Additional Acanthoceratids from Hokkaido : Studies of the Cretaceous Ammonites from Hokkaido and Saghalien-XXVIII

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Additional Acanthoceratids from Hokkaido

(Studies of the Cretaceous Ammonites from Hokkaido and Saghalien—XXVIII)

Tatsuro MATSUMOTO

Abstract

This paper contains primarily the systematic descriptions of twenty-one species of the Acanthoceratidae from Hokkaido as an addition to the previously published monographs. Eight new species are established and two new genera are proposed. Others are identified with or closely allied to already known species, which are revised on this occasion.

Broadly speaking, the succession of acanthoceratids in the Cenomanian sequence of Hokkaido shows fairly good agreement with that of western Europe, if minor local differences are ignored. Numerous multituberculate species belonging to several genera occur in the Turonian, showing a considerable diversity.

Introduction

Thirty species of the family Acanthoceratidae from the Upper Cretaceous of Hokkaido were monographed on previous occasions (MATSUMOTO and HASHIMOTO, 1953; MATSUMOTO et al., 1957; MATSUMOTO et al., 1969; MATSUMOTO and KAWANO, 1975).

More specimens in the subsequent acquisitions either are new or allow improved descriptions to be made. In this paper they are classified in twenty-one species, of which eight are entirely new and palaeontologically interesting for better understanding the multifarious differentiation of the acanthoceratids. Others are identical with or at least very closely allied to species already known outside Japan and are useful for international correlation of the fauna and the strata. Several species are redescribed for amendment of the previous definition and improvement of the occurrence records.

As has already been mentioned, ammonites belonging to the Acanthoceratidae, except for a few special cases, do not occur so abundantly in Hokkaido probably because of unfavourable palaeoecological, sedimentological and structural conditions. A described species is, thus, represented there by a limited number of specimens, sometimes by only a few specimens at the present moment. In other words, a natural state of a population can hardly be analysed with any precision and

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accordingly the assignment of a species may be provisional in a certain sense.

KENNEDY and HANCOCK's (1970) paper on *Acanthoceras* from Rouen, France, and KENNEDY's (1971) monograph of the Cenomanian ammonites from England seem to show a classification on sound grounds and have much enlightened me on sorting the specimens from Hokkaido, For example, a considerable extent of variability in an acanthoceratid species has been demonstrated by their work. This should be kept in mind in our case where only a small number of specimens is available.

As to the taxonomy at generic level and the natural classification of the Acanthoceratidae there are still more problems, as is exemplified by the discrepancy between the recent works of KENNEDY (1971) and THOMEL (1972). In this paper I do not treat these problems comprehensively, but I establish two new genera for certain distinct species from Hokkaido. Other previously established genera are also revised to some extent.

Notes on stratigraphy for the localities of the described specimens are omitted in this paper. Readers may refer to previously published stratigraphical papers, such as MATSUMOTO, 1942; MATSUMOTO and HARADA, 1964; MATSUMOTO, 1965 (p. 5 and text-figs. 2-5); MATSUMOTO, MURAMOTO and TAKAHASHI, 1969 (p. 285-290); MATSUMOTO and OKADA, 1973; NAGAO et al., 1954; TANAKA, 1963. We should, however, continue field work to make clear the details of stratigraphy in several areas of Hokkaido and to collect successively more specimens.

The repositories of the described specimens are as follows, with abbreviated indication at each head:

GH. : Department of Geology and Mineralogy, Hokkaido University, Sapporo
GK. : Department of Geology, Kyushu University, Fukuoka
HCS. : Geologic Section, Hokkaido Colliery & Steamship Co. Ltd., Yubari
M. : MURAMOTO Museum, Iwaki (Collections of Tatsuo MURAMOTO)
NSM. : National Science Museum, Okubo, Tokyo
UMUT. : University Museum, University of Tokyo, Hongo, Tokyo (indicated as GT. in my previous papers)
KM. : Collections of Kikuwo MURAMOTO, Yayoi, Mikasa
TT. : Collections of Takemi TAKAHASHI, Yayoi, Mikasa

For this study valuable specimens have been provided by Messrs. Tatsuo MURAMOTO, Kikuwo MURAMOTO and Takemi TAKAHASHI, who searched for fossils on the basis of my route maps or at my suggestion in the Ikushumbets, the Obira [=Obirashibe or Opirashibets] and the Oyubari [=Shuparo] areas. Several likewise valuable specimens in the collections of the Geological Section, Hokkaido Colliery & Steamship Co. Ltd., have been supplied for this study through Dr. Hisao SHIMOGAWARA and Mr. Hitomaru HONDA, former and present Chief Geologist, with

whom Messrs Yasutaka FUJISHIMA, Kokitsu YAGI, Saburo KAWABATA and Hidenobu ABE have cooperated. They have also assisted me in the field work in the Oyubari area. Dr. Yuzuru AGATSUMA and several other geologists of the Japan Petroleum Exploration Co. have helped me in various ways for my field work in Hokkaido. Mr. Akitoshi INOMA of the same company, Professor Wataru HASHIMOTO, Dr. Ikuwo OBATA and Mr. Masanobu KIKUCHI have provided some specimens for this study, along with necessary information on stratigraphy. I have examined also the type specimens at the University Museum, University of Tokyo, where Dr. Itaru HAYAMI has helped me. Dr. Hiromichi HIRANO and Miss Mutsuko HAYASHIDA have assisted me in taking photographs and typewriting manuscripts at our university. Mr. C. W. WRIGHT kindly read a part of the typescript, giving valuable suggestions. To all of these friends I should like to give high appreciation and sincere gratitude.

A part of the field work for this study was undertaken in aid of the grant defrayed from the Ministry of Education. Finally I thank Dr. Kametoshi KANMERA for his help in publishing this paper.

Systematic Descriptions

Family Acanthoceratidae DE GROSSOUVRE, 1894

Subfamily Mantelliceratinae HYATT, 1903

Genus *Calycoceras* HYATT, 1900

Type-species.—*Ammonites navicularis* MANTELL, 1822, by original designation. See WRIGHT, 1959 (ICZN opinion 557).

Diagnosis.—See MATSUMOTO, SAITO and FUKADA (1957, p. 8-9), COBBAN (1971, p. 13) and also KENNEDY (1971, p. 70).

Discusssion.—*Calycoceras* in the above definition is a highly polymorphic group. Several subgroups were suggested by MATSUMOTO et al. (1957, p. 9) and KENNEDY (1971, p. 70), but these authors refrained from establishing new subgenera, because the true relationships within the group remained uncertain.

In the meanwhile the following new subgeneric and generic names have been proposed by WIEDMANN (1960) and THOMEL (1972), with the type-species in square brackets:

Lotzeites WIEDMANN, 1960 [*Acanthoceras aberrans* KOSSMAT, 1895]

Gentoniceras THOMEL, 1972 [*Ammonites gentoni* BRONGNIART, 1822]

Newboldiceras THOMEL, 1972 [*Acanthoceras newboldi* KOSSMAT, 1897]

Subeucalycoceras THOMEL, 1972 [*Acanthoceras baylei* PERVINQUIÈRE, 1907]

Mourreiceras THOMEL, 1972 [*Newboldiceras* (*Mourreiceras*) *mourrei* THOMEL, 1972]

THOMEL (1972), furthermore, assigned the last three to the subfamily Acanthoceratinae, but I hesitate to follow this scheme.

In the *newboldi* subgroup the whorl may be subquadrate or polygonal in the section along the tuberculated rib, but the intercostal section shows more rounded outline. The spinose tubercles indeed persist for longer period in certain forms (e.g. *C. spinosum*), but these grade into forms in which tubercles tend to be absorbed by the predominant ribs. Ribbing of alternating primaries and secondaries for most growth-stages is diagnostic of *Calycoceras*, but on the last part (of variable length) of the adult body chamber primary ribs may predominate, without intercalated secondaries. This is remarkably shown in some of the *newboldi* subgroup, as illustrated by THOMEL (1972, pl. 41 and elsewhere), but is observable even in *C. naviculare* itself, as COBBAN (1971, p. 16) has recently noted. In the immature stages the difference between the *newboldi* and the *naviculare* subgroups is not great.

C. (*Lotzeites*) *aberrans* (KOSSMAT) shows distinctive characters in the immature stage, but is closely similar to *C.* of *naviculare* subgroup in ventral view. The looped ribs across the venter between the ventrolateral tubercles are not seen in *C.* (*L.*) *crassum* THOMEL and *C.* (*L.*) *nicensis* THOMEL, which, in turn, are somewhat allied to *C. spinosum*.

For the above reasons I would treat *Newboldiceras* and *Lotzeites* as subgenera of *Calycoceras*, if it is regarded as necessary to use these names. On this occasion I would not discuss further, but one of the species described below raises the same question.

Calycoceras sp. cf. *C. naviculare* (MANTELL)

Text-fig. 1

Compare.—

1822. *Ammonites navicularis* MANTELL, *Fossils South Down*, p. 198, pl. 22, fig. 5.
1971. *Calycoceras naviculare*, KENNEDY, *Spec. Papers in Palaeont.*, no. 8, p. 71 (containing almost complete list of synonymy), pl. 33, fig. 1; pl. 34, fig. 1; pl. 35, figs. 1, 2; pl. 36, figs. 1-4; pl. 37, figs. 1-3; pl. 47, figs. 1, 3, 5.
1971. *Calycoceras naviculare*, COBBAN, *U. S. Geol. Surv. Prof. Paper* 669, p. 13, pl. 1, figs. 1-3; pl. 10, figs. 1-8; pl. 11, figs. 1-5; pl. 12, figs. 1, 2; pl. 13, figs. 1-5; pl. 14, figs. 1-3; pl. 15, figs. 1, 2; pl. 16, figs. 1, 2; pl. 17; text-figs. 12-14.
1973. *Calycoceras naviculare*, WRIGHT and KENNEDY, *Ann. Paléont.* vol. 59, p. 22, pl. 1, fig. 1; text-fig. 7.

Material.—A specimen, from IK. B11, Ikushumbets, figured by IKEGAMI and OMORI (1957, pl. 7, fig. 1) without palaeontological description. It was preserved at the Hokkaido Gakugei University, Iwamizawa Branch, with register number OM. II-480.

Description.—This specimen is about 160 mm, in diameter near the end of the septate whorl and, therefore, must have been considerably larger when it had the body chamber, which now is unpreserved for the most part. It is somewhat deformed and its inner whorl is not well exposed.

The outer whorl is much depressed, about 105 mm in breadth and 63 mm in height in a costal section, and broadest at the umbilical tubercle or near the umbilical shoulder in an intercostal section. It has a broad and flat venter, rounded ventrolateral shoulders and inflated flanks.

The ribs are coarse, nearly rectiradiate, distant, separated by somewhat wider interspaces and alternately long and short. The ribs have strong umbilical tubercles and some of the shorter ribs arise near the umbilical tubercle. No tubercles remain on the venter but the rib is somewhat raised at the ventrolateral shoulder and flattens or even tends to be slightly concave on crossing the venter. At the earlier part of the outer whorl the ribs are less coarse and less distant.

The suture has a roughly subquadrate first lateral saddle and a broadly opened first lateral lobe.

Discussion.—So far as the observed characters are concerned, this specimen seems to fall within the variation of *Calycoceras naviculare* (MANTELL), which has been recently redescribed in detail by KENNEDY (1971), COBBAN (1971) and WRIGHT and KENNEDY (1973).

It has a broader whorl than the holotype and other normal examples of *C. naviculare*, but this may be partly due to the secondary deformation. In fact its whorl section is closely similar to an example (USNM 166373) figured by COBBAN (1971, text-fig. 13 D, pl. 10, fig. 8; pl. 11, figs. 4, 5).

Its ribs are more distant and accordingly less numerous than those of the holotype and most of the hitherto illustrated specimens of *C. naviculare*, but essentially similar to those on the last part of certain specimens, e.g. again USNM 166373. WRIGHT showed me large specimens which have on the outer whorl as distant and as coarse ribs as ours.

It is, thus, highly possible that this specimen represents an example of *C. naviculare* from Hokkaido, but as its inner whorl is not well known, I provisionally call it *Calycoceras* sp. cf. *C. naviculare* (MANTELL).

Occurrence.—The described specimen was obtained by T. OMORI from his loc. IK. B-11, during the construction of the water supply tunnel of the Katsurazawa Electric Power Station. It came from the lower part of Member IIc (mudstone) of the Mikasa Formation, in the Ikushumbets area, central Hokkaido.

Calycoceras naviculare occurs in the Upper Cenomanian of England, France and the Western Interior of the United States (KENNEDY, 1971; WRIGHT and KENNEDY, 1973; COBBAN, 1971; YOUNG 1957). Its stratigraphic range seems to extend somewhat downward in Madagascar and southern India (BESAIRIE and COLLIGNON, 1956; KOSSMAT, 1897). Examples from California are probably from the Upper Cenomanian (MATSUMOTO, 1959).

Calycoceras sp. nov. aff *C. crassum* THOMEL
Pl. 13, Fig. 2; Text-fig. 2

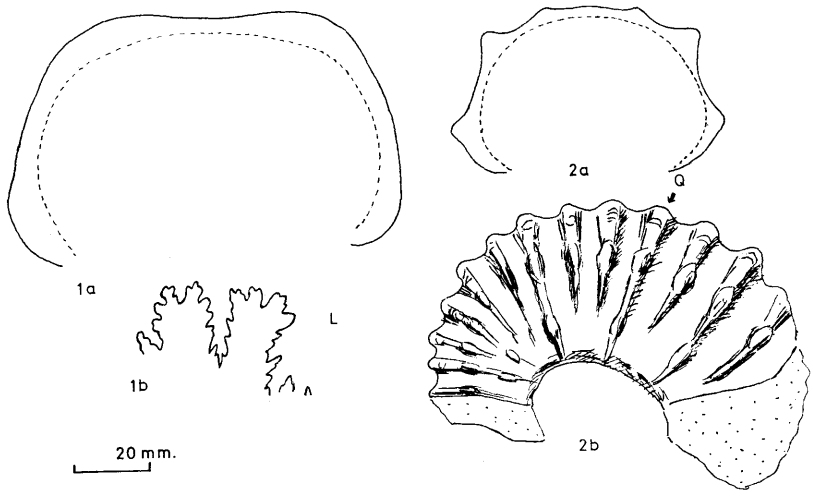
Compare.—

1966. *Calycoceras* (*Lotzeites*) *crassum* THOMEL, *in* PORTHAULT, THOMEL and VILLOUTREYS, *Bull. Soc. Géol. France*, 7 ser., vol. 8, p. 428, pl. 8, figs. 3-5.

1972. *Calycoceras* (*Lotzeites*) *crassum*, THOMEL, *Mem. Soc. Géol. France*, N.S., vol. 51, Mém. no. 116, p. 78, pl. 26, figs. 10-12.

Material.—NSM. PM 6665 [=M. 16853], from loc. Ik 1083 [=Ik 1103] (Coll. T. MURAMOTO).

Description.—The above specimen is a body chamber of a shell of about 100 mm in diameter. The whorl is much depressed, with height = 43.5 mm and breadth = 61.5 mm (b/h = 1.41) in intercostal section and height = 46.0 mm and breadth = 71.0 mm (b/h = 1.54) in costal section of the preserved last part. It is broadest at the umbilical shoulder. In the intercostal section the venter is broady



Figs. 1-2. *Calycoceras* spp.
1. *Calycoceras* sp. cf. *C. naviculare* (MANTELL). Whorl-section (a) and a part of the suture (b) of the described specimen from Ikushumbets. 2. *Calycoceras* sp. nov. aff. *C. crassum* THOMEL. Whorl-section at Q (a) and a lateral view (b) of NSM. PM6665, from Ik. 1083. (T. M. *delin.*)

rounded, flanks are inflated and the ventrolateral and the umbilical shoulders are rounded. The umbilicus is presumed to be fairly narrow, deep and surrounded by a steep wall.

The ribs are strong and fairly coarse, separated by the interspaces as broad as the ribs. They consist of primaries and secondaries in alternation. Occasionally two secondaries may be intercalated.

The umbilical tubercle on the primary rib is prominent and spinose, having a bullate base. All the ribs have fairly strong inner ventrolateral tubercles.

Those on the primary ribs are somewhat more spinose than those on the secondaries. The outer ventrolateral tubercles are weaker than the inner. The siphonal tubercle is faintly discernible only on the early part of the body chamber and disappears later.

When the test is preserved, the ribs are coarser and the tubercles are stronger than in the case of the internal mould.

Discussion.—Should the spinosity of the umbilical and the inner ventrolateral tubercles be ignored, this species would be considerably similar in shell-form and ornament to *Calycoceras naviculare* (MANTELL). With respect to the strong ribs and the spinose tubercles it is somewhat similar to *Calycoceras spinosum* (KOSSMAT) (or *C. newboldi spinosum* by some authors), but its whorl is much more depressed and its umbilical and inner ventrolateral tubercles are more spinose and more approximated than in that species.

The present specimen so closely resembles but is larger than the holotype of *Calycoceras bathyomphalum* (KOSSMAT) (1895, p. 197, pl. 25, fig. 4) that I once regarded it as an adult whorl of that species, as indicated by MATSUMOTO et al. (1969, p. 288). *C. bathyomphalum* has, however, a different type of outer whorl on which tubercles are rapidly reduced, as interpreted by KENNEDY (1971, p. 74) and WRIGHT (*in litt.*). On the small inner whorl of *C. bathyomphalum* the secondary ribs lack the inner ventrolateral tubercles, but on the larger whorl of the present specimen all the ribs have more or less spinose inner ventrolateral tubercles.

With respect to the highly depressed whorl with the maximum breadth near the umbilical shoulder, the mode of ribbing and the spinose tubercles the present specimen resembles the holotype of *Calycoceras* (*Lotzeites*) *crassum* THOMEL, from the Upper Cenomanian (zone 6) of southeastern France. Again in the latter, which is smaller and probably immature, the secondary ribs, whether freely intercalated or arising "at the expense of the inner ventrolateral tubercle" on the primary rib, lack the inner ventrolateral tubercle.

In *Calycoceras nicense* THOMEL (1972, p. 79, pl. 26, figs. 1-8), from the Upper Cenomanian (zone 5) of southeastern France, the inner ventrolateral tubercles are discernible on the secondary ribs but much weaker than in our species. Our species has more depressed whorl and more spinose and more approximated umbilical and ventrolateral tubercles than that French species, which in turn seems to be allied to *C. spinosum.*

To sum up, the described specimen probably represents a new species, but I postpone proposing a new specific name until the characters of the septate whorl is known. It should be noted that the present species is allied to *Calycoceras* (*Lotzeites*) in some respects, to the subgroup of *C. newboldi* in others and to that of *C. naviculare* in still others.

Occurrence.—The described specimen was obtained by T. MURAMOTO at loc. Ik 1083 [=Ik 1103*], Shimo-katsurazawa, from the so-called *Trigonia* sandstone in the lower part of the Mikasa Formation on the western wing of a major anticline, Ikushumbets area, central Hokkaido. *Calycoceras asiaticum* (JIMBO) and *Euomphaloceras meridionale* (STOLICZKA) occur in the same bed, which probably indicate Middle Cenomanian.

Genus *Eucalycoceras* SPATH, 1923

Type-species—Ammonites pentagonus JUKES-Browne (*in* JUKES-BROWNE and HILL, 1896) by original designation.

Diagnosis.—See KENNEDY (1971, p. 80).

Discussion.—KENNEDY (op. cit.) seems to restrict the genus to the group of *E. pentagonum*, following SPATH's (1937) later intention. There may remain a few species which are atypical but provisionally referred to *Eucalycoceras*.

Pseudocalycoceras THOMEL, 1969, is acknowledged as a natural group. Certain species which were once assigned to *Eucalycoceras* by some authors (or to *Protacanthoceras* by some others) are to be transferred to *Pseudocalycoceras* (see THOMEL, 1972, p. 87; MATSUMOTO and KAWANO, 1975 in press).

THOMEL (1972, p. 81) set up, furthermore, *Proeucalycoceras* as a subgenus of *Eucalycoeras*. I hesitate to accept his proposal, because he grouped in it some heterogeneous species such as *Mantelliceras lymense* (SPATH) and *Pseudocalycoceras dentonense* (MOREMAN), and because the type-species "*Calycoceras* (*Eucalycoceras*)" *besairiei* COLLIGNON (1937, p. 13, pl. 3, figs. 1-4; pl. 8, fig. 5) is peculiar in having distant, long ribs and strong umbilical tubercles on the outer whorl and because it is reported to occur in the Lower Cenomanian (see COLLIGNON, 1965, p. 138).

Eucalycoceras pentagonum (JUKES-BROWNE)

Pl. 11, Fig. 1

1896. *Ammonites pentagonus* JUKES-BROWNE; *in* JUKES-BROWNE and HILL, *Quart. Jour. Geol. Soc. London*, vol. 52, p. 156, pl. 5, fig. 1.

1971. *Eucalycoceras pentagonum*, KENNEDY, *Special Papers in Palaeont.*, no. 8, p. 81 (with full list of synonymy, from which *Ammonites harpax* STOLICZKA, 1864, pl. 38, fig. 2 should be excluded), pl. 48, figs. 1-6; pl. 49, fig. 1.

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* Ik 1103 was misused for two different localities. The correct Ik 1103 is the outcrop on the right bank of the Ikushumbets River at Shimo-katsurazawa, with which Ik 1083 is synonymous. Here is exposed Cenomanian sandstone, with *Calycoceras asiaticum*, on the western wing of the Ikushumbets anticline. The other is the misprinting of Ik 1003, the type-locality of *Reesidites minimus*, where was exposed the green sandstone near the Turonian-Coniacian boundary (now under the water of an artificial lake of the Katsurazawa dam). Misprinted Ik 1103 is indicated near the center of the map of fig. 2 and also in the explanation of plates 14 and 15 of MATSUMOTO, 1965, while the correct Ik 1003 is indicated in the columnar section of fig. 4, explanation of fig. 34 and the text in p. 69 of the same paper.

1972. *Eucalycoceras* (*Eucalycoeras*) *pentagonum*, THOMEL, *Mém. Soc. Géol. France*, N.S., vol. 51, mém. no. 116, p. 83, pl. 28, figs. 1, 10.

Material.—A specimen of Takemi TAKAHASHI's Collection, TT. 369401, from loc. Ik 1039.

Description.—The specimen is rather small, about 75 mm in dimeter, but almost wholly septate.

The whorl grows rapidly, showing the proportion of 1 to 2 between the inner and the outer ones. The umbilicus is about 30 percent of the diameter. The umbilical seam runs nearly along the row of inner ventrolateral tubercles. The whorl is much higher than broad, showing the proportion of 0.64 between breadth and height, although in a somewhat secondarily compressed condition, with a narrow round venter, flat flanks and steeply inclined umbilical walls.

Numerous ribs consist of alternating long and short ones. They are mostly rectiradiate and occasionally gently sigmoidal, showing slightly forward bend at the ventrolateral shoulder. On the last one third of the outer whorl the ribs are flat-topped, crowded, separated by narrow interspaces and slightly effaced at mid-flank. On some part two long ribs are branched at an umbilicat tubercle. The long ribs are projected into a transversely elongate umbilical tubercle and extended on the umbilical wall. All the ribs bear ventral tubercles in five nearly equidistant rows.

The suture is moderately incised; the first lateral lobe is deep, subrectangular in gross outline and slightly narrowed at the middle of its stem.

Discussion.—The specimen from Hokkaido is somewhat smaller than but closely resembles a medium-sized, wholly septate British example figured by KENNEDY (1971, pl. 49, fig. 1), although it is secondarily compressed. The ribs on its last part show features which are similar to those of the adult shell, but it is probably of middle growth-stage, because none of its ventral five rows of tubercles disappear and because it is almost wholly septate. In spite of the absence of the adult body chamber, this specimen is undoubtedly assigned to *Eucalycoceras pentagonum* (JUKES-BROWNE).

Occurrence.—The described specimen was found by T. TAKAHASHI at loc. Ik 1039, main course of the Ikushumbets River, from the mudstone of Member IIc, Mikasa Formation. *Desmoceras* (*Pseudouhligella*) *ezoanum* MATSUMOTO was collected from the same locality. *Calycoceras* cf. *naviculare* was found at a nearby locality in the same zone. This part lies immediately below the zone of *Kanabiceras septemseriatum*, represented by loc. Ik 1038.

E. pentagonum occurs in the *naviculare* Zone of southern England (KENNEDY, 1971, p. 83) and zone 6 of southeastern France (THOMEL, 1972, p. 83), Upper Cenomanian. The occurrence of our example in the sequence of Ikushumbets seems to be in harmony with that in England and France. *E. pentagonum* is

reported to occur in the Upper Cenomanian bed with *Neolobites vibrayeanus* of Portugal (CHOFFAT, 1898), and also in the Middle Cenomanian zone of *Euomphaloceras euomphalum* of Madagascar (COLLIGNON, 1964, p. 138) and in the "*Acanthoceras* horizon" of southern India (KOSSMAT, 1897, p. 15 [121]). Other records without illustration are not cited here.

Eucalycoceras sp. aff. *E. spathi* (COLLIGNON)
Pl. 11, Fig. 2

Compare.—

1937. *Calycoceras* (*Eucalycoceras*) *spathi* COLLIGNON, *Ann. Géol. Serv. Mines, Madagascar*, fasc. 8, p. 41, pl. 4, fig. 2; pl. 9 fig. 3.
1964. *Eucalycoceras spathi*, COLLIGNON, *Atlas des Fossiles Caracteristiques de Madagascar* (Ammonites), fasc. 11, p. 140, pl. 371, fig. 1614.

Material.—A specimen of K. MURAMOTO's Collection, KM. 458201, from loc. Ik 1046, and another in the Mikasa Senior High School, from loc. Ik 1045.

Description.—The smaller specimen, from Ik 1045, is secondarily compressed, about 85 mm in diameter, and has an umbilicus of moderate width (about 32 percent of the diameter). It has numerous ribs, nearly rectiradiate on the flank and gently projected at the ventrolateral part. Two ribs spring from a pointed umbilical tubercle but a slightly shorter one may start near the umbilical shoulder without tubercle. The inner and outer ventrolateral tubercles are discernible on each rib at this stage. (The siphonal tubercles are concealed in the rock matrix.) The ribs look fine on some part but somewhat broader and rather crowded on other part, probably depending on the mode of preservation of shell-layers.

The larger specimen, from loc. Ik 1046, which is somewhat deformed, is about 140 mm in diameter and has a somewhat narrower umbilicus (about 27 or 28 percent of diameter) than the preceding specimen. Its whorl is only slightly higher than broad, having a broadly rounded venter, flat flanks and steep or nearly vertical walls.

The ornament of the later half whorl, which probably represents the body chamber, differs considerably from that of the earlier half; still inner whorls are not exposed. In the former the ribs are comparatively more numerous and more approximated than in the latter, nearly rectiradiate on the flank, crossing the venter without notable projection; the umbilical tubercles are distinctly pointed, from which two or three ribs spring, sometimes with a slightly shorter intercalated one arising close to the umbilical tubercle; the ventral tubercles in five rows are almost obsolete, the siphonal ones completely disappear, the outer ventrolateral persist for a longer period, although much weakened, and the inner ventrolateral are faintly discernible only on the earlier portion of this last half whorl. The ribs are flat-topped when the shell layer is preserved, but look sharper or rounded on the internal mould. They are not effaced at mid-flank.

