Some Acanthoceratids from Hokkaido : Studies on the Cretaceous Ammonites from Hokkaido and Saghalien-XI

Matsumoto, Tatsuro
Faculty of Sciences, Kyushu University

Saito, Rinji
Kumamoto University

Fukada, Atsuo
Fukada Geological Institute

https://doi.org/10.5109/1524301

出版情報：九州大學理學部紀要 : Series D, Geology. 6 (1), pp.1-46, 1957-02-28. Faculty of Science, Kyushu University
バージョン：
権利関係：

Mem. Fac. Sci., Kyushu Univ., Ser. D, Geology, Vol. VI, No. 1,
pp. 1-45, text-figs. 1-14, plates 1-18, February, 1957

Some Acanthoceratids from Hokkaido

(Studies on the Cretaceous Ammonites from Hokkaido and Saghalien—XI)*

By

Tatsuro MATSUMOTO**, Rinji SAITO*** and Atsuo FUKADA****

Introduction

Compared with the Desmoceratacеae, which one of us (T.M.) has dealt with in a series of papers (Parts III—X), the Acanthocerataceae are not so richly represented in the Cretaceous deposits of Hokkaido and Saghalien. However they do occur, though in general rather sporadically but in some special cases fairly commonly, forming local subzones.

In spite of the importance of the Acanthocerataceae for world wide correlation, their systematic descriptions have been incomplete in our country. Only two Acanthoceratids were described by JIMBO (1894); a number of species including several new names were listed by YABE (1909) but his manuscript names have not been published; "Prionotropids" [=Collignoniceratidae and Peroniceratidae] have been partly monographed by YABE & SHIMIZU (1925; also YABE 1902); two rare genera *Yabeiceras* and *Pseudobarroisiceras* were proposed by TOKUNAGA & SHIMIZU (1926) and SHIMIZU (1932); a species of "*Mortoniceras*" [=*Texanites*] was reported by KAWADA (1929) from South Saghalien; a full description of "*Barroisiceras*" *minimum* (*ex* YABE MS.) was given by HAYASAKA & FUKADA (1951); the occurrence of *Pseudaspidoceras* was reported by MATSUMOTO & HASHIMOTO (1953) with a description of a new species; some nomenclatorially doubtful genera were discussed by WRIGHT & MATSUMOTO (1954), who did not, however, give any description of the species of Acanthocerataceae; lastly MATSUMOTO (1955) has recently discussed the evolution of Peroniceratidae but the monographic description of the group has been postponed.

In this paper some of the Acanthoceratidae from Hokkaido are described. We have not enough material of the family from Saghalien.

While MATSUMOTO was engaged in a study of Upper Cretaceous Ammonites

* Received June 12, 1956.

** Department of Geology, Kyushu University.

*** formerly Department of Geology and Mineralogy, Hokkaido University; at present Department of Geology, Kumamoto University.

**** formerly Department of Geology and Mineralogy, Hokkaido University; at present Fukada Geological Institute, Tokyo.

including the Acanthoceratids of his collection, FUKADA independently gave in 1952 a preliminary information in lectures at the University on the Acanthoceratids of the collections in Hokkaido University. This was not published because of some uncertainty in identification. About twenty years ago SAITO attempted to write a preliminary manuscript on some Cretaceous ammonites of Hokkaido University but the paper was not completed because he had to devote himself to some other works. The first author (T.M.) has continued to study not only his own collections in both Kyushu and Tokyo Universities but also others deposited in Tokyo and Hokkaido Universities, owing to kind permission of the authorities there as well as Emeritus Prof. H. YABE and the second and third authors. He brought with him a manuscript in the occasion of his visit to England, where he made additional studies. After his return home he has discussed with the two other authors, resulting in full agreement.

Thus the first author is principally responsible for the writings in the present paper, but because of much dependence on the second and third authors in the efforts of obtaining specimens, the preliminary studies and further discussions the combined names should be given as the authors of the entitled work.

The establishment of *Acanthoceras* and also *Hoplites* by NEUMAYR (1875) was indeed an epoch in the taxonomic history of the Cretaceous Ammonitina. However the genera at that date were too comprehensive and too composite. Since then a large number of genera have been introduced as the relatives of *Acanthoceras*, while many others have been separated from the group as independent, homoeomorphic forms.

The family (Acanthoceratidae) was established by DE GROSSOUVRE (1894) but it was still too heterogeneous. His concept of Acanthoceratidae approximately, though not exactly, corresponds to that of the superfamily Acanthocerataceae in our present knowledge, because *Stoliczkaia* NEUMAYR (1875), *Mammites* LAUBE & BRUDER (1886), "*Prionotropis* MEEK (1876)" [=*Collignoniceras* BREISTROFFER (1947)], *Gauthiericeras* GROSSOUVRE (1894), *Peroniceras* GROSSOUVRE (1894), "*Mortoniceras* MEEK (1876)" [=*Texanites* SPATH (1932)], *Tissotia* DOUVILLÉ (1890) and *Barroisiceras* GROSSOUVRE (1894), besides others, were included in the group. HYATT (1900, 1903) attempted to split this polyphyletic group and established Mantelliceratinae, Mammitidae, Metoicoceratidae, Prionotropidae [=Collignoniceratidae], Peroniceratidae, Tissotiidae, Pseudotissotiidae, Coilopoceratidae, Lenticeratidae, Sphenodiscidae, Mojsisoviccsidae, Brancoceratidae [=Hystatoceratidae], *etc.* His scheme of classification was provisionally and too briefly presented in ZITTEL-EASTMAN's Text-book of Paleontology (1900), so that it was rather difficult to understand the meaning of his proposed genera and families. Some of his revision was monographically published after his death under the title of "Pseudoceratites of the Cretaceous" (1903), edited by Dr.

STANTON. In that paper *Mantelliceras, Sharpeiceras, Acompsoceras, Metoicoceras, Pseudaspidoceras* and *Metasigaloceras*, among others, were defined and discussed. His taxonomic scheme still included various polyphyletic forms under one group. H. DOUVILLÉ (1912) attempted to sort the group in question and introduced Vascoceratidae.

A much more reasonable scheme of classification was presented by Dr. SPATH but he himself changed his own view as his works proceeded (SPATH, 1923, 1925 a, b, 1926 a, b, 1927, 1937). According to him the Acanthoceratids have their origin in *Stoliczkaia* of Lyelliceratidae and are divided from the early stage of their evolutional history into two branches, Acanthoceratinae and Mantelliceratinae. Grouping of the too numerous species of '*Acanthoceras*' was undertaken by KOSSMAT (1897) and then PERVINQUIÈRE (1907). Some of the species-groups correspond to HYATT's genera, but others had been left unnamed, until SPATH introduced generic names, *Submantelliceras, Paracalycoceras, Eucalycoceras, Protacanthoceras, Euomphaloceras* and *Romaniceras*. *Metacalycoceras* SPATH (1926) which has been cited by many subsequent authors, is a synonym of *Calycoceras* HYATT (1900), as SPATH later (1937) made clear. COLLIGNON (1929, 1939) has introduced *Cottreauites* and *Hourcquiceras* from the material of Madagascar. *Cunningtoniceras* COLLIGNON (1937) is regarded as a synonym of *Euomphaloceras* SPATH (1923). In addition to the above genera an aberrant genus *Dunveganoceras* was established by WARREN and STELCK (1940) from North American material (see also HAAS, 1949, 1951).

Recently C. W. WRIGHT has been engaged in a study of the group. His renewed collections on the foundation of field work in the British Chalk are admirable. The outline of his classification was presented in 1951 and 1952 and further details are to be published in the forthcoming "Treatise on Invertebrate Paleontology". There was a very instructive explanation at the Exhibition of the Geologists' Association in London (Oct., 1953), which one of us (T.M.) fortunately attended. We owe much to his reasonable and natural scheme of classification. REYMENT's (1955, 1956) recent remarks on the Acanthoceratacеae seem to depend much on WRIGHT's view too.

We do not intend in this paper to discuss comprehensively the taxonomy and evolution of the Acanthoceratidae, because our material is not sufficient for the subject. However some necessary remarks are given in connection with the genera under which our forms are described. From taxonomic necessity one new genus is established below. We cannot give with confidence an opinion whether the separation into subfamily Mantelliceratinae and Acanthoceratinae is necessary or unnecessary, but we have a doubt on the question. The point is mentioned in the descriptive part of that new genus. There are in Southwest Japan a few, interesting, horned examples which are related to *Mantelliceras* or *Sharpeiceras*, but they are not treated in the present paper. The phylogenetic relations of the Acanthoceratids with the various Turonian and later branches of Acanthoceratacеae must be very

interesting, but we have little evidence as to the problem, except for a few examples which are to be treated on another occasion.

One thing which should be mentioned in this introductory note is a fact concerning the occurrence of the fossils. Generally speaking Acanthoceratids are not abundant in our Cretaceous, but occasionally they are fairly common, forming local subzones. They are embedded in calcareous nodules in the fine sandy siltstones or silty fine sandstones. In the finer, more muddy rocks they also occur but are rather rare or sporadic. In some cases fossils of the large, probably mature shells are fairly common, but in other cases those of the small, probably immature shells are common. In the experience of one of us (T.M.) smaller, probably inner whorls are commonly found in the sandy Chloritic Marl (at the base of the Chalk) in England, while larger, probably mature shells and fragmentary outer whorls occur in the finer Grey Chalk or Chalk Marl. Numerous papers on the Cretaceous of Madagascar have illustrated Acanthoceratoid specimens of rather small or moderate size, while the Indian Ootatoor group have furnished larger examples. A set of these facts may owe to the conditions of sedimentary environment and preservation. Anyhow our larger examples provide some interesting material for studying the change of characters with growth.

The specimens to be described in this paper belong mainly to collections of one or other of the three authors and partly those of K. JIMBO, H. YABE, Y. MORITA, K. OTATUME, S. SATO, S. NAGAO & A. OSANAI and K. TANAKA and a few unrecorded persons. They are preserved in the following institutions with abbreviation in brackets:

Geological Institute, University of Tokyo (GT.);
Department of Geology & Mineralogy, Hokkaido University, Sapporo (GH.);
Department of Geology, Kyushu University, Fukuoka (GK.);
Geological Survey of Japan (GS.);
Fukada Geological Institute, Tokyo (FG.).

The following papers contain the stratigraphical descriptions of the formations from which the specimens have been furnished. Some necessary maps and tables of localities (with locality numbers, corresponding place-names and horizons) are to be found in them.

"Fundamentals in the Cretaceous Stratigraphy of Japan" (T.M. 1942–43);
"The Cretaceous System in the Japanese Islands" (T.M. [Editor] 1954);
"北海道幾春別川筋白堊系層序の予察" [A Preliminary Note on the Cretaceous Succession along the Ikushumbets Valley, Hokkaido] (T. NAGAO, R. SAITO & T. MATSUMOTO, 1938) (in Japanese);
"幾春別川流域の白堊系" [Cretaceous Deposits in the Ikushumbets Valley] (A. FUKADA, J. ISHII, T. ICHIKAWA and M. SARAKI, 1952) (in Japanese).

Systematic Descriptions

Order Ammonoidea
Superfamily Acanthocerataceae
Family Acanthoceratidae

Genus *Mantelliceras* HYATT, 1903

Type species.—*Mantelliceras mantelli* (J. SOWERBY).

Generic diagnosis.—Relatively compressed to moderately inflated shell, with a pair of ventral tubercles on each rib but without a mid-ventral one in the principal stages. The ribs are usually alternately long and short. Umbilical and sometimes lower lateral tubercles are present on the long ribs. Inner ventrolateral tubercles are sometimes developed but sometimes undiscernible. The ribs tend to be predominant over tubercles on the outer whorls, crossing over the external side.

Remarks.—SPATH (1937) ascribed the origin of *Mantelliceras* to *Stoliczkaia*. The opinion has been proved more concretely by WRIGHT's collection, because he has exhibited specimens of *Stoliczkaia*, in which the inner whorls have paired ventral tubercles and closely resemble young *Mantelliceras*. Such a form may lead to caenogenetically a compressed subgroup of *Mantelliceras*, as he has pointed out.

In the quite recent collection of one of us (T.M.) in the Ikushumbets valley both compressed and inflated examples of the genus have been found. They are to be described on another occasion. In the older collection there are two forms that are probably referable to the genus. The first one is fragmentary. The second one is represented by a large shell which show a peculiarity in that the outer tubercles disappear on the adult whorl.

Apart from the material from Hokkaido there is a specimen of a compressed *Mantelliceras* from Nagase in the Monobegawa valley, Shikoku (Southwest Japan). This will be described also on another occasion.

Distribution.—Cenomanian, principally its lower part; world wide.

Mantelliceras (?) sp.

Text fig. 1

Material.—GH. No. 3124, an imperfectly preserved specimen from the Ikushumbets valley, no further record of collection.

Description.—The preserved outer whorl is nearly as high as broad or slightly broader than high, with dimensions of 35 mm. in height and 37 mm. in width, broadest in the dorsal part and accordingly, somewhat trapezoidal in section, tends to be flattened on the venter and somewhat inflated on the flanks.

The ribs are usually, but not invariably, alternately long and short and are separated by broader interspaces. They cross the venter with slight weakening, being provided with peripheral, clavate tubercles, which become blunt in the pre-

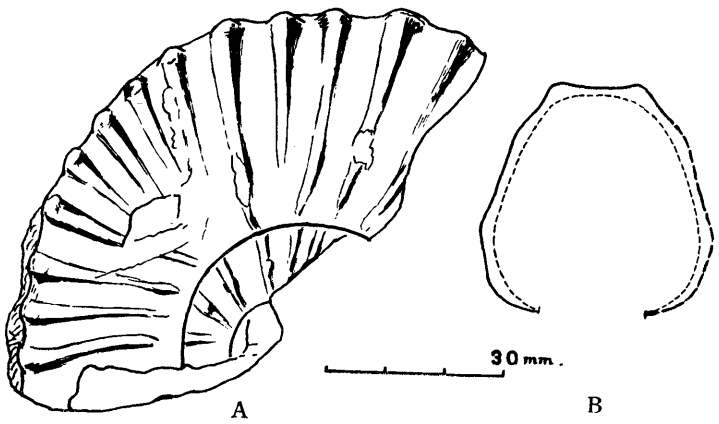


Fig. 1. *Mantelliceras* (?) sp. Lateral view (A) and whorl section (B).
GH. No. 3124 from Ikushumbets. T. M. *del.*

served last part. Besides the marginal tubercles faint bulges or angulations are occasionally discernible on the ribs in the outer lateral part and bullate elevations appear on the long ribs somewhat above the umbilical margin. The latter tubercles are sometimes prominent when the shell is preserved.

Comparison.—This specimen has been labelled "*Acanthoceras asiaticum* JIMBO", but that species at a corresponding size has prominent tubercles on the inner ventro-lateral part and weak ones at the mid-venter, so that the misidentification is evident. The present form probably belongs to the relatively inflated subgroup of *Mantelliceras*. It differs from *M. mantelli* (SOWERBY) in its rather trapezoidal whorl-section. Since the suture is not well exposed and since there are certain Upper Cenomanian forms that look like *Mantelliceras*, we should reserve its conclusive assignement to true *Mantelliceras* of Lower Cenomanian for another occasion of better collection.

Locality and horizon.—Exact horizon uncertain in the Mikasa formation in the Ikushumbets valley,* Ishikari Province, Hokkaido.

Mantelliceras (?) *nagaoi* sp. nov.

Pl. 12, fig. 1; Pl. 13, fig. 2; Text fig. 2

Material.—GH. No. 12007, holotype, a large specimen whose outer whorl is fairly well preserved but inner whorls are much crushed and weathered.

Specific diagnosis.—Very large, thick, discoidal shell with the last suture at a diameter of about 250 mm. The whorl grows fairly rapidly, overlapping about a third of the inner one. The width of umbilicus is slightly less than 30% of the diameter. The whorl is subrectangular in cross-section, with rather flattened or only gently inflated flanks and venter.

* If the Ikushumbets valley is the correct locality, the lithologic character strongly suggests the lowest part of the same formation.

