On Some Ammonites from the Cretaceous Fujikawa Formation of Shikoku

By

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with 2 Text-figures and 3 Plates

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ABSTRACT: Three species of ammonites from the upper part of the Fujikawa Formation of Shikoku are described. They are *Hypophylloceras yeharai* n. sp., *Mariella* sp. aff. *M. cantabrigiensis* (JUKES-BROWNE), and *Desmoceras* (*Pseudouhligella*) *dawsoni shikokuense* (YABE and SHIMIZU). On the basis of the described species and also of a revised stratigraphic observation, the fossiliferous part of the Fujikawa Formation is referred to the Albian, probably Upper Albian.

CONTENTS

I. INTRODUCTION

In the Outer Zone of Southwest Japan the Cretaceous System is distributed in a number of scattered areas, each of which forms a synclinorium or a structural basin, and is superimposed on the highly folded structure of the Upper Palaeozoic Chichibu Supergroup. The Katsuura-gawa valley (Fig. 1) in Tokushima Prefecture, eastern Shikoku, is one of them.

The stratigraphy of this area was studied by YEHARA (1924), NAGAO (in YABE, 1927), TSUKANO (1931), MATSUZAWA (1931), SUZUKI (1941), YAMASHITA (in HIRAYAMA et al., 1956, 1958), NUMANO and NAKANO (1965) and others. Although several ammonite species were listed and referred for the correlation of strata by the previous authors, few palaeontologic descriptions have been published (e. g. SHIMIZU, 1931). Accordingly there was a debate as regards the geological age of certain formations.

One of us (I. N.) has recently been engaged in a geological field work of the Katsuura-gawa valley at the suggestion of the other (T. M.). A revised stratigraphy of the area is presented in another paper written in Japanese (NAKAI, 1968). To cite from it the Cretaceous System of this area is divided into six formations, i. e. the Tatsukawa, Hanoura, Hoji, Fujikawa, Kushibuchi, and Tatsue Formations in ascending order, each of which represents a sedimentary cycle.

The Fujlkawa Formation, about 600 m thick, begins with conglomerate or very

coarse-grained sandstone, followed by medium to coarse-grained sandstone, and is occupied in the main part by black to bluish grey shale or mudstone. The basal sandstone contains abundantly *Pterotrigonia pocilliformis* (YOKOYAMA), while some ammonites occur in the upper part of the formation.

The Fujikawa Shale was regarded as the youngest member of the Lower Cretaceous by YABE (1927, p. 69), who correlated it with the Gault on the basis of *Beudanticeras shikokuense* YABE and SHIMIZU, 1927, from the shale. One of us (MATSUMOTO, 1954, p. 84) tentatively followed YABE's conclusion, although the generic determination of the ammonite was considered as inconvincible.

YAMASHITA (in HIRAYAMA et al. 1956, 58) combined the shale of the Fujikawa Formation with that of the Kushibuchi (in SUZUKI's and also NAKAI's sense) and referred his Fujikawa (s. l.) to the Gyliakian, approximately Cenomanian-Turonian, on the evidence of undescribed desmocertid ammonite and inocerami. NUMANO and NAKANO (1965, p. 111), however, ascribed the Fujikawa Shale to the Uppermost Miyakoan, probably Lowest Cenomanian, on the basis of *Desmoceras kossmati* MATSUMOTO.

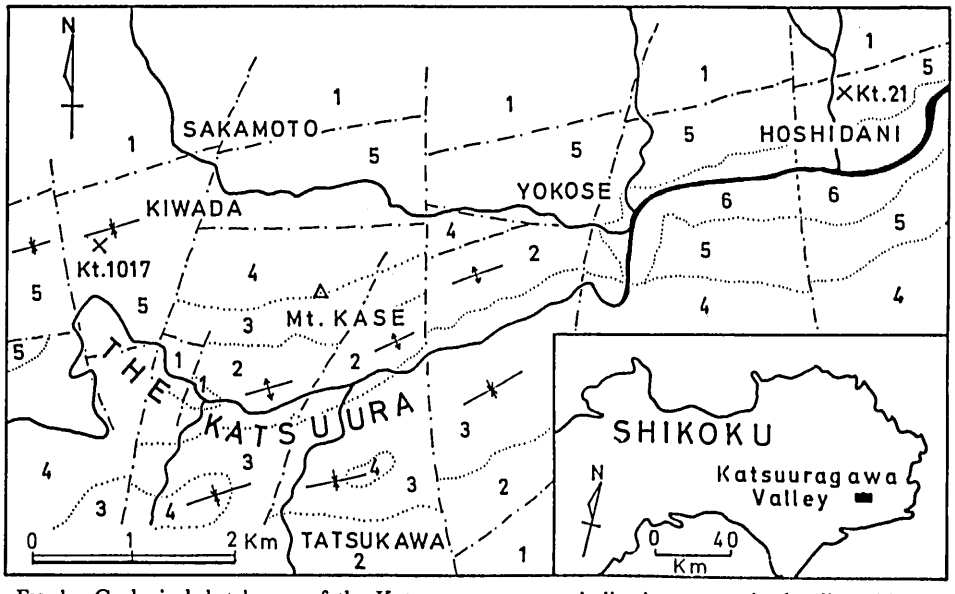

FIG. 1. Geological sketch map of the Katsuura-gawa area, indicating ammonite locality with ×. (Adapted from NAKAI, 1968). Geological formation, 1: Upper Palaeozoic Chichibu Supergroup, 2-5: Cretaceous, 2: Tatsukawa Formation, 3: Hanoura Formation, 4: Hoji Formation, 5: Fujikawa Formation, 6: Alluvium.

To settle the controversial age of the Fujikawa Formation a correct identification of ammonites, as well as a precise stratigraphic field work, is keenly needed. One of us (I. N.) has obtained some ammonites from two localities through his field work. Their location is indicated in Fig. 1. We have studied these specimens and also some of the

collections of the previous authors. This paper gives a result of our palaeontological study.

In the following descriptions the institutions at which the specimens are registered are denoted with the following symbols:

ANSP. : Academy of Natural Sciences, Philadelphia
GH. : Institute of Geology and Mineralogy, Hiroshima University, Hiroshima
GK. : Department of Geology, Kyushu University, Fukuoka
GSC. : Geological Survey of Canada, Ottawa
IGPS. : Institute of Geology and Palaeontology, Tohoku University, Sendai
KT. : Institute of Geology and Mineralogy, University of Kyoto—YEHARA's Collections, later to be removed to the Museum of Tenri University
MNP. : Museum National d' Histoire Naturelle, Paris
UCMP. : Museum of Paleontology, University of California, Berkeley

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II. PALAEONTOLOGICAL DESCRIPTIONS

Order Ammonoidea

Family Phylloceratidae ZITTEL, 1884

Genus *Hypophylloceras* SALFELD, 1924

Type-species—*Phylloceras onoense* STANTON, 1896, from the Lower Cretaceous of California.