In the earlier half of the last whorl, the ribs are less crowded, somewhat higher and coarser than in the later half, although they are fairly numerous and separated by the interspaces as narrow as the ribs; they are nearly rectiradiate on the flank and slightly projected at the ventrolateral shoulder and then cross the venter vertically. The umbilical tubercles are projected, where one or two long ribs arise, and the intercalated shorter ones arise at some distance above the row of umbilical tubercles. The ventral tubercles in five rows are distinct, clavate and equidistant; the siphonal tubercles are the weakest and the outer ventrolateral ones the strongest.

Discussion.—The two specimens resemble in essential points the holotype and the subsequent specimen of *Eucalycoceras spathi* (COLLIGNON) (1937, p. 41, pl. 4, fig. 2; pl. 9, fig. 3; 1964, p. 140, pl. 371, fig. 1614), from the Cenomanian of Madagascar. However, the suture is not precisely known in our specimens and the particularly ornamented body chamber as seen in one of our specimens has not been described in the Madagascar specimens. Therefore, I hesitate to conclude the specific identity, and would provisionally call our form *Eucalycoceras* sp. aff. *E. spathi* (COLLIGNON).

Eucalycoceras spathi (COLLIGNON) was listed by THOMEL (1972, p. 114) as an example of *Subeucalycoceras* THOMEL, 1972, but I do not understand well his assortment. The approximated and rather flat-topped ribbing as well as the obsolescence of the ventral tubercles on the body chamber, as seen in our larger specimen, is characteristic of *Eucalycoceras*. An example of *E. pentagonum* (JUKES-BROWNE) illustrated by KOSSMAT (1898, pl. 4, fig. 3) well exhibits similar features.

The present species may be atypical in having the whorl which is only slightly higher than broad, but otherwise it shows diagnostic features of *Eucalycoceras*. Therefore I refer it to *Eucalycoceras*.

Occurrence.—The smaller specimen was found by Mr. Masanobu KIKUCHI, a teacher of Mikasa Senior High School, with his students, at loc. Ik 1045, right bank of the main stream of the Ikushumbets River (13.6 m above the entrance of a small branch called the Suido-no sawa); the larger one was collected by Kikuwo MURAMOTO at loc. Ik 1046, left bank of the Ikushumbets River, facing Ik 1045. They were obtained from the greenish dark grey, fine-sandy siltstone in the uppermost part of Member IIb of the Mikasa Formation (see columnar section of fig. 4 in MATSUMOTO, 1965). This bed is immediately underlain by the bed with *Calycoceras orientale* and then followed below by the bed with *Euomphaloceras meridionale-Acanthoceras amphibolum*.

Genus *Shuparoceras* nov.

Type-species.—*Shuparoceras yagii* sp. nov., to be described below.

Diagnosis.—Medium-sized, rather compressed, moderately involute, fairly narrowly umbilicate, high-whorled ammonites, with numerous ribs of unequal length which are gently projected at the ventrolateral part, bullate umbilical tubercles at the end of the long ribs, lateral tubercles at least in some growth-stages and inner and outer ventrolateral and siphonal tubercles throughout. In the late growth-stage the ribs are broadened but lowered and the ventral and the lateral tubercles are normally weaken and finally disappear. There are periodic constrictions on the inner whorls. The suture is of general acanthoceratid pattern but more deeply and more finely incised than that of *Acanthoceras*.

Etymology.—The Yubari River, which is called the Shuparo in Ainu.

Remarks.—In addition to the type-species there is another new species, which, however, is atypical.

Discussion.—This genus is closely allied to the subgroup of *Calycoceras choffati* in various respects, but is distinguished by the presence of periodic constrictions and weak lateral tubercles. In the multituberculation it resembles *Yubariceras* or *Romaniceras*.

Distribution.—At present the genus is known only in Hokkaido. It is probably Turonian.

Shuparoceras yagii sp. nov.

Pl. 12, Fig. 1; Text-fig. 3

Material.—Holotype, HCS. No. 56. obtained from a floated nodule of the Yubari River immediately below the Shuparo dam by Mr. Kokitsu YAGI (1971-7-4) to whom the specific name is dedicated. It consists of a phragmocone and a posterior portion of the body chamber. Paratype K. MURAMOTO's Collection Yb3003, from a locality near T. M. 's loc. Y5194 of the Oyubari area.

Sepcific characters.—The shell is of moderate size, about 120 mm in diameter at the end of the septate whorl. It is fairly involute, nearly a half of the inner whorl being overlapped by the outer. The umbilicus is rather narrow for the family, occupying about a quarter of the entire shell diameter. The whorl increases

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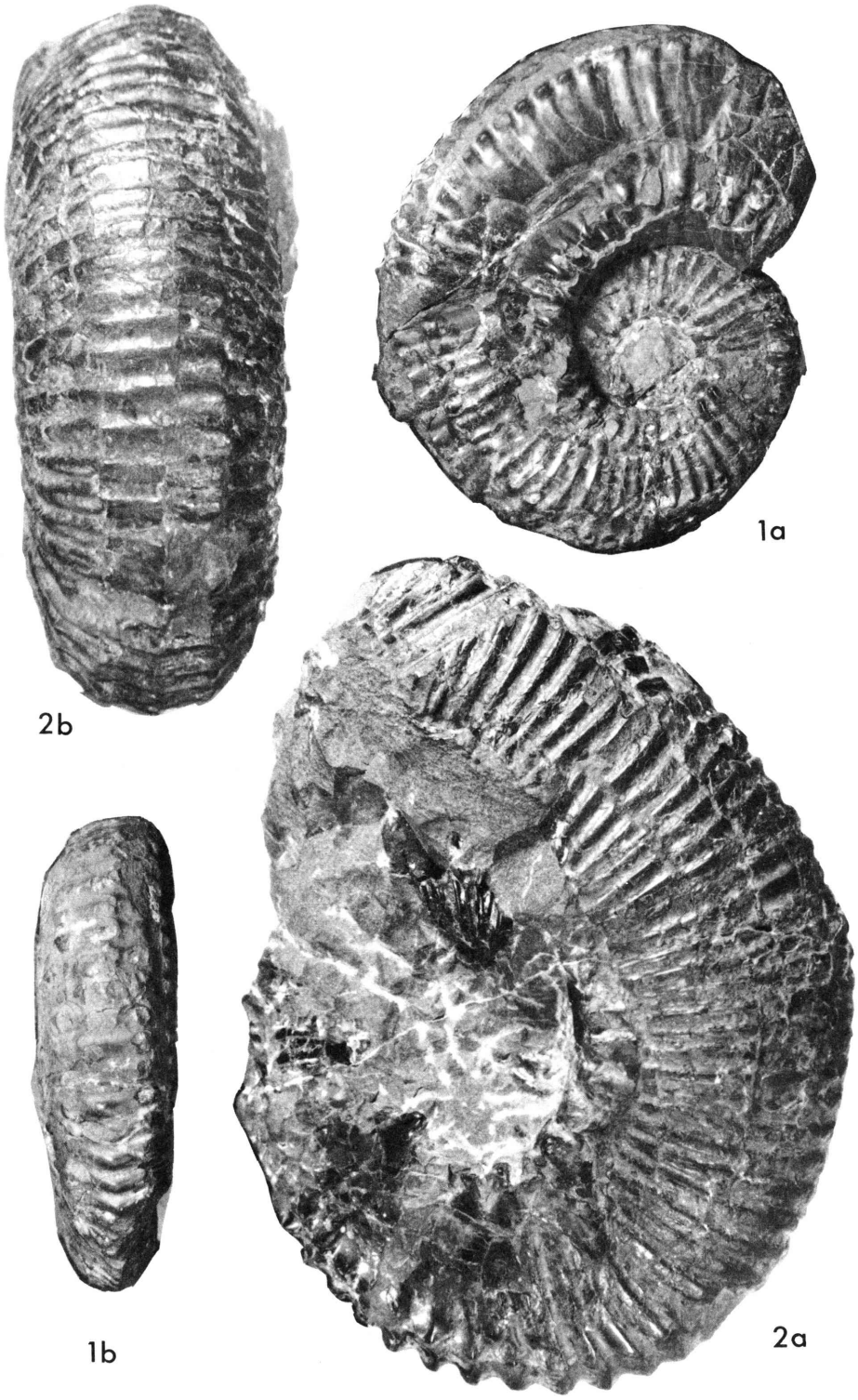
Explanation of Plate 11

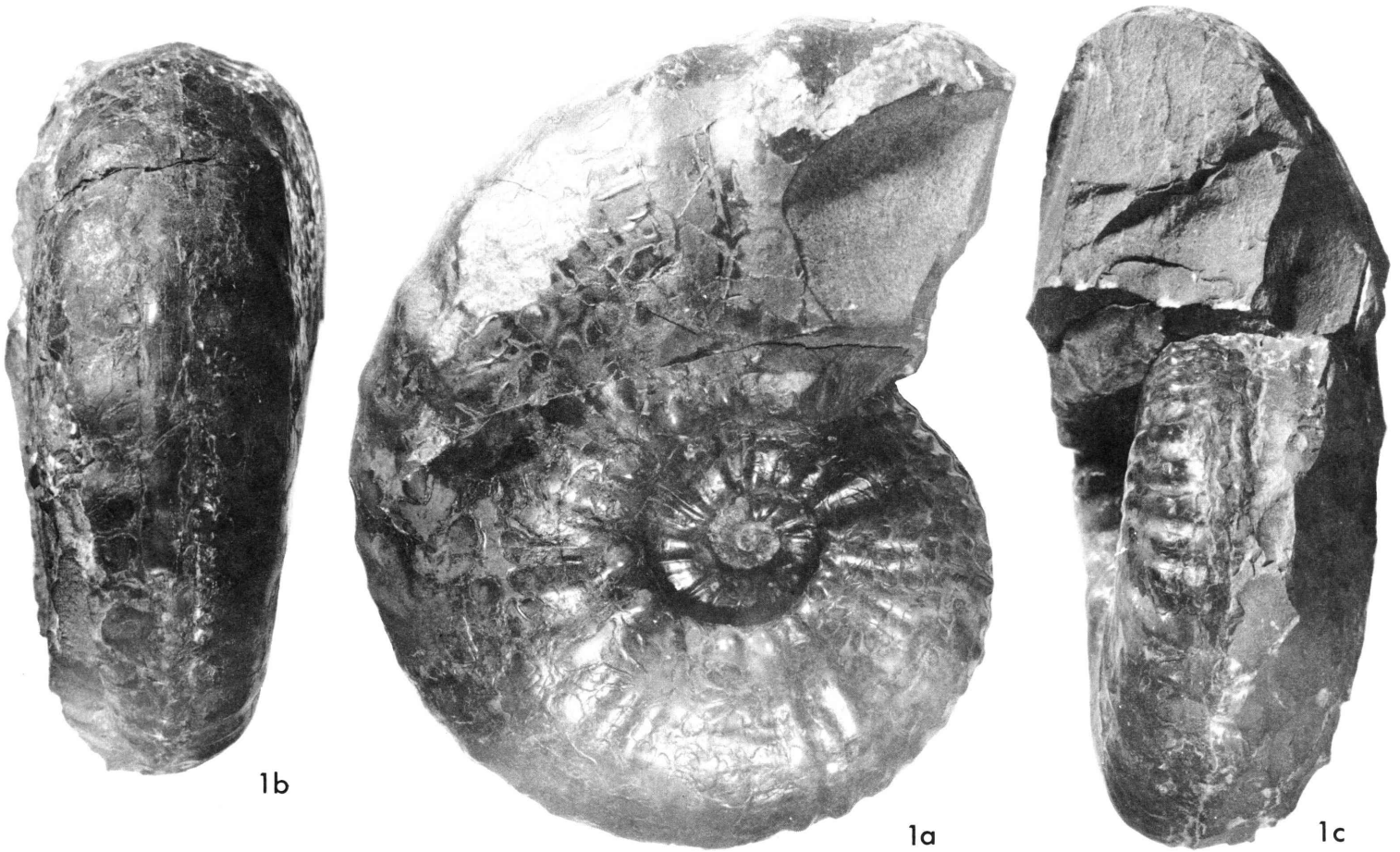
Fig. 1. *Eucalycoceras pentagonum* (JUKES-BROWNE).....Page 106
T. TAKAHASHI's Collection 369401, from loc. Ik 1039, Member IIc, Mikasa Formation, Ikushumbets. Lateral (a) and ventral (b) views, ×1.

Fig. 2. *Eucalycoceras* sp. aff. *E. spathi* (COLLIGNON).....Page 108
K. MURAMOTO's Collection, 458201, from loc. Ik 1046, upper part of Member IIb, Mikasa Formation, Ikushumbets. Lateral (a) and ventral views, ×0.8.

Kyushu Univ. (H. HIRANO) photos, without whitening.



T. MATSUMOTO: Additional Acanthoceratids



T. MATSUMOTO: Additional Acanthoceratids

rapidly with growth, showing the proportion of 1 to 3 in height between the inner and the outer ones. It is a little higher than broad (B./H.=ca 0.9), having somewhat convergent, nearly flat or very slightly convex flanks, subrounded ventrolateral shoulders, a rather flat, only gently arched, rather narrow venter, subangular umbilical shoulders and overhanging umbilical walls.

There are numerous ribs. On the flank they are nearly rectiradiate, sometimes slightly prorsiradiate or gently flexiradiate. On the last whorl there are 16 long ribs each of which has a distinct tubercle at the umbilical shoulder. One or two shorter ribs are inserted or branched. Thus ribs number 36 on the last whorl. All the ribs are gradually bent forward near the ventrolateral shoulder, showing a gentle projection on the venter. Up to the diameter of about 60 mm there are inner ventrolateral tubercles, but later than that stage they become indistinct and ribs are only slightly accentuated at their bending point. The outer ventrolateral and siphonal tubercles in three, fairly approximated rows persist for a longer period but gradually weaken in the late stage. They are rather small and the siphonal tubercles are clavate.

At the middle growth stage, with whorl-height of 25 to 35 mm, small and weak tubercles are discernible on some of the longer ribs at a point slightly below mid-flank.

In most growth-stages the ribs are rounded, rather narrow, and considerably close-set; some of the long ribs are more elevated than others and accompanied by a constriction. Thus, six constrictions are counted per whorl. In the later stages (i.e. on the last quarter of the septate whorl and the succeeding part of the body chamber) the ribs are lowered and broadened, becoming more distant with growth. They are especially lowered on the ventral part, where tubercles are blunt. On this probably adult whorl the bullate umbilical tubercles persist, the lateral tubercles are obsolete or completely disappear, and some ribs are accompanied by a slightly (but not much) deeper interspace, which can be reckoned as an obsolescent constriction.

The suture is generally of acanthoceratid type. The first lateral saddle (between E and L) is broad; the first lateral lobe (L), situated at mid-flank, is narrow and deep. The second lateral lobe (U2) is situated near the row of umbilical tubercles. It is much smaller than L. Auxiliaries are very small and situated mainly on the umbilical wall. The lobules that incise into saddles are

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Explanation of Plate 12

Fig. 1. *Shuparoceras yagii* gen. et sp. nov. .....Page 110
Holotype, HCS. No. 56 (K. YAGI Coll.), from the Yubari River. Lateral (a), ventral (b) and frontal (c) views, ×0.9.
Kyushu Univ. (H. HIRANO) photos, without whitening.

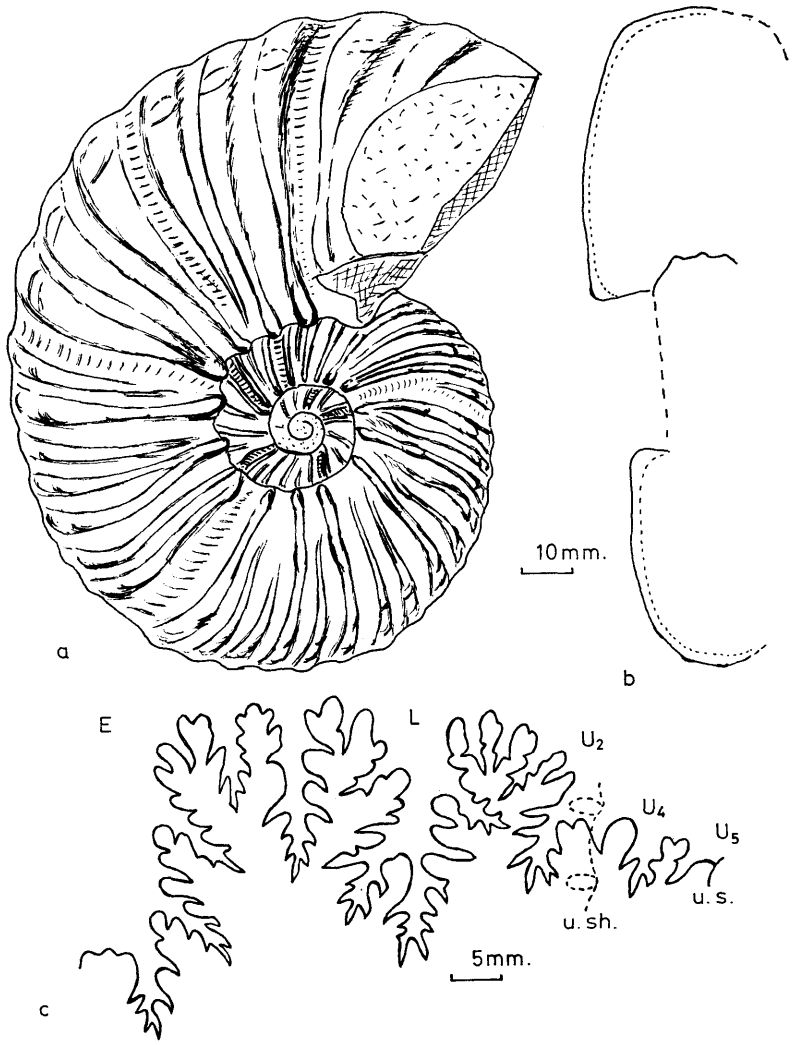


Fig. 3. *Shuparoceras yagii* sp. nov.
A sketch in lateral view (a), a diagrammatic whorl-section (b) and the external suture-line at whorl-height = 45 mm (c) of the holotype.
(T. M. *delin.*)

narrow and moderately deep. Accordingly the suture looks finely incised. The end of a foliole tends to be phylloid.

Measurements.—

	Diameter	Umbilicus	Height	Breadth	B./H.
Holotype (preserved end)	127.0(1)	31.0(.24)	62.0(.49)	~54(.43)	0.87
〃 (last septum)	118.0(1)	30.0(.25)	56.0(.47)	51.0(.43)	0.91
Paratype	105.0(1)	28.2(.27)	50.4(.48)	48.0(.45)	0.95

Remarks.—The paratype has somewhat stronger ribs and better developed

lateral tubercles than the holotype.

Discussion.—In shell-form and mode of ribbing the present species is similar to *Calycoceras choffati* (KOSSMAT) from the Cenomanian of southern India (KOSSMAT, 1897, p. 12, pl. 4, fig. 1) and South Africa (CRICK, 1907, p. 205, pl. 12, fig. 5) and also to *C.* aff. *choffati*, from the Middle Cenomanian *Acanthoceras rhotomagense* zone of England (KENNEDY, 1971, p. 75, pl. 38, fig. 5; pl. 39, figs. 1, 3). It is distinguished by less numerous, less crowded, and more rounded ribs, a more deeply incised suture with narrower lobes, and the presence of periodic constrictions and small lateral tubercles on some ribs.

The present species is somewhat allied to "*Romaniceras*" *indiduraense* JONES (1938, p. 119, pl. 7, figs. 2-4), from the Turonian Indidura Formation (Member 2 and 3) of Coahuila, Mexico, in the fairly involute, rapidly growing high whorl, numerous ribs and approximated rows of ventral tubercles. In the Mexican species the whorl is more compressed, the inner ventrolateral tubercles persist for a longer period, the lateral tubercles on some long ribs of later stages are more distinct than in ours, but there seems to be no marked constrictions.

The young shell of the present species is apparently similar to *Mantelliceras lymense* (SPATH, 1926), as represented by a part of "*Acanthoceras martimpreyi*" of PERVINQUIÈRE (1907, p. 289, pl. 16, fig 16 only), from the Cenomanian of Tunisia and England (KENNEDY, 1971, p. 60) and also to *Eucalycoceras rowei* (SPATH), from the Upper Cenomanian of Sarthe, France (HANCOCK, 1959, p. 251) and England (KENNEDY, 1971, p. 83, pl. 49, figs. 2-7; pl. 50, figs. 3-4, 6-7) with respect to the early disappearance of the inner ventrolateral tubercles and that some of the longer ribs are more elevated than others, but no marked constrictions and no lateral tubercles are developed in those two species.

To sum up, the observable characters of the present species are so peculiar that a new species is established under a new genus.

Occurrence.—The holotype was obtained by K. YAGI at Nanbu, immediately below the Shuparo dam, in a floated calcareous nodule on the floor of the Yubari River. No associated megafossil was found in the nodule. Judging from its lithological features the derivation of this nodule could possibly be sought in a Turonian siltstone of the sequences exposed in the Oyubari area. The paratype was obtained by K. MURAMOTO from a locality of the Isojiro-no-sawa, a tributary of the Yubari River, about 200 m south (along the strike) of T. MATSUMOTO's loc. Y5194, where *Inoceramus labiatus* was obtained.

Shuparoceras abei sp. nov.

Pl. 13, Fig. 1; Text-fig. 4

Material.—Holotype, HCS. No. 57, obtained from a floated nodule of the Yubari River, immediately below the Shuparo dam, by Mr. Hidenobu ABE, to

whom the specific name is dedicated. It consists of the septate whorls and a part (about 100°) of the body chamber. Paratype, T. TAKAHASHI's Coll. 45-8-11, from Hakkin-zawa of the same area.

Description.—The shell is of moderate size, about 135 mm in diameter at the preserved end of the holotype and 110 mm at the end of its septate whorl. About one third of the inner whorl is overlapped by the outer. The umbilicus is nearly or slightly less than 30 percent of the entire shell-diameter. The whorl increases moderately with growth, showing the proportion of 1 to 2 in height between the inner and the outer ones. It is a little higher than broad or slightly broader than high, having a gently arched venter, sloping subrounded shoulders, nearly parallel, only slightly convex flanks, subangular umbilical shoulders and nearly vertical to slightly overhanging umbilical walls.

On the inner whorl there are numerous, rather narrow, long and short, distinct ribs, some of which are periodically more elevated than others and accompanied by a constriction. In addition to the siphonal and the outer and the inner ventrolateral tubercles there is a row of tubercles at mid-flank, precisely at a half way between the inner ventrolateral and the umbilical shoulders. They are prominent on the periodically elevated ribs. The umbilical tubercle at the end of the long rib is somewhat bullate. The ribs are nearly rectiradiate on the main part of the flank and curved gently forward on the venter.

On the earlier part of the outer whorl some of the ribs and the mediolateral and the inner ventrolateral tubercles are much weakened, but the ventral three rows of tubercles persist, in which the siphonal ones are clavate. The umbilical tubercles are rather blunt and disposed at long intervals. The flank, thus, looks smoothish at this stage.

The ornamentation is rejuvenated, though weakly, on the later part of the outer whorl. At first, i.e. on the last part of the septate whorl, there are rather fine ribs on some of which faint inner and outer ventrolateral tubercles are discernible. Then, on the probably adult body chamber there appear fairly distant, low but considerably broad, long ribs, on which the umbilical and the lateral tubercles are discernible as weak bullae, the inner ventrolateral as larger but low elevations, and the outer ventrolateral and the siphonal as narrow and low clavi. A probable remnant of a constriction is recognized as a shallow radial depression, which shows a gently convex curvature on the venter.

The suture is of general acanthoceratid type. E is deep. The first lateral saddle (between E and L) is moderately broad and situated on the area covering the rows of outer and inner ventrolateral tubercles. L is longer than broad, having considerably deep lobules at its bottom, and situated at about the middle of the flank. U2 is much smaller than L and situated near the row of umbilical tubercles.

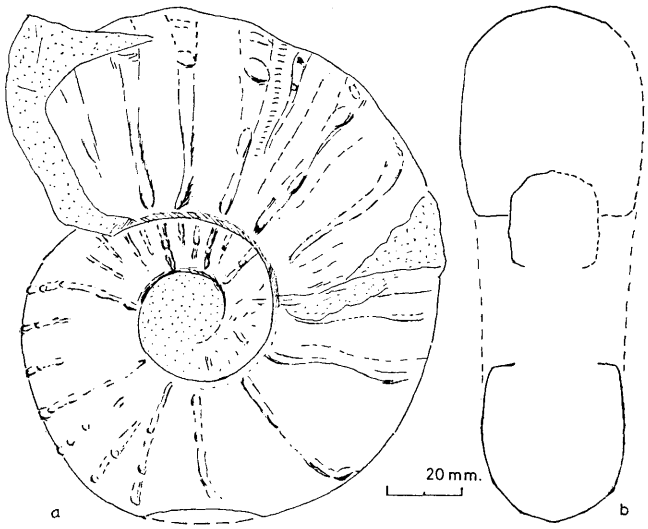


Fig. 4. *Shuparoceras abei* sp. nov.
A sketch in lateral view (a) and a diagrammatic whorl-section (b) of the holotype. (T. M. *delin.*)

Measurements.—

Specimen	Diameter	Umbilicus	Height	Breadth	B./H.
Holotype (end)	136.0(1)	41.0(.30)	56.5(.41)	51.0(.37)	0.90
〃 (−100°)	109.0(1)	31.4(.29)	48.8(.44)	43.3(.39)	0.88
Paratype (end)	166.0(1)	54.0(.32)	66.0(.40)	—	—
〃 (−120°)	129.0(1)	38.0(.29)	54.4(.42)	58.0(.45)	1.06

Remarks.—The paratype has somewhat broader whorls and more distinct lateral tubercles than the holotype.

Discussion.—The present species is so similar to the preceding species, *S. yagii*, in the whorl shape, numerous ribbing on the inner whorl, lowered but broadened ribbing on the probably adult whorl and the presence of constrictions and medio-lateral tubercles that it is assigned to the same genus, *Shuparococeras*. The specific distinction is that *S. abei* has a less involute and more widely umbilicate shell on which the mediolateral tubercles are better developed but the umbilical tubercles less so, its suture is not so deeply incised and its lateral lobe (L) is not so narrow as in *S. yagii*. Much weakening of the ribs at the late middle growth-stage seems to be particular to the present species.

In the general aspects of the shell-form and weak ornament of the outer whorl the present species apparently looks like *Nigericeras gignouxi* SCHNEEGANS (1943, p. 119, pl. 5, figs. 10-15, text-figs. 1, 2), from the Lower Turonian of western Africa, and also to *N. scotti* COBBAN (1971, p. 18, pl. 9, figs 1-4; pl. 18, figs. 1-9; text-figs. 15-17), from the Lower Turonian of Colorado, but its suture is much more deeply incised and has a distinctly narrower first lateral lobe. In *Nigericeras*

the ventral tubercles disappear at an earlier stage and, according to the previous descriptions, there are no mediolateral tubercles and no marked constrictions. Looking at the plaster cast (GK. H 9294) of the holotype of *N. gignouxi*, the type-species of *Nigericeras*, I have noticed that some of the interspaces of the ribs are somewhat deeper than others, being accompanied by periodically strong umbilical tubercles and by some sinuosity of the growth-lines. This may indicate the periodic apertural margin during growth, even if the constrictions are not distinctly marked. Anyhow, the present species cannot be assigned to the Vascoceratidae to which *Nigericeras* belongs.

