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Notes on Some Acanthoceratid Ammonites from the Oyubari Area, Hokkaido

By

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Abstract Acanthoceratid ammonites occur not rarely from the Cretaceous of the Oyubari area, central Hokkaido and some of them were described previously. We give in this paper additional descriptions of *Acanthoceras takahashii* MATSUMOTO, *Kamerunoceras* aff. *K. turoniense* (d'ORBIGNY), *Neomphaloceras pseudomphalum* (MATSUMOTO), *Romaniceras pseudodeverianum* (JIMBO) and *Shuparoceras yagii* MATSUMOTO on the ground of several specimens recently acquired by one of us (Y. K.) from this area. Especially we present our observation on the multituberculate acanthoceratids. Some remarks are also given on the general problem as to the occurrences of the acanthoceratid and other ornate ammonites in the Cretaceous deposits of Hokkaido.

Introduction

The ammonites belonging to the family Acanthoceratidae from the Cretaceous System in Hokkaido have been described in a number of papers (e.g. MATSUMOTO & HASHIMOTO, 1953; MATSUMOTO *et al.*, 1957; MATSUMOTO *et al.*, 1969; MATSUMOTO, 1975; MATSUMOTO & INOMA, 1975; MATSUMOTO & KAWANO, 1975; MATSUMOTO *et al.*, 1978; MATSUMOTO & OBATA, 1982; MATSUMOTO & UCHIDA, 1985), in accordance with the step by step advances of our work.

In fact the acanthoceratid fossils occur rather sporadically in Hokkaido and they have been acquired by chance, except in a few cases. This is one of the reasons why the acanthoceratids from Hokkaido were not monographed at once in a single volume but have been reported intermittently under dissimilar authorships. This paper is again a piece of such reports.

The material for this study depends on the recent acquisitions of one of us (Y.K.) from the Oyubari area. The Cretaceous stratigraphy of this area was investigated years ago by one of us (MATSUMOTO, 1942), who later visited there frequently with coworkers (e.g. HIRANO *et al.*, 1977). NAGAO *et al.* (1954) published an official geological map "Oyubari", which is generally useful but needs revision in minor details. The localities of the ammonites described in this paper were examined by one of us (T.M.) along with Y. KAWASHITA or independently. The specimens are at present in the Collections of Y. KAWASHITA (YKC), but would be eventually transferred to the Museum.

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For the time being, their plaster casts are kept in the National Science Museum, Tokyo (NSM) and also in the Geological Collections of Kyushu University, Fukuoka (GK).

As to the taxonomy of the family Acanthoceratidae, how to classify the multituberculate species is a problem. Our view is not quite identical with that of KENNEDY *et al.* (1980) and a discussion will be given to some extent in this paper.

Another problem concerns with the occurrences of the acanthoceratids and other ornate ammonites in terms of the facies or palaeoenvironmental factors. Some remarks on it will be given at the end of this paper.

Acknowledgements: Before going further, we wish to thank the authorities of the Yubari Branch Office of the Forestry Bureau for their offer of facilities in doing a field work in the area under their charge. Thanks are also to Professor Itaru HAYAMI for his help to let us have access to a type specimen kept at the University Museum of the University of Tokyo (UMUT) and to Dr. Masayuki NODA, Mr. Shinichi SATO and Miss Tomoko OSHIMA for their assistance in taking photographs of the specimens and preparing the typescript.

Palaeontological Descriptions

Family Acanthoceratidae de GROSSOUVRE, 1894
Subfamily Acanthoceratinae de GROSSOUVRE, 1894

Genus *Acanthoceras* NEUMAYR, 1875

Type species: *Ammonites rhotomagensis* BRONGNIART, 1822, by subsequent designation of de GROSSOUVRE (1894).

Remarks: Based on the restudy of the type-species by KENNEDY and HANCOCK (1970), a reliable generic diagnosis was given by KENNEDY (1971, p. 85), whom we follow. See also a short remark by one of us (MATSUMOTO, 1975, p. 126). A characteristic species from the Cenomanian of Hokkaido is redescribed below on the additional material from the Oyubari area.

Acanthoceras takahashii MATSUMOTO

Pl. 1, fig. 1; Pl. 2, fig. 1; Pl. 3, fig. 1; Text-fig. 1

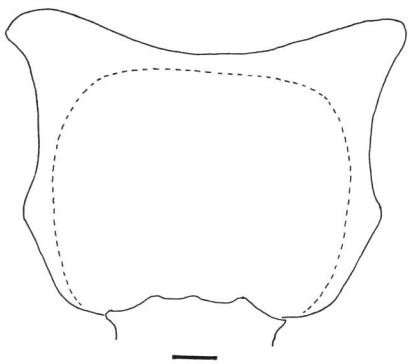
1975. *Acanthoceras takahashii* MATSUMOTO, p. 126, pl. 16, fig. 1; pl. 17, fig. 1; text-figs. 9–10.

Holotype: GK. H5605 (MATSUMOTO, 1975, pl. 16, fig. 1).

Material: Two specimens in Y. KAWASHITA's Collection, YKC. 570814 and YKC. 590715, from the route along the stream of Kaneobetsu, Oyubari area, whose plaster casts are kept at NSM. and GK.

Description: YKC. 570814 (Pl. 1, fig. 1; Pl. 2, fig. 1) is better preserved than the holotype in that it is less deformed and its both sides are well shown. YKC. 590715 (Pl. 3, fig. 1) is likewise fairly well preserved but its left side is somewhat eroded.

The two specimens are fairly large and preserve nearly completely the body-chamber of about a half whorl. The last septum is at the intercostal shell diameter=



Text-fig. 1. *Acanthoceras takahashii* MATSUMOTO. Diagrammatic whorl-section of YKC. 570814 at the adult stage. Scale bar=10 mm. (T. M. *delin.*)

108 mm in YKC. 570814 and 115 mm in YKC. 590715.

The shell is rather evolute, with the body-chamber slightly overlapping the ventral part of the next inner whorl. The body-chamber is much broader than high and widely subrectangular in interocostal section.

The phragmocone is somewhat broader than high and subquadrate in section. The umbilicus is medium-sized and surrounded by a steep, almost vertical wall.

The dimensions (in mm) are tabulated below:

Specimen	Diameter	Umbilicus	Height	Breadth	B/H
570814 (ic)	156.0	62.8 (.40)	53.0 (.34)	65.0 (.42)	1.23
(c)	172.0	65.0 (.37)	58.0 (.34)	73.0 (.42)	1.26
−360°	~71	27.0 (.38)	29.0 (.41)	34.0 (.48)	1.17
590715 (ic)	162.0	61.0 (.38)	60.5 (.37)	~72 (.44)	1.19
Holotype (ic)	176.0	62.5 (.35)	62.5 (.35)	~76 (.43)	1.21

(ic)=intercostal, (c)=costal (tubercles excluded), ~=approximate

The last whorl, which consists of the body-chamber and the late part of the phragmocone, is ornamented with twelve major ribs at wide intervals, without intercalated shorter one. Every rib is provided with a prominent tubercle at the ventrolateral shoulder and an umbilical tubercle whose peak is shifted to the inner lateral part. Early two ribs have three weak tubercles on the venter, i.e. on the siphonal line and on either side of the siphonal zone. Also a faint keel like elevation is discernible on the siphonal line at this early stage of the outer whorl. In the next stage the ventral tubercles disappear, whereas the ventrolateral and lower lateral (i.e. shifted umbilical) tubercles are gradually strengthened. On the body-chamber the ribs are much raised and the ventrolateral tubercles are enlarged to the horn-like elevations. The hyperno-dosity is most prominent on the last second and third ribs and the ventrolateral tubercle on the last rib near the shell aperture is somewhat lowered.

In the next inner whorl the ribs are weaker and less distant than those of the outer whorl, being sometimes intercalated by shorter ribs. For example, YKC. 570814 has 12 ribs in a half of its inner whorl. The ribs and tubercles are generally

weaker than those of the outer whorl and the umbilical tubercles are bullate and closer to the umbilical margin.

The stutre is of *Acanthoceras* pattern, with massive and broad lateral saddles.