Diagnosis.—Shell is involute and very narrowly umbilicate, consisting of fairly rapidly growing, compressed whorls, with a narrowly arched venter. Test is thin and covered with numerous, fine, somewhat flexuous subcostae, which may diverge near the umbilical margin. Sutures are complex, consisting of numerous, finely incised elements in both external and internal parts. Saddles in the external suture are fundamentally diphyllic, but are modified to some extent on the outer part, where each head of the bipartite branches is further bi- or tripartite. The first lateral lobe [L] is much larger than the external and the second lateral, and itself asymmetrically tripartite. Auxiliaries are regularly aligned with decreasing size towards the umbilical seam. Endings of the divided saddles and folioles are phylloid.

Remarks.—The typological uncertainty in the type-species, *Phylloceras onoense*

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STANTON, 1896, was resolved by PACKARD (1960), who designated UCMP. No. 12110, one of STANTON's syntypes, as the lectotype. An example illustrated by ANDERSON (1938, p. 142, pl. 11, fig. 1) is also to be referred to this species, although his designation of lectotype was illegal.

The sutures of *Hypophylloceras* are distinctive, as illustrated by MATSUMOTO (1959, text-figs. 5–7) and PACKARD (1960, text-figs. 1, 2; pl. 55, figs. 1, 2) for *H. onoense* and by D' ORBIGNY (1841, pl. 82, fig. 4) for *H. velledae* (MICHELIN).

We are not fully satisfied with WIEDMANN's (1964) interpretation of *Hypophylloceras*, in which he included such species as *Phylloceras aptiense* SAYN, 1920, *Ammonties subalpinus* D' ORBIGNY, 1850, *Phylloceras ellipticum* KOSSMAT, 1895, and *P. japonicum* MATSUMOTO, 1942. These species are considerably different in sutures and/or shell-form from the type-species of *Hypophylloceras*, but this is not the place to give further discussion.

As has already been explained by one of us (MATSUMOTO, 1959, p. 56), *Neophylloceras* SHIMIZU, 1934, is distinguishable from *Hypophylloceras* in its distinctly more complex sutures, with finely incised, multipartite saddles and folioles. The phylloid character of the terminals tends to become indistinct in *Neophylloceras*, but in the immature stage it is still kept. When the suture is seen through a semitransparent layer of the test, the terminals look, for some unknown reason, more phylloid than the actual ones in the exposed state, as one of us (T. M.) has noticed in *N. ramosum* MEEK, *N. subramosum* SPATH, *N. ultimum* SPATH, etc. Anyhow, *Neophylloceras* is so intimately related to *Hyophylloceras* that the subgeneric separation may be preferred, (e. g. BIRKELUND, 1965).

The species from the Fugjikawa Formation, described below, is referred to *Hypophylloceras* in a strict sense.

Hypophylloceras yeharai sp. nov.
Pl. I, Figs. 1–3; Pl. III, Fig. 1

Material.—Holotype: GK. H6842, from loc. Kt. 1017 (I. NAKAI Coll.). Paratypes: GK. H6843a, b, from the type-locality (I. NAKAI Coll.); KT. Nos. 660 and 661 of YEHARA's collection from the Katsuura-gawa area (no record of precise locality on the labels).

Etymology. — The specific name is dedicated to the late Dr. Shingo YEHARA [=EHARA], who contributed much to the Mesozoic stratigraphy of Shikoku.

Specific characters.—The shell is of moderate size, much involute and very narrowly umbilicate. The whorl is compressed, with height nearly twice as large as breadth, narrowly oval in section, and broadest at a point somewhat below the middle of the height. The umbilicus is very narrow, surrounded by a gently sloping wall, which passes to the flank with a broadly rounded shoulder. The flanks are very gently convex and slightly convergent, passing gradually to the narrow but rounded venter.

The surface of the shell is ornamented with numerous, gently flexuous subcostae, some of which are simple but others are bifurcated near the umbilical shoulder. On

the outer part of the whorl, i. e. on the venter and on the outer half of the flank, the subcostae are distinctly broader than the interspaces, and themselves are asymmetric in section, with a posteriorly gentle slope. Abour 40 subcostae are counted on the venter in the distance as large as the whorl-height and about 16 to 22 in that as large as the whorl-breadth.

The suture is of the same pattern as that of *Hypophylloceras onoense* (STANTON).

Measurements (in mm).—

Specimen	Diameter	Height	Breadth	(B./H.)	Umbilicus
GK. H6842	90±	55± (.6)	27± (.3)	(0.49)	6± (0.7)
〃 (inner whorl)	—	33.5	16.0+	(0.48+)	—
GK. H6843	—	50+10?	30±	(0.5±)	—
KT. 660	130	76 (.59)	21×2	(0.55)	—
For comparison					
H. onoense					
UCMP. 12110	125 (1)	70 (.56)	38 (.30)	(0.54)	—
CK. H9105	114 (1)	66 (.58)	34 (.30)	(0.51)	6± (.05)
ANSP. 12885	118 (1)	71 (.60)	36± (.30)	(0.50)	9± (.07)
H. n. sp. (PACKARD)					
UCMP. 12109	135 (1)	80 (.59)	46± (.34)	(0.57)	10 (.07)
H. velledae					
MNP. 2445	163.0 (1)	98.0 (.61)	60.0 (.36)	(0.61)	7± (.04)
〃 (−1/4 vol.)	123.5 (1)	68.5 (.55)	42.8 (.34)	(0.62)	—

Remarks.—Although the holotype and paratypes are more or less defective in preservation, they do show distinctive characters.

YEHARA (1924. p. 81) recorded the occurrence of "*Phylloceras* cf. *ramosum* (MEEK)" at Sakamoto in the Fujikawa Shale, but he gave no palaeontological description nor illustration. Specimens KT. Nos. 660 and 661 are probably the originals of this record, since they are the only available phylloceratid specimens in YEHARA's collection from the Katsuura-gawa area. His specimens are similar to ours in lithology and mode of preservation.

Comparisons.—In the relatively compressed shell-form and the pattern of sutures the present species resembles *Hypophylloceras onoense* (STANTON) from the Lower Cretaceous (probably Aptian) of Caifornia, but the subcostae of the former are distinctly broader, coarser and less numerous than those of the latter. In *H. onoense* the subcostae are extremely fine and numerous, a little more than 75 being counted on the venter in the distance of the whorl-height and about 33 in that of the whorl-breadth. They are, thus, twice as numerous as those in *H. yeharai*. The difference is evidently beyond the extent of variation.

