ribs are developed on the dorsal two thirds of the flanks. They are more or less widely separated, very broadly arcuate, or sometimes nearly straight on the dorsal half, being vertical to the axis of growth, strongest at about the mid-flank, from where they bend abruptly forward and fade out rapidly, leaving smoothish ventral portion of the flank. Another, less pronounced, node like thickening of the ribs are sometimes developed at the laterodorsal shoulder. On the siphonal keel may be discernible small, weak corrugations, which are two to three times as numerous as the ribs.

The elements of the suture are broad and massive, with numerous minute frills. The antisiphonal saddle is exceptionally narrow and deeply cut by the branches of U. The saddle between L and U is broader than that between L and E. At the bottom of L the top of the median minor saddle is somewhat lower than those of the lateral minor saddles.

Variation.—Without seeing numerous specimens from India, I cannot describe exactly the extent of variation of the presbent species. The eight specimens from the two localities in West Australia show fairly wide extent of variation. The Californian examples fall within it.

Although the widely separated, strong ribbing is generally regarded as characteristic of *Eubaculites ootacodensis* (STOLICZKA), the feature is not so constant as KOSSMAT (1895, p. 157) considered. SPATH (1940) mentioned the existence of a variety with less prominent ribs. One of the specimens from loc. LSJU. 3184 is weakly ribbed and much compressed especially towards the anterior end, but is otherwise provided with the diagnosis of *E. ootacodensis*. Another specimen represents an intermediate intensity of the ribs. The number of ribs within the distance of the average height varies from two to slightly over three. In the latter case, as exemplified by one of the specimens from loc. LSJU. 3186, the ribs are separated by the interspaces nearly as narrow as, or only slightly wider than, the ribs themselves.

The separation of the ribbed and smooth areas on the flank is not so well-marked as SPATH (1941, p. 48) considered. Only one specimen before me shows a faint trace of a longitudinal groove along the boundary. More frequently there can be seen the faint longitudinal grooves on both sides of the siphonal keel.

Tapering is generally slow, but one specimen from loc. LSJU. 3186 shows moderate tapering. A small, probably young example of California (loc. UC. B-4163), although secondarily deformed, shows rapid tapering. This might be the young of some other species, but the associated larger specimens are referable to *E. ootacodensis*.

Remarks.—The two specimens from "Martinez", described under *Baculites chicoensis* var. by GABB (1864, p. 80, pl. 14, fig. 29, 29a) are indistinguishable from some Australian examples of *E. ootacodensis* (STOLICZKA) before me. The Californian specimens were mentioned by KOSSMAT (1895, p. 157), in comparison with *B. vagina* var. *simplex,* and also by SPATH (1953, p. 46), who did not assign them to *Eubaculites*, having been misled by GABB's incorrect figures. GABB restored the illustration from the uncleaned specimens. The photographs and drawing of suture of one of the two (UC. 12116) are put in this paper, to show its flat-topped keel, with angular edges, *ootacodensis* type of ribs, characteristic suture, flat dorsum, and other features. The other specimen (ANSP.), which represents slightly younger part, has weaker ribs than the UC. specimen.

Other specimens of subsequent collections from different localities (UC. B-4136 and LSJU. 3362) are more or less crushed, but by synthetic judgment from several specimens (some showing better preserved suture, some the characteristic flat-topped keel, and some others ribbing) they are referable to, or at least best comparable with, *E. ootacodensis*.

I separate here temporarily *E. ootacodensis* (STOLICZKA) from *Eubaculites vagina* (FORBES), but I am not satisfied with the criteria which SPATH (1940, p. 48, 49) pointed out. I once saw the holotype of the latter species (FORBES, 1845, p. 114, pl. 10, fig. 4) (BM. C49762), the plaster cast of which is now before me, having been kindly sent from the British Museum (Natural History).

Generally speaking, *E. vagina* is distinguished by rapid tapering, subrounded dorsolateral shoulder, broadly rounded venter, ovoid cross section of the young shell, and weak ribs, on which thickenings at the dorsolateral edge and at the mid-flank are differentiated. But, *E. ootacodensis* is so variable that it can morphologically connect with *E. vagina.* According to KOSSMAT (1895), the two occur in the same bed and there is an intermediate form. Therefore, they could be varieties of the same species, as KOSSMAT considered. Yet there is some significant distinction in the suture. *E. ootacodensis* has narrow and deeply incised antisiphonal saddles, while *E. vagina* has broad and massive ones. This may be correlative with the narrow dorsum of the former and broad dorsum of the latter, and could change gradationally. Until sufficient number of specimens of India are carefully studied, I separate temporarily the two species from the above mentioned criteria.

Relationship between *Baculites occidentalis* MEEK and a certain species of *Eubaculites* has already been mentioned. It is reasonable to have *E. ootacodensis* at somewhat higher level than *B. occidentalis.* In rapid tapering, suboval cross section, weak ornaments, and suture *E. vagina* (FORBES) seems to be more closely related to *B. occidentalis* MEEK than *E. ootacodensis* (STOLICZKA), but the unmistakable representatives of *E. vagina* have not been found in California.

Occurrence.—Not abundant in California; GABB's locality of "Martinez", San Francisco Bay area, has not been subsequently confirmed. Its stratigraphic position is, accordingly, uncertain. The rock matrix of the specimen is calcareous sandstone. Another locality, UC. B-4163, is referred to Tierra Loma shale member, lower part of Moreno formation in Panoche Quadrangle, West San Joaquin Valley. Others, LSJU. 3362, LSJU. 3363, in Little Salado Canyon, Orestimba Quad., West San Joaquin Valley; their stratigraphic position is not well recorded, but is close to the locality where *Pachydiscus* cf. *P. subcompressus obsoletus* MATSUMOTO was obtained and about 200 feet higher than a locality of reptiles.

In India the species is reported to occur not only in the Valudayur beds but also in the Arriyaloor group. SPATH (1940, 1953) assigned the *Eubaculites*-bearing faunule of West Australia to the Maestrichtian, although he suggested that the whole fauna "may include ammonites just above as well as just below the borderline between the Campanian and the Maestrichtian". The geologic age of *E. ootacodensis* is, thus, in our present knowledge, most probably Maestrichtian, but can range down to latest Campanian.

Parts II and III to be continued

Announcement of the contents to be continued

Part II

Systematic descriptions (continued)

Part B. Ammonoids other than baculitids

Part III

Notes on stratigraphy

Collecting localities

Concluding remarks

Acknowledgements

Works cited

It is regretted that all the parts are not published at once. This may give inconvenience to a reader in connection with collecting localities and references which are cited in Part I. They are to be shown in the forthcoming Part III.