Occurrence.—The holotype was obtained by H. ABE at Nanbu, immediately below the Shuparo dam, in a floated calcareous nodule on the floor of the Yubari River. As in the case of the *S. yagii*, the derivation of this nodule could possibly be sought in a Turonian siltstone of the Oyubari area. Paratype was obtained by T. TAKAHASHI in a nodule fallen from T.MATSUMOTO's loc. Y5203 of the Hakkinzawa, a tributary of the Yubari River, where the zone of *Inoceramus hobetsensis* (probably Middle Turonian) is exposed,

Genus *Romaniceras* SPATH, 1923

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

Diagnosis.—Medium-sized to large, more or less evolute acanthoceratid ammonites with rounded to subrounded whorl sections. Ribs strong, with intercalated shorter ones. In addition to umbilical, inner and outer ventrolateral and siphonal tubercles there are one or two rows of tubercles on each flank. On the outer whorl all or some rows of tubercles weaken and may disappear.

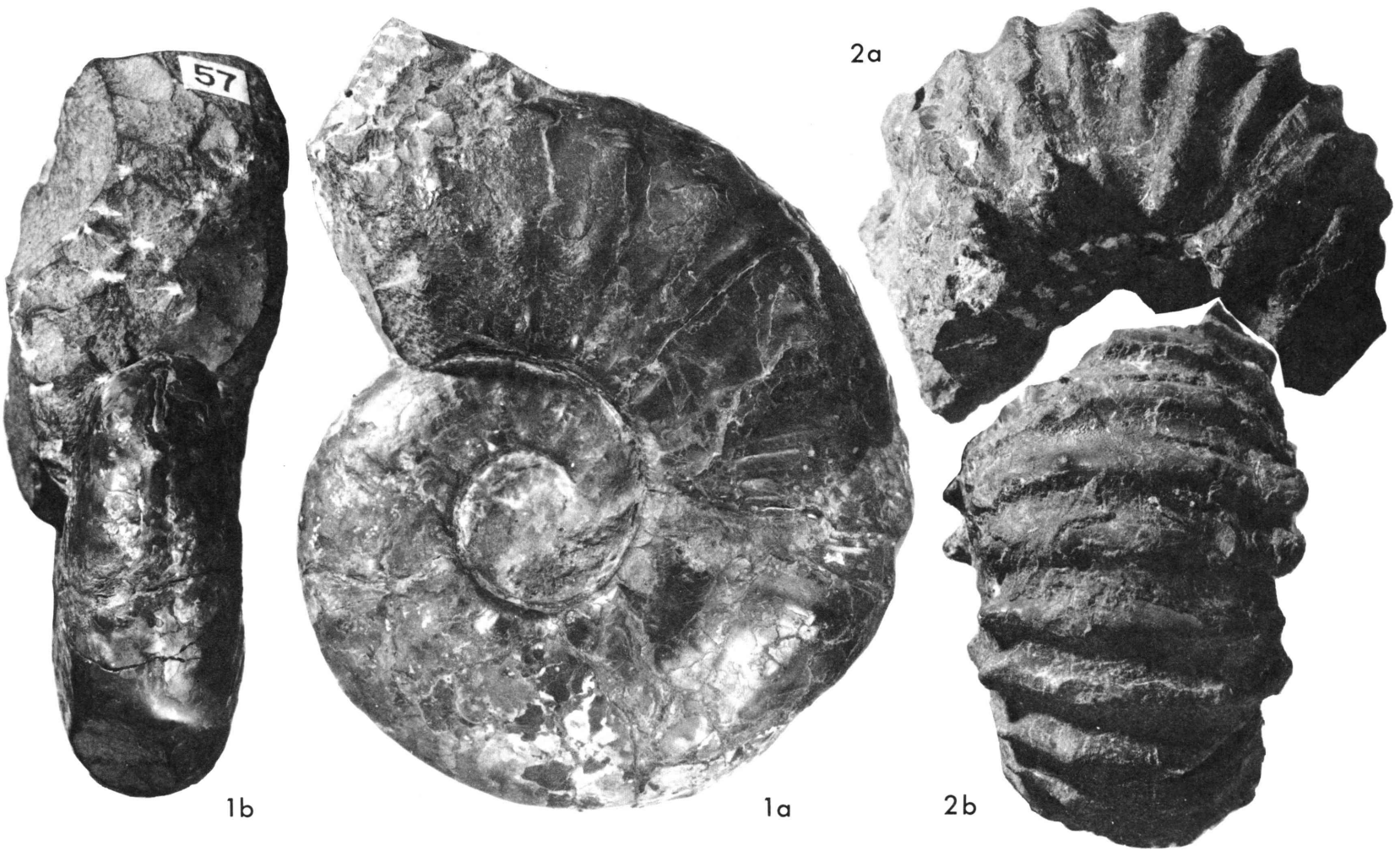
Distribution.—Worldwide and common in the Turonian, as *Calycoceras* is in the Middle to Upper Cenomanian. The recorded first appearance is in the Upper Cenomanian (? *Subglobosus* Zone) of England (WRIGHT and WRIGHT, 1951, p. 29).

Discussion.—From morphological resemblance and stratigraphical occurrence *Romaniceras* is generally regarded as a multituberculate derivative of *Calycoceras*, although the line of descent from species to species is not necessarily clear.

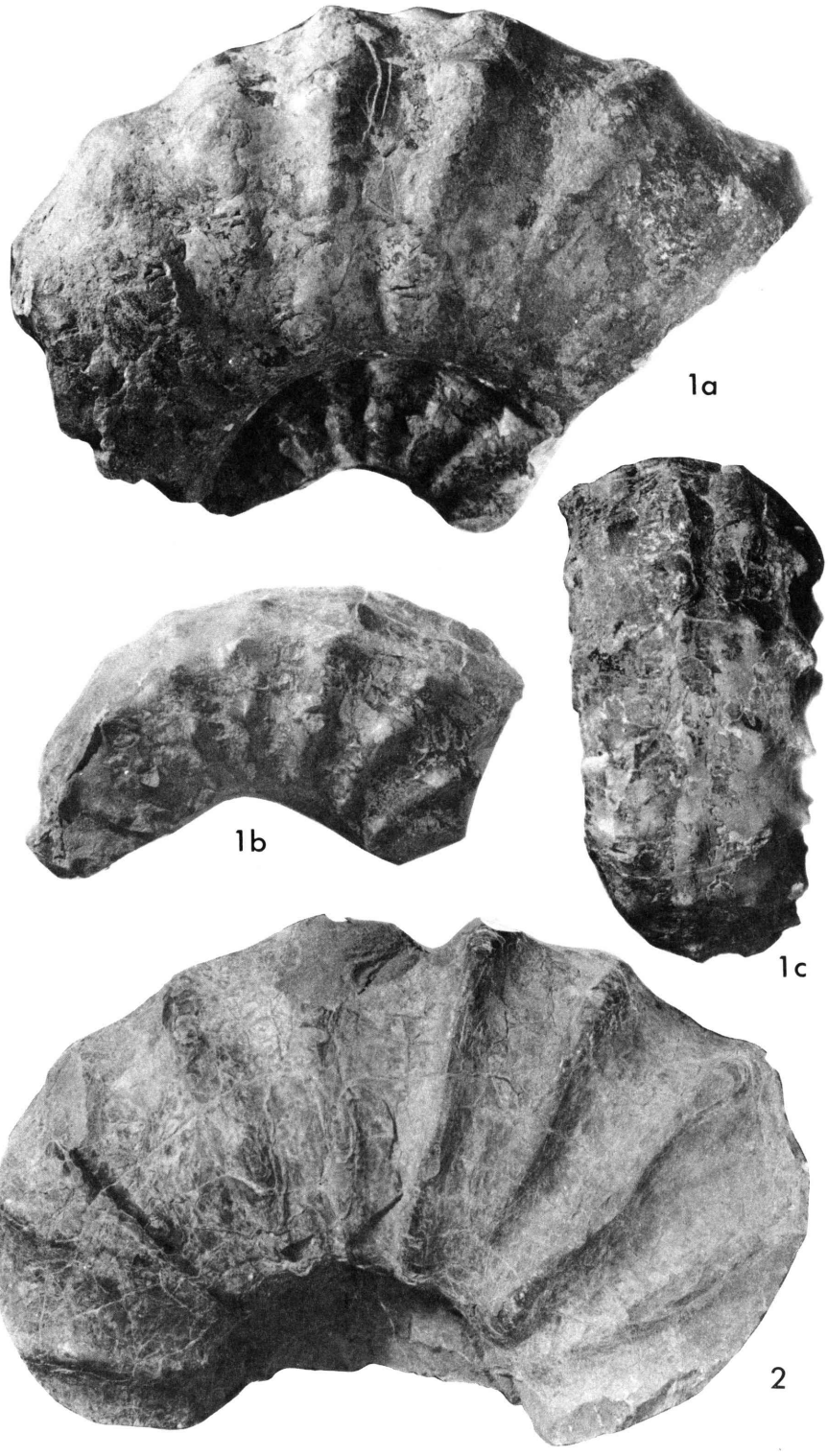
Explanation of Plate 13

Fig. 1. *Shuparoceras abei* gen. et sp. nov. ..... Page 113
Holotype, HCS. No. 57 (H. ABE Coll.), from the Yubari River. Lateral (a) and frontal (b) views, ×0.9.

Fig. 2. *Calycoceras* sp. nov. aff. *C. crassum* THOMEL ..... Page 104
NSM. PM6665 [T. MURAMOTO Coll. 16853], from loc. Ik 1083 [= "Ik 1103"], Shimokatsurazawa, Mikasa Formation, Ikushumbets. Lateral (a) and ventral (b) views, ×0.9.
Kyushu Univ. (H. HIRANO) photos, without whitening.



T. MATSUMOTO: Additional Acanthoceratids



T. MATSUMOTO: Additional Acanthoceratids

WIEDMANN (1960, p. 734; 1964, p. 122) proposed the subgenus *Proromaniceras*, with *R. pseudodeverianum* (JIMBO, 1898) as type-species, regarding it as closely connected with the subgroup of *Calycoceras orientale*. One of the criteria noted by WIEDMANN is that the lateral tubercle is more approximated to the umbilical one than to the inner ventrolateral. In fact the mode of tubercle disposition is one of the good criteria for discriminating species, but comprehensive consideration is necessary for tracing a natural group in the genus. For instance, *Romaniceras yezoense* sp. nov., to be described below, closely resembles *Romaniceras* (*Proromaniceras*) *pseudodeverianum hispanicum* WIEDMANN, and is only distinguished in having the lateral tubercles at mid-flank. It is probably a descendant of the subgroup of *C. newboldi-orientale*.

Just as *Calycoceras* includes several subgroups, so *Romaniceras* could be divisible into several subgroups. *Proromaniceras* may be one of them. However it is necessary to know the details of the relationships among species of *Romaniceras* before we introduce new subgenera.

The holotype of *R. pseudodeverianum* (JIMBO) was in a floated calcareous nodule of the Obira River and its stratigraphic position is unknown. I sought in vain examples of the same species from the Lower Turonian of this area. T. MURAMOTO obtained and presented to Kyushu University a specimen (GK. H5693) which can be called *Romaniceras* sp. aff. *R. pseudodeverianum* from a small branch of the Obira River where Middly to Upper Turonian strata are exposed. It has coarser and more distant ribs than the holotype and its prominent lateral tubercles are approximated to the umbilical tubercles.

Romaniceras sp. aff. *R. deverianum* (D'ORBIGNY)

Pl. 14, Fig. 1

Compare.—

1841. *Ammonites deverianus* D'ORBIGNY, *Paléontologie Francaise*, Terr. Crétacés, vol. 1, p. 356, pl. 110, figs. 1, 2.
1923. *Romaniceras deverianum*, SPATH, *Summ. Progr. Geol. Surv.*. 1922, p. 144.
1939. *Romaniceras deveriai*, COLLIGNON, *Ann. Géol. Serv. Mines, Madagascar*, fasc. 10, p. 33, pl. 8, figs. 2, 3; pl. 9, fig. 1.
1939. *Romaniceras deveriai* var. *massiaposensis* COLLIGNON, *Ibid.*, fasc. 10, p. 33, pl. 9, fig. 2.

Explanation of Plate 14

Fig. 1. *Romaniceras* sp. aff. *R. deverianum* (D' ORBIGNY) .....Page 117
GK. H5691 (T. M. Coll.), from loc. Y5206g, Hakkinzawa, Oyubari. Lateral view (a) of the outer and the inner whorls, ×0.8; lateral (a) and ventral (b) views of the inner whorl, ×1.

Fig. 2. *Romaniceras yezoense* sp. nov. .....Page 118
GK. H5694 (T. MURAMOTO Coll.), from loc. Ob-oc. 100p, Obira, lateral view, ×0.5.
Kyushu Univ. (H. HIRANO) photos, without whitening.

1965. *Romaniceras deveriai*, COLLIGNON, *Atlas des Fossiles Caracteristiques de Madagascar*, fasc. 12, p. 22, pl. 384, fig. 1655.

Material.—GK. H5691, from loc. Y5206g Oyubari area (coll. T. MATSUMOTO), consisting of a quarter each of an inner and an outer whorl. The last suture is at the middle of the outer whorl (at about 65 mm in height).

Description.—The above specimen, though incompletely preserved, has subrounded whorls, which are somewhat broader than high, distant coarse ribs, with only occasional intercalation or branching of a shorter one, and nearly equidistant nine rows of tubercles of moderate intensity. On the outer whorl the ribs broaden and the tubercles are somewhat lowered than on the inner whorl, but the tubercles still persist.

The suture is of *Acanthoceras* type, with a large, subquadrate first lateral saddle.

Discussion.—Although the specimen figured by D'ORBIGNY (1841) seems to have been lost (WRIGHT and WRIGHT, 1951, p. 29), the Hokkaido specimen (especially its inner whorl) is essentially similar to D'ORBIGNY's, illustration, except for that the ribs are somewhat more distant and the intercalation or branching of a shorter ribs is less frequent in ours than in D'ORBIGNY's. The specimens from Madagascar (COLLIGNON, 1939 and 1965) have more numerous and more crowded ribs.

As the extent of variation is not precisely known in *R. deverianum* itself, I call the Hokkaido specimen temporarily *Romaniceras* sp. aff. *R. deverianum*, implying that it is very close to but not morphologically quite identical with the normally known form of that species.

Occurrence.—Loc. Y5206g, Hakkin-zawa, Oyubari area, in the middle part of the Turonian sequence. At loc. Y5206d, about 3 m stratigraphically above Y5206g, where *Collignoniceras woollgari* was obtained. *Inoceramus hobetsensis* is common throughout Y5206b-h.

Romaniceras yezoense sp. nov.

Pl. 14, Fig. 2; Pl. 15, Fig. 1; Text-figs. 5-6

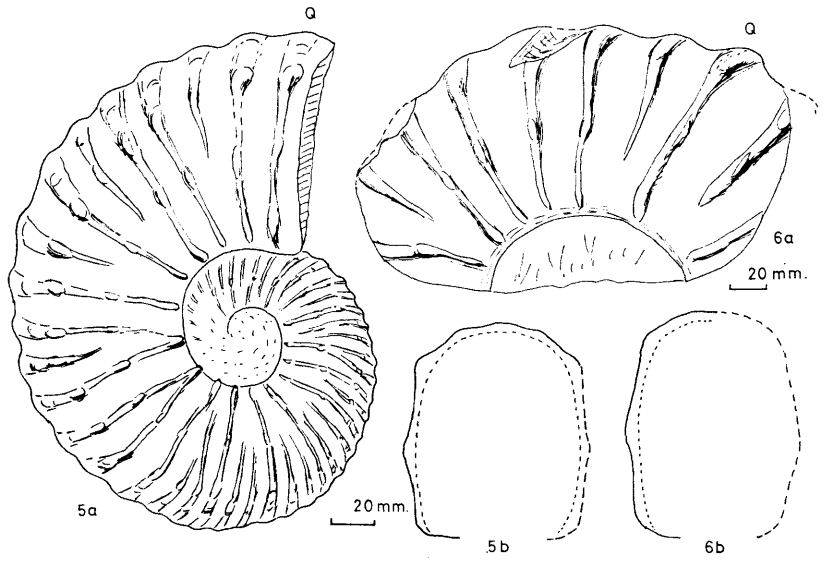
Material.—Holotype, GK. H5695, from loc. Y423, Yubari area (presented from the Hokkaido Colliery & Steamship Co. Ltd. to Kyushu University through Dr. H. SHIMOGAWARA, former Chief Geologist). Paratype, GK. H5694, from the Obira area (T. MURAMOTO Coll.). Several other probable examples (T. M. coll.).

Diagnosis.—This species is characterized by its (1) considerably large size, (2) fairly rapid growth of whorls (with proportion of about 2.5 between the inner and the next outer whorls in the holotype); (3) fairly narrow umbilicus (about 25 ($\pm$1) percent of diameter in the holotype); (4) subelliptical whorl-section, somewhat higher than broad, with a moderately rounded venter, sloping ventrolateral

shoulders, only slightly inflated flanks, subangular to subrounded umbilical shoulders and steep, nearly vertical umbilical walls; (5) numerous, rather crowded ribs on the septate whorl, consisting normally of alternating longer and shorter ones, occasionally with one more, still shorter one, nearly rectiradiate or slightly prorsiradiate on the flank, and gently curved forward on the venter, (6) much coarser and more distant ribs on the adult body chamber, separated by wider interspaces, alternated with a shorter one in some parts and without it on other parts, nearly rectiradiate or slightly prorsiradiate on the flank, gently curved forward at the ventrolateral shoulder, and run across the venter almost at right angle with the siphonal line with some broadening; (7) nine rows of tubercles, the umbilical ones on the longer ribs are bullate, and on the body chamber fairly prominent; the lateral ones situated at the middle of flank, midway between the umbilical and the ventrolateral ones, more or less bullate and strengthened on the long ribs of the body chamber; the ventrolateral ones are normally rounded, but only accentuated on some of the shorter ribs; and the ventral ones in three, fairly approximated rows, clavate and on the body chamber so weakened as to become nearly obsolete; and (8) moderately deep and narrow lobules in the incisions of the suture

Measurements.—

Specimen	Diameter	Umbilicus	Height	Breadth	B./H.
GK. H5695	218.0(1)	58.0(.26)	95.0(.43)	~76.(.35)	0.70
〃 (−90°)	160.0(1)	39.5(.24)	78.0(.49)	56.0(.35)	0.72



Figs. 5–6. *Romaniceras yezoense* sp. nov.
5. A sketch in lateral view (a) and a diagrammatic whorl-section at Q (b) of the holotype. 6. A sketch in lateral view (a) and a diagrammatic whorl-section at Q (b) of another large body chamber, GK. H5694. (T. M. *delin.*)

Remarks.—The septate part of the holotype is secondarily compressed and its inner whorl is very poorly preserved. The body chamber of the holotype occupies a little more than a half volution. Paratype is a fragmentary whorl, which shows essentially the same characters as the body chamber of the holotype, although it is larger than the holotype and still has a few septa at its posterior part. On this large whorl the ribs tend to be predominant over tubercles.

A fragmentary specimen (UMUT. I-3179) of a previous collection (*Romaniceras* sp. in MATSUMOTO et al., 1957, pl. 1, fig. 3) and two others of a recent acquisition (GK. H5696 and GK. H5697) can be called *Romaniceras* sp. cf. *R. yezoense.*

Discussion.—The present species should be regarded as one of the typical species of *Romaniceras*, although it is new. In fact it resembles *R. deverianum* (D'ORBIGNY), the type-species, but is distinguished in its much higher whorl, with flatter flanks and a narrower venter, and in that the tubercles are not so equally rounded as in that species. In previous descriptions I have not seen any unmistakable example of *R. deverianum* which clearly shows the characters of the adult body chamber. In the preserved last part of the shell with diameter of 120 mm or so (e.g. the specimens from the Upper Turonian of Madagascar illustrated by COLLIGNON, 1939, pl. 8, fig. 2; pl. 9, fig. 1; COLLIGNON, 1965, pl. 384, fig. 1655) the ribs tend to become less crowded but are not so distant and not so strong as in the adult whorl of this species. A large shell, from Uchaux, which was illustrated by ROMAN and MAZERAN (1913, text-fig. 4) might be an adult shell of *R. deverianum* or that of another species. Anyhow, its ribs are strong and predominant over tubercles, but much more crowded and show a more concave curve on the flank than those on the adult whorl of *R. yezoense.* Another, fairly large shell, from Lebanon, illustrated by BASSE (1937, pl. 9, fig. 1) under the name of *Acanthoceras* cf. *deverianum*, has nearly as corase and distant ribs on the body chamber as those of *R. yezoense*, but it seems to have a broader and more rounded whorl and, according to her description, eleven rows of tubercles as in *R. deverioide* (DE GROSSOUVRE). Furthermore, the lateral tubercles more distinctly persist in *R. yezoense.*

R. yezoense is somewhat similar to *R. uchauxiense* COLLIGNON, 1939 [=*Acanthoceras deverianum* ROMAN and MAZERAN, 1913, *non* D'ORBIGNY, 1841] in the rapidly growing high whorl, fairly narrow umbilicus, and coarsening ribs. *R. uchauxiense*, however, has somewhat more prorsiradiate ribs and more remarkably clavate, stronger ventral tubercles than *R. yezoense* at the stage with a shell diameter of 100 to 150 mm.

R. yezoense is clearly distinguished from *R. pseudodeverianum* (JIMBO) (1894, p. 33, pl. 5, fig. 1) (MATSUMOTO et al., 1957, p. 22, pl. 8 fig. 3, text-fig. 7) in its much narrower umbilicus, more crowded ribs on the septate whorl, coarser ribs

on the body chamber and the position of lateral tubercles at the middle of flank. The lateral tubercles are approximated to the umbilical tubercles in that species.

R. yezoense closely resembles *R. hispanicum* WIEDMANN (1960, p. 735, pl. 2, figs. 3, 4; 1964, p. 123, text-fig. 4) in many respects and differs in its larger size and the position of lateral tubercles at mid-flank. WIEDMANN estimated the umbilical ratio of the Spanish specimen at 35 percent, but it is actually 30 percent or so as can be measured on the photograph. This is not much different from ours. The Spanish specimen is, I think, sufficiently different from the holotype of *R. pseudodeverianum* for specific distinction.

It should be noted that *R. yezoense* is somewhat similar to *Calycoceras orientale* MATSUMOTO, SAITO and FUKADA (1957, p. 16, pl. 5, fig. 1; pl. 7, fig. 1) (MATSUMOTO, 1959, p. 73, pl. 19, fig. 1; text-fig. 30), from the Middle Cenomanian of Hokkaido and California, with respect to the shell-form and the mode of ribbing. In that species there is no lateral tubercle and the outer ventrolateral tubercles are more distinct and persist later, giving a rather polygonal whorl-section along a long rib.

A specimen (GK. H6839), from the Middle Turonian zone of *Inoceramus hobetsensis* in the Onogawa Group of eastern Kyushu, mentioned and illustrated by NODA (1969, p. 4, pl. 3, fig. 1) under the name of *Romaniceras* sp. shows essentially the same characters as the holotype of the present species. It is, however, much deformed and better to be provisionally called *Romaniceras* sp. cf. *R. yezoense*.

Occurrence.—The holotype was found by a geologist of the Hokkaido Colliery and Steamship Co., at a locality approximately corresponding to loc. Yb423 of MATSUMOTO and HARADA (1964), Ponhorokabetsu, from the middle part (unit Mk2 or Mk3) of the Mikasa Sandstone Formation in the Yubari [= "Hatonosu"] dome, Yubari, central Hokkaido. Fossils of "*Callista*" *pseudoplana* are contained in the sandy rock matrix filling the body chamber. The fossil assemblage of loc. Yb423 differs from that of loc. Yb67 , which in turn is referable to Lower Turonian. *Hyphantoceras* sp. and *Mesopuzosia indopacifica* were obtained at Yb423 itself, suggesting Middle, rather than Lower, Turonian. Paratype was found by T. MURAMOTO from his loc. Ob-oc. 100p, a calcareous nodule floated or fallen in the Nanbu-no-sawa, a tributary of the Obira River, where Middle to Upper Turonian sequence is exposed.

Other comparable specimens are also from Middle Turonian of Oyubari area and eastern Kyushu.

Romaniceras deverioide (DE GROSSOUVRE)

Pl. 15, Fig. 2; Text-fig. 7

1889. *Ammonites deverioides* DE GROSSOUVRE, *Bull. Soc. Géol. France*, 3 ser., vol. 17, p. 254, pl. 12, figs. 1, 2.

1959. *Romaniceras deverioide*, MATSUMOTO, *Mem. Fac. Sci., Kyushu Univ.*, Ser. D, Geol., Special vol. 1, p. 87 (with full list of synonymy), pl. 25, fig. 1; pl. 26, fig. 1, pl. 28, fig. 1; pl. 29, fig. 4; text-figs. 40-40

Material.—GK. H5685, collected by Prof. W. HASHIMOTO in 1956 and kindly donated to Kyushu University for study.

Description.—On the occasion of describing examples from California I (MATSUMOTO, 1959, p. 87) designated the lectotype, gave a redefinition and showed some examples of variation of *R. deverioide* (DE GROSSOUVRE).

The specimen from Hokkaido is rather small but well exhibits the following diagnostic features which enable us to identify it with *R. deverioide*: (1) rounded whorl which is somewhat broader than high, (2) moderate in the increase of whorl with growth (proportion in size of the inner whorl to the next outer whorl being approximately 1 to 2), (3) umbilicus of moderate size (32 percent of the shell-diameter), (4) coarse ribs, 23 per whorl, consisting usually of alternating long and short ones, which are nearly rectiradiate on the flank and show a broadly convex curve on crossing the venter, (5) nearly equidistant, strong tubercles in eleven rows, in which the three ventral ones are distinctly clavate, the inner ventrolateral less distinctly but tending to be so, the outer lateral conical and small, the inner lateral conical and prominent on the long rib, and the umbilical one bullate and (6) suture of *Acanthoceras* type, as shown in Text-fig. 7.

On this probably immature shell constrictions are hardly discernible on the costate whorl but on the nearly smooth earlier whorl of less than 10 mm in diameter there are periodic constrictions.