In this respect and also in the gently convex flanks, the present species is closer to *Hypophylloceras* n. sp. of PACKARD (1960, p. 425, pl. 56, fig. 2; pl. 57, figs. 1-3), from

the Cretaceous of California. In that PACKARD's unnamed species the subcostae are sharply crested on the ventral part and separated by wider interspaces, but in our species they are still coarser, less numerous, broader, gently headed and separated by narrower interspaces. Incidentally the stratigraphic position of PACKARD's species in California has not been determined, but the specimens which are comparable with PACKARD's have been reported from the Upper Albian of Hokkaido and Alaska (see MATSUMOTO and HARADA, 1964, p. 94).

In the coarseness of the subcostae *H. yeharai* resembles *Hypophylloceras*(?) *californicum* (ANDERSON) (1938, p. 143, pl. 12, fig. 7), from the Albian of California. Although ANDERSON's description is not sufficiently precise, his species seems to have broader whorls and straighter subcostae than ours.

The specimen reported under the name of *Hypophylloceras* cf. *H. californicum* by IMLAY (1960, p. 98, pl. 11, fig. 29), from the Albian of Alaska, is regretably crushed. Therefore, whether it is identified with *H. californicum* or *H. yeharai* is hardly decided.

The present species is somewhat similar to *Hypophylloceras velledae* (MICHELIN), from the Albian of Europe. "*Phylloceras velledae*" has been too broadly interpreted. We take here the species to be restricted to the natural group of individuals represented by the specimen illustrated by D' ORBIGNY (1841, p. 280, pl. 82, figs. 1–3) (MNP. 2445), which WIEDMANN (1964, p. 211, pl. 11 fig. 1) has proposed to designate as a neotype. We do not, however, agree with WIEDMANN (1964) in his subspecific treatment of well distinguishable species. The pattern of sutures is indeed similar or almost of the same type between different species of *Hypophyllocers*, but we should take also the appreciable differences in the size of umbilicus, shape of whorl, curvature of growth-lines, density, strength, and breadth of subcostae, etc. into consideration for the specific distinction. Unless the overlapping of the variations are confirmed, the separated species should not be regarded as subspecies. We regard, thus, *Hypophylloceras morelianum* (D' ORBIGNY, 1841), from the Upper Aptian and Lower Albian of southern Europe, and *Hypophylloceras aschiltaense* (BREISTROFFER, 1947), from the Aptian of Caucasus and Lower Albian of Majorca, as specifically distinct from *H. velledae*.

H. yeharai is more similar to *H. velledae* than to *H. morelianum* and *H. aschiltaense* in the high oval whorl-section and in the gently flexuous subcostae. It is, however, distinct from *H. velledae* in its more compressed whorl, with smaller proportion of breadth to height, and less numerous and broader subcostae. The subcostae of *H. velledae* are narrow and separated by interspaces slightly to fairly broader than the subcostae. They are numerous, about 55 being counted on the venter in the distance of the whorl-height and about 30 in that of the whorl-breadth.

Occurrence.—Loc. Kt. 1017, about 500 m southwest of Kiwada, near Sakamoto, Katsuura-machi, Tokushima Prefecture. The holotype and a paratype came from a layer of medium- to coarse-grained sandstone intercalated in the shale of the upper part of the Fujikawa Formation. The locality record of other paratypes in YEHARA's collection is not precise, but for the description by YEHARA (1924) as "Sakamoto, Fujikawa Shale, Katsuura-gawa valley". The lithologic characters of YEHARA's

specimens closely resembles that of the specimens from Kt. 1017.

Family Turrilitidae MEEK, 1876

Genus *Mariella* NOWAK, 1916

Type-species.— *Turrilites bergeri* BRONGNIART, 1822, from the Upper Albian of Europe (original designation).

Remarks.—Generic characters and affinities with other genera are clearly described by Spath (1937, p. 509–510).

Mariella sp. aff. *M. cantabrigiensis* (JUKES-BROWNE, 1877)

Pl. I, Fig. 4

Compare.—

1875. *Turrilites wiestii*, JUKES-BROWNE, p. 289 (*non* SHARPE, 1856)

1877. *Turrilites cantabrigiensis* JUKES-BROWNE, p. 493.

1937. *Mariella cantabrigiensis*, SPATH, p. 518, text-figs. 181a, b; 182d, e; pl. 57, fig. 36; pl. 58, figs. 1, 2.

Material.—A single, deformed specimen, GK. H6844, from loc. Kt. 21 (I. NAKAI Coll.).

Description.—A small turricone shows a considerable apical angle (about 30°) and a basal diameter of 18 mm. in a deformed state. Whorls are coiled closely and sinistrally.

Ribs are of moderate strength, separated by interspaces nearly as broad as or slightly narrower than the ribs, somewhat oblique on the side of the helix (i. e. on the ventral part) and continued to the basal part of the whorls to the umbilicus. There are 20 ribs per whorl.

Tubercles are in three rows on the side, nearly equidistant and of subequal intensity. They are somewhat clavate in at least a part of the growth-stages, becoming more rounded later. The tubercles of the fourth row on the basal part, at a considerable distance from the umbilicus but hidden by the succeeding whorl, are smaller than others but well pointed, becoming less distinct in the preserved last part.

Sutures are not clearly exposed.

Comparison.—The described specimen resembles the lectotype (text-fig. 182d of SPATH, 1937) and other examples of *Mariella cantabrigiensis* (JUKES-BROWNE), from the Upper Albian of England, but is not quite identical in that the tubercles are somewhat clavate at a certain growth-stage and that the fourth tubercles are more distinct and persistent.

M. gresslyi (PICTET and CAMPICHE, 1861) (see SPATH, 1937, p. 516, text-fig. 180; pl. 58 figs. 3, 4), from the Upper Albian of Europe, has more distinctly clavate tubercles and wider and flatter ribs. In that species the lower tubercles of the three rows are on the whorl-suture and hardly visible on the side. The tubercles of the fourth row on the base are said to occur more frequently in *M. gresslyi* than in *M. cantabrigiensis.*

Our specimen is fairly close to an atypical example of *M. gresslyi* described by BOULE et al. (1907, p. 37 [57], pl. 6 [13], fig. 2, 2a), from the Cenomanian of

Madagascar. The small tubercles of the fourth, basal row are discernible in the illustration, although authors did not mentioned the feature. In that Madagascar specimen the tubercles of the third row are on the whorl-suture and the ribs are weaker than ours.