Tatsuro MATSUMOTO

Upper Cretaceous Ammonites of California

Part I

Plates 30–45

Plate 30

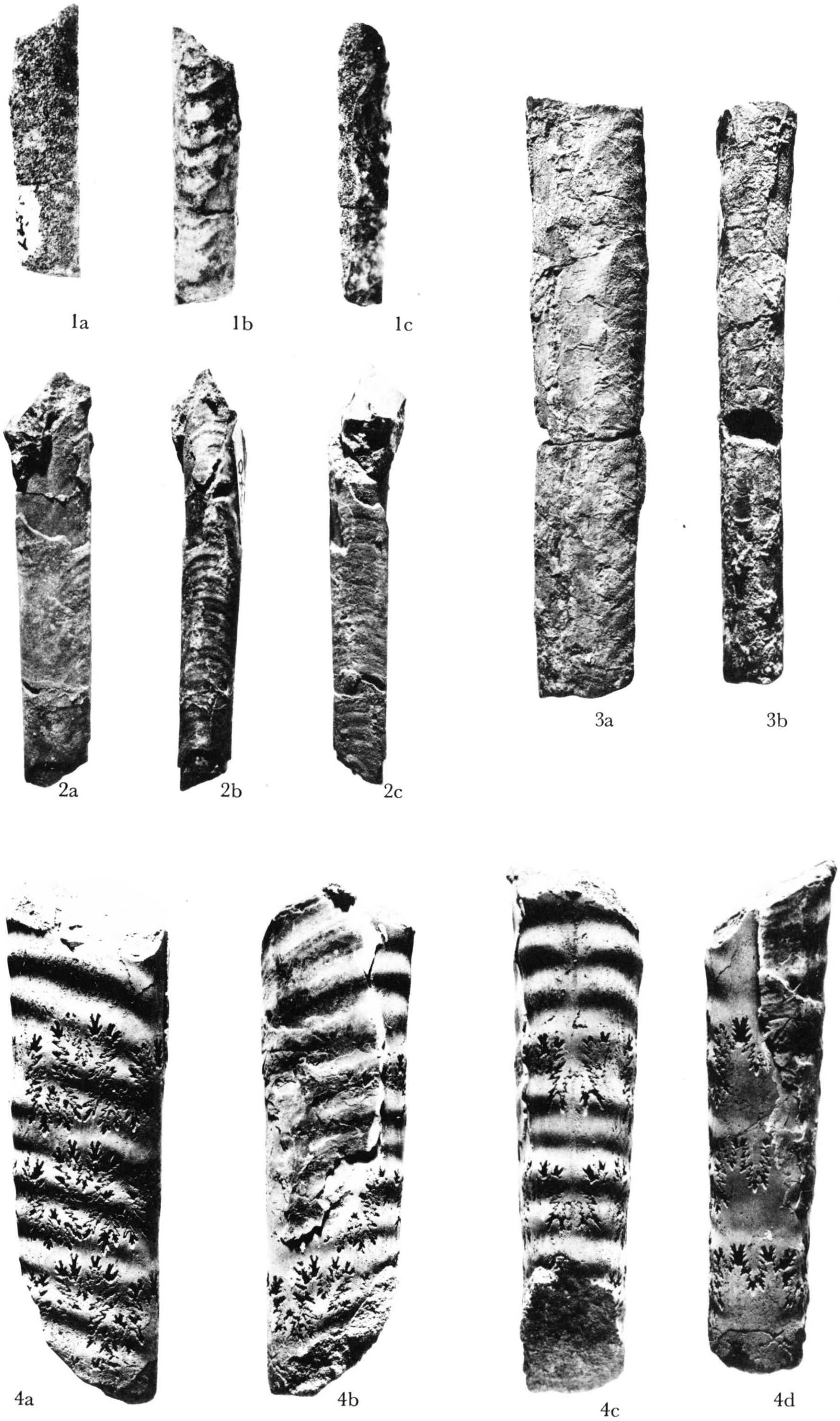
Explanation of Plate 30

Fig. 1. *Baculites columna* MORTON ....Page 161
Two lateral (a, b) and ventral (c) views, ×1. An example, LSJU. 8573, from loc. LSJU. 2251, top of the Panoche group in Panoche Hills (Coll. R. C. BROWN, S. W. MÜLLER, H. G. SCHENCK, and M. B. PAYNE). The right side (a) of the specimen is weathered.

Figs. 2, 3. *Sciponoceras* aff. *S. bohemicum* (FRITSCH)....................Page 109
2. Lateral (a), ventral (b), and dorsal (c) views, ×3/2. A specimen, UCLA. 28848, from loc. CIT. 1069, upper sandy part of the Baker Canyon member, Santa Ana Mountains (Coll. W. P. POPENOE).
3. Lateral (a) and ventral (b) views, ×1. A probably adult shell, UCLA. 28853, from loc. CIT. 1070, upper sandy part of the Baker Canyon member, Santa Ana Mountains (Coll. W. P. POPENOE).

Fig. 4. *Lechites* aff. *L. gaudini* (PICTET and CAMPICHE) ....Page 101
Two lateral (a, b), ventral (c), and dorsal (d) views, ×1. A specimen, UC. 37600, from loc. SOC. K-101, Huling Creek, One Quadrangle (Coll. M. V. KIRK).

Photos by Alexander TIHONRAVOV (1) and Takeo SUSUKI (2-4).



T. MATSUMOTO: Upper Cretaceous Ammonites of California

Plate 31

Explanation of Plate 31

Fig. 1. *Sciponoceras baculoide* (MANTELL) ....Page 104
Ventral (a), two lateral (b, d), and dorsal (c) views, ×1. A crushed body chamber, from loc. CAS. 34405, "Hayes Gulch", 2 miles northwest of Gas Point, Ono Quadrangle, NW. Sacramento Valley.

Figs. 2, 3. *Sciponoceras kossmati* (NOWAK) ....Page 106
2. Dorsolateral (a) and right lateral (b) views, ×3/2. An example from loc. CAS. 33706, conglomerate in Arroyo del Valle, Alameda County (Coll. A. S. HUCY), ×3/2.
3. Lateral view of another example from the same locality as above.

Fig. 4. *Sciponoceras* aff. *S. bohemicum* (FRITSCH) ....Page 109
Lateral view of an example, UCLA. 28854, from loc. CIT. 979, upper sandy part of the Baker Canyon member, Santa Ana Mountains (Coll. W. P. POPENOE), ×3/2.

Fig. 5. *Baculites rex* ANDERSON ....Page 136
Ventral (a), two lateral (b, d), and dorsal (c) views, ×1. An example from loc. CAS. 31567 [=31401], back of Antelope plane, southwest San Joaquin Valley (Coll. W. S. KNOUSE).

Photos by Charles E. CROMPTON (1–3, 5), without whitening, and by Takeo SUSUKI (4), with whitening.

1a 1b 1c 1d 2a 2b 3 4 5a 5b 5c 5d

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Plate 32

Explanation of Plate 32

Figs. 1–6. *Baculites schencki* sp. nov. ....Page 113

1. Dorsal (a), lateral (b), and ventral (c) views, ×1. One of the paratypes, UCLA. 28831, from loc. CIT. 1244 of the Redding area (Coll. W. P. POPENOE).
2. Dorsal (a), lateral (b), and ventral (c) views, ×3/2. Holotype, UCLA. 28830, from loc. CIT. 1034, Member IV of the Redding area (Coll. W. P. POPENOE and D. SCHARF).
3. Ventral (a) and lateral (b) views, ×1. A paratype, UCLA. 28832, from loc. CIT. 1244 of the Redding area (Coll. W. P. POPENOE).
4. Dorsal (a) and lateral (b) views, ×1. A paratype, UCLA. 28828 from loc. CIT. 1034, Member IV of the Redding area (Coll. W. P. POPENOE and D. SCHARF). Fairly prominent dorsolateral tubercles are shown under oblique light.
5. Ventral (a), lateral (b), and dorsal (c) views, ×1. A paratype, UCLA. 28829, from loc. CIT. 1034, Member IV of the Redding area (Coll. W. P. POPENOE and D. SCHARF).
6. Ventral (a), lateral (b), and dorsal (c) views, ×1. An example of a fairly strongly tuberculate variety, UCLA. 28841, from loc. CIT. 1034, Member IV of the Redding area (Coll. W. P. POPENOE and D. SCHARF).

Fig. 7. *Baculites boulei* COLLIGNON ....Page 118

Ventral (a), lateral (b), and dorsal (c) view, ×1. An example, UCLA. 28834, from loc. CIT. 1008, lower part of Member V of the Redding area (Coll. W. P. POPENOE and D. SCHARF).

Photos by Takeo SUSUKI.