The ornament is most prominent on the last quarter of the septate whorl, consisting of alternating long and short, radial ribs, with umbilical and inner lateral tubercles on the long ribs and weak ventro-lateral nodes (or bulges) on each rib. The ribs are separated by somewhat wider interspaces. In the preceding part the ornament is similar to the above, but the ribs are not so strong and two or three secondary ribs are inserted between the primaries. The secondary ribs almost reach the umbilical margin but have no inner lateral and umbilical tubercles, while the primary ribs have these tubercles of considerable intensity.

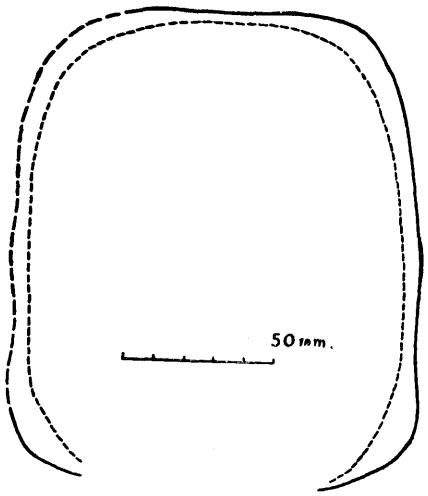


Fig. 2. *Mantelliceras* (?) *nagaoi*, n. sp. Whorl section of holotype. T. M. *del.*

On the body whorl the ribs are predominant whereas the tubercles are weakened. The ribs are fairly elevated, narrow and much separated and consist of alternating long and more or less short ones. The short ribs sometimes approach the long one near the umbilical margin. The umbilical and lower lateral tubercles on the long rib are much weakened, being discernible as slight thickenings or elevations on the rib. The marginal tubercles are almost undiscernible, but the ribs are broadened outward.

The suture is of the general Acanthoceratid pattern.

Measurements.—

Diameter	Height	Breadth	(B/H)	Umbilicus	(%)
400	155	142	(0.91)	117	(29.3)

Remarks.—The highly crushed condition of the inner whorls prevents us from accurate comparison with described forms of *Mantelliceras*, which are mostly not so large as the present one. In shell-form and in the predominance of the ribs over tubercles the present form is fairly similar to *Mantelliceras costatum* (MANTELL) (=*Ammonites mantelli* var. *costata* MANTELL, 1882, p. 113, 114, pl. xxi, fig. 9 only; see SPATH 1926 b, p. 431) from the zone of *Schloenbachia varians* in England but is much larger and its ribs are much more separated than in the British form. There is in T.M.'s collection from the *varians* zone at loc. T.M. 120, Culver Cliff, Isle of Wight (England) a specimen of *M. costatum*. It is about 80 mm. in diameter at the last septum and in its body whorl the tubercles are much weakened.

In the ornament of the septate part the present form resembles *Mantelliceras cantianum* SPATH (1926 a, p. 82) [=*Ammonites navicularis*, SHARPE, 1857, p. 39, pl. xviii, figs. 1, 2 (*non* MANTELL)] from the British *varians* zone, but that species is

more inflated and broader than ours. One of us (T.M.) has seen in the Sandown Museum (I. O. W.) an interesting specimen (No. 1984) labelled as "*Mantelliceras naviculare*", that came from 'Chloritic Marl' in Isle of Wight. It is about 135 mm. in diameter and is almost indistinguishable from the typical form of *M. cantianum* up to a diameter of 100 mm., but in the remaining part of about a half volution the tubercles are much weakened and the distant ribs of alternating long and short ones characterize the shell; the outer tubercles are almost lost in the last part. Thus the specimen is closely allied to the present form but has more inflated flanks and the ribs are broader in the last part. He furthermore has been another form at the British Museum (Nat. Hist.), BM. 82358 labelled as "*Ammonites mantelli* J. Sowerby", Lower Chalk, Beachy Head, Sussex, which seems to be related to ours. It is fairly large (being 230 mm. in diameter) but is still smaller than the specimen from Hokkaido. Its outer whorl is ornamented with distant ribs of alternating long and short ones with weakened umbilical and inner lateral elevations on the long ribs and angulated peripheral bulges on all the ribs. The latter bulges result from the union of the inner and outer ventrolateral tubercles. In this respect and in the flattened venter and flanks this form resembles ours, but it has coarser ribs and its inner lateral tubercles are less distinct.

To sum up the present form is related to *Mantelliceras costatum* (MANTELL) and *M. cantianum* (SPATH) but is peculiar, together with the above mentioned two forms, in the relatively large size and the extreme weakening of tubercles in the late growth-stage. The latter character remainds us the ornament of *Calycoceras* on one hand and that of *Stoliczkaia* on the other. However such tendency is also found in the outer whorls of certain *Mantelliceras* and many other Acanthoceratids.
Locality and horizon.—"Upper valley of the Abeshinai, MORITA's" Shibunnaitoge group" (i. e. the main part of the Middle Yezo group), collected by Y. MORITA who presented the specimen to the late Prof. T. NAGAO of Hokkaido University.

Genus *Calycoceras* HYATT, 1900

Synonym.—*Metacalycoceras* SPATH, 1926.

Type species.—*C. naviculare* (MANTELL).

Generic diagnosis.—Whorls are typically depressed to subrounded, but sometimes not so inflated, having an arched venter. Ribs are elevated but relatively narrow and consist of alternating long and short ones up to the full-grown stage. In the more or less young stage median-ventral, outer and inner ventrolateral and umbilical tubercles are well developed. As a general tendency the outer tubercles are sooner or later weakened or nearly completely obsolete as the shell grows on, while the ribs are prominent throughout life, crossing the external side without weakening. However in some cases the peripheral tubercles persist to, or rejuvenate on, the

full-grown, outer whorl. Even in such cases the ribs are still prominent. The suture is similar to that of *Mantelliceras*.

Remarks.—The type species of this often misunderstood genus is *C. naviculare* (MANTELL), as has been clearly pointed out by C. W. & E. V. WRIGHT (1951, p. 25). The misinterpretation of *C. naviculare* (MANTELL) itself has been clarified and settled (CRICK 1919, SPATH 1937, C. W. & E. V. WRIGHT 1951). One of us (T.M.) has also examined the British typical specimens, including the excellent examples of WRIGHT, that show the ontogenetic change of characters, as well as the holotype.

Now the genus seems to be fairly flexible and variable. Thus its various species can be sorted into the following subgroup, although they are very intimately related with one another:

(1) the subgroup of *C. newboldi* (KOSSMAT)–*C. spinosum* (KOSSMAT),

(2) the subgroup of *C. naviculare* (MANTELL) and

(3) the subgroup of *C. subgentoni* SPATH–*C. baylei* (PERVINQUIÈRE).

The first group can be said to occupy the center of the genus. It is most probably derived from the inflated subgroup of *Mantelliceras*, because there are so much resemblance between the two. Furthermore there are apparently transitional forms both in England* and in Japan**. This subgroup is very variable and probably gave rise not only to the other two subgroups but also to such genera as *Acanthoceras, Eucalycoceras* and probably *Protacanthoceras*. Apart from the Indian material the evidences are found in WRIGHT's collection and we hope for the full description of them.

Whether the *newboldi* subgroup is attributed to *Acanthoceras* or *Calycoceras* was a question to be considered. One of us (T.M.) has discussed that point with WRIGHT and agreed the conclusion that *Calycoceras* should be defined as to include within it the subgroup in question. The point is that in that subgroup the inner and outer ventrolateral tubercles, as well as the umbilical ones, persist to the large outer whorl of the full-grown shell. However the ribs are very prominent throughout life and cross the external side without notable weakening. They are usually alternately long and short as in *Mantelliceras*. In *Acanthoceras* (i. e. the *rhotomagense* group) the ribs are generally low and broad, while the tubercles are predominant, being sometimes horned; the ribs on the outer whorl are mostly long, with scarcely any intercalated shorter ones. Another distinction is found in the whorl-section. It is rather quadrate or rectangular in *Acanthoceras*, having a broad venter, whereas it is more or less rounded in *Calycoceras*, being characterized by the arched venter. In the subgroup of *C. newboldi-spinosum* the costal section is polygonal in the main part but occasionally subquadrate in the last part of the adult body whorl,

* Sedgwick Museum B 35634 is an example.

** The example in the recent collection from Ikushumbets will be described on another occasion.

as is shown by the Japanese specimen described below (text fig. 3). However the intercostal section shows a rounded venter. Another criterion may be in the extent of involution, *Calycoceras* being generally more involute than *Acanthoceras*.

Thus *C. newboldi* and its allies are generally distinguishable from typical *Acanthoceras*, the former having much more in common with *C. naviculare* (MANTELL) than with *A. rhotomagense* (DEFRANCE). However in the small immature whorls all the forms under discussion resemble one another. Furthermore there may be some transitional forms, as is suggested by an example from Isle of Wight that resembles *Acanthoceras vectense* SPATH but retains alternation of long and short ribs even in the outer whorl and by some others that have very prominent ribs crossing the venter without notable weakening in the outer whorl but have *Acanthoceras*-like characters in the inner whorls (e. g. Sedgwick Museum B 35736). The last example is considerably involute.

In the subgroups of *C. naviculare* and *C. subgentoni-baylei* the outer tubercles are weakened and become obsolete as the shell grows on. The disappearance of the median tubercle is a general tendency in all the subgroups of *Calycoceras* and *Acanthoceras* but takes place earlier in the two subgroups than in others. The outer and inner ventrolateral ones are sooner or later weakened but the stage of their disappearance varies by species and probably by individuals. Faint peripheral bulges or angulations are occasionally found instead of the prominent tubercles. In some other cases the rejuvenation of the peripheral tubercles is found on the adult whorl. In many cases the ribs cross the external side without any tubercles in more or less late growth-stages. Because of this flexibility and of common characters the subgroups under consideration can not be sharply separated from the more strongly tuberculate *newboldi-spinosum* subgroup.

The subgroup of *C. naviculare* has depressed and inflated whorls, while that of *C. subgentoni-baylei* has less inflated whorls. But there is transition in this character. Similarly in the strongly tuberculate subgroup of *newboldi-spinosum* there is a considerable extent of variation in the proportion of whorl-breadth and height and in the convexity of flanks. *C. newboldi* (KOSSMAT) itself seems to represent the moderate state. The more compressed and less strongly ribbed forms like *C. planecostum* (KOSSMAT) may lead to *Eucalycoceras*. WRIGHT (1933) has exhibited British examples that show serial changes from *Calycoceras* to *Eucalycoceras*.

In the Japanese province the species that belong to the subgroup of *C. newboldi* are most common and examples of the subgroups of *C. naviculare* and *C. subgentoni* are sporadically found. On the other hand true *Acanthoceras* is very rare in Japan, only a few doubtful fragmentary specimens and an *Euomphaloceras*-like form have been discovered in Hokkaido. They occur in the main part of the Paleogyliakian (approximately Cenomanian). As to the more accurate subzonal sequence of the

species further studies are wanted in both Japan and Europe, although certain species have been considered to be restricted to a limited part.

Calycoceras asiaticum (JIMBO)

Pl. 1, fig. 1, a, b, c; Pl. 2, fig. 1 a, b

1894. *Acanthoceras rhotomagense* var. *asiatica* JIMBO, p. 177 [31], pl. xx [iv], fig. 1, 1 a.
1927. *Acanthoceras asiaticum* JIMBO, YABE, p. 39 (13).

Material.—JIMBO has proposed his new name (*asiatica*) for a single specimen, GT. I-105 [=MM 7512], which is therefore the holotype of the species. Several other specimens from the type locality and other localities are also dealt with here. Among the latter a large specimen from Teshio Province (GT. I—3175) is illustrated.

Specific diagnosis.—Large shell with a rapid increase of whorls, moderate involution and fairly narrow umbilicus. The whorl is distinctly broader than high in the young stage and slightly so in the adult, polygonal in costal section but subrounded in intercostal section, being wider in the dorsal part than in the ventral one.

Ribs are moderately strong and consist of major and minor ones, which are usually, but not always, alternating. Those in the inner whorls (up to a whorl-height of about 45 mm.) are relatively crowded, being separated by narrower interspaces than the ribs themselves, and somewhat flattened on top; those in the outer whorl are rounded on top, considerably elevated and less closely set but not much distant, being separated by the interspaces nearly as broad as, or slightly broader than, the ribs. The ribs cross the venter even in the outer whorl. They are slightly bent forward at the periphery. The minor or secondary ribs are of unequal length and the inner and outer ventrolateral tubercles are fairly separated from each other. Consequently the inner ventrolateral tubercles are of unequal strength, being very prominent on the major ribs but weak on the relatively long secondary ribs and almost undiscernible on the short secondaries. This irregularity of the inner ventrolateral tubercles is remarkable in the outer whorl. The outer ventrolateral tubercles are more regular and fairly persistent, gradually decreasing their intensity and becoming bullate in the large outer whorl. The mid-ventral tubercles are weakened from fairly early growth-stage, being nearly obsolete in the outer whorl. The umbilical tubercles are bullate, being narrow but prominent, and displaced somewhat outward from the umbilical shoulder in the outer whorl. In addition to the above described tubercles faint elevations on the ribs are occasionally, but not always, discernible on the lateral part.

The sutures are similar to those in *Calycoceras newboldi.*

Remarks.—The present species is much more allied to *Calycoceras newboldi* (KOSSMAT)*

* The holotype of this well known, but often misunderstood, species was not designated by KOSSMAT. He put in his 'typical form of *Acanthoceras newboldi*' STOLICZKA's specimens which were described under the name of '*Ammonites rhotomagensis* var. *subcompressus* STOLICZKA' (1865, p. 68, pl. xxxiv, fig. 3; pl. xxxv, fig. 1; pl. xxxvii, fig. 1) and also under '*A. rhotomagensis*

(1897, p. 4 [111], p. i [xii], figs. 2a, b, 3a–c; pl. iii [xiv], fig. 2) from the Middle Ootatoor [Utatur] group of India than to *Acanthoceras rhotomagensis* (BRONGNIART *ex* DEFRANCE). Indeed it resembles *C. newboldi* so closely that KOSSMAT himself (1897, p. 5 [112]) once included JIMBO's specimen as an example of the typical form of his species. This opinion might still be held or the Japanese form could be regarded as only subspecifically separated from the Indian form, but from the available material at hand we are inclined to separate them specifically.

JIMBO's original specimen is actually somewhat deformed but fairly well reveals the characteristic features except for some doubtful points in shell-form. Furthermore the additional specimens from the type locality and other areas have supplemented it. The proportion between whorl-height and breadth varies to some extent, so that there is no great difference in this respect between the two species under consideration. However there is a difference in whorl shape. For *C. newboldi* has nearly flat (or slightly inflated) and parallel flanks, while *C. asiaticum* has more inflated and rather, if not remarkably, convergent ones. Another criterion is found in the inner ventrolateral tubercles. They are very regular and much distant from the umbilical shoulder in the Indian species. As have been described just above, in the Japanese species they are of unequal strength and fairly distant from the outer ventrolateral tubercles, tending to approach near the mid-flank.

The flattening at the top of the ribs is a tendency that appears in certain forms of the *newboldi* group. The character is observable in many immature shells of that group, although the ribs themselves are considerably strong. In the present species it is shown even in the middle growth-stage. In this respect and in other feature CRICK's South African form described under '*Acanthoceras newboldi* var. *spinosa* KOSSMAT' (CRICK, 1907, p. 199, pl. xii, fig. 3, 3a), the original of which (BM. C. 18204) one of us (T.M.) has examined, is close to *C. asiaticum*. CRICK's form is not referable to *C. spinosum* (KOSSMAT) to be redefined below. The flattening of the ribs is most characteristically manifested by *C. planecostatum* (KOSSMAT) (1897, p. 9 [116], pl. ii [xiii], fig. 1a–c] from the Middle Ootatoor group of India. That species resembles the present species in shell-form and ornament of the inner whorls but is clearly distinguished by its low, broad, crowded ribs and extremely weak tubercles on the outer whorl. It foreshadows *Eucalycoceras*.