To sum up, the specimen from the Fujikawa Formation is closely allied to but not quite identical with *M. cantabrigiensis* and *M. gresslyi*. Whether it is a mere variant of *M. cantabrigiensis*, or a subspecies, or another species is hardly decided. Until more material is assembled, we call it provisionally *Mariella* sp. aff. *M. cantabrigiensis*.

Occurrence.—The single specimen was collected at loc. Kt. 21, 500 m north of Hoshidani, Katsuura-machi, from the shale of the Fujikawa Formation. The stratigraphic level is slightly higer than that of two other species.

Family Desmoceratidae ZITTEL, 1895

Genus *Desmoceras* ZITTEL, 1884

Subgenus *Pseudouhligella* MATSUMOTO, 1938

Type-species.—*Desmoceras* (*Pseudouhligella*) *joponicum* YABE, 1904, from the Cenomanian of Japan.

Diagnosis.—This subgenus closely resembles *Desmoceras* (s. s.) [type-species *Desmoceras latidorsatum* (MICHELIN, 1836)] in having generally involute shells, more or less flexuous striae of growth or faint subcostae, similarly flexuous and periodic constrictions, and fairly complex sutures, with nearly symmetrically tripartite first lateral lobe and numerous, regularly decreasing, bifid saddles. It is, however, characterized by more compressed whorls which have high oval, instead of rounded to subquadrate, section, somewhat wider umbilicus, and more strongly projected constrictions and striae than in *Desmoceras* (s. s.).

Remarks.—In the "Treatise" Part L (MOORE [Ed.], 1957 ,p. L370), *Pseudouhligella* MATSUMOTO was denoted as valid at the date of 1942. The subgenus was, however, established by MATSUMOTO (1938, p. 23), with the designation of the type-species and description of diagnosis and distinction. *Pseudouhligella* is, thus, obviously valid at the date of 1938 in accordance with the "International Code of Zoological Nomenclature".

Pseudouhligella may be ranked at generic level by some authors, but we still keep it as a subgenus of *Desmoceras*, because it is intimately related with *Desmoceras* (s. s.) and the distinction is not so great.

Desmoceras (*Pseudouhligella*) *dawsoni* WHITEAVES, 1900

1884. *Haploceras beudanti*, WHITEAVES (*non* BRONGNIART, 1822), p. 205, p. 26, fig. 1.
1900. *Desmoceras dawsoni* WHITEAVES, p. 286, pl. 37, fig. 3.
1959. *Desmoceras* (*Pseudouhligella*) *dawsoni*, MATSUMOTO, p. 59, pl. 14, fig 2; pl. 15, figs. 1-2; pl. 16, fig. 1; text-fig. 8.

Remarks.—This species has recently been redescribed by one of us (MATSUMOTO, 1959), who has recognized a fairly wide extent of variation. The specimens from

Shikoku could be regarded as representing an extreme variant of the same species, but the subspecific separation is preferred in this paper for the reasons described below.

D. (*P.*) *dawsoni shikokuense* (YABE and SHIMIZU, 1927)
Pl. I, Figs. 5-6; Pl. II, Figs. 1-6; Pl. III, Fig. 2;
Text-fig. 2

1927. *Beudanticeras shikokuense* YABE and SHIMIZU, *in* YABE, p. 69 [43], pl. 3 [1], fig. 10.
1931. *Beudanticeras shikokuense*, SHIMIZU, p. 26, pl. 4, figs. 5-6.
1956. cf. *Desmoceras japonica* (*sic*), HIRAYAMA, YAMASHITA, SUYARI and NAKAGAWA, p. 24 (listed).
1965. *Desmoceras kossmati*, NUMANO and NAKANO, p. 105 (listed).

Material.—Holotype, by monotypy, IGPS. 35154 (YABE, 1927, pl. 3 [1], fig. 10; SHIMIZU, 1931, pl. 4, figs. 5-6). Other examples in subsequent collections: GK. H6845-6858, from loc. Kt. 1017 (I. NAKAI Coll.); KT. 659 (S. YEHARA Coll.) [=Plaster cast GK. H6884]; GH. H1001-1003 (K. NUMANO Coll.).

In addition to them there are more than than 25 poorly preserved specimens, which may be comparable with this subspecies. YAMASHITA's specimen has been examined, too.

Diagnosis.—*D.* (*P.*) *dawsoni shikokuense* is very similar to *D.* (*P.*) *dawsoni dawsoni* in essential characters, but shows on the average a smaller size of the adult shell, more evenly rounded venter and less ramarkably biconcave curvature of the constrictions.

Measurements (in mm.)—

Specimen	Diameter	Height	Breadth	(B./H.)	Umbilicus
GK. H6845 (inner wh.)	50.0(1)	31.5(.63)	19.0(.38)	(0.60)	6.5(.13)
(outer whorl)	95±		(highly deformed)		13.5(.14)
GK. H6851 (inner wh.)	41.0(1)	26.0(.63)	16.3(.40)	(0.62)	—
GK. H6853	30.8(1)	17.0(.55)	11.8(.38)	(0.69)	3.8(.12)
GK. H6857	26.5(1)	15.2(.57)	10.5(.39)	(0.69)	3.3(.12)
IGPS. 35154 (deformed adult)	58.5(1)	29.5(.50)	18+(.31)	(0.6+)	9±(.15)
GK. H6848 (deformed adult)	58.0(1)	29.5(.51)	18.5+(.32)	(0.62+)	9.5(.16)
KT. 659	52.5(1)	29.5(.56)	20.5(.39)	(0.69)	7.5(.14)
GH. H1001	32.3	17.6(.54)	13.4(.41)	(0.76)	5.1(.16)
For Comparsion					
GSC. 4992 (lectotype of *dawsoni*)	120+ (main part of body whorl crushed)				
	92.5(1)	47.5(.51)	28.5(.31)	(0.61)	13.7(.15)
USNM 129251 (Alaska) (at the last septum)	83.0(1)	43.0(.51)	26.3(.31)	(0.61)	12.0(.14)

Descriptive remarks.—A number of specimens before us, including IGPS. 35154, are regarded as adult, because they have the body-whorl in front of the approximated last sutures and because the last whorl is frequently constricted as in that of *D.* (*P.*) *dawsoni* of America. Most of our adult specimens are about 60 to 70 mm. in diameter

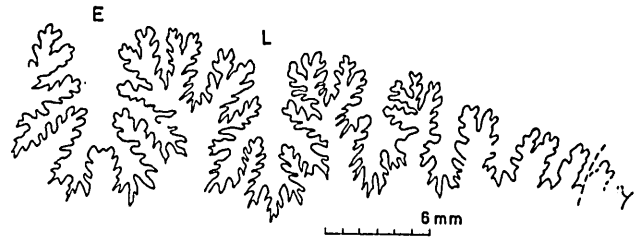

FIG. 2. Suture-line of *Desmoceras* (*Pseudouhligella*) *dawsoni shikokuense* (YABE and SHIMIZU). GK. H6848, at whorl-height=21mm. Fine incisions are partly reduced owing to erosion. A too much eroded part is restored from the less eroded one in the immediately preceding suture. (T. MATSUMOTO delin.)

and the largest is about 95 mm. They are evidently smaller than the adult examples from the Pacific Coast of North America, which are about 120 to 140 mm. in diameter, as exemplified by the lectotype[1] and some Alaskan examples described by one of us (MATSUMOTO, 1959). Although there may be a certain extent of variation in the size, the above difference in the average size of the adult shells between the two sides of the North Pacific cannot be overlooked.

