Matsumoto, T., 1959b

Mem. Fac. Sci., Kyushu Univ., Ser. D, Geology, Special Volume I,
iii + pp. 1-172, text-figs. 1-80; pls. 1-41, November 1959

Upper Cretaceous Ammonites of California

Part II*

By

Tatsuro MATSUMOTO

Systematic Descriptions

Part B. Ammonoids other than baculitids
Family Phylloceratidae ZITTEL, 1884

Representatives of the family Phylloceratidae occur rather sporadically in the Upper Cretaceous of the West Coast of North America. In California I have recognized examples of the two genera, *Neophylloceras* and *Phyllopachyceras*. As the last genus is represented by imperfectly preserved specimens, I exclude here its description. *Partschiceras* (?) *japonicum* (MATSUMOTO), which has recently been discovered in the probable Cenomanian of Alaska (MATSUMOTO, 1959a, p. 52, pl. 12, figs. 1a-c, 2a, b, 3a-c; text-fig. 2), has not yet been confirmed in California.

Genus *Neophylloceras* SHIMIZU, 1934

Type-species.—*Ammonites* (*Scaphites ?*) *ramosus* MEEK, 1857.

Synonym.—*Hyporbulites* BREISTROFFER, 1947.

Diagnosis.—See WRIGHT and MATSUMOTO, 1954, p. 109.

Remarks.—The relationship of *Neophylloceras* MEEK, 1857 with *Hypophylloceras* SPATH, 1927 and the synonymy of *Hyporbulites* BREISTROFFER, 1947 with *Neophylloceras* MEEK, 1857 were discussed, when I described *Neophylloceras seresitense* (PERVINQUIÈRE) from Alaska (MATSUMOTO, 1959a, p. 55). That species occurs also in California. It was described by ANDERSON (1958, p. 180, pl. 16, fig. 4, 4a) as *Phylloceras velledae*. One of ANDERSON's two hypotypes, from loc. CAS. 2233, a locality of *Calycoceras* cf. *newboldi* (KOSSMAT), is evidently an example of *N. seresitense*. The other, from loc. CAS. 31097, was not at my disposal.

Neophylloceras ramosum (MEEK)

Pl. 1, fig. 1a-d; Pl. 2, fig. 2; Pl. 8, fig. 1a-c

1857. *Ammonites* (*Scaphites* ?) *ramosus* MEEK, *Trans. Albany Inst.*, vol. 4, p. 45.

1876. *Phylloceras* ? *ramosum*, MEEK, *Bull. U. S. Geol. Geogr. Surv. Terr.*, vol. 2, no. 4, p. 371, pl. 5, fig. 1, 1a, 1b.

1903. *Phylloceras ramosum*, WHITEAVES, *Mesozoic Fossils*, vol. 1, pt. 5, p. 327.

* Received July 9, 1959. Continued from Part I (*Mem. Fac. Sci., Kyushu Univ.*, Ser. D, Geology, Vol. VIII, No. 4, pp. 91-171, text-figs. 1-85, pls. 30-45, March 1959).

? 1928. *Phylloceras* aff. *ramosum*, COLLIGNON, *Ann. Paléont.*, vol. 17. p. 7, pl. 1, figs. 2-4.
1934. *Neophylloceras ramosum*, SHIMIZU, *in* SHIMIZU & OBATA, *Cephalopoda*, p. 62.
1942. *Neophylloceras ramosum*, MATSUMOTO, *Proc. Imp. Acad. Japan*, vol. 18, p. 674.
1942. *Neophylloceras compressum* MATSUMOTO, *Proc. Imp. Acad. Japan*, vol. 18, p. 675, text-fig. 1a_2, b_2.
1952. *Neophylloceras ramosum*, USHER, *Geol. Surv. Canada, Bull.* 21, p. 49, pl. 1, figs. 4, 5.
1958. *Phylloceras ramosum*, ANDERSON, *Geol. Soc. Amer., Memoir* 71, p. 181, pl. 40, fig. 4, 4a.
1958. *Phylloceras vaculum* ANDERSON, *Geol. Soc. Amer., Memoir* 71, p. 181, pl. 40, fig. 3, 3a, 3b.
? 1958. *Phylloceras pachecoense* ANDERSON, *Geol. Soc. Amer., Memoir* 71, p. 182, pl. 53, fig. 1, 1a.

Holotype.—USNM. 12451, from "Komooks, Vancouver Island".

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

GK. H7001, from loc. TM. 2001 [=LSJU. 3288=CIT. 1346] (Coll. W. P. POPENOE & T. MATSUMOTO)

"Holotype (CIT. 3726) (Pl. 8, fig. 1a-c) and paratype of *Phylloceras vaculae* ANDERSON", from loc. CIT. 1346 (Coll. W. P. POPENOE)

Specimens from loc. LSJU. 2006 (Coll. J. M. KIRBY)

Fragmentary specimens from loc. LSJU. 2709 (Coll. W. E. KENNETT & Stanley McCOY)

An immature shell, LSJU. 8605, from loc. LSJU. 2735 (Coll. L. W. FUNKSHOUSER)

A specimen from loc. UCLA. 3642 (Coll. L. E. & R. B. SAUL)

A specimen from loc. UC. A-7581 (Coll. UC. Paleontology Class 137, 1951)

Doubtfully referable specimens, "holotype and other examples of *Phylloceras pachecoense* ANDERSON", from loc. CAS. 29108

Several fragments, some of which show well-exposed sutures and mode of ribbing, from loc. CAS. 1467 (no record of collector)

A comparable specimen from loc. CAS. 31245 (Coll. McCOY)

Measurements.*—

Specimen	Remarks	Diameter	Height	Breadth (B/H)	Umbilicus (%)
USNM. 12451	maximum	47.1			
"	¼ vol. earlier	39.2	22.3	11.7 (0.52)	3.2 (8)
CIT. 3726	(now preserved at UCLA.)	42.5	25.3	14.5 (0.56)	3.4 (8)
GSC. 5811	(Usher, 1952)	47.0	27.2	14.1 (0.52)	2.8 (6)
One from loc. CAS. 1467			*c.* 35.0	16.0 (0.46)	—
LSJU. 8605	(immature)	16.4	9.7	5.5 (0.56)	1.3 (8)

Diagnosis.—The species is characterized by a thin shell, great involution, very small umbilicus (less than 10 percent of the shell diameter), much compressed whorls, narrowly arched venter, rounded umbilical border, nearly parallel, rather than convergent, and only slightly convex flanks, thread-like, fine, narrow, and densely spaced subcostae, which incline moderately forward near the umbilicus, bend just below the mid-flank, run almost radially on the rest of the flanks, and again incline slightly forward near the venter, thus showing flexuosity. Near the umbilical half of the whorl can be seen the very faint, periodic constrictions, which give rise, on the surface of the shell, to low and narrow major ribs. The suture is very complicated, deeply and finely incised and has multipartite saddles, of which the phylloid terminals are indistinct. Minute phylloid terminals, however, are discernible, when the suture is not fully exposed but observed through the semi-transparent, inner layer of the shell.

* Measurements in this paper are in millimeters.

Remarks.—Though its name is well known, the species is represented by relatively few specimens from the West Coast of America. The holotype is a small, probably immature, shell. USHER (1952) has described an additional specimen from the upper Lambert formation, which is much larger than the holotype.

In the Upper Cretaceous of Japan and Sakhalin there is a larger number of specimens, which I have briefly reported under the name of *Neophylloceras compressum* MATSUMOTO (1942). Comparing them with the American types, I have confirmed that they are nothing but the representatives of *N. ramosum* (MEEK) on the other side of the Pacific Ocean. Thus *N. compressum* MATSUMOTO is here suppressed as a synonym of *N. ramosum* (MEEK).

The specimens which have recently been described as the holotype and paratype of *Phylloceras vaculae* ANDERSON (1958) should undoubtedly be referred to the same species. I myself have obtained another example from the same locality (CIT. 1346) as ANDERSON's specimens. The "outline flare" of the umbilical wall which ANDERSON (1958, p. 181) mentioned may correspond to what I (1942c, p. 675) called a spiral elevation at the umbilical margin. It may be feebly discernible in some specimens, but is never so distinct as in *N. subramosum* SPATH. In this and other respects I cannot find any distinction of specific importance between the holotypes of *N. ramosum* and "*P. vaculae*".

The specimen which was described as *Phylloceras pachecoense* ANDERSON (1958, p. 182, pl. 53, fig. 1, 1a) is larger than, but otherwise very similar to, typical examples of *Neophylloceras ramosum* (MEEK). Its flanks are more flattened and more clearly parallel than is shown in ANDERSON's sketch. There are, in addition to ANDERSON's illustrated specimen, more specimens in the same rock (CAS. 29108), that show inner whorls of smaller size; these are indistinguishable from unmistakable examples of *N. ramosum* (MEEK). Some of the Japanese examples of *N. ramosum* reach a moderate size; for instance, a specimen (GT. I-3506) from the Campanian zone of *Inoceramus schmidti-Canadoceras kossmati* is still septate at a diameter of 60 mm., so that the complete shell with body chamber, if preserved, must exceed 100 mm. in diameter. This size is intermediate between the holotypes of *Neophylloceras ramosum* (MEEK) and *Phyllo-*

ceras pachecoense ANDERSON. However, the latter is still septate and, accordingly, unusually large. Many molluscan shells from the same bed as this specimen (the so-called Garzas bed) reach an unusually large size probably owing to some ecological environment.

The specimens from the Lower Cretaceous of California, which were referred to *Ammonites ramosus* by GABB (1864, p. 65, pl. 11, fig. 12, 12a; pl. 12, fig. 12b), including his hypotypes (of 1864) in the Museum of Invertebrate Paleontology, University of California, Berkeley, and his homeotype in the Academy of Natural Science of Philadelphia (No. 12885), are mostly *Hypophylloceras onoense* (STANTON) (1895, p. 73) and partly another species of *Hypophylloceras*. They are clearly distinguished from the true *Neophylloceras ramosum* (MEEK) by their less complex sutures, with distinct phylloid terminals to the subdivided saddles (cf. Pl. 2, figs. 1 and 2).

Similarly the specimens from the Kennicott formation of Alaska, which were listed by MOFFIT (1938, table facing p. 80) as *Phylloceras* cf. *ramosum*, are not true *N. ramosum* (MEEK), but are *N.* cf. *seresitense* (PERVINQUIÈRE). IMLAY and REESIDE (1954, p. 234) have recorded the occurrence of *N. ramosum* (MEEK) in a formation overlying the Naknek formation at Cape Kaguyak, southwest Alaska. This is, I think, reliable, but I have had missed the opportunity of seeing the specimens.

I have not seen the specimens from the Quiriquina beds of Chile, but according to the description and figures of STEINMANN (1895, p. 80, pl. 5, fig. 4a, b; text-fig. 6), his "*Phylloceras ramosum*" does not seem to me to be identical with *N. ramosum* (MEEK), in that it has less flexuous subcostae, although they are doubtlessly allied to each other. Presumably it is close to *Neophylloceras lambertense* USHER (1952, p. 50, pl. 1, figs. 1-3). In fact, USHER put it in the synonymy of his species. This may be warrantable, but, without seeing the actual specimens, I hesitate to give a final conclusion.

Occurrence.—Localities TM. 2001=CIT. 1346, Member III of Popenoe in the Redding area, along with *Subprionocyclus normalis* (ANDERSON); LSJU. 2735, Upper Cretaceous of the Arroyo del Valle area, Tesla Quadrangle, along with *Subprionocyclus normalis* (ANDERSON); LSJU. 2006, lower part of the Funks formation or highest part of Sites formation, Rumsey Hills area; UCLA. 3642, basal part of the Chico formation in the type Chico area; LSJU. 2709, Enos Canyon, Yolo County (associated with *Metaplacenticeras pacificum*, etc.); CAS. 1467, 7 miles NW. of Winters (probably same as, or close to, LSJU. 2709), Yolo County (associated with *Metaplacenticeras pacificum* and *Desmophyllites diphylloides*); CAS. 31245, Arroyo del Valle, Bay Area (associated with *Metaplacenticeras pacificum* and *Baculites inornatus*); UC. A-7581, Reef Ridge, Kings County, in a shale unit probably equivalent to the relatively higher part of the Panoche group, associated with *Baculites inornatus* MEEK; probable examples from CAS. 29108, the so-called Garzas bed, probably belonging to the upper part of Panoche group, Merced County, west side San Joaquin Valley.

Thus the California examples, which I have referred to *N. ramosum*, came from various horizons between Upper Turonian and Upper Campanian. The occurrence in Japan proves the long stratigraphic range of this species, from Turonian to Upper Campanian.

According to USHER (1952) the species has been found in the Upper Lambert formation of Nanaimo group in British Columbia.

Neophylloceras hetonaiense MATSUMOTO

Pl. 3, fig. 1a-d

1942. *Neophylloceras hetonaiense* MATSUMOTO, *Proc. Imp. Acad. Japan*, vol. 18, p. 675, text-fig. $1a_a$, b_a.
1953. *Neophylloceras hetonaiense*, SPATH, *Falkland Isl. Dep. Surv. Sci. Rep.* no. 3, p. 5, pl. 1, fig. 2.

Types.—I established this species on several syntypes (MATSUMOTO, 1942). The lectotype, here designated, is GK. H3801a, from loc. H12b, bed IV b, Hetonai area, Hokkaido, the dimensions of which are shown below.

Material.—GK. H7002, GK. H7003, and another in LSJU from loc. TM. 204 (=LSJU. 3329) (Coll. M. B. PAYNE & T. MATSUMOTO); two immature examples of the tuberculate variety from locs. CAS. 29656 (Coll. A. BENNISON) and CAS. 31310 (Coll. C. C. CHURCH & J. J. BRYON).

Measurements.—

Specimen	Diameter	Height	Breadth (B/H)	Umbilicus (%)
GK. H 7002	55.0	33.1	18.5 (0.56)	3.0 (5)
GK. H 7003	—	33.0	18.3 (0.55)	3.0
GK. H 3801a (lectotype)	31.0	17.5	10.0 (0.57)	2.0 (6)

Diagnosis.—This species is characterized, like *Neophylloceras ramosum* (MEEK), by great involution, very small umbilicus, much compressed whorls, and densely spaced, fine subcostae. The flank is evenly convex, with the maximum breadth of whorl at its middle, from where it inclines gradually towards umbilicus and also towards the narrowly arched venter. The subcostae incline slightly forward near the umbilicus, gradually change their curvature near the mid-flank and run almost radially on the main part of the whorl, showing less flexuosity than in *N. ramosum* (MEEK). On the inner half of the inner whorl blunt and short major ribs or bullae may develop, sometimes becoming strong enough to be called tubercles but sometimes very faint. The riblets correspond to the weak furrows on the mould. The suture is of nearly the same type as that of *N. ramosum* (MEEK).

Remarks.—The closest ally of the present species may be *Neophylloceras lambertense* USHER (1952, p. 50, pl. 1, figs. 1-3), the types of which came from the upper part of the Lambert formation. Even such a detailed feature as the forward concavity of "a line touching the posterior ends of the auxiliary lobes" is common to both species. This might not be, however, so important for the specific classification of *Neophylloceras*. The distinctions are the much less flexuous subcostae and more flattened flanks of *N. lambertense* than *N. hetonaiense*. Although USHER mentioned shallow, radial depressions near the umbilicus

of it occur in the Gulf Coast-Western Interior region. The succession of species is best known in Japan and may be summarized as follows:

Damesites laticarinatus SAITO and MATSUMOTO, 1956: Cenomanian

D. ainuanus MATSUMOTO, 1957: Turonian

D. damesi (JIMBO) (1894): Coniacian-Lower Campanian

D. semicostatus MATSUMOTO, 1942: Coniacian-Lower Campanian

D. sugata (FORBES) (1846): Santonian-Campanian

D. hetonaiensis MATSUMOTO, 1942: Maestrichtian

In California and Oregon species of *Damesites* do not occur so abundantly as in Japan. Three new species were established by ANDERSON (1958) under the generic name *Kotoceras*. Two of them are, in my opinion, identical and referable to one of the Japanese species. One more species, described by ANDERSON under a new generic and specific name can be included in another Japanese species.

Damesites damesi intermedius MATSUMOTO

Text-figs. 3-5

1927. *Desmoceras (Kotôceras) damesi*, YABE (*non* JIMBO), *Sci. Rep. Tohoku Imp. Univ.*, 2nd ser. vol. 11, p. 44 [18], pl. 7 [5], fig. 9, 9a.

1954. *Damesites damesi intermedia* MATSUMOTO, *Cret. System in the Japanese Islands*, Appendix, p. 270, pl. 6 [22], fig. 4a, b.

1956. *Damesites damesi intermedius*, MATSUMOTO and OBATA, *Mem. Fac. Sci., Kyushu Univ.*, ser. D, vol. 5, p. 131, pl. 27, figs. 1, 2a, b.

1958. *Kotôceras richardsoni* ANDERSON, *Geol. Soc. Amer., Memoir* 71, p. 217, pl. 36, fig. 3, 3a.

1958. *Kotôceras frazierense* ANDERSON, *Geol. Soc. Amer., Memoir* 71, p. 217, pl. 40, fig. 5, 5a.

Holotype of the subspecies.—GK. H3269, from loc. U513, bed Ur2, Upper Yezo group, Urakawa area, Hokkaido (MATSUMOTO, 1954a, pl. 6 [22], fig. 4a, b) (see also MATSUMOTO and OBATA, 1956, pl. 27, fig. 2a, b).

Material.—Several Californian examples are before me, including ANDERSON's 1958 originals:

A specimen which was designated as the holotype of "*Kotôceras richardsoni*" ANDERSON (1958, p. 217, pl. 36, fig. 3, 3a), from loc. CAS. 455A

A specimen, CIT. 3724, designated as the holotype of "*Kotôceras frazierense*" ANDERSON (1958, p. 217, pl. 40, fig. 5, 5a), from loc. CIT. 1347, here shown in Text-fig. 5 (Coll. W. P. POPENOE and W. A. FINDLAY)

CIT. 3476 (Text-fig. 3), from loc. CIT. 1034 (Coll. W. P. POPENOE and D. SCHARF)

Two specimens (one of them Text-fig. 4), from loc. UCLA. 3368 (Coll. James VALENTINE)

Measurements.—

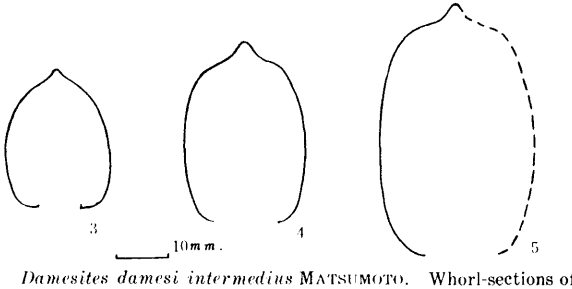
Specimen	Diameter	Height	Breadth (B/H)	Umbilicus (%)
"*K. richardsoni*"	*c.* 50	26	22 (0.84)	7 (14)
CIT. 3724*	86.5	49.3	—	7 (8)
CIT. 3476	*c.* 46	24.8	19.3 (0.77)	4.2 (9)
One from loc. UCLA. 3368*	—	34.8	23.7 (0.68)	—
GK. H 3269 (body whorl excluded)	49.5	28.2	23.2 (0.82)	4.5 (9)

* The specimens are secondarily compressed.

Descriptive remarks.—The Californian specimens listed above have in common the characteristic features that the whorl is involute and moderately compressed with gently inflated flanks, that the umbilicus is small with a subrounded shoulder, that the ventral keel is elevated but has moderately broad base, without accompanying noticeable furrows, that the constrictions are roughly prorsiradiate, with only slight biconcavity on the flank, and remarkably projected on the venter, and that the surface is nearly smooth, except for very weak thread-like subcostae sometimes discernible on the outer whorl.

These characters conform with the diagnosis of *Damesites damesi intermedius* MATSUMOTO (1954, p. 270; MATSUMOTO and OBATA, 1956, p. 131). ANDERSON was right in comparing one of his specimens (i.e. his "*Kotôceras richardsoni*") with the illustrated specimen of YABE (1927, pl. 7 [5], fig. 9, 9a), from Hokkaido. That Japanese specimen should be referred to *D. damesi intermedius* rather than to *D. damesi damesi* (JIMBO) (1894, p. 26, pl. 1 [17], figs. 2, 2a, 2b, 3; MATSUMOTO, 1954a, p. 267, pl. 5 [21], figs. 1a-d, 2a, b, 3a, b; text-figs. 10 [56], 11 [57]). The distinction which ANDERSON recognized between "*Kotôceras richardsoni*" and "*K. frazierense*" is a matter of preservation and also of individual variation. Actually the holotype of *K. frazierense* is secondarily crushed.

I have no comments on the small, presumably immature, specimens which were described as *Kotôceras subsugatum* ANDERSON (1958, p. 217, pl. 35, fig. 2, 2a) [=*Desmoceras sugatum*, ANDERSON, 1902, p. 98, pl. 3, figs. 98, 99], because all the specimens were lost in the San Francisco 1906 fire and because the specific diagnosis is not well expressed on the specimens of such small sizes.



Figs. 3-5. *Damesites damesi intermedius* MATSUMOTO. Whorl-sections of three examples.

3. CIT. 3476, from loc. CIT. 1034, Oak Run, Member IV of the Redding area, Shasta County.

4. A specimen from loc. UCLA. 3368, Clover Creek, Member IV of the Redding area.

5. CIT. 3724, from loc. CIT. 1347, Roaring River, Ono Quadrangle, Shasta County.

Occurrence.—Loc. CIT. 1347, which is, according to POPENOE (an answer to my inquiry), in the highest part of the Cretaceous beds exposed along the Roaring River, a tributary to Cottonwood Creek, Shasta County. It seems to be somewhat above the locality of Turonian ammonites. ANDERSON recorded this locality as "Little Cow Creek", of the Redding area, which does not agree with POPENOE's information.

Loc. CIT. 1034, Member IV of the Redding area. At the same locality there are *Peroniceras shastense* ANDERSON, *Prionocycloceras* sp., and *Baculites schencki* MATSUMOTO. The assemblage indicates the Coniacian.

Loc. UCLA. 3368, Member IV of the Redding area.

Loc. CAS. 455A, "Sidney RICHARDSON ranch, 4 miles north of Montague", Siskiyou County. The stratigraphic position of this locality is not precisely known, but among the associated species I identify *Otoscaphites* sp. and *Inoceramus* cf. *uwajimensis* YEHARA, which suggest the Coniacian. Other Lower Senonian ammonites are known at a nearby locality.

From these available records *D. damesi intermedius* seems to occur in the Coniacian of California. It is interesting to note that in the Japanese province *D. damesi damesi* occur more abundantly than *D. damesi intermedius*, persisting from the Coniacian to the Lower Campanian. I have already suggested (MATSUMOTO, 1957, p. 88) that *D. damesi intermedius* may represent an intermediate position from *D. ainuanus* MATSUMOTO of the Upper Turonian to *D. damesi damesi* and also to *D. sugata* (FORBES) of the Senonian.

Damesites hetonaiensis fresnoensis (ANDERSON)

1958. *Neokotoceras fresnoense* ANDERSON, *Geol. Soc. Amer., Memoir* 71, p. 218, pl. 57, figs. 1, 2, 3, 4, 5.

Holotype.—The specimen illustrated by ANDERSON, 1958 pl. 57, figs. 1, 2, 5, as designated by ANDERSON. The type locality is CAS. 2362 [=CAS. 463].

Material.—In addition to the holotype and the illustrated paratypes, I have dealt with several other specimens, from locs. CAS. 2362, CAS. 2366, and CAS. 2368 (Coll. F. M. ANDERSON; J. A. TAFF, C. C. CHURCH, C. M. CROSS, & G. D. HANNA; Max BINKHAUSER).

Measurements.—

Specimen	Diameter	Height	Breadth (B/H)	Umbilicus (%)
Holotype of *D.h.f.*	106	60.5	37.0 (0.61)	7.9 (7.4)
Paratype (ANDERSON, pl. 57, f. 3)	164 (body whorl) 116.5	66.5	40.3 (0.60)	9.0 (7.7)
" (" pl. 57, f. 4)	31.6	18.4	14.6 (0.79)	1.8 (5.7)
Holotype of *D.h.h.*	44.0	26.0	17.0 (0.65)	3.3 (7.5)

Descriptive remarks.—This form is characterized by a very involute shell, with a very narrow, crater-like umbilicus, relatively compressed whorls, a narrow and sharp, ventral keel which appear relatively early in growth-stage, very fine subcostae which show gentle sinuosity on the flank and are remarkably projected on the venter, weak constrictions which are only occasionally discernible on the outer whorl, and sutures similar to those of *Damesites damesi*, with very finely and deeply incised elements.

In all the above characters it can be specifically included in *Damesites hetonaiensis* MATSUMOTO (1954a, p. 271, pl. 6 [22], figs. 1a-c, 2a, b, 3a, b; text-fig. 12 [58]). The only distinction that can be considered in our present knowledge is that the Californian form is represented by the specimens of moderately large size (diameters being 100-200 mm. in the adult body whorl), on which the subcostae are fine but distinct, while the Japanese one, so far as I know, by those of relatively small size (below 100 mm. in diameter), on which the subcostae are very fine and sometimes indistinct. This might be merely a difference in growth-stages. In fact the immature specimens of California are indistinguishable from the Japanese type specimens. It is rather difficult to decide whether the Japanese specimens are still immature or already mature at that small size, although some of them have crushed body whorls. There may be also some difference in geological age between the Californian and Japanese forms. For the time being the two forms are separated subspecifically as follows:

Damesites hetonaiensis hetonaiensis, characterized by a relatively small size and very faint subcostae

Damesites hetonaiensis fresnoensis, characterized by a relatively large size and fine but fairly distinct subcostae

ANDERSON (1958, p. 218) established a new genus, *Neokotôceras*, for this Californian form, but its separation from *Damesites* is not warrantable. He mentioned the absence of the constriction on the adult whorl, but actually it is occasionally found, as a photograph (ANDERSON, 1958, pl. 57, fig. 3) clearly indicates. Size was considered by him a criterion, but there are some examples of *Damesites semicostatus* MATSUMOTO, which attain fairly large size (see MATSUMOTO and OBATA, 1956, pl. 26, fig. 2a, b; pl. 30, fig. 6). The suture is not of *Puzosia* type but of *Desmoceras* type, being similar to that of *D. damesi* or *D. semicostatus*. Its external saddle is not tripartite but bipartite, although somewhat assymmetric. Thus the differences from the already known species of *Damesites* are not more than specific. Therefore *Neokotôceras* should be suppressed as a subjective synonym of *Damesites*.

Among the hitherto described species, *D. semicostatus* is the closest ally of *D. hetonaiensis*, but the latter has a smaller keel, somewhat more compressed whorls, finer and less flexuous subcostae, less frequent constrictions, and more finely incised sutures than the former. *D. hetonaiensis fresnoensis* may represent an intermediate stage between *D. semicostatus* and *D. hetonaiensis hetonaiensis*.

Occurrence.—Locs. CAS. 2362, CAS. 2366, and CAS. 2368, "Ragged Valley shale" or "*Pachydiscus* silt" in the northern part of Coalinga Quadrangle, Fresno County, west side of the San Joaquin Valley. Among the associated species there are *Pachydiscus egertoni* (FORBES), *Anagaudryceras mikobokense* COLLIGNON, and *Gaudryceras* (*Vertebrites*) *kayei* (FORBES). The suggested age is the Lower Maestrichtian or the highest part of the Campanian.

Subfamily Hauericeratinae MATSUMOTO, 1938
Genus *Hauericeras* DE GROSSOUVRE, 1894
Subgenus *Gardeniceras* MATSUMOTO and OBATA, 1956

Type-species (of the subgenus).—*Ammonites gardeni* BAILY, 1855.