Weakening or disappearance of the outer tubercles, especially median and inner ventrolateral ones, may take place in various growth-stages even in the same species. However, so far as the examined specimens are concerned, in *C. asiaticum* the ventrolateral tubercles persist into such a late growth-stage as shown by the

typicus' (STOLICZKA, 1865, p. 68, pl. xxxiv, fig. 4; pl. xxxvi, fig. 1; pl. xxxvii, fig. 2). Now questions have remained whether the specific name is *subcompressum* or *newboldi* and which of the illustrated specimens should be designated as lectotype. In this paper we do not intend to settle the problem, without seeing the Indian specimens.

holotype and other larger specimens, whose diameters are about or over 200 mm. Similar statement seems to be applicable for typical *C. newboldi*, but we have not seen sufficient number of the Indian specimens. The British form which was mentioned by KOSSMAT (1897, p. 6 [113]) (BM. 37574) as an example of '*A. newboldi*' has already lost its inner ventrolateral and median tubercles at a diameter of 35 mm. and its outer ventrolateral tubercles tend to be absorbed by the rib in its preserved last part (at a diameter of 43 mm.). This should not, in our opinion, be referred to *C. newboldi* but may be an immature of a species that belongs to the *naviculare* or *subgentoni* subgroup.

The Japanese form was once regarded as specially identical with a Tunisian form which was described under the name '*Acanthoceras jimboi* var. *tunetana* PERVINQUIÈRE (1907, p. 262, pl. xiv, fig. 2 a, b). But the Tunisian form is distinct from ours in its much higher whorl and less prominent tubercles, so that it should be called *Calycoceras tunetanum* (PERVINQUIÈRE).* Two 'varieties' of *C. newboldi* have been described from Madagascar (COLLIGNON, 1937, p. 40, pl. iii, figs. 6, 7; pl. viii, figs. 6, 7), but neither is identical with *C. asiaticum*.

The faint lateral elevations, that are occasionally discernible in the present species, are rather peculiar for *Calycoceras*. The character may either be reminiscent of the inner lateral tuberculation in *Mantelliceras* or foreshadow the mediolateral one in *Romaniceras*.

Occurrence.—Common at loc. IK 2 (T.M.), near the gorge of the Ikushumbets, lower part of the Mikasa Sandstone (=YABE's *Trigonia* Sandstone), the type locality; Middle portion of the Lower Member of the same formation on the eastern wing of an anticline along the Ikushumbets; exact locality unrecorded in the Teshio River (GT. I-3175).

Calycoceras spinosum (KOSSMAT)

Pl. 3, fig. 1a, b, c; Pl. 4, figs. 1a, b, c, 2a, b; Text fig. 3

1865. *Ammonites rhotomagensis pp.*, STOLICZKA, p. 68, pl. xxxv, fig. 2.
1898. *Acanthoceras newboldi* var. *spinosa* KOSSMAT, p. 1 [114], pl. ii [xiii] figs. 2 a-c, 3 a, b; pl. iii [xiv], fig. 1 a, b.
1937. *Calycoceras (Eucalycoceras) newboldi* var. *spinosa*, COLLIGNON, p. 39.
1952. *Calycoceras newboldi* var. *spinosa*, WRIGHT & WRIGHT, p. 26.

Material.—Apart from poorly preserved specimens there is a large specimen (GH. 12437 from Nionosawa, Saku area, Teshio Province) in S. SATO's collection which was at first regarded by A. FUKADA as new. From careful inspection of the characters that change with growth we have at present no doubt in referring it to *Calycoceras spinosum* (KOSSMAT). Furthermore the character of the species in the

* PERVINQUIÈRE designated JIMBO's specimen as the typical form of his *Ac. jimboi*, so that nomenclatorially *jimboi* should be synonymized with *asiaticum*.

full grown stage has been clarified from the study of this Japanese specimen. Another specimen (GT. I-3167 from loc. T 26, bed IIb in the Abeshinai Valley, T. M. Coll.) of moderate size is illustrated too.

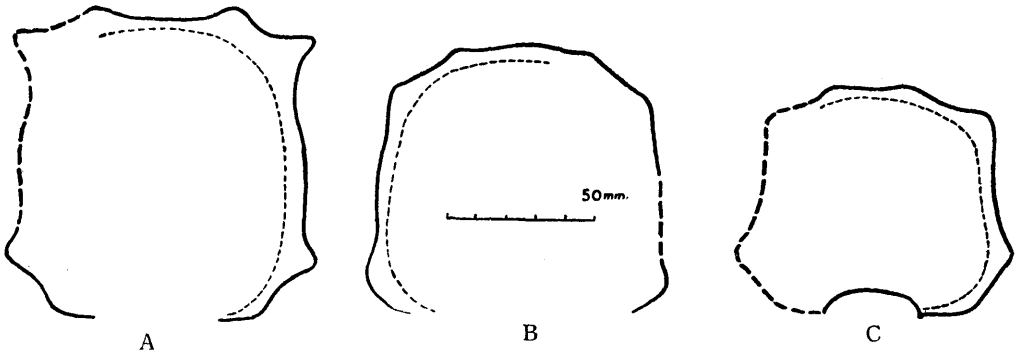


Fig. 3. *Calycoceras spinosum* (KOSSMAT). Whorls sections of the outer whorl at diameters of 220 mm. (A), 185 mm. (B), and 135 mm. (C). GH. No. 12437 from the Nionosawa, Saku area, Teshio Province, Hokkaido. T. M. *del.*

Specific diagnosis.—Large shell with a rapid increase of whorls, considerable involution and fairly narrow umbilicus. Whorls in the main growth-stages are much broader than high, widest between the umbilical tubercles, trapezoidally polygonal in costal section and rather subrounded in intercostal section. Whorl-height increases somewhat more rapidly than whorl-breadth, so that the anterior part of the full-grown body whorl is only slightly broader than high and not so trapezoidal as in the main part, though angulated at shoulders in costal section.

Radial ribs are very strong and consist of usually, but not always, alternating long (major) and short (minor) ones. In the main part of the septate whorls they are coarse and separated by interspaces somewhat wider than the ribs. On the long ribs the umbilical tubercles are spinose; the inner ventrolateral tubercles are prominent, forming marginal spines. On the short ribs the inner ventrolateral tubercles are not so strong and sometimes very faint. The outer ventrolateral tubercles in this stage are of moderate strength and rather clavate, but within the breadth of the ribs. The median tubercles are small but distinct in the inner whorls and almost obsolete in the whorl of the middle-growth stage over 70 mm. in diameter.

In the adult body whorl and adjacent septate portion over 120 mm. in diameter the ribs become gradually distant, being separated by wide interspaces; shorter ribs are less frequently intercalated than before. The ribs are very prominent and cross the venter without notable weakening. The umbilical and inner ventrolateral tubercles are also prominent, being somewhat thickened on the long ribs. The ribs are narrow but elevated and slightly arcuate between the two tubercles on the flank. The outer ventrolateral tubercles are not clavate but elevated on the rib. The distance between the two ventrolateral tubercles is shortened, while the venter

become broad and the median ventral tubercles are lost. In spite of the polygonally subquadrate, costal section the intercostal section is subrounded.

The suture is similar to that of *Calycoceras newboldi*, having relatively narrow and deep L.

Measurements.—

	Diameter	Height	Breadth	(B/H)	Umbilicus	(%)
Outer whorl Ca	220	106	109	(1.0)	67 (?)	(30)
Next inner whorl	86	41	47	(1.1)	23	(27)

Remarks.—The present species has been fairly well defined since the description of KOSSMAT (1897). However the Japanese specimens supplement the definition, especially about the character of the adult body whorl. In every feature of the shell up to a diameter of about 150 mm, our form precisely agrees with the illustrated specimens from the Middle Ootatoor group of India, so that we have no doubt about their specific identity. The predominance of both the ribs and tubercles (except the median ones) even in the adult whorl is one of the characteristic features. From this and other diagnosis described above the specific separation of *C. spinosum* from *C. newboldi* is safely justified.

Considering the occurrence in Japan and England outside the type area, South India, the present species seems to have widespread distribution. However so far as the specimens* which one of us (T.M.) has ever examined are concerned, the British form has its own characteristics. Namely its ribs are always somewhat more distant and, accordingly, less numerous than in the typical form of *C. spinosum* (being about 25 per whorl as compared with about 30 or more). However the difference is by no means great. The British form might fall within the variation of *C. spinosum*, or could be separated subspecifically or otherwise. Without seeing more specimens, especially larger adult whorls, we cannot definitely give a conclusion about the British form. For the time being it is to be called as *Calycoceras* aff. *spinosum* (KOSSMAT).

In view of the intimate relation between *Mantelliceras* and *Calycoceras*, it should not be overlooked that similarity in shell-form and ornament is found between *M. cantianum* SPATH and *C.* aff. *spinosum* (KOSSMAT) mentioned above.

Occurrence in Japan.—Bed II b of the zone of *Desmoceras* (*Pseudouhligella*) *japonicum* in the Abeshinai-Saku area, Teshio Province, Hokkaido. Comparable but imperfectly preserved, large specimens have been found in the subzone of *Calycoceras asiaticum* in the middle of the same *japonicum* zone in the Mikasa formation on the eastern wing of the anticline in the Ikushumbets valley, Ishikari Province, Hokkaido. Middle part of Paleogyliakian (approximately Cenomanian).

* The examples are BM. 37577 from Chard, C. W. WRIGHT's Coll. 19540, 20525, 20586 and somewhat larger but still septate C. W. W. 22011. Another example is found in the Palaeontological Museum of the Imperial College, University of London.

The species seems to be widespread, because they have been reported from South India, Madagascar, Southeast Africa, Palestine (?), Tunisia and Europe. However it is necessary to reexamine the specimen for accurate specific identification. The occurrence in Japan indicates the distribution of the species in the Circum-Pacific region.

Calycoceras orientale sp. nov.

Pl. 5, fig. 1 a, b, c; Pl. 7, fig. 1

Material.—Holotype, GT. I-3168 from loc. T 711 b, the Nio-no-sawa, upper part of Beds IIb, zone of *Desmoceras* (*Pseudouhligella*) *japonicum*, in the Middle Yezo Group, the Abeshinai-Saku area, Teshio Province, Hokkaido (T. M. Coll.). Other specimens: GT. I-3171 (loc. T 225, II b), GT. I-3172 (loc. T 225 c, II b), GT. I-3173 (loc. T 228 p 2, II b) and probably GT. I-3172 ("Rutkee") in the Abeshinai, Teshio Province (the first three T. M. Coll.; the last one in old coll.); GK. H 1520 (loc. Y 232 p, bed II j or possibly II k) and several others from bed II j in the Shiyubari valley, Ishikari Province (T. M. Coll.). There is a comparable specimen in K. TANAKA's Coll. from the Opirashibets valley (loc. NH 608), which is preserved in the Museum of the Geological Survey of Japan.

Specific diagnosis.—Large shell with rapid growth of whorls and considerable overlapping in late growth-stages with fairly narrow umbilicus. Outer whorls are somewhat higher than broad, polygonal in costal section and subrounded in intercostal one, having an arched venter.

Ribs are prominent as in *C. spinosum* (KOSSMAT); one or two shorter ones are intercalated between the longer ones. In the main part of the septate whorl the inner ventrolateral tubercles on the long ribs are the most prominent but those on the short ribs are weak or occasionally undiscernible; the outer ventrolateral tubercles are of moderate strength and almost of equal size; the mid-ventral ones the weakest; the umbilical tubercles on the long ribs are fairly elevated and bullate.

In the large outer whorl the ribs are distinctly predominant over tubercles and the inner and outer ventrolateral tubercles becomes increasingly apart from each other; the ribs are fairly distant, still consisting of alternating long and short ones.

Measurements:—

Specimen	Diameter	Height	Breadth	B/H	Umbilicus	(%)
GT. I-3168	186	86	Ca 78	(0.9)	52.5	(28)
TANAKA's Coll.	161	71.5	Ca 65	(0.6)	45.5	(28)

Remarks.—The present species is allied to *Calycoceras spinosum* (KOSSMAT), which is redefined above, in the general construction of ornament and polygonal whorl-section, but the whorl of the former is much more compressed as compared with the depressed one of the latter. The outer and inner ventrolateral tubercles are distant in the former but rather close to each other in the latter. In this respect the

present species is rather similar to *Calycoceras asiaticum*, but its whorl is somewhat more compressed and its ribs are more distant than in that species.

In the relatively compressed whorl and the distances between the two ventro-lateral tubercles the present species is somewhat similar to *Calycoceras tunetanum* (PERVINQUIÈRE) (1907, p. 263, pl. xiv, fig. 2 a-b)* from the Cenomanian of Tunisia, but the ribs in ours is much more distant, stronger and provided with more elevated tubercles than in that Tunisian species.

Occurrence.—Paleogyliakian or the zone of *Desmoceras* (*Pseudouhligella*) *japonicum* in Hokkaido. So far as the carefully collected specimens are concerned, the species is rather common in the middle part of the zone.

Calycoceras sp. nov. (?)

Pl. 7, fig. 2; Text fig. 4

Material.—A fairly large specimen, GH. 12009, the inner whorl of which is not well preserved (R. SAITO Coll.).

Measurements (in approximation).—

	Diameter	Height	Breadth	(B/H)	Umbilicus	(%)
GH. 12009	150	69			52 (?)	(34)
		63.5	60 (?)	(0.9)		

Descriptive remarks.—In the lateral view this form is very similar to *Calycoceras spinosum* (KOSSMAT) of corresponding size, for it is ornamented with distant, strong, often slightly arcuate ribs of different length, roughly alternating, provided with

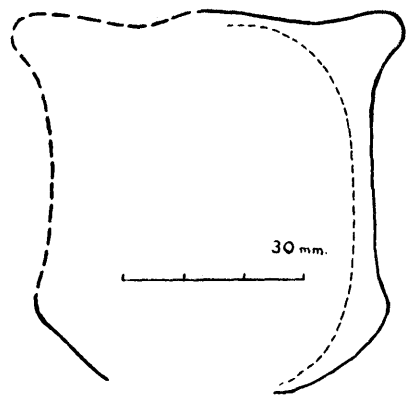


Fig. 4. *Calycoceras* sp. nov. (?)
Whorl-section of GH. No. 12009, the Abeshinai area, Teshio Province, Hokkaido. T. M. *del.*

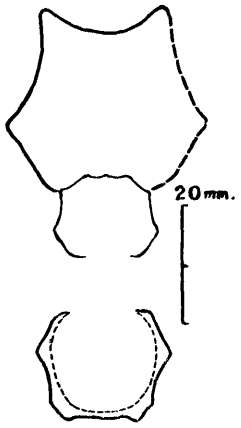


Fig. 5. *'Acanthoceras' cornigerum* CRICK. Whorl sections of holotype, BM. C. 18230. T. M. *del.* by kind permission of Keeper of Geology, British Museum (Natural History).

* See footnote in page 13.

prominent umbilical and ventrolateral tubercles. However, instead of the outer and inner ventrolateral tubercles as found in *C. spinosum*, there is only one very prominent, peripheral tubercle in the present form. This peculiar feature may be developed by unification of the two peripheral tubercles, but the too poorly preserved state of the inner whorls prevents us from definite statement.

In fact approach and then unification of the two ventrolateral tubercles are found in *Acanthoceras sussexiense* (MANTELL), as has been clearly demonstrated by C. W. WRIGHT, but that species belongs to true *Acanthoceras*. In connexion with this peculiar feature another Acanthoceratid from South Africa should be considered. That is '*Acanthoceras*' *cornigerum* CRICK (1907, p. 207, pl. xiii, fig. 1, 1a). Its single type specimen (BM. C. 18230) clearly shows the change from the normal fairly distant, outer and inner ventrolateral tubercles in the inner whorl to a prominent, rather horned, marginal one in the outer whorl (which is still septate and only about 70 mm. in diameter) (see text figs. 4, 5). In both Japanese and South African forms the umbilical tubercles on the long ribs become fairly apart from the umbilical suture with growth.