Although some of the specimens from Shikoku are secondarily deformed, the observations of the shell-from, as well as the measurements, depend primarily upon selected, less deformed specimens or undeformed part of the specimens. They show the same type of shell-form as the Canadian lectotype and other examples from California and Alaska, being characterized by involute shells, compressed whorls, gently convex and convergent flanks with the maximum breadth in the lower part, a fairly narrow umbilicus, steeply inclined umbilical wall and subrounded umbilical shoulder. The venter is, however, less narrowly arched, in other words more evenly rounded, in our form than in the typical one of America. The proportion of breadth to height is 0.6 to 0.7 in our specimens. Even in the secondarily compressed examples (e. g. IGPS. 35154 and GK. H6848) the value is the same (0.6) as that of the undeformed ones from America. Therefore, it may be allowed to state that on the average our form is less compressed than the American one, although the variations of the two forms certainly overlap each other. More specimens of better preservation would confirm this point.

Some of the specimens are so remarkably deformed that the original shell-form has been modified in various ways. For example, the flattened flank and the subangular umbilical shoulder as seen on GK. H6848 probably owe to the secondary deformation. It should be noted, in this connexion, that a secondarily compressed specimen listed by TANAKA (*in* TSUSHIMA et al. 1958) as *Desmoceras* sp., from loc. NH 635, unit Mb (lower part of Middle Yezo Group) of the Obirashibets [Tappu] area, Hokkaido, is

1) The indication of the specimen illustrated by WHITEAVES (Geol. Surv. Canada No. 4992) as holotype by MATSUMOTO (1959, p. 60) is obviously incorrect, because WHITEAVES (1900, p. 286) established *Desmoceras dawsoni* on syntypic specimens. The specimen of WHITEAVES, 1884, pl. 26, fig. 1, 1a, is here designated as the lectotype of *Desmoceras dawsoni* WHITEAVES (1900).

very similar to this specimen in these and also other features. There are still more examples of this subspecies in the recent collections of one of us (T. M.) from Hokkaido.

The flexuous constrictions are frequent and well marked on the body-whorl of the specimens from the Fujikawa Formation, about 4 to 6 per semi-volution. They are biconcave on the flank and considerably projected on the venter, but the concavity is generally shallower and the lappet like projection on the flank is less remarkable than in the constrictions on the larger body-whorl of the typical *D.* (*P.*) *dawsoni* from North America. A rib like elevation behind the constriction and intervening faint subcostae are sometimes preserved on the ventral part. On the septate whorl the constrictions are weak and less frequent, being sometimes hardly discernible. These features are the same as those in American examples.

Sutures, which are exposed on more than ten specimens from Shikoku and also on several from Hokkaido, are of the same pattern as those of *D.* (*P.*) *dawsoni* from America (see MATSUMOTO, 1959, p. 60, text-fig. 8). This pattern is generally similar to that of *D.* (*P.*) *japonicum* (see MATSUMOTO, 1954, p. 255, text-figs. 2 [48]–4 [50]), but is distinguishable from the latter in the narrower stems and more expanded branches of lobes and saddles. The first lateral lobe (L) is slightly deeper than the external lobe (E).

To sum up, the described specimens are best regarded as representing a subspecies of *Desmoceras* (*Pseudouhligella*) *dawsoni* in the Japanese province, to which the name *shikokuense* of YABE and SHIMIZU (1927) is to be applied. *D.* (*P.*) *dawsoni shikokuense* on the Japanese side of North Pacific is very intimately related to but not quite identical with *D.* (*P.*) *dawsoni dawsoni* on the American side, although the variations of the two subspecies overlap each other to some extent. "*Beudanticeras alamoense*" ANDERSON (1958, p. 213, pl. 5, fig. 2; fig. 2a being inadequately drawn), from the Upper Albian of California, was regarded by one of us (MATSUMOTO, 1959, p. 61) as an extreme variant of *D.* (*P.*) *dawsoni*. It shows so to speak intermediate features in the shell size, roundness of venter and curvature of constrictions between the two subspecies. In other words ANDERSON's specimen may represent an extreme part of the variation of *D.* (*P.*) *dawsoni dawsoni*, which approaches to the other part of the variation of *D.* (*P.*) *dawsoni shikokuense*. Incidentally ANDERSON seems to have incorrectly recorded the dimensions of that specimen. For instance, its umbilicus is actually 15 precent of diameter instead of 18 percent, being well comparable with the proportion in *D.* (*P.*) *dawsoni*.

D. (*P.*) *dawsoni dawsoni* and *shikokuense* both were once assigned to genus *Beudanticeras*. This is not warranted, because *Beudanticeras* has a different pattern of suture in which the first lateral lobe is extremely large, much deeper than the external lobe, and very asymmetric. The suture of *Beudanticeras* is often, but not always, greatly reduced. SHIMIZU's (1931, p. 27) description of the suture-line on IGPS. 35174 failed to explain the actual feature. The specimens in our collection, as well as SHIMIZU's, all show the typical sutural pattern of *Desmoceras* (*Pseudouhligella*).

The three small specimens identified by NUMANO and NAKANO (1965) as *Desmoceras kossmati* have indeed broader whorls than other measured examples of *D.* (*P.*) *dawsoni shikokuense*, but are probably within the variation of the present subspecies. *D. kossmati* MATSUMOTO has much broader whorls, more broadly rounded venter, and less frequent constrictions. Although the proportion of breadth to height in *D. kossmati* is somewhat decreased at a certain immature stage, it is still larger (0.8–0.9) than that of *D.* (*P.*) *dawsoni shikokuense*.

The specimen compared by YAMASHITA (*in* HIYARAYAMA et al. 1956) with *Desmoceras japoincum* is about 55 mm in diameter but is rather poorly preseved. It is probably a deformed specimen of *D.* (*P.*) *dawsoni shikokuense*, because it has more frequent constrictions than *D.* (*P.*) *japonicum*.