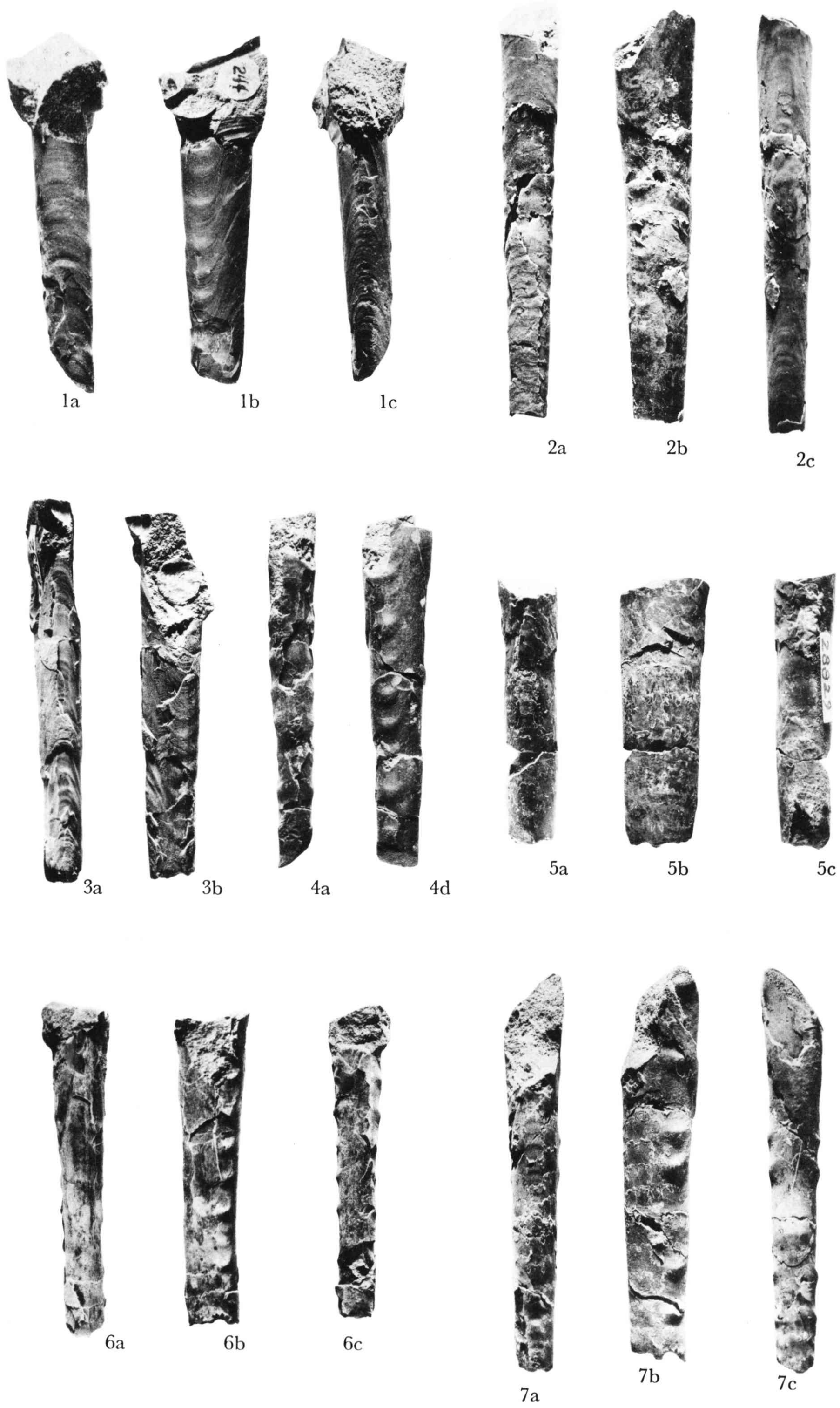

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Plate 33

Explanation of Plate 33

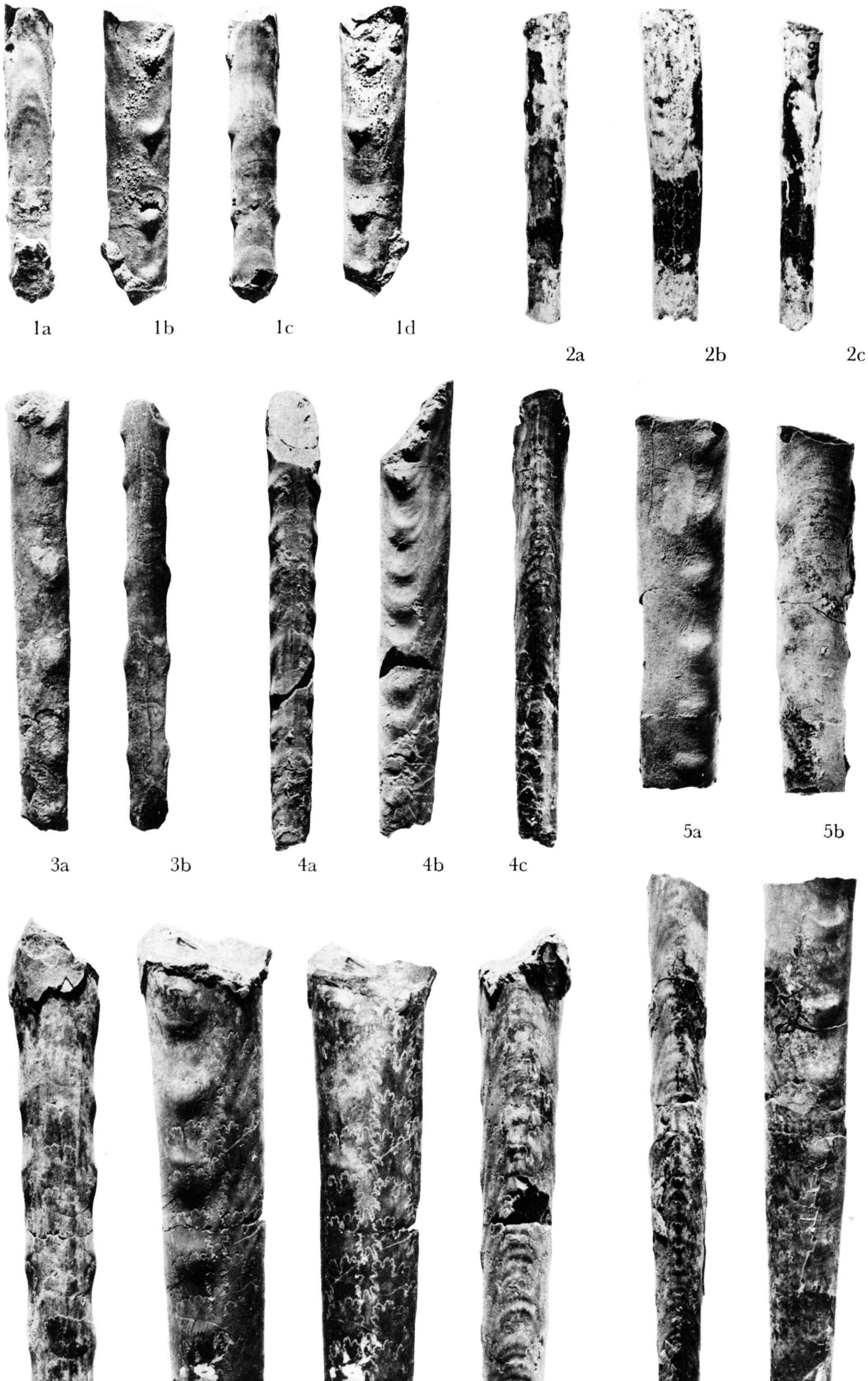
Figs. 1–3. *Baculites capensis* WOODS ....Page 121

1. Ventral (a), two lateral (b, d), and dorsal (c) views, ×1. An example LSJU. 8565, from loc. LSJU. 2880, upper part of the lower half of the Chico formation, Chico Creek (Coll. R. E. COOK).
2. Dorsal (a), lateral (b), and ventral (c) views, ×1. An example LSJU. 8564, from loc. LSJU. 2880, upper part of the lower half of the Chico formation, Chico Creek (Coll. R. E. COOK).
3. Lateral (a) and dorsal (b) views of an example, UCLA. 28838, from loc. UCLA. 3627, upper part of the lower half of the Chico formation, Chico Creek (Coll. L. E. and R. B. SAUL).