While the costal whorl-section is polygonal in the African form, it is rather subquadrate in ours, although the intercostal section is more or less rounded in both forms. The less depressed whorl in the present form is another criterion to distinguish it from *C. spinosum*, but the specimen in question is somewhat deformed. The subquadrate costal section and the strong ribs remind us of such forms as *Acanthoceras sherborni* SPATH (1926 a, p. 82) [=*Ammonites cenomanenis* SHARPE, 1857, p. 37, pl. xvii, fig. 1 a, b], but the similarity is only apparent, because the British species belongs to true *Acanthoceras*, having subquadrate, intercostal whorl-section and straight ribs of equal length in the outer whorl.

One more peculiar feature in the present form is the slight and occasional elevation of the ribs at the mid-flank. This is similar to the character found in *Calycoceras asiaticum* (JIMBO). In this connexion Mr. C. W. WRIGHT has showed to one of us (T. M.) an interesting specimen in his collection (C. W. W. 10206) from the probable Upper Cenomanian at Compton Bay, Isle of Wight, England. It is fairly similar to *Calycoceras newboldi* (KOSSMAT), but slight elevations are occasionally discernible at the mid-flank in the middle growth-stage. We agree with WRIGHT in regarding the specimen as transitional from *Calycoceras* to *Romaniceras*. Apart from that point, it has fairly coarse and distant ribs in the outer whorl, on which the inner and outer ventrolateral tubercles tend to approach to each other, being contrary to those in *C. asiaticum*. However the marginal tubercles are not completely united in this fairly large, but still septate, specimen. One of us (T.M.) has obtained from a boulder of the Grey Chalk (Lower Chalk) at the same Compton Bay (loc. T. M. 217) a fragmentary body whorl of a large shell of *Calycoceras*. In this specimen very distant, coarse ribs cross the venter and a single bulge or

angulation of the rib is found at its periphery. This might be the adult body whorl of WRIGHT's form or its ally and, at the same time, it is fairly similar to the form in question from Hokkaido.

To sum up the present form, like the African species mentioned above, may represent a special member of the group of *Calycoceras newboldi-spinosum*. It may be a new species (to which one of us [R. S.] was once inclined to give a name*), yet the available material is too incomplete to establish a definite species.

Occurrence.—Rare. The specimen came from the "Kitanosawa", a tributary of the Abeshinai, Teshio Province, Hokkaido.

Calycoceras cf. *stoliczkai* COLLIGNON

Pl. 6, fig. 1 a, b

Compare.

1865. *Ammonites navicularis*, STOLICZKA (non MANTELL), p. 73, pl. xxxix, figs. 2–4.
1897. *Acanthoceras naviculare*, KOSSMAT, p. 11 [118].
1898. *Acanthoceras naviculare*, CHOFFAT, p. 72, pl. iv, fig. 6; pl. vi, figs. 1, 2.
1937. *Calycoceras* (*Metacalycoceras*) *stoliczkai* COLLIGNON, p. 48.

Material.—A somewhat deformed outer whorl, GK. H 1523 from Y 143 d, bed II j in the Shiyubari valley, Ishikari Province, Hokkaido. Several other poorly preserved, smaller specimens from the same bed.

Description.—The illustrated specimen (GK. H 1523) is fairly large, with a diameter of about 195 mm., and has a partly preserved body chamber. Whorl is much broader than high, being 95 mm. in breadth and 68 mm. in height (b/h=1.4) at the last septum, broadest near the subrounded umbilical shoulders, gradually rounded to the broadly arched venter and is rather semicircular or lunate in cross-section. Umbilicus is deep, surrounded by vertical wall and of moderate width.

The outer whorl is ornamented with very strong ribs that are usually alternately long and short. The long ribs are provided with prominent tubercles at the umbilical shoulder, while the short ribs disappear just above it. Other tubercles are nearly completely obsolete on the outer whorl, but are discernible on the inner whorls. On the septate part the ribs are separated by the interspaces nearly as broad as the ribs. On the adult body whorl the ribs become gradually distant, being separated by the broader interspaces. The ribs are nearly rectiradiate or slightly bent forward on the ventro-lateral part; they cross the venter without decreasing their strength.

The sutures are somewhat eroded but show such a pattern as shown in *Calycoceras boulei* COLLIGNON (1937, p. 43, pl. v, fig. 4, 4a; pl. viii, fig. 11).

Comparison.—From the above described characteristics the Japanese form in question is best comparable to *Calycoceras stoliczkai* COLLIGNON from the Middle and doubt-

* The nomenclatorially invalid name *Acanthoceras teshioensis* SAITO MS., was listed in a recent publication (T. MATSUMOTO [Editor], 1954, p. 16) for this form.

fully also Upper Ootatoor group of India and the Cenomanian of Portugal. Because of some insufficiency in our material we hesitate to conclude definite identity.

Calycoceras boulei COLLIGNON (1937, p. 43, pl. v, figs. 2–4; pl. viii, fig. 9–11) from the Upper Cenomanian of Madagascar is very similar to *C. stoliczkai* COLLIGNON in shell-form and ribbing, as the author himself has pointed out. The former is represented by relatively small specimen (the largest one being 121 mm. in diameter) and retains ventrolateral tubercles. Presumably the tubercles, except for the umbilical ones, may disappear in the full-grown shell of *C. boulei* and thus the Malgash form might become almost indistinguishable from the Indian form, or the difference might be so slight that the subspecific separation could be justified. However COLLIGNON (1954) listed both "*Metacalycoceras*" *boulei* and "*M.*" *stoliczkai* in the same zone of *Acanthoceras rhotomagence* in the Cenomanian of Madagascar. According to WRIGHT, *C. boulei* is a probable ancestor of *C. naviculare*, appearing somewhat earlier than that species.

Occurrence.—Rare in Hokkaido; Bed II j in the Shiyubari valley, from which the Japanese form came, belongs to the middle part of the Paleogyliakian. This part may be older than the highest portion of the zone of *Holaster subglobosus*, in which *C. naviculare* (MANTELL) is common. However correlation between Japanese and British beds is at present difficult on such a fine scale.

Calycoceras sp. indet *α*

Pl. 6, fig. 2

Material.—A fragmentary whorl of fairly large shell, GK. H 1522, which is too incompletely preserved to be specifically identified.

Description.—The whorl is 90 mm. in height and probably nearly as broad as that. The flanks are only gently inflated and the venter is moderately arched. Radial ribs are fairly strong, relatively narrow but elevated, separated by the interspaces somewhat broader than the ribs, consist of alternated long and short ones, and cross over the venter without decreasing their strength. The long ribs are provided with bullate tubercles above the umbilical shoulder and sometimes show slight flexuosity; the short ribs reach fairly close to the umbilical margin, decreasing their strength or tending to be united with the long rib at the umbilical tubercle.

Comparison.—This form resembles *Calycoceras orientale*, described above, of corresponding size in the costal section and in ribbing, but the ribs have already lost the outer tubercles. It is fairly similar to *C. gentoni* (BRONGN. *ex* DEFRANCE MS.) (R. DOUVILLÉ, 1911, *Palaeontologia Universalis*, Century III, no. 223, 223 a) and *C. subgentoni* (SPATH) (1926 a, p. 83; 1937 a, p. 279) [=*Ammonites navicularis*, SHARPE, 1857, p. 39, pl. xviii, figs. 3 a, b, 5 a, b only (*non* MANTELL)] but is much larger than the types of the European species, so that exact comparisons are difficult.

Locality and horizon.—Loc. Y 510, the Tenguzawa, a tributary of the Shiyubari, bed

II k, upper middle part of the zone of *Desmoceras* (*Pseudouhligella*) *japonicum*, Ishikari Province, central Hokkaido. The comparable European species, mentioned above, are known in the zone of *Schloenbachia varians* and are reported to occur in Tunisia and Persia.

Calycoceras sp. indet β

Text fig. 6

Material.—A fragmentary whorl of moderate size, GH. No. 5342, labelled as "*Acanthoceras*" sp, an internal mould.

Description.—The whorl is compressed with height of 41.5 mm. and breadth of about 30.5 mm. (b/h=0.7), being flattened on flanks that gradually pass to the narrowly arched venter.

The radial ribs are prominent, regular and equidistant, being separated by broad interspaces. The long ribs have bullate tubercles above the umbilical border, while the short ones fade out there. They have no outer tubercles and cross the venter with a considerable elevation.

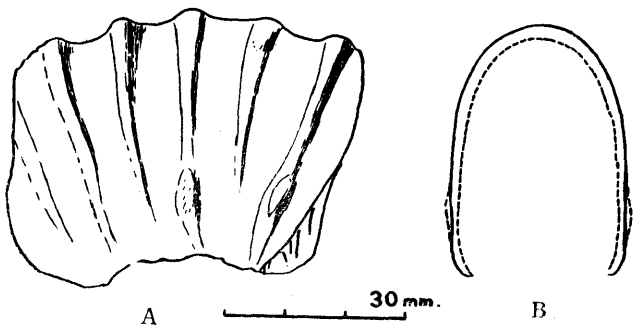


Fig. 6. *Calycoceras* sp. indet. Lateral view (A) and a whorl-section (B) of a fragmentary specimen, GH. 5342 from the Abeshinai area, Teshio Province. T. M. *del.*

No sutures are observable, suggesting that the specimen is a fragment of the body whorl.

Comparison.—In the compressed and laterally flattened shell and the predominent ribs the present form is fairly similar to *Calycoceras jeanneti* COLLIGNON (1939, p. 18, pl. vi, fig. 1, 1 a, 1 b), but its ribs are more distant and its venter is more narrowly arched than that Malgash species.

Locality and horizon.—A pebble in the lower course of the Kurumi-zawa, Itaya-Nojo in the Abeshinai area, Teshio Province, northern Hokkaido. It is presumably derived from bed II c (δ), upper part of the Paleogyliakian.

Genus *Romaniceras* SPATH, 1923

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

Type species.—*Romaniceras deverianum* (D'ORBIGNY).

Generic diagnosis.—Similar to *Calycoceras* in shell form, ribbing and suture, but provided with more than one rows of lateral tubercles in addition to those present in *Calycoceras* of *newboldi-spinosum* subgroup (see above). The external tubercles are weakened or obsolete on the large outer whorl.

Remarks.—Type species by original designation is *Romaniceras deverianum* (D'ORBIGNY), but the specimen figured by D'ORBIGNY is said to have been lost. There is an unsettled point in selecting neotype (see BASSE, 1937; COLLIGNON, 1937 and WRIGHT & WRIGHT, 1951).

In spite of this confusion the genus has been well understood and the generic diagnosis can be described as above. From the stratigraphical occurrence and morphological resemblance and, furthermore, from the transitional forms, *Romaniceras* is best regarded as a multituberculate derivative from the group of *Calycoceras newboldi-spinosum*. As has been demonstrated by ROMAN & MAZERAN (1913, p. 26, text fig. 4) and BASSE (1937, pl. viii, fig. 1 a, b; pl. ix, fig. 1 a, b), the outer whorl of the full-grown *Romaniceras* has strong ribs that are predominant over the tubercles and cross the rounded venter. The same feature is observed in our specimens. The character is again similar to that found in *Calycoceras*.

Certain species that have been assigned to *Romaniceras* are removed to a new genus to be established below, because they are more intimately related to *Acanthoceras* than to *Calycoceras*.

Distribution.—World wide in the Turonian. The genus is generally more common in the Upper Turonian, but is found also in the Lower Turonian. Furthermore, it is said to appear in the British Upper Cenomanian.

Romaniceras pseudodeverianum (JIMBO)

Pl. 8, fig. 3; Text fig. 7 A—D

1894. *Acanthoceras pseudodeverianum* JIMBO, p. 33 [178], pl. v [xxi], fig. 1, 1 a, 1 b.

Material.—Holotype is GT. I-106 from a pebble of the Opirashibets, Teshio Province, Hokkaido (Coll. K. JIMBO). It is a fairly large internal mould of an adult shell. The inner whorl is only partly preserved. Another fragmentary whorl in the unrecorded collection of Hokkaido University (GH. 12437) is comparable to the present species.

Specific diagnosis.—Discoidal shell, with little involution and an umbilicus of moderate size. Whorls are slightly higher than broad in the mature stage but slightly broader than high in the immature stage, having a subrounded umbilical shoulder, somewhat flattened flanks and a moderately arched venter.

The ribs are strong, nearly rectiradiate or slightly prorsiradiate and separated by the broader interspaces. The secondary ribs are occasionally, but never frequently, intercalated or bifurcated. The shorter ribs, if present, are only slightly shorter than the long ones, or branched out at or below the inner lateral tubercle. The ribs are provided with prominent tubercles arranged in nine rows. The tubercles are of subequal intensity, except for the weak median one. The paired ventral tubercles are much closer to the median one than to the ventrolateral one, which, in turn, is much separated from the lateral one. The last one is fairly close to the

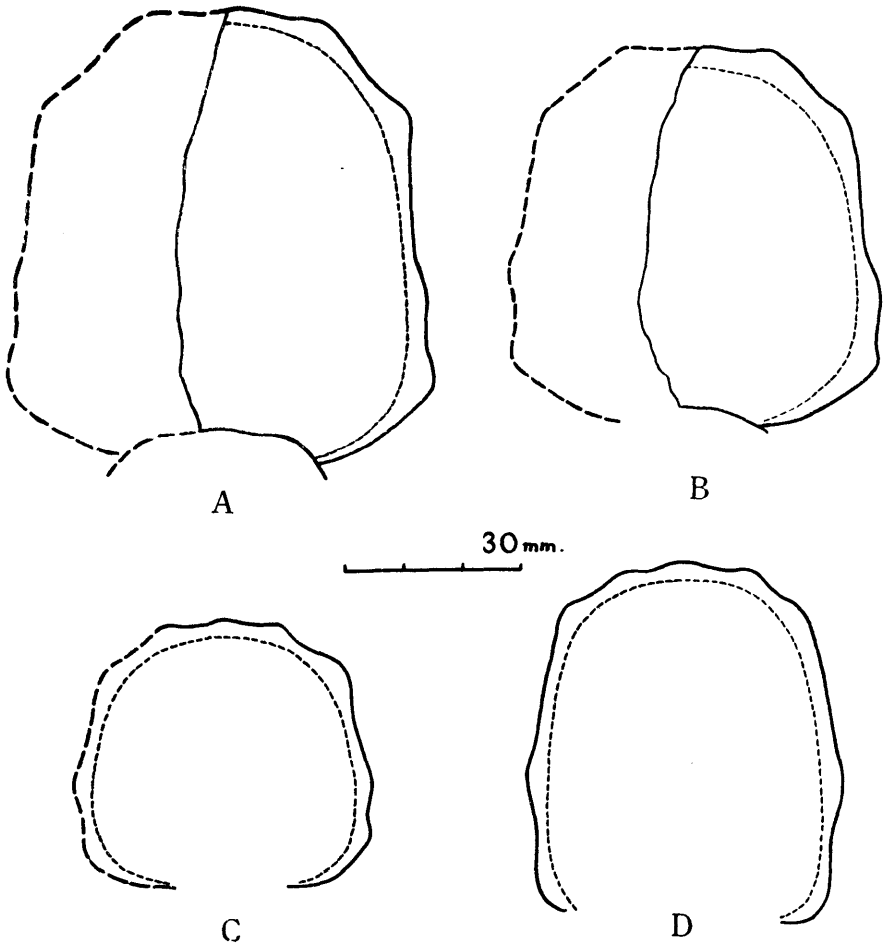


Fig. 7. Whorl-sections of *Romaniceras pseudodeverianum* (JIMBO). A. Holotype at a diameter of 195 mm.; B. *Ditto*, about a quarter whorl earlier (diam.=160 mm.); C. *Ditto*, about a half whorl earlier than B. D. A comparable specimen, GH. No. 12437. T. M. *del.*

one at the umbilical shoulder, so that it is better called inner or lower lateral tubercle. The ribs tend to be predominant over the tubercles in the outer whorl.

Measurements.—

	Diameter	Height	Breadth	(B/H)	Umbilicus	(%)
GT. I-106	195	75	Ca 36×2=72	(0.96)	68.5	(35)
		45	„ 25×2=50	(1.10)		
GH. 12437		60	53	(0.90)		

Remarks.—This species may be somewhat indefinite because of the imperfection of the holotype and insufficiency of supplemental material. Yet the properties so far observed are characteristic enough to separate it from other species of *Romaniceras*.