Comparison and discussion: So far as the holotype, paratype and two hypotypes (here described) are concerned, the diagnostic features are kept fairly constantly in *Acanthoceras takahashii* with little variation.

In the holotype and YKC. 590715 the ribs are strictly rectiradiate and the ventrolateral horns on the last second and third ribs are much stretched, whereas in the paratype GK. H5606 and YKC. 570814 some ribs are slightly sinuous and the ventrolateral horns are thicker. These are, however, minor differences and much less significant than the considerable variation in *Acanthoceras rhotomagense* described by KENNEDY and HANCOCK (1970).

As one of us (MATSUMOTO, 1975, p. 128–130) discussed previously, *A. takahashii* is closely allied to *A. tunetanum* PERVINQUIÈRE from Europe and Africa and to *A. amphibolum* MORROW from North America, but is distinguished in its larger size, broader whorl, less involution, wider umbilicus and more strongly raised ribs on the body-chamber. It is also similar to *A.* aff. *A. tunetanum* PERVINQUIÈRE (see KENNEDY, 1971), but the shorter ribs persist in the latter.

The specimens from Hokkaido described under *A. amphibolum* by MATSUMOTO *et al.* (1969, p. 266, pl. 31, fig. 1) are somewhat distorted and the measurements do not tell correctly the shell-form. For example, they may have originally broader outer whorl. They came from the same bed as the paratype of *A. takahashii* and may be incompletely preserved examples of *A. takahashii* rather than *A. amphibolum*.

Anyhow, *A. tunetanum*, *A. amphibolum* and *A. takahashii* form a species group in the genus *Acanthoceras* in which *A. rhotomagense* represents another, typical species group. If sufficient samples be assembled from the respective provinces for statistic study, these three named taxa could possibly be defined as geographical subspecies of a more comprehensively defined species. In the present state of our knowledge, we treat *A. takahashii* as an independent species.

Occurrence: YKC. 590715 was obtained by Y. KAWASHITA from an outcrop of mudstone on the southern side of the forestry road immediately south of the second bridge on the stream Kaneobetsu, a tributary of the Yubari, southwestern part of the Oyubari quadrangle. It is associated with *Mikasaites* sp. in the same nodule. *Desmoceras japonicum* YABE occurs also at this locality.

YKC. 570815 was in a washed out nodule into a narrow gully just 500 m southeast of the above locality. The exposed rock in the gully is the mustone containing limy nodules.

The mudstone of the above two localities belongs to Member My 6 (Hikagenosawa Shale) of NAGAO *et al.* (1954), mainly Middle Cenomanian. It should be noted that the adult specimens with body-chamber occur in the sandstone of Mikasa in the west and also in the contemporary mudstone in the east.

Subfamily Euomphaloceratinae COOPER, 1978

Remarks: COOPER (1978) proposed this subfamily for the multituberculate derivatives of *Acanthoceras*. Subsequently his view was confirmed by KENNEDY and WRIGHT (1979) and KENNEDY *et al.* (1980). These authors have attempted to demonstrate the line of descent from *Euomphaloceras* SPATH via *Kamerunoceras* REYMENT to *Romaniceras* SPATH, *Yubariceras* MATSUMOTO, SAITO et FUKADA, etc., and thus concluded the monophyletic origin of the multituberculate acanthoceratids.

Prior to these works, polyphyletic origins were interpreted from the studies of the Japanese materials (MATSUMOTO *et al.*, 1957; MATSUMOTO, 1975) primarily from the morphological similarity, which is now commented as merely a homoeomorphy. The specimens from Hokkaido have indeed given some interesting examples of this group in morphological features, but they are not sufficiently numerous and the records of their stratigraphic occurrences are not always precise enough. We should endeavour to overcome these dificiencies, although our work may proceed slowly and step by step. We do not think it easy to trace a line of descent at specific level, because the gradual change may be only one of various cases in the diverse aspects of evolution. Anyhow, we describe below four species which may give some suggestions to the problem.

Genus ***Kamerunoceras*** REYMENT, 1954

Type species: *Acanthoceras eschii* SOLGER, 1904 by the original designation of REYMENT, 1954.

Remarks: KENNEDY and WRIGHT (1979) have given a clear redefinition of this genus and discussed its systematic position. In this paper we follow them in essential points, but there remains much to be worked out about the evolutionary relationships at the level of species.

The low, keel-like siphonal ridge comprising siphonal clavi, which may be more numerous than the long ribs, is regarded as one of the diagnostic characters of this genus. On examining the syntypes and other specimens, one of us (T.M.) noticed the same feature in the ontogenetic development of *Acanthoceras amphibolum* MORROW, as COBBAN and SCOTT (1979) have also mentioned. *A. amphibolum* and probably also *A. takahashii* MATSUMOTO may foreshadow certain characters of *Euomphaloceras* (including subgenus *Kanabiceras*) and also *Kamerunoceras*. How this kind of *Acanthoceras* species evolved to what species of *Euomphaloceras* and then to what species of *Kamerunoceras* and finally to what species of *Romaniceras* has not yet been demonstrated precisely. The species described below may be interesting for this problem.

Kamerunoceras has been known from the Lower and lower Middle Turonian of Europe, the Middle East, north and west Africa, Madagascar, South and Central America, Texas and U. S. Western Interior (KENNEDY and WRIGHT, 1979; RENZ, 1982). Now its distribution is expanded to Japan or the northwestern Pacific.

Kamerunoceras aff. *K. turoniense* (d'ORBIGNY, 1850)

Pl. 4, figs. 1, 2

Compare:

1850. *Ammonites turoniensis* d'ORBIGNY, p. 190.

1979. *Kemerunoceras turoniense* (d'ORBIGNY); KENNEDY and WRIGHT, p. 1170, pl. 2, figs. 1–11; pl. 3, figs. 1–2; pl. 4, figs. 1–3; text-figs. 2–3 (with full list of synonymy).

Material: A single large specimen, YKC. 560914, from the Isojiro-sawa, whose plaster casts are kept at NSM. and GK.

Description: This is an internal mould, whose last whorl is fairly well preserved on the left side without secondary deformation but incomplete on the right side with secondary compression. Its inner whorl is not well preserved either.

The dimensions (in mm) are tabulated below:

	Diameter		Umbilicus	Height	Breadth**	B/H
(1)	Intercostal	231.5 (1)	96.5 (.42)	74.0 (.32)	~64 (.28)	0.83
(2)	Costal*	231.0 (1)	92.5 (.40)	77.0 (.33)	~77 (.33)	1.0

* (2) is immediately behind (1); ** restored from the left half

The head of the last suture is at about D=195 mm and the body-chamber is preserved for about a quarter whorl. Should the body-chamber be assumed to occupy about a half whorl, then the entire shell diameter would attain to about 260 mm, which is probably the largest of the hitherto reported specimens of *Kamerunoceras*.

The whorl is evolute, slightly overlapping the inner whorl, expanding with a rather low ratio, and embraces a wide umbilicus. As the specimen is little deformed, the whorl shape can be restored to be nearly as high as broad and thickly ovoid or subrounded in the intercostal section and rather polygonal in the costal section. The umbilical shoulder is subrounded; the flanks of the outer whorl are somewhat convex and the venter is gently arched. The maximum breadth is in the lower part between the upward shifted umbilical tubercles.

The ribs are much distant (i.e. separated by wide interspaces), numbering 8 or 9 in a half whorl. They are nearly rectiradiate, strongly raised and rather predominant over tubercles. The umbilical tubercles are bullate and their highest points are shifted upward to the inner lateral position. The inner ventrolateral tubercles are mostly conical and prominent, forming a subangular shoulder in the costal section. The outer ventrolateral tubercles are clavate and closer to the siphonal clavi, which in turn form a train on a keel-like ridge. No secondary rib and no additional tubercle are developed on the interspaces in the observable part of the outer whorl. Noteworthy is the fact that a weak but unnegligible upper lateral tubercle is superimposed on at least the preserved last two ribs.

The suture is of general acanthoceratid pattern.