The subgeneric diagnosis and the distinction from *Hauericeras* (*Hauericeras*) have already been given by MATSUMOTO and OBATA (1956, p. 133-135). In spite of a recent suppression of *Gardeniceras* (see MOORE [Editor], 1957, p. L371), I still keep it as a subgenus of *Hauericeras*, because it represents a natural subgroup and is taxonomically (and also stratigraphically) useful.

Hauericeras (*Gardeniceras*) *angustum* YABE
Pl. 4, fig. 4a-c

1865. *Ammonites gardeni*, STOLICZKA (*non* BAILY), *Mem. Geol. Surv. India, Pal. Indica*, ser. 3, vol. 1, p. 61, pl. 28, fig. 4.
1890. *Desmoceras gardeni*, YOKOYAMA, *Palaeontographica*, vol. 36, p. 184, pl. 20, fig. 10.
1898. *Desmoceras* (*Hauericeras*) *gardeni*, KOSSMAT, *Beitr. Pal. Geol. Oesterr.-Ungarns Or.*, vol. 11, p. 123, pl. 18, figs. 7a, b, 8, 10.
1904. *Hauericeras gardeni*, YABE, *Jour. Coll. Sci., Imp. Univ. Tokyo*, vol. 18, p. 32.
1904. *Hauericeras angustum* YABE, *Jour. Coll. Sci., Imp. Univ. Tokyo*, vol. 18, p. 33, pl. 5, figs. 5, 6.
1952. *Hauericeras gardeni*, USHER, *Geol. Surv. Canada, Bull.* 21, p. 61, pl. 5, figs. 1, 2.
1956. *Hauericeras* (*Gardeniceras*) *angustum*, MATSUMOTO and OBATA, *Mem. Fac. Sci., Kyushu Univ.*, ser. D, vol. 5, p. 137, pl. 24, fig. 6; pl. 28, figs. 1a, b, 2; pl. 29, fig. 1a, b, 2a, b, 3a, b, 4a, b, 5; text-figs. 5, 7.
1958. *Hauericeras mickeyi* ANDERSON, *Geol. Soc. Amer., Memoir* 71, p. 219, pl. 47, fig. 2, 2a.

Holotype.—GT. I-259, from the Upper Yezo group in the Urakawa area, Hokkaido, as originally designated by YABE (1904, pl. 5, figs. 5, 6) (see also MATSUMOTO and OBATA, 1956, pl. 29, fig. 2a, b).

Material.—I refer the following specimens to this species:

"Holotype of *Hauericeras mickeyi* ANDERSON (1958, p. 219, pl. 47, fig. 2, 2a), from loc. CAS. 27835, Chico Creek (Coll. J. A. TAFF, G. D. HANNA, and C. M. CROSS)

UCLA. 28826 (Pl. 4, fig. 4a-c) [=CIT. 3474], from loc. CIT. 1017, Chico Creek (Coll. W. P. POPENOE and D. W. SCHARF)

CIT. 3730 (now preserved at UCLA), from loc. CIT. 1226, Chico Creek (Coll. W. P. POPENOE)

UCLA. 28824 and UCLA. 28825, from loc. UCLA. 3633, Chico Creek (Coll. L. E. & R. B. SAUL)

They are fairly well preserved, although they are still immature. There are fragmentary specimens, from loc. UCLA. 3623 and UCLA. 3627, which are comparable with the present species.

Measurements.—

Specimen	Diameter	Height	Breadth (B/H)	Umbilicus (%)
Holotype of *H. mickeyi*	59.5	21.5	11.0 (0.51)	23.0 (38)
UCLA. 28826	46.0	18.3	—	16.1 (35)
	40.8	15.9	8.5 (0.53)	14.3 (35)
UCLA. 28824	—	26.3	12.8 (0.48)	—
UCLA. 28825	31.8	13.3	7.2 (0.54)	—
Holotype (GT. I-254)	33	14	7 (0.5)	11 (33)
GT. I-3852	41.3	15.5	8.7 (0.55)	15.5 (37.5)

For other Japanese examples see MATSUMOTO and OBATA, 1956, p. 138-139.

Descriptive remarks.—The specific diagnosis and the distinction from *Hauericeras* (*Gardeniceras*) *gardeni* (BAILY) have been fully given by MATSUMOTO and OBATA (1956, p. 139-144). They also reviewed the specimens from India and British Columbia, which had been called *Hauericeras gardeni* but which they referred to *H.* (*G.*) *angustum* in the emended sense.

The Californian specimens listed above can also be assigned to *H.* (*G.*) *angustum* from every diagnostic feature. As MATSUMOTO and OBATA remarked, the proportion between whorl-breadth and height and that between width of umbilicus and diameter of shell vary with growth. This is well exemplified in a diagram and the measurements of the Californian specimens clearly conform with the line of *H.* (*G.*) *angustum* (see MATSUMOTO and OBATA, 1956, text-figs. 11, 12). The constrictions are weak, gently sigmoidal on the flank, and very infrequent on the whorl of the late growth-stage, as in the Japanese examples.

As the holotype of *Hauericeras mickeyi* ANDERSON (1958, pl. 47, fig. 2, 2a) has proved to be an immature specimen of *H.* (*G.*) *angustum* YABE (1904, emended MATSUMOTO and OBATA, 1956), the specific name *mickeyi* should be suppressed as a synonym of *angustum*.

The holotype, LSJU. 390, of *Hauericeras transitionale* WARING (1917, p. 69, pl. 9, fig. 15), from loc. LSJU. 2, Los Angeles County, is too crushed for accurate measurements. Therefore I cannot decide whether it is referable to *H. angustum* or not.

Occurrence.—Locs. CIT. 1017, CIT. 1226, UCLA. 3633, UCLA. 3624 (cf.), and CAS. 27835, all in Chico Creek, upper part of the lower half of the section of the Chico formation in the type area. From the stratigraphic position and the associated species, *Baculites capensis* WOODS and *Polyptychoceras* cf. *obstrictum* (JIMBO), the beds from which *H.* (*G.*) *angustum* came are assigned to the Santonian. In Japan and South Sakhalin the species is common in the Santonian and ranges upwards in the lower part of the Campanian (Infrahetonaian).

Family Muniericeratidae WRIGHT, 1952
Genus *Tragodesmoceras* SPATH, 1922

Type-species.—*Desmoceras clypealoide* LEONHARDT, 1897.

Generic diagnosis.—See WRIGHT (*in* MOORE [Editor]) 1957, p. L381.

Tragodesmoceras ashlandicum (ANDERSON)

Pl. 5, fig. 1a, b; Text-figs. 8-10

1902. *Desmoceras ashlandicum* ANDERSON, *Proc. Calif. Acad. Sci.*, 3rd ser., vol. 2, p. 100, pl. 4, figs. 107, 109.

1956. *Tragodesmoceras ashlandicum*, PECK, IMLAY, and POPENOE, *Bull. Amer. Ass. Petrol. Geol.*, vol. 40, p. 1979 (listed only).

1958. *Pachydiscus ashlandicus*, ANDERSON, *Geol. Soc. Amer., Memoir* 71, p. 221, pl. 27, figs. 3, 3a, 4, 4a.

1958. *Pachydiscus oregonensis* ANDERSON, *Geol. Soc. Amer., Memoir* 71, p. 221, pl. 27, figs. 2, 2a.

Holotype.—CAS. 33, illustrated by ANDERSON (1902, Pl. 4, figs. 107, 109; 1958, pl. 27, figs. 3, 3a), from loc. CAS. 446, "4 miles southeast of Ashland, Oregon."

Material.—In addition to ANDERSON's holotype and paratype the following specimens are referred to this species:

The holotype of "*Pachydiscus oregonensis*" ANDERSON (1958, pl. 27, figs. 2, 2a)

UCLA. 28798 (Pl. 5, fig. 1a, b; Text-fig. 8), from loc. CIT. 1444 (Coll. W. P. POPENOE)

A fragmentary specimen (Text-fig. 9), from loc. CIT. 1195 (Coll. W. P. POPENOE & AHLROTH)

Another fragmentary whorl (Text-fig. 10), from loc. CIT. 1208 (Coll. W. P. POPENOE & AHLROTH)

Measurements.—

Specimen	Diameter	Height	Breadth (B/H)	Umbilicus (%)
CAS. 33 (holotype)	77.5	32.0	25.0 (0.78)	21.5 (27)
"*P. oregonensis*"	*c.* 105(?)	49	34 (0.69)	24.5 (24)
UCLA. 28798	162	69.5	61.5 (0.88)	47.8 (29)
〃 〃 (intercostal)	162	69.5	56.5 (0.81)	
〃 〃 (early)	—	51.0	37.5 (0.73)	32.3
〃 〃 (intercostal)		51.0	36.0 (0.70)	
One from loc. CIT. 1195	—	46.0	31.0 (0.67)	—
One from loc. CIT. 1208	—	30.0	23.3 (0.77)	—

Diagnosis.—The full-grown shell is large. It is moderately involute, slightly more than a half of the inner whorl being overlapped by the outer. The whorl is higher than broad, the proportion ranging from 0.67 to 0.88 in the available data, broadest at a position slightly above the umbilical margin, and gradually convergent towards the venter. The flank is slightly inflated in a general view but more flattened on the lower part; the mature whorl is more inflated than the immature. The venter is fastigate, but the mid-venter tends to be rounded on the outer whorl. The umbilicus is fairly narrow to moderate, being 23 to 29 percent of the diameter on the basis of the available data. The umbilical wall is nearly vertical and has a subangular shoulder.

The whorl is ornamented with ribs of unequal length. Every third, fourth, or fifth is longer and somewhat stronger than others, sinuous on the flank, starting from the umbilical shoulder, where they are slightly elevated, if not

distinctly tuberculate. The shorter ribs appear near or somewhat above the middle of the flank. Both the longer and shorter ribs are projected on the venter, tending to form obtuse chevrons. On the ventral part of the whorl of middle growth-stage the ribs are of moderate strength and separated by slightly broader interspaces. On the adult whorl the major ribs are broadened, and straightened or slightly projected, fading away towards the venter, while all the minor ribs are much weakened or nearly obsolete.

The suture is very similar to that of *Gardeniceras*, and accordingly to that of *Puzosia*, having a large, assymmetrically trifid L, which is deeper than E, and remarkably descending auxiliaries.

Remarks.—As compared with the type-species, *T. clypealoide* (LEONHARDT)

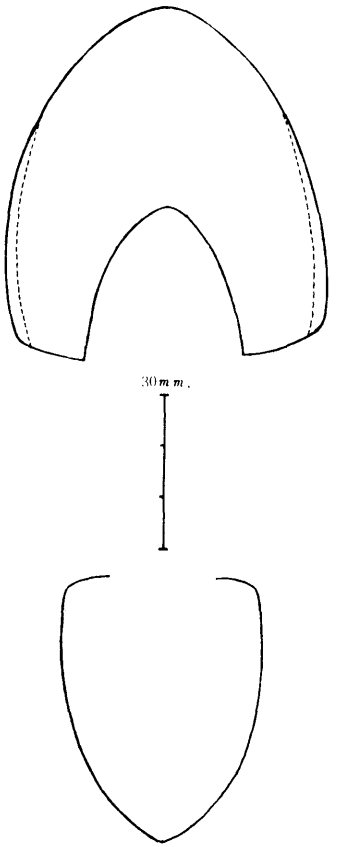
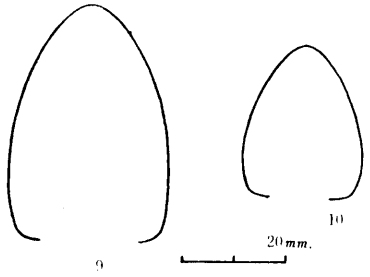


Fig. 8. *Tragodesmoceras ashlandicum* (ANDERSON). Cross section of an example, UCLA. 28798, from loc. CIT. 1444, Member I of the Redding area. See Pl. 5, fig. 1a, b for other views.



Figs. 9, 10. *Tragodesmoceras ashlandicum* (ANDERSON).
9. A specimen from loc. CIT. 1195, Member I of the Redding area, Shasta County.
10. Another from loc. CIT. 1208, Member I of the Redding area.

(1897, p. 57, pl. 6, fig. 2), from the Turonian of Europe, and its allied species, *T. clypeale* (SCHLÜTER) (1872, p. 51, pl. 15, figs. 9-14), from the Coniacian of Europe, *T. ashlandicum* is larger, more evolute, and has the suture of *Puzosia* type rather than *Desmoceras* type. The slight elevation at the umbilical end of the major rib is another feature peculiar to the present species, but is not so strongly tuberculate as in *Muniericeras*.

While *T. clypealoide* and *T. clypeale* seem to have affinity with such members of the Desmoceratinae as *Pseudouhligella* and *Tragodesmoceroides*, *T. ashlandicum* is apparently similar to such members of the Puzosiinae as *Austiniceras* and *Mesopuzosia*. There might be parallel development in species groups derived from different stocks, but the evidence for tracing the origin of the present species is not yet sufficient to allow the establishment of a new genus. It should be also noted that the present species in some respects resembles *Hauericeras* (*s. l.*)

In the Western Interior province there are certain forms which are similar to the present species. An example was kindly shown to me by Dr. COBBAN in his collection. *T. bassi* MORROW (1935, p. 468, pl. 52, figs. 1a-c; pl. 53, figs. 3-5; text-figs. 1, 3), from the Jetmore member of the Greenhorn formation, Kansas, may be another example. There is also a form, as represented by an immature specimen, from the Carlile shale, Wyoming, now preserved in C. W. WRIGHT's collection, which is somewhat intermediate between *T. clypealoide* and a more evolute form.

A large specimen from California, UCLA. 28798 (Pl. 5, fig. 1a, b) is interesting in that it shows the change of characters with growth. Although its adult whorl is somewhat inflated, its inner whorl is less so, being close to ANDERSON's holotype. If we plot the proportion of height and breadth on a diagram, a smoothly curved line is obtained (Fig. 11). The holotype of *"Pachydiscus oregonensis"* ANDERSON (1958, p. 221, pl. 27, figs. 2, 2a) in its dimensions falls on the same line. From this and other points this specimen is proved to be referable to *T. ashlandicum*, and thus the specific name *oregonensis* should be

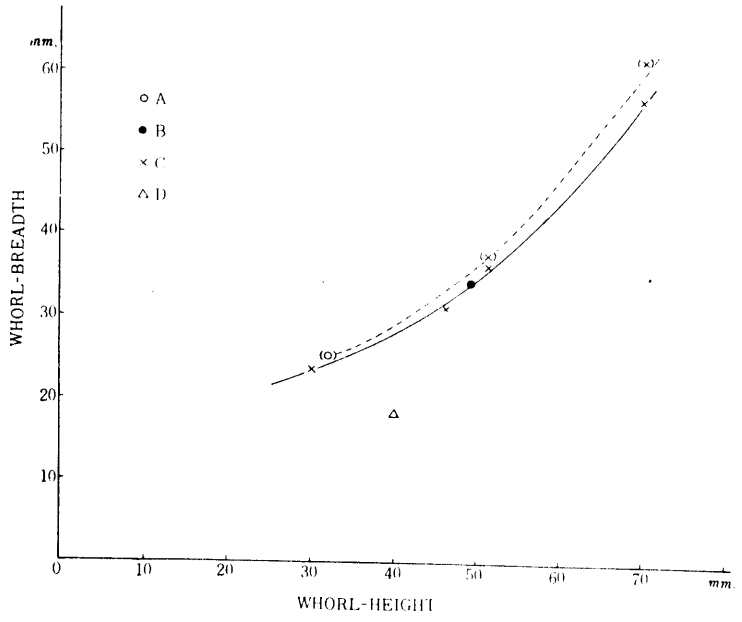


Fig. 11. Diagram showing the proportion between breadth and height of whorls in *Tragodesmoceras ashlandicum* (ANDERSON). A: holotype of *T. ashlandicum*; B: *"T. oregonensis"* ANDERSON; C: other examples of *T. ashlandicum*; D: *T. averilli* ANDERSON (for comparison); ( ): intercostal measurements.

suppressed. The holotype of *"Pachydiscus averilli"* ANDERSON (1958, p. 222, pl. 7, figs. 4, 4a) in its dimension deviates considerably from the line and is more weakly ornamented. This may be a different species, although it is referable to *Tragodesmoceras*.

Occurrence.—Type locality CAS. 446, "4 miles southeast of Ashland, Oregon". Another locality is recorded as "Forty-nine mine near Phoenix, Oregon" (ANDERSON, 1958, p. 221, for *"P. oregonensis"*). The stratigraphic position for these localities have not precisely described, but PECK, IMLAY, and POPENOE (1956, p. 1979) listed *T. ashlandicum* as one of the species in their Members I & II of the Hornbrook formation of the general area of southwestern Oregon and northern California.

Locs. CIT. 1444, CIT. 1195, and CIT. 1208 in sandstones of Member I of the Redding area, Shasta County, California. This member is best referred to the Turonian from its stratigraphic position and contained fossils.

Family Pachydiscidae SPATH, 1922

In California the pachydiscids occur fairly commonly, but are confined to

the upper part of the Upper Cretaceous. They are represented by *Eupachydiscus*, *Anapachydiscus*, *Pachydiscus*, *Canadoceras*, and *Patagiosites*. No species of *Eopachydiscus*, *Lewesiceras*, and *Pachydiscoides* have been found there.

While the various, interesting examples of the bituberculate pachydiscids are known in Japan and Sakhalin (see MATSUMOTO, 1955b), very few occur in California. Among the specimens at my disposal there are only two, crushed specimens of *Menuites* sp., from loc. CIT. 623, Point Conception, Santa Barbara County (Coll. J. DORRANCE) and loc. CAS. 13289, Point Loma, San Diego County (no record of collector). Another, small, very poorly preserved specimen, from loc. LSJU. 1999, west side of the Capay Valley, Yolo County (Coll. J. M. KIRBY), may be comparable with *Menuites pussilus* MATSUMOTO (1955b, p. 165, pl. 32, figs. 1a-d, 2a-d, 3a-c, 4a, b), but cannot be identified with certainty.

Genus *Eupachydiscus* SPATH, 1922

Type-species.—*Ammonites isculensis* REDTENBACHER, 1893, by original designation.

Synonym.—*Mesopachydiscus* YABE and SHIMIZU, 1926.

Generic diagnosis.—See MATSUMOTO, 1954a (p. 281); WRIGHT *in* MOORE [Editor], 1957, p. L380. The constriction was accounted as one of the diagnostic features of this genus in my older papers (1947, p. 37; 1951, p. 22), but this should not be stressed too much, because on the outer whorl it may or may not develop depending on species.

Remarks.—This strongly ribbed genus is readily identified. It is common in the upper part of the Urakawan in the Japanese province, approximately equivalents of the Santonian *plus* (?) Lower Campanian, but the type-species occurs, according to BRINKMANN (1935), in the Upper Coniacian and Lower Santonian of the Alpine Gosau beds. Whether *Eupachydiscus* was derived from *Lewesiceras*, *Anapachydiscus*, or otherwise is not clear in our present knowledge. It cannot be overlooked, however, that a Coniacian example from California, to be described below, resembles a certain species of *Lewesiceras*.

I have recognized the following species of *Eupachydiscus* in the Upper Cretaceous of the West Coast.

(1) *Eupachydiscus* sp. aff. *E. teshioensis* (JIMBO)
(2) *Eupachydiscus haradai* (JIMBO), including "*Pachydiscus perplicatus*" WHITEAVES and "*Pachydiscus haradai*" of USHER (1952)
(3) *Eupachydiscus* sp. cf. *E. levyi* (DE GROSSOUVRE)
(4) *Eupachydiscus* sp. nov. (?) aff. *E. lamberti* COLLIGNON

I describe here the first two species. The third species is represented only by a small, probably immature, specimen, from "a mine shaft underneath the lavas, Manton, California", donated by Mr. H. E. VOKES to Stanford University. In spite of its small size the specimen has already distant and rather rectiradiate ribs, which are normally found on the adult whorl of *E. levyi* (GROSSOUVRE) (1894, p. 178, pl. 21; pl. 30, figs. 1, 2), from the Alps-Maritimes and the Campanian

of Madagascar (COLLIGNON, 1938, p. 14, pl. 3, figs. 3, 3a; text-fig. A; 1955, p. 34). The fourth species resembles *E. lamberti* (COLLIGNON) (1938, p. 35, pl. 5, figs. 3, 3a, 3b; 1955, p. 45, pl. 10, figs. 1, 1a, 1b), from the "middle Campanian" of Madagascar, in the relatively high outer whorl, which is ornamented with distant, rather rectiradiate, strong ribs. The species is represented by two gigantic specimens, UCLA, 28683 and 28684 (Pl. 7, figs. 1a-c, 2) from loc. UCLA. 3956, Santa Monica Mountains, California, now preserved at the University of California at Los Angeles. There is another comparable, fragmentary, body whorl, from the Santa Ana Mountains, in the collection of Standford University. Another well preserved specimen, which Dr. D. L. JONES showed me in his collection at the U. S. Geological Survey, Menlo Park, may be allied to this species. One of the differences between the species from Madagascar and California is that the ribs are weakened or interrupted on the siphonal line in the former but rather exaggerated in the latter. The full description of this interesting, probably new species will be given by Dr. JONES.

Eupachydiscus sp. aff. *E. teshioensis* (JIMBO)

Pl. 6, figs. 1a-c; Text-fig. 12

Compare.—

1874. *Pachydiscus teshioensis* JIMBO, *Pal. Abh.*, Bd. 6 [N.F. 2], p. 30 [176], pl. 3 [19], figs. 1, 1a, 1b.

Holotype of E. teshioensis (JIMBO).—An original specimen of JIMBO (1894, pl. 3 [19], figs. 1, 1a, 1b), from the Upper Cretaceous of the "Tsikapunnai", Abeshinai area, Teshio Province, Hokkaido.

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

UCLA. 28799 (Pl. 6, figs. 1a-c; Text-fig. 12), from loc. UCLA. 3368 (Coll. James VALENTINE)

A fragmentary, inner whorl, from loc. UCLA. 3782 (Coll. W. P. POPENOE)

Another specimen of moderate size, from loc. UCLA. 3783 (Coll. W. P. POPENOE); others from loc. SOC. K-53, 55 (Coll. KENNELL & ROBINS)

Measurements.—

Specimen	Diameter	Height	Breadth (B/H)	Umbilicus (%)
Holotype (deformed)	249.0	85.0	142.0 (1.66)	82.0 (33)
GK. H 3414 (hypotype)	220	72.0	104.5 (1.45)	65.3 (29.7)
UCLA. 28799	106.5	49.5	63.5 (1.28)	30.0 (28)
〃 (1/2 vol. early)	—	33.0	39.6 (1.20)	—
One from loc. 3782	—	22.0	30.2 (1.34)	—
One from loc. 3783	57.0	25.5	30.9 (1.21)	12.5 (22)
Holotype of *L. beantalyense* (after COLLIGNON)	72	35	54 (1.54)	21 (29)
L. tongoboryense (after COLLIGNON)	59	27	38 (1.40)	18 (31)

Descriptive remarks.—In the relatively inflated and depressed whorls and the arcuate and strong ribs, the Californian specimens under consideration are best comparable with *Eupachydiscus teshioensis* (JIMBO) from Japan. The

Canadoceras yokoyamai (JIMBO)

Pl. 12, fig. 1a-c; Pl. 13, figs. 1a-c, 2; Pl. 14, fig. 1a, b; Pl. 15, fig. 1a-c

1894. *Pachydiscus yokoyamai* JIMBO, *Pal. Abh.*, Bd. 6 [N. F. 2], p. 31 [177], pl. 2 [18], fig. 3, 3a, 3b.

? 1903. *Pachydiscus multisulcatus* WHITEAVES, *Mesozoic Fossils*, vol. 1, pt. 5, p. 349, text-fig. 50; pl. 50.

? 1952. *Pachydiscus multisulcatus*, USHER, *Geol. Surv. Canada, Bull.* 21, p. 81, pl. 16, figs. 1-4; pl. 31, fig. 8.

1954. *Canadoceras yokoyamai*, MATSUMOTO, *Cret. System Japanese Islands*, Appendix, p. 302, pl. 13 [29], fig. 2a, b; pl. 17 [33], figs. 1a, b, 2; text-fig. 26 [72].

1954. *Canadoceras* aff. *kossmati* MATSUMOTO (*pro parte*), *Cret. System Japanese Islands*, Appendix, p. 296, pl. 20 [36], fig. 4a, b.

1958. *Canadoceras fraternum*, ANDERSON (*non* GABB), *Geol. Soc. Amer., Memoir* 71, p. 233, pl. 50, fig. 1.

Holotype.—GT. I-103 from "Tsiptaushibets, a branch of the Tumbets, Kitami province, Hokkaido". A number of other examples from the Campanian of Hokkaido and Sakhalin have been shown in my paper (1954a).

Material.—The Californian examples of the present species, which I have examined, are as follows:

UC. 14938 from loc. UC. 2701, and another from loc. UC. 2699, Chico Creek, Butte County (no record of collectors)

LSJU. 8532 (Pl. 12, fig. 1a-c) from loc. LSJU. 2609, Chico Creek, Butte County (Coll. R. E. COOK)

LSJU. 8528 (Pl. 13, figs. 1a-c, 2), 8529, 8530, 8531A, and 8531B (Pl. 14, fig. 1a, b) from loc. LSJU. 3355, Mill Creek, Tehama County (Coll. S. W. MULLER)

GK. H7004 from loc. TM. 1011 [=LSJU. 3300], Chico Creek, Butte County (Coll. T. MATSUMOTO and S. CHUBER)

A young specimen, UCLA. 28843 (Pl. 15, fig. 1a-c), from loc. UCLA. 3637, Chico Creek, Butte County (Coll. L. E. & R. B. SAUL)

A comparable specimen from loc. CIT. 1053, Orange County (Coll. W. P. POPENOE)

Measurements.—

Specimen	Remarks	Diameter	Height	Breadth (B/H)	Umbilicus (%)
US. 14938	(last whorl)	203.0	85.5	77.5 (0.90)	60.7 (30)
	(½ whorl earlier)	—	47.3	43.7 (0.92)	—
LSJU. 8532	(at the last septum)	*c.* 160	63.0	62.0 (0.98)	49.0 (31)
	(½ whorl earlier)	115.0	44.0	44.5 (1.01)	37.8 (32)
	(1 whorl earlier)	*c.* 85	34.6	35.5 (1.02)	28.4 (33)
LSJU. 8528	(at the illustrated suture)	120.0	52.4	53.5 (1.02)	31.8 (26)
	(½ whorl earlier)	—	37.8	40.9 (1.08)	—
LSJU. 8529	(last whorl)	*c.* 105	46.0	46.0 (1.0)	—
	(½ whorl earlier)		33.6	37.4 (1.11)	
LSJU. 8531B (undeformed part)		75.0	34.5	34.5 (1.0)	20.2 (27)
GK. H 7004 (immature)		35.5	14.0	16.0 (1.14)	12.5 (35)
One from loc. UC. 2699		90.5	38.0		27.0 (30)
//	(slightly earlier)	-	34.7	34.7 (1.00)	
UCLA. 28843 (immature)		33.0	13.8	16.2 (1.17)	11.5 (34)

Diagnosis.—The whorl is relatively thick, somewhat broader than high in the earlier growth-stages, and nearly as broad as high in the later. The flank is convex and the venter is moderately rounded. The umbilicus is fairly narrow and fairly deep, with a steep umbilical wall and a rounded shoulder. The maximum breadth of the whorl is at or slightly above the umbilical shoulder.

The ribs are relatively coarse and strong, as compared with other species of *Canadoceras*, becoming, however, weak on the body whorl of the full grown shell. They are separated by interspaces as broad as or slightly broader than themselves. They are of unequal length, but even the shorter ribs arise slightly above the umbilical shoulder. Some of the shorter ribs branch from the longer ones, and others are intercalated. The periodic, long and strong ribs are provided with prominent tubercles at the umbilical shoulder and are associated with constrictions on the internal mould, but tuberculated long ribs without accompanying constrictions may be found. The tubercles become weak and bullate on the outer whorl. The ribs are prorsiradiate, gently arcuate on the flank, concave anteriorly, and show a projection of moderate intensity on the venter.