The frontal view of the holotype was restored by JIMBO (1894, pl. v, fig. 1 a) and

is too compressed. Actually the outer whorl is slightly higher than broad or nearly as high as broad. The species is similar to *Calycoceras orientale* sp. nov. (described above) in the whorl section and ornament, except for the lateral tubercles, but has somewhat larger umbilicus and longer and less frequent secondary ribs than in that species. In fact there is an intermediate form as represented by GT. I-3178 (Pl. 1, fig. 2). The present species resembles *R. deverianum* D'ORBIGNY (1840, p. 356, pl. cx; FRITSCH & SCHLOENBACH, 1872, p. 32, pl. vii, figs. 4, 5; ROMAN & MAZERAN, p. 25, pl. iii, fig. 2, 2a; COLLIGNON, 1939, p. 33 and 37, pl. viii, figs. 2, 3, 3a; pl. ix, fig. 1, 1a) from the Turonian of Europe and Madagascar. But its lower lateral tubercle is much distant from the ventrolateral one, being close to the umbilical one, while the European species has nearly equidistant tubercles. There may be again difference in length and breadth of the ribs, but the various illustrations of that D'ORBIGNY's species seems to show a certain extent of variation in this respect. *R. pseudodeverianum* is evidently more compressed than *R. deverianum.*

Occurrence.—The records are insufficient to decide the exact horizons of both the holotype and another comparable specimen. The species is rather rare, and more careful collection is wanted.

Romaniceras aff. *uchauxiense* COLLIGNON

Pl. 9, figs. 1a-c, 2; Pl. 14, fig. 1a, b; Pl. 15, fig. 2

Compare:

1913. *Acanthoceras deverianum*, ROMAN & MAZERAN, p. 25, pl. iii, fig. 1, 1a only.
1939. *Romaniceras uchauxiense* COLLIGNON, p. 38, pl. x, fig. 1, 1a.

Material.—GH. No. 4935 from the Bannosawa, Pankemoyuparo in the Oyubari area, Ishikari Province, Hokkaido, K. OTATUME Coll., somewhat fragmentary. GT. I-344 from the Popets [Hobetsu], Iburi Province (H. YABE Coll.), a smaller, probably immature form.

Descriptive remarks.—The larger specimen was provisionally labelled by K. OTATUME as "*Acanthoceras pseudodeverianum* JIMBO", but is actually more akin to *Romaniceras uchauxiense* COLLIGNON from the Turonian of France and Madagascar.

The outer whorl, which is still septate, is somewhat higher than broad, being 66 mm. in height and 60 mm. in breadth. It is ornamented with rather coarse, usually alternately longer and shorter ribs and nine rows of tubercles. The ribs are slightly prorsiradiate and cross continuously over the moderately arched venter with some enlargement of their breadth. They are separated by slightly broader interspaces. The umbilical tubercle at the end of the long rib is bullate. The lateral tubercle is weak and situated somewhat below the mid-flank. The ventrolateral tubercle is the largest and has a rounded base. The paired and median ventral tubercles are more or less clavate. In addition to the distinctly discernible nine rows of tubercles a very faint, clavate elevation within the breadth of the ribs is

discernible fairly close to and inside the outer ventrolateral (i.e. paired ventral) tubercles. The last character is a peculiar character which is particular to the present form. In other respects the specimen in question is very close to *Romaniceras uchauxiense* COLLIGNON.

The smaller specimen, about 65 mm. in diameter, is slightly broader than high, being 31 mm. in height and 37 mm. in breadth, but has an arched, instead of flattened, venter and gently convex flanks. It has coarse, but not much elevated, ribs of unequal length, separated by the interspaces as narrow as the ribs. There are nine rows of tubercles. The outer ones become clavate as the shell grows on. The faint elevation inside the outer ventrolateral tubercle is not found in this small example. Thus it is indistinguishable from the inner whorl of *Romaniceras uchauxiense* COLLIGNON of the corresponding size. However the two Japanese specimens may represent respectively later and earlier growth-stages of the same form, that should be provisionally called *R.* aff. *uchauxiense* COLLIGNON, since the larger one is slightly dissimilar from the typical French form.

Occurrence.—Rare in the zone of *Inoceramus hobetsensis*, in the Oyubari and Popets [Hobetsu] area, Hokkaido, Neogyliakian, approximately Turonian.

Romaniceras (?) *otatumei* sp. nov.

Pl. 2, fig. 2a, b

Material.—A single, small specimen, GT. I-3185, with a partly preserved body whorl, holotype. (K. OTATUME's Coll., presented to T. M.).

Specific diagnosis.—Small shell with little overlapping of whorls and an umbilicus of moderate width. Whorls are nearly as broad as high or slightly broader than high, gently convex on flanks, moderately arched on the external side and subangular at the umbilical shoulder.

The inner whorl has frequent constrictions, which are accompanied by the relatively elevated major ribs, and weak secondary ribs between them. The major ribs are provided with faint bulges at the umbilical shoulder and in the lower lateral part.

The outer whorl has fairly strong, rectiradiate ribs and nine rows of tubercles. On the septate part every third rib is broader and much more elevated than others. Thus the differentiation into major and minor ribs is distinctly shown. Even the minor ribs reach the umbilical margin but their umbilical tubercles are almost undiscernible. The lateral tubercle on the minor rib is small and bullate. The major ribs have small but distinct umbilical tubercles and a very prominent and large lateral tubercle. The lateral and umbilical tubercles are relatively close to each other. The difference in strength between major and minor ribs and also their tubercles are slight on the external side. The ribs are bent slightly forward at the periphery. The inner ventrolateral tubercle is fairly prominent and especially so

and spinose on the major rib. The outer ventrolateral and mid-ventral tubercles are more or less clavate. The outer ventrolateral tubercle is closer to the inner ventrolateral one than to mid-ventral one.

On the late part of the body whorl the ribs become gradually coarse and distant. The external tubercles are nearly equidistant.

The suture-line, so far as observable, is similar to that of young *Acanthoceras* and not much pseudoceratitic.

Measurements.—

	Diameter	Height	Breadth	(B/H)	Umbilicus	(%)
GT. I-3185	42.5	15.5	16.4	(1.0+)	14.1	(33)

Remarks.—The late Dr. K. OTATUME presented the specimen in question to one of us (T.M.) as a probable immature example of '*Romaniceras*' *japonicum* (YABE MS.). However the observable characters are distinct enough to separate it from that species (to be described below under *Yubariceras* [*Romaniceras*?] *japonicum*, sp. nov.) as well as from other species of *Romaniceras*.

In spite of the small size the specimen is regarded as adult, because it has a body whorl in which ornaments become very coarse as in many other adult whorls of Acanthoceratids. Consequently the small size may be a character of the present species. In other words acceleration of sexual maturity may have taken place in this peculiar species.

The peculiarity is found, furthermore, in the development of frequent constrictions on the inner whorl and in the mode of differentiation into major and minor ribs. As a constricted Acanthoceratid COLLIGNON established *Hourcquiceras* (COLLIGNON, 1939, p. 19). It was at first regarded as a subgenus of *Calycoceras* but it has a more pseudoceratitic suture, so that it must be a distinct genus. Anyhow in suture and other points the present species has nothing to do with *Hourcquiceras*. In the general features it is best attributed to *Romaniceras*. As judged from its peculiar characters it is probably a special, short offshoot from the principal stock of *Romaniceras*. Therefore a new subgeneric separation might be justified. However the available material is too insufficient to decide that. For the time being the present species is placed in *Romaniceras* with a query.

Occurrence.—Rare in the Neogyliakian (Turonian). The holotype came from the zone of *Inoceramus hobetsensis-Tragodesmoceroides subcostatus* at Nutapomanai, Kamihobets, Hobets [Popets], Iburi Province, Hokkaido. More precise horizon has not been determined.

Genus *Yubariceras* nov.

Type species.—*Yubariceras yubarense* sp. nov. (to be described below).

Generic diagnosis.—Similar to typical *Acanthoceras* in the relatively evolute and thick whorls, moderate size of umbilicus, subquadrate whorl-section, broad venter,

usually rectiradiate and rather broad but low ribs and predominant tubercles as well as in sutures. The tubercles are in nine or eleven rows as in *Romaniceras*, one or two pairs of lateral tubercles being added to umbilical, ventrolateral and three ventral ones of *Acanthoceras*.

Remarks.—In our present knowledge the examples of the proposed genus are the type species and two other species from Hokkaido described below. '*Romaniceras*' *ornatissimum* (STOLICZKA) (1865) from India and '*Romaniceras*' *adkinsi* JONES (1938) from Mexico may better be replaced to the new genus.*

In multituberculation *Yubariceras* is similar to *Romaniceras*. However the former has quadrate whorls, a rather flat and broad venter, subparallel and less inflated flanks and tubercles that are predominant over ribs which, in turn, are weakened in the late growth-stage; the latter has polygonal, costal and subrounded, intercostal whorl-sections, an arched venter and prominent ribs on which tubercles are much weakened with growth. There is some difference in the suture of the outer whorl between the two genera as in *Acanthoceras* and *Calycoceras*.

From both the morphological and stratigraphical grounds the new genus is best regarded as a descendant from true *Acanthoceras*. As has been mentioned above, *Romaniceras* is most probably derived from *Calycoceras* (of *newboldi* subgroup). Since the *newboldi* group is distinguished from *Acanthoceras*, the generic separation of the group in question from *Romaniceras* is justified. Thus *Yubariceras* and *Romaniceras* are in parallel relation.

Acanthoceras and *Calycoceras* have been put in separate subfamilies, Acanthoceratinae and Mantelliceratinae respectively. We have not sufficient material to discuss comprehensively whether the separation is necessary or unnecessary. However the two main branches, if existent, do not seem to be much apart, since the modes of specialization are fairly similar to each other. Thus multituberculation takes place contemporaneously in the two 'subfamilies'. *Yubariceras* is so similar to *Romaniceras* that someone might treat the former as a subgenus of the latter. Again the horned tubercles are not exclusively found in Acanthoceratinae. We know a horned example of Mantelliceratinae, although it is not described in this paper.

Distribution.—Neogyliakian (approximately Turonian) in Japan, India and Mexico. Taking into consideration the world wide distribution of *Acanthoceras*, *Yubariceras* will probably be discovered in regions other than the above cited areas.

Yubariceras yubarense (*ex* YABE MS.) sp. nov.

Pl. 8, fig. 1 a, b; Pl. 10, fig. 1 a, b; Pl. 11, fig. 1 a, b; Pl. 13, fig. 1 a, b; Pl. 15, fig. 1; Text figs. 8, 9

* From GROSSOUVRE's description *Ammonites deverioides* var. *armata* GROSSOUVRE (1889, p. 525) from Europe could be regarded as an example of *Yubariceras*. He did not illustrate that form. Without seeing the original specimen, we cannot conclusively decide its assignement.

1909. *Acanthoceras yubarense* YABE (MS.), *nom. nud.*, p. 441 (listed only).
1927. *Acanthoceras (Kossmatia) yubarense*, YABE, *nom. nud.*, p. 42 (16) (listed), pl. vi, fig. 1a, b.

Material.—GT. I-343 [=MM 7620], an internal mould of the middle growth-stage, from a pebble of the Pankemoyuparo, near the mouth of the Kaneobets, the Yubari valley, central Hokkaido. This is the original of YABE's MS. name and is designated here as holotype. There is a fragmentary specimen of a middle-aged shell from the Pompoyubari, a tributary of the Yubari.

There are three examples of the full-grown stage: GH. No. 12005 from the Uesugi-zawa, Nakahobets, Yufutsu-gun, Iburi Province (OTATUME Coll.); GK, H 1531 from loc. Y 462, bed II g-r, of the Shuyubari valley (T. M. Coll.); GK. H 1532 from a boulder at Y 469 of the same area, probably derived from bed II r or II s. (T. M. Coll.). Besides them there are comparable specimens in A. F.'s Coll. from Oyubari (Near loc. 3021) and K. TANAKA's Coll. from the Opirashibets, Hokkaido.

Specific diagnosis.—Shell is fairly large in the full-grown stage. Whorls grow rather slowly with little overlapping. Umbilicus is of moderate width. The whorl is much broader than high and subquadrate in cross-section being provided with gently inflated, parallel flanks and rather flattened, broad, external side.

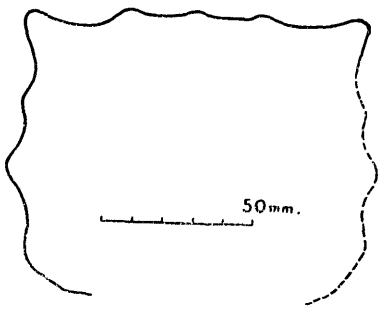


Fig. 8. *Yubariceras yubarense* sp. nov. Costal whorl-section of an adult shell, GH. 12005. T. M. *del.*

The shell is ornamented with rectiradiate ribs and eleven rows of tubercles. The ribs are low but of moderate breadth. On the septate whorls longer and shorter ribs are differentiated but the difference in length is not great; they are separated by interspaces somewhat broader than the ribs. On the adult whorl the ribs are very distant and of equal length; fine riblets or striae are occasionally discernible in the interspaces.

The umbilical tubercle is of moderate strength, bullate and developed only at the end of the long rib. The inner lateral tubercle is characteristically prominent, having a bullate base. In the immature shell the short ribs sometimes branch at the inner lateral tubercles. The outer lateral tubercle is small but distinctly developed. The ventrolateral tubercle is large and prominent, with a rounded base, forming an angular shoulder.

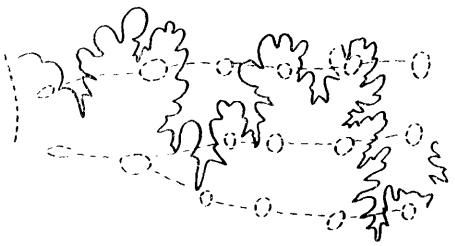


Fig. 9. *Yubariceras yubarense* sp. nov. Suture of holotype, enlarged. T. M. *del.*

* see footnote in p. 27

The paired ventral tubercles are fairly prominent and more (in early) or less (in late stages) clavate. The tubercle at the mid-venter is also clavate but less prominent than the paired ones, being much weakened in the late stage. The tubercles are nearly equidistant. They are mostly discernible even on the adult body whorl, where the inner lateral and ventrolateral ones are especially prominent.

The suture-line is similar to that of *Acanthoceras rhotomagense*, with an asymmetrically trifid lateral lobe and a broad external saddle.

Measurements.—

Specimens	Diameter	Height	Breadth	(B/H)	Umbilicus	(%)
GT. I-343	86	38.5	49.5	(1.3)	30	(35)
GH. 12005	225	90.0	124.0	(1.4)	74	(33)

Remarks.—If the two lateral tubercles are excluded, the present species is fairly similar to *Acanthoceras rhotomagense* (DEFRANCE). The fact should be noted in connexion with the origin of *Yubariceras*.

Romaniceras deverioides (GROSSOUVRE) (1889, p. 524, pl. xii; COLLIGNON 1939, p. 37) [=*Acanthoceras deverianum* BASSE, 1937, *pars*, p. 180, pl. viii, fig. 1 a, b] from the Turonian of France and Syria has eleven rows of tubercles, but it has prominent ribs and rounded whorls, suggesting its ultimate origin in *Calycoceras*.

Yubariceras ornatissimum (STOLICZKA) (1865, p. 75, pl. xl.) from India has eleven rows of tubercles, but its ribs are, as judged from the illustration, much more elevated than in ours. In STOLICZKA's figure* the outer lateral tubercle is close to the peripheral one, while in ours the tubercles are nearly equidistant.

Yubariceras n. sp. (?)

aff. *Y.* (?) *adkinsi* (JONES)

Pl. 16, fig. 1 a, b, c; Text fig. 10

Compare:

1938. *Romaniceras adkinsi* JONES, p. 120, pl. 8, figs. 4, 5.