Measurements.—

Specimen	Diameter	Umbilicus	Height	Breadlh	B./H.
GK. H5685	71.0(1)	23.2(.32)	30.4(.43)	36.2(.51)	1.17

Occurrence.—Loc. 629-9 of W. HASHIMOTO in the first tributary of the western branch (called the "Sodensen-no-sawa") of the Nutapomanai, a tributary of the Hobetsu River, Yufutsu-gun, Iburi province, central Hokkaido. Prof. HASHIMOTO reports (*in litt.*) that the mudstone exposed at this locality is in his unit

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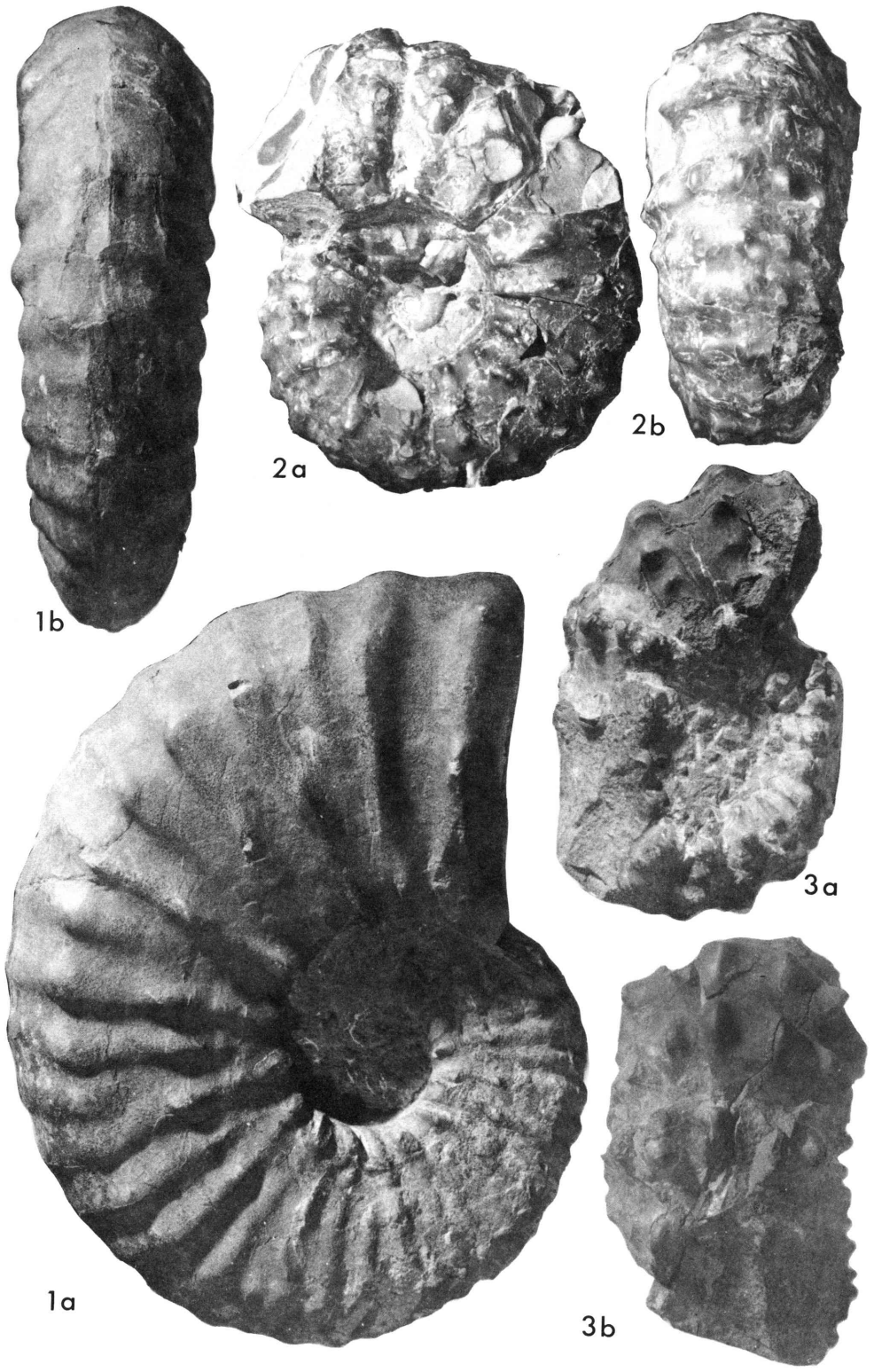
Explanation of Plate 15

Fig. 1. *Romaniceras yezoense* sp. nov. .....Page 118
Holotype, GK. H5695, from loc. Yb423, Mikasa Formation, Yubari dome. Lateral (a) (×0.6) and ventral (b) (×0.4) views.

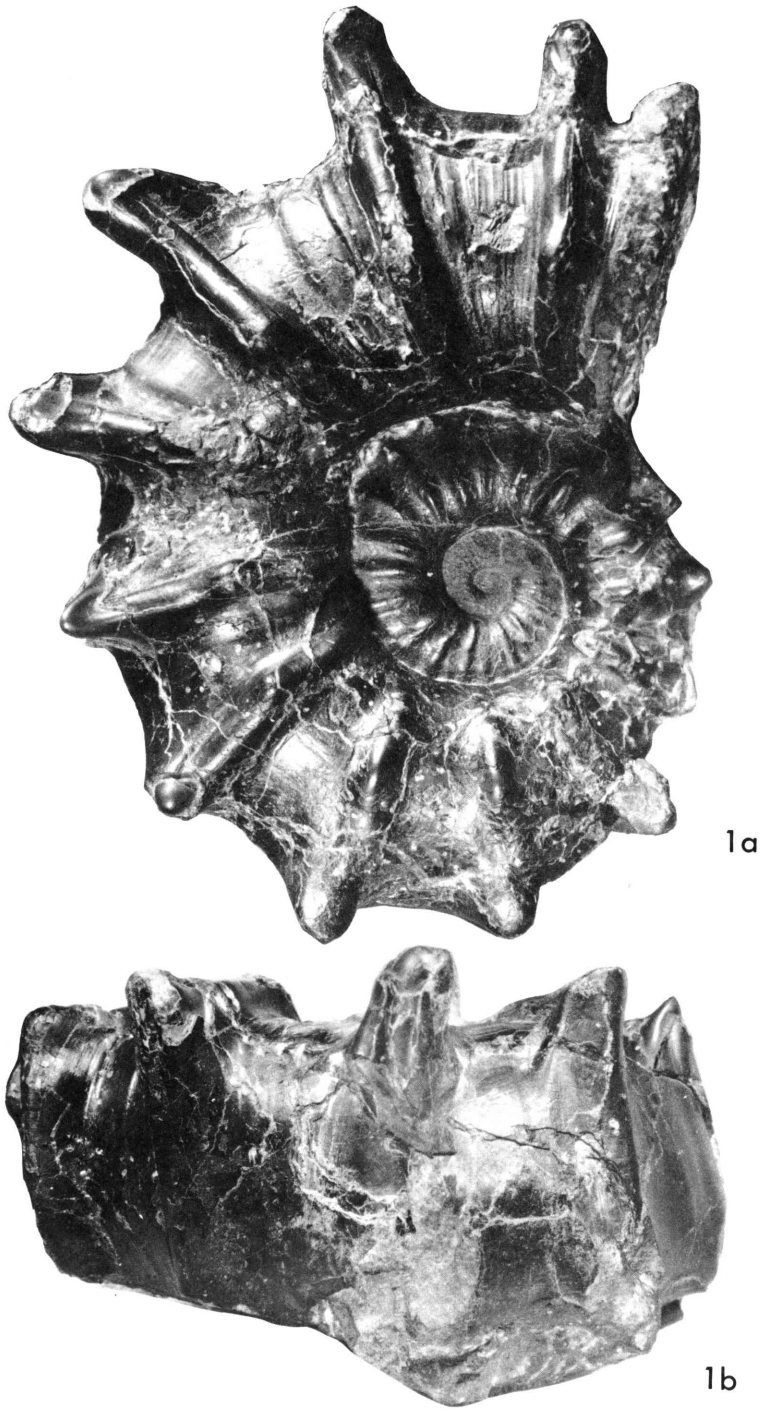
Fig. 2. *Romaniceras deverioide* (DE GROSSOUVRE) .....Page 122
GK. H5685 (W. HASHIMOTO Coll.), from loc. 629-9, Nutapomanai, zone of *Inoceramus hobetsensis*, Hobetsu area. Lateral (a) and ventral (b) views, ×1.

Fig. 3. *Romaniceras* [New Genus?] *aequicostatum* sp. nov. .....Page 124
Holotype, GK. H5690 (T. MURAMOTO Coll.), from loc. Ik1420p, Ikushumbets. Lateral (a) and ventral (b) views, ×1.

Kyushu Univ. (H. HIRANO) photos, without whitening.



T. MATSUMOTO: Additional Acanthoceratids



T. MATSUMOTO: Additional Acanthoceratids

Mm (unpublished report) and belongs to the zone of *Inoceramus hobetsensis*, probably Middle Turonian.

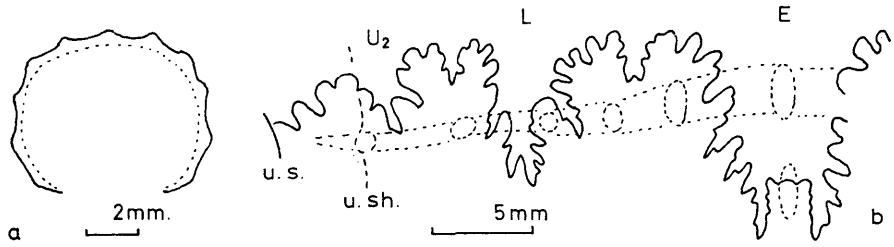


Fig. 7. *Romaniceras deverioide* (DE GROSSOUVRE)
Diagrammatic whorl-section (a) and the external suture (b) at whorl-height = 16 mm of GK. H5685. (T. M. *delin.*)

Romaniceras (?) sp. cf. *R. kanei* JONES

Pl. 19, Fig. 4

Compare.—

1938. *Romaniceras kanei* JONES, *Bull. Geol. Soc. Amer.*, vol. 49, p. 120, pl. 8, figs. 2, 7, 8; pl. 9, fig. 6.

Material.—GK. H5699, from the Hakkin-zawa, Oyubari (collected and presented to T. M. by K. MURAMOTO and T. TAKAHASHI). Holotype of *R. kanei* is University of Michigan, 16819, whose plaster-cast is in Kyushu University, GK. H9145.

Description.—The specimen is small (about 55 mm in diameter) and secondarily deformed but exhibits the following characteristic features: (1) a moderate rate of whorl growth, (2) subquadrate whorl section, (3) numerous, fairly crowded rectiradiate or slightly prorsiradiate ribs, about 30 per whorl, in the middle growth-stage (40-80 mm in diameter), (4) less frequent intercalation of shorter ribs on the immature whorl of less than 40 mm, (5) fairly distant ribbing on the early whorl less than 20 mm in diameter, (6) eleven rows of tubercles, (7) distinct tubercles in five nearly equidistant rows on the ventral part, (8) inner lateral tubercles appearing at about 25 mm in shell diameter, distinct and close to the umbilical ones and (9) outer lateral tubercles being fairly distinct on the immature whorl but becoming weaker on the whorl with diameters over 50 mm or so.

Discussion.—Although the specimen from Hokkaido is incompletely preserved, it conforms so well to the holotype of *Romaniceras kanei* JONES, from an uncertain locality in Coahuila, Mexico, in the observed characters that it is probably

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Explanation of Plate 16

Fig. 1. *Acanthoceras takahashii* sp. nov. ..... Page 126
Holotype, GK. H5605 (T. TAKAHASHI Coll.), from Ikushumbets. Lateral (a) and ventral (b) views, ×0.6.
Kyushu Univ. (H. HIRANO) photos, without whitening.

identified with that species.

The holotype of *R. kanei* probably represents the shell of middle growth-stage and the characters of the adult body chamber are not known. So far as the observable material is concerned, this species is fairly similar to *Yubariceras japonicum* MATSUMOTO, SAITO and FUKADA, 1959, in the subquadrate whorl section, infrequent or no intercalation of shorter ribs on the whorl of early growth-stages, approximation of the lower lateral tubercles to the umbilical ones etc., and distinguished in having the outer lateral tubercles, wider umbilicus, less flexuous ribs and no perceptible constrictions. For the resemblance this species might be better transferred to *Yubariceras*. However, inasmuch as the presence of periodic constrictions is not confirmed, this species is provisionally retained in *Romaniceras* with a query.

Occurrence.—The described specimen was obtained in the Hakkin-zawa of the Oyubari area by K. MURAMOTO and T. TAKAHASHI, without a precise locality record. In the rock matrix drifted fragments of woody material are contained in abundance. This feature is often seen in the facies of the Saku Formation (Turonian) in this area.

Romaniceras [New Genus ?] *aequicostatum* sp. nov.

Pl. 15, Fig. 3; Text-fig. 8

Material.—Holotype, GK. H5690, from loc. Ik 1420p, collected by T. MURAMOTO.

Diagnosis.—This species is characterized by (1) its small size, (2) much depressed whorl, with a broadly rounded venter and inflated flanks, broadest at the lower lateral tubercle (B/H=1.5), (3) fairly distant, equally long, thick, and strong ribs, without intercalation of shorter ribs, 17 or so per whorl, nearly rectiradiate on the flank and broadened and very gently curved forward on the venter, (4) eleven rows of tubercles; the ventral three are clavate and strengthened as the whorl grows, the ventrolateral one prominent and somewhat spinose (sharply pointed), the upper lateral somewhat smaller than others, the lower lateral prominent, and the umbilical small but distinct.

Measurements.—

Specimen	Diameter	Umbilicus	Height	Breadth	B./H.
GK. H5690	68.0(1)	22(.32)	27.5(.40)	39.0(.57)	1.4
〃 (−180°)	—	—	17.5	27.7	1.5

Remarks.—The specimen is somewhat deformed and the above figures show unrestored dimensions. In addition to this specimen there was a fragmentary outer whorl, of probably the same individual, on which ribs are still more strengthened, tending to absorb tubercles.

Discussion.—Although a single, somewhat deformed specimen is available at present, its characters are so diagnostic that a new specific name is proposed

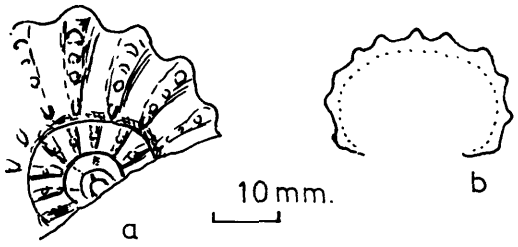


Fig. 8. *Romaniceras* [New genus?] *aequicostatum* sp. nov.
Sketch in lateral view of immature stage (a) and a diagrammatic whorl-section (b) of the holotype (T. M. *delin.*)

here.

The shell-form of the present species is similar to that of *Calycoceras*, especially to that of immature *C. naviculare* (MANTELL) (as illustrated by KENNEDY, 1971, pl. 36, figs. 2–4; pl. 37, fig. 3). Aside from more numerous rows of stronger tubercles, the ribs of the present species are all equally long as compared with alternating long and short ribs in *Calycoceras*. In this respect this species cannot be directly connected with *Calycoceras*. In the same respect it is quite distinct from any other species of *Romaniceras*. With respect to the prominent, clavate ventral tubercles it is somewhat similar to *R. uchauxiense* COLLIGNON (1939, p. 33, pl. 10, fig. 1) [=*Acathoceras deverianum*, ROMAN and MAZERAN, 1913, p. 25, pl. 3, figs. 1–2; *non* D'ORBIGNY, 1841], but the latter has alternating long and short ribs and less depressed whorls.

In the presence of eleven rows of tubercles this species is similar to *Romaniceras deverioide* (DE GROSSOUVRE) and *Yubariceras ornatissimum* (STOLICZKA), but those species again have shorter intercalated ribs at least on the septate whorls. *Y. ornatissimum* has a less rounded, subquadrate whorl like that of *Y. yubarense*.

It is interesting to see a similarity between the shell of the present species and an immature shell of certain species of *Douvilleiceras* (e. g. *D. mammillatum* and *D. orbignyi*). The latter, however, has no siphonal tubercles but a siphonal depression and a different pattern of suture. The similarity is a heterochronous homeomorphy.

To sum up, the present species has such peculiar characters that it probably represents a new genus allied to but distinguishable from either *Romaniceras* or *Yubariceras*. Until better and more material is obtained, I describe it provisionally under the heading *Romaniceras* [New Genus ?].

Occurrence.—Holotype was obtained by T. MURAMOTO at loc. Ik 1420p, a pebble of Kami-ichi-no-sawa, a branch of the Ikushumbets. As its rock matrix is sandy it may have derived from some bed of the upper part of the Mikasa Formation exposed on the northwestern side of the valley. This would suggest Middle or Upper Turonian age.

Subfamily Acanthoceratinae HYATT, 1900

Genus *Acanthoceras* NEUMAYR, 1875

Type-species.—*Ammonites rhotomagensis* BRONGNIART, 1822, by subsequent designation of DE GROSSOUVRE (1894).

Diagnosis.—See KENNEDY, 1971, p. 85.

Discussion.—On a previous occasion MATSUMOTO et al. (1969) complained of too incomplete information about *Acanthoceras rhotomagense* itself, but this has been satisfied by the work of KENNEDY and HANCOCK (1970) who described in detail various forms of this species through the examination of populations from the Middle Cenomanian Craie Chloritée of Rouen, France. They furthermore discussed its affinities with other species.

The restricted genus, i.e. the *rhotomagense* group, has thus been well defined and characterizes the early part of the Middle Cenomanian, occurring in north-west Europe, South Africa, Madagascar, north Australia, Peru and Texas (KENNEDY and HANCOCK, 1970, p. 487).

Whether any species of the same group occurs in the circum-Pacific region or not is open to question. Examples from Hokkaido which were identified with *Acanthoceras amphibolum* MORROW by MATSUMOTO et al. (1969, p. 266, pl. 31, fig. 1) can be considered as evidence for the wider distribution. They came from the lower portion of the middle part of the Cenomonian sequence in the Ikushumbets area.

As KENNEDY (1971, p. 85) has pointed out, *Acanthoceras* includes a number of groups which may require subgeneric separation. Whether *Pseudacanthoceras* THOMEL, 1972 meets with this requirement at least partly or not is questionable but I have not here good meterial to discuss it further.

In the present circumstances I describe a new species under *Acanthoceras*, without giving a subgeneric name, although it shows distinctly peculiar characters.

Acanthoceras takahashii sp. nov.

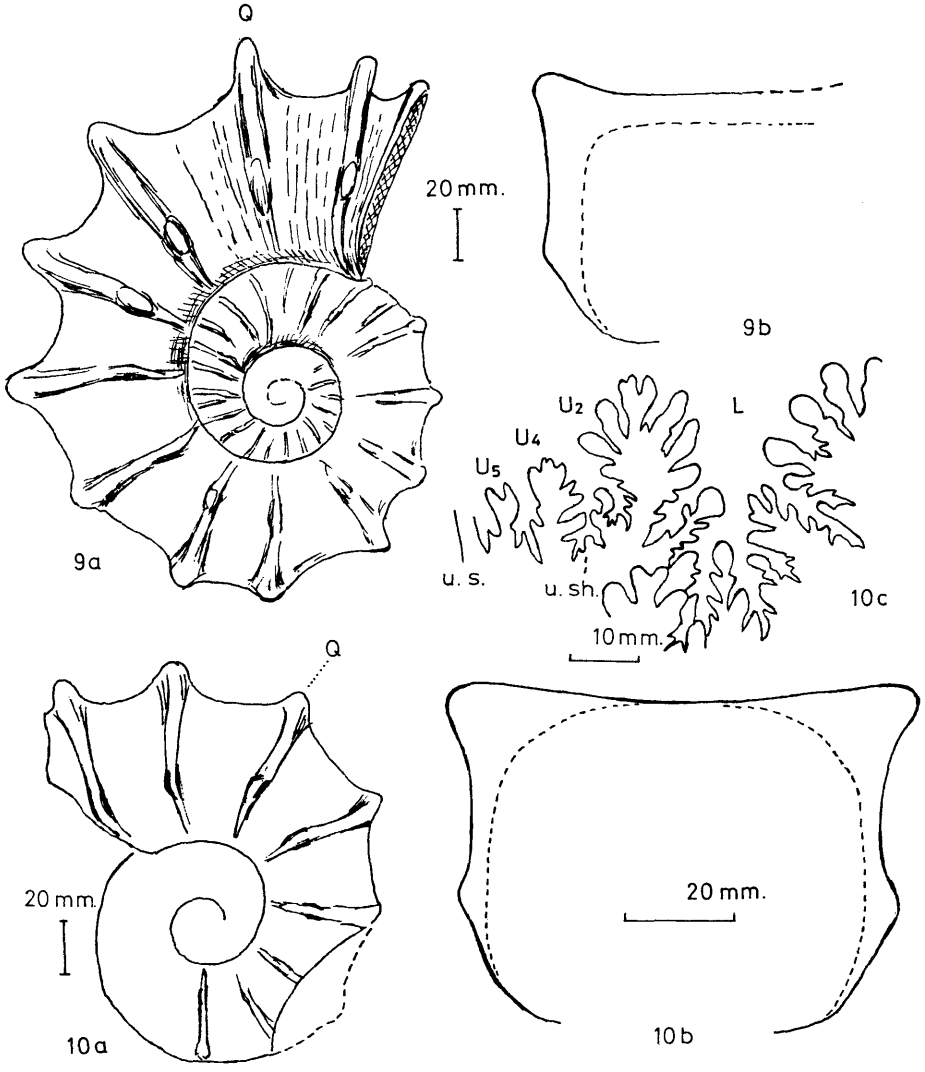
Pl. 16, Fig. 1; Pl. 17, Fig. 1; Text-figs. 9-10

Material.—Holotype, GK. H5605, from the Kami-ichi-no-sawa; paratype, GK. H5606, from loc. Ik 1102, both collected by Takemi TAKAHASHI, to whom the specific name is dedicated.

Diagnosis.—The shell is fairly large, about 190 mm in diameter in the holotype and about 130 mm at the end of its phragmocone. It is rather evolute, with the umbilical seam of the outer whorl running along the row of inner ventrolateral tubercles of the inner whorl.

The adult body chamber is much broader than high, having a subquadrate intercostal section, a broad venter, flat or only gently inflated flanks, steep and high umbilical walls and subrounded ventrolateral and umbilical shoulders.

The outer whorl is ornamented with much distant long ribs, numbering 13 per whorl without intercalated shorter ribs. The ribs are provided with prominent tubercles at the ventrolateral shoulders and at some distance above the umbilical shoulders. These ribs are nearly rectiradiate and cross the venter vertically. On the septate part of the outer whorl they are not strong and especially lowered on the venter, whereas the bullate umbilical tubercles and the horn-like ventrolateral tubercles are predominant. On the body chamber the ribs strengthen and on its last part they are remarkably raised, forming a wall-like elevation that encircles the whorl on both the flank and the venter. The ventrolateral and the



Figs. 9-10. *Acanthoceras takahashii* sp. nov.
9. Sketch in lateral view (a) and whorl-section (b) of the holotype. 10. Lateral view (a), diagrammatic whorl-section (b) and a part of the suture (c) of GK. H5606. (T. M. *delin.*)

umbilical tubercles are superimposed on the raised ribs, forming angulations.

The inner whorl is subquadrate in section and does not seem to be so broad as the outer whorl (though secondarily compressed in the actual specimens).

The ribs on the inner whorl are of moderate intensity, more numerous, 23 or so per whorl, with sometimes but not regularly intercalated shorter ones. The interspaces are somewhat broader than the ribs on the later two thirds of the inner whorl but nearly as narrow as the ribs on the earlier part. The umbilical tubercles on the inner whorl are bullate and bluntly pointed at some distance from the umbilical margin. On the sloping umbilical wall some ribs are prorsiradiate and gradually bend at the umbilical tubercle to become rectiradiate on the main part of the flank. The inner ventrolateral tubercles are moderately prominent; the outer ventrolateral weak and somewhat clavate; siphonal tubercles very weak.

The suture is similar to that of *Acanthoceras rhotomagense*, as illustrated by DE GROSSOUVRE (1894, text-fig. 12) and KENNEDY and HANCOCK (1970, text-figs. 2,5; pl. 90, fig. 4; pl. 96, figs. 1-3), having rather a dome-like gross outline of the lateral saddles and somewhat phylloid aspect at the end of folioles.

Measurements.—

Specimen	Diameter	Umbilicus	Height	Breadth	B./H.
GK. H5605(c)	192.5(1)	63.5(.33)	75.8(.39)	~104(.54)	1.37
〃 (ic)	176.0(1)	62.5(.35)	62.5(.35)	~ 76(.43)	1.21
〃(−90°) (c)	158.0(1)	52.0(.33)	65.0(.41)	97.5(.61)	1.50
〃 〃 (ic)	139.0(1)	51.5(.37)	57.2(.41)	73.5(.53)	1.28
GK. H5606 (c)	163.0(1)	54.3(.33)	68.8(.42)	86.6(.53)	1.26
〃 (ic)	158.0(1)	53.5(.34)	62.0(.39)	69.8(.44)	1.13

(c) = costal (ic) = intercostal

Remarks.—In the holotype the body chamber occupies about a half whorl. At the preserved last part the whorl height is slightly decreased and the last rib is slightly less distant, lower, narrower and provided with less stretched vetrolateral tubercles than the preceding two ribs. The growth lines at the last part are parallel to the rectiradiate last rib, suggesting the simple apertural margin.

The paratype has the last septum at about 150 mm in diameter and only an earlier quarter of the body chamber is preserved.

Discussion.—The present species is somewhat similar to *Acanthoceras jukesbrownei* (SPATH) (see KENNEDY, 1971, p. 88) from the *rhotomagense* Zone of southern England in general aspects, but in the former alternation of long and short ribs is not so far retained as in the latter.

It is probably more closely allied to *Acanthoceras tunetanum* PERVINQUIÈRE (1907, p. 268, pl. 13, fig. 4 as *Acanthoceras confusum* var *tunetana*; see KENNEDY and HANCOCK, 1970, p. 479), from the Cenomanian of Tunisia and southern England. Shorter ribs are sometimes intercalated on the inner whorl of the former, but

they are scarcely seen on that of the latter. The adult whorl of *A. tunetanum* is not so large and not so much depressed as that of the present species.

It should be noted that the shell in the middle growth-stage of the present species resembles the lectotype of *Acanthoceras latum* CRICK (1907, p. 195, pl. 12, fig. 2) (also KENNEDY, 1971, pl. 56, fig. 1), from the Cenomanian of South Africa, and another example from the Middle Cenomanian of England (KENNEDY, 1971, p. 89, pl. 57, fig. 1), but such a remarkable ornament as that of the adult body chamber of the present species is not known in CRICK's species. The outer ventrolateral and the siphonal tubercles persist for longer period in *A. latum* than in *A. takahashii.*

Acanthoceras sp. cf. *A. quadratum* CRICK, from nothern Australia (WRIGHT, 1963, p. 606, pl. 86, fig. 2; pl. 87, fig. 1) is somewhat similar to the present species, but its outer whorl has less prominent ventrolateral tubercles and less raised ribs. Its inner whorl is probably more similar to the holotype of *A. quadratum* (CRICK, 1907, p. 192, pl. 13, fig. 2), in which alternation of long and short ribs persists up to the diameter of 100 mm.

The specimen, from the same locality Ik 1102, which was identified with *Acanthoceras cornigerum* CRICK (MATSUMOTO et al., 1969, p. 268, pl. 32, fig. 1; text-fig. 5) is somewhat similar to the present specimens especially with respect to relatively less distant, less strong, sometimes flexuous ribs with intercalated shorter ones on the inner whorl and much distant, strong, rectiradiate long ribs with horned ventrolateral and outward shifted umbilical tubercles on the outer whorl. Its whorl is less depressed and has a trapezoidal section with a narrower venter than the present form, showing a peculiar disposition of ventrolateral tubercles as in CRICK's holotype.

KENNEDY and HANCOCK (1970) have revealed a considerable variability of *Acanthoceras rhotomagense* from fossil populations of the type locality at Rouen, France. This may be similarly applied to other species of *Acanthoceras.* Consequently it could be considered that such nominal taxa as *Acanthoceras jukesbrownei, A. tunetana, A. latum, A. quadratum* and *A. cornigerum* might represent merely examples of a polymorphic single species. However, this has not yet been proved with satisfactory evidence and the specimens from Hokkaido are not sufficiently numerous to lead an answer to the question. At least for the time being I follow KENNEDY (1971) who regards these species as distinct. Under these circumstances I regard *A. takahashii* as a species which is closely allied to but distinguishable from the above cited ones.

A similar discussion can also be applied to *Acanthoceras amphibolum* MORROW (see MATSUMOTO et al., 1969, p. 266; COBBAN and SCOTT, 1972, p. 65) and *Acanthoceras athabascense* WARREN and STELCK (1955, p. 71) from North America. *A. takahashii* resembles them with respect to the distant ribs, horned ventrolateral

tubercles and upward shifted umbilical tubercles on the outer whorl. It is, however, distinguished in having more frequently intercalated shorter ribs on the inner whorl and remarkably raised ribs on the last part and a much broader body chamber than the above two species.