There is no significant difference in suture among the species of *Canadoceras*.

The shell sometimes reaches a large size. An example from California has the last suture at a diameter of about 230 mm.

Remarks.—Almost all the specimens from California listed above match so well the Japanese examples of *Canadoceras yokoyamai* (JIMBO), that I am confident about the identity of species. A few specimens from Chico Creek have, however, a relatively wide umbilicus as compared with the usual examples. They exhibit otherwise the diagnostic features of the present species, and are best referred to it. If the widely umbilicate form were proved to occur slightly higher (or lower) level than the normal one, it might be separated subspecifically. So far as the available material is concerned, such a situation is not likely to happen. In Japan, Sakhalin, and Alaska (in the collection of Paleontological Laboratory of Shell Oil Co. at Seattle) there are examples of widely umbilicate *Canadoceras multicostatum* MATSUMOTO (1954a, p. 304, pl. 18 [34], figs. 1a, b, c, 2; text-fig. 28 [74]), but that species is clearly distinguished from *C. yokoyamai* (JIMBO) by its more compressed whorls and more numerous, more crowded, and finer ribs.

The present species was once regarded by SPATH (1922, p. 124) as a probable example of *Nowakites*. From the descriptions and illustrations of the species of *Nowakites*, from the Lower Senonian of Europe, I hesitate to give here clear distinction between *Nowakites* and *Canadoceras*. The diagnosis of *Nowakites* recently written by COLLIGNON (1955, p. 13) can well be also applied to some species of *Canadoceras*. Frequent umbilical tubercles may characterize *Nowakites*. In addition, we could expect distinction in sutures and in the size of the adult shell. However, the suture of the holotype of the type-species of *Nowakites*, *Pachydiscus carezi* GROSSOUVRE (1894 [1893], p. 190, pl. 25, fig. 3), is not known.

Anyhow, *C. yokoyamai* (JIMBO) is so intimately allied to *C. kossmati* MATSUMOTO and also *C. newberryanum* (MEEK), the type-species of *Canadoceras*, that I think it reasonable and natural to refer this species to *Canadoceras*, which genus is better defined and better known (see MATSUMOTO, 1954a, p. 290) than *Nowakites*.

The distinction of *C. yokoyamai* (JIMBO) from *C. newberryanum* (MEEK) and also from *C. kossmati* (MATSUMOTO) lies in its broader whorl and coarser ribs. In this respect *C. yokoyamai* (JIMBO) is closer to *C. multisulcatum* (WHITEAVES) (1903, p. 349, pl. 50; USHER, 1952, p. 81, pl. 16, figs. 1-4; pl. 31, fig. 8), as I mentioned previously (1954 [1953], p. 304). On seeing the examples from California, with some variability, I am rather inclined to doubt the specific distinction between *C. yokoyamai* (JIMBO) and *C. multisulcatum* (WHITEAVES). WHITEAVES' illustrated specimen of *Pachydiscus multisulcatus* (1903, text-fig. 24 and pl. 50), GSC. 5856, which is here designated as lectotype (not holotype, despite USHER's indication [1952, p. 84], since it is one of the syntypic specimens), has rather semielliptical whorl section just like the typical examples of *C. yokoyamai* (JIMBO). Minor difference in ribbing may not be significant, since the species is variable in that point, as USHER has mentioned (1952, p. 84). Some of the Canadian specimens have a wide umbilicus, just as some of the Californian ones have. One of the Japanese examples, GK. H3540, which came from the bed below the level of unmistakable *C. kossmati* MATSUMOTO, was considered by myself (1954 [1953], p. 296) to be possibly referable to *C. multisulcatum* (WHITEAVES), although it was listed and illustrated temporarily as *C.* aff. *kossmati* MATSUMOTO (1954a, p 296, pl. 20 [36], fig. 4, 4a). This is, in my present knowledge, better regarded as being within the variation of *C. yokoyamai* (JIMBO).

From all the above observation, *C. multisulcatum* (WHITEAVES) (1903) very probably falls in the synonymy of *C. yokoyamai* (JIMBO) (1894). However, I suspend a final conclusion until I get an opportunity of studying the type specimens of the former.

C. yokoyamai (JIMBO) might be sometimes misidentified with *Eupachydiscus haradai* (JIMBO), especially with the relatively less inflated representative of that species on the West Coast. In the former there is a decrease in the intensity of ornament on the whorl of the later growth-stages, while the latter shows an increase of ornament on the mature whorls. A periodic constriction is another criterion.

Occurrence.—Locs. UC. 2701, UC. 2699, LSJU. 2609, UCLA. 3637, and TM. 1011 [=LSJU. 3300], all from the lower part of the upper half of the Chico formation in the type section of Chico Creek, Butte County (along with *Submortoniceras chicoense* (TRASK) and *Baculites chicoensis* (TRASK)) and LSJU. 3355, Pape Place, Mill Creek, Tehama County (along with *Inoceramus naumanni* YOKOYAMA).

A comparable specimen came from loc. CIT. 1053, upper part of the Holz shale in Santa Ana Mountains, Orange County.

Thus, in California the species is found in the beds which are considered lower than those of *C. newberryanum* (MEEK). In the Nanaimo group of Vancouver Islands, according to USHER, *C. multisulcatum* (WHITEAVES), which is probably identical with *C. yokoyamai* (JIMBO), is said to occur in the Upper Qualicum formation, while *C. newberryanum* (MEEK) occurs in the Haslam and Ceder District formations.

In Japan and Sakhalin the ranges of *C. yokoyamai* (JIMBO) and *C. kossmati* MATSUMOTO overlap each other in the "Lower Hetonaian" (zone of *Inoceramus schmidti*), but the former species appears earlier than the latter. Some of the examples of *C. yokoyamai* (JIMBO), including JIMBO's original specimen, have not yet been stratigraphically well located.

Canadoceras mysticum MATSUMOTO

Pl. 15, figs. 2, 3a-c

1954. *Canadoceras mysticum* MATSUMOTO, *Cret. System Japanese Islands*, Appendix, p. 307, pl. 15 [31], figs. 2a, b; pl. 19 [35], figs. 1a, b, c, 2a, b; text-figs. 29 [75] and 30 [76].

Holotype.—GK. H 5184, from the zone of *Inoceramus schmidti*, Teshio Province, Hokkaido (MATSUMOTO, 1954a, pl. 19 [35], fig. 1a, b, c).

Material.—The Californian specimens which I refer to this species are UCLA. 28842 (Pl. 15, fig. 3a-c), from loc. UCLA. 3637, and UCLA. 28844 (Pl. 15, fig. 2), from loc. UCLA. 3636 (both Coll. L. E. & R. B. SAUL). There are some fragmentary whorls which are comparable with this species.

Measurements.—

Specimen	Diameter	Height	Breadth (B/H)	Umbilicus (%)
GK. H 5184	92.5	40.8	31.2 (0.76)	25.0 (27)
	82.0	35.5	30.4 (0.85)	22.3 (27)
UCLA. 28842	71.0	30.3	26.9 (0.88)	20.6 (29)
	—	22.8	20.4 (0.89)	—
UCLA. 28844	65.0	29.0	c. 11×2 (0.76)	16.4 (25)

Specific diagnosis.—The whorl is considerably involute with a fairly narrow umbilicus. It is relatively compressed, with a narrowly arched venter and flattened flanks. The ribs are numerous, relatively weak, and nearly radiate or gently flexuous on the main part of the flank, passing gradually to a ventral projection. In more or less late growth-stage the constrictions and major ribs are prorsiradiate. The constrictions are frequent but shallow. The umbilical tubercles are indistinct, being discernible as weak bullae along the major ribs or sometimes almost obsolete. The suture is of typical *Pachydiscus* pattern.

Remarks.—The two illustrated specimens are not quite identical in the curvature of the ribs, obliqueness of the constriction and weakness of the tubercles. The differences are minor and can be ignored as variation within the same species, as in the case of the Japanese specimens. In the essential features the Californian examples match the Japanese ones. The ribs, which are numerous and rather crowded on the immature whorls, become more distant on the adult whorl, as shown in the holotype. Although the adult body chamber is only

imperfectly preserved in one of the Californian specimens, the tendency towards this character is well recognized on the outer whorl.

The weakening of the ornament in this species foreshadows *Patagiosites*. The latter genus is represented in California by a species which occur in strata probably younger than the beds containing *C. mysticum*.

Occurrence.—Locs. UCLA. 3637 and UCLA. 3636 on Chico Creek, lower part of the upper half of the Chico formation in this area, Butte County, east side of the Sacramento Valley, California. From the same localities *Canadoceras yokoyamai*, *Submortoniceras chicoense*, and *Baculites chicoensis*, among others, have been obtained.

C. mysticum is a rare species in the Japanese Campanian. Its discovery, although rare, in California is noteworthy.

Genus *Patagiosites* SPATH, 1953

Type-species.—*Ammonites patagiosus* SCHLÜTER, 1867.

Generic diagnosis.—See SPATH, 1953 (*Falkland Isl. Dep. Survey, Sci. Rep.*, No. 3), p. 38; WRIGHT *in* MOORE [Editor], 1957, p. L 380.

Remarks.—I once pointed out the close affinity of *Patagiosites* with *Canadoceras* (MATSUMOTO, 1954a, p. 294). Thus I agree with WRIGHT (1957, p. L 380) in regarding *Patagiosites* as probably a reduced derivative of *Canadoceras*. SPATH's statement that the suture of *Patagiosites* should be puzosid type and less advanced than that of *Anapachydiscus* or *Pachydiscus (s.s.)* is not tenable. The suture is quite similar to that of *Anapachydiscus*, *Pachydiscus*, or *Canadoceras*.

In California there is one species of *Patagiosites* as described below. The occurrence of this genus in California is quite reasonable, because *Canadoceras* is common in the northern Pacific region. In fact *Canadoceras compressum* MATSUMOTO (1954a, p. 310, pl. 20 [36], figs. 1, 2a, b, 3; text-fig. 31 [77]) from Japan is better transferred to *Patagiosites*.

Patagiosites arbucklensis (ANDERSON)

Pl. 16, fig. 1a-c; Pl. 17, figs. 1a, b, 2a, b

1958. *Eupachydiscus arbucklensis* ANDERSON, *Geol. Soc. Amer., Memoir* 71, p. 223, pl. 44, fig. 1, 1a; pl. 45, fig. 1.
1958. *Eupachydiscus willgreeni* ANDERSON, *Geol. Soc. Amer., Memoir* 71, p. 223, pl. 46, fig. 2.
1958. *Nowakites dobbinsi* ANDERSON, *Geol. Soc. Amer., Memoir* 71, p. 231, pl. 44, fig. 2, 2a.
1958. *Nowakites rumseyensis* ANDERSON, *Geol. Soc. Amer., Memoir* 71, p. 231, pl. 45, fig. 3.
1958. *Puzosia (Parapuzosia) arenaica* ANDERSON, *Geol. Soc. Amer., Memoir* 71, pl. 46, fig. 4, 4a.
1958. *Puzosia (Holcodiscoides) gorrilli* ANDERSON, *Geol. Soc. Amer., Memoir* 71, p. 240, pl. 46, fig. 4, 4a.

Holotype.—The holotype by original designation is the specimen illustrated by ANDERSON, 1958, pl. 44, fig. 1, 1a. Its locality is CAS. 25730.

Material.—In addition to the holotype and paratype of ANDERSON's *Eupachydiscus arbucklensis*, there are many specimens from the same type locality (CAS. 25730) (Coll. H. L. DOBBINS). They received from ANDERSON (1958) five other new names, but represent specimens of different growth-stages or varieties of the same species (see above synonymy). There is another example from loc. CAS. 33717 (Coll. H. L. DOBBINS).

In the collections of other institutions, from the same locality and its vicinity, there are still more examples of this species. They are as follows:

UC. 14939, with a label of *Eupachydiscus arbucklensis* ANDERSON, from loc. UC. 190, Sand Creek, west of Arbuckle (Coll. no record)

LSJU. 8517-A (Pl. 16, fig. 1a-c), LSJU. 8518 (Pl. 17, fig. 1a, b), LSJU. 8521 (Pl. 17, fig. 2a, b), LSJU. 8517-B, 8519, 8522, 8523 from loc. LSJU. 3169 (Coll. J. M. KIRBY)

Specimens, without register numbers, from locs. SOC. K-237, K-238, K-239, and K-240 (all Coll. M. V. KIRK)

Measurements.—

Specimen	Diameter	Height	Breadth (B/H)	Umbilicus (%)
CAS. holotype	119.7	48.0	42.0 (0.87)	36.5 (30)
CAS. paratype	170.5	68.0	65.0 (0.95)	51.3 (30)
UC. 14939	118.5	47.5	—	35.6 (30)
LSJU. 8516	106.4	44.7	—	30.3 (28)
〃 〃 (1/4 vol. early)	85.7	37.2	—	22.6 (26)
LSJU. 8517	c. 180	72.0	62.6 (0.87)	59.5 (33)
LSJU. 8518	35.5	14.7	13.8 (0.93)	9.8 (28)
LSJU. 8520	120.0	50.0	43.5 (0.87)	33.4 (29)

Diagnosis.—The shell is discoidal, moderately involute, and fairly large, growing rather slowly, with an umbilicus of moderate size, so that it resembles *Puzosia*. The whorl is somewhat higher than broad; the proportion of its height and breadth is 10:8-9.5. It has a narrowly arched venter, rather flattened or only slightly convex flanks, with the maximum breadth near the umbilical margin, and a steeply inclined, but not vertical, umbilical wall.

The inner whorls, of diameters below 50 mm. or so, are ornamented with numerous flexuous ribs, umbilical tubercles, and periodic constrictions. The ribs are of unequal length and strength; the periodic major ribs are provided with prominent tubercles at the umbilical shoulder and usually, but not always, bordered by constrictions; many of the minor ribs start near the umbilical margin, sometimes tending to be united with the major ones near the umbilical tubercles; a few minor ribs are shorter than others, appearing only near the mid-flank. On the venter all the ribs are bent forward and separated by the interspaces, which are as narrow as or slightly broader than the ribs.

On the middle whorl, at diameters from 50 mm. to about 100 mm., the ribs and the tubercles are weakened. The major ribs are frequent but rather irregular in distance and strength; some of them are very weak. The umbilical tubercles are bullate. Narrow and shallow constrictions are discernible along some of the

In the shell-form and the ornamentation the described specimen of California closely resembles the outer whorl of *Acanthoceras pepperense* MOREMAN (1942, p. 204, pl. 32, fig. 5; text-fig. 2 m) (Text-fig. 39 of this paper), from the Tarrant formation of the Eagle Ford group of Texas. In addition to the holotype, BEG. 19803, there are several specimens, from loc. BEG. 2411 and BEG. 2410, the flag member of the Eagle Ford group, which are best referred to *A. pepperense*. The one figured by ADKINS (1928, pl. 27, fig. 2) as "*Acanthoceras* n. sp.", from loc. BEG. 2410, may be one of them. From the observation of all the available specimens I conclude that *A. pepperense* is fairly close to an upright-horned species of *Acanthoceras*, which occurs somewhat below the zone of *Acanthoceras amphibolum* and is considered by COBBAN (personal conversation) to be new, and in my opinion is closely related to *Acanthoceras cornigerum* CRICK (1907, p. 207, pl. 13, fig. 1, 1a; MATSUMOTO, SAITO, and FUKADA, 1957, text-fig. 5), from Zululand, South Africa. On the other hand, the less strongly horned, earlier whorl of *A. pepperense* is almost indistinguishable from the British Lower Chalk *A. sherborni* SPATH (1926, p. 63) [=*Ammonites cenomanensis*, SHARPE (*non* D'ARCHIAC), 1857, p. 37, pl. 17, fig. 1a, b], but for a slightly narrower umbilicus.

There is another Californian specimen which should be taken into consideration. It is an imperfectly preserved ventral portion of a septate whorl, from loc. LSJU. 2958, Walthan Creek of Coalinga Quadrangle, Lower Waltham formation (Coll. S. W. MULLER). It resembles *A. sherborni* but is closer to *Acanthoceras evolutum* SPATH (1926, p. 82) [=*Ammonites sussexiensis*, SHARPE (*non* MANTELL), 1855, p. 34, pl. 15, fig. 1] in the ornamentation on the venter.

Occurrence.—Loc. CAS. 2324, north side of Walthan Creek, presumably Lower Waltham formation, Coalinga Quadrangle, Fresno County, west side of the San Joaquin Valley.

Genus *Romaniceras* SPATH, 1923

Type-species.—*Ammonites deverianus* D'ORBIGNY, 1841, by original designation.

Synonym.—*Kossmatia*, YABE, 1927 (*non* UHLIG, 1907) (see WRIGHT and MATSUMOTO, 1954, p. 128).

Generic diagnosis.—See MATSUMOTO, SAITO, and FUKADA, 1957 (*Mem. Fac. Sci., Kyushu Univ.*, ser. D, vol. 6, no. 1), p. 21.

Remarks.—*Romaniceras* is proved to be a multituberculate derivative from *Calycoceras*, while *Acanthoceras* gives rise to *Yubariceras* (see MATSUMOTO *et al*, 1957, p. 22 and p. 26).

In California there are fairly well preserved specimens of *Romaniceras*, which I identify with the two species, *R. deverioide* (DE GROSSOUVRE) and *R.* sp. aff. *R. pseudodeverianum* (JIMBO). There is another undeterminable species, which are probably distinguished from these two.

Romaniceras deverioide (DE GROSSOUVRE)

Pl. 25, fig. 1a-c; Pl. 26, fig. 1a-c; Pl. 28, fig. 1a, b; Pl. 29, fig. 4a-c; Text-figs. 40-44

1889. *Ammonites deverioides* DE GROSSOUVRE, *Bull. Soc. Géol. France*, 3 ser., vol. 17, p. 524, pl. 12, figs. 1, 2.
1897. *Ammonites deverioides*, PERON, *Mém. Soc. Géol. France, Paléont.*, no. 17, p. 21, pl. 1, figs. 2, 3.
1931. *Romaniceras loboense* ADKINS, *Univ. Texas Bull.*, no. 3101, p. 44, pl. 2, figs. 1, 21; pl. 3, fig. 5.
1937. *Acanthoceras deverianum*, BASSE (*pro parte*) (*non* D'ORBIGNY), *Haut-comm. Repub. franç. Syrie Lyban, Notes et mém.* 2, p. 180, pl. 8, fig. 1a, b.
1939. *Romaniceras deverioides*, COLLIGNON, *Ann. Géol. Serv. Mines, Madagascar*, vol. 10, p. 37.
1958. *Mantelliceras conquistador* ANDERSON, *Geol. Soc. Amer., Memoir* 71, pl. 245, pl. 15, fig. 2.
1958. *Mantelliceras* aff. *conquistador* ANDERSON, *Geol. Soc. Amer., Memoir* 71, p. 245, pl. 14, fig. 2.
1958. *Mantelliceras* aff. *conquistador* ANDERSON, *Geol. Soc. Amer., Memoir* 71, p. 245, pl. 14, fig. 2.
1958. *Romaniceras hesperium* ANDERSON, *Geol. Soc. Amer., Memoir* 71, p. 246, pl. 23, fig. 1, 1a.

Lectotype.—DE GROSSOUVRE (1889) established this species on syntypes. The figured specimen (DE GROSSOUVRE, 1889, pl. 12, figs. 1, 2) is here designated as the lectotype. It is now preserved at the Ecole de Mines, Paris and its plaster cast has been kindly sent to Kyushu University (GK. H9139) through Dr. J. SORNAY. According to his information, it came from one of the numerous quarries in the "tuffeau" in the neighborhood of Bourré (Loir et Cher), France.

Material.—The following, relatively well-preserved specimens are the Californian examples of the present species.

Three measured and illustrated specimens, UC. 32251 (Pl. 25, fig. 1a-c; Text-fig. 41), UC. 15748 (Pl. 26, fig. 1a-c; Text-fig. 43), and UC. 33831 (Text-fig. 44a, b), from loc SOC. K-225 (Coll. M. V. KIRK)

Two measured and illustrated specimens, CIT. 3727 (Pl. 28, fig. 1a, b; Text-fig. 42) and UCLA. 28796 (Pl. 29, fig. 4a-c), and also three other measured specimens from loc. CIT. 1345 (Coll. W. P. POPENOE & Carl AHLROTH)

A specimen from loc. CIT. 1190 (Coll. W. P. POPENOE & Carl AHLROTH)

A specimen, GK. H7048, from loc. TM. 2003 [=LSJU. 3290] (Coll. W. P. POPENOE & T. MATSUMOTO)

Three specimens of different growth-stages in the collection of USGS. Menlo Park, from Swede Creek, Redding area (Coll. W. P. POPENOE & R. W. BROWN)

ANDERSON's (1958, p. 245, pl. 14, fig. 2; pl. 15, fig. 2; pl. 23, fig. 1, 1a) specimens from loc. CAS. 31230 and CAS. 31231 [=CIT. 1345]

I have also studied the Texas specimens from loc. BEG. 2612 in comparison with the Californian ones.

Measurements.

Specimen	Diameter	Height	Breadth (B/H)	Umbilicus (%)
Lectotype	122.5	51.8	62.0 (1.19)	38.3 (31)
〃 (½ vol. earlier)	98.2	43.0	52.5 (1.22)	30.0 (31)
R. loboense (holotype)		73.0	83.6 (1.14)	—
Another from BEG. 2612		55.5	66.0 (1.18)	—
CIT. 3727	*c.* 125	54.3	64.3 (1.20)	29.7 (32)
〃 (earlier)	*c.* 90	38.5	47.8 (1.23)	—
UCLA. 28796	73.6	37.3	46.0 (1.23)	21.8 (30)
Another from CIT. 1345	54.4	24.0	29.5 (1.22)	16.0 (29)
〃 〃		31.8	38.3 (1.20)	—
〃 〃		*c.* 70	*c.* 42.5×2 (1.21)	—
UC. 32251 (costal)	89.0	38.5	51.5 (1.33)	25.7 (29)
〃 (intercostal)		36.8	44.0 (1.19)	—
UC. 15748 (costal)		54.6	74.5 (1.36)	—
〃 (intercostal)		52.2	66.0 (1.26)	—
UC. 33831	172.5	67.5	87.0 (1.28)	55.5 (32)
〃 (½ vol. early)		44.5	58.1 (1.30)	—
USGS. Menlo Park		31.0	37.0 (1.19)	—
〃 〃 (another)		44.7	53.7 (1.20)	—
GK. H 7048		54.5	71.7 (1.31)	—

Diagnosis.—The shell is thickly discoidal, relatively evolute, and moderately widely umbilicate; the umbilicus being 28-32 percent of the shell-diameter. The full-grown shell may be considerably large. The whorl is broader than high, moderately to broadly rounded on the venter, fairly inflated on the flank, and steep and high on the umbilical wall.

The ribs are strong and widely spaced especially on the outer whorl. They are nearly rectiradiate on the sides, but may show a very broadly convex curve on crossing the venter. The secondary ribs are less numerous than the primary ribs. The tubercles are in eleven rows; they are generally strong but the siphonal one is weakened on the outer whorl; the three tubercles on the venter are clavate; the lower ventrolateral one is not so clearly clavate as the upper; the upper lateral one is conical and normally weaker than the adjacent two; the lower lateral the most prominent and situated below the mid-flank; the umbilical one bullate and sometimes weakened.

The suture is of typical *Romaniceras* pattern. The saddle between E and L is subrectangular in general outline, cut with considerably deep and narrow lobules. The saddle between L and U_2 is massive. The external lobe (E) is the deepest. The lateral lobe (L) is extremely asymmetric.

Variation.—The proportion between height and breadth of the whorl changes by individuals and also by growth-stages, ranging from 10: 11.4 to 10:13.6. In correlation with this variation the venter is moderately to broadly rounded.

Generally the ribs become distant on the outer whorl, being separated by much wider interspaces than the ribs themselves. The distance and, accordingly, the number per whorl, of the ribs vary also by individuals.

The ribs are moderately broad and elevated, crossing the venter without interruption, but on a few specimens (obtained from the same locality as the strongly costate ones) they are less elevated than in the usual examples. The feature may change also by the mode of preservation; the internal mould shows a weaker ornament than the actual shell.

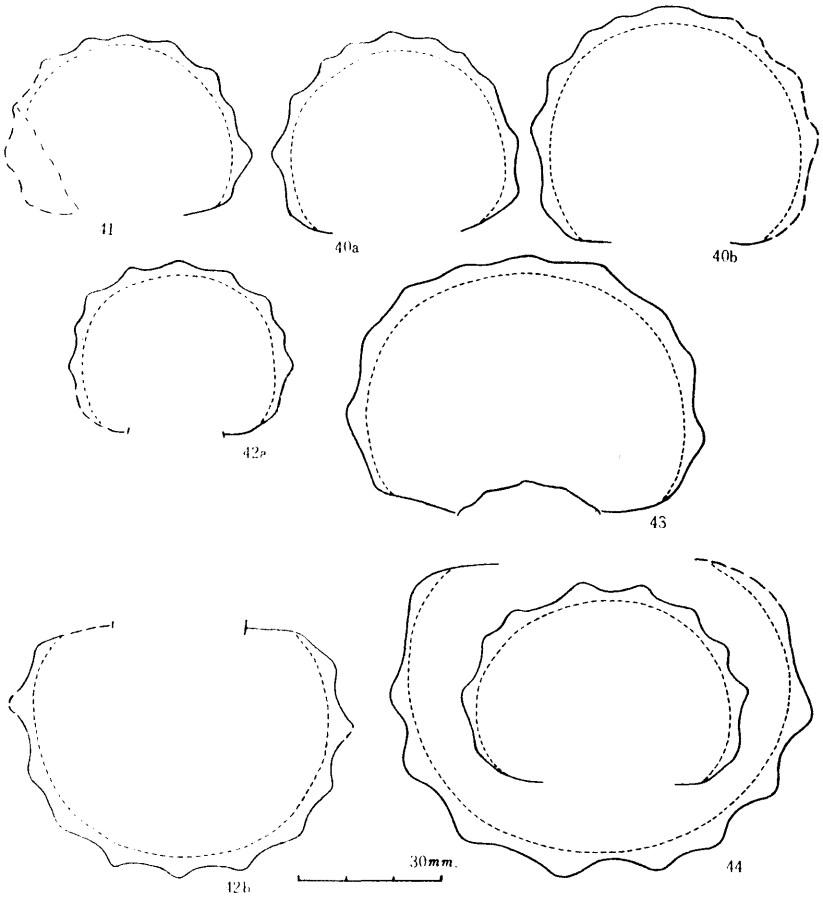
The tubercles on the rib are nearly equidistant in the normal case. The lectotype, the illustrated specimen of DE GROSSOUVRE (1889, pl. 12, figs. 1, 2), is rather peculiar in that the two ventrolateral tubercles approach each other (Text-fig. 40a, b). I do not regard this as a specific character, because Dr. SORNAY, in reply to my inquiry, has clarified a fact that in many specimens from Bourré, the type locality, the two ventrolateral tubercles are more separated than in the lectotype and that the spacing of the tubercles is roughly equidistant, showing minor variation even on the same individual. The same feature is observable on the American specimens. On some specimens from California and Texas the distance between the two ventrolateral tubercles are slightly wider than that between the lower ventrolateral and upper lateral ones. Even an asymmetric configuration of the tubercles is occasionally seen, as is indicated by illustration (Pl. 29, fig. 4a-c; Text-fig. 44a, b). This is abnormal, but probably confused ANDERSON and led him to refer some of the examples of the present species to *Mantelliceras* (*M. conquistador* ANDERSON, 1958, p. 245, pl. 15, fig. 2; pl. 14, fig. 2).