Comparison and discussion: The described specimen is closely allied to *Kamerunoceras turoniense* (d'ORBIGNY, 1850), which has been recently revised by KENNEDY and WRIGHT (1979). As they have described, that species shows a certain extent of

variation. The described specimen from Hokkaido shows some characters which exceed beyond the known extent of variation in that (1) its shell size is much larger, that (2) its whorl is subrounded rather than subrectangular in section, with more convex flanks, that (3) the ribs are much more distant and accordingly less numerous, and that (4) incipient lateral tubercles appear on some ribs of the body-chamber.

The lectotype of *K. turoniense* (d'ORBIGNY) (see KENNEDY and WRIGHT, 1979, pl. 3, figs. 1, 2) is only 150 mm in the maximum diameter and its tubercles are predominant over ribs. That of *Ammonites salmuriensis* COURTILLER, a synonym of *K. turoniense* (see KENNEDY and WRIGHT, 1979, pl. 4, figs. 1–3, whose figures should be indicated as $\times 3/5$ instead of $\times 1$, as judged from the dimensions in table 1), has ribs predominant over tubercles like those of ours but less convex flanks and is smaller than ours. The ribs are weakened on the last part of its outer whorl which must represents the full-grown stage. Whether the same feature exists on our form or not is not known because of the incomplete preservation of the body-chamber, but the ventrolateral tubercles become bullate on the preserved last rib.

As only a single specimen is at our disposal, we hesitate to give a conclusion, whether it represents a subspecies of *K. turoniense* or a distinct species allied to *K. turoniense*. Anyhow, the appearance of incipient lateral tubercles on a part of the outer whorl is interesting in that it seems to support KENNEDY and WRIGHT's view of the derivation of *Romaniceras* from *Kamerunoceras*. *R. kallesi* (ZAZVORKA), the earliest species of *Romaniceras* according to them, has, however, more numerous ribs than those of *K. turoniense* with some intercalated shorter ribs. *R. pseudodeverianum* (JIMBO), redescribed in this paper, can be regarded as being closer to *K. turoniense* in this and other respects than *K. kallesi*.

Occurrence: The specimen was obtained as a floated nodule in the upper reaches of the Isojiro-sawa, Oyubari area, where dark grey shale with thin layers of sandstone is exposed, which is lithologically similar to the rock matrix of the fosssil. The outcropping beds are near the boundary of Members My 7 and My 8 of NAGAO *et al.*, 1954, which is referred to the upper part of the Lower Turonian or the lower part of the Middle Turonian. *Fagesia* sp. was obtained at a nearby locality as a transported nodule and *Muramotoceras* sp. occurs commonly in a part stratigraphically somewhat higher than (i.e. west of) this locality. This record is roughly concordant with the known stratigraphic occurrence of *K. turoniense* in Europe (KENNEDY and WRIGHT, 1979, p. 1176).

Genus ***Neomphaloceras*** MATSUMOTO et OBATA, 1982

Type species: *Yubariceras pseudomphalum* MATSUMOTO, 1975.

Remarks: This genus is closely allied to *Euomphaloceras* SPATH, 1923, in many respects but is distinguished in having an additional row of lateral tubercles. We are inclined to presume that *Yubariceras* MATSUMOTO, SAITO et FUKADA, 1957 in a correct sense could have descended from *Euomphaloceras* by way of *Neomphaloceras* acquiring

two rows of lateral tubercles, as we have discussed in more detail (MATSUMOTO and OBATA, 1982, p. 71–73). To test this idea we try to find any piece of evidence. The description below is a fraction of our effort.

Neomphaloceras pseudomphalum (MATSUMOTO)

Pl. 5, fig. 1

1975. *Yubariceras pseudomphalum* MATSUMOTO, p. 146, pl. 22, fig. 1.
1982. *Neomphaloceras pseudomphalum* (MATSUMOTO); MATSUMOTO and OBATA, p. 73, pl. 2, fig. 1; pl. 5, fig. 1.

Holotype: MC. 76 of the MURAMOTOS' Collection from the Oyubari area, figured by MATSUMOTO (1975, pl. 22, fig. 1).

Material: YKC. 560920, from the Kamimaki-zawa.

Description: This specimen is much larger than the holotype and shows more clearly the characters of the outer whorl. The specimen from the Ashibetsu area described previously by MATSUMOTO and OBATA (1982) does have the outer whorl which, however, was much eroded and distorted. This deficiency is supplemented by the specimen described herein.

This specimen is large. The head of its last suture is at 212 mm in diameter and its body-chamber is preserved for about 90°. Should the body-chamber be assumed as long as a half whorl, then the entire shell diameter would be about 300 mm.

Measured dimensions in mm are tabulated below:

Specimen	Diameter	Umbilicus	Height	Breadth	B/H
YKC. 560920	212.0	67.0 (.32)	89.0 (.42)	>98 (.46)	>1.10
Holotype	93.0	30.0 (.32)	—	—	—
〃 (−45°)	—	—	39.0	45.5	1.17

The outer whorl enlarges with a moderate rate (about 1.5 in height increase for 180°; 2.3 for 360°), overlapping about an outer third (in height) of the next inner whorl. The umbilicus is of moderate width, showing the same ratio of U/D as that of the holotype.

The whorl is somewhat broader than high and subquadrate in cross-section, having a broad venter, rather flat, parallel flanks and steeply inclined, nearly vertical umbilical wall.

The main part of the adult whorl, that consists of the last part of the phragmocone and the body-chamber has thick and fairly strong primary ribs at wide intervals without intercalated secondary ones. The primary ribs are nearly rectiradiate or slightly concave to the anterior. In the septate part they have umbilical, lateral, large inner and small outer ventrolateral tubercles. On the body-chamber the horn-like ventrolateral tubercles are developed from the united twos. No tubercle is discernible on the median line of the venter at the adult stage.

In the preceding one whorl of the phragmocone, that represents the middle growth-stage, the primary ribs are disposed likewise distantly, numbering 12 per whorl,

and fairly strong but not so thick as those of the adult stage. They have prominent tubercles in a row at about the middle of the flank and moderately strong ones at the umbilical shoulder. The latter is somewhat bullate. In addition to the primaries, one to three shorter secondary ribs are intervened between the primaries or occasionally a shorter rib branches from the major rib at about the lateral tubercle. Owing to some erosion, the intensity of the inner and outer ventrolateral tubercles at this stage is not well shown by this specimen but the clavate tubercles do exist on the siphonal line. (see MATSUMOTO and OBATA, 1982 about the characters of this part observed on the Ashibetsu specimen.)

A still younger part of this specimen is not well shown either but one of us (T.M.) knows a small immature specimen in another collection form the same Oyubari area, which will be described in another paper.

Occurrence: The described specimen was embedded in the mudstone exposed at a point in a gully about 250 m upstream (i.e. northward) from the conference with the middle course of the stream Agemaki-zawa, a branch of the River Yubari-gawa in the Oyubari area. From the same and nearby localities *Inoceramus* (*Inoceramus*) sp. aff. *I.* (*I.*) *hobetsensis* NAGAO et MATSUMOTO (non-sulcate form) occurs commonly, which suggests rather lower part of the Middle Turonian in the scale of the Japanese province. This conforms generally with the stratigraphic position of the hitherto reported examples of *Neomphaloceras pseudomphalum*. Incidentally, one of us (T.M.) revisited the locality of the Ashibetsu specimen, which came from a branch stream called the Takinosawa, misreported as the Naka-poroko-zawa by MATSUMOTO and OBATA (1982, p. 74). *I.* (*I.*) aff. *I.* (*I.*) *hobetsensis* (non-sulcate form) occurs in the nearby outcrops of mudstone, which is below the beds with typical *I.* (*I.*) *hobetsensis*.

Neomphaloceras cf. *N. pseudomphalum* (MATSUMOTO)

Pl. 6, fig. 1

Material: YKC. 590813 acquired by Y. KAWASHITA from an outcrop on the route of the Kaneobetsu.

Description: This is a large specimen obtained in situ, but incompletely preserved. Its right side is not shown probably because of dissolution during the fossilization. Even on its left side the characters of the inner whorls are not well shown and the venter is eroded on the septate part of the outer whorl.