Occurrence.—The specimens of NAKAI's collection were mostly obtained from Kt. 1017, and partly from the nearby localities Kt. 1018 and Kt. 1019, all of which about 500 m southwest of Kiwada, near Sakamoto, Katsuura-machi, from a layer of sandstone intercalated in the shale of the upper part of the Fujikawa Formation, Tokushima Prefecture. The locality where the holotype was obtained is not precisely indicated, except for the record of "west of Sakamoto, Fujikawa Shale," but is presumably the same as loc. Kt. 1017. YAMASHITA's specimens came from a calcareous nodule in the Fujikawa Formation at the entrance of Nakayama, north of Yokose, and NUMANO's from approximately the same locality as Kt. 1017.

The aforementioned specimen of TANAKA's collection, which is comparable with the present subspecies, came from unit Mb, lower part of the Middle Yezo Group, Tappu [Obirashibets] area, Hokkaido. More examples, though not yet described, of this subspecies have recently be obtained by one of us (T. M.), with the aid of T. MURAMOTO, from loc. R27p, from the *Mortoniceras* bearing bed of the Soeushinai area, adjacent to the north of the Obirashibets, Hokkaido.

III. CONCLUDING REMARKS

The described ammonites from the upper part of the Fujikawa Formation are summarized as follows:

1. *Hypophylloceras yeharai* sp. nov.
2. *Mariella* sp. aff. *M. cantabrigiensis* (JUKES-BROWNE)
3. *Desmoceras* (*Pseudouhligella*) *dawsoni shikokuense* (YABE and SHIMIZU)

As the first species is new, it may not be useful for the correlation of strata. But it is allied to *H.* n. sp. of PACKARD, whose probable examples occur in the Upper Albian of Hokkaido, to *H. californicum* (ANDERSON), from the Albian of California and Alaska (?), and also to *H. velledae* (MICHELIN), from the Albian of Europe and Africa. In Hokkaido species of *Hypophylloceras* (s. s.) are known in the Lower Cretaceous, while various species of *Neophylloceras* occur in the Upper Cretaceous.

The second species is closely allied to, if not identical with, *M. cantabrigiensis*, from the Upper Albian of England and is also somewhat similar to *M. gresslyi* (PICTET and

CAMPICHE), from the Upper Albian of Europe and Madgascar.

The third species is of prime importance for the age determination, since the succession of species of the Desmoceratidae is fairly well known in the Cretaceous of Hokkaido and California. *D.* (*P.*) *dawsoni dawsoni* occurs in the Albian (mainly Upper Albian) of California, British Columbia, and Alaska. *D.* (*P.*) *dawsoni shikokuense* is probably a geographical subspecies of *D. dawsoni* in the Japanese province. In the Cretaceous sequence of the Tappu-Soeushinai area, Hokkaido, the subspecies occurs in a layer below the zone of *Desmoceras kossmati* and considerably lower than that of *D.* (*P.*) *japonicum*. While *Graysonites* sp. occurs, among others, in the zone of *Desmoceras kossmati*, indicating lower part of Lower Cenomanian, *Mortoniceras* (s. s.) sp. has been recently found by one of us (T. M.) from the unit with *D.* (*P.*) *dawsoni shikokuense* in the sequence of Soeushinai, which indicates an Upper Albian age.

Taking all of the above facts into consideration, we conclude that the ammonites bearing upper part of the Fujikawa Formation is assigned to the Albian, probably Upper Albian, in terms of the international scale. We should search for more definite evidence, such as species of *Mortoniceras* or other genera of the Acanthocerataceae or Hoplitaceae. One of us (T. M.) once saw a small specimen of *Mortoniceras* (*Durnovarites*) sp. [=*Pervinquieria* sp. listed by FUJITA, 1943, p. 210] from a black shale of the uppermost part of the Monobegawa Group (locally called by FUJITA the Kaminirao beds), at a locality (FUJITA's field no. 22), northwest of Ukeko, Kaminirao-mura, in the upper reaches of the Monobe-gawa, Kochi Prefecture. This is, however, about 50 km. apart from the present localities near Sakamoto in the Katsuura-gawa area. Anyhow, YABE's (1927) assignment of the Fujikawa Shale to the upper part of the Monobegawa Series (or Group) is approved by the present study. The shale of the Fujikawa Formation should be stratigraphically separated from that of the Kushibuchi Formation, since Upper Cretaceous species of *Inoceramus* (e. g. *I. uwajimensis* YEHARA) are contained in the latter.

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ALPHABETIC LIST OF PLACE-NAMES, WITH JAPANESE WRITING (*Kanji*)

Fujikawa	藤　川	Mt. Kase	稼勢山
Hanoura	羽ノ浦	Nakayama	中　山
Hoji	傍　示	Obirashibets	小平薬
Hoshidani	星　谷	Sakamoto	坂　本
Kaminirao	上韮生	Soeushinai	添牛内
Katsuura-gawa	勝浦川	Tappu	達　布
Katsuura-machi	勝浦町	Tatsukawa	立　川
Kiwada	黄　檗	Ukeko	ウケ子
Kushibuchi	櫛　淵	Yokose	横　瀬
Monobe-gawa	物部川		

Isao NAKAI: INSTITUTE OF GEOLOGY AND MINERALOGY, FACULTY OF SCIENCE, HIROSHIMA UNIVERSITY, HIROSHIMA

Tatsuro MATSUMOTO: DEPARTMENT OF GEOLOGY, FACULTY OF SCIENCE, KYUSHU UNIVERSITY, FUKUOKA

Explanation of Plate I

(Figures of natural size unless otherwise stated.)

Hypophylloceras yeharai sp. nov.

Fig. 1. Holotype, GK. H6842, internal and external moulds of an incomplete whorl, from loc. Kt. 1017, about 500 m southwest of Kiwada, Katsuura-machi, Tokushima Prefecture.

Fig. 2. Paratype, GK. H6843, lateral (a) and frontal (b) views of an internal mould, from loc. Kt. 1017.