Figs. 4–7. *Baculites boulei* COLLIGNON ....Page 118

4. Dorsal (a), lateral (b), and ventral (c) views, ×1. An example, UCLA. 28833, from loc. CIT. 1008, lower part of Member V of the Redding area (Coll. W. P. POPENOE and D. SCHARF).
5. Lateral (a) and dorsal (b) views, ×1. An example, LSJU. 8577 from loc. LSJU. 3350, Holtz shale of the Santa Ana Mountains (Coll. NISBELL).
6. Dorsal (a), lateral (b, c), and ventral (d) views, ×1. An example UCLA. 28836, from loc. CIT. 1007, Member IV of the Redding area (Coll. W. P. POPENOE and D. SCHARF). One (c) of the lateral views is taken without whitening and oblique lighting to show the sutures.
7. Ventral (a) and lateral (b) views, ×1. An example, UCLA. 28835, from loc. CIT. 1007, Member IV of the Redding area (Coll. W. P. POPENOE and D. SCHARF).

Photos by Takeo SUSUKI (1, 3, 4, 6, 7) and Alexander TIHONRAVOV (2, 5).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6d
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7b

Plate 34

Explanation of Plate 34

Figs. 1–2. *Baculites lomaensis* ANDERSON ....Page 126

1. Ventral (a), lateral (b), and dorsal (c) views, ×1. An example, LSJU. 8614, from loc. LSJU. 1631, "Ragged Valley shale", north of Coalinga, Fresno County (Coll. S. V. MULLER and REINHARDT). Photos taken in oblique light on the whitened specimen.
2. Dorsal (a), the other lateral (b), and ventral (c) views of the same specimen as above, ×1. Photos taken under normal light, without whitening.

Fig. 3. *Baculites* aff. *B. anceps* LAMARCK ....Page 130
Two lateral (a, c), ventral (b), and dorsal (d) views, ×1. An example, LSJU. 8561, from loc. LSJU. 1840, Arroyo del Valle, Alameda County (Coll. J. P. SMITH).

Fig. 4. *Baculites columna* MORTON ....Page 161
Lateral (a), ventral (b), and dorsal (c) views, ×3/2. A specimen, LSJU. 8575, from loc. LSJU. 2251, top sandstone of the Panoche group in Panoche Hills (Coll. R. C. BROWN, S. W. MULLER, H. G. SCHENCK, and M. B. PAYNE).

Fig. 5. *Baculites rex* ANDERSON ....Page 136
Lateral view, ×1. An example, LSJU. 8598, from loc. LSJU. 3329A, Marca shale of the Moreno formation in Panoche Hills (Coll. M. A. PAYNE and T. MATSUMOTO).

Photos by Takeo SUSUKI (1, 4) and Alexander TIHONRAVOV (2, 3, 5).

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Plate 35

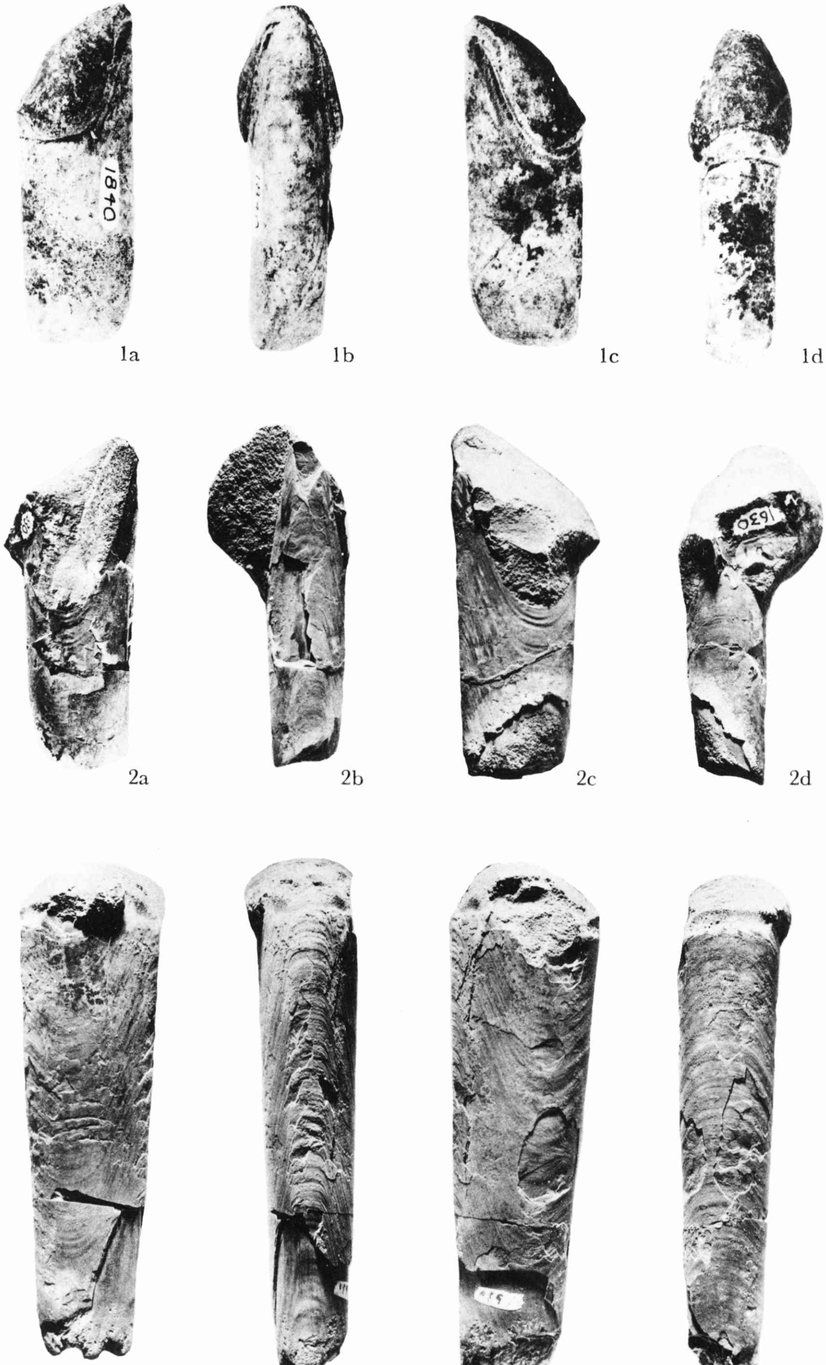
Explanation of Plate 35

Fig. 1. *Baculites* aff. *B. anceps* LAMARCK ....Page 130
Two lateral (a, c), ventral (b), and dorsal (d) views, ×1. A specimen showing the apertural margin, LSJU. 8556, from loc. LSJU. 1840, Arroyo del Valle, Alameda County (Coll. J. P. SMITH).

Figs. 2, 3. *Baculites occidentalis* MEEK..................................Page 150

2. Two lateral (a, c), ventral (b), and dorsal (d) views, ×1. A specimen showing the apertural margin, LSJU. 8609, from loc. LSJU. 1630, "Ragged Valley shale", north of Coalinga, Fresno County (Coll. S. W. MULLER and students).
3. Two lateral (a, c), ventral (b), and dorsal (d) views, ×1. A specimen representing the body chamber, LSJU. 8554, from loc. LSJU. 1630, "Ragged Valley shale", north of Coalinga, Fresno County (Coll. S. W. MULLER and students).

Photos by Alexander TIHONRAVOV (1) and Takeo SUSUKI (2, 3).