Material.—Two, somewhat crushed specimens of dissimilar size: the large GK. H 1533, provided with a large body-whorl from loc. Y 216 p, and the smaller, poorly preserved GK. H 1534, showing a whorl of the middle-growth stage from loc. Y 134 p, both of which have been derived from the upper part of the Saku formation in the Shiyubari valley, Ishikari Province, Hokkaido (T. M. Coll.). Another fragmentary specimen of moderate size in A. F.'s Coll. from loc. 803, Oyubari, Ishikari Province.

Measurements (in approximation).—

Specimen	Diameter	Height	Breadth	(B/H)	Umbilicus	(%)
GK. H 1533	Ca 195 (max.)					
„	185	74	89	(1.2)	54	(29)
F.G. ——		31	42	(1.3)		

* KOSSMAT's reillustration does not agree with STOLICZKA's in this point.

Descriptive remarks.—Whorls grow fairly rapidly with moderate involution. They are broader than high and subquadrate in cross-section, with vertical and high umbilical walls, subrounded umbilical shoulders, only slightly inflated or rather flattened flanks, subrounded peripheries and a broad venter. The shell-form is thus of *Yubariceras* type, resembling that of *Acanthoceras*.

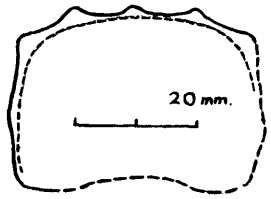


Fig. 10. *Yubariceras* n. sp. (?) aff. *Y.* (?) *adkinsi* JONES. Whorl-section of an example from loc. 803, Oyubari area. T. M. *del.*

In the inner whorl the ribs are of moderate intensity and provided with nine tubercles. The mid-ventral tubercle is the weakest, while the bullate lateral one on the long rib is prominent. The ribs are rectiradiate and separated by somewhat wider interspaces. Every second or third rib is longer. The ribs are weakened on the venter, while the outer tubercles predominates.

On the last part of the septate whorls and on the large, adult, body whorl both the ribs and tubercles gradually become blunt. The ribs are fairly distant and still of unequal length but those in the last part are equally long. The lateral tubercles are replaced by bullate, occasionally sharp, elevations; the umbilical ones are much weakened and the peripheral and paired ventral ones are represented by slight bulges on the rib. The rib is broad but low on the venter and especially lowered at the mid-venter, where no tubercle is found.

Although the rib crosses over the venter even on the outer whorl, it is much weaker than in *Romaniceras*. The feature is similar to that found in the outer whorl of certain species of *Acanthoceras*. Thus in the ornamentation the present form is better ascribed to *Yubariceras* than to *Romaniceras*. It is fairly similar to *Y. yubarense* sp. nov. in the characters of the inner whorls, but it has nine, instead of eleven, rows of tubercles. In the outer whorl it has less distinct tubercles than that species.

The Japanese form under consideration seems to be closely allied to "*Romaniceras*" *adkinsi* JONES from the Indiana formation of Coahuila, Mexico in the quadrate whorl and the ribs and tubercles of moderate intensity. JONES' illustration (1938, pl. 8, figs. 4, 5) suggests the broadening of the ribs with growth, as in ours. The Japanese specimen (GK. H 1533) represents a shell of still later growth-stage. Thus the Japanese form is possibly referable or at least closely allied to the Mexican species. However, without seeing the specimen itself, we cannot decide the specific identity or distinction. Anyhow that Mexican species (*R. adkinsi* JONES) may be an example of *Yubariceras*.

Occurrence.—The two specimens in T.M.'s Coll. came from the upper part of the Neogyliakian. A.F.'s specimen also belongs to the Neogyliakian. The more accurate stratigraphical range of the species should be determined by further research.

Yubariceras [*Romaniceras*?] *japonicum* (*ex* YABE MS.) sp. nov.

Pl. 8, fig. 2; Text figs. 11, 12

1909. *Acanthoceras japonicum* YABE MS., p. 441, *nom. nud.*, listed only.
1927. *Acanthoceras* (*Kossmatia*) *japonicum*, YABE, *nom. nud.*, p. 42 (16), listed only.

Material.—Holotype is GT. I-345 [=MM 7622], H. YABE, Coll., an internal mould of a probably middle-aged shell.

Specific diagnosis.—The whorls grow fairly rapidly with little overlapping; the umbilicus is of moderate width and surrounded by a subangular shoulder; the whorl-section is trapezoidally subquadrate, being slightly broader than high and broadest in the dorsal part; the venter is broadly arched.

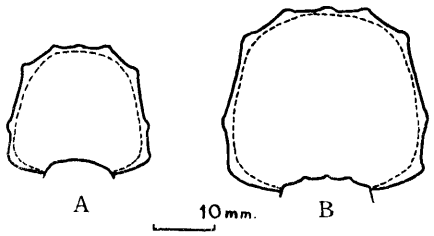


Fig. 11. *Yubariceras* [*Romaniceras*?] *japonicum* (*ex* YABE MS.) sp. nov. Whorl-sections at diameters of 49 mm. (A) and 66 mm. (B). Holotype, GT. I-345. T. M. *del.*

The ribs are separated by interspaces that are nearly as broad as themselves in the early growth-stage but somewhat broader than the ribs in the late stage. They consist of stronger, longer ones and weaker, shorter ones; they are, however, nearly of equal intensity on the external side. Some of the ribs show slight flexuosity on the flanks.

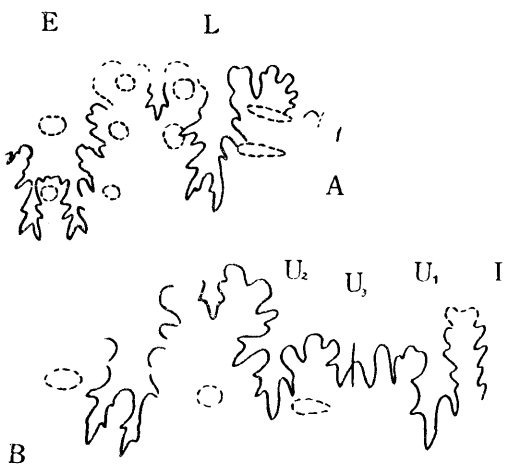


Fig. 12. *Yubariceras* [*Romaniceras*?] *japonicum* sp. nov. Partial suture-lines of the holotype at diameters of 36 mm. (A) and 66 mm. (B) respectively. T. M. *del.*

There are nine rows of tubercles: the umbilical one of moderate strength at the end of the long rib, the lateral one of unequal intensity which is prominent on the long rib and very weak on the short rib, the most prominent ventrolateral one with a rounded base and the weaker paired and median, ventral ones with clavate bases. The lateral tubercle is rather close to the umbilical one and not situated at the mid-flank.

Measurements.—

	Diameter	Height	Breadth	(B/H)	Umbilicus	(%)
GT. I-345	61.0	27.5	29.5	(1.07)	19.0	(31)

Remarks.—The holotype is relatively small and wholly septate. Therefore it is evidently immature. At first we considered that it might be an immature example of what we described above under the heading of *Yubariceras* n. sp. (?), aff. *Y.* (?) *adkinsi* (JONES). However the inner whorl of the latter has more regular tubercles and more rectangular whorl-sections. In spite of the immaturity the specimen can

be taken to represent a new species that is characterized by the dorsally thick whorls, unequal intensity of the lateral tubercles, their position in the proximity of umbilical tubercles and slight but unnegligible flexuosity of some ribs. In these respects the present species is distinguished from the hitherto known species of *Romaniceras* that posses nine rows of tubercles.

It should be noted that the present species is very similar to *Acanthoceras* (s.s.) *flexuosum* CRICK (1907, p. 184, pl. xii, fig. 1, 1a; VENZO 1936, p. 84 [26], pl. vii [iii], fig. 6; pl. xi [vii], fig. 5) from the Cenomanian of Sowtheast Africa. Its lateral tubercles and somewhat larger umbilicus are the distinction. From this fact the present species is better attributed to *Yubariceras* than to *Romaniceras*. However for exact generic assignment the adult whorl is needed in addition to the immature ones. Therefore the species under consideration is called provisionally *Yubariceras* [*Romaniceras*?] *japonicum*.

Occurrence.—Rare. The holotype came from a pebble of the Yubari, Ishikari Province, Hokkaido. According to YABE (1909, 1927) it is derived from his "*Mammites*" bed, i. e. Neogyliakian, approximately Turonian.

Genus *Acanthoceras* NEUMAYR, 1875

Type species.—*Acanthoceras rhotomagense* (BRONGNIART *ex* DEFRANCE MS.).

Generic diagnosis.—Relatively evolute whorls with quadrate or subquadrate sections, being as wide as high or wider than high. The ribs are comparatively broad and low, while tubercles are well developed. On the inner whorls the ribs are alternated in length, but in the outer whorl they are equally long and distant. They are usually rectiradiate but occasionally somewhat flexuous. There are seven rows of tubercles; the ventrolateral ones are the largest and in some species tend to be horned; the three rows of tubercles on the broad venter are rather small and the median one especially may become obsolete as the shell grows on. Occasionally the outer ventral and ventrolateral tubercles are united into a large marginal one. Sutures tend to be reduced, having broad, bifid, external saddles and asymmetrically bifid or trifid lateral lobes.

Remarks.—The genus is well known, but it has been used by many authors in too wide sense. The diagnosis of the adequately defined genus may be described as above. As has been already mentioned (p. 9, 10), *Acanthoceras* is clearly distinguished from *Calycoceras*. There is, however, no sharp boundary between certain species of *Acanthoceras* (e. g. *A. vectense* SPATH and its allies) with relatively strong ribs and *Calycoceras* of the *newboldi-spinosum* group. Genetically they may be intimately related.

Whether '*Acanthoceras*' *tarrantense* (ADKINS) (1928, p. 241, pl. xxviii, fig. 3; pl. xxix, fig. 1; STEPHENSON, 1953, p. 198, pl. 45, figs. 9, 10; pl. 46, figs. 2–4) and its

allies from the Gulf Coast and Western Interior of North America belong to *Acanthoceras*, *Calycoceras* or some other genus has still to be settled. However no examples of that group have been found in Japan, so that we do not touch the question in this paper.

Distribution.—The genus is widespread in the Upper Cenomanian. In contrast to the relative abundance of *Calycoceras* only a few examples of *Acanthoceras* have been found in the Upper Cretaceous of Hokkaido.

Acanthoceras aff. *evolutum* SPATH

Pl. 14, fig. 2 a, b.

Compare:

1857. *Ammonites sussexiensis*, SHARPE, p. 34, pl. xv, fig. 1 a, b, c (non MANTELL).
1925. *Acanthoceras evolutum* SPATH, 1925 a, p. 83.

Material.—GT. I-3165 from T 26 p, the Abeshinai area, Teshio Province (T. M. Coll.).

Description.—Since the specimen is still septate, the full-grown body whorl must be fairly large. The whorls grow at a moderate rate, with little overlapping. The umbilicus is of moderate width, surrounded by a steep wall. The whorl is slightly broader than high, being subquadrate in section, with a fairly broad venter.

The whorl in the middle growth-stage is ornamented with distant, rectiradiate, major ribs, that are provided with prominent tubercles at the umbilical shoulder and at the ventrolateral margin. The ribs are strong on the flank and cross over the venter with decreasing intensity. There are minor ribs on the external side which are branched out from, or intercalated between, the major ones. The ventral tubercles in three rows are small and indistinct, two times or more in number than the peripheral ones, becoming gradually obsolete as the shell grows on. The intercalated minor ribs sometimes show small, indistinct, peripheral bulges and soon disappear on the outer half of the flank, but occasionally have ventrolateral tubercles and reach near the umbilical shoulder, though much weakened.

The outer half whorl of the specimen is unfortunately much water-worn, but seems to be provided with distant ribs and prominent marginal tubercles.

The suture is of the *Acanthoceras* type, with relatively broad saddles and fairly wide, apparently bifid, lateral lobe.

Measurements (in approximation).—

Diameter	Height	Breadth	(B/H)	Umbilicus	(%)
165	71.5	>72		53.3	(32)
113	48.0	53	(1.1)	37.0	(33)

Comparison.—In most of the observable characters the Japanese form in question is closely allied to *Acanthoceras evolutum* SPATH from the Cenomanian of England. Development of some of the minor ribs beyond the outer side and somewhat broader whorl in our form might be the criteria to distinguish it from that species, but

could be regarded as a subspecific difference. The imperfection of the specimen and scarcity of material prevent us from precise determination. Anyhow the present form is an example of true *Acanthoceras* occurring in the Paleogyliakian of Hokkaido.

Occurrence.—Rare. The specimen came probably from the upper part of bed II b or II b–c [β] that belongs to the Upper Paleogyliakian, approximately Upper Cenomanian.

Genus *Euomphaloceras* SPATH, 1923

Type species.—Euomphaloceras euomphalum (SHARPE).

Synonym.—Cunningtoniceras COLLIGNON, 1937.

Ornamentation of the outer whorl characterized by the large, horned ventro-lateral tubercles and somewhat prominent lower lateral tubercles on the distant, broad ribs may be one of the diagnosis of this genus. But similar ornamentation and also multiplication of the ventral tubercles as compared with the lateral one do appear in certain species of true *Acanthoceras*. C. W. & E. V. WRIGHT (1951, p. 29) have already pointed out that many specimens of *Acanthoceras* have wrongly been referred to "*cunningtoni*" SHARPE [=*E. euomphalum* (SHARPE)].

The most reliable criterion may be the constriction-like depressions appearing periodically along some of the ventral ribs in certain growth-stages of *Euomphaloceras*. The depressed and horned costal whorl-section resembling a face of an oriental ogre (*oni-men* in Japan) is characteristic of *Euomphaloceras*, while *Acanthoceras* has more regularly quadrate or rectangular whorl-section. However the intermediate feature is found in certain species of *Acanthoceras*.

Anyhow the alliance of *Euomphaloceras* to *Acanthoceras* is so intimate that derivation of the former from the latter, through such forms as *A. evolutum* SPATH, may be justified, if there is ample stratigraphical evidence.

In England the genus seems to be confined to the Upper Cenomanian, but its range in other areas has not yet been precisely determined. Our comparable forms occur in the middle part of the Paleogyliakian.

Euomphaloceras cf. *euomphalum* (SHARPE)

Pl. 15, fig. 3

Compare:

1855. *Ammonites euomphalus* SHARPE, p. 31, pl. xiii, fig. 4 a–c.
1855. *Ammonites cunningtoni* SHARPE, p. 35, pl. xv, fig. 2.
1897. *Acanthoceras cunningtoni* SHARPE var. *cornuta* KOSSMAT, p. 18 [125], pl. v [xvi], fig. 1 a–c.
1907. *Acanthoceras cunningtoni* SHARPE, PERVINQUIÈRE, p. 277, pl. xv, fig. 1 a–c.

1923. *Euomphaloceras euomphalum* (SHARPE), SPATH, p. 143, footnote 4.
1937. *Acanthoceras (Cunningtoniceras) cunningtoni* (SHARPE), COLLIGNON, p. 40.
1951. *Euomphaloceras euomphalum* (SHARPE), WRIGHT & WRIGHT, p. 29.

Material.—An imperfectly preserved specimen, GT. I-3186 from loc. T 621, bed II b, the Abeshinai area (T. M. Coll.); the body whorl is partly preserved. Another specimen, GT. I-3054, from loc. T 43, bed II b of the same area (T. M. Coll.).

Description.—The outer whorl has very distant, broad and low ribs, each of which is provided with a fairly prominent tubercle at the ventrolateral margin. There are three rows of tubercles on the venter of the septate part. Small median tubercles are three times as numerous as the peripheral ones. Those of the other two rows correspond in number to the ventrolateral ones and are somewhat clavate, lying on the common base of the horned, large, marginal ones. A faint constriction-like depression is occasionally discernible on the venter.