The remarkably raised ribs on the last part of the body chamber in *A. takahashii* remind us of flared ribs on the outer whorl of *Dunveganoceras albertense* (WARREN, 1930), from the Upper Cenomanian of the Western Interior province of North America, but in the latter the tubercles are amalgamated into flared ribs, the section of the outer whorl is not quadrate and the siphonal tubercles disappear earlier.

Occurrence.—The holotype was found by T. TAKAHASHI from the upper reaches of the Kami-ichi-no-sawa (TA. 1 = 42.6.11) a tributary of the Ikushumbets, in a sandstone bed, about 6000 m. apart from loc. Ik 1102 along the general strike (N50°E). The paratype was obtained also by T. TAKAHASHI (TA. 2=43.4.30) at loc. Ik 1102 from a sandstone bed in the middle part of Member IIb of the Mikasa Formation (for location see MATSUMOTO et al., 1969, text-fig. 9) on the eastern wing of a major anticline in the Ikushumbets area, central Hokkaido. From the same bed were obtained other horned acanthoceratid species, *A. amphibolum*, *A. cornigerum* and *Euomphaloceras meridionale*. This may imply their similarity in ecological conditions as well as their synchronism.

Genus *Yubariceras* MATSUMOTO, SAITO and FUKADA, 1957

Type-species.—*Yubariceras yubarense* MATSUMOTO, SAITO and FUKADA, 1957, by original designation.

Diagnosis.—The shell is fairly large in the typical species, but may be moderate or small in some particular species. The whorl is rather evolute, encircling the umbilicus of moderate width (about 25 to 35 percent of diameter), nearly as high as broad or somewhat broader than high, subquadrate in section with a broadly arched venter.

The ribs are typically rectiradiate on the flank, but may be slightly flexuous in some species, mostly simple and equally long on the whorl of late growth-stages, and gently curved forwards or nearly straight on the venter; shorter ribs

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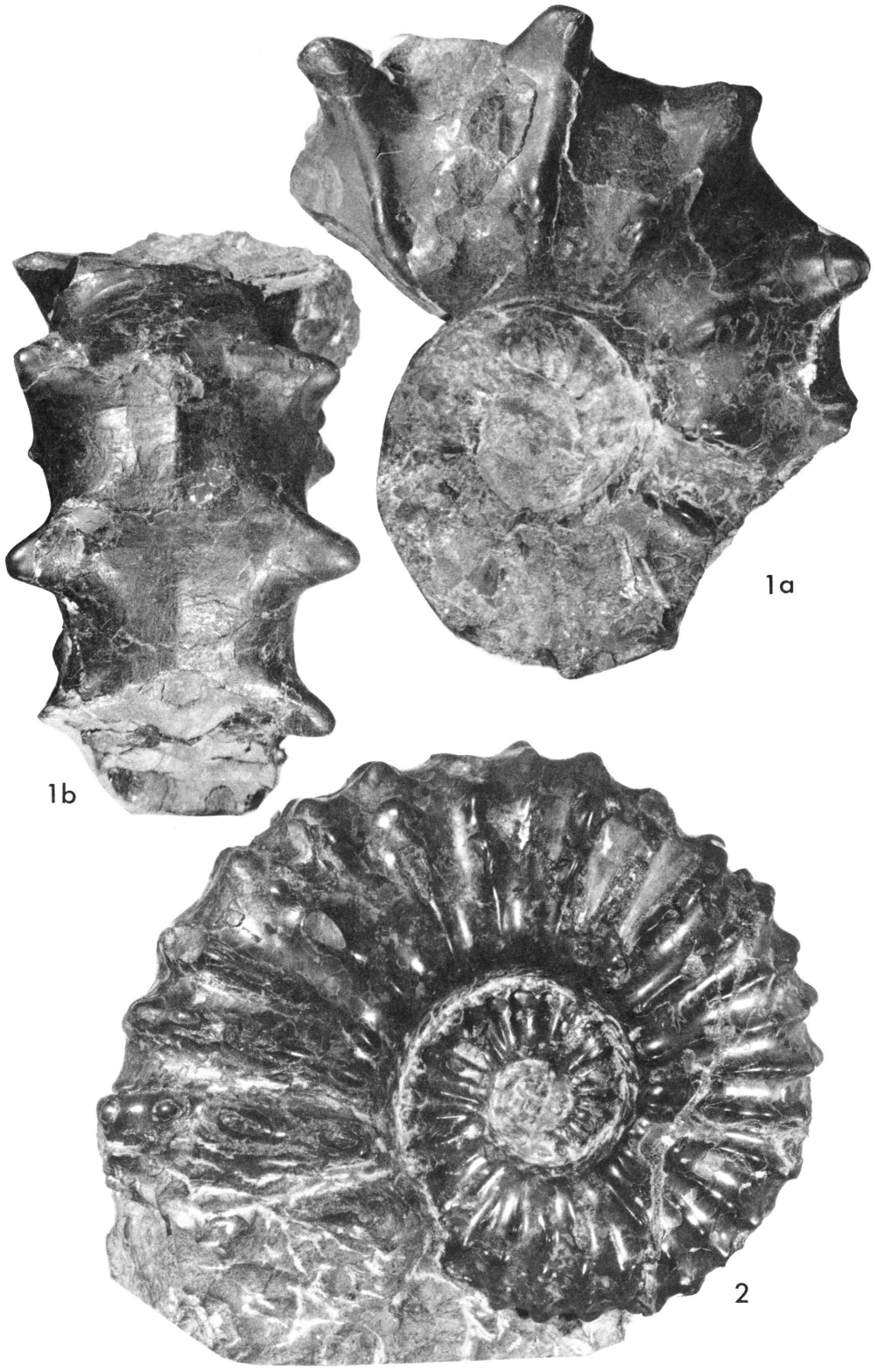
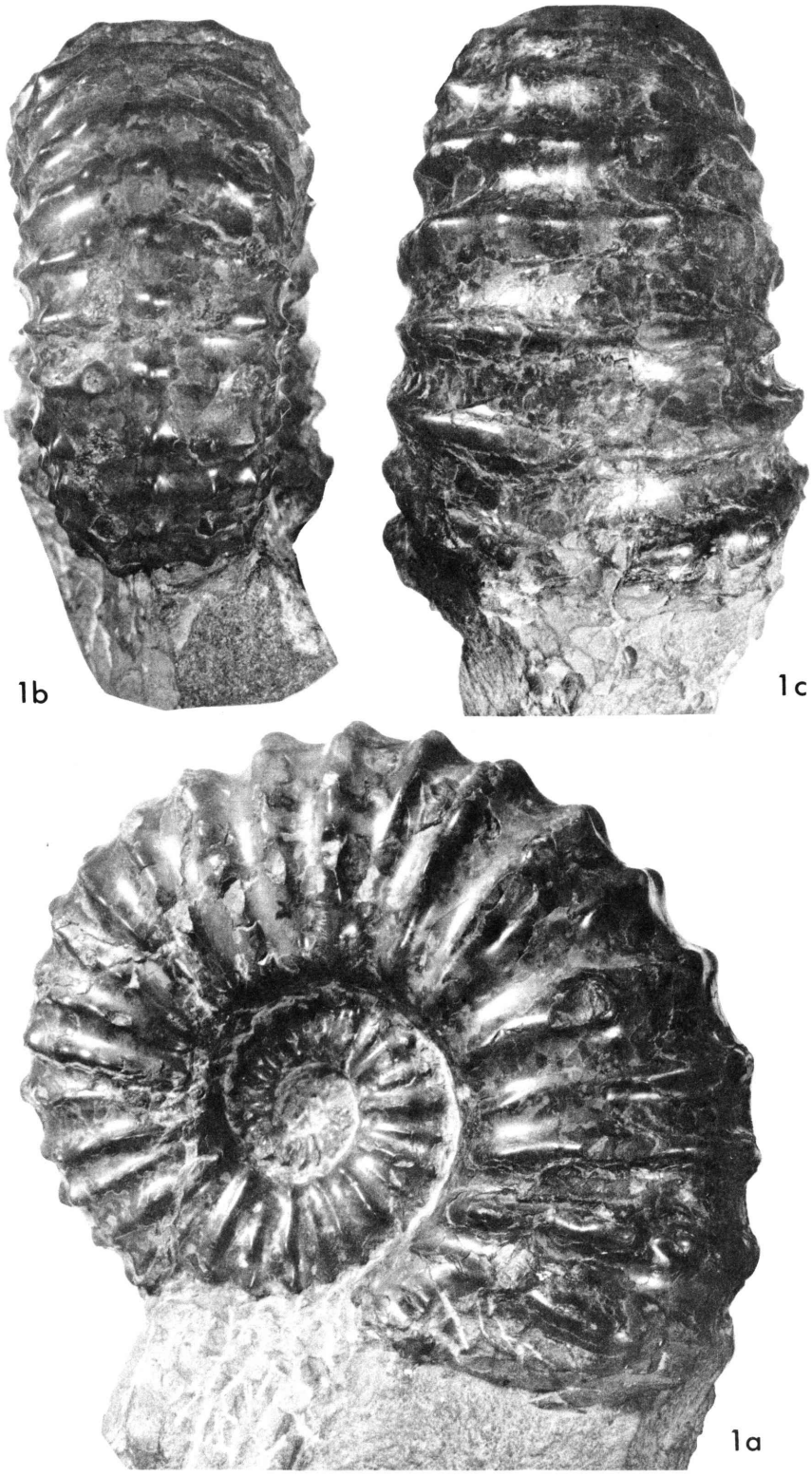
Explanation of Plate 17

Fig. 1. *Acanthoceras takahashii* sp. nov. ..... Page 126
Paratype, GK. H5606 (T. TAKAHASHI Coll.), from loc. Ik 1102, middle part of Member IIb, Mikasa Formation, Ikushumbets. Lateral (a) and ventral (b) views, × 0.6.

Fig. 2. *Yubariceras* sp. aff. *Y. ornatissimum* (STOLICZKA) ..... Page 135
HCS. No. 8 (S. KAWABATA Coll.), from Hobetsu. Right lateral view, ×0.8.
Kyushu Univ. (H. HIRANO) photos, without whitening.



T. MATSUMOTO: Additional Acanthoceratids



T. MATSUMOTO: Additional Acanthoceratids

are intercalated or bifurcated in more or less early growth-stages depending on species. There are nine or eleven rows of tubercles; the umbilical, the lateral (in one or two rows on each flank), the inner and the outer ventrolateral and the siphonal ones. (In relation to the whorl shape the inner ventrolateral tubercle may be situated at the ventrolateral shoulder and the outer ventrolateral one may be better called ventral in some species.)

On the whorls of early growth-stages there are periodic constrictions, which become less distinct in the middle stage and hardly discernible in the adult. A variable number of extra ribs sometimes occur on the ventral part, being often associated with the constriction.

The suture is of *Acanthoceras* type.

Remarks.—I refer the following species to the genus *Yubariceras*:

Y. yubarense MATSUMOTO, SAITO and FUKADA, 1957
Y. ornatissimum (STOLICZKA, 1865)
Y. japonicum MATSUMOTO, SAITO and FUKADA, 1957
Y. otatumei (MATSUMOTO, SAITO and FUKADA, 1957)
Y. pseudomphalum sp. nov.
Y. fujishimai sp. nov.

Before entering in the description of the two new species, the previously established species are redescribed with some amendment. Furthermore, there are forms which are provisionally called *Yubariceras* sp. aff. *Y. ornatissimum*, *Yubariceras* sp. aff. *Y. japonicum* and *Yubariceras* n. sp.

Distribution.—As far as the available information is concerned, the genus *Yubariceras* is confined to the Turonian. For some reasons the number of species and that of collected specimens are larger in the Middle and the Upper Turonian (i.e. zone of *Inoceramus hobetsensis* and that of *Inoceramus teshioensis*) than in the Lower Turonian (i.e. zone of *Inoceramus labiatus*) in the sequences of Hokkaido. An example of *Y. otatumei* certainly occurs in the subzone of *Reesidites minimus* near the top of Turonian.

In the case of Hokkaido specimens of *Yubariceras* do not occur so abundantly as those of *Gaudryceras*, *Anagaudryceras*, *Scaphites*, *Mesopuzosia* and *Inoceramus*, but the former are often associated with the latter, occurring in calcareous nodules of fine-sandy siltstone rather than in those of less prolific claystone facies.

Outside the Japanese province, hitherto described examples of *Yubariceras*

Explanation of Plate 18

Fig. 1. *Yubariceras* sp. aff. *Y. ornatissimum* (STOLICZKA) ..... Page 135
HCS. No. 8 (S. KAWABATA Coll.), from the Inasato-no-sawa, Hobetsu. Left lateral (a), postero-ventral (b) and antero-ventral (c) views, ×0.8.
Kyushu Univ. (H. HIRANO) photos, without whitening.

have been known from southern India and Madagascar. In Madagascar *Y. yubarense* is recorded to occur in the Lower Turonian (COLLIGNON, 1965). More widespread geographic distribution would be expected, as is suggested by Dr. COBBAN's personal information (letter to me in 1972) that probable examples of *Yubariceras* are found from North America.

Discussion.—On the grounds of the morphological similarity and the order of stratigraphical occurrence, *Yubariceras* was interpreted as a multituberculate derivative of *Acanthoceras* (MATSUMOTO et al., 1957). Through the present study it has been made clear that *Yubariceras* has characteristically periodic constrictions on inner whorls up to the middle growth-stage and that extra ribs sometimes occur on the ventral part. These features remind us of *Euomphaloceras*, but hypernodosity is absent in *Yubariceras* or not so remarkably manifested as in *Euomphaloceras*.

In view of a considerable diversity in *Yubariceras*, as exemplified by various species described in the following pages, there may have been several lines of descent for the species of *Yubariceras*. In fact *Y. pseudomphalum* n. sp. must be intimately connected with such a species as *E. lonsdalei*. KENNEDY and HANCOCK (1970, pl. 93, figs. 1, 2) have shown a form of *Euomphaloceras* sp. which is transitional from *Acanthoceras rhotomagense*. Such a form could well be an ancestor for some species of *Yubariceras*, although the actual line of descent has not yet been precisely traced.

A more fundamental question is the morphology and the function of periodic constrictions. In fact well marked constrictions are rather rare in most genera of the Acanthoceratidae. They are discernible in *Tunesites* PERVINQUIÈRE, 1907 and *Hourcquiceras* COLLIGNON, 1939, besides *Euomphaloceras* and *Yubariceras*. In *Romaniceras deverioide* (this paper) weak constrictions are discernible only on the whorl of very early growth-stage. In *Sumitomoceras faustum* constrictions are marked only on the body chamber (MATSUMOTO et al., 1969, p. 284). In general, even if the constrictions are not well marked periodic arrest of growth must have taken place during the enlargement of the shell. This should be proved by examining the shell structure. I presume that the strength of a constriction may be concerned with the mode of life of ammonoids. In other words the development of a better marked constriction might be an adaptation to a certain mode of life and accordingly could occur in certain lines of descent from more than one ancestral stock.

Anyhow, the origin(s) of the species of *Yubariceras* can be sought in a certain species group of *Euomphaloceras* as well as in a transitional form between *Acanthoceras* and *Euomphaloceras*. It is interesting to note here that THOMEL (1972, p. 158) regards *Acanthoceras vergonsense* THOMEL, which approaches *Euomphaloceras* in some respects, as a probable ancestor of *Schindewolfites*

WIEDMANN, 1960. The latter genus shows hypernodosity and is said to be characterized by the "irregularity of ornament." Anyhow, *Schindewolfites* is a close relative of *Yubariceras* and might better be included in *Yubariceras* as a subgenus, if its characters in ontogeny were sufficienily known.

Yubariceras yubarense MATSUMOTO, SAITO and FUKADA

Pl. 19, Fig. 1; Text-fig. 11

1957. *Yubariceras yubarense* (ex YABE MS.) MATSUMOTO, SAITO and FUKADA, *Mem. Fac. Sci., Kyushu Univ.*, Ser. D, Geol., vol. 6, no. 1, p. 27, pl. 8, fig. 1; pl. 10, fig. 1; pl. 11, fig. 1; pl. 13, fig. 1; pl. 15, fig. 1, text-figs. 8-9.

1965. *Yubariceras yubarense*, COLLIGNON, *Atlas des Fossiles Caracteristiques de Madagascar* (Ammonites), fasc. 12, p. 24, pl. 385, fig. 1657.

Holotype.—UMUT. MM 7620 [=I-343], from a pebble of the Pankemoyuparo, near the mouth of the Kaneobetsu, Oyubari area (Coll. H. YABE) (MATSUMOTO et al., 1957, pl. 8, fig. 1), the plaster cast of which is GK. H9009.

Material.—In addition to the specimens which were described in the previous paper (MATSUMOTO et al., 1957, p. 28), there is a well preserved immature specimen which enables us to give a revised description: HCS. No. 7, collected by S. KAWABATA (1970-7-12), from a calcareous nodule in the upper reaches of an unnamed small tributary (here temporarily called Inasato-no-sawa) of the Hobetsu River, Yufutsu-gun, central Hokkaido. There are a few incompletely preserved specimens from the Obira area which are probably referable to this species.

Diagnosis.—The shell is fairly large, attaining 225 mm in diameter in the largest known specimen (GH. 12005). It is rather evolute, with a little overlap of whorls. The umbilical seam of the outer whorl runs immediately outside the row of outer lateral tubercles of the next inner whorl. The umbilicus is of moderate size, occupying about 31 to 35 percent of the entire shell diameter. The whorl increases moderately with growth, showing the proportion of 1 to 2 in height between the inner and the next outer one. It is distinctly broader than high (B./H. = 1.2-1.4) and subrectangular in cross-section, having a broad, nearly flat or gently arched venter, rounded ventrolateral shoulders, gently convex, nearly parallel flanks, subrounded umbilical shoulders and vertical, fairly high walls.

The ribs are distant and of moderate intensity. They are mostly long, but occasionally a shorter rib is inserted. There is a certain extent of variation in rib density and intensity. Thus ribs number 19 to 24 per whorl. Most of the ribs are nearly rectiradiate on the flank and gently curved forward or nearly straight on the venter. Some of the ribs (along the constrictions) may be gently flexuous on the flank and curved a little more distinctl forward on the venter.

There are well marked periodic constrictions on the inner whorls of less

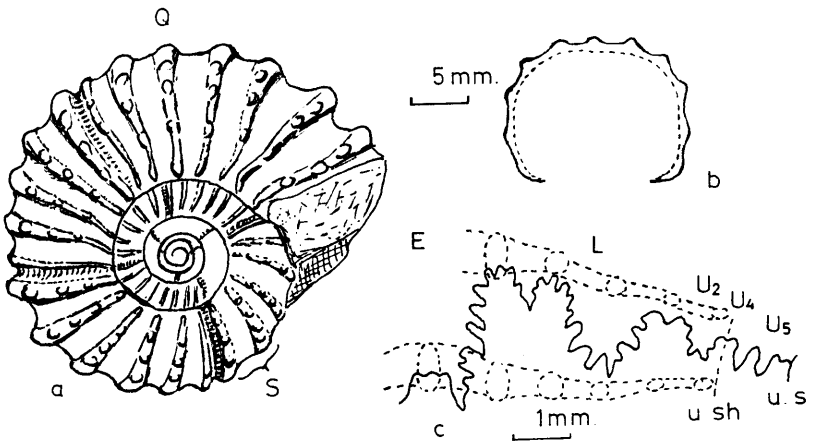


Fig. 11. *Yubariceras yubarense* MATSUMOTO, SAITO and FUKADA
Lateral view (a), whorl-section at Q (b) and the external suture (c) at S of an immature example, HCS. No. 7. (T. M. *delin.*)

than 30 mm in diameter, each of which is accompanied by a stronger rib behind it and a narrower and lower rib in front of it. Even in the earlier smoothish whorls of less than 8 mm in diameter there are constrictions. On the whorl of the middle growth-stage, as exemplified by the holotype with diameters of 40 to 80 mm, shallow constrictions are discernible. Unless the shell structure is examined, the constrictions are hardly recognized on the adult whorl.

The tubercles are in eleven rows. Those at the umbilical shoulder are rather small and sometimes bullate. The inner lateral tubercles are rounded or somewhat bullate, fairly strong on the long ribs, and especially prominent on the periodic strong ribs. The outer lateral tubercles are generally smaller and weaker than others, but in a certain limited part of a young shell they may be as strong as others. The inner ventrolateral are generally strong and have a rounded base. They become more prominent in later stages. The outer ventrolateral and the siphonal tubercles are clavate. They are considerably strong up to the middle growth-stage (i.e. to a diameter of about 80 mm) and gradually weaken toward the adult stage. On the adult body chamber the siphonnl tubercles are hardly discernible. The eleven rows of tubercles are nearly equidistant, although there may be some variation between individuals and also with growth. The inner lateral tubercles are always aligned inside the mid-flank.

The suture is of general acanthoceratid pattern. E is deep; L of moderate depth and fairly wide; U2 much small and situated near the row of umbilical tubercles. The first lateral saddle between E and L is broad, massive and subquadrate in rough outline and bipartite at the head. The second lateral saddle between L and U2 is smaller than but similar in outline to the first.

Measurements.—

Specimen (Position)	Diameter	Umbilicus	Height	Breadth	B./H.
HCS. 7 (−60°)	30.5(1)	10.8(.35)	12.8(.42)	16.4(.54)	1.28
UMUT. MM7620	85.5(1)	28.3(.33)	35.5(.41)	45.4(.53)	1.28
COLLIGNON (1965)	150.0(1)	50.0(.33)	67.0(.45)	84.0(.56)	1.25

Discussion.—*Yubariceras yubarense* is similar to *Romaniceras deverioide* (DE GROSSOUVRE, 1889) (emend. MATSUMOTO, 1959, p. 87), from the Turonian of France, Texas, California and Japan, in having nearly equidistant eleven rows of tubercles and fairly coarse ribs. The former has an *Acanthoceras*-like shell-form with a subquadrate whorl-section, whereas the latter has a *Calycoceras*-like shell-form with a rounded whorl-section. Constrictions are better marked on the whorls of early to middle growth-stages in the former, but are weakly marked only on the whorls of very early growth-stage in the latter.

Y. yubarense is closely allied to *Y. ornatissimum* (STOLICZKA) which is to be described below. The distinction is that in the former the ribs are not so much elevated and the inner lateral tubercles are not so distant from the umbilical tubercles as in the latter.

Occurrence.—Although the holotype was collected in a fallen or floated calcareous nodule, the general geology around the type locality suggests a high possibility of its derivation from Member My9 of the Oyubari sequence (NAGAO et al., 1954). This is on the extension of the upper part (Member IIq-IIr) of the Saku Formation in the Shiyubari valley (MATSUMOTO, 1942), where two paratypes were obtained (GK. H1531 from loc. Y462 and GK. H1532 from Y469p).

An immature specimen illustrated in this paper was obtained by S. KAWABATA (1970-7-12) in the upper reaches of an unnamed small tributary (here temporarily called the Inasato-no-sawa) of the Hobetsu River, Yufutsu-gun, Iburi province, from the zone of *Inoceramus hobetsensis*. A large paratype (GH. 12005) of OTATUME's collection came also from the lower part of the same *I. hobetsensis* zone of the Hobetsu area.

Two incompletely preserved but probably referable specimens were collected by T. MURAMOTO at two localities (Ob-A1p and Ob-S-6p) of the Sato-no-sawa, a small branch of the Kamikinembetsu-zawa, where Middle and Upper Turonian strata are generally exposed.

Thus, the available evidence indicates the occurrence of this species in the Middle and probably also Upper Turonian of Hokkaido, although the true range is not yet precisely determined.

COLLIGNON (1965) reported the occurrence of this species in the Lower Turonian zone of *Fagesia superstes* of Madagascar.

Yubariceras sp. aff. *Y. ornatissimum* (STOLICZKA)

Pl. 17, Fig. 2; Pl. 18, Fig. 1

Compare.—

1865. *Ammonites ornatissimus* STOLICZKA, *Pal. Indica*, vol. 1, p. 75, pl. 40.
1897. *Acanthoceras ornatissimum*, KOSSMAT, *Beitr. Geol. Pal. Oesterr.-Ungarns*, vol. 11, p. 16.

Holotype of *Y. ornatissimum*.—GSI. No. 174, monotype specimen described and illustrated by STOLICZKA (1865, p. 75, pl. 40) (Text-fig. 12 in this paper).

Material.—A fairly well preserved specimen, HCS. No. 8, from Hobetsu, central Hokkaido, collected by S. KAWABATA (45.7.12) is concerned with the present description.

Description of the holotype.—By courtesy of Mr. M.V.S. SASTRY, I had an opportunity to observe the holotype at Calcutta. It is an incomplete specimen consisting of about a quarter each of the outer and the next inner whorl. The last suture is in the posterior part of the outer whorl.

Diagnostic features observable on the holotype are (1) large size, (2) a little overlap of whorls (the ventral part of the inner whorl outside the row of outer lateral tubercles being overlapped by the outer whorl); (3) much broad whorl, showing the proportion of breadth to height [B./H.] from 1.29 to 1.45 in costal

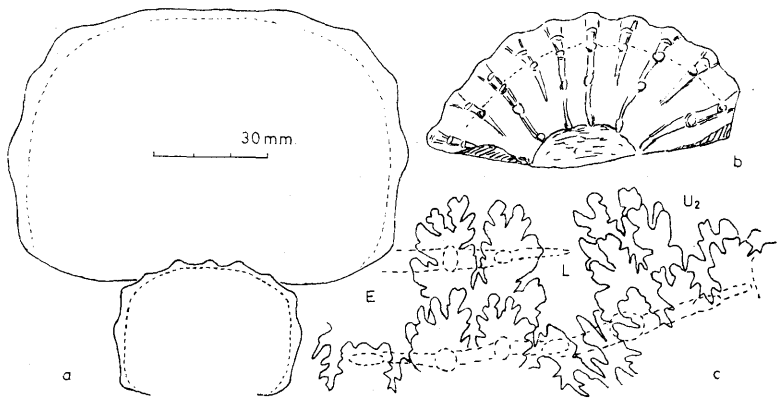


Fig. 12. *Yubariceras ornatissimum* (STOLICZKA)
Diagrammatic whorl-section (a), laleral view of the inner whorl (b) and the external suture on the outer whorl (c) of the holotype from India.
(T. M. *delin.*)

section and 1.25 to 1.43 in intercostal section; (4) subrectangular whorl-section, with a broad, very gently arched (earlier) to nearly flat (later) venter, sloping, subrounded (costal) or rounded (intercostal) ventrolateral shoulders, nearly flat or only slightly convex, subparallel flanks, subangular (costal) or subrounded (intercostal) umbilical shoulders and nearly vertical, fairly high umbilical walls; (5) distant, strongly elevated, nearly rectiradiate ribs, separated by wider interspaces, consisting of longer and shorter ones, with less frequent intercalation of the latter on the outer whorl; (6) eleven rows of tubercles, of which the outer nine are

nearly equidistant but the lower lateral one is much separated from the umbilical one (the distance being about 1.5 times as long as that of others) and the most prominent of all; (7) moderately strong, outer lateral tubercles, forming the ventrolateral shoulders on the inner whorl, smaller somewhat clavate inner ventrolateral tubercles rather shifted onto the ventral part, moderately strong somewhat clavate outer ventrolateral tubercles and a slightly lower and likewise clavate siphonal tubercle on the inner whorl; (8) broadening of the ribs, widened base of tubercles on the outer whorl; ventral three rows of tubercles, especially the siphonal one, much weakened and tending to disappear on the body chamber; (9) suture of general *Acanthoceras* pattern, with subsquarish outline of lateral saddles (see Text-fig. 12).