The approximate dimensions (in mm) are tabulated below:

	Diameter	Umbilicus	Height	Breadth
(1)	~360	123 (.34)	160 (.44)	——
(2)	306	104 (.34)	140 (.45)	——

(1) Near the preserved end. (2) 45° prior to (1)

The body-chamber is preserved for at least 150°. Sould its full length be assumed as 180°, the entire diameter would be about 400 mm. The last septum is at about 250 mm in diameter.

The whorl enlarges with a moderate rate, encircling the umbilicus of moderate width. It has a vertical wall around the umbilicus, only gently convex or rather flat flanks, subrounded ventrolateral shoulder and broad venter. It is inferred to be broader than high and subquadrate in sections, although the right side is unpreserved.

The body-chamber has primary ribs at fairly wide intervals without intercalated secondaries. The tubercles at the ventrolateral shoulder are thickly elevated and indistinctly doubled, with an outer smaller one about to be absorbed by a larger inner one, and the horn-like protuberance may have developed on the unpreserved late part of the body-chamber. The umbilical and lateral tubercles are strong on the earlier three ribs of the body-chamber as well as on the primary ribs on the late part of the septate whorl. The lateral tubercles are somewhat, but not much, closer to the umbilical ones than to the ventrolateral ones. They are thickened but becoming blunt on the later ribs of the body-chamber.

On the septate part of the outer whorl a shorter secondary rib is as a rule intercalated between the distant primary ribs. Owing to the erosion the siphonal tubercles are not preserved.

The ribs are nearly rectiradiate on the septate part. They are thickened and slightly concave on the body-chamber, projecting gently towards the ventrolateral shoulder.

The suture is simplified owing to erosion.

Remarks: This specimen resembles the preceding example of *Neomphaloceras pseudomphalum* in the general aspects. It is, however, somewhat larger and its lateral tubercles are situated somewhat closer to the umbilical ones. These differences may be regarded as a variation within the same species. As its preservation is incomplete, we hesitate to conclude a definite identity.

A deficiency is the unpreserved state of the siphonal tubercles on the septate whorl. If the siphonal tubercles were originally absent, this specimen could be regarded as a derivative of *Mammites* which acquired a lateral row of tubercles, that would be a species of *Polyaspidoceras* MATSUMOTO, 1977. Unless better preserved specimens be obtained, we do not take a too much hypothetical view.

Occurrence: This specimen was obtained by Y. KAWASHITA from the mudstone exposed at a point 100 m upstream from the conference with the artificial lake of Shuparo on the right side of the tributary called Kaneobetsu. The bed is in the Zone of *Inoceramus hobetsensis*, characterized by the common occurrence of typical large forms of the zonal index, upper part of the Middle Turonian in the Japanese province.

Genus ***Romaniceras*** SPATH, 1923

Type-species: *Ammonites deverianus* d'ORBIGNY, 1841 by the original designation by SPATH, 1923.

Remarks: In this paper *Romaniceras* is taken provisionally in a strict sense, that is the subgenus *R.* (*Romaniceras*) defined by KENNEDY *et al.* (1980) (see MATSUMOTO and UCHIDA, 1985 for the discussion).

Romaniceras pseudodeverianum (JIMBO)

Pl. 4, fig. 3; Pl. 7, fig. 1; Pl. 8, figs. 3, 4

1894. *Acanthoceras pseudodeverianum* JIMBO, p. 178, pl. 21, fig. 1.
1957. *Romaniceras pseudodeverianum* (JIMBO); MATSUMOTO *et al.*, p. 22, pl. 8, fig. 8.
1960. *Romaniceras* (*Proromaniceras*) *pseudodeverianum* (JIMBO); WIEDMANN, p. 735.
1963. *Romaniceras pseudodeverianum* (JIMBO); MATSUMOTO, p. 44, pl. 64, fig. 1.
1980. *Romaniceras* (*Romaniceras*) *deverianum* (d'ORBIGNY); KENNEDY *et al.*, p. 332 (pars), pl. 43, figs. 1–3.
1985. *Romaniceras kallesi* (ZÁZVORKA); MATSUMOTO & UCHIDA, p. 2, pl. 1, figs. 1, 2; text-fig. 1.

Material: YKC. 580703, from the Shiyubari, Oyubari area, whose plaster casts are kept at NSM. and GK. Its left half is well preserved with test attached partly, but for its eroded last part.

Description: The phragmocone ends at about 130 mm in diameter and the body-chamber is preserved for 160°. On the assumption that the full length of the body-chamber is 180°, we estimate the entire shell diameter as 175 mm or so.

The whorl enlarges with a moderate rate (1.38 in the ratio of height increase in a half whorl), overlapping about a quarter (in height) of the next inner whorl. The umbilicus is moderately wide, surrounded by a steep wall. The whorl is somewhat higher than broad and subrectangular in section, with slightly convex or nearly flat, subparallel flanks, angular (costal) or subangular (intercostal) umbilical and ventrolateral shoulders and a gently arched venter which is nearly flat between the rows of outer ventrolateral tubercles and gently to moderately sloping from the row of outer ventrolateral tubercles to that of the inner ones.

On the phragmocone the ribs are fairly numerous, 19 per half whorl. The longer primary ribs with tubercles at the umbilical shoulder are normally alternated with secondary ribs of unequal length. Occasionally a short rib branches from the long one. On the visible earlier part of the inner whorl with radius of 30 to 40 mm, some of the long ribs are unusually thick and provided with stronger tubercles, but otherwise the ribs on the phragmocone are narrow, slightly prorsiradiate or occasionally gently flexiradiate on the flank and somewhat projected on the ventrolateral part. The umbilical and lateral tubercles are bullate.

On the body-chamber the ribs become gradually coarser and the intercalation of shorter ribs become infrequent and thus the ribs number 16 per half whorl. On the observable part of the body-chamber the tubercles are fairly strong, showing the well surviving lateral ones.

On both the inner and outer whorls the ribs are narrower than the interspaces, the latter of which may have striae on the surface. The lateral tubercles are closer to the umbilical ones and more distant from the inner ventrolateral ones. The distance between the inner and outer ventrolateral tubercles is moderate and that between the outer ventrolateral and siphonal ones is the shortest. The latter two tubercles are clavate, the inner ventrolateral conical.

The suture is of *Acanthoceras* pattern; lobes are deeper than broad; lateral saddles

are rather massive and bipartite.

Dimensions (in mm) are tabulated below:

Specimen	Diameter	Umbilicus	Height	Breadth*	B/H
YKC. 580703	153.0 (1)	57.0 (.37)	58.5 (.38)	~25×2 (.33)	0.85
UMUT. MM 7516	189.0 (1)	68.0 (.36)	71.0 (.38)	~31×2 (.33)	0.87
〃 (costal)	192.0 (1)	68.0 (.35)	73.0 (.38)	~33×2 (.34)	0.90
*R. kallesi***	141.0 (0)	50.6 (.36)	54.5 (.36)	48.5 (.34)	0.89

* For the reason of taphonomy as discussed by TANABE *et al.*, 1984, the right half deserves measurements.

** Measured for comparison on the Nantes specimen of *R. kallesi* (adapted from KENNEDY *et al.*, 1980, p. 344 and pl. 44)

Comparison and discussion: The holotype of *Romaniceras pseudodeverianum* (JIMBO) was found years ago from a nodule on the floor of the River Obirashibetsu, northwestern Hokkaido. Lately S. UCHIDA, a friend of ours, has obtained an interesting specimen of *Romaniceras* from the mudstone of the zone of *Inoceramus hobetsensis* exposed at loc. R 4017a of TANABE *et al.* (1977) on the left side of the same river. Quite recently, this has been described provisionally under *R. kallesi* (ZÁZVORKA) by MATSUMOTO and UCHIDA (1985). They have proposed, on the evidence available on that occasion, the two alternatives that *R. pseudodeverianum* (JIMBO, 1894) could be a senior synonym of *R. kallesi* (ZÁZVORKA, 1958) or that the two species could be distinct but closely allied to each other.