Remarks.—I agree with COLLIGNON (1939, p. 38) in separating *R. deverioide* (DE GROSSOUVRE) from *Ammonites ornatissimus* STOLICZKA (1865, p. 75, pl. 40). KOSSMAT (1897, p. 16 [123], text-figs. 2-4) did not compared GROSSOUVRE's illustrated specimen with STOLICZKA's. His specimen from Ruillé (Sarthe), France is probably identical with *Ammonites deverioides* var. *armata* DE GROSSOUVRE (1889, p. 525), which could be synonimized with *Ammonites ornatissimus* STOLICZKA. Unfortunately the type of *armata*, which was not illustrated, is now missing and that of *ornatissimus* is imperfectly preserved. Therefore I cannot decide the synonymy, but I suggest that they may be referred to *Yubariceras*.

Ammonites deverioides var. *inermis* DE GROSSOUVRE (1889, p. 525), which received another name, *Acanthoceras bizeti* DE GROSSOUVRE (1901, p. 780), is in my opinion distinctly separable from *R. deverioide*. The plaster cast of the probably original specimen of *inermis*, from the Turonian of Bourré (Loir & Cher), France, has been kindly presented to Kyushu University (GK. H9140) through Dr. J. SORNAY. It has more compressed whorl and more crowded ribs than the lectotype of *R. deverioide*; its tubercles are very weak or almost obsolete on its flattened flanks but are distinct and approximated on its narrowly rounded venter. In other words this species is rather allied to *Eucalycoceras* (?) *shastense* (REAGAN) to be described below.

If *Romaniceras deverioide* (DE GROSSOUVRE) is amended as above and if its variation is recognized as described in the preceding paragraph, the Californian examples under consideration are reasonably identified with this species.

Romaniceras loboense ADKINS (1931, p. 44, pl. 2, figs. 1, 21; pl. 3, fig. 5) is in my opinion specifically identical with *R. deverioide* (DE GROSSOUVRE). Its



Figs. 40–44. *Romaniceras deverioide* (DE GROSSOUVRE). Whorl-sections of five specimens.

40. Two sections (a, b) of a plaster cast of the holotype, from a quarry in the "tuffeau" in the neighborhood of Bourré (Loir et Cher), Middle Turonian, France.

41. UC. 32251, from loc. SOC. K-225, Swede Creek, Redding area, Shasta County. See Pl. 25, fig. 1a–c for other views.

42. CIT. 3727, from loc. CIT. 1345, Swede Creek, Redding area. See Pl. 28, fig. 1a, b for other views.

43. UC. 15748, from loc. SOC. K-225, Swede Creek, Redding area. See Pl. 26, fig. 1a–c for other views.

44. UC. 33831 from loc. SOC. K-225, Swede Creek, Redding area.

holotype, from loc. BEG. 2612 in northwest Texas, is quite identical with the normal examples from California, being within the range of variation of *R. deverioide*. Its shell-form is almost indistinguishable from that of the lectotype of *R. deverioide*. ADKINS (1931, pl. 2, fig. 21) illustrated in lateral view only a half of the fragmentary whorl of his type specimen. The other half was measured by him and its cross section is illustrated here (Text-fig. 45). Unfortunately ADKINS' illustration and description failed to show clearly the eleven (instead of nine) tubercles, among which the lower lateral one on the longer rib is the most prominent. "The faint, bullate, mid-flank tubercles" of ADKINS' description is discernible only on the shorter ribs. I have recognized another example of this species in the collection from the same loc. BEG. 2612. *Romaniceras cumminsi* ADKINS (1931, p. 43, pl. 3, fig. 6), which has page priority over *R. loboense* ADKINS, might be identical with the present species, but I cannot give accurate remarks on it, because its holotype is missing.

A specimen from loc. UC. B-2040, in a conglomerate of the Venado formation equivalent crossing Putah Creek, west side of the Sacramento Valley, has eleven rows of tubercles, but its ribs and tubercles are weaker and its whorl is more rounded than *R. deverioide*. It may represent a different species from *R. deverioide*, but I cannot give a specific name, because only a single, poorly preserved specimen is at my disposal.

Occurrence.—Locs. CIT. 1345, CAS. 3123, CAS. 31230, LSJU. 3290 [=TM. 2003], and SOC. K-225, close to one another, on Swede Creek (French Creek on map of Milville Quadrangle), Redding area and loc. CIT. 1190, north of Bella Vista, Redding area. The last locality is referred to the lower part of Member II of POPENOE. The localities on Swede Creek were once assigned to Member IV, but the area is so isolated that the assignement is doubtful. They may be time-stratigraphically about the same level as CIT. 1190.

In France the type locality of *Romaniceras deverioide* (DE GROSSOUVRE)

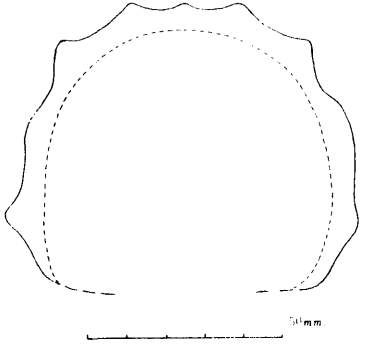


Fig. 45. *Romaniceras deverioide* (DE GROSSOUVRE). Whorl-section of an example from loc. BEG. 2612, Chipsa Summit, Eagle Ford Shale. This is the holotype of *Romaniceras loboense* ADKINS.

was at first referred to the upper part of the Ligerian (Lower Turonian). According to DE GROSSOUVRE's later work (1901, p. 780) the species is always accompanied with *Collignoniceras woollgari* (MANTELL). J. SORNAY has informed me (a letter dated December 19, 1957) that the "tuffeau" in the neighbourhood of Bourré (Loir et Cher), from which the original specimens came, is Middle Turonian.

The type locality of *Romaniceras loboense* ADKINS is BEG. 2612, Chispa Summit, in western Texas, "zone 3" of the equivalent of the Eagle Ford group. Among the associated species of BEG. 2612, *Pseudoaspidoceras* (?) sp. of ADKINS (1931, p. 53, pl. 2, fig. 2) is a good example of the outer whorl of *Collignoniceras woollgari* (MANTELL). The association thus proves that loc. BEG. 2612 represents the middle part of Turonian. Thus *R. deverioide* seems to be a good indices of the Middle Turonian. Its occurrence in Member II of the Redding area in California is in harmony with this statement.

Romaniceras sp. aff. *R. pseudodeverianum* (JIMBO)
Pl. 27, fig. 1a, b; Text-fig. 46

Compare.—

1894. *Acanthoceras pseudodeverianum* JIMBO, *Pal. Abh.*, Bd. 6, (N.F. 2), p. 178 [33], pl. 21 [5], fig. 1, 1a, 1b.
1957. *Romaniceras pseudodeverianum*, MATSUMOTO, SAITO, and FUKADA, *Mem. Fac. Sci., Kyushu Univ.*, ser. D, vol. 6, p. 22, pl. 8, fig. 3; text-fig. 7A-D.

Holotype of Romaniceras pseudodeverianum.—GT. I-106 (JIMBO, 1894, pl. 21 [5], fig. 1, 1a, 1b; MATSUMOTO, SAITO, and FUKADA, 1957, pl. 8, fig. 3, text-fig. 7A-C), from Hokkaido.

Material.—The Californian specimen here described is GK. H7050, from loc. TM. 2002 [LSJU. 3289] (Coll. W. P. POPENOE & T. MATSUMOTO).

Measurements.—

Specimen	Diameter	Height	Breadth (B/H)	Umbilicus (%)
GT. I-106	185	75	36×2 (0.96)	68.5 (35)
		45	25×2 (1.10)	
	c. 122	52.5	60.9 (1.16)	38.5 (31)
GK. H 7050	(intercostal)	51.5	56.6 (1.10)	
	101.0	47.4	55.4 (1.16)	32.0 (32)
R. deverianum (holotype)	94	39	44 (1.13)	29 (31)

Descriptive remarks.—The Californian specimen before me is very close to, but not quite identical with, *Romaniceras pseudodeverianum* (JIMBO) (1894, p. 178 [33], pl. 21 [5], fig. 1, 1a, 1b; MATSUMOTO, SAITO, and FUKADA, 1957, p. 22, pl. 8, fig. 3; text-fig. 7A-D), from Japan, and also *Romaniceras deverianum* (D'ORBIGNY) (1840, p. 256, pl. 110; FRITSCH and SCHLOENBACH, 1872, p. 32, pl. 7, figs. 4, 5; ROMAN and MAZERAN, 1913, p. 25, pl. 3, fig. 2, 2a only; COLLIGNON, 1939, p. 33, and 37, pl. 8, figs. 2, 3, 3a; pl. 9, fig. 1, 1a), from the Turonian of Europe and Madagascar, in the rounded venter, prominent ribs, and nine rows of tubercles. Its whorl is less compressed than in *R. pseudodeverianum*, being nearly as broad as that of *R. deverianum*. Its ribs are separated by wide interspaces and its tubercles are not equidistant. In this respect it is closer to *R. pseudodeverianum*, although the ribs are less numerous than those of the Japanese holotype.

There is an abnormal feature in the configuration of the tubercles of this Californian specimen. The distance between the lateral and umbilical tubercles is much shorter than that between the lateral and ventrolateral tubercles on one side of the whorl, as in the Japanese examples of *R. pseudodeverianum*, but the former is slightly longer than the latter on the other side of the whorl; the lateral tubercles are the most prominent on both sides (see Text-fig. 46).

The ribs are rather narrow and sharp on the internal mould of the outer whorl, but may be fairly thick and strong on the shell and on the inner whorl. They cross the venter without decreasing in strength and without noticeable broadening; the ventral tubercles are not clavate. The shorter ribs are less frequent than the longer ones. In all of these characters the specimen under consideration is distinguishable from *Romaniceras uchauxiense* COLLIGNON (1939, p. 38, pl. 10, fig. 1, 1a; MATSUMOTO, SAITO, and FUKADA, 1957, p. 24, pl. 9, figs. 1a-c, 2; pl. 14, fig. 1a, b; pl. 15, fig. 2) [=*Acanthoceras deverianum* of ROMAN and MAZERAN, 1913, p. 25, pl. 3, fig. 1, 1a only], and is evidently closer to *R. pseudodeverianum*.

As the Japanese examples are not numerous, the extent of variation of *R. pseudodeverianum* is not exactly known. There is only one specimen from California which is not quite identical with the Japanese holotype and may belong to a new species. For the time being I call this Californian example *Romaniceras* aff. *R. pseudodeverianum* (JIMBO).

In addition to this Californian representative, I have noticed a few, imperfectly preserved specimens from Texas which can be best compared with *R. pseudodeverianum*. One of them came from loc. BEG. 2612, Chispa summit, west Texas, the same locality as *R. deverioide* (GROSSOUVRE) [=*R. loboense* ADKINS, 1931]. Another came from "Burnet Road, Travis County, Texas, the condensed zone of the Upper Eagle Ford".

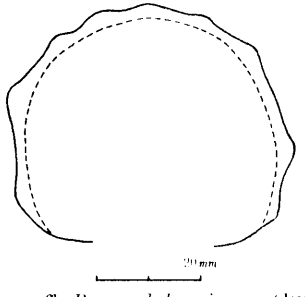


Fig. 46 *Romaniceras* sp. aff. *R. pseudodeverianum* (JIMBO). Whorl-section of a specimen, GK. H 7050, from loc. TM. 2002 [LSJU. 3289], Swede Creek, Redding area, Shasta County. Note the asymmetric configuration of the tubercles. See Pl. 27, fig. 1a, b for other views.

they are much weakened and finally absorbed by the horn-like, inner ventrolateral tubercles.

Occurrence.—Loc. CAS. 445A, FITCH ranch [= SMITH ranch], west of Phoenix, southwest Oregon. The stratigraphic position of this locality is not accurately known. *Otoscaphites perrini* (ANDERSON) and *Hyphantoceras* (?) *ceratopse* (ANDERSON) occur from the same loc. CAS. 445A.

The recorded occurrence is too solitary. In view of the interregional importance as discussed above, the stratigraphical and geographical distribution of this interesting species needs to be clarified.

Subprionocyclus neptuni (GEINITZ)

Pl. 29, figs. 2, 3a, b; Pl. 30, figs. 1a-c, 2a, b; Text-figs. 60a, b, 61a, b, 62, 63

1849. *Ammonites neptuni* GEINITZ, *Das Quadersandstein oder Kreidegebirge in Deutschland*, pl. 3, fig. 3.
1872. *Ammonites neptuni*, GEINITZ, *Palaeontographica*, vol. 20, p. 85, pl. 36, fig. 4.
1872. *Ammonites neptuni*, SCHLÜTER, *Palaeontographica*, vol. 21, p. 36, pl. 11, figs. 1-7.
1872. *Ammonites neptuni*, FRITSCH, *Cephalopoden der böhmischen Kreideformation*, p. 30, pl. 3, fig. 4.
1896. *Prionocyclus neptuni*, WOODS, *Quart. Jour. Geol. Soc. London*, vol. 52, p. 77, pl. 2, fig. 11; pl. 3, figs. 1, 2, 4 (*non* fig. 3).
1902. *Schloenbachia siskiyouensis* ANDERSON, *Proc. Calif. Acad. Sci.*, 3rd ser., vol. 1, no. 1, p. 119, pl. 1, figs. 19, 20.
1902. *Schloenbachia knighteni* ANDERSON, *Proc. Calif. Acad. Sci.*, 3rd ser., vol. 1, no. 1, p. 119, pl. 1, figs. 1-4; pl. 2, figs. 39, 40.
? 1907. *Prionotropis neptuni*, PERVINQUIÈRE, *Études de paléontologie tunisienne*, 1, céph. terr. second., p. 254.
1931. *Prionotropis neptuni*, COLLIGNON, *Ann. Géol. Serv. Mines, Madagascar*, fasc. 1, p. 24, pl. 4, figs. 1, 1a, 1b, 2.
1951. *Prionocyclus neptuni*, WRIGHT and WRIGHT, *Palaeontogr. Soc.*, 1950, p. 30.
1954. *Subprionocyclus neptuni*, WRIGHT and MATSUMOTO, *Mem. Fac. Sci., Kyushu Univ.*, ser. D, Geol., vol. 4, no. 2, p. 129.
1958. *Oregoniceras knighteni*, ANDERSON, *Geol. Soc. Amer., Memoir* 71, p. 264, pl. 24, fig. 5, 5a, 5b; pl. 33, figs. 1, 1a, 3 (*non* ? 2).
1958. *Oregoniceras siskiyouense*, ANDERSON, *Geol. Soc. Amer., Memoir* 71, p. 266, pl. 23, figs. 2, 3; pl. 24, figs. 1, 1a, 2, 3.
? 1958. *Oregoniceras jillsoni*, ANDERSON, *Geol. Soc. Amer., Memoir* 71, p. 267, pl. 19, fig. 6, 6a.

Types.—GEINITZ (1849) established the present species on apparently more than one specimens. The figured specimen (GEINITZ, 1849, pl. 3, fig. 3) is here designated as the lectotype. It came from "dem Plänerkalke von Strehlen, Sachsen, Mittler Quadermergel", Turonian. I have not seen GEINITZ's original specimens, but saw the hypotypes of WOODS (1896) and also WRIGHT and WRIGHT (1951).

Material.—I refer to the present species a considerable number of specimens from California and adjacent areas. The examples are as follows:

A well-preserved (UC. 31501) (Pl. 30, fig. 2a, b; Text-fig. 60a, b) and another (UC. 31438) (Text-fig. 61a, b) adult shells and an immature one (UC. 35694) (Pl. 30, fig. 1a-c) from loc. SOC. K-221 (Coll. M. V. KIRK)
UCLA. 28781 (Pl. 29, fig. 3a, b), UCLA. 28782 (Pl. 29, fig. 2), and several others from loc. CIT. 1042 (Coll. W. P. POPENOE & W. A. FINDLAY)
Several specimens (UCLA.) from loc. CIT. 1062 (Coll. W. P. POPENOE)
A specimen (UCLA.) from loc. CIT. 1266 (Coll. W. P. POPENOE)
CAS. 25, one of the syntypes of *Schloenbachia siskiyouensis* ANDERSON (1902, pl. 1, figs. 19, 20), erroneously called the neotype by ANDERSON (1958, pl. 24, fig. 3), and other examples of "*Oregoniceras siskiyouense* ANDERSON" (1958, pl. 24, figs. 1, 1a, 2) from loc. CAS. 445
Two of the syntypes of *Schloenbachia knighteni* ANDERSON (1902, pl. 1, fig. 1), which were incorrectly figured as one, from loc. CAS. 445 (see also ANDERSON, 1958, pl. 24, fig. 5, which was illegitimately called the holotype) (CAS. Coll. F. M. ANDERSON)
Other syntypes of *Schloenbachia knighteni* ANDERSON (1902, pl. 1, figs. 2-4; pl. 11, figs. 39, 40) (see also ANDERSON, 1958, pl. 35, figs. 1, 1a, 3) (CAS. Coll. F. M. ANDERSON)

In addition to the above, there are many, relatively poorly preserved, comparable specimens.

Measurements.—

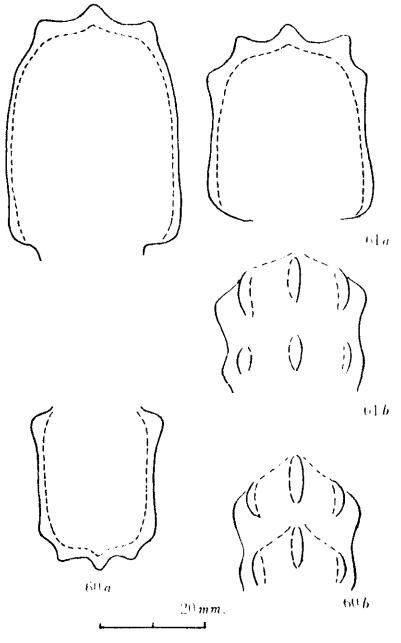
Specimen	Diameter	Height	Breadth (B/H)	Umbilicus (%)
UC. 31501	109.0	47.5	34.8 (0.73)	32.5 (29)
〃 (intercostal)		42.0	32.0 (0.78)	--
UC. 31438	92.5	39.0	31.9 (0.81)	27.5 (29)
UCLA. 28782	62.5	29.2	20.7 (0.70)	17.6 (28)
UCLA. 28781	--	27.5	19.3 (0.70)	--
Another from CIT. 1042	--	34.5	23.0 (0.66)	--
Another from CIT. 1042	24.7	11.2	7.2 (0.64)	7.2 (29)
Another from CIT. 1042	80.0	27.2	--	20.0 (25)
One from CIT. 1062		33.8	20.5 (0.60)	
One from CIT. 1266	34.5	16.5	10.0 (0.60)	9.0 (26)
CAS. 25 ("*S. siskiyouensis*")	45.0	21.7	15.3 (0.70)	11.3 (25)
CAS. ("*S. knighteni*") (deform.)	66.4	30.0	18.8 (0.63)	18.8 (28)
CAS. ("*S. knighteni*") (deform.)	--	41.0	26.0 (0.63)	--
GSM. 37235 (WOODS, 1896, pl. 3, fig. 2)	32.8	14.0	8.0 (0.57)	10.0 (31)
C. W. WRIGHT 21325	--	25.3	16.3 (0.64)	--

Diagnosis.—The full-grown shell is of moderate size, but in many cases relatively small specimens are common. It is considerably involute and its umbilicus is fairly narrow or of moderate size. The whorl is compressed, relatively more so in the young stages than in the late ones. The proportion of breadth to height is 0.7 (on average) ±0.1. The flanks are only slightly convex, roughly parallel on the main part, and tend to be slightly convergent toward the venter. The maximum breadth is between the umbilical tubercles in

the costal section, but may be at the mid-flank in the intercostal section. The umbilical wall is low but steep, often nearly vertical, and has a subangular shoulder. The whorl is shouldered at the ventrolateral point and has a serrated keel at the mid-venter.

The ribs are gently sigmoidal and somewhat prorsiradiate, normally springing in pairs from the umbilical tubercles. Double tubercles are developed on all the ribs at the ventrolateral shoulder, of which the inner one is often nodose and may be weakened on the outer whorl and the outer one is distinctly clavate. The serration on the keel corresponds to each rib, being situated somewhat forward from the outer ventrolateral clava; the connecting weak ribs form a more or less acute chevrons on the venter. The ribs and tubercles are relatively fine on the inner, young whorl, moderately coarse on the main part of the whorl of the middle growth-stage, and flattened or weakened on the adult body whorl. The density of the ribs vary also by individuals. On the outer whorl the secondary ribs may become intercalatory.

The suture is relatively simple, being incised by small dentations. E is moderately broad; the saddle between E and L is broad, subquadrate to dome

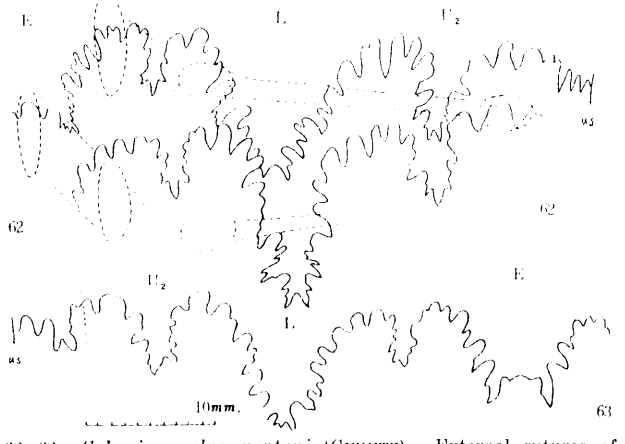


Figs. 60, 61. *Subprionocyclus neptuni* (GEINITZ). Whorl-sections (a) and ventral ornaments (b) of two mature shells.
60. UC. 31501, from loc. SOC. K 221, Swede Creek, Redding area, Shasta County. See Pl. 30, fig. 2a, b for other views.
61. UC. 31438, from the same loc. SOC. K-221.

like in general outline, asymmetrically bipartite by a narrow lobule; L is deep, generally narrow, but may be broadened on the last part, and variably bi- or tripartite; the saddle between L and U_2 is asymmetric, and higher but narrower than the external one; U_2 is small and narrow; the auxiliaries are not numerous.

Variation.— On studying the examples from the Upper Turonian of England, I noticed a great variability of this species in the involution and compression of the whorl, density and flexuosity of the ribs, strength of tubercles, etc. Other European examples, as illustrated by GEINITZ (1849, 1872), FRITSCH (1872), and SCHLÜTER (1872), suggest a similar feature, although some of them seem to have been secondarily deformed. COLLIGNON (1931, p. 24, pl. 4, figs. 1, 1a, 1b, 2) clearly demonstrated the high variability of this species from the examples from Madagascar. The same is true for the examples from California and Oregon.

The three specimens from loc. SOC. K-221 are well preserved but differ from one another. The illustrated, adult shell (UC. 31501) is rather typical in every respect, although the ribs are apparently coarser than those of the lectotype from Germany. This difference may be due to change of characters with growth, because I have seen a general tendency that the ribs are finer and the whorl is more compressed in the immature shell than in the mature one. The second specimen, UC. 31438, which is as large as the first one, has more rectangular whorl-section (Text-fig. 61a), less flexuous and more distant ribs, on which the lower ventrolateral tubercles persist for a longer period than that. In spite of relatively coarse ribbing on the outer whorl, this specimen has fine



Figs. 62, 63. *Subprionocyclus neptuni* (GEINITZ). External sutures of two mature whorls.
62. The last third and fourth sutures of a specimen, UC. 31501, from loc. SOC. K 221, Swede Creek, Redding area, Shasta County. See Pl. 30, fig. 2a, b and Text-fig. 60a, b.
63. The last fourth suture of another specimen, UC. 31438, from the same loc. SOC. K-221. See Text-fig. 61a, b.

and crowded ribs on the small, inner whorl. The third, small specimen, UC. 35694, about 24 mm. in diameter, probably represents the immature shell, because it shows as fine and crowded ribs as the inner whorl of the second specimen. It is relatively compressed. On this specimen and on others as large as it, the lower ventrolateral tubercles are indistinct, foreshadowing the characters of *Reesidites* WRIGHT and MATSUMOTO, 1954. The lower ventrolateral tubercles tend to be weakened also on the whorl of relatively late growth stage. Therefore the double ventrolateral tubercles characterize the main, middle growth-stage.

From loc. CIT. 1531 (=LSJU. 3291=TM. 2005) were obtained many small specimens, which are specifically indeterminable but well comparable with such immature whorls of this species as mentioned above. I collected from the same locality a few fragmentary larger whorls on which double ventrolateral tubercles are shown. Therefore the specimens from this locality are most reasonably referable to *Subprionocyclus* sp., if not exactly called *S. neptuni* (GEINITZ) *juvenile*.

A considerable number of specimens from loc. CIT. 1042, Siskiyou County, northern part of California show similarly variation in the involution and compression of whorls, density and coarseness of the ribs, distinctness of the lower ventrolateral tubercles, etc. In this general area and adjacent part of southwestern Oregon, ANDERSON established a large number of species under *Schlocnbachia* in 1902 and under *Oregoniceras* in 1958. Some of his types are unfortunately too small for specific distinction, because the immature shells alone are not enough for defining the specific diagnosis. *Schlocnbachia oregonensis* ANDERSON is such an example. Some others are, however, large and sufficient for comments. Among them the types of "*Oregoniceras siskiyouense* (ANDERSON)" (1958, p. 266, pl. 23, figs. 2, 3; pl. 24, figs. 1, 1a, 2, 3) are certainly within the range of variation of *Subprionocyclus neptuni* (GEINITZ); its original type (holotype ?) (CAS. 25) (ANDERSON, 1902, p. 119, pl. 1, figs. 19, 20) is a typical example of *S. neptuni*, being close to GEINITZ's illustrated type (lectotype of *S. neptuni*).

The available evidence proves that *Oregoniceras knighteni* (ANDERSON) is also specifically identical with *Subprionocyclus neptuni* (GEINITZ). ANDERSON established *Schlocnbachia knighteni* on several syntypic specimens (1902, p. 119, pl. 1, figs. 1-4; pl. 2, figs. 39, 40). A fragmentary body whorl and another somewhat smaller, but better preserved shell were united in one figure (ANDERSON, 1902, pl. 1, fig. 1), that shows incorrectly an evolute shell. Actually they do not fit to each other, but represent different individuals. The former is probably a relatively flattened and multicostate variety, on the body whorl of which the lower ventrolateral tubercles are much weakened. The latter belongs rather to a typical form of *Subprionocyclus neptuni*, although on its outer whorl the lower ventrolateral tubercles are considerably weakened. Other specimens described by ANDERSON under the specific name *knighteni* are small, but well comparable with the inner whorls of relatively widely umbilicate and flattened variety of *S. neptuni*,

like some British, as well as other Californian, examples. Since these variants are gradational to and associated with the typical form, separation into different species is not natural. ANDERSON described that the ribs of *knighteni* as simple and almost straight, but his original specimens actually show flexuous ribs which essentially spring in pairs from the umbilical tubercles but sometimes have intercalated secondaries.

Oregoniceras jillsoni ANDERSON (1958, p. 267, pl. 19, fig. 6, 6a) is not distinct enough for specific separation from *Subprionocyclus neptuni*. Its holotype is a fragmentary body whorl, which is comparable with the last portion of the adult specimen from loc. K-221 (see above), although the double ventrolateral tubercles are better kept on ANDERSON's specimen. Its paratype is indistinguishable from what ANDERSON called *Oregoniceras knighteni*, and, accordingly, falls within the variation of *S. neptuni*.

Remarks.—*Ammonites neptuni* GEINITZ has received several generic names by different authors. WOODS (1896) assigned it to *Prionocyclus* which was followed by WRIGHT and WRIGHT (1951). The French paleontologists, PERVINQUIÈRE (1907) and then COLLIGNON (1931), referred it to *Prionotropis* [= *Collignoniceras*]. ANDERSON (1902) mentioned that his *Schlocnbachia siskiyouensis* and *Schlocnbachia knighteni* appeared to be referable to *Barroisiceras*, but later (1958) assigned them to his *Oregoniceras*.