As the whorls of younger stages are not preserved in the holotype, the presence or absence of constrictions is not known.

Description of the Hokkaido specimen.—The last suture is at the whorl height of about 55 mm and the main part of the body chamber is not preserved in this specimen. This means that the size of the shell was not much different from that of the holotype. The whorl is increased moderately with growth, showing the proportion of 1 to 2 in size (breadth or height) between the inner and the next outer ones. The umbilicus is measured at about 31 percent of the entire shell diameter.

Almost all the diagnositic features presented by the holotype are shown in the Hokkaido specimen, except that described in (7). In our specimen the outer lateral tubercle is as a rule smaller and weaker than the inner ventrolateral one, which, in turn, presents the aspect of a ventrolateral shoulder in costal section.

In the last mentioned respect this specimen is rather similar to the holotype and other specimens of *Yubariceras yubarense*, but with respect to the strongly elevated ribbing and a long distance between the umbilical and the inner lateral tubercles it is much closer to the holotype of *Y. ornatissimum*. These facts might suggest that *Y. yubarense* and *Y. ornatissimum* could be of identical species, showing aspects of great variation. For the time being the two species are separated and the present specimen is provisionally called *Yubariceras* sp. aff. *Y. ornatissimum*.

On the third inner whorl of the Hokkaido specimen, with a diameter of presumably 30 mm or so, a constriction is discernible which is associated with a more elevated rib. Still inner whorls are unfortunately destroyed. On the other hand on the succeeding whorl, up to the diameter of about 80 mm, some of the long ribs are periodically more elevated than others and provided with a very prominent lower lateral tubercle. The rib immediately in front of the periodically strong one is narrower than others and has no or a very weak lower lateral tubercle. The interspace between these two ribs may be somewhat deeper than others, if

not forming a distinct constriction. This feature is fairly similar to that observed on the middle-aged shell of *Y. yubarense*, in which periodic constrictions are better discernible. From these facts, I am inclined to consider that a periodic arrest of growth essentially corresponding to the formation of a periodic constriction may have taken place in the Hokkaido specimen and presumably also in *Y. ornatissimum* itself.

Measurements.—

Specimen	Diameter	Umbilicus	Height	Breadth	B./H.
GSI. 174 (outer)	—	—	73.0	106.0	1.45
〃 (inner)	—	—	56.5	50.0	1.34
HCS. 8 (end)	145.0(1)	45.3(.31)	59.0(.40)	80.0(.55)	1.35
〃 (−90°)	120.0(1)	38.0(.31)	47.5(.39)	63.0(.52)	1.32

Occurrence.—The described specimen was found by S. KAWABATA in a calcareous nodule in the upper reaches of an unnamed small tributary (here temporarily called Inasato-no-sawa) of the Hobetsu River, Yufutsu-gun, central Hokkaido. This is generally of the same area, if not of identical bed, where a specimen of *Y. yubarense* was obtained.

According to KOSSMAT (1897, p. 18) the holotype of *Y. ornatissimum* occurred in the upper part of the Utatur [Ootatoor] Group of southern India. This may be Lower Turonian.

Yubariceras sp. nov. (?)

Pl. 20, Fig. 1

Material.—GK. H5698, from loc. Yb 333bp (coll. T. MURAMOTO and T. MATSUMOTO).

Description.—This is an incompletely preserved internal mould, consisting of a part (about 60°) of the outer whorl and a ventral portion of the next inner whorl. The outer whorl has three last septa and the beginning of the body chamber. It is much broader than high, with the dimensions: height = 50.0 mm,

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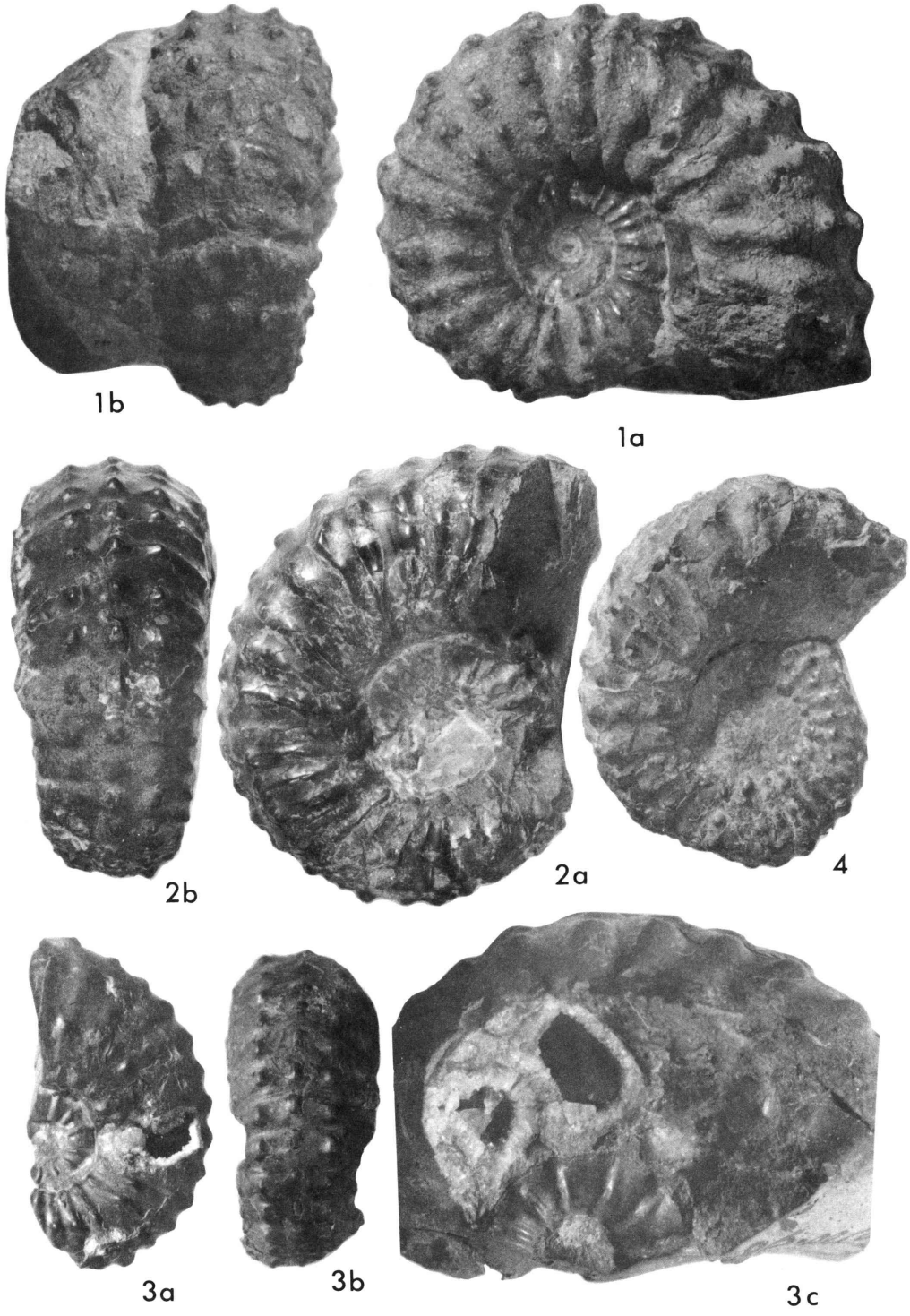
Explanation of Plate 19

Fig. 1. *Yubariceras yubarense* MATSUMOTO, SAITO and FUKADA .....Page 133
An immature specimen. HCS. No. 7 (S. KAWABATA Coll.), from the Inasato-no-sawa, Hobetsu. Lateral (a) and ventral (b) views, ×2.

Figs. 2-3. *Yubariceras japonicum* MATSUMOTO, SAITO and FUKADA .....Page 139
2. GK. H5687 [=M. 72, T. MURAMOTO Coll.], from the Taki-no-sawa, Oyubari. Lateral (a) and ventral (b) views, ×1.
3. M. 73 (T. MURAMOTO Coll.), from Ob-00106p, Obira. Right lateral (a) and ventral (b) views, ×1; enlarged left lateral view (c), in which the inner whorl is exposed, ×2.

Fig. 4. *Romaniceras* sp. cf. *R. kanei* JONES .....Page 123
GK. H5699 (Coll. K. MURAMOTO and T. TAKAHASHI), from the Hakkin-zawa, Oyubari. Lateral view, ×1.

Kyushu Univ. (H. HIRANO) photos, without whitening.



T. MATSUMOTO: Additional Acanthoceratids

breadth = 77.5 mm, b/h = 1.55 in an intercostal section having a depressed subrectangular section, a broad venter, nearly parallel flanks and almost vertical, high umbilical walls.

The increase of whorl seems to be rapid. The outer whorl is about three times as wide as the next inner one.

The outer whorl has distant, low but broad ribs, which consist of alternating primaries and secondaries at this last part of the septate stage. The primary rib has a distinct tubercle at the umbilical shoulder and a prominent lateral tubercle somewhat below the mid-flank. The secondary rib is nearly as long as the primary but devoid of these tubercles. Every rib has a prominent tubercle at the subangular ventrolateral shoulder. The rib shows a gently forward curve on the ventral part. The siphonal and the paired ventral (i.e. shifted outer ventrolateral) tubercles are still retained as faint bulges at this stage.

On the preserved ventral part of the inner whorl there are fairly crowded numerous somewhat projected ribs. The ventrolateral shoulder is rather at the outer ventrolateral tubercle. The train of siphonal clavi apparently forms a keel like elevation.

The suture exposed on the outer whorl is similar to that of *Yubariceras yubarense*.

Discussion.—The outer whorl of the present specimen resembles that of *Yubariceras yubarense* and *Y. ornatissimum* described in the preceding pages, but is much broader and has only one instead of two rows of lateral tubercles. It is close to *Y. ornatissimum* in the persistence of alternation of primary and secondary ribs but the ribs are much lower than in that species. The lateral tubercle is closer to the umbilical tubercle in this form but they are much separated in *Y. ornatissimum*. The marked difference in the whorl breadth and the rib density between the inner and the outer whorls is characteristic of the present form.

The described specimen probably represents a new species of *Yubariceras*, but I would not propose a new name until better preserved specimens are obtained.

Occurrence.—The specimen was found in a fallen block of sandstone at loc. Yb 333b, along the lower course of the Ponhorokabetsu, Yubari (for location see MATSUMOTO and HARADA, 1964, map of pl. 11). *Glycymeris hokkaidoensis* (YABE and NAGAO) occurs abundantly in the same sandstone, which is referred to unit Mk3 of the Mikasa Formation (MATSUMOTO and HARADA, 1964). The age is probably Middle Turonian.

Yubariceras japonicum MATSUMOTO, SAITO and FUKADA

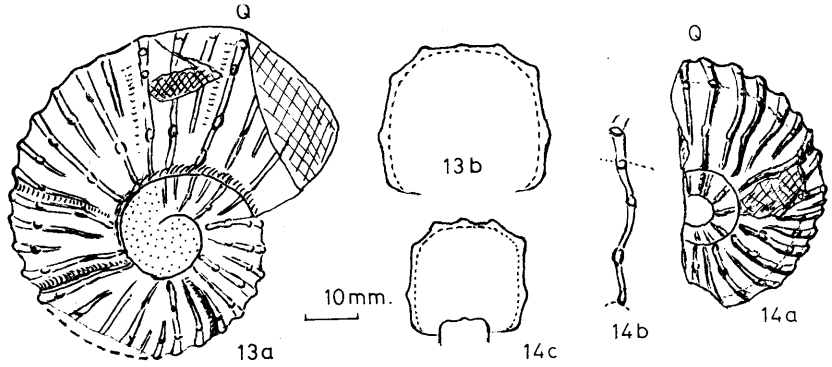
Pl. 19, Figs. 2-3; Pl. 21, Fig. 2; Text-figs. 13-14

1957. *Yubariceras [Romaniceras?] japonicum* (ex YABE MS.) MATSUMOTO, SAITO and FUKADA. *Mem. Fac. Sci., Kyushu Univ.*, Ser. D, Geol., vol. 6, no. 1, p. 31,

pl. 8, fig. 2; text-figs. 11, 12.

Material.—Holotype, UMUT. MM 7622 [= I-345] from the Oyubari area (YABE's Coll.). The following three specimens subsequently collected by T. MURAMOTO are useful for clearer definition of the present species: GK. H 5687 [= M. 72], from Taki-no-sawa, Oyubari area; M. 73, from Ob-00106p. and M. 74, from Ob-08 p, Obira area.

Diagnosis.—This species is characterized by its (1) fairly rapidly growing whorls, showing the proportion of whorl-height between the inner and the next outer whorls at about 2.5; (2) subquadrate whorl-section with a broadly arched venter and subparallel or slowly convergent flanks; (3) numerous (32 or 33) ribs of moderate to low intensity on the whorl of middle growth-stage (with diameters from about 30 to 70 mm), consisting of longer and somewhat shorter ones; (4) gentle but diagnostic flexuosity of some ribs on the flank; (5) gently forward curvature of the ribs on the venter; (6) nine rows of tubercles, in which the lateral one is closer to the umbilical one than to the one at the ventrolateral shoulder; (7) periodic constrictions which are weakened with growth, being accompanied by a relatively raised, major ribs; (8) occasional appearance of a much shorter extra rib along some of the constrictions, which bears no lateral tubercles and sometimes no lower ventrolateral tubercles either, and (9) rather narrow stem of the first lateral lobe (L) of the suture.



Figs. 13-14. *Yubariceras japonicum* MATSUMOTO, SAITO and FUKADA.
13. Sketch in lateral view (a) and a diagrammatic whorl-section (b) at Q of the holotype. 14. Lateral view (a), whorl-section (b) at Q and an enlarged sketch of a flexuous rib of M. 73. (T. M. *delin.*)

Remarks.—As the holotype (about 70 mm in the maximum diameter) is wholly septate, the full-grown shell must be larger. In M. 73 (about 50 mm in diameter) the impression of a still outer whorl is preserved. The diameter of the missing outer whorl would be about 120 mm. In the same specimen the inner whorl of about 20 mm in diameter is observable (Pl. 19, Fig. 3). In contrast to numerous ribbing on the whorl of middle growth-stage, it has only a small number (6 on a

half whorl) of much distant, major ribs of moderate intensity some of which accompany a narrow constriction.

As was described previously (MATSUMOTO et al., 1957, p. 31, text-fig. 11), the whorl-section of the holotype is trapezoidally subquadrate, being broadest in the dorsal part. Other specimens have nearly parallel flanks. The difference is, however, by no means great, being well within the extent of variation. With respect to the proportion of breadth to height only a small extent of variation is shown by the four specimens.

There is a considerable variation between individuals and also between shells of different growth-stage in the frequency of intercalated shorter ribs. On the holotype, which is wholly septate and probably represents a middle growth-stage, long and short ribs are as a rule alternated. On the outer whorl of GK. H 5687, which is nearly as large as the holotype, the intercalated shorter ribs are mostly long, appearing at a point between the umbilical shoulder and the row of lateral tubercles. Some of the two adjacent longer ribs have no intercalated shorter one. On the observable outer whorl of M. 73 the shorter ribs occur less frequently and are almost as long as the longer ones, although they have no umbilical tubercles.

So far as the holotype and GK. H 5687 of about 60 or 70 mm in diameter are regarded as representing middle growth-stage, no example of the mature shell has been found in the available collection. How the characters would change in the adult whorl should be studied in the future. Judging from the general tendency in *Yubariceras*, it could be expected that the intercalation of shorter ribs would become more infrequent or none in the adult stage.

In the shell of the middle growth-stage, the umbilical tubercles at the end of the long ribs are moderately strong; the lateral tubercles are more or less bullate and of unequal intensity, being fairly prominent on the longer ribs, especially so on the periodically stronger ribs and weak on the shorter ribs; the tubercles at the ventrolateral shoulder are nearly equally prominent, generally rounded at the base but sometimes somewhat clavate; the ventral three tubercles are more or less clavate and moderately prominent at this stage, although they may be weakened on the whorl of later stages. On a part of the holotype, on which the outer shell layer is preserved, the ventral tubercles are much more clavate than on other parts.

Forms which are outside the extent of the above variation are to be described under *Yubariceras* sp. aff. *Y. japonicum* (see p. 143).

Measurements.—

Specimen	Diameter	Umbilicus	Height	Breadth	B./H.
UMUT. MM 7622	61.0(1)	19.0(.31)	27.5(.45)	29.5(.48)	1.07
GK. H 5687	67.5(1)	21.3(.31)	29.0(.43)	32.2(.43)	1.11
M. 73	~50.0(1)	14.5(.29)	22.8(.46)	24.0(.48)	1.05
M. 74	47.5(1)	15.0(.31)	20.5(.43)	22.0(.46)	1.07

Discussion.—Previously (MATSUMOTO et al., 1957, p. 31) this species was assigned to *Yubariceras* with a query, retaining a possibility that it might be referable to *Romaniceras*. Subsequently it was regarded by WIEDMANN (1960, p. 735; 1964, p. 123), though again with a query, as an example of *Romaniceras* (*Proromaniceras*).

With respect to the configuration of tubercles *Y. japonicum* is indeed similar to *Romaniceras pseudodeverianum* (JIMBO), but the latter has higher whorl of subelliptical section and more distant, more distinctly rectiradiate ribs which become predominant over tubercles on the outer whorl, showing closer affinity with a probably ancestral group of *Calycoceras orientale*.

As is shown by the above described characters, this species is unrelated to *Calycoceras* and more allied to certain species of *Acanthoceras*. If its lateral tubercles were excluded, it would closely resemble a form of *Acanthoceras rhotomagense* called *A. rhotomagense* var. *subflexuosum* SPATH (see KENNEDY and HANCOCK, 1970, p. 469, pl. 90, figs. 1-4), from the Middle Cenomanian of Europe. The presence of lateral tubercles and that of weak constrictions which are accompanied by comparatively more raised ribs and occasionally with extra ventral ribs are diagnostic. The distant ribbing in the young immature stage without intercalation of shorter ones, as seen in M. 73, seems to be particular to the present species, being similar to the costation on the outer whorl of such a form as *Acanthoceras rhotomagense* var. *confusum* (GUERANGER) (see KENNEDY and HANCOCK, 1970, p. 478, pl. 94, figs. 1-4, pl. 95, fig. 1).

Summarizing the above observations, I refer the present species to the genus *Yubariceras*. Should the short distance between the lateral and the umbilical tubercles be stressed, a new subgeneric name might be required under *Yubariceras*, just as *Proromaniceras* was proposed under *Romaniceras*. Under the present circumstances I would not dare to propose it. If one more row of tubercles were added at the outer lateral part, a form like *Yubariceras yubarense* could be led. *Y. japonicum* and *Y. yubarense* are, however, nearly contemporary. Besides the difference in the number of tubercles, *Y. japonicum* has generally more crowded, more numerous and more flexuous ribs and weaker tubercles than *Y. yubarense* in the middle growth-stage.

Occurrence.—The holotype was in a calcareous nodule in the Yubari River, Oyubari area, central Hokkaido. Although YABE (1927) listed this species [*Acanthoceras* (*Kossmatia*) *japonica* YABE MS. nom. nud.] under his *Mammites* bed, this does not mean that it was collected together with *Mammites* sp. (The actual specimen of *Mammites* sp. in YABE's collection was found in the Obira area).

GK. H 5697 [=M. 72], which closely resembles the holotype, was collected from Taki-no-sawa [=Penkemoyuparo], Oyubari area, together with *Inoceramus tenuistriatus* NAGAO and MATSUMOTO.

M. 73 was from loc. Ob-00106p of MURAMOTO, Nanbu-no-sawa, a small tributary of the Obirashibe River, together with *Inoceramus teshioensis* NAGAO and MATSUMOTO, and M. 74 from his loc. Ob-08p [=R 2257p of MATSUMOTO], Kami-kinembetsu-zawa, a tributary of the same river, Obira area, District of Rumoi (Teshio province), northwestern Hokkaido, together with *Inoceramus hobetsensis* NAGAO and MATSUMOTO.

Thus, the available records suggest the age of Middle to Upper Turonian.

Yubariceras sp. aff. *Y. japonicum* MATSUMOTO, SAITO and FUKADA

Pl. 21, Figs. 3-4; Pl. 23, Fig. 2

Material.—GK. H 5686, from loc. IA 1618 (A. INOMA's Coll), on which shell layers are partly preserved, and NSM. 5817 from loc. Ik 1425 p (T. MURAMOTO's Coll.).

Description.—The above two specimens are similar to the holotype and other examples of *Y. japonicum*, described in the preceding pages, with respect to the characters (1), (2), (4), (5), (6), (7), and (9). The flanks are nearly parallel and the venter is more rounded. Ribs are less numerous (12 in a half whorl), separated by wider interspaces. They are more flexuous and more distinctly prorsiradiate on the flank on the whorl of a late growth-stage. The lateral tubercles are more distinctly bullate and tend to be intimately connected with the umbilical bullae.

The two specimens are not quite identical to each other in that the three rows of ventral tubercles are distinctly clavate in GK. H 5686 but less so and the ventral projection of ribs is more pronounced in NSM. 5817, in which an extra rib is discernible. The former has a wider umbilicus.

The inner whorl preserved in GK. H 5686 has distant long ribs and periodic constrictions but the ribs are weaker than in M. 73 of *Y. japonicum*.

The two specimens seem to represent a form which is closely allied to but not morphologically quite identical with *Yubariceras japonicum*. It may be a chronologically somewhat older subspecies, but the available evidence is not sufficient to lead a definite conclusion. For the time being I call the two specimens *Yubariceras* sp. aff. *Y. japonicum*.

Measurements.—

Specimen	Diameter	Umbilicus	Height	Breadth	B./H.
GK. H 5686	84.0(1)	28.5(.34)	30.0(.35)	32.4(.38)	1.08
NSM. 5817	63.5(1)	19.5(.30)	27.5(.43)	28.5(.45)	1.03

Occurrence.—GK. H 5686 was obtained by A. INOMA at loc. IA. 1618, Yamamonbetsu area, Hidaka province, from his unit B (JPE unpublished report), which he refers to the lower half of Turonian.

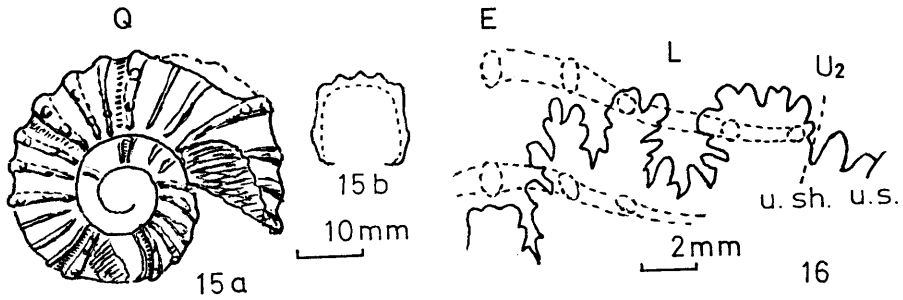
NSM. 5817 was collected by T. MURAMOTO at loc. Ik 1425p, a floated calcareous nodule of Kami-ichi-no-sawa, Ikushumbets area, and its stratigraphic position is uncertain.

Yubariceras otatumei (MATSUMOTO, SAITO and FUKADA)
Pl. 21, Fig. 1; Text-figs. 15-16

1957. *Romaniceras* (?) *otatumei* MATSUMOTO, SAITO and FUKADA, *Mem. Fac Sci., Kyushu Univ.*, Ser. D, Geol., vol. 6, no. 1, p. 25, pl. 2, fig. 2.

Material.—Holotype is UMUT. I-3185, as originally designated. Another, similarly small specimen, M. 75 of T. MURAMOTO's Collection, from loc. Ob-Ap3, is a good example in the subsequent acquisition. The two specimens are represented by internal moulds, but shell layers are in part preserved.