In connexion with this problem the KAWASHITA's specimen (abbreviated as K in the comparison below) described in this paper deserves attention. It shows somewhat intermediate features between the UCHIDA's specimen (U) and JIMBO's (J) (i.e. the holotype of *R. pseudodeverianum*). For instance, the diameter of the full-grown shell on the assumption that the body-chamber is as long as 180° would be 160 mm in U, 175 mm in K and 200 mm in J; B/H in restored whorl section would be 0.82–0.84 in U, 0.85 in K and 0.87 in J, provided that a half side is assumed to have been little deformed in contrast to the unpreserved or dissolved other half; the umbilicus is 30–32% of D (shell diameter) in U but 35–37% in both K and J: the number of the ribs on the last half of the septate whorl is 21–20 in U, (as in the French Nantes specimen of *R. kallesi*), 19 in K and 16 in J: that of the ribs on the first 90° of the body-chamber is commonly 7 or 8 in the three specimens (U, K. and J) from Hokkaido, whereas it is more numerous (11 or more) in the Nantes specimen and the holotype of *R. kallesi*. In fact, on the body-chamber of the Japanese specimens the ribs are generally coarser and more distant than those of *R. kallesi* from Europe, except for WIEDMANN's (1960) *hispanicum*. In the Japanese specimens the tubercles are fairly strong on some ribs on both the body-chamber and phragmocone.

On the ground of the above facts, we are inclined to regard the three specimens from Hokkaido as belonging to the same species, i.e. *R. pseudodeverianum* (JIMBO), showing some extent of variation. The JIMBO's specimen may represent the extreme end of the variation which seems to approach to *R. deverianum* (d'ORBIGNY) in the

comparatively coarser ribbing and stronger tuberculation, whereas the UCHIDA's specimen may be near the other end of the variation in that its phragmocone is fairly close to *R. kallesi*. As MATSUMOTO and UCHIDA (1985) mentioned, *R. pseudodeverianum* and *R. kallesi* have commonly certain diagnostic characters, such as the subrectangular whorl-section, moderately wide umbilicus, numerous rather narrow ribs, generally weak tubercles on the phragmocone (with some exceptions in the Japanese form), and approximation of the lateral and umbilical tubercles. The distinction of the two taxa becomes clear in the adult body-chamber. The Japanese form is larger and has coarser ribs on which fairly strong tubercles persist longer.

To sum up the above observation, we would suggest that the two taxa could be regarded as the geographical subspecies of the same species. Anyhow, we should look for still more specimens in both provinces of Japan and Europe (or Euramerica) to examine this presumption.

Occurrence: Y. KAWASHITA obtained this specimen at about loc. Y 217 of MATSUMOTO (1942) from a boulder on the bed of the River Shiyubari running roughly southward in parallel with the general trend of the strata, which belong to the middle part of the Saku Formation. It was probably derived from the middle part of the Turonian. The stratigraphical range of this species in Hokkaido should be worked out by collecting more specimens.

Genus ***Shuparoceras*** MATSUMOTO, 1975

Type species: *Shuparoceras yagii* MATSUMOTO, 1975.

Remarks: *Shuparoceras* is characterized by its flat, parallel sided whorl with a moderately arched venter, numerous ribs with frequently intercalated shorter ones in immature stages, nine rows of tubercles of which the five on the ventral part are fairly approximated, presence of periodic constrictions and peculiar weakening or effacing of the ribs and tubercles at certain growth-stages.

Some of the above characters conform fairly well with the diagnostic features of *Eucalycoceras* from the Middle to Upper Cenomanian, but no species which could link *Eucalycoceras* with *Shuparoceras* has been found. We could presume diverse evolutionary lines for the multituberculated acanthoceratids as a working hypothesis, but the phylogenetic origin of *Shuparoceras* is at present by no means certain.

KENNEDY *et al.* (1980) are inclined to evaluate *Shuparoceras* as a subgenus of *Romaniceras*, but no transitional species has been found between them. We would rather prefer to keep *Shuparoceras* as distinct from *Romaniceras* on the basis of the above diagnosis, but should search for more reliable evidence to test the independence of the two genera.

The specimen from New Mexico which was assigned to *Shuparoceras* by KENNEDY *et al.* (1980, text-fig. 2) indeed resembles the septate shell of this genus, but it lacks the body-chamber which should show more clearly the diagnostic features.

Shuparoceras yagii MATSUMOTO

Pl. 8, figs. 1, 2

1975. *Shuparoceras yagii* MATSUMOTO, p. 110, pl. 12, fig. 1, text-fig. 3.

Holotype: HCS. No. 56 (Coll. K. YAGI) from the Oyubari area.

Material: YKC. 530321 from loc. Y 5201, right side of the River Hakkin-zawa ["Shirakin-gawa"], Oyubari area.

Description: This specimen has the last septum at 60 mm in diameter and the body-chamber for about 190° on whose last part intercalated ribs disappear. Therefore it can be regarded as representing an adult shell, but it is smaller than the holotype whose last septum is at 118 mm in diameter. The dimensions (in mm) are tabulated below:

Specimen	Diameter	Umbilicus	Height	Breadth	B/H
YKC. 530321	87.0	23.0 (.26)	41.0 (.47)	35.0 (.40)	0.85
〃 −180°	66.0	17.4 (.26)	30.6 (.46)	28.0 (.42)	0.91
Holotype	118.0	30.0 (.25)	56.0 (.47)	51.0 (.43)	0.91

The whorl expands with a fairly high rate, i.e. 2.88 in whorl-height (outer H= 46.0; inner H=16.0), and the shell is moderately involute. Accordingly the umbilicus is fairly narrow for the subfamily. The whorl is somewhat higher than broad, showing nearly the same ratio of B/H as that of the holotype, with a moderately arched venter, flat, subparallel flanks, subangular umbilical shoulders and almost vertical umbilical walls.

There are numerous ribs of unequal length and intensity. Some of them are gently fiexiradiate others nearly rectiradiate or slightly prorsiradiate.

On the preserved last 50° of the body-chamber, the ribs are nearly equally long, moderately strong and somewhat flattened on the outer part, having clavate inner and outer ventrolateral and siphonal tubercles, but narrowed on the inner (i.e. towards the umbilical) part, with bullate inner lateral tubercles, which are fairly prominent at the bending point of the rib. Some of these ribs have a tubercle at the umbilical shoulder but others are narrowed and weakened towards the umbilicus and free from the umbilical tubercle.

On the earlier part of the body-chamber as long as 140°, the ribs and tubercles are weakened or effaced. Intercalated or branched ribs occur frequently. The umbilical and inner lateral tubercles are occasionally discernible as faint elevations; the inner ventrolateral tubercles persist better but weakened and disappear on the last one third of 140°; the ventral tubercles are much weakened and almost lost.

The last 150° of the phragmocone has numerous, gently flexuous ribs of normal intensity. One to three shorter and weaker ribs intervene between the longer ribs. All the ribs have small nodes in five, equidistant rows on the ventral part. The long ribs have inner lateral and umbilical tubercles, which are both bullate and close to each other. The highest top of the umbilical bulla is at the umbilical shoulder. Some of the long ribs are accompanied by constrictions. At this stage the ribs are gently curved

forward on the ventral part.

On the preceding part, i.e. the last 120° of the inner whorl the ribs and tubercles are weakened, except for the long rib along the constriction. The still preceding part seems to have the ornamentation of normal intensity, with stronger ribs along the constrictions.

The suture is not well exposed because the shell layer is preserved. A partly exposed pattern shows a considerable incision like the suture of the holotype.

Comparison and discussion: This specimen resembles the holotype in essential points and is referred to the same species. Aside from the difference in shell size, the earlier part of the body-chamber has weakened or effaced ribs and tubercles in the two specimens. In this specimen the ornamentation is strengthened in the late part of the body-chamber. In the holotype this character is unknown, because the corresponding part is not preserved.

We do not know exactly the meaning of the weakened ornaments occurring at certain stages. Certainly, this is not pathologic, because the same feature is shown commonly in the three available specimens. It cannot be overlooked that the loss of lateral tubercles at a considerable interval, together with some other characters, suggests a similarity to certain species of *Eucalycoceras*. We should try to find a form from the Lower Turonian or uppermost Cenomanian which could represent the ancestor of *Shuparoceras yagii*.