1a 1b 1c 1d

2a 2b 2c 2d

3a 3b 3c 3d

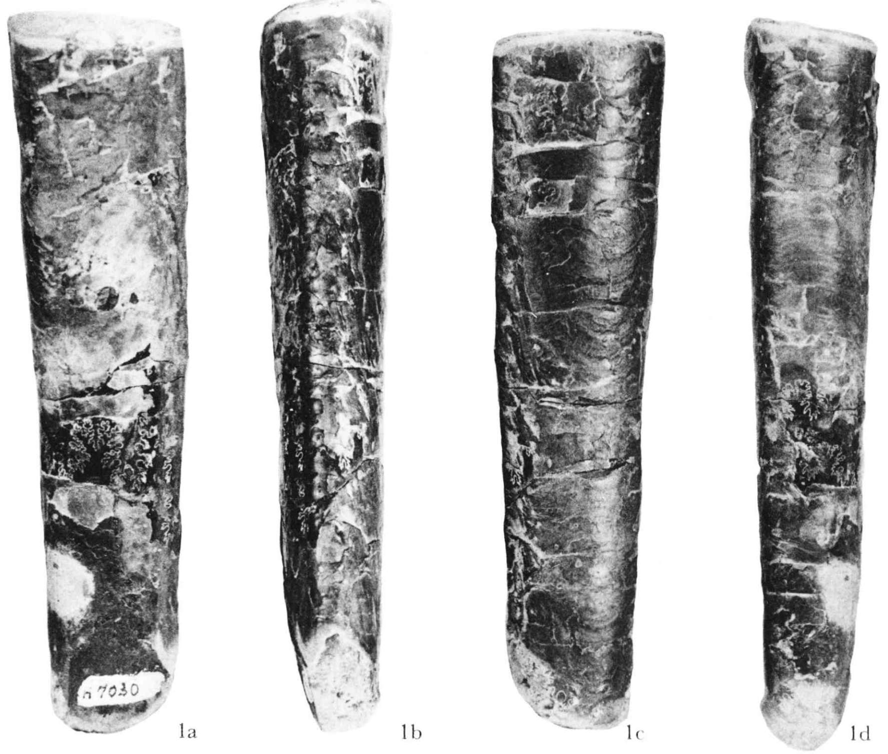
Plate 36

Explanation of Plate 36

Fig. 1. *Baculites occidentalis* MEEK ....Page 150
Two lateral (a, c), ventral (b), and dorsal (d) views, ×1. An example, GK. H 7030, from loc. TM. 509 c [=LSJU. 3343 c], "Ragged Valley shale", Los Gatos Creek in Coalinga Quadrangle, Fresno County (Coll. M. B. PAYNE and T. MATSUMOTO).

Fig. 2. *Baculites chicoensis* TRASK ....Page 145
Two lateral (a, c), ventral (b), and dorsal (d) views, ×1. The proposed neotype, LSJU. 8537, from loc. LSJU. 2609, upper half of the Chico formation in the section of Chico Creek, Butte County (Coll. R. E. COOK).

Photos by Ikuwo OBATA (1) and Alexander TIHONRAVOV (2), without whitening.



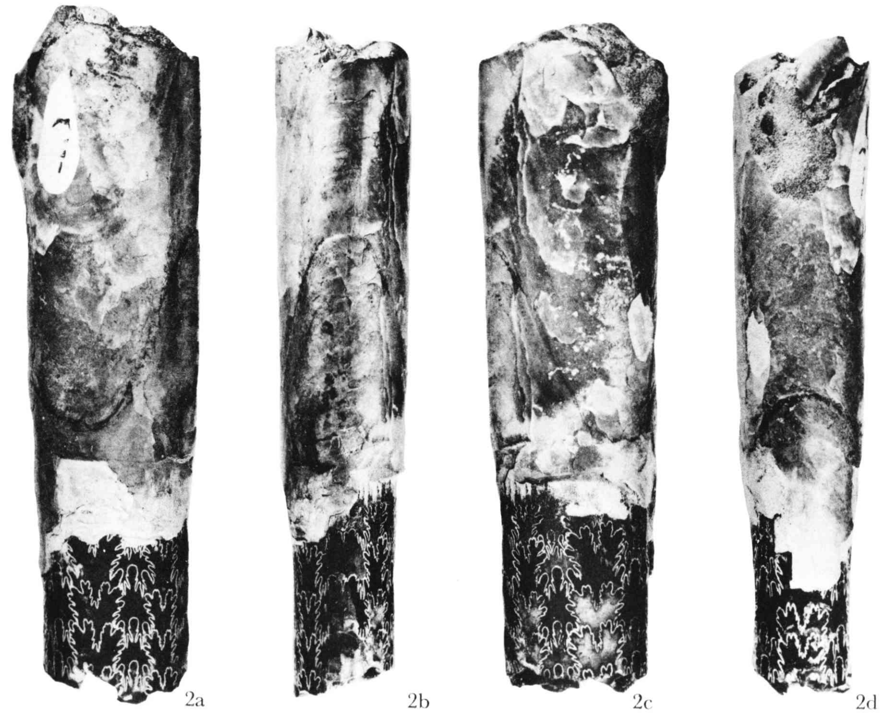


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Plate 37

Explanation of Plate 37

Fig. 1. *Baculites chicoensis* TRASK ....Page 145
Two lateral (a, c), ventral (b), and dorsal (d) views, ×1. A specimen, LSJU. 8538, from loc. LSJU. 2609, upper half of the Chico formation in the section of Chico Creek, Butte County (Coll. R. E. COOK).

Photos by Alexander TIHONRAVOV, without whitening.

1a 1b 1c 1d

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Plate 38

Explanation of Plate 38

Fig. 1. *Baculites inornatus* MEEK ....Page 155
Ventral (a), lateral (b), and dorsal (c) views, ×1. A costate example from loc. UC. B-5323, Baja California (Coll. E. C. ALLISON).

Photos by David H. MASSIE.