Fig. 3. Rubber model taken from an external mould of the same individual as above (GK. H6843b)

Mariella sp. aff. *M. cantabrigiensis* (Jukes-Browne)

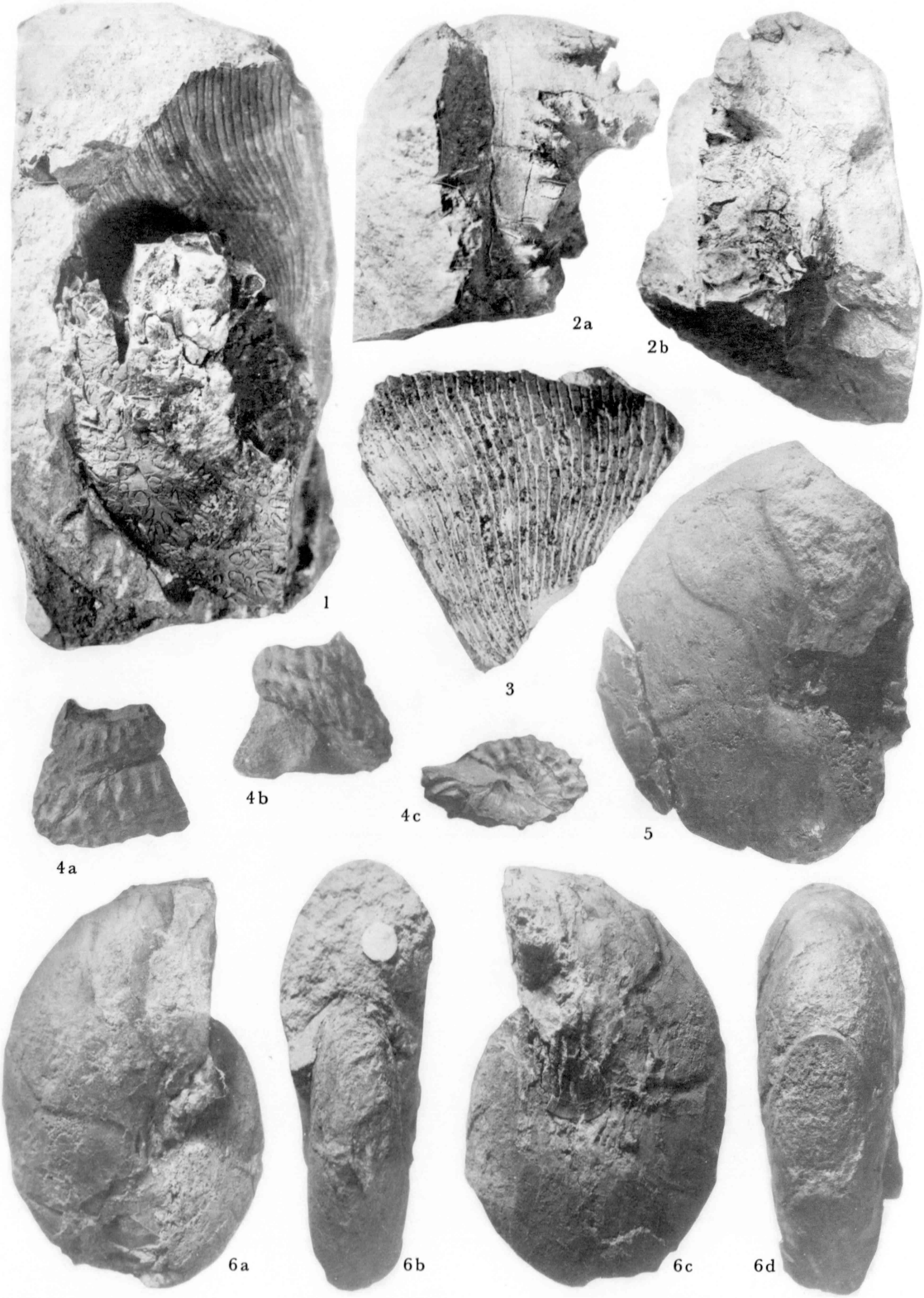
Fig. 4. GK. H6844, two ventral (a, b) and basal (c) views of an internal mould, × 1.5, from loc. Kt. 21, about 500 m north of Hoshidani, Katsuura-machi, Tokushima Prefecture.

Desmoceras (*Pseudouhligella*) *dawsoni shikokuense* (Yabe and Shimizu)

Fig. 5. GK. H6847, lateral view of an internal mould, from loc. Kt. 1017, about 500 m southwest of Kiwada.

Fig. 6. GK. H6846, two lateral (a, c), frontal (b) and ventral (d) views of an internal mould, from loc. Kt. 1017.

Kyushu University photos, without whitening.


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

Explanation of Plate II

(All figures of natural size.)

Desmoceras (*Pseudouhligella*) *dawsoni shikokuense* (Yabe and Shimizu)

Fig. 1. GK. H6849, lateral view of an internal mould, from loc. Kt. 1017, about 500 m southwest of Kiwada, Katsuura-machi, Tokushima Prefecture.

Fig. 2. GK. H6848, lateral (a) and ventral (b) views of an internal mould, from loc. Kt. 1017.

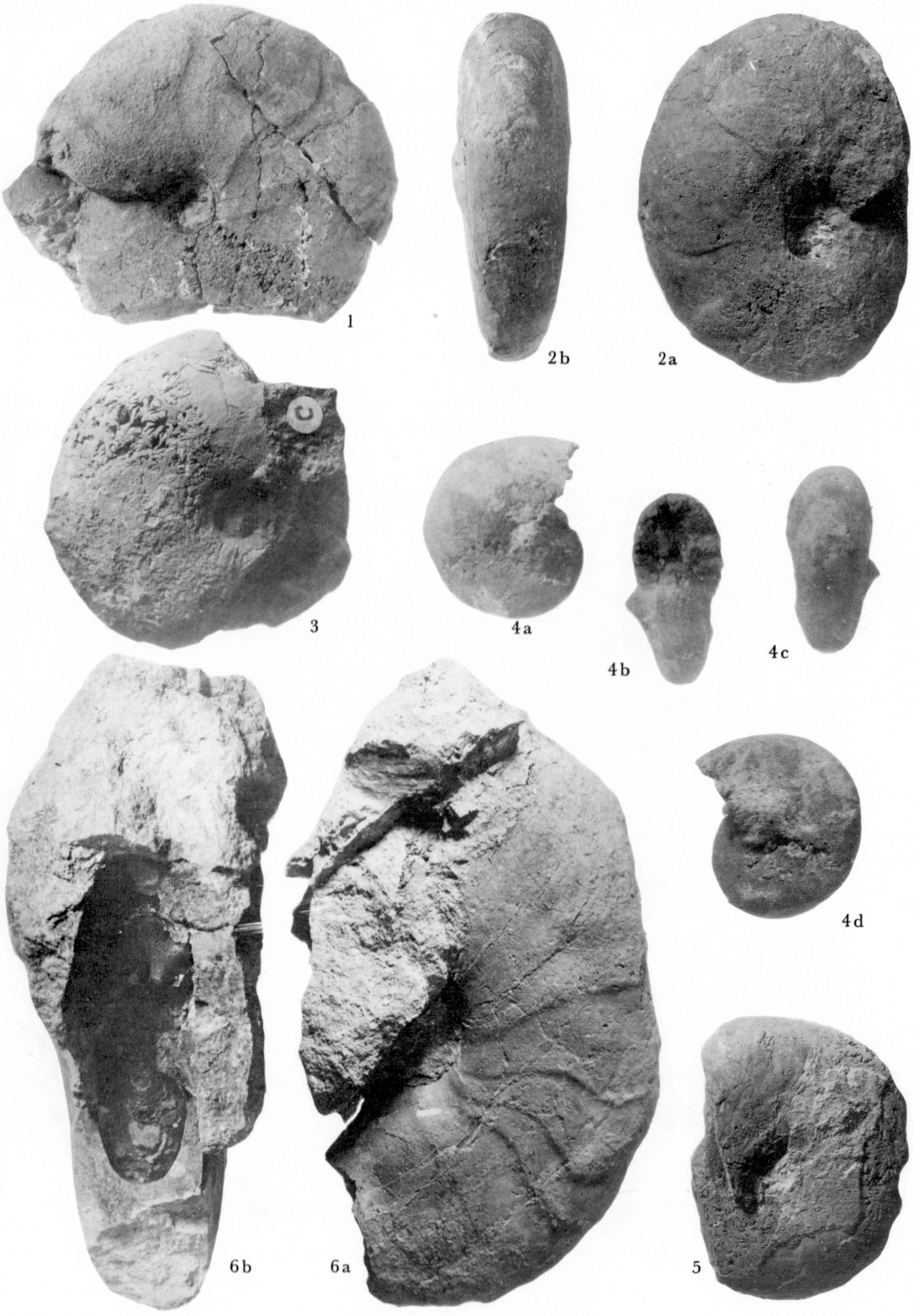
Fig. 3. GK. H6850, lateral view of an internal mould, from loc. Kt. 1017.