Occurrence: In a limy nodule contained in the mudstone exposed at loc. Y 5201, on the right side of the River Hakkin-zawa [="Shirakin-gawa"], a tributary of the River Yubari-gawa, Oyubari area. The mudstone of this locality is allocated in the upper part of Member My 8 of NAGAO *et al.* (1954) and is referred to the Middle Turonian.

Further Remarks

As to the Cretaceous basin of sedimentation in the central belt of Hokkaido, previously called the Yezo geosyncline, the main sources of the clastics are presumed to have been in the mountainous land in the west. Especially, with respects to the Cenomanian and Turonian, sandstone and sandy siltstone predominate in the western part of the basin, as represented by the Mikasa Sandstone Formation, whereas mudstone is generally common in the eastern part (i.e. closer to the belt of serpentinite), with some intercalated thin layers of sandstone at several levels (see MATSUMOTO and OKADA, 1971). The part consisting of mudstone and sandstone in frequent alternation in the Middle to Upper Turonian has been called the Saku Formation (see MATSUMOTO and OKADA, 1973). On the basis of the above mentioned general configuration of the lithofacies as well as the contained fossils, it has been generally thought that the sediments in the western part are near-shore, shallower sea facies and those in the eastern part comparatively deeper, off-shore facies.

The Mikasa (="Ikushumbets") district, from the Pombets area eastward up to

the artificial lake of Katsura-zawa dam, and also the Manji and Hatonosu domes on its southern extension represent the western part, whereas the Oyubari and southerly adjoining Hobetsu areas are in the eastern part.

As to the contained fossils, the bivalves such as trigonians and glycymerids occur in the western area, although their abundant occurrence is restricted within several particular beds, whereas the microfossils such as planktonic foraminifera and radiolaria are contained more commonly in fine-grained sediments of the eastern belt.

In accordance with this general tendency, the ammonites belonging to the Acanthoceratidae and Collignoniceratidae were thought sparse in the eastern part, but recently the collection of these ornate ammonites has increased to a considerable extent through careful field works. Moreover, the mature shells, with body chamber at least partly preserved, are acquired fairly commonly. This implies that these ammonites were not always postmortem drifts from a shallower habitat in the west. Then, in what depth of sea-water the ammonite-bearing strata were formed is a question.

The Cretaceous strata of the Oyubari-Hobetsu area are more complicated in geologic structure than those of the western area, showing thrusts and overturned foldings. Modern geologists (e.g. OKADA, 1983; KIMINAMI & KOTANI, 1983) in favour of plate tectonics regard the Cretaceous sedimentary basin under consideration as a forearc basin in front of the volcanic mountains in the west, as one of us suggested previously (MATSUMOTO & OKADA, 1973). The depth of the sea-waters in this basin is presumed to have increased generally eastward, with a temporarily uplifted serpentinite belt, and also changed with age. Turbidites were accumulated to a considerable amount in certain parts. The authors, however, have not shown the depth quantitatively.

In the Mikasa and adjacent areas in the west there are several places where ornate ammonites occur abundantly. For instance, numerous specimens of *Mantelliceras japonicum* MATSUMOTO *et al.* (1969) were collected at loc. Ik 1100, when the sandstone quarry was in operation; *Reesidites minimus* (HAYASAKA et FUKADA) formed a prolific zone exposed at several places along the River Ikushumbets, which are now submerged under the water of the Katsura-zawa dam, although immature specimens were much more numerous than mature ones (see OBATA, 1965); *Subprionocyclus neptuni* (GEINITZ) occurs commonly in the strata of particular facies in the Manji dome (OBATA and FUTAKAMI, 1977).

The seemingly sparse occurrence of ornate ammonites in the eastern part may be, at least partly, due to the collection failure. At loc. Y 5290, an outcrop of mudstone on the River Hakkin-zawa of the Oyubari area (HIRANO *et al.*, 1977), numerous specimens of *Calycoceras* sp. were observed, although they were deformed and the outcrop facing a deeper part of the river water was unfavourable for our satisfactory collection. One of us (T.M.) saw a certain place in the Hobetsu area where quite a number of specimens of *Romaniceras* and the like were scattered on a river floor in a washout state. They may have been derived from a sliding of a fossiliferous bed. According to the recent study of FUTAKAMI (1985, MS), collignoniceratid ammonites are found

fairly commonly at certain localities in the Oyubari area.

Speaking generally, the Cretaceous sediments of the Oyubari-Hobetsu area in the east represent comparatively more off-shore facies than those of the Mikasa and other areas in the west, but some part of the sediments, i.e. the beds containing ornate ammonites, might have been formed under the neritic sea. It could be also postulated that ornate ammonites of the Acanthocerataceae, whose habitat has been regarded as fairly shallow, might have a broader habitat of a considerable range of depth. This problem should be worked out through synthetic judgement on the results of analyses from various fields, such as gross-tectonics, sedimentology, palaeoecology of associated mega- and micro-fossils, especially the benthos as well as trace fossils, and functional morphology of ammonites themselves. In this paper of palaeontological description we merely point out the problem and leave it for future study.

The sequence which ranges from the uppermost Cenomanian to mid-Turonian is occupied by rather coarse-grained sandstone with some conglomerate in the Mikasa [Ikushumbets] area. The sediments contain glycymerids and even ostreids, being unfavourable for ammonites. Therefore, we have to go to the Oyubari-Hobetsu area to search for the acanthoceratids of these ages, which are most important to make clear the natural history of the multituberculate forms, although the strata are fairly disturbed there.

The Saku, Kotanbetsu and Obira areas in northwestern Hokkaido (MATSUMOTO & OKADA, 1973; TANABE *et al.*, 1977; MATSUMOTO *et al.*, 1978) may be another region where the material for this problem can be supplied, since the facies of the Cenomanian and Turonian in this region seems to be generally intermediate between that of the eastern and western parts of central Hokkaido and the geologic structure is not so complicated as in the Oyubari-Hobetsu area.

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Explanation of Plates 1–8

(Bar=10 mm; arrow: end of phragmocone)

Plate 1

Fig. 1. *Acanthoceras takahashii* MATSUMOTO
YKC. 570814 from the Kaneobetsu route, Oyubari area. Frontal (a) and right lateral (b) views, *ca.* ×0.7

Plate 2

Fig. 1. *Acanthoceras takahashii* MATSUMOTO
YKC. 570814 (same as in Pl. 1.). Ventral (a) and left lateral (b) views, *ca.* ×0.7

Plate 3

Fig. 1. *Acanthoceras takahashii* MATSUMOTO
YKC. 590715 from the Kaneobetsu route, Oyubari area. Right lateral view, *ca.* ×0.8

Plate 4

Figs. 1–2. *Kamerunoceras* aff. *K. turoniense* (d'ORBIGNY)
YKC. 560914 from the upper reaches of the Isojirono-sawa, Oyubari area. 1: lateral view, *ca.* ×0.43. 2: diagrammatic whorl-section at a mature stage.
Fig. 3. *Romaniceras pseudodeverianum* (JIMBO)
YKC. 580703 from the Shiyubari, Oyubari area. Diagrammatic whorl-section at a mature stage. (see Pl. 7, fig. 1 for photographs of the same specimen). Broken line in the diagram is a restored outline.

Plate 5

Fig. 1. *Neomphaloceras pseudomphalum* (MATSUMOTO)
YKC. 560920 from the Agemaki-zawa, Oyubari area. Lateral (a) and ventral (b) views, *ca.* ×0.5.

Plate 6

Fig. 1. *Neomphaloceras* cf. *N. pseudomphalum* (MATSUMOTO)
YKC. 590813 from a cliff on the right side of the Kaneobetsu at 100 m upstream from the conference with the Shuparo lake, Oyubari area. Lateral view, *ca.* ×0.4.