SHIMIZU (1932) set up *Subprionocyclus*, designating *Prionocyclus hitchinensis* BILLINGHURST (1928, p. 516, pl. 16, figs. 1a-f, 2a-b) as the type-species. This British species is unfortunately based on a few, small, probably immature shells and SHIMIZU's statement of the generic distinction was inadequate. WRIGHT and MATSUMOTO (1954, p. 129) noticed, however, that *Prionocyclus hitchinensis* BILLINGHURST, *Ammonites neptuni* GEINITZ, and their allies form a distinct group, for which the generic name *Subprionocyclus* should be used, with a revised definition. Actually *S. neptuni* (GEINITZ) is the best known example of this genus.

Subprionocyclus neptuni (GEINITZ) resembles in general respects the inner whorls of *Collignoniceras woollgari* (MANTELL) (SHARPE, 1855, p. 27, pl. 11, figs. 1, 2); in both the double ventrolateral tubercles and serrated keel are developed. While the lower ventrolateral tubercles are wakened on the outer whorl of the former, the double ventrolateral tubercles are united into prominent horns on that of the latter. Also on the outer whorl the ribs are much stronger and more distant in the latter than in the former. On the inner whorl the difference is not remarkable, but the former has more or less flexuous ribs which normally spring in pairs from the umbilical nodes, sometimes with intercalating secondaries, while the latter has nearly equally long, simple, prorsiradiate ribs. Although there is variation in shell-form, the latter is on average more evolute and more robust than the former.

Subprionocyclus neptuni (GEINITZ) is similar to *Prionocyclus wyomingensis* MEEK (1876, p. 452; WHITE, 1883, p. 35, pl. 15, fig. 1) in some respects. The principal difference is that the upper ones of the double ventrolateral tubercles

are distinct and clavate and the lower ones may be weakened on the whorl of the former, while the upper ones are very indistinct and the lower ones are strengthened on the latter. The serration of the keel is fine in the latter, being more numerous than the ribbing. In *P. wyomingensis* the ribs spring in pairs from the umbilical tubercles, as in *S. neptuni*, but there are intercalating ribs which do not have umbilical tubercles, and the ribs are rather irregularly arranged in strength, length, and curvature. In *P. wyomingensis* the weakened outer tubercles are on the ventral part, close to the keel, extending to the strongly projected ventral ribs. On average the whorl of *P. wyomingensis* is more evolute than that of *S. neptuni*.

I conclude that *Ammonites neptuni* GEINITZ should be referred to *Subprionocyclus*, which is related to but distinct from both *Collignoniceras* and *Prionocyclus*. Taking all the available facts into consideration, *Subprionocyclus* and *Prionocyclus* are probably parallel derivations from *Collignoniceras*.

Occurrence.—Fairly common in California and Oregon: loc. SOC. K-221, presumably time-stratigraphically equivalent of Member III; locs. CIT. 1266, CIT. 1264, and (cf.) CIT. 1531 [=LSJU. 3291], relatively lower part of Member III of the Redding area, northeast side of the Sacramento Valley; locs. CIT. 1042, (cf.) CIT. 1044, and (cf.) CAS. 444A, the Hornbrook-Henley area, Siskiyou County, northern California; loc. CAS. 445, "Forty-nine", southwestern Oregon. The stratigraphic position in the last two areas are not precisely known, but PECK, IMLAY, and POPENOE (1956) recently listed *Subprionocyclus* sp. from their Member I of the Hornbrook formation. Loc. CIT. 1062, upper part of the Baker Canyon sandstone member in the Santa Ana Mountains, where *Sciponoceras* sp. aff. *S. bohemicum* (FRITSCH) is associated.

The species is known in the Upper Turonian of England, Germany and adjacent areas of Europe, Madagascar and also Japan.

Subprionocyclus normalis (ANDERSON)

Pl. 29, fig. 1a, b; Pl. 31, figs. 1a-d, 2a-d, 3, 4a, b, 5a, b;
Text-figs. 64a, b, 65, 66a, b

1958. *Oregoniceras normale* ANDERSON, *Geol. Soc. Amer., Memoir* 71, p. 268, pl. 25, fig. 8, 8a.

Holotype.—The specimen (CAS. Coll.) designated and illustrated by ANDERSON (1958, p. 268, pl. 25, fig. 8, 8a). It came from "Forty-nine mine, 2 miles south of Phoenix, Oregon".

Material.—In addition to ANDERSON's specimens, there are a large number of specimens in the recent collections. The better preserved examples are as follows:

UCLA. 28783 (Pl. 31, fig. 2a-d), UCLA. 28784 (Pl. 31, fig. 1a-d), UCLA. 28785-28795, from loc. CIT. 1346 (Coll. W. P. POPENOE & J. HOEL)

GK. H 7038-7046 (Pl. 31, figs. 3, 4, and 5 for GK. H 7040, H 7041, and H 7038 and Pl. 29, fig. 1 for H 7046) from loc. TM. 2001=LSJU. 3288 (Coll. W. P. POPENOE & T. MATSUMOTO)

LSJU. 8584-8587 from loc. LSJU. 2711 (Coll. W. P. POPENOE)

LSJU. 8588-8591, LSJU. 8601 from loc. LSJU. 2735 (Coll. L. F. FUNKHOUSER)

GK. H 7017 from loc. TM. 7001=CIT. 79 (Coll. Peter RODDA, W. P. POPENOE & T. MATSUMOTO)

In every case of the above localities, there are still more unlisted specimens.

Measurements.—

Specimen	Diameter	Height	Breadth (B/H)	Umbilicus (%)	Tubercles umbilical/ventral
Holotype (CAS.)	42.2	22.0	11.8 (0.53)	9.5 (22)	11/27+?2
GK. H 7038	45.0	21.0	6.0×2(0.57)	11.5 (25)	10/28
GK. H 7039	31.0	13.5	8.0 (0.59)	9.0 (29)	10/23
GK. H 7040	29.0	13.5	5.0 (second. def.)	7.5 (26)	10/23
GK. H 7041	28.0	14.0	8.5 (0.60)	5.7 (20)	10/25
GK. H 7042	34.0	17.0	10.0 (0.58)	7.0 (20)	9/20+?4
GK. H 7043	31.3	14.3	8.0 (0.56)	6.3 (20)	9+0/26
GK. H 7046	c. 65.0	27.8	8.0×2(0.57)	18.0 (27)	5/12 per whorl
UCLA. 28783	44.0	23.5	12.5 (0.53)	6.8 (15)	8/29
UCLA. 28784	36.0	18.5	9.3 (0.50)	7.4 (20)	9/23
UCLA. 28785	42.5	20.0	11.0 (0.55)	10.0 (23)	9/23
UCLA. 28786	34.2	16.9	9.5 (0.56)	7.8 (22)	9/24
UCLA. 28787	35.0	16.8	9.0 (0.53)	8.5 (24)	11/26?±1
UCLA. 28788	26.7	11.8	6.8 (0.57)	7.2 (27)	10/24?±1
UCLA. 28789	28.7	13.4	c. 8.5 (0.63?)	7.8 (27)	10/22
UCLA. 28790	26.3	13.0	6.8 (0.52)	6.0 (21)	11/34
UCLA. 28791	25.0	11.7	6.8 (0.58)	5.9 (23)	8+0/19+?2
UCLA. 28792	25.5	11.3	6.8 (0.60)	7.1 (27)	13/27+?2
UCLA. 28793	20.5	9.1	6.0 (0.65)	5.5 (27)	8+0/24+0
UCLA. 28794	17.3	7.5	4.5 (0.60)	5.3 (30)	10+0/35+0
UCLA. 28795	15.0	7.0	4.2 (0.60)	3.8 (25)	8+0/20+0
LSJU. 8584	36.1	18.2	9.6 (0.52)	8.2 (23)	7/21
LSJU. 8585	33.8	16.5	9.2 (0.55)	6.4 (19)	8/23
LSJU. 8586	27.5	11.7	7.5 (0.64)	8.5 (30)	11/24+?1
LSJU. 8587	23.4	9.8	6.4 (0.65)	6.6 (28)	12/24
LSJU. 8588	37.3	19.5	8.8 (second. def.)	8.0 (21)	12/32
LSJU. 8589	30.7	14.0		8.5 (27)	11/28
LSJU. 8590	24.0	10.5	6.0 (0.57)	7.3 (30)	14/35
One from loc. LSJU. 3288	70.0	33.3	14.5 (second. def.)	9.2 (23)	9/—
For comparison:					
CAS. (*O. phoenixense*)	39.3	18.2	9.3 (0.51)	9.2 (23)	11/33
CAS. 36 (*O. oregonense*)	43.2	17.8	10.0 (0.56)	12.5 (29)	18/46

Diagnosis.—The shell is fairly small; the largest example is 70 mm., but many specimens that are probably adult are below 50 mm. in diameter. It is considerably involute and grows rapidly; consequently the umbilicus is fairly narrow. The whorl is much higher than broad, the proportion of breadth to height being mostly 0.5-0.6; the umbilical wall is low and steep, but not vertical; the umbilical shoulder is subrounded; the flanks are flattened, or only slightly convex, and roughly parallel or slightly convergent; the venter is narrow,

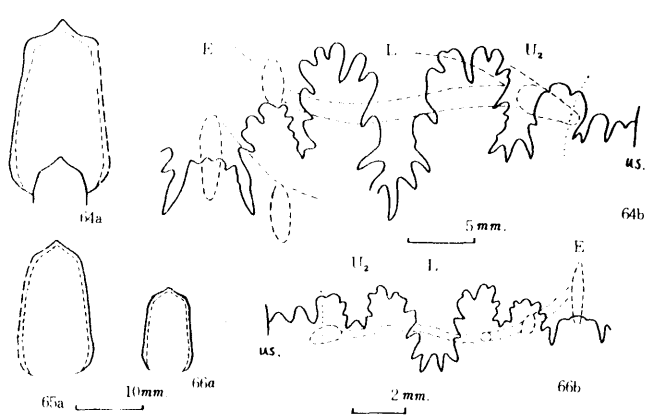
shouldered at the ventrolateral point, fastigate towards the narrow median keel.

The ribs are flexuous, springing in pairs from the prorsiradiate umbilical bullae. There are also intercalating secondary ribs. All the ribs are provided with ventrolateral and medioventral clavi, forming acute chevrons on the venter; the lower ventrolateral tubercles are small, indistinct, and discernible on the whorl of a relatively limited period of the middle growth-stage. The ribs are moderate in intensity and density, being separated by interspaces which are nearly as narrow as the ribs themselves. On the last part of the adult body whorl, the ribs, tubercles, and keel are much weakened.

The suture is generally of the same pattern as that of *Subprionocyclus neptuni* (GEINITZ) (see the description), but its saddles are more slender, its lobes are narrower and deeper, and minor incisions are sharper than in the corresponding growth-stage of the latter. The saddle between E and L is very asymmetric.

Variation.—From a large number of specimens from one and the same locality, a considerable extent of variation is recognized. The measurements above listed may demonstrate the situation. The ratio of umbilicus to diameter, for instance, ranges from 15 to 30 percent, although it is commonly 20-27 percent. The proportion of whorl breadth to height again extends fairly widely, although it is normally less than 0.7 and commonly 0.5-0.6.

The ribs begin to appear sooner or later at a shell diameter of about 10 mm. The number of the ribs per whorl differs by individuals and also by growth-stages. Because of branching and intercalation, the ribs (or tubercles) on the ventral part are two to three times as numerous as the umbilical bullae. The



Figs. 64-66. *Subprionocyclus normalis* (ANDERSON). Whorl-sections (a) and sutures (b).

64. GK. H7046, from loc. TM. 2001 [=LSJU. 3288], Member III of the Redding area, Shasta County. See Pl. 29, fig. 1a, b.

65. GK. H7038, from the same loc. TM. 2001. See Pl. 31, fig. 5a, b.

66. GK. H7039, a small specimen, from loc. TM. 2001.

number of the umbilical bullae ranges from 7 to 14, being commonly 9-12 and that of the ribs (or ventral tubercles) ranges from 22 to 35 per whorl. Thus the shell is normally ornamented by ribs of moderate distance and fineness, but is sometimes considerably multicostate, if not densicostate.

Remarks.—This species is intimately allied to *Subprionocyclus neptuni* (GEINITZ). In fact the extreme end member (e.g. UCLA. 28789) of the former approaches closely to that of the latter. Generally speaking, however, the former is smaller, more compressed, more involute, and more narrowly umbilicate and has more fastigate venter, weaker ornament, shorter period of duble ventrolateral tubercles, and more slender elements of suture.

In these respects the present species is close to *Reesidites minimus* (HAYASAKA and FUKADA) (1951, see WRIGHT and MATSUMOTO, 1954, p. 130). The relationship is so intimate that *Subprionocyclus normalis* may be regarded as intermediate between *Subprionocyclus neptuni* and *Reesidites minimus*, which in turn may give rise to *Barroisiceras* spp. The complete absence of the double ventrolateral tubercles at any growth stage is a criterion to distinguish *Reesidites* from *Subprionocyclus*. From the intimate resemblance of *S. normalis* and *R. minimus*, it might be suggested that *Reesidites* would be better classified as a subgenus of *Subprionocyclus*. Someone might hold the view that *Reesidites* could be regarded as a subgenus of *Barroisiceras*. This is not the place to discuss further, because the available material of California is not sufficiently continuous for tracing the evolutional change. Anyhow the present species is important for the question.

The description of the present species depends much on a large number of specimens from a limited portion of the stratigraphic succession. I was inclined to give a new specific name for them, before I saw ANDERSON's (1958) monograph. The typical example of the present species just fits the holotype of *Oregoniceras normale* ANDERSON (1958, p. 268, pl. 25, fig. 8, 8a), so that his specific name should be used. In addition to this ANDERSON (1958) described a large number of species under *Oregoniceras*. As I have already mentioned, some of them, especially *Oregoniceras siskiyouense* (ANDERSON) and *O. knighteni* (ANDERSON), fall in the synonymy of *Subprionocyclus neptuni* (GEINITZ). Others are, however, based on too imperfect or too small specimens to judge clearly their specific identity with or distinction from the species already known. Possibly *O. phoenixense* ANDERSON (1958, p. 266, pl. 25, fig. 7, 7a; pl. 33, fig. 6, 6a), may be merely a multicostate variety of *Subprionocyclus normalis* (ANDERSON). Nomenclatorially the former would preoccupy the latter in page, but until the specific identity can be confirmed *S. normalis* should be used for the specimens described in this paper.

Schloenbachia oregonensis ANDERSON (1902, p. 122, pl. 2, fig. 48) was designated as the type species of *Oregoniceras* ANDERSON (1958, p. 263). Its holotype, CAS. 36 from loc. CAS. 445, is again a small specimen, which is characterized by dense and numerous ribs. Its whorl is nearly as compressed as that of *S. normalis*, but its multicostation is beyond the limit of variation

of the latter (see measurements). The doubling of the ventrolateral tubercles is not clear on the holotype of *O. oregonense* and even on the immature whorls of *Subprionocyclus neptuni* and other related species. In fact the holotype of *S. hitchinensis* BILLINGHURST (1928, p. 516, pl. 16, figs. 1a-f, 2a-b) resembles in many respects that of *O. oregonense*. From the available material, however, I cannot decide accurately whether *O. oregonense* belongs to *Subprionocyclus* or to *Reesidites*. Anyhow *Oregoniceras* ANDERSON, 1958 is a synonym of either *Subprionocyclus* SHIMIZU, 1932 or *Reesidites* WRIGHT and MATSUMOTO, 1954. I hope that further, careful, subzonal field work will provide us with better evidence for clearing this and other points.

Occurrence.—Abundant at localities CIT. 1346, CIT. 1346A, TM. 2001= LSJU. 3288, Little Cow Creek, in the middle to upper part of Member III of POPENOE (1943), Redding area, northeastern side of the Sacramento Valley, California. Comparable specimens occur fairly commonly at localities CIT. 79 [=TM. 7001], CIT. 978 and CIT. 1164, top of Baker Canyon sandstone or basal part of Holtz shale member in the Santa Ana Mountains, California. So far as the available records are concerned, *S. normalis* occurs at slightly higher level than *S. neptuni*, and is a good indicator of the horizon.

The two species were reported to occur at CAS. 445, "Forty-nine mine", southwest Oregon, but their stratigraphic positions are not clear. The specimens of *S. normalis* and certain others of ANDERSON's *Oregoniceras* are coated with dark green matter, while those of *S. neptuni* (=*O. siskiyouense*, *O. knighteni*, etc.) are not green. This suggests that loc. CAS. 445 may include fossils of more than one level.

Subfamily Peroniceratinae HYATT, 1900

Representatives of Peroniceratinae occur very sparsely in California. They have been already described by GABB (1864, 1869) and ANDERSON (1902, 1958). As I had opportunity of seeing most of their original specimens I give here short comments.

The holotype of *Prionocycloceras crenulatum* (ANDERSON) (1902, p. 125, pl. 1, figs. 17, 18) was lost in the San Francisco fire and a neotype has been unofficially proposed by ANDERSON (1958, p. 263, pl. 34, fig. 5, 5a). According to ANDERSON they came from RICHARDSON's ranch, 4 miles north of Montague, Siskiyou County. The locality should be within the Hornbrook formation of PECK, IMLAY, and POPENOE (1956), despite their suggestion that the Lower Senonian may be absent in the Hornbrook formation.

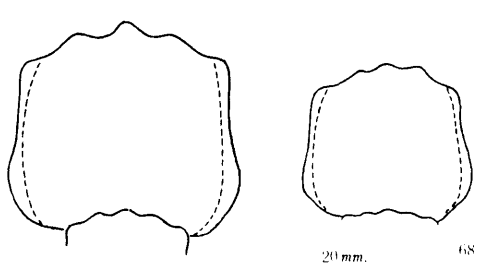
ANDERSON's neotype has a finely crenulated, prominent, ventral keel, coarse ribs, strong ventrolateral and umbilical tubercles. The ventrolateral tubercles are not doubled and the whorl-section is quadrangular. This species is, thus, a representative of *Prionocycloceras* in California. Another species *Prionocyclus californicus* ANDERSON (1958, p. 262, pl. 69, fig. 4, 4a, 4b) is questionable. Its holotype is too fragmentary and too young for a precise generic assignment,

but is probably an example of *Prionocycloceras*. It came from loc. CIT. 1034, Oak Run, Member IV of the Redding area, associated with the holotype of *Peroniceras shastense* ANDERSON (1958, p. 260, pl. 69, fig. 5, 5a, 5b, 5c) (Coll. POPENOE & FINDLEY). The latter is so poorly preserved that its distinction from other well known species of *Peroniceras* is not clear.

At loc. CIT. 1007, Oak Run, from the same member IV of the Redding area, W. P. POPENOE and D. SCHARF obtained a small but well preserved ammonite (Pl. 31, fig. 6a, b), which I regard as an immature shell of *Peroniceras* sp. Its whorl is evolute, broader than high, and subquadrate in section, with a distinct, ventral keel accompanied on each side by a groove and then a faint elevation. The last is at the end of the ventral projection of the ribs and presumably develops to a more distinct keel on the outer whorl. The ribs are mostly simple, rarely bifurcating, fairly distant, nearly rectiradiate on the flank, and provided with the bullate, umbilical and the nodose, ventrolateral tubercles.

Peroniceras tehamense (GABB) (1869, p. 132) [*Ammonites subtricarinatus*, GABB (*non* D'ORBIGNY), 1864, p. 60, pl. 10, fig. 4, 4a] was established on at least three fragmentary specimens, UC. 12102 (Text-fig. 67), UC. 14850 (Text-fig. 68), and UC. 14851, which may belong to more than one individual, and came from "the vicinity of Battle Creek, Tehama County". This species is distinguished by a subquadrate whorl-section which is broader than high, three distinct ventral keels, simple, prorsiradiate, slightly flexuous ribs, bullate umbilical and rounded ventrolateral tubercles. In these respects *Peroniceras rousseauxi* DE GROSSOUVRE (1894, p. 142, pl. 11, fig. 5), from the Coniacian of France, is very similar to and possibly identical with *P. tehamense* (GABB, 1869).

Peroniceras quintoense ANDERSON (1958, p. 260, pl. 47, fig. 1, 1a) is indefinite, because it is based on a single, large, but secondarily deformed specimen. ANDERSON illustrated only a part of the outer whorl. Its inner whorl resembles *Peroniceras subtricarinatum* D'ORBIGNY (1840, p. 397, pl. 91, figs. 1, 2), but its outer whorl has prorsiradiate ribs, bullate umbilical and rounded ventrolateral tubercles like that of *P. tehamense*. Anyhow it is an example of *Peroniceras* came from loc. CAS. 29596, a shaly unit on Quinto Creek, presumably



Figs. 67, 68. *Peroniceras tehamense* (GABB). Whorl-sections.
67. A body-whorl, UC. 12102, one of GABB's syntypes.
68. A septate whorl, UC. 14850, another of GABB's syntypes.

an equivalent of the Lower Marlife formation of the Panoche group, Merced County, west side of the San Joaquin Valley.

Subfamily Texanitinae COLLIGNON, 1948
Genus *Texanites* SPATH, 1932

Type-species.—*Ammonites texanus* ROEMER, 1852.

Generic diagnosis.—See COLLIGNON, 1948, p. 62.

Remarks.—I have emended COLLIGNON's definition of *Texanites*, separating *Protexanites* MATSUMOTO, 1955 as an ancestral genus.

Texanites is world-wide in the Santonian but begins to appear in the Upper Coniacian and persists to the Lower Campanian. In California I have recognized only one species of *Texanites* represented by a few, imperfectly preserved specimens.

Texanites cf. *kawasakii* (KAWADA)
Pl. 28, fig. 2a, b

Compare.—

1929. *Mortoniceras kawasakii* KAWADA, *Jour. Geol. Soc. Tokyo*, vol. 36, p. 4 (English), pl. 14, figs. 2-4.

Holotype of Texanites kawasakii.—A single specimen described and illustrated by KAWADA (1929, p. 4, pl. 14, figs. 2-4), from the Miho group of the Naibuchi area, south Sakhalin.

Material.—The described Californian examples are a fragmentary whorl, UCLA. 28847 (Pl. 28, fig. 2a, b), and two other poorly preserved specimens, from loc. UCLA. 3373 (Coll. R. W. IMLAY & W. P. POPENOE).

Descriptive remarks.—The Californian specimens are all fragmentary but show some characteristic features. The whorl is subquadrate, somewhat convergent, and slightly higher than broad in costal section. The ventral keel is continuous. The ribs are simple, equally long, nearly straight to slightly concave, broadened towards the venter, and provided with approximately equidistant tubercles in five rows. The bullate umbilical tubercle tends to be doubled; the lower lateral is moderately strong, the upper lateral rounded but weak, the ventrolateral strongest and clavate, and the ventral clavate and moderately high. The suture, which is partly exposed, is of *Texanites* type.

Texanites kawasakii (KAWADA) was established on a single, probably immature whorl. There are two more specimens of this species in the collection of the University of Tokyo from the same Miho group, south Sakhalin and another from the Santonian of Hokkaido in the collection of Kyushu University. Two of them are more than 100 mm. in diameter. The Californian example illustrated in this paper is very similar to their outer whorls, on which the doubling of the umbilical bullae is also shown.

Occurrence.—Loc. UCLA. 3373, Oak Run valley, Member IV of the Redding area, Shasta County, northeast side of the Sacramento Valley. The type locality

of *Texanites kawasakii* is on the lower course of the Santan, a tributary of the Naibuchi. This should be within the zone Mh6 (zone of *Inoceramus naumanni*) of the Miho group (MATSUMOTO, 1942, p. 159, pls. 5, 8). Other examples came also from the Upper Urakawan (i.e. approximately Santonian) of Hokkaido and Sakhalin.

Genus *Submortoniceras* SPATH, 1921

Type-species.—*Submortoniceras woodsi* SPATH, 1921.

Generic diagnosis.—The whorl is moderately involute, increasing rapidly in height, compressed, and typically trapezoidal in section, with convergent flanks. The ribs are numerous, branching or intercalating at or above the umbilical margin, slightly flexuous or slightly prorsiradiate, and on the outer whorl much weakened. The tubercles are in five rows, among which those on the flanks are weakened and may finally disappear on the outer whorls, while the ventral (i.e. outer ventrolateral) and umbilical ones persist for a longer period. Even the ventral tubercles and keel may be smoothed in the latest growth-stage. The suture is considerably variable, following the general pattern of the Texanitinae.

Remarks.—I had an opportunity of studying the holotype of *Submortoniceras woodsi* which Dr. A. W. CROMPTON, the Director of the South African Museum, kindly let me borrow at Stanford University. Plaster casts of it are now at several institutions in the United States and at Kyushu University. I was also allowed to study the original types and WELLER's (1907) and also GARDNER's (1916) hypotypes of *Ammonites delawarensis* MORTON, 1830 and *Ammonites vanuxemi* MORTON, 1830. Through the study of these types and the specimens from California and Japan, as well as from the survey of literature, I regard SPATH's (1921) proposal of *Submortoniceras* as reasonable despite the imperfect preservation of the holotype of *S. woodsi*.

The generic diagnosis given by COLLIGNON (1948, p. 64) is in principle acceptable, but the relationships with other genera must be discussed. From the available evidence I am inclined to search for the origin of *Submortoniceras* in *Protexanites* MATSUMOTO, 1955. The intermediate species, which occur in the Santonian of Japan and Sakhalin, are also related to certain species of *Texanites* SPATH, 1932.

Delawarella COLLIGNON, 1948, which has been established for *Ammonites delawarensis* MORTON, 1830, the type-species, and related species, is more intimately allied to *Submortoniceras* than to *Menabites* COLLIGNON, 1948. *Menabites* (*s.l.*), including subgenera *Menabites* (*s.s.*), *Bererella* COLLIGNON, 1948, and *Australiella* COLLIGNON, 1948, has a persistent trituberculate stage, in which the upper lateral tubercles are shifted towards the ventrolateral shoulder and are very prominent, as compared with the small, multiple, ventral tubercles (see COLLIGNON, 1948, pl. 7 [1], figs. 8, 9). In *Delawarella*, as in *Submortoniceras*, the quadri- and then pentatuberculate stages begin early in growth, the lateral and even the ventrolateral tubercles are weakened on the outer whorl,

pressed, but shows the ornaments of *forma α* in the above description. Accordingly ANDERSON's later name *randalli* could well be identical with his earlier name *buttense*. Anyhow, both of them are include in *S. chicoense* (TRASK).

Associated with a large number of specimens of *Submortoniceras chicoense* (TRASK) in the Chico-Pentz area, occurs specimens of peculiar character. They were called *Butticeras studleyi* ANDERSON (1958, p. 272, pl. 51, figs. 3, 4, 4a) and *Butticeras buttense* ANDERSON (1958, p. 272, pl. 53, figs. 3, 3a, 3b, 4). They are small, less than 45 mm. in shell diameter, but have already lost their tuberculation and keel on the body whorl of that small size (in *studleyi*), or even earlier than that (in *buttense*). The outer whorl has, accordingly, narrowly rounded, smoothish venter. The septate part, however, has clavate ventral tubercles and the keel. The shell is relatively evolute and flattened; the umbilicus is shallow and fairly wide, but sometimes fairly narrow; the umbilical tubercles are small, distant and not numerous (6 or 7 per whorl); the lateral ribs are weak; the suture is apprently simple, with shallow and minor incisions.

These peculiar examples might be regarded as an extreme variant of *S. chicoense* (TRASK). This might be true, but in our present knowledge, I hesitate to conclude so, because it deviate too far from the typical form of *S. chicoense* (TRASK) and no transitional specimens have been found. Anyhow they are referable to *Submortoniceras*, because many species of *Submortoniceras*, including the type species, *S. woodsi* (SPATH) and *S. angusteumbilicatum* COLLIGNON, have a distinctive tendency to weakening of the ornament on the outer whorl. Thus the generic name *Butticeras* ANDERSON, 1958 falls in the synonymy of *Submortoniceras* SPATH, 1921.