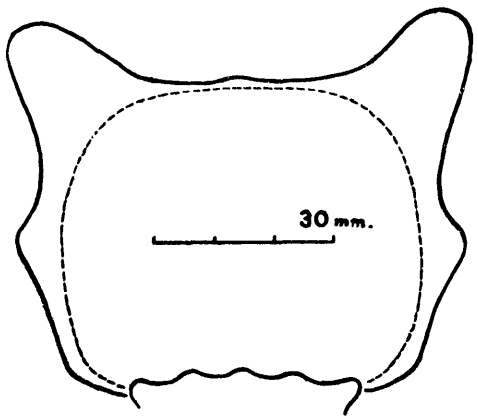


Fig. 13. *Euomphaloceras euomphalum* (SHARPE) Whorl section of an example, BM. 88704, from England. T.M. *del.* by kind permission of the Keeper of Geology, British Museum (Nat. Hist.).

The next inner whorl has distant ribs, spinose marginal tubercles and less prominent umbilical tubercles.

Suture of the *Acanthoceras* type, with apparently bifid, wide lateral lobe.

The characters of the inner whorl as young as the holotype of *E. euomphalum* (BM. 50158) are not unfortunately well exhibited.

Comparison.—In spite of the imperfection of our specimen, its close resemblance to *E. euomphalum* of corresponding size cannot be denied, so that it is comparable to that widespread species. So far as the observable characters are concerned, it is most closely allied to the Indian form described by KOSSMAT as *Acanthoceras cunningtoni* var. *cornuta*. The difference of the Indian form from the British one is so slight that it can be ignored as a variation within the same species. More evidences are necessary to justify the subspecific separation.

Occurrence.—Rare in bed II b of the Abeshinai area, Teshio Province, probably the middle part of the Paleogyliakian.

Euomphaloceras [*Acanthoceras* ?] sp. indet.

Pl. 17, fig. 1 a, b, c; Pl. 18, fig. 1 a, b

Material.—Two imperfectly preserved specimens, GH. 12438 and GH. 12439, from loc. Oy 58, the Hakkin-zawa, a tributary of the Yubari, in the Oyubari area, Ishikari

Province, Hokkaido (S. NAGAO & A. OSANAI Coll.).

Description.—The two specimens of somewhat different sizes from the same locality are probably of the same species.

The larger specimen has a horned body whorl, which is broader than high and has much distant, coarse, radial ribs and on each rib a fairly elevated tubercle above the umbilical shoulder and a very large, outward produced, horned tubercle at the ventrolateral margin. On the broad external side the tubercles are obsolete and only a few intercalated, minor ribs are occasionally discernible besides the low and broad major ribs. The preceding part of the shell is unfortunately destroyed. The next inner whorl shows on its lateral side fairly distant ribs of moderate intensity, with umbilical and marginal tubercles. Its external side is concealed, so that the ventral ornament is not well shown. The minor ribs extend beyond the periphery to the flank.

The smaller specimen shows the septate whorl and a posterior portion of the body whorl. The outer whorl with diameters over 80 mm. is subquadrate in section and has distant, coarse ribs, each of which is provided with a bullate tubercle at the umbilical shoulder and a horned peripheral one. The ribs cross the venter with much weakening and broadening. The ventral tubercles are obsolete also at this stage. The preceding two-fifths of the whorl is so poorly preserved that its character is not precisely known. The next inner whorl with diameters below 55 mm. shows fairly distant ribs, umbilical and ventrolateral tubercles in the lateral view. Its external side has minor ribs which are divided from or intercalated between the major lateral ribs and three rows of small tubercles. A faint constriction-like depression is occasionally discernible along some of the ventral rib. The ventral tubercles are twice to three times as numerous as the ventrolateral ones. Some of the intercalated minor ribs extend beyond the periphery to the mid-flank.

In both specimens the whorls show little involution and the umbilicus is of moderate size.

Measurements.—

Specimen	Diameter	Height	Breadth	(B/H)	Umbilicus	(%)
GH. 12439	Ca 94	35.5	37.8	(1.07)	35	(37)
GH. 12438 (costal)	Ca 145	65.0	79.0	(1.20)	Ca 50	(35)
„ (intercostal)		55.0	60.0	(1.10)		

Comparison.—The form in question is fairly similar to the one described above under *Acanthoceras* aff. *evolutum* SPATH, but its ribs are much more distant, broader and lower and its marginal tubercles are larger and much more distinctly horned than in that form. They are probably of different species, though possibly intimately related with each other. From the faint constriction-like depression in the inner whorl and the strongly horned tubercle in the body whorl the present form is referable rather to *Euomphaloceras.* However certain species of *Acanthoceras* have

similarly horned body whorl. In fact our form resembles '*Acanthoceras* (?)' *eulessanum* STEPHENSON (1953, p. 201, pl. 47, fig. 5; pl. 48, figs. 3, 4) from the upper part of the Woodbine formation of Texas, but that species and closely related '*Acanthoceras*' *lonsdalei* ADKINS (1928, p. 244, pl. xxvi, fig. 5, pl. xxvii, fig. 3), might well be the American examples of *Euomphaloceras*.

Since the specimens from Hokkaido are imperfectly preserved, we hesitate to identify them definitely. For the time being the present form is called *Euomphaloceras* [*Acanthoceras*?] sp. indet.

Occurrence.—Rare in the Paleogyliakian of the Oyubari area, Ishikari Province. A well preserved specimen of *Turrilites costatus* LAMARCK came from the same bed as the present form.

Eucalycoceras SPATH, 1923

Type species.—*Eucalycoceras pentagonum* (JUKES-BROWNE).

Generic diagnosis.—Compressed whorls ornamented with numerous ribs that are usually, but not always, weakened in the adult stage. The five rows of tubercles on the relatively narrowly arched venter are much separated from the umbilical ones and are also obsolete in the adult whorl. The sutures are similar to those of *Calycoceras*.

Remarks.—SPATH (1923) at first included in this genus the *newboldi* group, but that group was later (1937, p. 279) replaced to *Calycoceras*. Thus *Eucalycoceras* should be restricted to the *pentagonum* group, as diagnosed above. This has been already pointed out by C. W. & E. V. WRIGHT (1951, p. 26), contrary to the current misunderstanding. But still in some recent papers the generic name is used in too broad sense.

As is suggested by the Indian examples, *Eucalycoceras* may have been derived from the group of *Calycoceras newboldi* through such forms as *C. planecostum* (KOSSMAT). Similar relationship has recently been demonstrated by C. W. WRIGHT (1953) with the English examples. In England the two described species, *E. pentagonum* (JUKES-BROWNE) and *E. lymense* SPATH, occur in the upper Cenomanian *subglobosus* zone. In North America later examples are known. In Madagascar and India *E.* [*Calycoceras*?] *choffati* (KOSSMAT)* has been reported to occur together with *Calycoceras newboldi*. COLLIGNON has described several other species in the Upper Cenomanian of Madagascar.

The Japanese example described below came from the upper part of the Paleogyliakian.

* *Choffati* may be a *Calycoceras* of *planecostatum* group.

Eucalycoceras sp. indet.

Pl. 11, fig. 2a, b; Text fig. 14

Material.—Two fragmentary whorls of dissimilar sizes, GH. 12434 and GH. 12435 from the Ikushumbets valley. (R. S. Coll.).

Descriptive remarks.—The whorl is relatively compressed (b/h≒0.8) with nearly parallel and flattened flanks and a moderately arched venter. The radial ribs are of moderate breadth and height and are separated by the wider interspaces. The rib is bent forward on the inner half of the flank, then runs radially and crosses the venter without weakening. The clavate outer tubercles are found on the rib in the middle-growth stage but gradually become obsolete later. The umbilical tubercle is also much weakened. The ribs in the late part become less distant and weak.

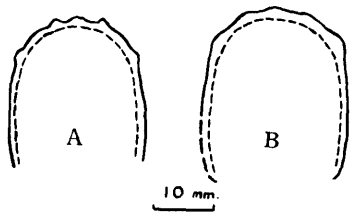


Fig. 14. *Eucalycoceras* sp. Whorl-sections at different growth-stages (A and B).

The paired ventral tubercles are much closer to the mid-ventral tubercle than to the ventrolateral one.

The observable characters indicate that the Japanese form under consideration probably belongs to *Eucalycoceras*. It is fairly similar to *E. leonense* ADKINS (1928, p. 240, pl. xxviii, fig. 1; pl. xxix, fig. 3) and also to the outer whorl of *E. harpax* (STOLICZKA) (1865, p. 72, pl. xxxix, fig. 1a, b) from the Middle Ootatoor group of South India. Its ribs are much more distant than in *E. pentagonum* (JUKES-BROWNE).

Its resemblance to '*Protacanthoceras*' *jullieni* COLLIGNON (1937, p. 36, pl. ii, figs. 1, 1a, 1b, 2; pl. viii, fig. 3) cannot be ignored.

Since our material is insufficient, accurate identification should be reserved. Here is only notified the existence of a probable *Eucalycoceras* in Japan.

Occurrence.—Rare. The specimens have been found near the top of the middle member of the Mikasa formation in the Ikushumbets valley on the eastern wing of the anticline. This horizon has been called "*Calycoceras* zone" (FUKADA, *et al.*, 1952), but it should be revised as *Eucalycoceras*-bearing bed. The later occurrence of the present form than *Calycoceras asiaticum*, *C. spinosum* and *C. orientale* may be worthy of attention, but its true range has not yet been clearly determined.

Genus *Protacanthoceras* SPATH, 1923

Type species.—*Protacanthoceras bunburianum* (SHARPE).

Generic diagnosis.—The shell is relatively small or of moderate size. The whorls are compressed with flattened flanks and rather narrowly arched venter. The ribs are weak or tend to be so. The ventral tubercles in three rows are clavate and

very close together. The ventrolateral tubercles are not strong. The umbilical tubercles are small, less numerous than the external ones and tend to be weakened in the late growth-stage. The sutures are relatively simple with broad saddles and lobes which have reduced incisions, being similar in general pattern to those of immature Acanthoceratids.

Remarks.—SPATH (1923) has established the genus for the English Cenomanian species, *Ammonites bunburianum* SHARPE (1853) (type species), *A. triseriale* J. DE SOWERBY (1836) and *A. compressum* JUKES-BROWNE (1896). He defined the genus later (SPATH, 1937, p. 279) and considered it as a "dwarf offshoot" of the subfamily Acanthoceratinae. COLLIGNON (1937) has added several examples from Madagascar and has attempted to demonstrate the derivation of *Protacanthoceras* from *Eucalycoceras* through such intermediate forms as *E. besairiei* COLLIGNON. C. W. WRIGHT (1953) has also exhibited specimens that indicate close affinity between the two genera and furthermore suggested that *Protacanthoceras* can lead to *Metoicoceras* and *Neocardioceras* of Lower Turonian.

Our material does not at present contribute much to these interesting subjects related to the genus. However occurrence of the Japanese example, which is close to an English form, indicates, together with the hitherto known African and Indian records, the world wide distribution of the genus.

Protacanthoceras sp. nov. (?)

Pl. 14, fig. 3

Material.—GH. 7874 from the *Trigonia* Sandstone at Katsurazawa, the Ikushumbets valley (NEMOTO Coll. presented to Hokkaido University), a small specimen in which the body whorl is deformed and partly destroyed but the septate part is well preserved.

Description.—Small, involute shell with compressed whorls, flattened flanks, a narrowly arched venter and a narrow umbilicus.

The three ventral rows of tubercles are close together, clavate and fairly prominent. The ventrolateral tubercle is of moderate intensity, somewhat separated from the ventral one and is much distant from the small tubercle at the umbilical margin. Ribs are weak, slightly flexuous on the flank, bent forward between the ventrolateral and ventral tubercles and feebly cross the venter. There are occasional shorter ribs that are intercalated on the external half of the whorl or branched out near the umbilical tubercle.

The suture-line tends to be reduced showing minor incisions on the general pattern of immature Acanthoceratids.

Measurements.—

	Diameter	Height	Breadth	(B/H)	Umbilicus	(%)
Septate part	14.0	7.7	Ca 6.0	(0.8)	1.8	(13)

Remarks.—In all the above characters the Japanese form closely resembles a British Cenomanian form described by JUKES-BROWNE (1896, p. 157, pl. v, fig. 4, 4 a) under *Ammonites* (*Acanthoceras*) *hippocastanum* SHARPE var. *compressus* JUKES-BROWNE. C. W. & E. V. WRIGHT (1951, p. 28) have designated the original of JUKES-BROWNE's fig. 5 (GSM 53484) as lectotype of *Protacanthoceras compressum* (JUKES-BROWNE) and remarked that other specimens belong to different forms. Probably the Japanese form should receive, together with that allied English form (JUKES-BROWNE's fig. 4), a new name. Here it is provisionally described under *Protacanthoceras* n. sp. (?).

Occurrence.—Rare in the Paleogyliakian of Hokkaido. The precise horizon of the specimen is not recorded. From the lithic character of the matrix, fine sandy calcareous rock, and the associated simple coral and *Anisoceras*-like fragmentary specimen, it is presumably the upper Paleogyliakian part of the "*Trigonia* Sandstone" (=Mikasa formation). Further careful collection is wanted.

Summary

As a summarized result we list here the species of the Acanthoceratids from Hokkaido which have been described above, with their affinity and horizons.

(1) *Mantelliceras* (?) sp. [related to *M. mantelli* (SOWERBY)] (horizon uncertain), p. 5, text fig. 1

(2) *Mantelliceras* (?) *nagaoi* n. sp. [related to *M. costatum* (MANTELL)] (Paleogyliakian), p. 6, pl. 12, fig. 1; pl. 13, fig. 2; text fig. 2

(3) *Calycoceras asiaticum* (JIMBO) [allied to *C. newboldi* (KOSSMAT)] (Middle part of the Paleogyliakian), p. 11, pl. 1, fig. 1; pl. 2, fig. 1

(4) *Calycoceras spinosum* (KOSSMAT) (Middle part of the Paleogyliakian), p. 13, pl. 3, fig. 1; pl. 4, figs. 1, 2; text fig. 3

(5) *Calycoceras orientale* n. sp. [allied to *C. spinosum* (KOSSMAT)] (Middle part of the Paleogyliakian), p. 16, pl. 5, fig. 1; pl. 7, fig. 1

(6) *Calycoceras* sp. nov. (?) [related to *C. spinosum* (KOSSMAT); similar to '*Acanthoceras*' *cornigerum* CRICK] horizon uncertain), p. 17, pl. 7, fig. 2; text fig. 4

(7) *Calycoceras* cf. *stoliczkai* COLLIGNON [allied to *C. naviculare* (MANTELL); and similar to *C. boulei* COLLIGNON] (Middle part of the Paleogyliakian), p. 19, pl. 6, fig. 1

(8) *Calycoceras* sp. indet α [similar to *C. subgentoni* (SPATH)] (Middle part of the Paleogyliakian), p. 20, pl. 6, fig. 2

(9) *Calycoceras* sp. indet β [similar to *C. jeanneti* COLLIGNON] (Upper part of the Paleogyliakian), p. 21, text fig. 6

(10) *Romaniceras pseudodeverianum* (JIMBO) [similar to *R. deverianum* D'ORBIGNY); allied to *Calycoceras orientale* n. sp.] (horizon uncertain), p. 22, pl. 8, fig. 3; text fig. 7

(11) *Romaniceras* aff. *uchauxiense* COLLIGNON (Neogyliakian), p. 24, pl. 9, figs. 1, 2; pl. 14, fig. 1; pl. 15, fig. 2

(12) *Romaniceras* (?) *otatumei* n. sp. [a peculiar form] (Neogyliakian), p. 25, pl. 2, fig. 2

(13) *Yubariceras yubarense* (*ex* YABE MS.) n. sp. related to *Acanthoceras rhotomagense* (DEFRANCE); similar to *Y. ornatissimum* (STOLICZKA) (Neogyliakian, principally its upper part), 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

(14) *Yubariceras* n. sp. (?) [allied to *Y. yubarense* n. sp. similar to *Y.* (?) *adkinsi* (JONES)] (Neogyliakian, principally its upper part), p. 29, pl. 16, fig. 1; text fig. 10

(15) *Yubariceras* [*Romaniceras* ?] *japonicum* (*ex* YABE MS.) sp. nov. [related to *Acanthoceras flexuosum* CRICK; similar to *Y.* n. sp. (?) aff. *adkinsi* (JONES)] (Neogyliakian), p. 31, pl. 8, fig. 2; text figs. 11, 12

(16) *Acanthoceras* aff. *evolutum* SPATH [somewhat transitional to *Euomphaloceras*] (Upper Paleogyliakian), p. 33, pl. 14, fig. 2

(17) *Euomphaloceras* cf. *euomphalum* (SHARPE) (Middle part of the Paleogyliakian), p. 34, pl. 15, fig. 3

(18) *Euomphaloceras* [*Acanthoceras* ?] sp. indet [related to *Acanthoceras evolutum* SPATH] (Paleogyliakian), p. 35, pl. 17, fig. 1; pl. 18, fig. 1

(19) *Eucalycoceras* sp. indet. [similar to *E. leonense* ADKINS] (Upper part of the Paleogyliakian), p. 38, pl. 11, fig. 2; text fig. 14

(20) *Protacanthoceras* sp. nov. (?) [similar to *P. compressum* (Jukes-Browne)] (Paleogyliakian), p. 39, pl. 14, fig. 3

Among the above listed twenty forms several species, e. g. (3), (4), (5) and (13), are relatively common, defining subzones, but many others are rather rare, including undetermined species and species of uncertain horizon. Thus we have much to do concerning the Acanthoceratids from Hokkaido. Several species are left undescribed, awaiting additional material.