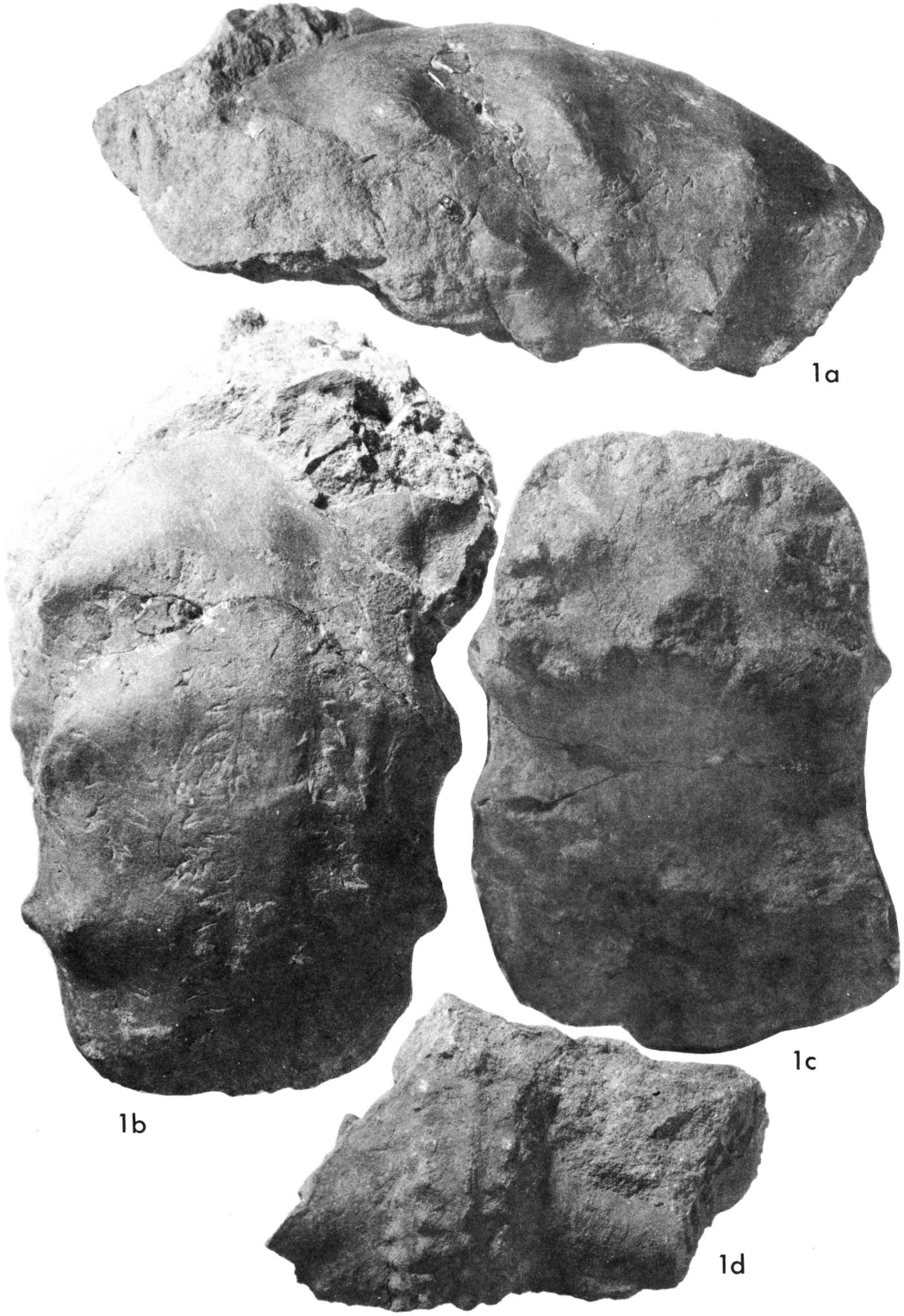
Diagnosis.—This species is characterized by its (1) small size; (2) rather slowly growing whorl, with a little overlap; (3) umbilicus of moderate size; (4) earlier, subrounded and later, subquadrate whorl section, a little broader than high, with a gently inflated flanks and a broadly rounded venter; (5) nearly smooth and periodically constricted shell of an early stage (with diameters below 15 mm); (6) equally long ribs of moderate intensity, 23 or so per whorl in the late growth-stage, some of which are periodically stronger than others and on the septate whorl accompanied with an indistinct narrow constriction and sometimes also with a smaller (narrower and/or shorter) extra rib; (7) periodic occurrence of a fairly wide interspace between the ribs, although for most parts the ribs are



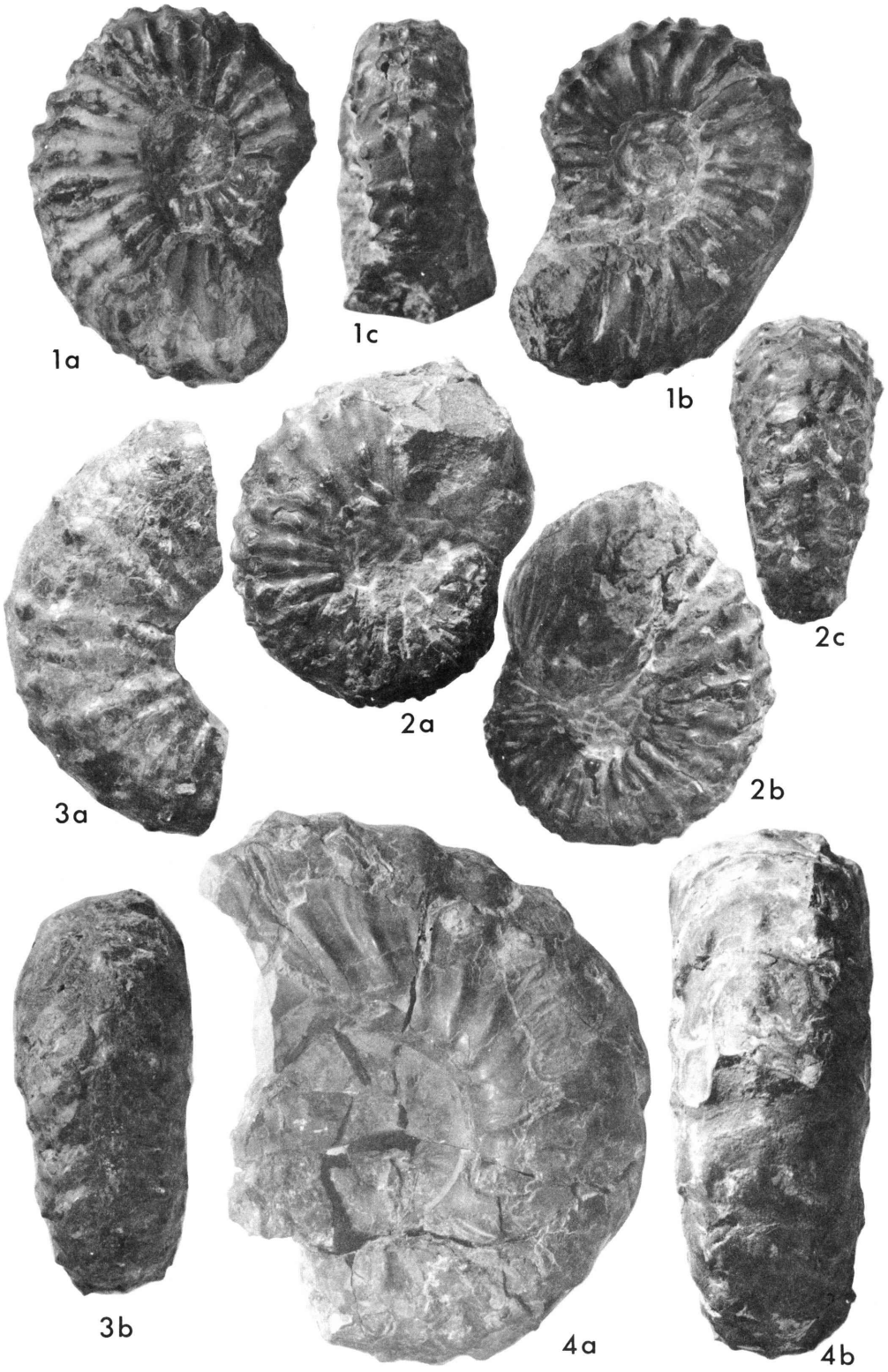
Figs. 15-16. *Yubariceras otatumei* (MATSUMOTO, SAITO and FUKADA)
15. A sketch in lateral view (a) and a diagrammatic whorl-section (b) at Q of the holotype. 16. External suture at whorl-height = 8.5 mm of M. 75.
(T. M. *delin*)

Explanation of Plate 20

Fig. 1. *Yubariceras* sp. nov. (?).....Page 138
GK. H5898 (T. MURAMOTO and T. MATSUMOTO Coll.), from loc. Yb 336p, Mikasa Formation, Yubari dome. Lateral (a) and ventral (b) views and a natural whorl-section with dorsal side (c) of the outer whorl, × 0.8; dorsal view of the inner whorl, ×1.
Kyushu Univ. (HIRANO) photos without whitening.



T. MATSUMOTO: Additional Acanthoceratids



T. MATSUMOTO: Additional Acanthoceratids

separated by interspaces somewhat or a little wider than the ribs; (8) nearly rectiradiate or slightly prorsiradiate course of the ribs on the flank and a more or less forward curve of them on the venter; the extra ribs show a more pronounced ventral projection; (9) nine rows of tubercles, in which the umbilical and the lateral tubercles are prominent on the periodically strong ribs and very weak and bullate on some of the long but narrower ribs; (10) somewhat shorter distance between the umbilical and the lateral tubercles than that between the lateral and the ventrolateral ones, the difference becoming larger as the whorl grows and (11) rather narrow stem of L in the suture.

Measurements.—

Specimen	Diameter	Umbilicus	Height	Breadth	B./H.
UMUT. I-3185	42.5(1)	14.1(.33)	15.5(.36)	16.4(.38)	1.06
〃 (−90°)	32.0(1)	12.0(.37)	13.0(.40)	14.0(.43)	1.07
M. 75	37.5(1)	12.5(.33)	14.6(.38)	15.8(.42)	1.08

Remarks.—The two specimens closely resemble each other, except for that the ventral tubercles in three rows are distinctly clavate in GT. I-3185, but less distinctly clavate in M. 75.

Discussion.—Although this species was provisionally referred to *Romaniceras* with a query (MATSUMOTO et al., 1957, p. 26), it is better assigned to *Yubariceras*, because it has a subquadrate whorl section, predominant long ribs almost without shorter ribs, periodic constrictions and some extra ribs.

In spite of the small size the two specimens both have a body chamber on which ribs are coarsened and constriction is not well marked. They can be, therefore, regarded as representing an adult stage. The unusually small size is probably a specific character, but it could be considered that the present form might be a microform of a dimorphic species. In such an interpretation *Yubariceras japonicum*, described in the preceding pages, could be considered as a possible macroform. *Y. otatumei* indeed resembles *Y. japonicum* in some

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Explanation of Plate 21

Fig. 1. *Yubariceras otatumei* (MATSUMOTO, SAITO aud FUKADA).....Page 144
M. 75 (T. MURAMOTO Coll.), from Ob-A-p3, Obira. Right (a) and left (b) lateral and ventral (c) views, ×1.

Fig. 2. *Yubariceras japonicum* MATSUMOTO, SAITO and FUKADA.....Page 139
M. 74 (T. MURAMOTO Coll.), from Ob-08p, Obira. Left (a) and right (b) lateral and ventral (c) views, ×1.

Fig. 3-4. *Yubariceras* sp. aff. *Y. japonicum* MATSUMOTO, SAITO and FUKADA .....Page 143
3. NSM. 5817 (T. MURAMOTO Coll.), from loc. Ik 1425p, Ikushumbets, Lateral (a) and ventral (b) views, ×1. (see also Pl. 23, Fig. 2).
4. GK. H5686 (A. INOMA Coll.), from Yamamonbetsu, Hidaka. Lateral (a) and ventral (b) views, ×1.

Kyushu Univ. (H. HIRANO) photos, without whitening.

respects, but the former has a wider umbilicus and less numerous, more distant ribs in which shorter ribs are scarcely intercalated or secondary ribs are nearly as long as the major ones. The ribs are often characteristically flexuous in *Y. japonicum*, whereas they are rectiradiate in *Y. otatumei*. For these reasons I conclude that *Y. japonicum* and *Y. otatumei* are specifically distinct.

It should be noted that *Y. otatumei* is allied to "*Acanthoceras douvillei*" PERVINQUIÈRE (1907, p. 274, pl. 12, figs. 2, 3), from the Lower Turonian of Tunisia, in many respects, including the peculiar spacing of the ribs medtioned in (7). In the immature shell of PERVINQUIÈRE's species, as represented by his pl. 12, fig. 2, constrictions and extra ribs seem to exist, although they have been overlooked. (I follow PERVINQUIÈRE about the specific identity between the two illustrated specimens: PERVINQUIÈRE, 1907, pl. 12, figs. 2 and 3). The incipient lateral tubercles exist in *A. douvillei* as the original author had already mentioned and as COLLIGNON (1965, p. 38, pl. 392, fig 1672) observed on an example from Madagascar. *A. douvillei* was referred by WIEDMANN (1960, p. 736) to his *Schindewolfites*, but it seems to have more regular ornament than *S. inaequicostatus* WIEDMANN, the type-species. Anyhow, *Y. otatumei* has a row of distinct lateral tubercles which is more approximated to the row of umbilical tubercles.

Occurrence.—The holotype was obtained by the late Dr. OTATUME from the zone of *Inoceramus hobetsensis* at Nutapomanai, Kami-hobetsu, Hobetsu area, Yufutsu-gun, Iburi province, central Hokkaido. M. 75 was collected by T. MURAMOTO from his loc. Ob-A-p3, Sato-no-sawa, a small branch stream of the Kami-kinembetsu-zawa, Obira area, District of Rumoi (part of Teshio Province), northwestern Hokkaido, occurring together with *Reesidites minimus*. These records indicate that *Yubariceras otatumei* ranges from Middle to Upper Turonian.

Yubariceras pseudomphalum sp. nov.

Pl. 22, Fig. 1

Material.—Holotype is M. 76 of MURAMOTO's Collection, from Taki-no-sawa, Oyubari area, found by Mr. Igarashi and transferrd to T. MURAMOTO. Paratype, which probably represents the inner whorl, is M. 77 of MURAMOTO's Collection, from loc. Ob-S-A4p2, Obira area.

Diagnosis.—This species is characterized by (1) rather evolute whorl encircling the umbilicus of moderate width; (2) subquadrate whorl-section, somewhat broader than high, broadest at the mid-flank, with nearly parallel and gently inflated flanks and a broadly arched venter; (3) nearly rectiradiate and sometimes gently flexuous ribs, which show a gently forward curve on the venter; (4) differentiation of the ribs on the septate whorl into relatively stronger (broader and more elevated) and weaker (narrower, lower, and sometimes shorter) ribs; (5) presence of extra ribs on the ventral part and weak constrictions on the septate

whorl; (6) distant major ribs, without intercalated minor ones, on the body chamber; (7) nine rows of tubercles, in which the umbilical, the lateral and the ventrolateral ones are nearly equidistant on the flank; ventral tubercles in five rows are equidistant though at a shorter interval; (8) somewhat more numerous tubercles on the venter than on the flank on account of the extra ribs; (9) prominence of the tubercles at the ventrolateral shoulder especially on the outer whorl; moderate intensity of the lateral tubercles on the stronger ribs in contrast to the weak and sometimes imperceptible lateral bullae on the weaker ribs, and (10) sutures of *Acanthoceras* type, with moderately deep and narrow lobules.

Measurements.—

Specimen	Diameter	Umbilicus	Height	Breadth	B./H.
M. 76	93.0	30.0(.32)	—	—	—
〃 (−45°)	—	—	39.0	45.5	1.17
M. 77	19.3	6.6(.34)	7.5	10.2	1.36

Remarks.—The smaller paratype, M. 77 has relatively broader whorl and somewhat more crowded ribs than M. 76 (holotype), but they are essentially the same in diagnostic features. Therefore, M. 77 is regarded as probably an immature shell of the same species. M. 76 has the last suture at whorl-height of 37 mm.

Discussion.—Although the type specimens are incompletely preserved, the observed characters are sufficiently distinct for separating this species from others.

Y. pseudomphalum somewhat resembles *Y. japonicum*, but the former has a wider umbilicus and a broader whorl than the latter. The lateral tubercle is at about the middle of the flank, approximately midway between the umbilical and the ventrolateral tubercles in *Y. pseudomphalum*, but is in the lower (i.e. inner) part of the flank, being closer to the umbilical tubercles in *Y. joponicum*. Furthermore, the ventral extra ribs and consequently the extra ventral tubercles occur more frequently in *Y. pseudomphalum* than in *Y. japonicum*, although the variations in this respect may overlap to some extent between the two species.

If the lateral tubercles were excluded, the shell of the present species would resemble that of *Euomphaloceras lonsdalei* (Adkins) (1928, p. 244, pl. 26, fig. 5; pl. 27, fig. 3), from the Cenomanian of Texas, and also that of *Acanthoceras rhotomagense pseudeuomphalum* Thomel (1972, p. 135, pl. 56, figs. 3-5; pl. 70, figs. 8-13) and especially closely that of "*Euomphaloceras* sp. transitional from *Acanthoceras rhotomagense* var. *sussexiense*" of Kennedy and Hancock (1970, pl. 93, figs. 1, 2), from the Cenomanian of Rouen, France.

This fact strongly suggests that the origin of the present species can be sought in this kind of species and that many, if not all, of the species of *Yubariceras* may have derived from certain species of *Euomphaloceras*, or a

group of *Acanthoceras* species which are transitional to *Euomphaloceras*.

Occurrence.—Holotype was collected from one of the floated calcareous nodules in the Taki-no-sawa [= Pankemoyuparo], Oyubari area, central Hokkaido. Its stratigraphic position is, therefore, uncertain, although Turonian strata are well exposed and relatively prolific in the sequence along this stream. Paratype was collected by T. MURAMOTO from loc. Ob-S-A-4p2, Sato-no-sawa, Obira area, within the Turonian sequence.

Yubariceras fujishimai sp. nov.

Pl. 22, Fig. 2; Pl. 23, Fig. 3; Text-fig. 17

Material.—Holotype is HCS. No. 40, from the Kaneobetsu, Oyubari area, collected by Yasutaka FUJISHIMA, to whom the specific name is dedicated.

Diagnosis.—This species has a shell of moderate size (about 125 mm in diameter) which shows a remarkable difference between the septate whorl and the adult body chamber.

The septate shell is characterized by (1) moderately increasing whorl encircling the umbilicus of moderate width (about 30 percent of the shell diameter); (2) subquadrate whorl-section, slightly broader than high, with a broadly arched venter, subrounded ventrolateral shoulders, nearly parallel flanks, subangular umbilical walls; (3) ribs consisting of longer ones of moderate intensity and weaker

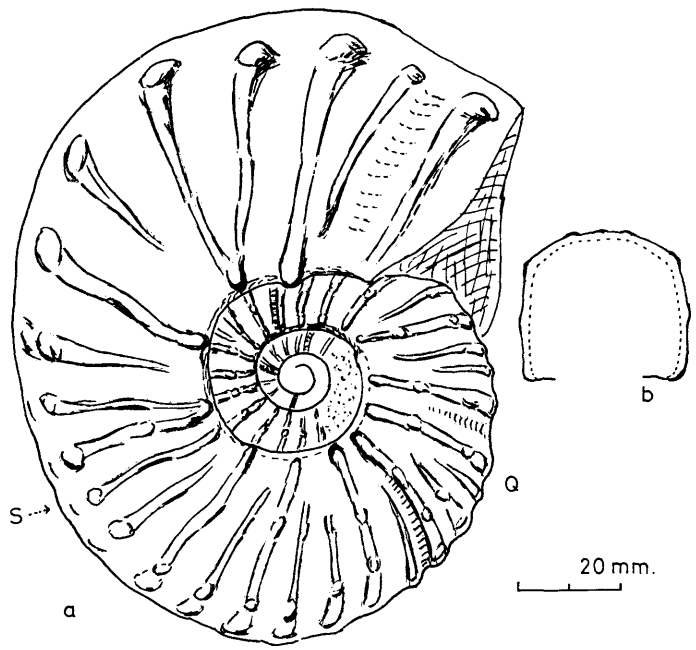


Fig. 17. *Yubariceras fujishimai* sp. nov.
A sketch in lateral view (a) and a diagrammatic whorl-section (b) at Q of the holotype. S: position of the last suture. (T. M. *delin.*)

shorter ones, which altogether are numerous, fairly crowded, nearly rectiradiate or slightly flexuous on the flank and curved gently forward on the ventral part; (4) presence of periodic constrictions, in association with more raised ribs, on the inner whorl, which may persist as shallow, indistinct ones on the outer whorl; (5) nine rows of tubercles, of which the lateral ones are fairly strong on the long ribs, situated at about the middle of the flank, midway between the smaller umbilical and the weaker ventrolateral ones; ventral ones in three rows are more or less clavate; (6) the presence of extra ribs and accordingly smaller extra tubercles on the ventral part and (7) moderately incised sutures of *Acanthoceras* type.

The adult body chamber, which occupies about a half whorl, and the last part of the septate whorl immediately preceding to the body chamber are characterized by (8) more quadrate shape with a flatter venter, subangular shoulders, flat and parallel flanks, angular umbilical shoulders, and vertical or even slightly overhanging, high umbilical walls; (9) longer and shorter ribs, becoming more distant as the whorl grows, much weakened, being almost imperceptible on the venter, and some of which tend to be obsolete even on the flank; (10) distant, prominent umbilical tubercles which may be produced to the umbilicus; (11) distant, prominent ventrolateral tubercles, which are strengthened on the last quarter whorl to form a short horn and twice as numerous as the umbilical ones; (12) weakened lateral tubercles, some of which remain as faint bullae and others lost and (13) disappearance of the ventral tubercles.

Measurements.—

Position	Diameter	Umbilicus	Height	Breadth	B./H.
−80°*	125.0	30.5(.24)	55.0(.44)	55.0(.44)	1.0
−260°	68.0	20.4(.30)	34.4(.50)	35.6(.52)	1.03

* measured in a deformed state

Remarks.—The body chamber considerably embraces the next inner whorl and the umbilicus is fairly narrow, although its deformed condition may have modified the original dimensions to some extent.

Discussion.—Although only a single specimen is available, the observed characters are diagnostic enough for representing a new species.

The septate whorl of this species closely resembles that of *Yubariceras pseudomphalum* n. sp. described in the preceding pages. Therefore, someone might consider a possibility of sexual dimorphism between the two forms whose adult whorls are remarkably different. However, if we compare them carefully, the distinction can be found even in the septate part that the present species has more frequently intercalated shorter ribs and a less depressed whorl.

With respect to the weakening or obsolescence of the ribs and strengthening of the umbilical and the ventrolateral tubercles on the adult body chamber this

species is somewhat similar to *Acanthoceras stephensoni* ADKINS (1928, p. 246, pl. 31, figs. 1, 2) from the Eagle Ford Flag Member (Upper Cenomanian) of Texas, but the presence of the lateral tubercles and less persistence of ventral tubercles enable us to distinguish it from that species.

Occurrence.—The holotype was obtained by Y. FUJISHIMA at a locality about 400 m southeast from the mouth of the Kaneobetsu River, a tributary of the Penkemoyuparo, Oyubari area, from the bed assigned to My 9 of NAGAO et al. (1954), Upper Turonian. Numerous specimens of *Scaphites* were associated with it.

Genus ***Obiraceras*** nov.

Type-species.—*Obiraceras ornatum* sp. nov. (to be described below), from the Turonian of Hokkaido.

Diagnosis.—Rather evolute ammonites with an umbilicus of moderate width, a subquadrate or subrectangular whorl section, a rather flat or gently arched venter, parallel flanks and low but nearly vertical walls.

The shell is ornamented with nearly rectiradiate ribs, which consist of longer primaries and shorter or narrower secondaries, and tubercles in nine rows. The umbilical, the lateral and the inner ventrolateral tubercles on the primary ribs are prominent and somewhat spinose in the late growth-stages. At the adolescent stage multituberculation occurs on the venter on account of doubling of the inner and the outer ventrolateral tubercles. The shorter ribs have no or scarcely perceptible lateral tubercles.

The suture is of *Acanthoceras* pattern in general aspects, but has a fairly narrow, deep and roughly rectangular stem of the first lateral lobe and fairly deep lobules.

Etymology.—The generic name is taken from the Obira [=Obirashibetsu or Opirashibets] area, District of Rumoi, northwestern Hokkaido, where numerous Cretaceous ammonites have been obtained since the date of JIMBO (1894)'s work.

Discussion.—This new genus is proposed to accommodate *Obiraceras ornatum* n. sp., to be described below, which is somewhat similar to certain species of *Yubariceras* and *Schidewolfites*, but has particular characters which deviate considerably from the generic characters of those two genera.

Obiraceras resembles *Yubariceras* with respect to the subquadrate whorl and the presence of lateral tubercles, but is distinguished in the absence of clearly perceptible constrictions, persistence of intercalated secondary ribs up to the end of the adult body chamber, absence or poor development of the lateral and the umbilical tubercles on the secondary ribs in contrast to the well development of them on the primary ribs and the doubling of the ventrolateral tubercles at the mature stage.

Obiraceras is considered to be allied to *Schindewolfites*, WIEDMANN, 1960,

since *O. ornatum* somewhat resembles *S. schindewolfi* COLLIGNON, as is explained in the description of the species. On the basis of *S. inaequicostatus* WIEDMANN, 1960, the type-species, and *S. ganuzai* WIEDMANN, 1960, another Lower Turonian species, the irregularity of the ribs, the development of the lateral tubercles in approximation to the inner ventrolateral ones on the outer whorl and the absence of them in the inner whorl were regarded by WIEDMANN (1960, p. 736; 1964, p. 124) as diagnostic features of *Schindewolfites*. These features are not shown by *Obiraceras ornatum*, in which ribs are more regular, although the primaries and the secondaries are distinguished, the lateral tubercles are distinctly developed on both the inner and the outer whorls more or less below the middle of the flank, i.e. closer to the umbilical tubercles. There is also a distinction in the suture. The first lateral lobe is broadly opened in the type-species (WIEDMANN, 1960, text-fig. 3) and other related species (e.g. *S. isovokyensis* COLLINGON, 1965, p. 30, pl. 388, fig. 1663) of *Schindewolfites*, but comparatively narrower and deeper in the type-species of *Obiraceras*. Furthermore, the doubling of the ventrolateral tubercles on the mature whorl is again particular to *Obiraceras*.

The last character reminds us of a similar but better developed multituberculation in *Douvilleiceras* of Lower Albian age. The spinose lateral tubercle may be another homoeomorphy. It is interesting to note that a homoeomorphic similarity is observable between *Schindewolfites* and *Eodouvilleiceras* of Upper Aptian age. In the Douvilleiceratidae there is no siphonal tubercle.

If the lateral tubercles were excluded, the shell of *Obiraceras* would be closely similar to that of *Acanthoceras*, but the intercalated secondary ribs persist to the last growth-stage in *Obiraceras*. In this and other respects, I am rather inclined to consider that *Obiraceras* may have been derived from *Schindewolfites* rather than directly from *Acanthoceras*.

Distribution.—In our present knowledge *Obiraceras* is represented only by a single species, *O. ornatum*, which is found rarely from the Turonian (presumably Upper Turonian) of Hokkaido. In view of its affinity with *Schindewolfites*, somewhat more extensive geographic distribution could be expected.

Obiraceras ornatum sp. nov.

Pl. 23, Fig. 1; Text-fig. 18

Material.—Holotype, GK. H 5689, collected by Kikuwo MURAMOTO (1969-10-25), from the Sato-no-sawa, Obira area.

Diagnosis.—This species is characterized by its (1) comparatively small shell, about 100 mm in diameter at the adult stage; (2) moderately increasing whorls, with a slight overlap, encircling an umbilicus of moderate width (about 33 percent of the shell diameter); (3) subquadrate to subrectangular whorl-section, nearly as high as broad in early stages and somewhat higher than broad in the late stage,

having parallel flanks, low and nearly vertical umbilical walls, subangular umbilical and ventrolateral shoulders and a nearly flat (for costal part) or only slighlty convex venter (for intercostal part); (4) numerous ribs, consisting of fairly strong primaries and intercalated secondaries, which are nearly rectiradiate on the flank and cross the venter almost vertically; (5) nine rows of tubercles, the ventral five of which are on every rib but the lateral and the umbilical ones are normally on the primary ribs; (6) spinosity of the ventrolateral, the lateral and the umbilical tubercles on the primary ribs in the middle to late growth-stages, except for the gerontic stage; (7) doubling of the ventrolateral tubercles at the adolescent stage (i.e. in the last part of the septate whorl and the early part of the body chamber);

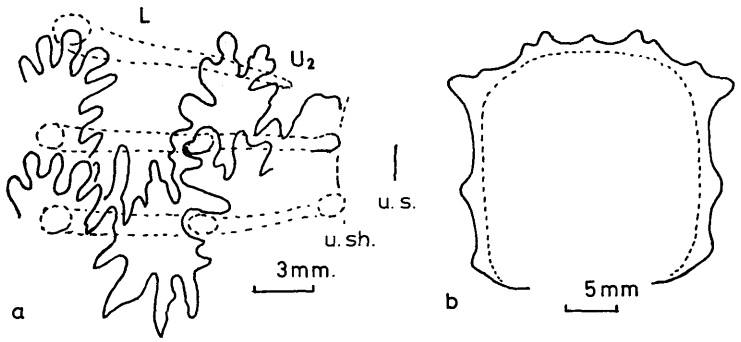


Fig. 18. *Obiraceras ornatum* gen. et sp. nov.
External sutures exposed on the flank (a) and a diagrammatic whorl-section (b) at the adolescent stage of the holotype. (T. M. *delin.*)

(8) the position of the lateral tubercle somewhat below the middle of the flank, being closer to the umbilical tubercle than to the ventrolateral one; (9) weakening of the siphonal tubercles on the body chamber; (10) rather narrow and deep, roughly rectangular first lateral lobe and narrow and fairly deep lobule in the suture.

In addition to the above the following may be also reckoned as specific characters. (11) The secondary ribs are of unequal length, some being nearly as long as the primaries but devoid of an umbilical tubercle and some others shorter. Occasionally two primaries are adjacent to each other, without intercalated secodaries. On the flank the secondary ribs are more or less weaker and narrower than the primaries and have no or a very faint lateral bulla. (12) On the ventral part the primary and the secondary ribs are nearly equally coarse, rather crowded, separated by the interspaces somewhat narrower than the ribs and provided with fairly strong tubercles. The ribs are broadened and lowered on the siphonal zone of the venter and the siphonal tubercles are also weakened as the whorl grows. (13) The doubling of the ventrolateral tubercles takes place asymmetrically. Namely the inner subdivision is stronger, larger and spinose in the case of the inner ventrolateral tubercle, whereas the outer subdivision is stronger and more distinctly clavate in the case of the outer ventrolateral tubercle. (14) On the

last part (about 45°) of the body chamber, which probably represents a gerontic stage, even the primary ribs are narrowed and lowered and the umbilical and the lateral tubercles are bullate and weakened. Consequently the difference in ornament between the primaries and the secondaries on the flank is not so remarkable as in the immediately preceding mature or adolescent stage. The ribs seem to be gently convex at this stage. On account of incomplete preservation the characters on the ventral part at this stage are unkown.