Occurrence.—Locs. CAS. 27838, LSJU. 2609, 2882; UC. A-4654, A-1420; UCLA. 3637, 3641, 3642, 3643, 3644, 3645, 3647; CIT. 1040; SOC. K-179, K-180, K-199; TM. 1014 [=LSJU. 3297], TM. 1015 [=LSJU. 3295], all in Chico Creek, upper half of the Chico formation in its type area, always associated with *Baculites chicoensis* TRASK. LSJU. 2882, CAS. 1125, CIT. "P36-33", Butte Creek; LSJU. 3293+CAS. 1125+TM. 1000, near Pentz (Pence), equivalent of the upper part of the type Chico formation (associated with *Baculites chicoensis*). The species occurs abundantly in the type Chico area of east side Sacramento Valley, but is very rare in other areas. The only locality which I have confirmed outside the Chico area is loc. LSJU. 3356, Redmont Cut, along the Western Pacific Railroad, east of Altamont, Alameda County, Bay area. Here the specimens are embedded in the shale in crushed condition and associated with *Baculites chicoensis* TRASK.

Subfamily Lenticeratinae HYATT, 1900
Genus *Pseudoschloenbachia* SPATH, 1921

Type-species.—*Pseudoschloenbachia umbulazi* (BAILY).

Generic diagnosis.—See WRIGHT *in* MOORE [Editor], 1957, p. L436.

Remarks.—The systematic position of *Pseudoschloenbachia* is still questionable. As this is not the place to discuss it, I follow WRIGHT's temporary scheme.

Pseudoschloenbachia sp. aff. *P. boulei* (BASSE)
Pl. 35, fig. 3a, b; Pl. 36, fig. 2a, b; Text-fig. 69

Compare.—

1931. *Schloenbachia* (*Municeriteras*) *boulei* BASSE, *Mongr. Paleont. Crét. Prov. Maintirano, Madagascar*, p. 42, pl. 5, fig. 4; pl. 13, fig. 6a, b.

1932. *Schloenbachia* (*Municeriteras*) *boulei*, COLLIGNON, *Ann. Paléont.* vol. 21, p. 31, pl. 4, fig. 2, 2a, text-fig. 18.

Material.—Only five specimens are before me, UC. 31503 (Pl. 36, fig. 2a, b; Text-fig. 69) and another from loc. SOC. K-229 (Coll. M. V. KIRK), two from loc. SOC. K-230A (Coll. M. V. KIRK), and UCLA. 28845 (Pl. 35, fig. 3a, b) from loc. UCLA. 3790 (Coll. W. P. POPENOE), all being more or less imperfectly preserved.

Measurements.—

Specimen	Diameter	Height	Breadth (B/H)	Umbilicus (%)
UC. 31503	72.5	40.0	*c.* 21 (0.52)	11.3 (16)
One fron K-230A	72.0	36.0	—	12.4 (17)
UCLA. 28845	*c.* 95 (estim.)	49 (est.)	—	14.0 (14)
COLLIGNON (1932)	119	65	32 (0.49)	21 (18)
P. brannani USHER (1952)	75	37.5	18.7 (0.50)	9.7 (13)

Fig. 69. *Pseudoschloenbachia* sp. aff. *P. boulei* (BASSE). Diagrammatic outline of the frontal view. UC. 31503, from loc. SOC. K-229, Hooten Gulch, upper part of Member V in the Redding area, Shasta County. See Pl. 36, fig. 2a, b for other views.

Description.—The best preserved specimen (Pl. 36, fig. 1a, b) has a diameter of about 80 mm., in which the body whorl of about a half volution is preserved. From the position of the last suture on another, half preserved, specimen (Pl. 35, fig. 1a, b), its maximum diameter is estimated at about 95 mm.

The shell is involute and fairly narrowly umbilicate. The whorl is much compressed, being nearly twice as broad as high in the relatively well preserved specimen. Other, probably secondarily deformed, specimens have apparently more compressed whorls. The flanks are only slightly convex and gradually convergent; the umbilical shoulder is subangular and the wall is low but steep, being slightly concave; the venter is fastigate and has a high keel.

Small but distinct tubercles are developed at the umbilical shoulder. Their number per whorl is inconstant, for instance, 9 in a half whorl of an adult example, but 11 in a full whorl of the septate part of another specimen. From these umbilical tubercles spring usually two, but sometimes one, low, blunt ribs. On the septate whorl the ribs are falcoid or even falcate, with a slight node-like elevation at the bend of the mid-flank and another blunt ventrolateral tubercle at their ends. The ribs are separated by wider interspaces. On the body whorl the ribs are much weakened, only discernible as fait, broad undulations on a portion of the flank. They are usually single and prorsiradiate and show gentle flexuosity on the upper part, being thus less falcoid than on the septate whorl. The ventrolateral tubercles become extremely faint and finally disappear on the adult body whorl. In addition to the major undulations, fine but rather irregular riblets are sometimes developed and also very fine lirae can be discernible in parallel to the major undulations.

The suture is similar to that of *Pseudoschloenbachia umbulazi* (BAILEY) (see SPATH, 1921, p. 241, text-fig. B) in general pattern, but the elements are relatively narrow.

Remarks.—In shell-form, ornament, and suture the Californian specimens here dealt with are undoubtedly referable to the genus *Pseudoschloenbachia*. They may represent a new species, but the material is not enough to erect it. The closest ally among the hitherto described species is *Psudoschloenbachia boulei* (BASSE) (1931), p. 42, pl. 5, fig. 4; pl. 13, fig. 6a, b) (COLLIGNON, 1932, p. 31, pl. 4, fig. 2, 2a, text-fig. 18) from the Lower Campanian of Madagascar. That Madagascar species has more regular, numerous riblets on the body whorl and broader saddles than the Californian form. I do not know, however, the real range of variation of *P. boulei* (BASSE).

Pseudoschloenbachia brannani USHER (1952, p. 92, pl. 34, figs. 3, 4; pl. 31, fig. 25), from the Haslam formation of the Nanaimo group in Vancouver Island, may be another allied species. It has on the outer whorl numerous fine ribs which are more strongly falcoid than in *P. boulei* (BASSE). The ornament of its inner whorl is not known. Also its suture differs considerably from that of the Californian and Madagascar species in that the first lateral lobe is extremely broad and deep as compared with other lobes.

Occurrence.—Locs. SOC. K-229, K-230A, and UCLA. 3790, all in a limited portion, Hooten Gulch and its neighborhood, upper part of the Member V of POPENOE in the Redding area. This may be either Upper Santonian or Lowest Campanian.

The occurrence of *P. brannani* USHER in Vancouver Island is also infrequent. In Japan there is no well confirmed example of *Pseudoschloenbachia*, but the rare species which was described as "*Pseudobarroisiceras nagaoi* SHIMIZU" (1932, p. 3, pl. 1, figs. 1, 2, 4, 5, 6, 7, 8) is, in my opinion, possibly the young whorl of a species of *Pseudoschloenbachia*, which is close to, if not identical with, *P. besairiei* COLLIGNON (1932, p. 34, pl. 4, fig. 5, 5a, 5b). The locality of the Japanese specimens, lower course of the Wakkawen, a tributary of the Abeshinai, should be assigned to Upper Santonian or Lower Campanian, instead of Coniacian (see MATSUMOTO, 1942, maps of pls. 10, 12).

Family Placenticeratidae HYATT, 1900

Metaplacenticeras SPATH, 1926 is represented by a large number of specimens in California. This is a strong contrast to the abundant occurrence of *Placenticeras* MEEK, 1870 in the Western Interior province.

Four species of *Metaplacenticeras* have been established: *M. pacificum* (SMITH) (1900, p. 207, pls. 26-28; ANDERSON, 1902, p. 79, pl. 8, figs. 162-164; pl. 9, fig. 180; 1958, p. 254, pl. 37, figs. 1, 2, 3, 4, 4a), *M. californicum* (ANDERSON) (1902, p. 78, pl. 8, figs. 173-177; 1958, p. 254, pl. 36, fig. 1), *M. sanctaemonicae* (WARING) (1917, p. 70, pl. 9, figs. 20, 21; ANDERSON, 1958, p. 255), and *M.* (?) *bowersi* ANDERSON (1958, p. 255, pl. 70, figs. 3, 4, 4a) [=*Acanthoceras compressum* ANDERSON (1902, p. 107, pl. 9, fig. 187)].

On looking at numerous specimens I am inclined to admit a great variation of the species of *Metaplacenticeras*. There seems to be, for instance, gradation from the finely ribbed, much compressed form to the coarsely ornamented, less compressed one. The situation seems to be similar to that observed in *Submortoniceras chicoense* (TRASK). The relationships between *M. pacificum*, *M. californicum* and *M. sanctaemonicae* should be carefully studied. Unfortunately I had not enough time for doing detailed measurements. As the original types of *Placenticeras pacificum* SMITH, 1900 and *Placenticeras californicum* ANDERSON, 1902 were lost, a necessary procedure should be taken for designating and validating the neotype. In the present paper I have to omit a revised description.

In connection with the great variability of *Metaplacenticeras* the relationship of *Metaplacenticeras subtilistriatum* (JIMBO) (1894, p. 171 [25], pl. 17 [1], fig. 1) (MATSUMOTO, 1953, p. 140, pl. 13, figs. 1-4, text-figs. 1-9), from Japan, with the American species should be restudied. So far as the available material is concerned, the Japanese species resembles *M. pacificum* in the immature stage, but has considerably broad, falcate ribs on the adult whorl. The ventrolateral clavi are much weakened and finally smoothed on the body whorl of *M. subtilistriatum*. There may be, however, a variation in the Japanese species, so a careful comparison based on further collecting is needed

Genus *Zelandites* MARSHALL, 1926

Type-species.—*Zelandites kaiparaensis* MARSHALL, 1926, by original designation.

Synonym.—*Varunaites* SHIMIZU, 1926; *Hypogaudryceras* SHIMIZU, 1934; *Anazelandites* MATSUMOTO, 1938 (all subjective synonyms; see WRIGHT and MATSUMOTO, 1954, p. 113).

Generic diagnosis.—See WRIGHT, 1957 (*in* MOORE [Editor], 1957), p. L200; MATSUMOTO, 1938b, p. 139.

Remarks.—Despite the wide distribution of the genus in the Indo-Pacific-Mediterranean region, representatives of *Zelandites* in the Cretaceous of the West Coast of North America were not recorded in the previous literature. Aside from a poorly preserved *Zelandites* cf. *inflatus* MATSUMOTO from loc. SOC. K-206, Roaring River, Ono area, Shasta County (Coll. M. V. KIRK), I have recognized only a single specimen in Mrs. SAUL's collection from Chico Creek.

Zelandites sp.
Text-fig. 71

Material.—A single, imperfectly preserved specimen, from loc. UCLA. 3648 (Coll. L. E. & R. B. SAUL).

Descriptive remarks.—The shell is small, being 22.3 mm. in diameter. The whorl is compressed and egg-shaped in cross section, with the maximum breadth somewhat below the middle of the flank. The proportion of breadth and height is similar to that of *Zelandites kawanoi* (JIMBO) (1894, p. 28, pl. 1, fig. 7; YABE, 1903, p. 41; MATSUMOTO, 1938b, p. 143, pl. 14, figs. 3, 4a, b), with b/h=0.77 [breadth=7.2, height=9.3 mm.], but the whorl section of that Japanese Santonian species is elliptical with the maximum breadth at the middle of the flank. In this respect the Californian specimen is closer to *Zelandites kaiparaensis* MARSHALL (1926, p. 147, pl. 19, fig. 9, 9a; pl. 31, figs. 1, 2; MATSUMOTO, 1938b, p. 147, text-fig. 2), from the Campanian of New Zealand, which has the convergent whorl section. *Z. kaiparaensis* has, however, a wider umbilicus than the present form. In this specimen the umbilicus is about 24 per cent of the shell diameter [umb.=5.3, diam.=22.3 mm.]. The surface is nearly smooth, but for a weak, prorsiradiate constriction.

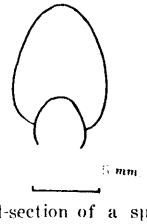


Fig. 71. *Zelandites* sp. Whorl-section of a specimen from loc. UCLA. 3648, Chico Creek, Butte County.

To sum up the specimen under consideration is allied to, but not quite identical with, *Z. kaiparaensis* and *Z. kawanoi*. For accurate determination more specimens of better preservation are needed.

Occurrence.—Loc. UCLA. 3648, in the highest fossiliferous bed of the Chico formation exposed along Chico Creek, Butte County, east side of the Sacramento Valley. This is the first record of the occurrence of *Zelandites* in California.

Subfamily Tetragonitinae HYATT, 1900
Genus *Tetragonites* KOSSMAT, 1895

Type-species.—*Ammonites timotheanus* PICTET, 1847

Synonym.—*Epigoniceras* SPATH, 1925 (see HOWARTH, 1958, p. 9; MATSUMOTO, 1959a, p. 78).

Generic diagnosis.—The shell is rather evolute to moderately involute. The whorl section is typically squarish, subquadrate or trapezoidal, but may be rounded on the venter. The surface is nearly smooth and usually constricted. The growth-lines and the constrictions are prorsiradiate on the flank, crossing the venter nearly vertically to the siphonal line or with a shallow backward sinus. The suture is of lytoceratid type, but has trifid saddles on both sides of the lateral lobe.

Remarks.—In the Upper Cretaceous of California there are at least two species of *Tetragonites* (*s.s.*), which are described below. The Cenomanian (*plus* Upper Albian) species which I have recorded from Japan and Alaska under the heading "*Tetragonites* sp. nov. (?)" (MATSUMOTO, 1942c, p. 671; 1959a, p. 77, pl. 22, figs. 1a-c, 2a-c; text-fig. 15) is expected to occur in California, but I have seen only a few specimens from the Albian part.

Saghalinites WRIGHT and MATSUMOTO, 1954 is best attached to *Tetragonites* as a subgenus. Typical examples have not yet been found in California, although the specimen which was described as *Lytoceras* (*Tetragonites*) *henleyense* ANDERSON (1958, p. 185, pl. 12, fig. 5, 5a; pl. 41, fig. 7) is apparently transitional to this subgenus.

Tetragonites glabrus (JIMBO)
Pl. 39, figs. 2, 3a, b; Text-figs. 72, 73

1894. *Lytoceras glabrum* JIMBO, *Pal. Abh., Bd.* 6 (N. F. 2), p. 180 [34], pl. 22 [6], fig. 2, 2a.
1902. *Lytoceras* (*Tetragonites*) *jacksonense* ANDERSON, *Proc. Calif. Acad. Sci.*, 3rd ser., vol. 2, p. 82, pl. 5, figs. 124, 125.
1903. *Tetragonites glabrus*, YABE, *Jour. Coll. Sci., Imp. Univ. Tokyo*, vol. 18, art. 2, p. 43, pl. 7, figs. 2, 5.
1903. *Tetragonites sphaeronotus*, YABE (*non* JIMBO), *Jour. Coll. Sci., Imp. Univ. Tokyo*, vol. 18, art. 2, p. 45, pl. 7, fig. 1a, b.
1942. *Epigoniceras glabrum*, MATSUMOTO, *Proc. Imp. Acad. Japan*, vol. 18, p. 672.
1958. *Lytoceras* (*Tetragonites*) *jacksonense*, ANDERSON, *Geol. Soc. Amer., Memoir* 71, p. 186, pl. 10, fig. 2, 2a.

Holotype.—JIMBO's original specimen (1894, pl. 22 [6], fig. 2, 2a), the body whorl of which is deformed. Cat. No. GT. I-111.

Material.—A considerable number of specimens from California and Oregon are referable to this species. Examples are:

CAS. No. 44, the holotype of *Lytoceras* (*Tetragonites*) *jacksonense* ANDERSON (1902, pl. 5, figs. 124, 125) [=ANDERSON, 1958, pl. 10, fig. 2, 2a] (Text-fig. 73 in this paper), from loc. CAS. 445

UCLA. No. 28823, from loc. CIT. 1533 (Coll. W. P. POPENOE & Carl AHLROTH)

A fragmentary outer whorl (Text-fig. 72), from loc. CIT. 1598 (Coll. W. P. POPENOE & G. P. ZEBAL)

A moderately large specimen, CIT. No. 3725 [=UCLA. 28859] (Pl. 39, figs. 2, 3a, b), the body whorl of which is crushed, from loc. CIT. 1346, with a label of *T. jacksonense* ANDERSON (Coll. W. P. POPENOE and Jane HOEL)

A specimen from loc. UC. A-4866

There are other less perfectly preserved comparable specimens from locs. CIT. 1533, SOC. K-41, UCLA. 3371, UC. B-2040, and UC. A-7305.

Measurements.—

Specimen	Diameter	Height	Breadth (B/H)	Umbilicus (%)
Holotype (at the last suture)	51.1	24.2	26.5 (1.09)	11.3 (22)
CAS. 44 (uncrushed part)	42.5	20.0	21.5 (1.07)	11.0 (26)
UCLA. 28823	30.0	14.5	15.5 (1.07)	8.1 (27)
One from CIT. 1598		42.5	43.5 (1.02)	--
CIT. 3725 [UCLA. 28859]	45.0	22.0	22.0 (1.00)	10.0 (22)

Diagnosis.—The full-grown shell is of moderate size. The whorl grows rapidly, with a considerable overlapping. It is slightly broader than high or sometimes as broad as high, being broadest in the lower part, and subtetragonal in cross section, with subangular umbilical shoulders, gently convex and somewhat convergent flanks, and a rounded venter. The umbilicus is deep and fairly narrow, 22-27 percent of the diameter, and surrounded by the almost vertically wall.

The shell is thin, nearly smooth, with only lirae and some constrictions. The

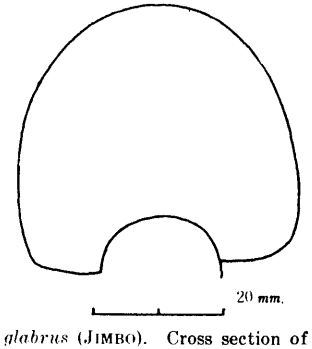


Fig. 72. *Tetragonites glabrus* (JIMBO). Cross section of a fragmentary whorl, from loc. CIT. 1598, Member II of the Redding area, Shasta County.

lirae are somewhat prorsiradiate on the flank and show a shallow, backward sinus on the venter. The constrictions vary in strength and frequency.

The suture is similar to that of *Tetragonites epigonus* KOSSMAT (1895, pl. 17 [3], fig. 4c).

Remarks.—The species occurs abundantly in the Upper Cretaceous (Turonian to Santonian, probably also lower portion of Campanian) of Hokkaido and South Sakhalin. The body whorl is, however, often secondarily deformed, as in the case of JIMBO's original specimens. Therefore *T. glabrus* has not been so correctly understood as it ought to be.

Studying the specimens of California and Oregon, as listed above, I am convinced of the specific identity between the forms of the east and west side of the northern Pacific region. The holotype of *Lytoceras* (*Tetragonites*) *jacksonense* ANDERSON (1902, pl. 5, figs. 124, 125) was illustrated as if its whorl was elliptical in cross section. This came again from the deformed state. The undeformed, septate part of the whorl has subangular umbilical shoulder and high, nearly vertical umbilical wall, as in the Japanese examples. The constrictions are very infrequent and indistinct on ANDERSON's specimen, as in many examples from Hokkaido and Sakhalin. In addition to the holotype of *L.* (*T.*) *jacksonense*, several other specimens from California show the characters quite identical with the diagnosis of *T. glabrus*. Therefore *Lytoceras* (*Tetragonites*) *jacksonense* ANDERSON, 1902 falls in the synonymy of *Lytoceras glabrus* JIMBO, 1894.

I have described *Epigoniceras glabrum* var. *problematica* MATSUMOTO (1942c, p. 672, text-fig. 1a, b). As this represents an intermediate position between *Tetragonites glabrus* (*s.s.*) and *T. popetensis* YABE, the subspecific ranking may be justified. The subspecies should be called *Tetragonites glabrus problematicus* and I here designate as lectotype the specimen illustrated in my previous paper (MATSUMOTO, 1942c, text-fig. 1a, b), GT. "Cr. 503", from the Miho group, Naibuchi Valley, South Sakhalin. No example of this subspecies has yet been recognized

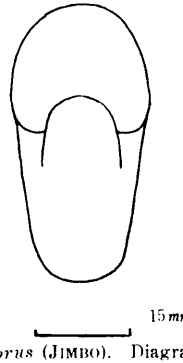


Fig. 73. *Tetragonites glabrus* (JIMBO). Diagrammatic cross section of an example from Oregon, CAS. 44 [= holotype of *Lytoceras* (*Tetragonites*) *jacksonense* ANDERSON].

from California and Oregon. The occurrence of this subspecies in the basal part of the Campanian of Madagascar (COLLIGNON, 1956, p. 89, pl. 11, fig. 5, 5a, 5b) is very interesting. In connection with this wide distribution it cannot be overlooked that *Tetragonites beantalyensis* COLLIGNON (1956, p. 83, pl. 10, fig. 1, 1a, 1b) from the Coniacian of Madagascar is almost indistinguishable from immature *T. glabrus* and that *T. embergeri* COLLIGNON (1956, p. 84, pl. 10, figs. 2, 2a, 2b, 3, 3a, 3b) is also very closely allied to *T. glabrus*.

Occurrence.—Locs. CAS. 445, "Forty-nine mine", Oregon; CIT. 1346, Member III of the Redding area; CIT 1533 and CIT. 1598, Member II of the same area, California. Comparable specimens are from loc. CIT. 1533, SOC. K-41, and UCLA. 3371, Member II of the Redding area; UC. B-2040, *Romaniceras* locality, Venado conglomeratic sandstone at the dam of Putah Creek, Solano-Napa County boundary; and UC. A-4866, Venado sandstone equivalent near Fruto, Glenn County. All of these are referable to the Turonian. There is another locality, UC. A-7305, in Venado sandstone, north of Cache Creek, Yolo County, where *Tetragonites* sp. was found.

Tetragonites popetensis YABE

Text-fig. 74

1903. *Tetragonites popetensis* YABE, *Jour. Coll. Sci., Imp. Univ. Tokyo*, vol. 18, art. 2, p. 48, pl. 7, figs. 4a, b, 6.

1942. *Epigoniceras popetense*, MATSUMOTO, *Proc. Imp. Acad. Japan*, vol. 18, p. 672.

1958. *Lytoceras* (*Tetragonites*) *kernense* ANDERSON, *Geol. Soc. Amer., Memoir* 71, p. 187, pl. 32, fig. 4; pl. 73, fig. 6.

1958. *Lytoceras* (*Tetragonites*) *epigonum*, ANDERSON (*non* KOSSMAT), *Geol. Soc. Amer., Memoir* 71, p. 187, pl. 65, figs. 4, 5; pl. 67, fig. 3, 3a.

? 1958. *Lytoceras* (*Tetragonites*) *henleyense* ANDERSON, *Geol. Soc. Amer., Memoir* 71, p. 185, pl. 12, fig. 5, 5a; pl. 41, fig. 7.

Holotype.—GT. I-207, one of the figured specimens of YABE (1903, pl. 7, fig. 4a, b), from Shisanushibe, Hokkaido, by original designation.

Material.—The following Californian examples are referred to this species:

(1) Specimens from loc. CAS. 1552, including the holotype and paratype of *Lytoceras* (*Tetragonites*) *kernense* ANDERSON (1958, p. 187, pl. 32, fig. 4; pl. 73, fig. 6) (Coll. G. D. HANNA and J. H. SHOW)

(2) Many specimens from loc. CAS. 2362, including the hypotypes of *Lytoceras* (*Tetragonites*) *epigonum* of ANDERSON (*non* KOSSMAT) (1958, p. 187, pl. 65, figs. 4, 5) (Coll. C. C. CHURCH) (Text-fig. 74 in this paper)

(3) Specimens from loc. CAS. 2361 (Coll. C. C. CHURCH)

(4) A specimen from loc. CAS. 29102, hypotype of *Lytoceras* (*Tetragonites*) *epigonum* of ANDERSON (1958, pl. 67, fig. 3, 3a) (Coll. Allan BENNISON)

(5) Specimens from locs. LSJU. 3345 [=TM. 507] and LSJU. 3343c [=TM. 509c] (Coll. M. B. PAYNE & T. MATSUMOTO)

Measurements.

Specimen	Diameter	Height	Breadth (B/H)	Umbilicus (%)
GT. I 207 (after YABE)	34.0	14.5	15.0 (1.03)	10.5 (31)
ANDERSON, 1958, pl. 65, f. 1	33.0	14.3	14.8 (1.03)	10.0 (30)
ANDERSON, 1958, pl. 65, f. 5	33.2	13.8	14.6 (1.05)	9.1 (27)
ANDERSON, 1958, pl. 12, f. 5	43.3	16.1	17.2 (1.06)	15.7 (36)

Diagnosis.—The shell is relatively small. The whorls grow rather slowly, with involution of about ½. The umbilicus is of moderate width, being about 30 (±3) per cent of the shell diameter. The whorl is parallel sided, with gently convex and somewhat flattened flanks, a gently rounded venter, an abruptly bent umbilical shoulder, and a vertical umbilical wall. It is thus, subquadrate in cross section, the height being not much different from breadth, except in the very early growth-stage.

The surface is nearly smooth, with very fine growth-lines, and fairly frequently constricted. The growth-lines and the constrictions are remarkably prorsiradiate on the flank, crossing the venter with a slight backward sinus and with decreased intensity.

The suture is similar to that of *Tetragonites epigonus* KOSSMAT (1895, p. 135 [39], pl. 17 [3], fig. 4c).

Remarks.—This species resembles *Tetragonites epigonus* KOSSMAT (1895, p. 135 [39], pl. 17 [3], figs. 4a-c, 5a, b), but is distinguished by its parallel, not convergent, flanks (cf. Text-fig. 74 with Text-fig. 75), smaller involution, and generally wider umbilicus.

As I have mentioned (MATSUMOTO, 1942c, p. 672-3), there are a few intermediate forms in Japan.

Although ANDERSON (1958, p. 187, pl. 65, figs. 4, 5; pl. 67, fig. 3, 3a) referred certain Californian specimens to *T. epigonus*, they are better assigned to *T. popetensis*. Similarly *Lytoceras* (*Tetragonites*) *kernense* ANDERSON (1958, p. 167, pl. 32, fig. 4; pl. 73, fig. 6) cannot be separated from *T. popetensis*. ANDERSON's holotype is given in his measurements as higher than broad, but the specimen itself is secondarily deformed. Otherwise it is indistinguishable from *T. popetensis*. It should, therefore, be called *Tetragonites* cf. *popetensis* YABE.

The holotype of *Lytoceras* (*Tetragonites*) *henleyense* ANDERSON (1958, p. 185, pl. 12, fig. 5, 5a; pl. 41, fig. 7) is very close to *T. popetensis*. The only difference is its wider umbilicus. From ANDERSON's measurements the umbilicus is 41 percent of the shell diameter, but in my measurements it is 36 percent.

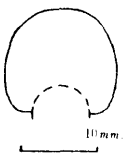


Fig. 74. *Tetragonites popetensis* YABE. Whorl-section of a Californian example [= *T. epigonum*, ANDERSON 1958, pl. 65, fig. 4 (*non* KOSSMAT)], from loc. CAS. 2362, Los Gatos Creek, northwest of Coalinga, Fresno County.

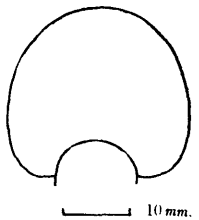


Fig. 75. *Tetragonites epigonus* KOSSMAT. Whorl-section, shown for comparison with that of *T. popetensis* YABE (Fig. 74). Adapted from KOSSMAT, 1895.

Therefore the difference from the normal examples of *T. popetensis* is by no means great. This specimen may be a mere variant, or a subspecies of *T. popetensis* that would represent a transitional state to *Tetragonites* (*Saghalinites*). To determine which is the case more specimens from the type locality, CAS. 444, are needed. ANDERSON's assignment to the Coniacian is not tenable, because the associated species, *Metaplacenticeras pacificum* (SMITH) and *Desmophyllites diphylloides* (FORBES), indicate the Upper Senonian, probably Upper Campanian.