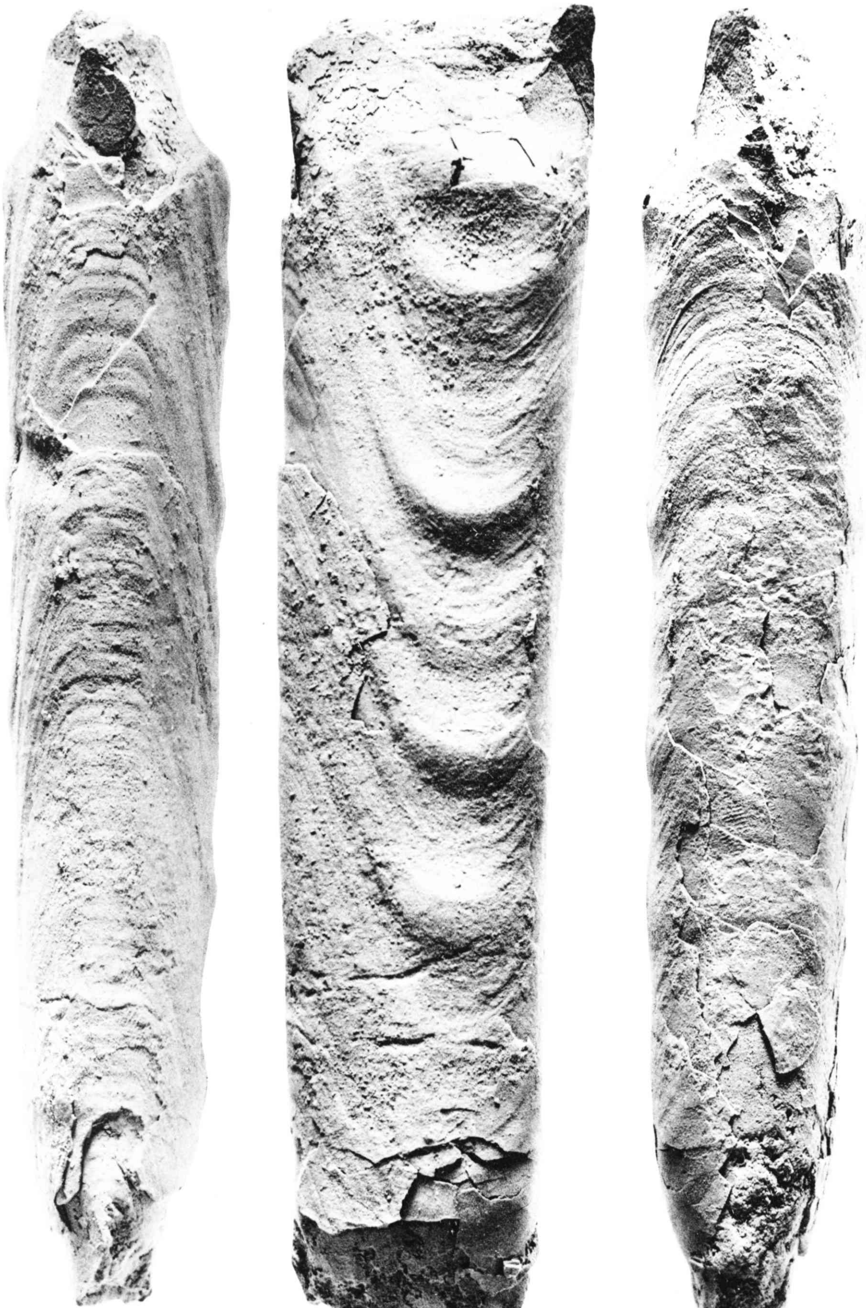

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Plate 39

Explanation of Plate 39

Figs. 1–3. *Baculites rex* ANDERSON....................................Page 136

1. Dorsal (a), lateral (b), and ventral (c) views, ×1. A small, probably immature shell, GK. H 7036, from loc. TM. 507 [=LSJU. 3345], Ragged Valley shale of Los Gatos Creek, Coalinga Quadrangle, Fresno County (Coll. M. B. PAYNE and T. MATSUMOTO).
2. Dorsal (a), lateral (b), and ventral (c) views, ×1. A specimen, LSJU. 8597, from loc. LSJU. 3347, "Black Mountain" (Coll. H. HANNIBAL and A. W. AMBROSE).
3. Lateral view of a large example, LSJU. 8600, from loc. LSJU. 2795, Debris Dam sandstone of the Santa Barbara Mountains (Coll. J. G. MARKS), ×1/2.

Photos by Ikuwo OBATA (1) and Alexander TIHONRAVOV (2, 3), without whitening.

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Plate 40

Explanation of Plate 40

Fig. 1. *Baculites rex* ANDERSON ....Page 136
Dorsal (a), lateral (b), and ventral (c) views, × 1. A specimen, UC. 37605, from loc. UC. A-4959 Media Agua Creek, back of Antelope plain, Kern County, showing a nearly complete length of the body chamber and the posterior portion of the septate part (Coll. University of California, Paleontology 137 class, 1949).

Photos by David H. MASSIE.

1a 1b 1c

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Plate 41

Explanation of Plate 41

Fig. 1. *Baculites occidentalis* MEEK ....Page 150
Two lateral (a, c), ventral (b), and dorsal (d) views, × 1. A specimen, LSJU. 8553, from loc. LSJU. 3344, Post Canyon, a branch of Los Gatos Creek, Coalinga Quadrangle, Fresno County (Coll. B. NATERA).

Photos by Takeo SUSUKI.

1a 1b 1c 1d

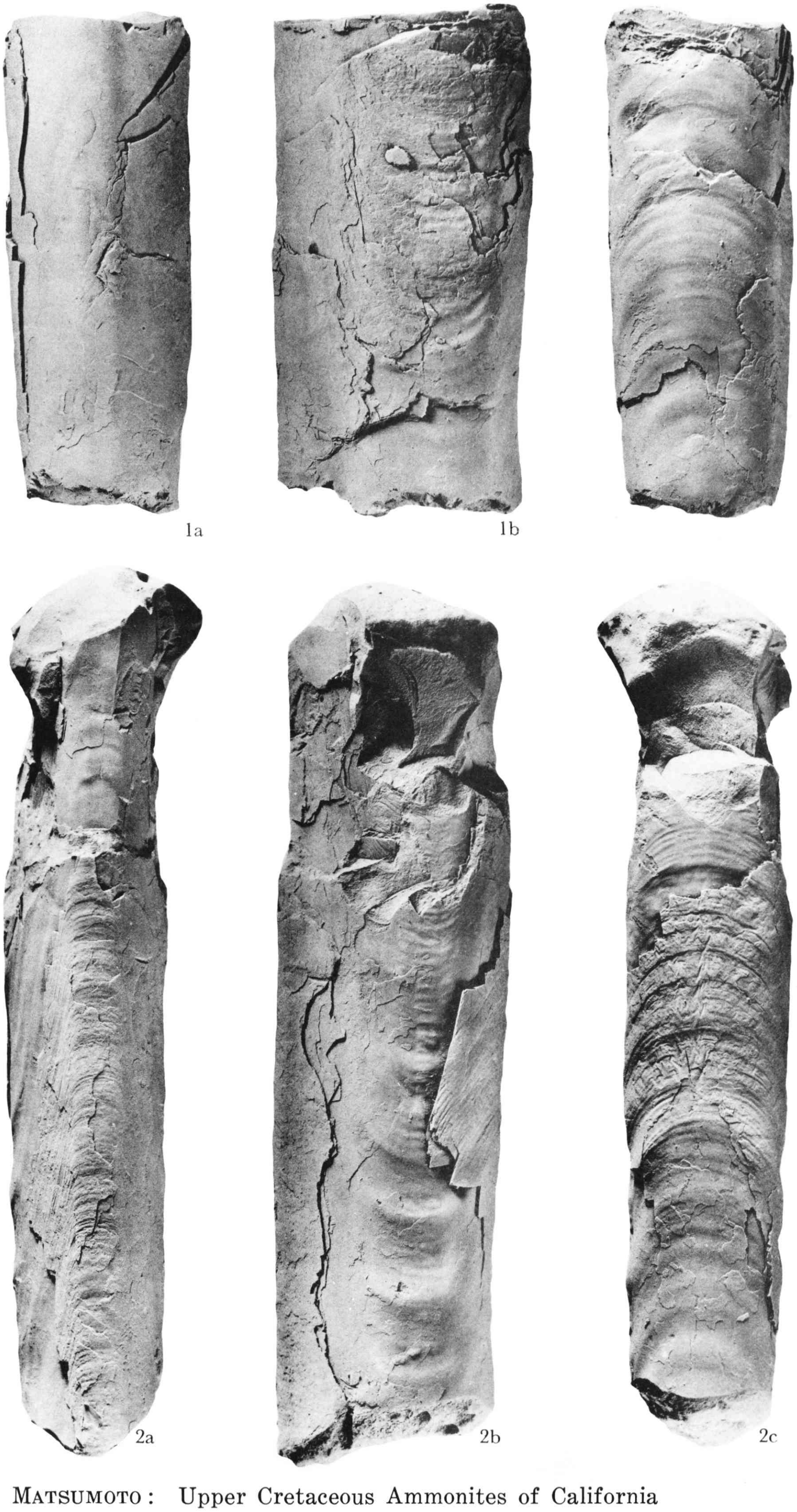
Plate 42

Explanation of Plate 42

Figs. 1, 2. *Baculites occidentalis* MEEK ....Page 150

1. Ventral (a), lateral (b), and dorsal (c) views, ×1. One of MEEK's syntypes, USNM. 1363, from "Komooks", Vancouver Island.
2. Ventral (a), lateral (b), and dorsal (c) views, × 1. Another of MEEK's syntypes, USNM. 1363, from "Komooks", Vancouver Island.

Photos by Nelson W. SHUPE.