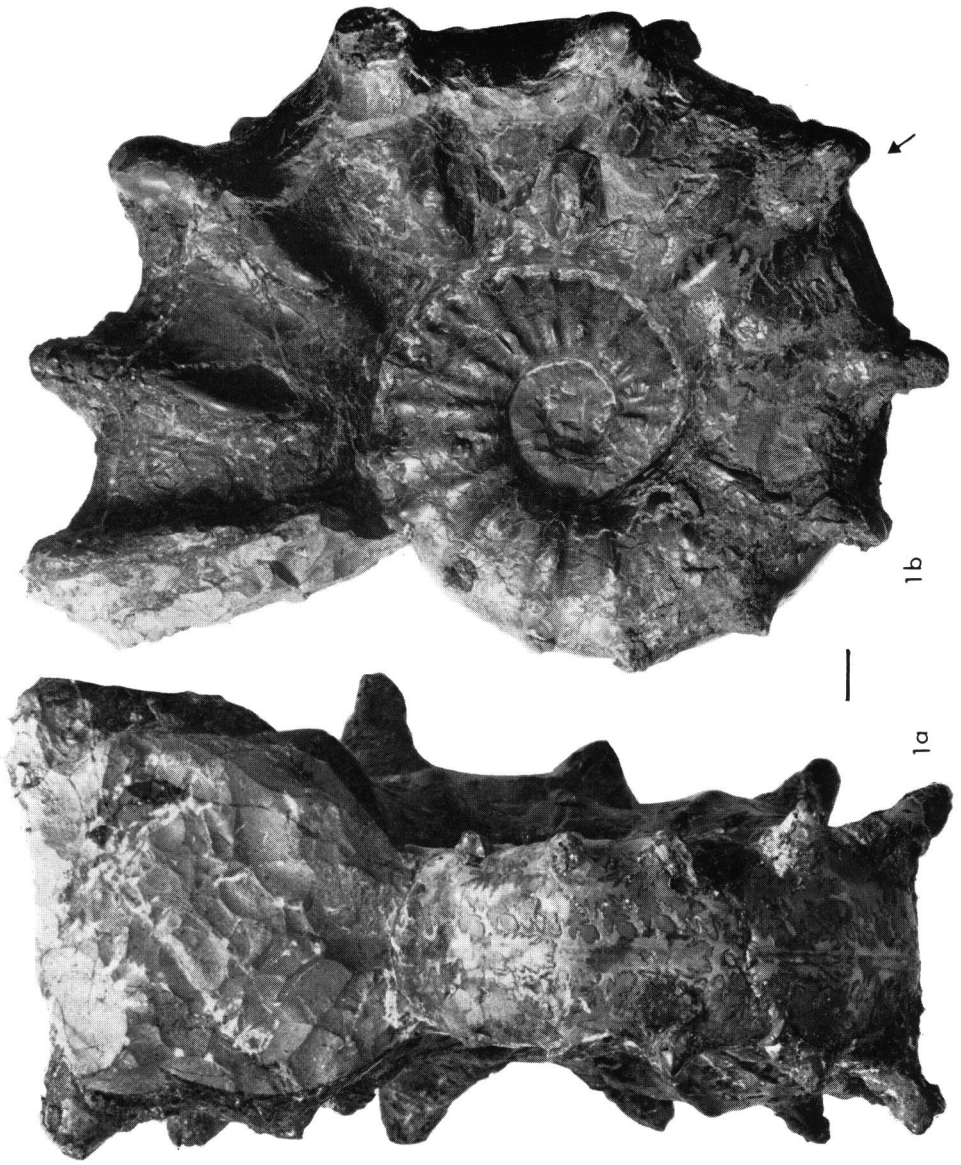
Plate 7

Fig. 1. *Romaniceras pseudodeverianum* (JIMBO)
YKC. 580703 from the Shiyubari, Oyubari area. Lateral view of the entire shell (a) and ventral view of the septate whorl (b), *ca.* ×0.8.

Plate 8

Figs. 1–2. *Shuparoceras yagii* MATSUMOTO
YKC. 530321 from loc. Y5201, Hakkin-zawa, Oyubari area. Ventral (1a), lateral (1b) and frontal (1c) views, *ca.* ×0.8; This specimen has the last septum at 60 mm in diameter. Diagrammatic whorl-section at an adult stage (2).
Figs. 3–4. *Romaniceras pseudodeverianum* (JIMBO)
Holotype, UMUT. MM 7516 from the Obirashibetsu area. Right lateral view (3), *ca.* ×0.5; diagrammatic whorl-section of the right half (4).

Photos by courtesy of Dr. M. NODA and Mr. S. SATO. Diagrams T. MATSUMOTO *delin.*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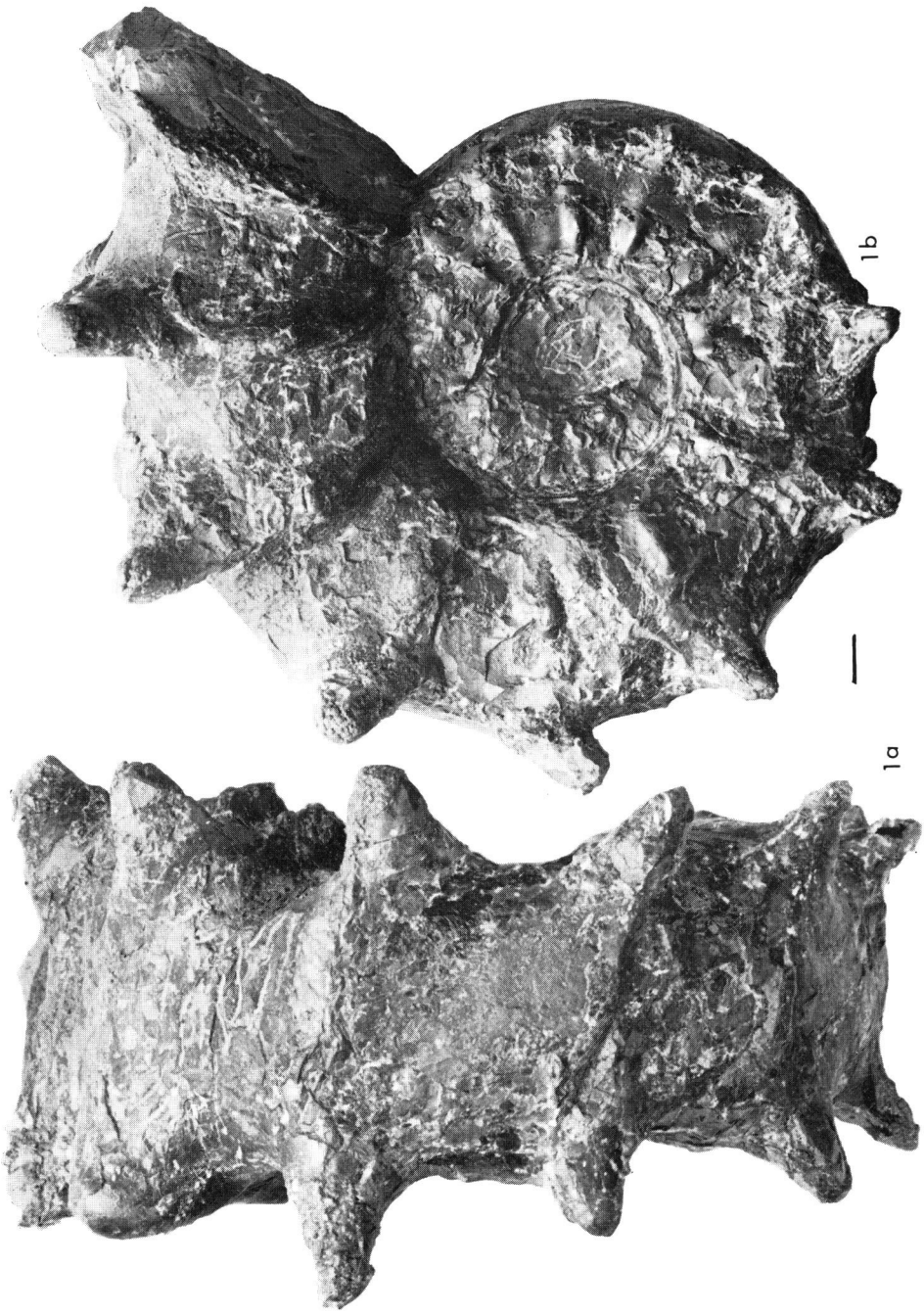
1a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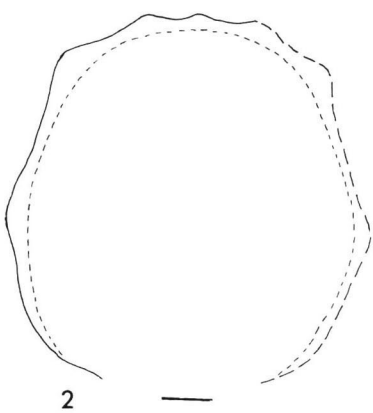