Occurrence.—The species does not seem uncommon in California. Loc. CAS. 1552, north end of Shale Hills, Kern County, southwest side of the San Joaquin Valley, where *Desmophyllites diphylloides* and *Baculites rex* are associated. Loc. CAS. 2362, "*Pachydiscus* silt" or Ragged Valley shale of Los Gatos Creek, northwest of Coalinga, west side of the San Joaquin Valley; also loc. CAS. 2361, presumably the same formation in Joaquin Rock Quadrangle, west side of the above two localities, there are *Damesites hetonaiensis fresnoensis*, *Gaudryceras* (*Vertebrites*) *kayei* (FORBES), *Pachydiscus* cf. *egertoni*, and *Baculites lomaensis*. Locs. LSJU. 3343c and LSJU. 3345, Los Gatos Creek, not far from loc. CAS. 2362. Loc. CAS. 29102, "Garzas limestone" in Volta Quadrangle, Merced County, west side of the San Joaquin Valley.

In Hokkaido and Sakhalin the species is common in the Upper Senonian (Campanian and Maestrichtian) [=Hetonaian *plus* Uppermost Urakawan].

Genus *Pseudophyllites* KOSSMAT, 1895

Type-species.—*Ammonites indra* FORBES, 1846.

Generic diagnosis.—See WRIGHT, 1957 (*in* MOORE [Editor], 1957), p. L203.

Remarks.—This genus is widespread in the Indo-Pacific region. In California, so far as I know, it is represented by a few imperfectly preserved specimens, as briefly described below.

Pseudophyllites cf. *indra* (FORBES)

Compare.—

1846. *Ammonites indra* FORBES, *Trans. Geol. Soc. London*, 2 ser., vol. 7, p. 105, pl. 11, fig. 7.

1865. *Ammonites indra*, STOLICZKA, *Mem. Geol. Surv. India, Pal. Indica*, ser. 3, vol. 1, p. 112, pl. 18, fig. 2a, b.
1879. *Ammonites indra*, WHITEAVES, *Geol. Surv. Canada, Mesozoic Fossils*, vol. 1, pt. 2, p. 105, pl. 13, fig. 2, 2a.
1895. *Pseudophyllites indra*, KOSSMAT, *Beitr. Pal. Geol. Oesterr.-Ung. Or.*, vol. 9, p. 137 [41], pl. 16 [2], figs. 6-9; pl. 17 [3], figs. 6, 7; pl. 18 [4], fig. 3.
1904. *Lytoceras indra*, BOULE, LEMOINE, and THEVENIN, *Ann. Paléont.*, vol. 1, p. 2, pl. 1, fig. 1, 1a, 1b.
1906. *Pseudophyllites* cf. *indra*, WOODS, *Ann. South Afr. Museum*, vol. 4, p. 334, pl. 41, fig. 6a, b.
1909. *Pseudophyllites indra*, KILLIAN and REBOUL, *Wiss. Erg. Schwed. Südpolar Exp.*, 1901-1903, vol. 3, no. 6, p. 14, fig. 3.
1938. *Pseudophyllites indra*, COLLIGNON, *Ann. Géol. Serv. Mines, Madagascar*, vol. 9, p. 24, text-fig. E.
1952. *Pseudophyllites indra*, USHER, *Geol. Surv. Canada, Bull.* 21, p. 57, pl. 3, figs. 2-13, pl. 31, figs. 15-17.
1956. *Pseudophyllites indra*, COLLIGNON, *Ann. Géol. Serv. Mines, Madagascar*, vol. 23, p. 90.

Material.—Imperfectly preserved specimens, from loc. UC. A-6598 (Coll. S. G. CLARK) and loc. UCLA. 2415 (Coll. L. E. SAUL), in California.

Descriptive remarks.—As understood from the descriptions of previous authors (see above list of synonymy), *Pseudophyllites indra* shows some variation in the proportion between whorl-breadth and height and in the roundness of the venter. The specimen from loc. UC. A-6598 resembles one of the specimens from the Nanaimo group of British Columbia (USHER, 1952, pl. 3, figs. 11-13). Another specimen, from loc. UCLA. 2415, can be compared with the example from the Catarina formation. The last mentioned, No. 4247 (CAS.), was once erroneously regarded as an example (not the holotype) of *Pachydiscus catarinae* ANDERSON and HANNA (1935, p. 19, pl. 3, figs. 2, 3). This is close to the typical examples of *Pseudophyllites indra* (FORBES) from India but has more evenly rounded venter. In this respect it approaches *Pseudophyllites peregrinus* SPATH (1953, p. 7, pl. 1, figs. 6-9) from Graham Land and from Madagascar (COLLIGNON, 1956, p. 92, text-fig. 12), but its whorl is not so broad as in the typical examples of *P. peregrinus*. The Californian material at my disposal is unfortunately too poor for further discussion.

Occurrence.—Loc. UC. A-6598, west of Kelly Creek, Covelo Quadrangle, Mendocino County. Loc. UCLA. 2415, in an isolated outcrop of the Cretaceous strata in El Toro Quadrangle, with *Anapachydiscus* cf. *arrialoorensis*, *Metaplacenticeras* cf. *pacificum*, and *Baculites* cf. *rex*.

According to COLLIGNON (1956, p. 91) *Pseudophyllites indra* ranges from the boundary of Santonian-Campanian, all through the Campanian, to the Lower Maestrichtian.

Family Turrilitidae MEEK, 1876

Species belonging to the Turrilitidae occur sparsely in California and Oregon.

Japanese species, *Neocrioceras* (?) *sanushibense* WRIGHT and MATSUMOTO (1954, p. 121, pl. 7, fig. 5a, b; text-fig. 22), which is apparently transitional between *Neocrioceras* and *Pseudoxybeloceras*. *"Oxybeloceras" petrolense* ANDERSON (1958, p. 203, pl. 56, fig. 1) may be another example of *Pseudoxybeloceras* which has a few major ribs only on the curved portion, but otherwise is close to *P. quadrinodosum*. Mr. C. W. WRIGHT (a letter of Sept. 10, 1958) has shown me a photograph of another interesting specimens from the Turonian of England which is also transitional between *Neocrioceras* and *Pseudoxybeloceras*.

From the above observations *Pseudoxybeloceras* is better attached to Nostoceratidae than to Diplomoceratidae. *Oxybeloceras* HYATT, 1900, without constriction, and *Solenoceras* CONRAD, 1860, with collared constriction, are close to *Pseudoxybeloceras*, but their arms are in contact. *Exiteloceras* HYATT, 1894 is elliptically coiled, without straight parts, and has somewhat irregular ribbing and only upper ventrolateral tubercles. Probably *Exiteloceras* and *Pseudoxybeloceras* are in parallel or sister relationship. *Neocrioceras* SPATH, 1921 may be more closely related to *Pseudoxybeloceras* than WRIGHT and MATSUMOTO (1954) once considered. The ultimate origin of these genera may be in a plastic genus *Hyphantoceras* HYATT, 1900, but the actual lineages of the evolution are not yet precisely known.

In Japan *Pseudoxybeloceras* is proved to be long ranging, from the Upper Turonian to the Campanian. It seems to be widespread in the Campanian, because probable representatives are recognized in California (here mentioned), Pondoland of southeast Africa, and New Zealand (see WRIGHT and MATSUMOTO, 1954, p. 120).

Pseudoxybeloceras lineatum (GABB)

Pl. 40, fig. 1a-d; Pl. 41, fig. 1a-c; Text-figs. 76-79

1869. *Ancyloceras* ? *lineatum* GABB, *Palaeont. Calif.*, vol. 2, p. 139, pl. 23, fig. 18, 18a, b, c.
1958. *Oxybeloceras lineatum*, ANDERSON, *Geol. Soc. Amer., Memoir* 71, p. 202.
? 1958. *Oxybeloceras taffi* ANDERSON, *Geol. Soc. Amer., Memoir* 71, p. 203, pl. 51, fig. 6, 6a.

Types.—GABB (1869) based this species on two syntypes. The illustrated one (Pl. 40, fig. 1a-d; Text-fig. 76 of this paper), now preserved in the Museum of Comparative Zoölogy, Harvard University, is here designated as the lectotype.

Material.—In addition to the lectotype, I refer the following specimens to the present species.

LSJU. 8579 (Pl. 41, fig. 1a-c; Text-fig. 79), from loc. LSJU. 2609 (Coll. R. E. COOK); a specimen (Text-fig. 77) from loc. UCLA. 3637 (Coll. L. E. & R. B. SAUL); another (Text-fig. 78) from loc. CAS. 1467A (Coll. RAMBKE); another fragment from loc. CIT. 83 (Coll. B. M. MOORE); others from loc. CIT. 1400 [Sucia Island] (Coll. R. DURBIN & W. P. POPENOE)

Measurements.—

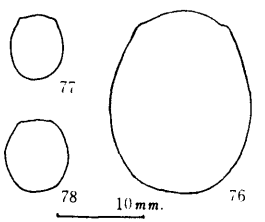
Specimen	Height	Breadth (B/H)	Distance	Number of ribs / Distance
Lectotype	{22.4 {21.8	{18.0 (0.80) {16.3 (0.75)	31.0	14/31
One from loc. UCLA. 3637	{ 9.4 { 7.8	{— {6.3 (0.81)	40.0	10/12
Another from loc. CIT. 1400	{ 9.0 { 8.3	{7.9 (0.88) {7.5 (0.90)	20.0	12/10

Description.—No perfectly preserved specimen has been found. The smallest fragment among the available specimens is curved, suggesting that the early whorl is openly helicoid or almost crioceroid. The specimen of the next growth-stage is broadly arcuate, suggesting a flattening elliptical coil. The later whorl, as seen in a specimen, LSJU. 8579, consists of two, long and straight, parallel arms and a curved, U-shaped part, lying in one plane. The lectotype probably represents a part of this straight arm, which is still septate. A complete outline of the body whorl is not yet known.

The whorl is somewhat higher than broad, being elliptical in section. It is ornamented with numerous, fine, entire ribs, which are separated by the interspaces slightly broader than the ribs themselves. They are prorsiradiate; more so on the earlier whorl, showing a moderate sinus on the dorsum; only slightly oblique or nearly vertical on the straight arm of the late whorl. Each rib has a small, spinose, ventrolateral tubercle. On the later whorl a few, low, and indistinct major ribs are infrequently recognized, on which the tubercles are larger than the others and the minor ribs form a loop at the tubercle. In addition, a faint, lower ventrolateral node is sometimes, but not always, discernible on the major rib. It is not confirmed in the lectotype.

The suture is as described in the generic diagnosis.

Remarks.—From all the observable characters this species is best referred to *Pseudoxybeloceras*. It has a more elliptical, in stead of polygonal, whorl section than *P. quadrinodosum* (JIMBO) (1894, p. 185 [39], pl. 23 [7], figs. 3, 4) (WRIGHT and MATSUMOTO, 1954, p. 120, pl. 7, fig. 6a, b; text-figs. 6, 9-12). The latter species has upper and lower ventrolateral tubercles on each rib of its later whorl, while the lower ventrolateral tubercles are only occasionally discernible on the major



Figs. 76-78. *Pseudoxybeloceras lineatum* (GABB). Cross sections of three specimens.
76. Lectotype in the collection of MCZ. Harvard. See Pl. 40, fig. 1a-d.
77. An example from loc. UCLA. 3637, Chico Creek, Butte County.
78. Another from loc. CIT. 1400, Sucia Island, Washington.

Fig. 79. *Pseudoxybeloceras lineatum* (GABB). Suture near the curved part of an example, LSJU. 8579, from loc. LSJU. 2609, Chico Creek, Butte County. See Pl. 11, fig. 1a–c for other views.

ribs of the former. The major ribs are absent in *P. quadrinodosus*, but appear on the later whorl of *P. lineatum*, although they are faint and infrequent. The major rib and looping of the minor ribs at the tubercles remind us of the ornament of *Neocrioceras spinigerum* (JIMBO) (1894, p. 184 [38], pl. 24 [8], fig. 1, 1a, 1b) and also of *N.* (?) *sanushibense* WRIGHT and MATSUMOTO (1954, p. 121, pl. 7, fig. 5a, b; text-fig. 22). *N.* (?) *sanushibense* is close to *P. lineatum* in that it has a straight arm, but it has more constant, quadritubercles, stronger major ribs, and broader whorls. It may represent a transitional state between *Neocrioceras* and *Pseudoxybeloceras*.

The holotype of *Oxybeloceras taffi* ANDERSON (1958, p. 203, pl. 51, fig. 6, 6a), from loc. CAS. 27838, Chico Creek, may be a fragment of the present species. It is, however, too poorly preserved for concluding definitely the synonymy of *taffi* with *lineatum*.

Occurrence.—The type locality is recorded as "Texas Flat Coral near Folsom," east side of the Sacramento Valley. Other localities of subsequent collections are clearer. Locs. LSJU. 2609 and UCLA. 3637, both in the lower part of the upper half of the section of the Chico formation in Chico Creek, Butte County, east side of the Sacramento Valley, where this species is associated with *Submortoniceras chicoense* and *Baculites chicoensis*. Loc. CAS. 1467A, Enos Canyon, Yolo County, west side of the Sacramento Valley, where *Desmophyllites diphylloides*, *Metaplacenticeras pacificum*, etc. occur. Loc. CIT. 83, calcareous sandstone at the top of the Holz shale, Santa Ana Mountains, Orange County. Loc. CIT. 1400, Nanaimo group of Sucia Island, Washington, where *Desmophyllites diphylloides* and *Hoplitoplacenticeras* sp., among others, occur. To sum up, *P. lineatum* occurs at various levels in the Campanian of the West Coast.

Family Diplomoceratidae SPATH, 1926

There are representatives of *Scalarites* WRIGHT and MATSUMOTO, 1954, *Glyptoxoceras* SPATH, 1926, and *Ryugasella* WRIGHT and MATSUMOTO, 1954 in the Upper Cretaceous of California and adjacent areas, as described below.

While *Polyptychoceras* YABE, 1927 [type-species, *Anisoceras pseudogaultinum* YOKOYAMA, 1890, by subsequent designation of SHIMIZU, 1935a, p. 271] occurs abundantly in Hokkaido and Sakhalin, it is very rare on the West Coast of America. *Ptychoceras rancourrecuse* WHITEAVES (1879, p. 113, pl. 14, fig. 3, 3a; USHER, 1952, p. 101, pl. 26, fig. 5, 6), from the Trent River formation of the Nanaimo group, is probably an example of *Polyptychoceras*, close to *P. pseudogaultinum* (YOKOYAMA) (1890, p. 181, pl. 20, figs. 1-3). *"Hamites obstrictus"* of WHITEAVES (1903, p. 334, pl. 44, fig. 3) and USHER (1952, p. 100, pl. 26, fig. 7), from the upper Lambert formation of the Nanaimo group, is not referable to the true *Polyptychoceras obstrictum* (JIMBO) (1894, p. 184 [38], pl. 23 [7], fig. 2, 2a, 2b). SHIMIZU (1935a, p. 272) wrongly assigned this Japanese species to *Diplomoceras* and incorrectly recorded it as Maestrichtian. The Nanaimo species is probably to be referred to *Diplomoceras*, close to *D. tenuisulcatus* (FORBES) (1846, p. 116, pl. 11, fig. 3). *Diplomoceras* is represented by the better known *D. notabile* WHITEAVES (1903, p. 335, pl. 44, fig. 4, 4a, 4b); USHER, 1952, p. 109, pl. 29, fig. 2; pl. 30, fig. 1; pl. 31, figs. 26, 27), from the same upper Lambert formation. More species of *Diplomoceras* have been recorded by ANDERSON (1952) from California, although some are indefinite and doubtful.

Genus *Scalarites* WRIGHT and MATSUMOTO, 1954

Type-species.—*Helicoceras scalare* YABE, 1904.

Generic diagnosis.—See WRIGHT and MATSUMOTO, 1954, p. 115.

Remarks.—*Scalarites* is close to *Glyptoxoceras* SPATH, 1925 and also to *Diplomoceras* HYATT, 1900. Flared ribs and constrictions occur more frequently in *Scalarites*. Perhaps there is some distinction in the mode of coiling. *Scalarites* shows very shallow open helicoid spire followed by loose elliptical coiling. *Glyptoxoceras* typically has more closed, *Bostrychoceras*-like helix in the initial growth-stage, a less elliptical, crioceras-like coiling in the middle, and a U-shaped last whorl. *Diplomoceras* has two or three, subparallel, straight or broadly curved shafts, in addition to the initial, loose helicoid spire. Its suture is more florid than that of *Scalarites*. *Polyptychoceras* YABE, 1927 has three or four, parallel, straight and long shafts which are approximated or nearly in contact with each other. It is similar to *Scalarites* in suture. From the stratigraphic occurrence and morphological characters of various species, *Glyptoxoceras*, *Diplomoceras*, and *Polyptychoceras* are probably derived from *Scalarites*, which in turn, is probably a descendant of a nontuberculate subgroup of *Hyphantoceras*.

Although the specimens at my disposal are fragmentary, I have recognized a probable representative of *Scalarites* in California.

Scalarites cf. *mihoensis* WRIGHT and MATSUMOTO

Pl. 37, fig. 3

Compare.—

1954. *Scalarites mihoensis* WRIGHT and MATSUMOTO, *Mem. Fac. Sci., Kyushu*

Univ., ser. D, vol. 4, p. 118, pl. 7, figs. 1, 2; text-fig. 2.

Types.—Holotype of *S. mihoensis* is GT. I-2951a (WRIGHT and MATSUMOTO, 1954, pl. 7, fig. 1) by original designation. It is immature and is supplemented by several paratypes. These types came from the Upper Turonian and the Coniacian of South Sakhalin and Hokkaido.

Material.—A figured specimen (Pl. 37, fig. 3), UCLA. 28780, and other ten fragmentary whorls of different sizes from loc. CIT. 1532 (Coll. W. P. POPENOE & Carl AHLROTH); several fragments from locs. CIT. 1533 (Coll. W. P. POPENOE & Carl AHLROTH) and CIT. 1346 (Coll. W. P. POPENOE & Jane HOEL).

Measurements.—

Specimen	Height	Breadth (B/H)	Number of ribs Distance nearly equal to height
One from loc. CIT. 1532	2.9	2.6 (0.89)	5/3.0
Another from loc. CIT. 1532	{8.9 {9.2	7.8 (0.88)} 8.2 (0.89)}	9/9.0
Another " " "	9.5	8.1 (0.85)	7/9.0
Another " " "	11.7	10.0 (0.85)	8/11.0
UCLA. 28780	—	—	9/10.0

Descriptive remarks.—Some of the fragmentary whorls show broadly arcuate parts and others more strongly curved, U-shaped portions, thus indicating elliptical coiling of *S. mihoensis* type. The section of the undeformed whorl is subcircular to broadly elliptical, slightly higher than broad, with the antisiphonal area more broadly rounded than the siphonal area on the later whorls.

The annular ribs are fairly numerous, of moderate strength, relatively narrow, and separated by broader interspaces. The periodic, flared ribs, with associated constriction, are less frequent than those of *S. scalaris* (YABE) (1904, p. 9, pl. 3, figs. 2, 3a-c).

From all the observable characters the described specimens of California are best referred to *S. mihoensis* WRIGHT and MATSUMOTO.

The holotype of *Hamites ellipticus* ANDERSON (1902, p. 87, pl. 3, figs. 102, 103; pl. 10, fig. 191), from "Forty-nine Mine, Oregon" apparently resembles *Scalarites mihoensis* in the curvature of the whorl and the mode of ribbing. There are doubtful, infrequent constrictions. This is probably an example of *Scalarites*, although ANDERSON (1958, p. 198, pl. 39, fig. 5, 5a) recently referred it to *Diplomoceras*. ANDERSON's holotype is more compressed than the normal examples of *S. mihoensis*.

Occurrence.—Locs. CIT. 1532 and CIT. 1533, Member II (near the top) of the Redding area; loc. CIT. 1346, Member III (*Subprionocyclus normalis* bed) of the same area, Shasta County, northeast side of the Sacramento Valley.

Genus *Glyptoxoceras* SPATH, 1926

Type-species.—*Hamites rugatus* FORBES, 1846. Since this nominal species was originally designated as the "genotype" of *Glyptoxoceras* (SPATH, 1925, p. 30), it is the type-species, despite the fact that *Hamites* (*Anisoceras*) *rugatus* of KOSSMAT (1895, *non* FORBES) has been shown by SHIMIZU (1835, p. 272) to be a synonym of *Glyptoxoceras indicum* (FORBES, 1846).

Generic diagnosis.—See SHIMIZU, 1935, p. 272; WRIGHT *in* MOORE [Editor], 1957, p. L227.

Remarks.—SHIMIZU (1935, p. 272) accounted the asymmetrically bifid antisiphonal lobe (I) as a criterion by which to distinguish this genus from other allied genera, but this should not be stressed too much, because the character is variable and not important. Normally I is trifid, but may be modified, especially on the curved or helicoid part.

The relationship of *Glyptoxoceras* with *Scalarites*, *Diplomoceras*, and *Polyptychoceras* has been mentioned above (see p. 165).

Glyptoxoceras ranges from Santonian to Maestrichtian. The type-species occurs in the Valudayur beds of the Pondicherry area, southern India.

The similarity of *Glyptoxoceras* to *Heteroceras* D'ORBIGNY, 1849 of the Barremian and Aptian is an example of homeomorphy. *Glyptoxoceras* shows bilateral symmetry in its later growth-stages.

Glyptoxoceras indicum (FORBES), 1846

Pl. 41, figs. 2-6; Text-fig. 80

1846. *Hamites indicus* FORBES, *Trans. Geol. Soc. London*, 2 ser., vol. 7, p. 116.
1895. *Hamites* (*Anisoceras*) *indicus*, KOSSMAT, *Beitr. Pal. Geol. Oesterr.-Ungarns Or.*, vol. 9, p. 145 [49], pl. 19 [5], fig. 4a-c.
1895. *Hamites* (*Anisoceras*) *rugatum*, KOSSMAT (*non* FORBES), *Beitr. Pal. Geol. Oesterr.-Ungarns Or.*, vol. 9, p. 146 [50], pl. 19 [5], fig. 7a, b, 9 (8a, b doubtful).
1935. *Glyptoxoceras indicum*, SHIMIZU, *Proc. Imp. Acad. Sci.*, vol. 11, p. 272.

Types.—FORBES based this species on several syntypes (see KOSSMAT, 1895, p. 145 [49]). The illustrated specimen of FORBES (1846, pl. 11, fig. 4), which was erroneously called the holotype by SHIMIZU (1935, p. 272), has been removed from *Hamites indicus* to *Hamites subcompressus* (see KOSSMAT, 1895, p. 145; SHIMIZU, 1935a, p. 272). Another of FORBES' syntypes, BM. 1049b, was illustrated by KOSSMAT (1895, pl. 19 [5], fig. 4a, b). This is designated here as the lectotype of *Glyptoxoceras indicum* (FORBES). It was incorrectly called a paratype and misrecorded as BM. 10498 by SHIMIZU (1935a). The specimen with register number BM. 10498 is the illustrated syntype of *Hamites largesulcatus* FORBES (1846, pl. 11, fig. 1).

Material.—Five specimens, UC. 36433-36437 (Pl. 41, figs. 6, 2, 4, 5, 3; Text-fig. 80), from loc. UC. A-3826 (Coll. Allan BENNISON), which altogether give us the correct shape of the shell. Other fragmentary pieces, from loc. LSJU. 2251 [≒LSJU. 3326], are comparable with the present species.

Diagnosis.—The initial coils are helicoid, relatively closed, soon followed by a crioceroid, planospiral coil, and finally passing into an elliptical coil, up to the broadly U-shaped, last part. The main part is, thus, bilaterally symmetric. The longer diameter of the last ellipse is about 75 mm. to 85 mm.; the shorter one about 55 mm. to 65 mm. The whorl is nearly circular in section, slightly

Explanation of Plate 3

(Figures of natural size unless otherwise stated)

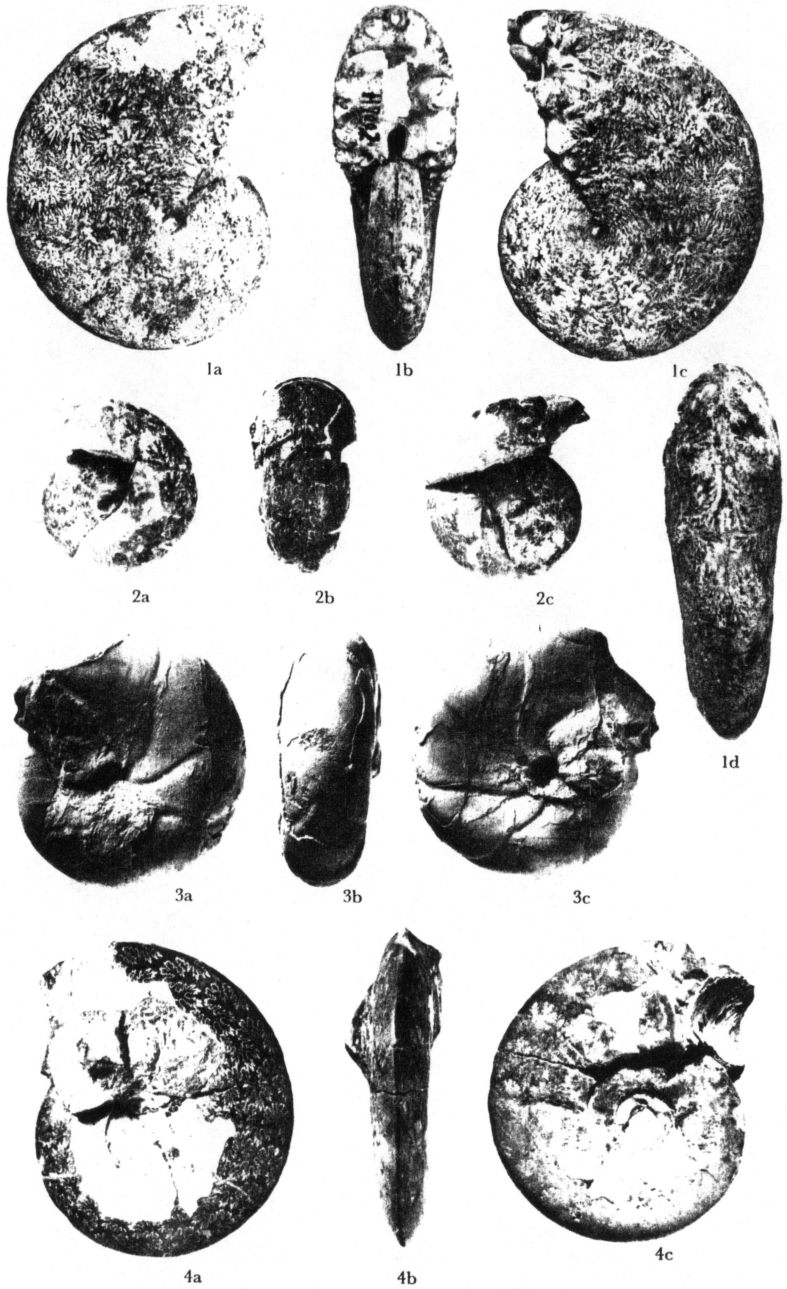
Fig. 1. *Neophylloceras hetonaiense* MATSUMOTO.....Page 5
Two sides (a, c), front (b), and back (d) views. A specimen, GK. H 7002, from loc. LSJU. 3329 [=TM. 204], Marca shale of the Moreno formation, Panoche Hills, west side of the San Joaquin Valley (Coll. M. B. PAYNE & T. MATSUMOTO).

Fig. 2. *Desmoceras kossmati* MATSUMOTO .....Page 7
Two sides (a, c) and back (b) views, slightly reduced. LSJU. 8581, from loc. LSJU. 3337, Priest Valley Quadrangle, west of Coalinga, Fresno County, west side of the San Joaquin Valley (Coll. S. W. MULLER).