T. MATSUMOTO: Upper Cretaceous Ammonites of California

Plate 43

Explanation of Plate 43

Figs. 1–3. *Baculites kirki* sp. nov. ....Page 143

1. Ventral (a), lateral (b), and dorsal (c) views, ×1. Holotype, UC. 35693, from loc. SOC. K-229, Hooten Gulch, upper part of Member V in the Redding area (Coll. M. V. KIRK).
2. Ventral (a), lateral, (b), and dorsal (c) views, ×2. One of the paratypes, UC. 34871, from the same loc. SOC. K-229 (Coll. M. V. KIRK).
3. Dorsal (a), lateral (b), and ventral (c) views, × 1. Another paratype, UCLA. 28827, from loc. CIT. 1006, lower part of Member V in the Redding area (Coll. W. P. POPENOE and D. SCHARF).

Fig. 4. *Baculites columna* MORTON ....Page 161
Dorsal (a), lateral (b), and ventral (c) views, ×2. A fragmentary specimen from loc. UC. A-4684, "Garzas sandstone" of Volta Quadrangle, west side of the San Joaquin Valley (Coll. University of California, Paleontology 103 class, 1948).

Fig. 5. *Baculites inornatus* MEEK ....Page 155
Dorsal (a), lateral (b), and ventral (c) views, ×1. Lectotype, USNM. 1259, from Sucia Island, Washington.

Fig. 6. *Eubaculites ootacodensis* (STOLICZKA) ....Page 166
Lateral view of a specimen from loc. LSJU. 3186, Mira marl, West Australia (see Pl. 44, fig. 1a, b), ×1.

Photos by David H. MASSIE (1, 2, 4), Takeo SUSUKI (3), Nelson W. SHUPE (5), and Alexander TIHONRAVOV (6).