Measurements.—

Specimen	Diameter	Umbilicus	Height	Breadth	B./H.
GK. H 5689	66.5(1)	22.0(.33)	28.7(.43)	27.8(.42)	0.96

Remarks—The body chamber occupies at least about a half volution. The above figures show the dimensions at the early part of the body chamber under somewhat deformed condition.

Discussion.—The inner whorl of this species is somewhat similar to that of *Yubariceras japonicum*, but the former has a flatter and norrower venter, no perceptible constrictions, more distant and distinctly rectiradiate primary ribs, which are not so curved forward on the venter, no or scarcely discernible lateral tubercles on the secondary ribs, spinose inner ventrolateral tubercles even in the immature stages. The distinction in the characters of the outer whorl is remarkable between the two species.

The present species is considerably similar to *Schindewolfites schindewolfi* COLLIGNON (1965, p. 31, pl. 389, fig. 1665), from the "Middle Turonian" zone of *Pseudaspidoceras conciliatum* of Madagascar, in quadrate whorl, rectiradiate, fairly strong primary ribs, with some intercalated secondaries, and nine rows of tubercles in which ventrolateral ones are spinose. The former has more distinct lateral tubercles, which are spinose on the mature whorl, and shows the doubling of the inner and the outer ventrolateral tubercles at the mature stage. There might be some difference in suture, although COLLIGNON did not mention the suture of *S. schindewolfi*.

To sum up, the present species is so particular that it is regarded as new and a new genus has been proposed to accommodate it.

Occurrence.—The holotype was found by K. MURAMOTO (dated S. 44-10-25), from loc. Ob-S-Rl-RP5, a calcareous nodule in Sato-no-sawa (Migi-ichi-no-sawa, Migi-sawa), a tributary of the Kami-kinembetsu River, a major branch of the Obira River, Obira area, Rumoi District, northwestern Hokkaido. As *Inoceramus teshioensis*, *Scalarites* sp. and many other heteromorph ammonites (to be described separately) were obtained in the same spot, the age of the original bed is presumably Upper Turonian.

Concluding Remarks

Taxonomic results.—The species described in this paper are as follows:

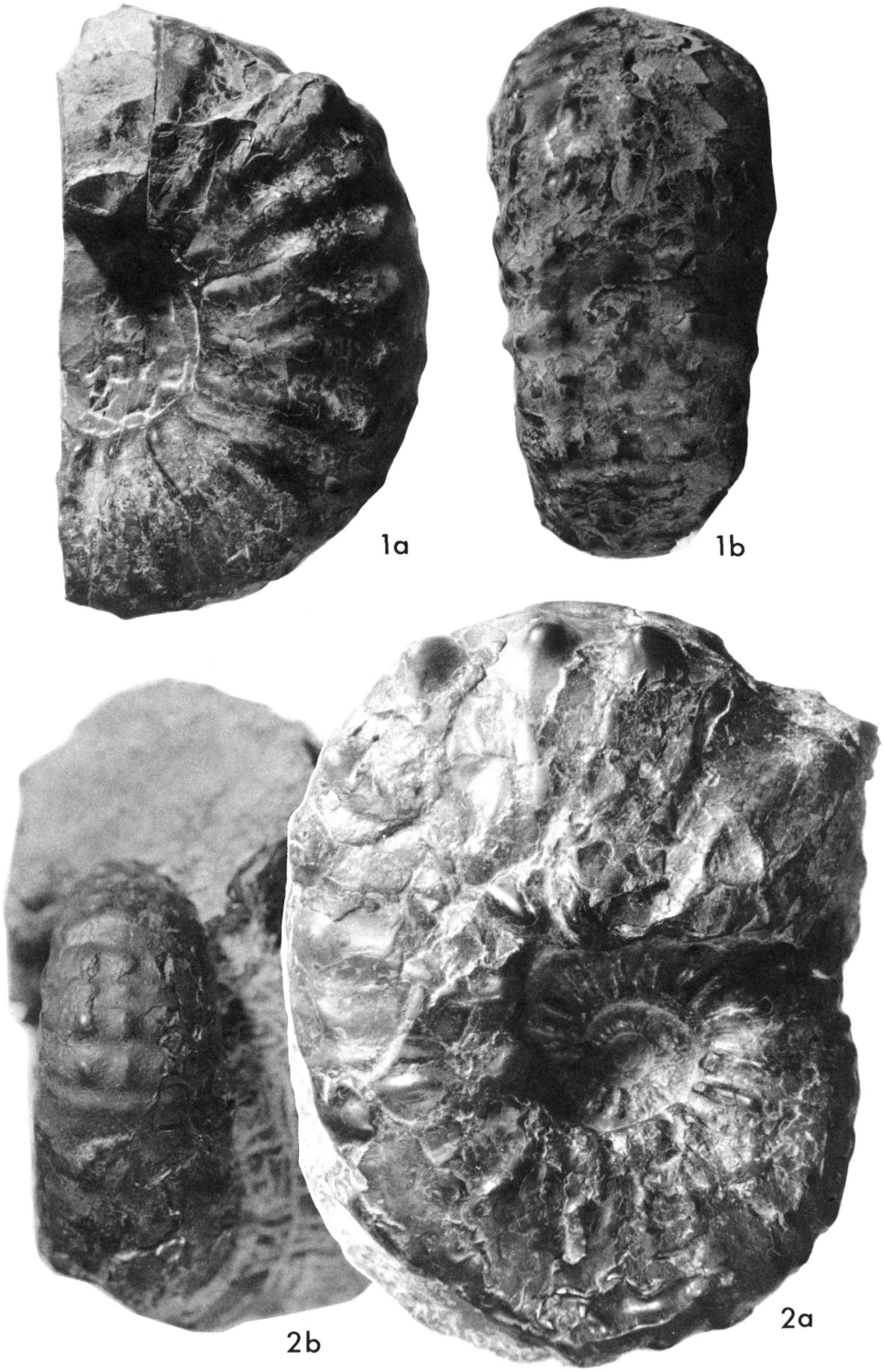
(1) *Calycoceras* sp. cf. *C. naviculare* (MANTELL), p. 102, Text-fig. 1
(2) *Calycoceras* sp. nov. aff. *C. crassum* (THOMEL), p. 104, Pl. 13, Fig. 2; Text-fig. 2
(3) *Eucalycoceras pentagonum* (JUKES-BROWNE), p. 106, Pl. 11, Fig. 1
(4) *Eucalycoceras* sp. aff. *E. spathi* (COLLIGNON), p. 108, Pl. 11, Fig. 2
(5) *Shuparoceras yagii* sp., nov., p. 110; Pl. 12, Fig. 1; Text-fig. 3
(6) *Shuparoceras abei* sp. nov., p. 113, Pl. 13, Fig. 1; Text-fig. 4
(7) *Romaniceras* sp. aff. *R. deverianum*, p. 117, Pl. 14, Fig. 1
(8) *Romaniceras yezoense* sp. nov., p. 118, Pl. 14, Fig. 2; Pl. 15, Fig. 1; Text-figs. 5-6
(9) *Romaniceras deverioide* (DE GROSSOUVRE), p. 122, Pl. 15, Fig. 2: Text-fig. 7
(10) *Romaniceras* (?) sp. cf. *R. kanei* JONES, p. 123, Pl. 19, Fig. 4
(11) *Romaniceras* [New Genus ?] *aequicostatum* sp. nov., p. 124, Pl. 15, Fig. 3; Text-fig. 8
(12) *Acanthoceras takahashii* sp. nov., p. 126, Pl. 16, Fig. 1; Pl. 17, Fig. 1; Text-figs. 9-10
(13) *Yubariceras yubarense* MATSUMOTO, SAITO and FUKADA, p. 133, Pl. 19, Fig. 1; Text-fig. 11
(14) *Yubariceras* sp. aff. *Y. ornatissimum* (STOLICZKA), p. 135, Pl. 17, Fig. 2; Pl. 18, Fig. 1
(15) *Yubariceras* sp. nov. (?), p. 138, Pl. 20, Fig. 1
(16) *Yubariceras japonicum* MATSUMOTO, SAITO and FUKADA, p. 139, Pl. 19, Figs. 2-3; Pl. 21, Fig. 2; Text-figs. 13-14
(17) *Yubariceras* sp. aff. *Y. japonicum* MATSUMOTO, SAITO and FUKADA, p. 143, Pl. 21, Figs. 3-4; Pl. 23, Fig. 2
(18) *Yubariceras otatumei* (MATSUMOTO, SAITO and FUKADA), p. 144, Pl. 21, Fig. 1; Text-figs. 15-16
(19) *Yubariceras pseudomphalum* sp. nov., p. 146, Pl. 22, Fig. 1
(20) *Yubariceras fujishimai* sp. nov., p. 148, Pl. 22, Fig. 2; Text-fig. 17
(21) *Obiraceras ornatum* sp. nov., p. 151, Pl. 23, Fig. 1; Text-fig. 18

Explanation of Plate 22

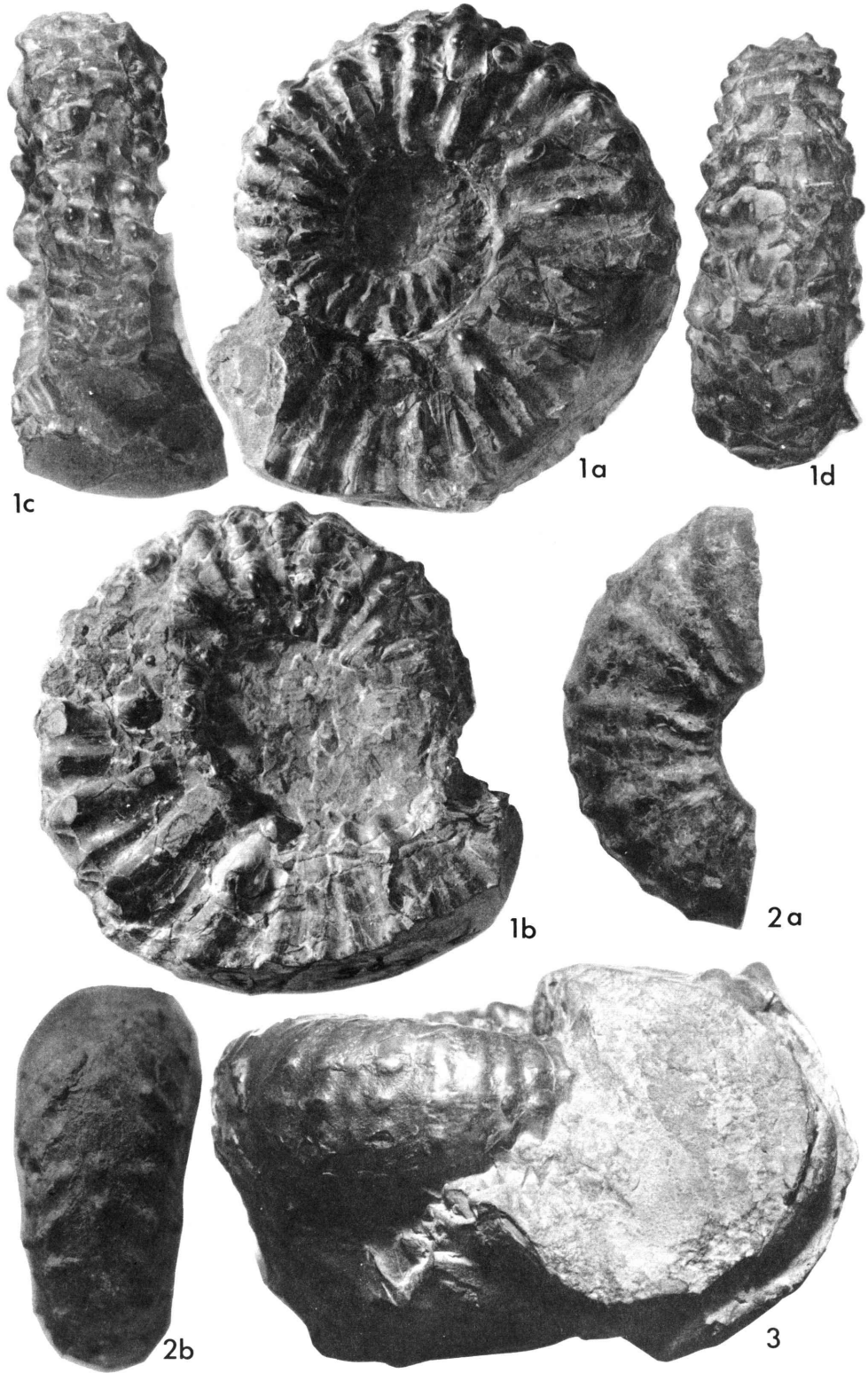
Fig. 1. *Yubariceras pseudomphalum* sp. nov. .....Page 146
Holotype, M. 76 (T. MURAMOTO Coll.), from the Taki-no-sawa, Oyubari. Lateral (a) and ventral (b) views, ×1,

Fig. 2. *Yubariceras fujishimai* sp. nov. .....Page 148
Holotype, HCS. No. 40 (Y. FUJISHIMA Coll.), from the Kaneobetsu, Oyubari. Lateral view (a), ×0.9; frontal view (b), ×0.8.

Kyushu Univ. (H. HIRANO) photos, without whitening.



T. MATSUMOTO: Additional Acanthoceratids



T. MATSUMOTO: Additional Acanthoceratids

Eight of twenty-one species are entirely new and two new genera, *Shuparoceras* and *Obiraceras*, are established. *Shuparoceras* is allied to the group of *Calycoceras choffati* but has lateral tubercles and periodic constrictions in certain growth-stages. *Obiraceras* is allied to *Schindewolfites* but has prominent lateral tubercles from much earlier growth-stage and shows doubling of ventrolateral tubercles as the mature stage. *Romaniceras* [New Genus ?] *aequicostatum* is distinct from other species of *Romaniceras* in having equally long ribs throughout growth without intercalation of shorter ribs and probably represents a new genus, but I would not propose a new name until better material is obtained.

In addition to the establishment of the new species and the new genera, I redefined several species on the basis of subsequent collections and also through the restudy of the types. *Yubariceras yubarense, Y. japonicum* and *Y. otatumei* are redefined among others. *Yubariceras*, thus revised, normally has periodic constrictions in early growth-stages. The genus seems to have been derived from a certain subgroup of *Euomphaloceras* or an intermediate form between *Acanthoceras* and *Euomphaloceras*.

Aside from the three interesting species of *Calycoceras* and *Acanthoceras* (1, 2 and 12 in the above list) and a few examples of *Eucalycoceras* from Hokkaido (3 and 4), the species described in this paper are mostly multituberculate acanthoceratids. I have shown what kinds of forms are found in our province and discussed as far as possible their relations with one another and with other species.

The multituberculate acanthoceratids are polyphyletic and sorted into at least five genera, *Romaniceras, Shuparoceras, Yubariceras, Schindewolfites* and *Obiraceras*. *Romaniceras* and *Yubariceras* contain numerous species, some of which seem to show a homoeomorphic similarity and others some particular deviation or specialization. As a whole a considerably great diversity in the multituberculate acanthoceratids has been demonstrated by the described species from Japan. If the faunas of other provinces (especially the Gulf Coast and the Western Interior of North America) were fully described, a greater diversity and

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Explanation of Plate 23

Fig. 1. *Obiraceaas ornatum* gen. et sp. nov. .....Page 151
Holotype, GK. H5689 (K. Muramoto Coll.), from Ob-S, Obira. Left lateral (a), right lateral (b), frontal (c) and back (d) views, ×1.

Fig. 2. *Yubariceras* sp. aff. *Y. japonicum* Matsumoto, Saito and Fukada .....Page 143
NSM. 5817 (T. Muramoto Coll.), from Ik. 1425p, Ikushumbets. Lateral (a) and back (b) views, ×1. (in a light different from that of Pl. 21, Fig. 3),

Fig. 3. *Yubariceras fujishimai* sp. nov. .....Page 148
Holotype, HCS. No. 40 (Y. Fujishima Coll.), Oyubari. Frontal view, ×0.8 (see also Pl. 22, Fig. 2).

Kyushu Univ. (1,3: H. Hirano; 2: K. Kanmera) photos.

a better sorting than that in the present scheme would be shown.

How these diverse species were differentiated and evolved would be another problem to be worked out in the future. It should be noted in this connexion that fifteen species of the multituberculate acanthoceratids described in this paper are nearly contemporary, occuring in the Middle and the Upper Turonian (i.e. the zone of *Inoceramus hobetsensis* and that of *Inoceramus teshioensis*) in Hokkaido. Only a few (5, 17 and possibly 19 in the above list) came presumably from the lower part of the Turonian.

In the discussion of the systematic descriptions I have pointed out a problem concerning the periodic constrictions in some acanthoceratids. How it should be evaluated in the taxonomy may depend on its correlation with other characters and its bearing on the natural life history of ammonoids.

Biostratigraphic results.—On the previous occasion (MATSUMOTO et. al., 1969, p. 286-290) the succession of acanthoceratid species in the Cretaceous sequence of Hokkaido was summarized on the basis of the data available at that time. The data described in that paper is essentially correct, except for minor revision.

Recently the Acanthoceratidae from the Cenomanian of England and France have been described with fine reference to the stratigraphic sequences (e.g. HANCOCK, 1960; KENNEDY and HANCOCK, 1970; KENNEDY, 1971; THOMEL, 1965, 1972; JUIGNET, KENNEDY and WRIGHT, 1973). The results are very useful for correlating our sequence with that of the standard sequence in Europe. Broadly speaking the succession of the acanthoceratids in the Cenomanian of Hokkaido shows fairly good agreement with that of western Europe, if we exclude minor differences which may have arisen from local factors. Examples for this statement are described below, although there are still several species from Hokkaido which should be described in detail.

The best succession of Cenomanian acanthoceratid species is displayed in the sequence of the Ikushumbets area and may be supplemented by that of other areas. The following is a concise citation of the previous description (MATSUMOTO et al., 1969, p. 286-290; see also MATSUMOTO, 1965, fig. 4 for the columnar section), with necessary revision.

(1) **Basal Zone.** This is the Zone of *Desmoceras kossmati* and represented by Member IIa of the Mikasa Formation of the Ikushumbets sequence. Here only a fragmentary specimen of *Mantelliceras* (*Submantelliceras*) cf. *discoidale* was found. For some reasons the ammonites occur more abundantly in the same zone of the Soeushinai area (HASHIMOTO et al., 1965), where *Graysonites wooldridgei* and *Graysonites* aff. *adkinsi* characteristically occur together with *Stoliczkaia* aff. *africana*, *S.* aff. *dorsetensis*, *Euhystrichoceras nicaisei*, *Prionocycloides proratum*, etc. The fauna of this area, which is about 100 km north of

Ikushumbets, awaits further study and publication.

(2) **Lower Zone.** This is represented by the lower 20 m of Member IIb and is characterized by *Mantelliceras japonicum* which is associated with *M. cantianum*, *Sharpeiceras kongo*, *Hypoturrilites* sp., *Ostlingoceras puzosiforme*, numerous tetragonitids and desmoceratids.

(3) **Middle Zone.** This is represented by the main 110 m of Member IIb of the Mikasa Formation on the eastern wing of the Ikushumbets anticline. Lithostratigraphically it is subdivisible into (a) the lower part in which thick bedded less muddy sandstone is predominant and (b) the upper part in which silty fine sandstone predominates. The ammonites differ between (a) and (b) probably in accordance with the facies difference as follows:

(3a) Strongly ornate large acanthoceratids, *Acanthoceras amphibolum*, *Ac.* cf. *cornigerum*, *Ac. takahashii* and *Euomphaloceras meridionale.*

(3b) *Calycoceras orientale* belonging to the *newboldi* group, associated with *Desmoceras* (*Pseudouhligella*) *japonicum*, large puzosian species probably referable to *Puzosia* and *Austiniceras*. *Eucalycoceras* cf. *spathi* was found near the top of this unit.

On the western wing of the Ikushumbets anticline the ammonite bearing bed is in a limited portion of the lower part of the Mikasa Formation on account of the facies change that near shore or proximal part of deltaic sediments predominate in the west. It is represented by a bed with *Calycoceras asiaticum* (a species of the *newboldi* group) at Shimo-katsurazawa, where *Calycoeras* n. sp. allied to *C. crassum* or to *C. spinosum* and an immature shell of *Euomphaloceras meridionale* were also found. Whether this bed is correlated with (3a) or (3b) on the eastern wing is not precisely determined, although I am rather inclined to the latter.

Calycoceras of the *newboldi* group and certain species of *Euomphaloceras* occur in the middle part of the Cenomanian sequences in other areas of Hokkaido. In other words the Middle Zone is widely recognized in Hokkaido. *Calycoceras* cf. *stoliczkai* described by MATSUMOTO et al. (1957, p. 19, pl. 6, fig. 1) is probably from this zone of the Shiyubari area. KENNEDY (1971, p. 71) identified it with *C. naviculare*, though with a query. Whether it is truly so or referable to *C. boulei* or otherwise should be determined by better material.

(4) **Upper Zone.** This is represented by the main part of Member IIc (excluding the uppermost part). Here came *Calycoceras* cf. *naviculare* and *Eucalycoceras pentagonum*, although very rarely. Large shells of *Pachydesmoceras* and smaller desmoceratids, *Desmoceras* (*Pseudouhligella*) *japonicum* and *D.* (*P.*) *ezoanum*, occur more commonly and large shells of the group of *Inoceramus concentricus*, provisionally called *Inoceramus pennatulus*, are characteristic. *Euomphaloceras asura* probably came from this zone of the Abeshinai-

Saku area. As the acanthoceratid species are scarce and as no representatives of the Metoicoceratinae have beed found from Hokkaido, the definition of the Upper Zone is less clear than that of others.

(5) **Uppermost Zone.** This is represented by the uppermost 15 m mudstone of Member IIc of the Mikasa Formation on the eastern wing of the Ikushumbets anticline. *Kanabiceras septemseriatum* and *Sumitomoceras faustum* are characteristic of this zone. *Sciponoceras kossmati* is also common, although this species seems to be long ranging. Other species belonging to the Desmoceratidae, Tetragonitidae (Gaudryceratinae), Scaphitidae and other heteromorpha from this zone should be carefully studied. Recently *Pseudocalycoceras* sp. aff. *P. dentonense* (MOREMAN) has been found here as described in another paper (MATSUMOTO and KAWANO, 1975 in press). Inocerami from this zone seem to be idedtified with *I. labiatus* as will be described in another paper (NODA and MATSUMOTO, in preparation). Whether this zone is correlated with the Uppermost Cenomanian or the Lowest Turonian is a problem as is discussed in these separate papers.

Apart from this questionable Uppermost Zone, the following correlation can be concluded on the basis of the characteristic acanthoceratids and their succession:

(1) Basal Zone: Zone 1, i.e. the zone of *Submantelliceras martimpreyi* of southeastern France
(2) Lower Zone: Zone 2, i.e. the zone of *Mantelliceras mantelli* of southeastern France: *Mantelliceras mantelli* Zone of southern England
(3) Middle Zone: Zones 3 and 4, i.e. the zone of *Acanthoceras praecursor* and that of *A. rhotomagense* of southeastern France: *Acanthoceras rhotomagense* Zone of southern England
(4) Upper Zone: Zone 5; i.e. the zone of *Calycoceras naviculare* of southeastern France: *Calycoceras naviculare* Zone of southern England.

(1) and (2) are Lower Cenomanian, (3) is Middle Cenomanian and (4) Upper Cenomanian.

The succession of the acanthoceratid species in the Turonian of Hokkaido is not so clearly manifested as that of the Cenomanian. A zonal subdivision can be established by means of the collignoniceratid species and inocerami (see MATSUMOTO, 1971, p. 154). Aside from the Lower Turonian *Pseudaspidocoras* and *Mammites*, which are rare and not yet fully described, numerous species of the multituberculate acanthoceratids occur in the Middle and the Upper Turonian of various areas. Even in the uppermost Turonian subzone of *Reesidites minimus* there is an example, that is *Yubariceras otatumei* redescribed in this paper.

Remarks on facies problem.—The hitherto described acanthoceratid species from Hokkaido are about fifty and there are some more awaiting description. This number is by no means small, although the number of the specimens may

not be great. Although Hokkaido belonged palaeobiogeographically to the northwestern Pacific province in the Cretaceous period, many genera of this family distributed there. For instance, *Mantelliceras*, *Sharpeiceras*, *Calycoceras*, *Acanthoceras*, *Euomphaloceras*, *Eucalycoceras*, *Romaniceras*, *Mammites* and *Pseudaspidoceras*, which occur commonly in the shelf facies sediments of Europe, Middle East, northern Africa, southern Africa, Madagascar, southern India, North American Gulf and Interior provinces etc., do occur in the sediments of the so-called geosynclinal facies of Hokkaido. In addition well ornate *Yubariceras* occurs not infrequently there. The difference in the mode of occurrence seems to be due to that of the facies, which reflects palaeo-environmental conditions.

The sedimentological conditions of the Cretaceous deposits of Hokkaido were outlined by MATSUMOTO and OKADA (1971) and have recently been described and discussed in more detail for the Cenomanian and Turonian parts by the same authors (1973). According to them the Cenomanian and Turonian fossiliferous deposits of Hokkaido represent miogeosynclinal accumulation under the sea of shallow to moderate depth; the muddy sediments are interfingered with prodeltaic sandy ones in some parts (e.g. Mikasa Formation) and also mixed with some influx of turbidites in some other parts (e.g. a part of the Saku Formation). The source tectono-volcanic mountains were somewhere in the west and the off-shore probably deeper environments in the east. A narrow labile shelf may have existed at the shoulder between the rising mountains and the subsiding miogeosyncline.

The fossils of the acanthoceratids are mainly distributed in the western belt, if not absent in the eastern belt. Even in the western belt they do not occur uniformly, being affected by local variation of facies within the belt, as has been described by MATSUMOTO and OKADA (1973). They seem to occur in the rocks formed under optimum ecological environments and favourable sedimentological conditions.

In the Cretaceous deposits of Hokkaido ammonites of the Acanthoceratidae (and also the Collignoniceratidae) are generally embedded at intervals and do not occur in abundance. Those with the adult body chamber are rather common, suggesting a comparatively quiet sedimentary condition. The scattered mode of occurrence often in association with less strongly ornate desmoceratids and tetragonitids may suggest more pelagic environments than the case of the abundant occurrence in the shelf facies (see also MATSUMOTO, 1971, p. 153).

In accordance with the diverse shell characters various acanthoceratid species must have had their respective modes of life and ecological niches, which may have changed with growth. This problem is not dealt with in this paper, although some facts which may be concerned with the problem are described.

The structural condition in Hokkaido that fairly steeply inclined strata are

exposed along narrow valleys of mountainous areas gives us less chance of obtaining numerous fossils than that of the flat lying strata of extensive exposures in the shelf areas. This may strengthen the impression that the acanthoceratids occur sparsely in the Cretaceous deposits of Hokkaido, but actually they cannot be simply described as rare. In my experience of field work a considerable number of specimens of the same species occurred in a bed when the ammonite bearing bed is exposed along the strike (e.g. *Calycoceras asiaticum* at Shimokatsurazawa); the occurrence of a limited number (2 or 3) of large adult specimens within an exposure of a short interval, which cuts a bed almost perpendicular to the strike, does not necessarily mean a rarity (e.g. *Sharpeiceras kongo* at loc. Ik 1100, Katsurazawa quarry).

Considering the above situation, the apparently sparse occurrence of the acanthoceratids in the sequences of Hokkaido would not make a strong objection against the correlation with the zones in other provinces of shelf facies.

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