Fig. 4. GK. H6857, two lateral (a, d), frontal (b) and ventral (c) views of an internal mould, from loc. Kt. 1017.

Fig. 5. GK. H6855, lateral view of an internal mould, from loc. Kt. 1017.

Fig. 6. GK. H6845, lateral (a) and frontal (b) views of an internal mould, from loc. Kt. 1017.

Kyushu University photos, without whitening.


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

Explanation of Plate III

(Figures of natural size unless otherwise stated.)

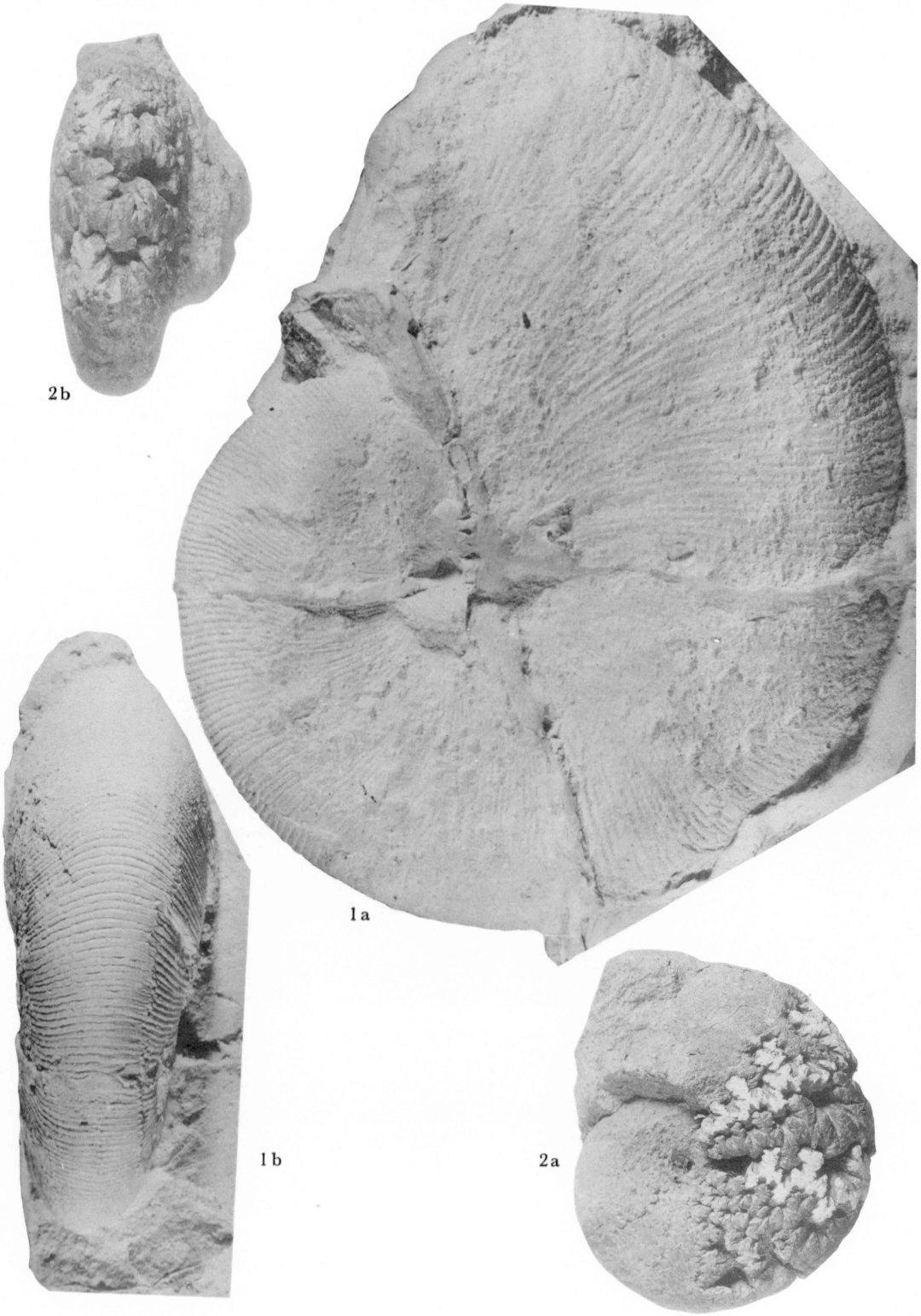
Hypophylloceras yeharai sp. nov.

Fig. 1. GK. H6833, lateral (a) and ventral (b) views of a plaster cast taken from the paratype, KT. 660, × 1.1 (S. Yehara Coll.).

Desmoceras (*Pseudouhligella*) *dawsoni shikokuense* (Yabe and Shimizu)

Fig. 2. KT. 659, lateral (a) and ventral (b) views (S. Yehara Coll.).

Kyushu University photos, without whitening.


2b
1a
1b
2a