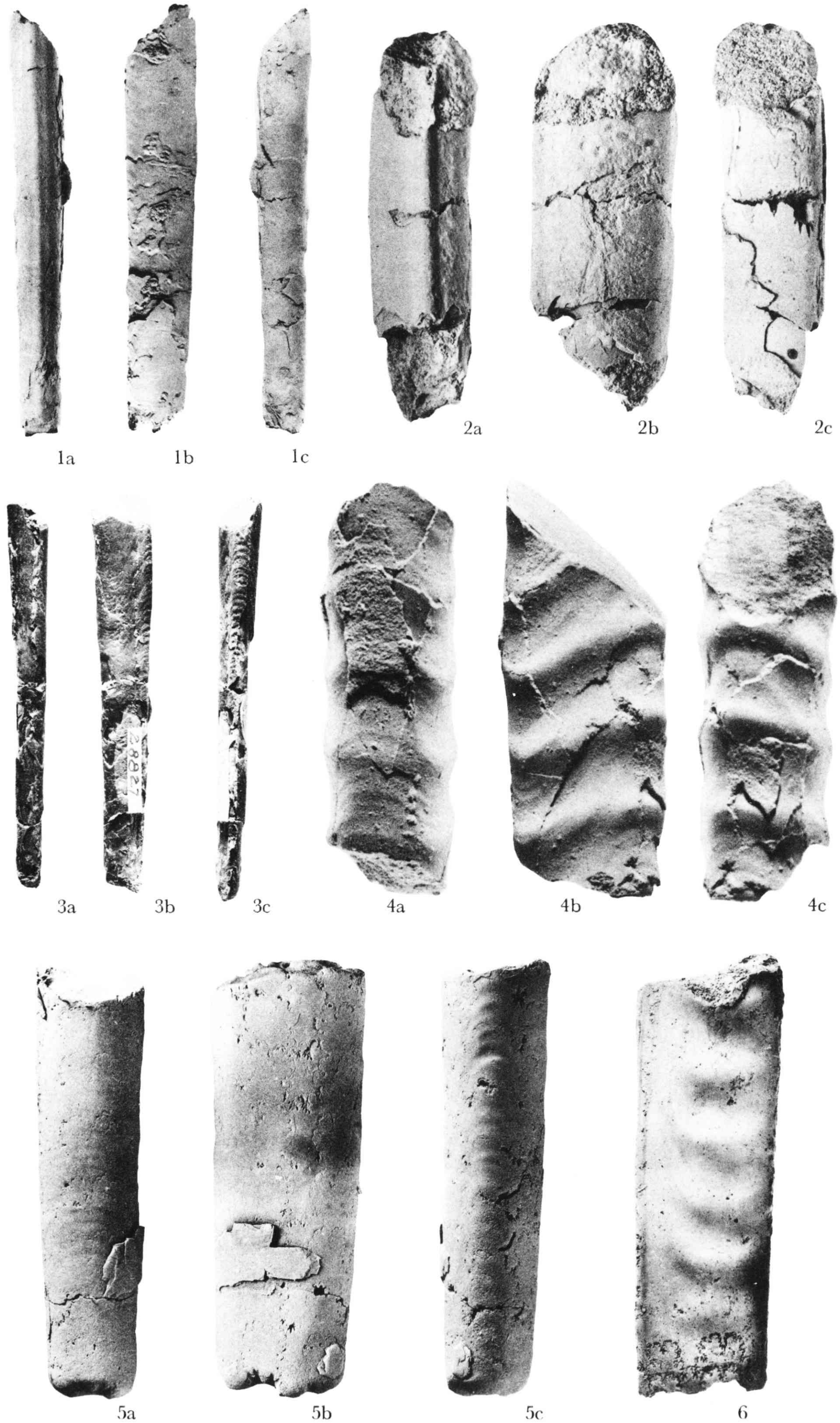

1a
1b
1c
2a
2b
2c
3a
3b
3c
4a
4b
4c
5a
5b
5c
6

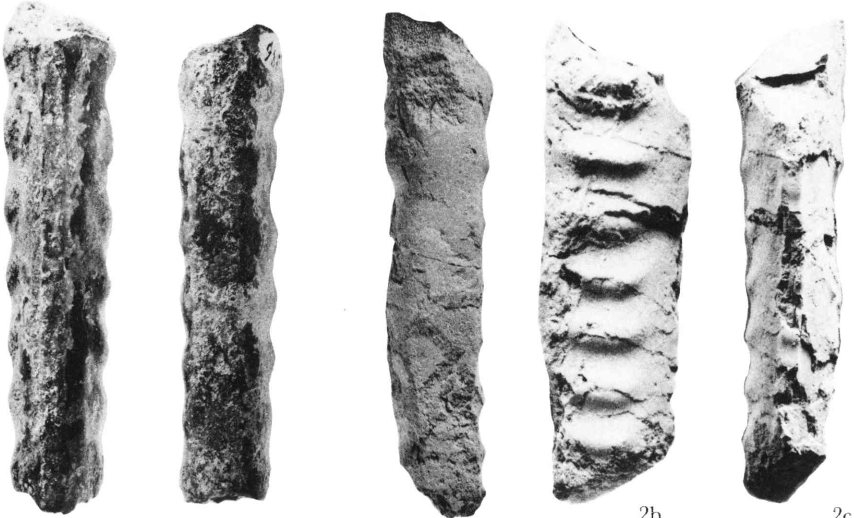
Plate 44

Explanation of Plate 44

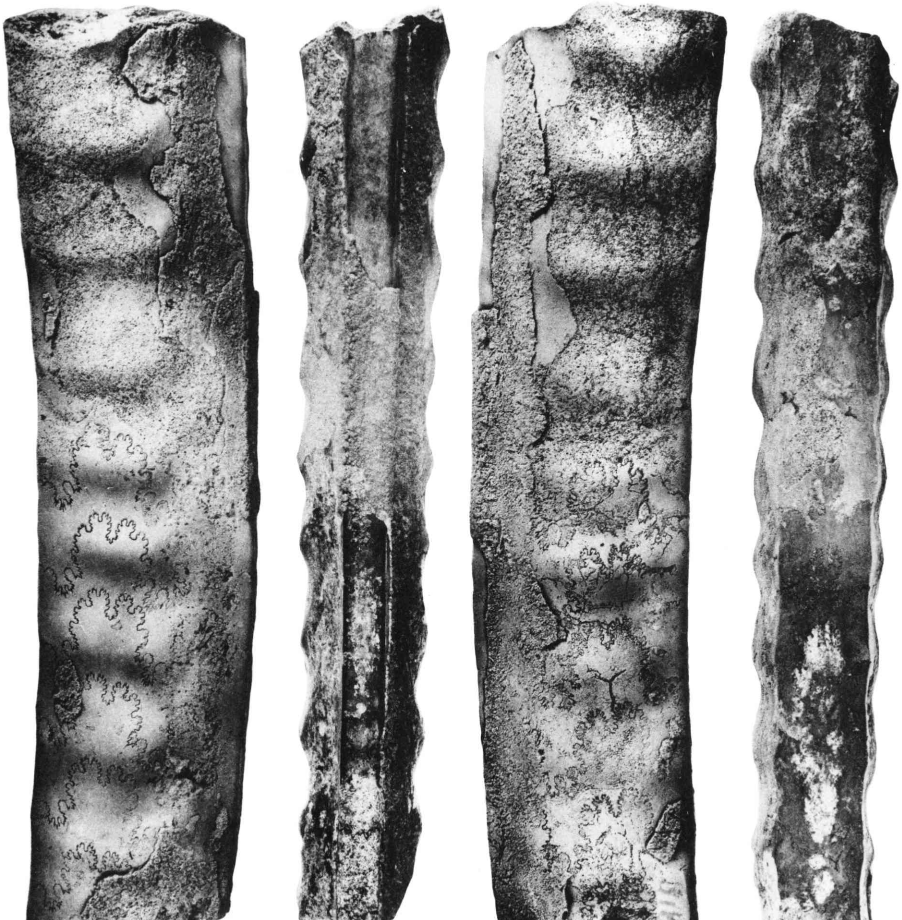
Figs. 1–3. *Eubaculites ootacodensis* (STOLICZKA) ....Page 166

1. Ventral (a) and dorsal (b) views, ×1. A specimen from loc. LSJU. 3186, Mira marl, West Australia. See Pl. 43, fig. 6 for the lateral view of the same specimen.
2. Dorsal (a), lateral (b), and ventral (c) views, ×1. An example, UC. 12116, one of GABB's hypotypes of *Baculites chicoensis* (GABB, 1864, pl. 14, fig. 29), from Martinez, Bay area.
3. Two lateral (a, c), ventral (b), and dorsal (d) views, ×1. A specimen from loc. LSJU. 3184, Mira marl, West Australia.

Photos by Alexander TIHONRAVOV (1, 3) and David H. MASSIE (2).



1a 1b 2a 2b 2c



3a 3b 3c 3d

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Plate 45

Explanation of Plate 45

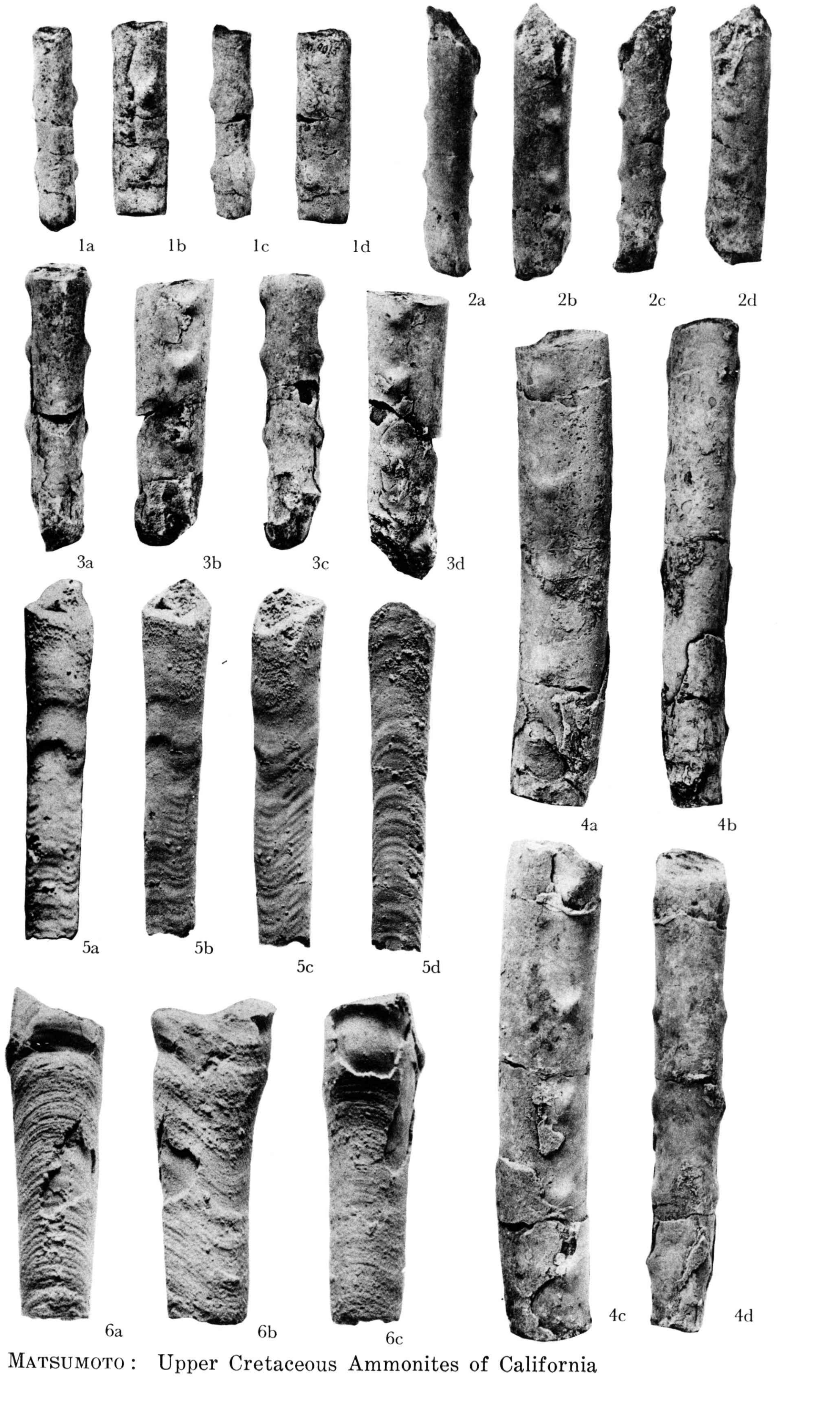
Figs. 1–4. *Baculites capensis* WOODS ....Page 121

1. Ventral (a), two lateral (b, d), and dorsal (c) views, ×1. An example, GK. H 7015, from loc. TM. 14 [=LSJU. 3320], lower part of the Upper Marlife member of Panoche group, Panoche Hills (Coll. T. MATSUMOTO).
2. Ventral (a), two lateral (b, d), and dorsal (c) views, ×1. Another example, GK. H 7014, from loc. TM. 14 [=LSJU. 3320] (Coll. T. MATSUMOTO).
3. Ventral (a), two lateral (b, d), and dorsal (c) views, ×1. A strongly tuberculate example, GK. H 7012, from loc. TM. 14 [=LSJU. 3320] (Coll. T. MATSUMOTO).
4. Two lateral (a, c), ventral (b), and dorsal (d) views, ×1. An example, GK. H 7010, from loc. TM. 14 [=LSJU. 3320] (Coll. T. MATSUMOTO).

Figs. 5, 6. *Baculites* (?) aff. *B. teres* FORBES ....Page 163

5. Dorsal (a), dorsolateral (b), lateral (c), and ventral (d) views, ×2. An example, UC. 33521, from loc. UC. A-4684, "Garzas sandstone" of Volta Quadrangle (Coll. UC. Paleo. 103 class).
6, Ventral (a), lateral (b), and dorsal (c) views, ×2. Another example, UC. 33522, from loc. UC. A-4684 (Coll. UC. Paleo. 103 class).

Photos by Ikuwo OBATA (1-4) and David H. MASSIE (5, 6).



T. MATSUMOTO: Upper Cretaceous Ammonites of California