Fig. 3. *Desmophyllites diphylloides* (FORBES).....Page 9
Two sides (a, c) and back (b) views. LSJU. 8583, from loc. LSJU. 2732, Arroyo del Valle, Tesla Quadrangle, Alameda County, Bay Area (Coll. L. W. FUNKHOUSER).

Fig. 4. *Hauericeras* (*Gardeniceras*) *angustum* YABE.....Page 24
Two sides (a, c) and back (b) views. UCLA. 28826 [=CIT. 3474] from loc. CIT. 1017, lower part of the section on Chico Creek, east side of the Sacramento Valley (Coll. W. P. POPENOE & D. SCHARF).

Photos by Ikuwo OBATA (1), Alexander TIHONRAVOV (2, 3), and Takeo SUSUKI (4); (3) with and others without whitening.



Explanation of Plate 5

(Figures reduced to three fourths of natural size in linear dimension)

Fig. 1. *Tragodesmoceras ashlandicum* (ANDERSON).....Page 26
Side (a) and back (b) views. UCLA. 28798, from loc. CIT. 1444, Member I of the Redding area, Shasta County, California (Coll. W. P. POPENOE).

Photos by Takeo SUSUKI, without whitening.

Explanation of Plate 6

Fig. 1. *Eupachydiscus* sp. aff. *E. teshioensis* (JIMBO) .....Page 31
Two sides (a, b) and back (c) views, approximately ×3/4. UCLA. 28799, from loc. UCLA. 3368, Member IV of the Redding area, Shasta County, California (Coll. James VALENTINE).

Fig. 2. *Mesopuzosia pacifica* MATSUMOTO .....Page 18
Side view, ×1. GK. H 7029, from loc. TM. 2002 [=LSJU. 3289], Swede Creek of the Redding area, Shasta County, California (Coll. W. P. POPENOE & T. MATSUMOTO).

Photos by Takeo SUSUKI (1) and Ikuwo OBATA (2), without whitening.

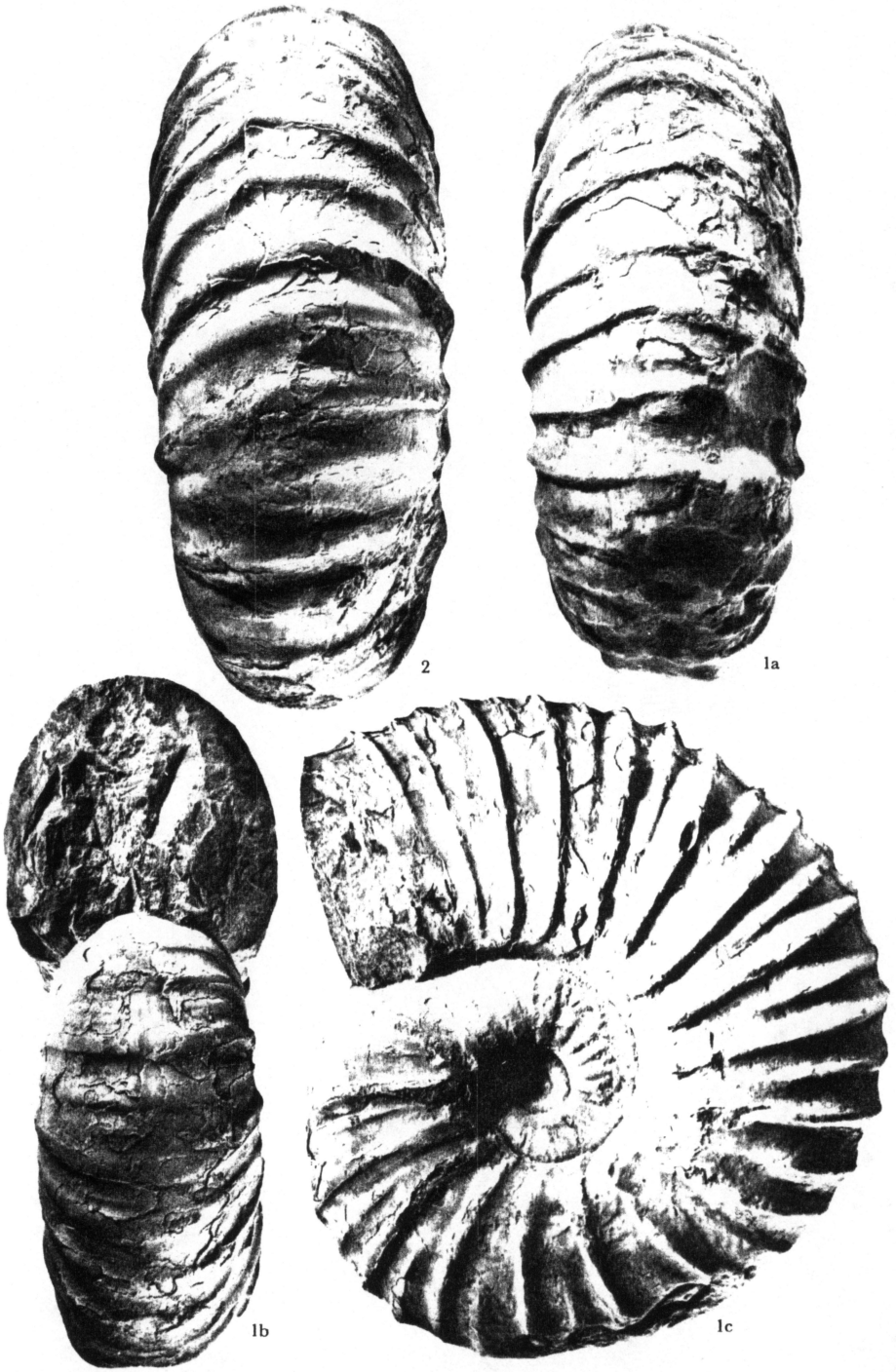
Explanation of Plate 7

(All figures one fifth of natural size in linear dimension)

Figs. 1, 2. *Eupachydiscus* sp. nov. (?) aff. *E. lamberti* COLLIGNON .....Page 31

1. Back (a), front (b), and side (c) views of a gigantic specimen, UCLA. 28683, from loc. UCLA. 3956, quarry in Santa Ynez Canyon, Santa Monica Mountains, Los Angeles County (Coll. W. P. POPENOE).
2. Back view of another gigantic specimen, UCLA. 28684, from the same locality as above.

Photos by Takeo SUSUKI, with white coating.



T. MATSUMOTO: Upper Cretaceous Ammonites of California

Explanation of Plate 8

(All figures of natural size)

Fig. 1. *Neophylloceras ramosum* (MEEK) ..... Page 1
Two sides (a, c) and back (b) views. An example, CIT. 3726 [=UCLA. 28858], from loc. CIT. 1346, Member III of the Redding area, Shasta County, California (Coll. W. P. POPENOE). This was designated as the holotype of *Phylloceras vacullae* ANDERSON (1958, p. 181, pl. 40, fig. 4, 4a), but is nothing but an example of *N. ramosum* (MEEK).

Fig. 2. *Pachydiscus suciaensis* (MEEK) ..... Page 36
Back (a), two sides (b, c), and front (d) views. Lectotype, designated in this paper (p. 36), USNM. 12396 [=MEEK, 1876, pl. 5, fig. 2, 2a], from "Komooks", Vancouver Island, British Columbia.

Photos by Takeo SUSUKI (1) and Nelson SHUPE, with whitening.

T. MATSUMOTO : Upper Cretaceous Ammonites of California

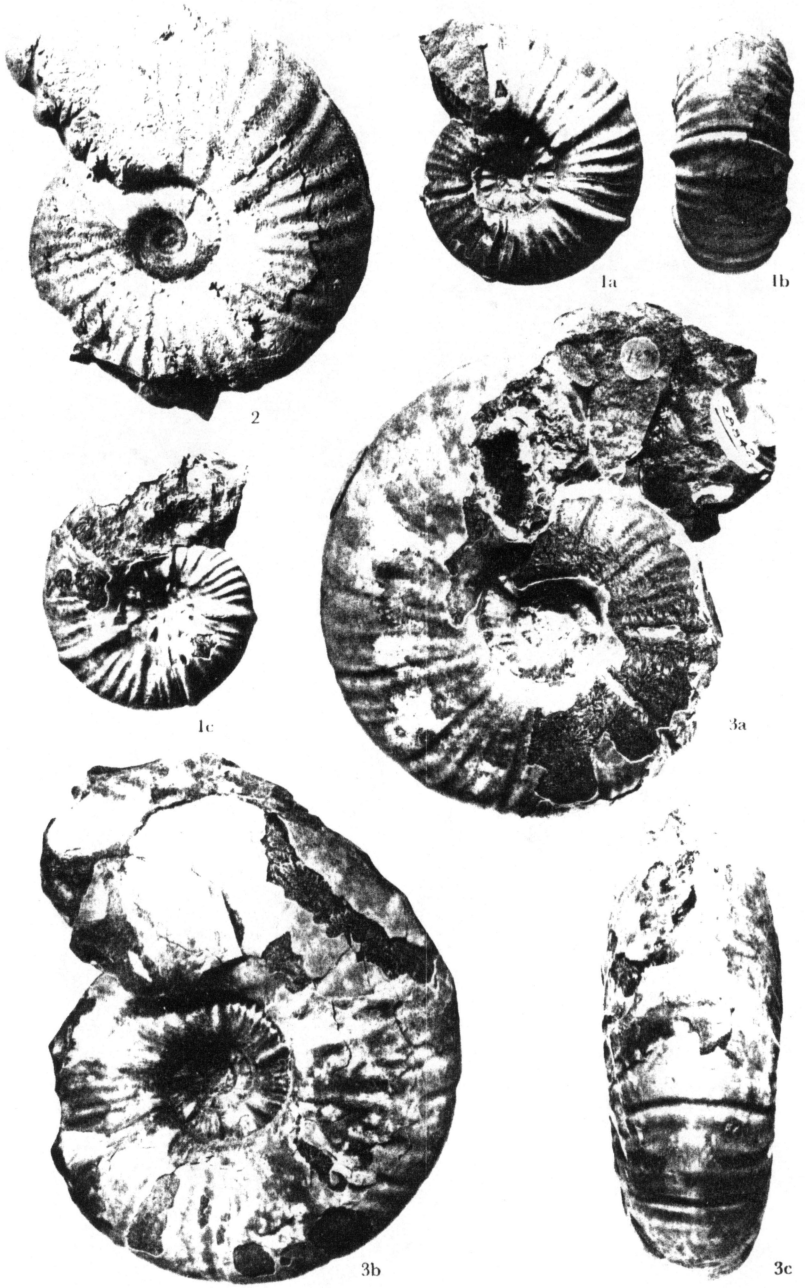
Explanation of Plate 15

(All figures of natural size)

Fig. 1. *Canadoceras yokoyamai* (JIMBO) ..... Page 56
Two sides (a, c) and back (b) views. An immature example, UCLA. 28843, from loc. UCLA. 3637, Chico formation of Chico Creek, Butte County, east side of the Sacramento Valley, California (Coll. L. E. & R. B. SAUL).

Figs. 2, 3. *Canadoceras mysticum* MATSUMOTO ..... Page 59
2. Side view of an example, UCLA. 28844, from loc. UCLA. 3636, Chico formation, Chico Creek, Butte County, California (Coll. L. E. & R. B. SAUL).
3. Two sides (a, b) and back (c) views. An example, UCLA. 28842, from loc. UCLA. 3637, Chico formation, Chico Creek, Butte County, California (Coll. L. E. & R. B. SAUL).

Photos by Takeo SUSUKI, without whitening.



Explanation of Plate 28

(All figures of natural size)

Fig. 1. *Romaniceras deverioide* (de GROSSOUVRE) .....Page 87
Back (a) and side (b) views. CIT. 3727, from loc. CIT. 1345, Swede Creek of the Redding area, Shasta County, California (Coll. W. P. POPENOE & Carl AHLROTH). This is a paratype of "*Romaniceras hesperium*" ANDERSON, 1958.

Fig. 2. *Texanites* cf. *kawasakii* (KAWADA).....Page 124
Side (a) and section (b) views of a fragmentary whorl, UCLA. 28847, from loc. UCLA. 3373, Member IV, Oak Run, Redding area, Shasta County, California (Coll. R. W. IMLAY and W. P. POPENOE).

Photos by Takeo SUSUKI, with whitening.

Explanation of Plate 29

(All figures of natural size)

Fig. 1. *Subprionocyclus noramlis* (ANDERSON) .....Page 118
Back (a) and side (b) views of a relatively large specimen. GK. H7046, from loc. TM. 2001 [=LSJU. 3288], Little Cow Creek, Member III of the Redding area, Shasta County, California (Coll. W. P. POPENOE & T. MATSUMOTO).

Figs. 2, 3. *Subprionocyclus neptuni* (GEINITZ) .....Page 112
2. Side view of a Californian example UCLA. 28782, from loc. CIT. 1042, left bank of Rancheria Gulch, Yreka Quadrangle, Siskiyou County, sandstone near the base of the Upper Cretaceous section in the gulch (Coll. W. P. POPENOE & FINDLAY).
3. Back (a) and side (b) views of another example, UCLA. 28781, from the same loc. CIT. 1042, Siskiyou County (Coll. W. P. POPENOE & FINDLAY).

Fig. 4. *Romaniceras deverioide* (de GROSSOUVRE) .....Page 87
Front (a), back (b), and side (c) views of an immature specimen. UCLA. 28796, from loc. CIT. 1345, Swede Creek, Redding area, Shasta County, California (Coll. W. P. POPENOE & Carl AHLROTH). Note the asymmetric configuration of the tubercles.

Photos by Takeo SUSUKI (2–4) and Ikuwo OBATA (1).

T. MATSUMOTO: Upper Cretaceous Ammonites of California

Explanation of Plate 31

(Figures of natural size unless otherwise stated)

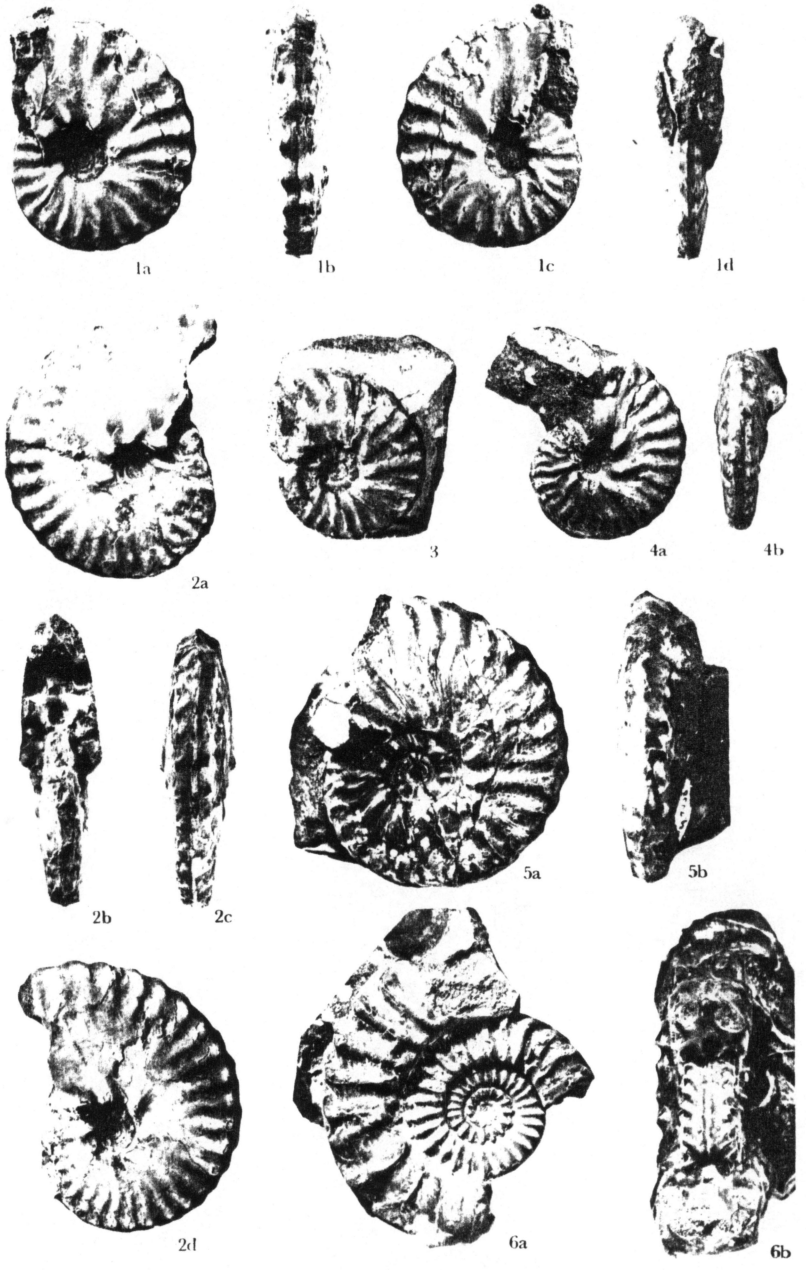
Figs. 1–5. *Subprionocyclus normalis* (ANDERSON).....Page 118

1. Two sides (a, c), back (b), and front (d) views of an example. UCLA. 38784, from loc. CIT. 1346, Little Cow Creek, Member III in the Redding area, Shasta County, northeast side of the Sacramento Valley (Coll. W. P. POPENOE & Jane HOEL).
2. Two sides (a, d), front (b), and back (c) views of another, involute, example. UCLA. 38783, from the same loc. CIT. 1346 (Coll. W. P. POPENOE & Jane HOEL).
3. Side view of an example, GK. H7040, from loc. TM. 2001 [=LSJU. 3288], Little Cow Creek, Member III in the Redding area, Shasta County, northeast side of the Sacramento Valley (Coll. W. P. POPENOE & T. MATSUMOTO).
4. Side (a) and back (b) views of another example, GK. H7041, from the same loc. TM. 2001 (Coll. W. P. POPENOE & T. MATSUMOTO).
5. Side (a) and back (b) views of another example, GK. H7038, from the same loc. TM. 2001 (Coll. W. P. POPENOE & T. MATSUMOTO).

Fig. 6. *Peroniceras* sp. *juvenile* .....Page 123

Side (a) and section (b) views ($\times 3/2$) of a specimen, UCLA. 27879, from loc. CIT. 1007, Oak Run, Member IV in the Redding area, Shasta County, northeast side of the Sacramento Valley (Coll. W. P. POPENOE & D. SCHARF).

Photos by Takeo SUSUKI (1, 2, 6), with whitening, and Ikuwo OBATA (3–5), without whitening.



Explanation of Plate 35

(All figures of natural size)

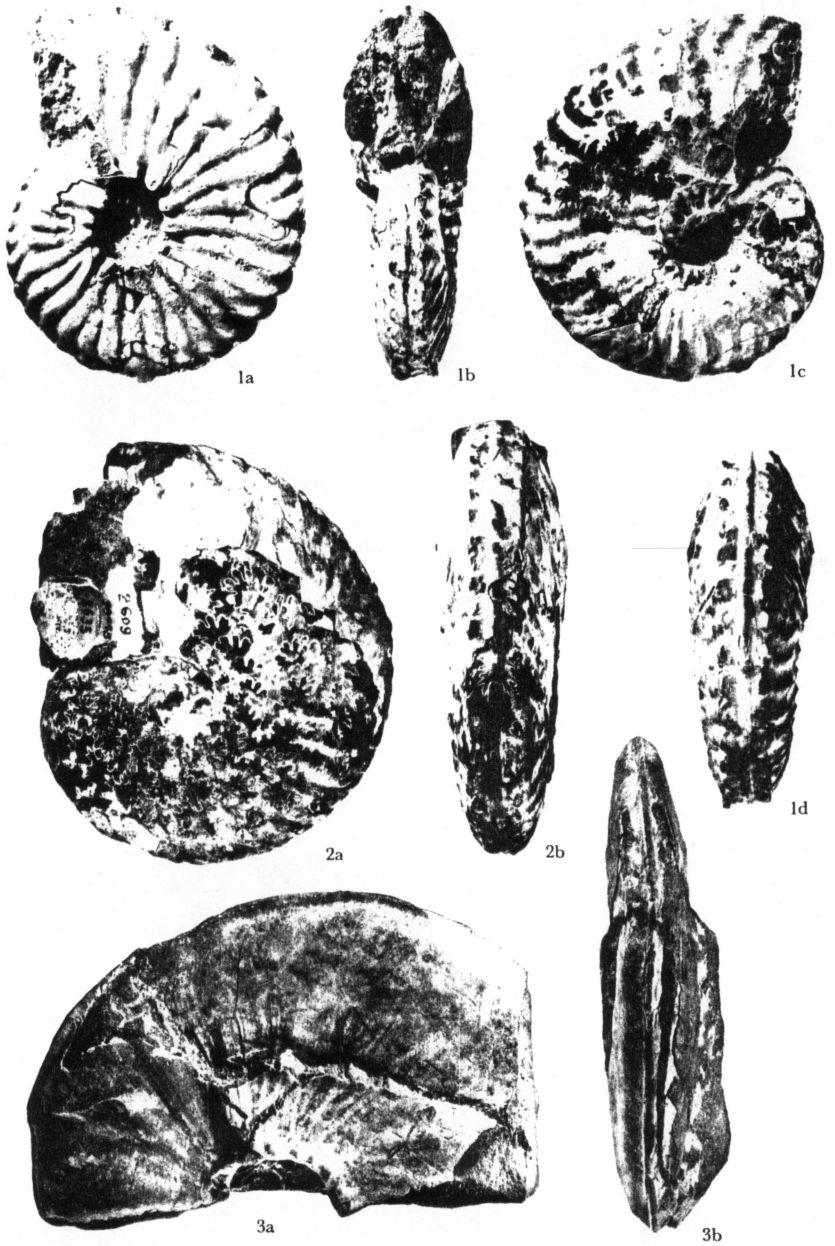
Figs. 1, 2. *Submortoniceras chicoense* (TRASK) ..... Page 126

1. Two lateral (a, c), front (b), and back (d) views of a moderate example [*forma* β in the text], LSJU. 8633, from loc. LSJU. 2609, Chico Creek, in the upper half of the type section of the Chico formation (*s. s.*), Butte County, east side of the Sacramento Valley, California (Coll. R. E. COOK).
2. Side (a) and back (b) views of a finely ornamented and compressed example [*forma* γ in the text], LSJU. 8635, from the same loc. LSJU. 2609, Chico Creek, Butte County, California (Coll. R. E. COOK).

Fig. 3. *Pseudoschloenbachia* sp. aff. *P. boulei* (BASSE) ..... Page 133

Side (a) and back (b) views of a specimen, UCLA. 28845, from loc. UCLA. 3790, Hooten Gulch, upper part of Member V in the Redding area, Shasta County, northeast side of the Sacramento Valley, California (Coll. W. P. POPENOE).

Photos by Alexander TIHONRAVOV (1, 2) and Takeo SUSUKI (3); 1a, 3a, and 3b with whitening; others without whitening.



Explanation of Plate 37

(All figures of natural size)

Fig. 1. *Anagaudryceras yamashitai* (YABE) .....Page 138
Two sides (a, b), back (b), and front (d) views. An example, GK. H7027, from loc. TM. 11 [= LSJU. 3319], lower part of the Upper Marlife formation, Panoche group in Panoche Hills, west side of the San Joaquin Valley, California (Coll. M. B. PAYNE & T. MATSUMOTO).

Fig. 2. *Gaudryceras* (*s. s.*) cf. *denmanense* WHITEAVES .....Page 144
Back (a) and side (b) views. An immature example LSJU. 8580, from loc. LSJU. 2880, Chico Creek, in the lower half of the type section of the Chico formation (*s. s.*), Butte County, east side of the Sacramento Valley, California (Coll. R. E. COOK).

Fig. 3. *Scalarites* cf. *mihoensis* WRIGHT and MATSUMOTO .....Page 165
Side view of a fragmentary whorl, UCLA. 28780, from loc. CIT. 1532, Little Cow Creek, top of Member II in the Redding area, Shasta County, California (Coll. W. P. POPENOE & Carl AHLROTH).

Fig. 4. *Ryugasella ryugasensis* WRIGHT and MATSUMOTO .....Page 169
Ventral (a), lateral (b), and dorsal (c) views. An example. LSJU. 8579, from loc. LSJU. 2609, Chico Creek, in the upper half of the type section of the Chico formation (*s. s.*), Butte County, east side of the Sacramento Valley, California (Coll. R. E. COOK).

Photos by Alexander TIHONRAVOV (2, 4), Takeo SUSUKI (3), and Ikuwo OBATA (1), without whitening.

T. MATSUMOTO: Upper Cretaceous Ammonites of California

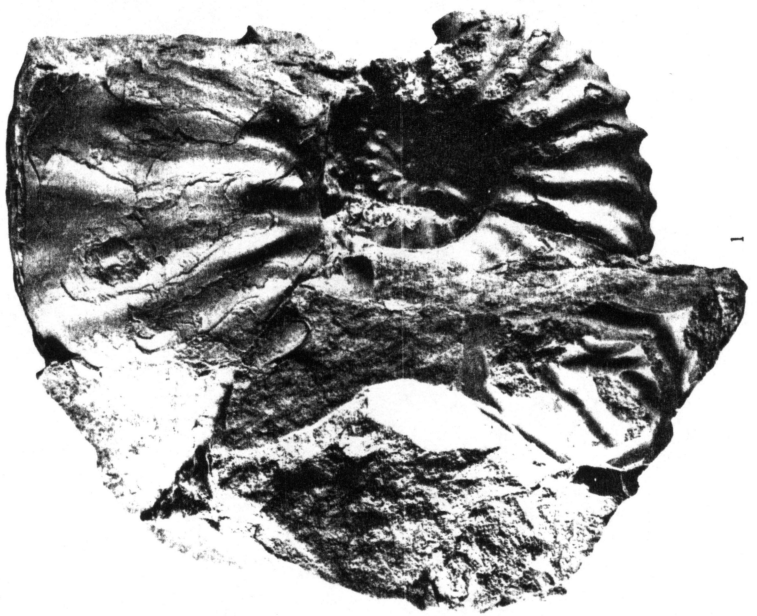
Explanation of Plate 39

(Figures of natural size, unless otherwise stated)

Fig. 1. *Acanthoceras whitei* nom. nov. .....Page 82
Side view of the holotype, USNM. 20121, the original specimen of *Ammonites turneri* WHITE (*non* SOWERBY), from Currys Canada, Mt. Diablo area, California. (See Pl. 22, fig. 1a–c for other views).

Figs. 2, 3. *Tetragonites glabrus* (JIMBO) .....Page 149
2. Side view of an example, CIT. 3723 [=UCLA. 28859], from loc. CIT. 1346, Little Cow Creek, Member III of the Redding area, Shasta County, California (Coll. W. P. POPENOE & Jane HOEL). The body whorl is crushed.
3. Side (a) and front (b) views, slightly enlarged, of the some specimen as above. About a half of the highly crushed body whorl is detached away, but the remaining half is still somewhat deformed.

Photos by Nelson SHUPE (1) and Takeo SUSUKI (2, 3), with whitening.



Explanation of Plate 40

(Figures of natural size)

Fig. 1. *Pseudoxybeloceras lineatum* (GABB) ..... Page 162
Two lateral (a, c), ventral (b), and dorsal (d) views. Lectotype, preserved in the Museum of Comparative Zoölogy, Harvard University [= *Ancyloceras*? *lineatum* GABB, 1869, pl. 23, fig. 18, 18a, b, c]. Photographs kindly supplied through Dr. B. KUMMEL, with whitening.

Fig. 2. *Bostrychoceras* sp. aff. *B. otsukai* (YABE) ..... Page 160
Two views (a, b) of a specimen, UCLA. 28846, from loc. UCLA. 3370, Hooten Gulch, upper part of Member V, close to the contact with Member VI, Redding area, Shasta County, northeast side of the Sacramento Valley (Coll. John FRICK). Photographs taken by Takeo SUSUKI, with slight whitening.