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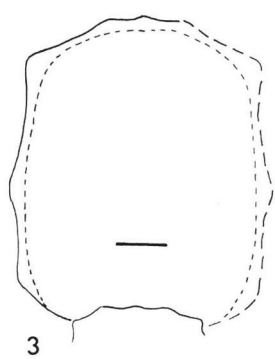

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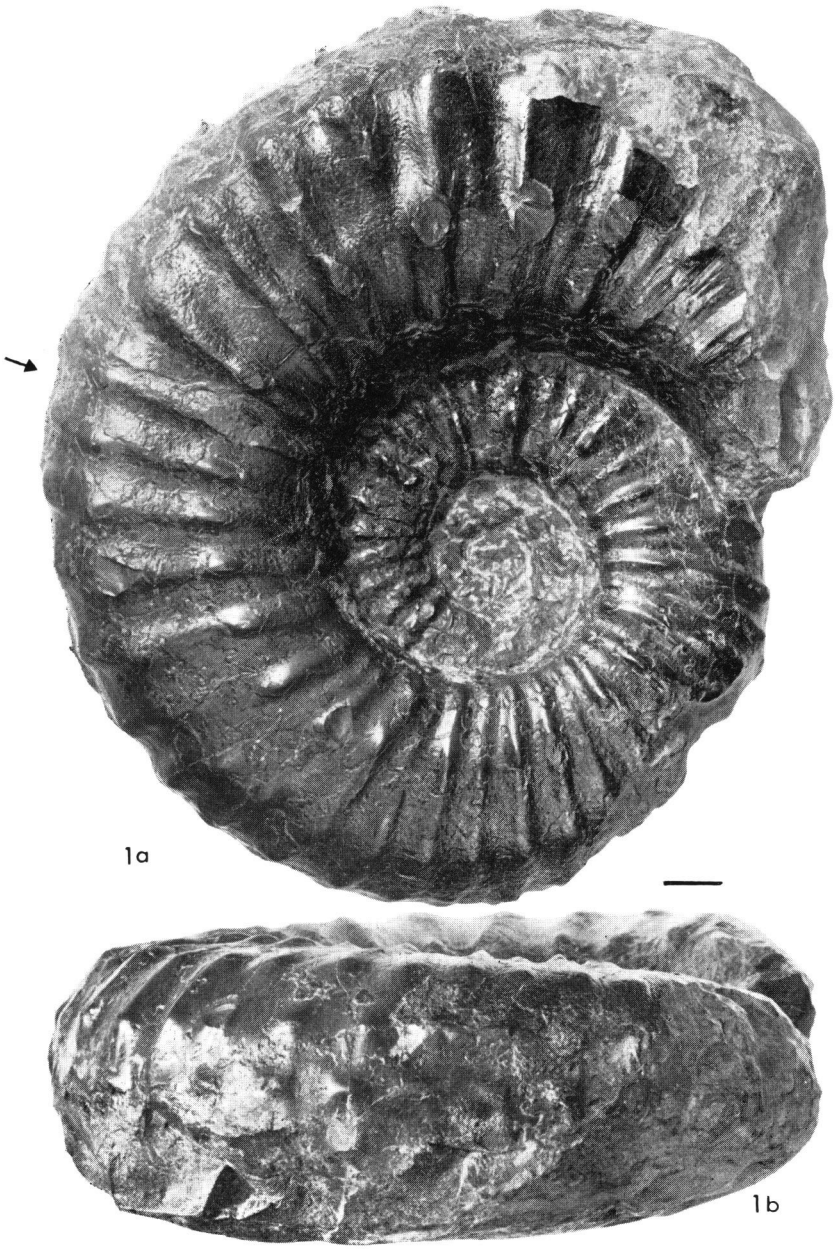
1b
1a


1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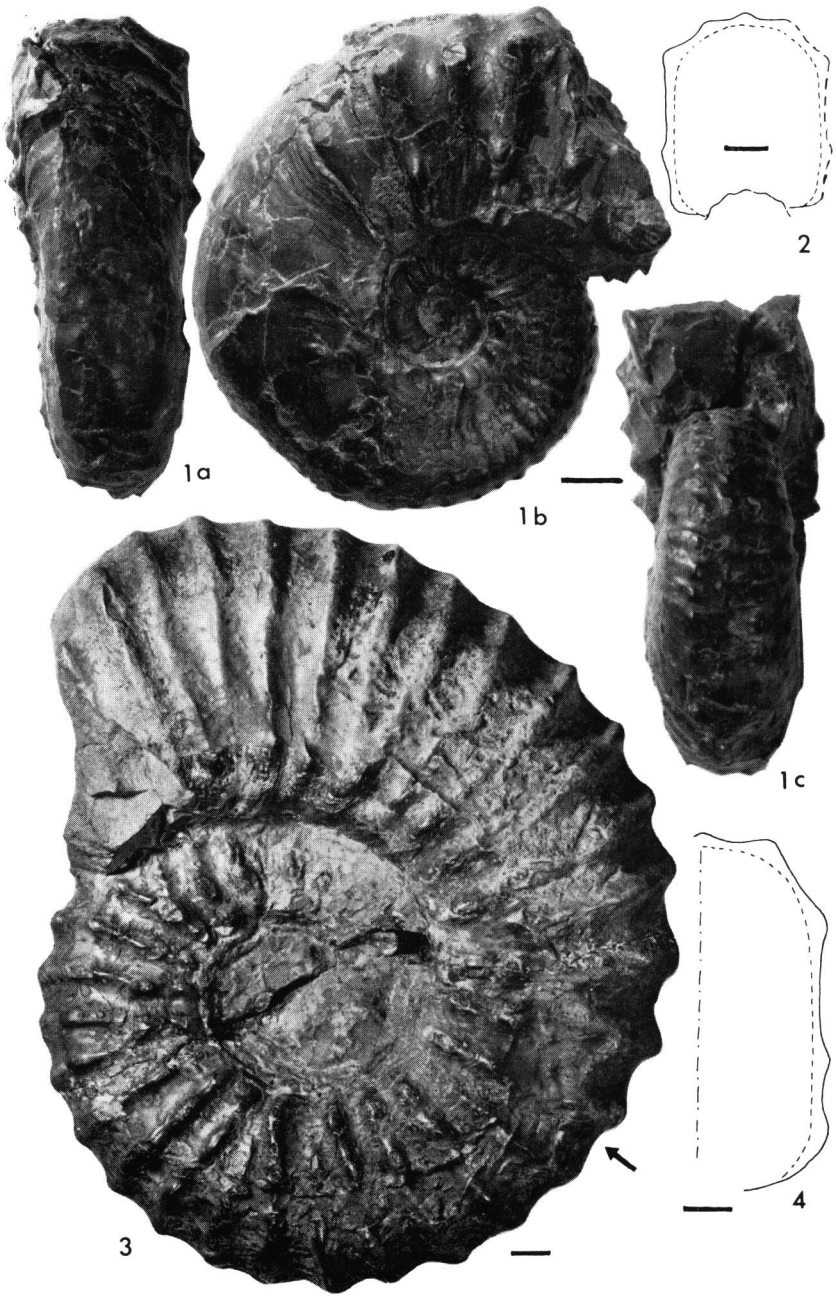
1a
1b
2
1c
3
4