Outside the Japanese province the Acanthoceratids are fairly common in certain areas. However even in those areas the species and genera of the family have not yet been so sufficiently described for the requirement of modern palaeontology and their succession has not been so accurately known as in the case of the Gault Hoplitids. Under these circumstances it is desirable to describe monographically what sort of forms are found in the Japanese province and at which horizon they occur. We have attempted, furthermore, in several places to give remarks on the

* (for p. 42) MATSUMOTO, T.: Zoning of the Upper Cretaceous in Japan and adjacent areas, with special reference to world wide correlation, read in the *Cretaceous Symposium, XXth International Geological Congress, Mexico*, Sept., 1956.

evolutional relation of certain forms. As to the problem of stratigraphical correlation another paper* is necessary.

Acknowledgements

We are indebted to the many kind friends who have helped us in various ways. In particular we wish to thank Mr. C. W. WRIGHT who has given to one of us (T. M.) frequent opportunities for fruitful discussion, allowed him the use of the private collections and critically read the typescript; Professor Emeritus H. YABE, Messrs. S. NAGAO and A. OSANAI in Sapporo, Mr. K. TANAKA of the Geological Survey of Japan, Mr. M. KIKUCHI of Mikasa High Shool in Hokkaido, Messrs. T. & K. MURAMOTO and T. OHMORI at Yayoi in Hokkaido who have provided us with many precious specimens for study; Dr. I. HAYASAKA and the late Dr. T. NAGAO, formerly Professors at Hokkaido University, and Professor M. MINATO of the same university, Professor T. KOBAYASHI of the University of Tokyo, through whom we have had access to the collection in the two universities; Mr. W. N. EDWARDS, Keeper of Geology, British Museum (Natural History), Professor W. B. R. KING of Cambridge University and Mr. A. G. BRIGHTON, Curator of the Sedgwick Museum, who have rendered facilities in those institutions where one of us (T. M.) has been enabled to work through a British Council Scholarship; Mr. J. P. CONLIN in Texas who has provided us some American specimens for comparison with ours; and Dr. J. M. HANCOCK of the King's College, London who has kindly sent to one of us (T. M.) some books which are hardly accessible here; Mr. D. PHILLIPS of the British Museum (Natural History), Mr. I. OBATA and Miss Junko TAKAMIYA of the Department of Geology, Kyushu University who have assisted us in various ways; and Messrs. C. UEKI and S. KUMANO who have photographed for us a number of specimens figured in the plates.

Finally our thanks are due to Professor T. TOMITA and Professor R. TORIYAMA for their effort in arranging this paper for publication by the Faculty of Science, Kyushu University. We are indebted to the Ministry of Education whose aid has rendered it possible for us to undertake this study.

Works Cited

ADKINS, W. S. 1928. Handbook of Texas Cretaceous Fossils. *Univ. Texas Bull.* No. **2838**, 303 pp., 37 pls., index.

BASSE, É. 1937. Les Céphalopodes Crétacés des Massifs Côtiers Syriens. Haut-Commissaritat de la République Française en Syrie et au Liban. *Service des Travaux Publics* [*Sect. d'Études Géologiques*] *Notes et Mémoires*, **2**, p. 165–200, pls. viii–xi.

BREISTROFFER, M. 1947. Notes des nomenclature paléozoologique *Proc. verb. mens. Soc. Sci. Dauphiné*, 26th year, no. **195**, 5 pp.

CHOFFAT, P. 1898 Recueil d'Etudes Paléontol. sur la Faune Crétacique du Portugal, Vol. **1**, 2e ser., p. 41–86, pls. ceph. iii–xxii, Lisbonne.

——— 1903. Contribution à la Connaissance géologique des Colonies Portugaises d'Afrique, 1. Le Crétacique de Conducia. 29 pp., 8 pls.

CRICK, G. C. 1907. Cretaceous Fossils of Natal. Vol. **3**, *Third and Final Report of the Geological Survey of Natal and Zululand*, p. 161–250, pls. x–xv.

——— 1919. On *Ammonites navicularis* MANTELL. *Proc. Malac. Soc.*, **13**, p. 154–160, pl. iv.

COLLIGNON, M. 1928–29. Les Céphalopodes du Cénomanien pyriteux de Diègo-Suarez. -Paléontol. Madagascar xv. *Ann. Pal.*, **17**, p. 137–162, pls. vi–xix; *Ibid.* **18**, p. 1–55, pls. i–vii.

1937. Ammonites Cénomaniennes du Sud-ouest de Madagascar. *Ann. Géol. Serv. des Mines, Madagascar*, 8, p. 31–72, pls. i–xi.

——— 1939. Fossiles Cénomaniens et Turoniens du Menabe de Madagascar. *Ann. Géol. Serv. des Mines, Madagascar*, **10**, p. 1–49, pls. i–xi.

——— 1954. Essai de Nomenclature Stratigraphiques des Terrains Sedimentaires de Madagascar. *Travaux du Bureau Géologique, Madagascar* **63**, 66 pp.

DOUVILLÉ, H. 1890. Sur la classification des Cératites de la Craie. *Bull. Soc. géol. France*, [3], **18**, p. 275.

——— 1911. Evolution et Classification des Pulchelliidés. *Ibid.*, [4], **11**, p. 285–320.

DOUVILLÉ, R. 1911. *Ammonites gentoni* DEFRANCE, *in* BRONGNIART, 1822. *Palaeontologia Universalis.* Century III, no. 223, 223 a.

FRITSCH, A. & SCHLOENBACH, U. 1872. Cephalopoden der böhmischen Kreide. 52 pp., 16 pls., Prag.

FUKADA, A., ISHII, J., ICHIKAWA, T. & SARAKI, M. [深田淳夫, 石井次郎, 市川輝雄, 皿木正夫] 1952. 幾春別川流域の白聖系 [Cretaceous Deposits in the Ikushumbets Valley (in Japanese)] 北海道地質要報 **21** 号 [*Bull. Géol. Assoc. Hokkaido*, No. **21**, p. 1–19, 1 table and 1 map.]

GROSSOUVRE, A. DE 1889. Sur le terrain crétacé dan le Sud-Ouest de basin de Paris. *Bull. Soc. Géol. France*, [3], **17** (1888–89), p. 475–525, pls. xi, xii.

——— 1894. Recherches sur la Craie Supérieure. Deuxième Partie. Paléontologie. Les Ammonites de la Craie Supérieure. *Mém. Carte Géol. Dét. France* (1893), 264 pp., 39 pls.

HASS, O. 1949. Acanthoceratid Ammonoidea from near Greybull, Wyoming. *Bull. Amer. Mus. Nat. Hist.*, **93**, Art. 1, 40 pp., 15 pls.

——— 1951. Supplementary Notes on the Ammonoid Genus *Dunveganoceras*. *Amer. Mus. Novitates*, No. **1490**, p. 1–21.

HAYASAKA, I. & FUKADA, A. 1951. On the ontogeny of *Barroisiceras minimum* YABE from the Upper Ammonite Bed, Hokkaido. *Jour. Fac. Sci., Hokkaido Univ.*, [4], **7**, p. 324–333, pls. i–ii.

HYATT, A. 1900. Cephalopoda *in* ZITTEL-EASTMAN, Textbook of Palaeontology, 2nd ed., Vol. I, p. 502–592, London.

——— 1903. Pseudoceratites of the Cretaceous. *Mon. U. S. Géol-Surv.*, **44**, 351 pp., 47 pls.

JIMBO, K. 1894. Beiträge zur Kenntniss der Fauna der Kreideformation von Hokkaido. *Palaeont. Abhandl. N. F.* **2** [**6**], p. 149–194 [1–48], pls. xvii–xxx [i–ix].

JONES, T. S. 1938. Geology of Sierra de la Pena and paleontology of the Indiana formation, Coahuila, Mexico. *Bull. Geol. Soc. Amer.*, **48**, p. 69–150, pls. 1–13.

JUKES-BROWNE, A. J. 1896. Critical Remarks on some of the Fossils, *in* JUKES-BROWNE, A. J. & HILL, W. 1896: A Delimitation of the Cenomanian, being a Comparison of the Corresponding Beds in S. W. England and W. France. *Quart. Jour. Geol. Soc. London*, **52**, p. 99–178 (especially p. 142–158), pl. v.

KAWADA, M. 1929. On Some New Species of Ammonites from the Naibuchi District, South Saghalien. *Jour. Geol. Soc. Tokyo* [*Japan*], **36**, (English pages) 1–6, pl. xiv.

KOSSMAT, F. 1897. Untersuchungen über die südindische Kreideformation. Zweiter Theil. *Beitr. Pal Géol. Öst., Ung. Or.*, **11**, p. 1–46 (108–153), pls. i–viii (xii–xix).

LAUBE, C. C. & BRUDER, G. 1887. Ammoniten der böhmischen Kreide. *Palaeontographica*, **33**, p. 217–239, pls. xxiii–xxix.

MANTELL, G. 1822. Fossils of the South Downs, 320 pp., 43 pls. London.

MATSUMOTO, T. [MATUMOTO] 1942-1943. Fundamentals in the Cretaceous Stratigraphy of Japan. Part I. *Mem. Fac. Sci., Kyushu Imp. Univ.*, [D], **1**, p. 129-280, pls. v-xx (1942); Parts II & III. *Ibid.*, **2**, p. 97-237 (1943).

——— 1955. Evolution of Peroniceratidae. *Trans. Proc. Palaeont. Soc. Japan, N. S.*, **18**, p. 37-44.

MATSUMOTO, T. [Editor] 1954. The Cretaceous System in the Japanese Islands. xiv+314 pp., 36 pls., Tokyo.

MATSUMOTO, T. & HASHIMOTO, W. 1953. A Find of *Pseudaspidoceras* from Hokkaido, Japan. *Trans. Proc. Palaeont. Soc. Japan, N. S.*, **12**, p. 97-102, pl. 10.

MEEK, F. B. 1876. *in* MEEK, F. B. & HAYDEN, F. V., A Report on the Invertebrate Cretaceous and Tertiary Fossils of the Upper Missouri Country. *U. S. Geol. Surv. Territ.*, **9**, 8 xix+629 pp., pls. i-xlv.

NAGAO, T., SAITO, R., & MATSUMOTO, T. [長尾巧, 斉藤林次, 松本達郎] 1938. 北海道幾春別川筋白聖系の層序の予察 [A Preliminary Note on the Cretaceous Succession along the Ikushumbets Valley, Hokkaido (in Japanese). *Jour. Geol. Soc. Japan*, **45**, p. 257-263.

NEUMAYR, M. 1875. Die Ammoniten der Kreide und die Systematik der Ammonitiden. *Zeitschr. deutsch. Geol. Gesell.*, **27**, p. 854-892.

ORBIGNY, A. D'. 1840-42. Paléontologie Francaise, Terrains Crétacés, 662 pp., 148 pls. (p. 1-120, 1840; p. 121-430, 1841; p. 431-662, 1842), Paris.

PERVINQUIÈRE, L. 1907. Etudes de Paléontologie Tunisienne, I. Céphalopodes des Terrains Sécondaires. *Carte Géol. Tunise*, 428 pp., 27 pls.

ROMAN, F. & MAZERAN, P. 1920. Monographie paléontologique de la faune du Turonien du Bassin d'Uchaux et de ses dependences. *Arch. Musée hist. nat. Lyon*, **12**, p. 1-137, pls. i-xi.

REYMENT, R. A. 1955. The Cretaceous Ammonoidea of Southern Nigeria and the Southern Cameroons. *Bull. Géol. Surv. Nigeria*, **25**, 112 pp., 25 pls.

——— 1956. On the Stratigraphy and Palaeontology of Nigeria and the Cameroons, British West Africa. *Géol. Förening. Stockholm Förhandl.* **78**, p. 17-96.

SHARPE, D. 1853-57. Description of the Fossil Remains of Mollusca found in the Chalk of England. *Palaeontogr. Soc.*, 68 pp., 27 pls. (1-26, pls. i-x, 1853; 27-36, pls. xi-xvi, 1855; 37-68, pls. xvii-xxvii, 1857).

SHIMIZU, S. 1932. On a new type of Senonian Ammonites, *Pseudobarroisiceras nanaoi* SHIMIZU gen. et sp. nov., from Teshio Province, Hokkaido. *Japan. Jour. Geol. & Geogr.*, **10**, p. 1-4, pl. i.

SOWERBY, J. 1812-1823. The Mineral Conchology of Great Britain. Vols. I-IV (pars), pls. i-ccclxxxiii. London.

SOWERBY, J. DE C. 1823-1846. The Mineral Conchology of Great Britain. Vols. IV (pars)-VII, pls. ccclxxxiv-dcxlviii. London.

SPATH, L. F. 1923. On the Ammonite Horizons of the Gault and Contiguous Deposits. *Summ. Progr. Geol. Surv.* (1922), p. 139-149.

——— 1952 a. Senonian Ammonoidea from Jamaica. *Geol. Mag.*, **62**, p. 28-32, pl. i.

——— 1925 b. On Upper Albian Ammonites from Portuguese East Africa. With an Appendix on Upper Cretaceous Ammonites from Maputoland. *Ann. Transvaal Mus.*, **11**, pt. 3, p. 179-200, pls. xxviii-xxxvii.

——— 1926 a. On New Ammonites from the English Chalk. *Geol. Mag.*, **63**, p, 77-83.

——— 1926 b. On the Zones of the Cenomanian and the Uppermost Albian. *Proc. Geol. Assoc.*, p. 402-432.

——— 1927. Revision of the Jurassic cephalopod fauna of Kachh (Cutch) *Mem. Geol. Surv. India (Pal. Indica), N. S.*, **9**, mem. no. 2, part 1, 84 pp., 7 pls.

——— 1932. A Monograph of the Ammonoidea of the Gault, Part IX, *Palaeontogr. Soc.* (1930), p. 379-410, pls. xxxvii-xlii.

——— 1937 a. The Nomenclature of Some Lower Chalk Ammonites. *Geol. Mag.*, **74**, p. 277-281.

——— 1937 b. A Monograph of the Ammonoidea of the Gault, Part XII, *Palaeontogr. Soc.* (1936), 497–540, pl. lvii-lviii.

STEPHENSON, L. W. 1952. Larger Invertebrate Fossils of the Woodbine Formation (Cenomanian) of Texas. *U. S. Geol. Surv. Prof. Paper*, **242**, 226 pp. 59 pls.

STOLICZKA, F. 1863-65. Ammonitidae, with revision of the Nautilidae, & c. *in* BLANFORD & STOLICZKA (1861–65). The Fossil Cephalopoda of the Cretaceous Rocks of Southern India. *Mem. Geol. Surv. India* (*Pal. Indica*), 216 pp., 94 pls.

TOKUNAGA, S. & SHIMIZU, S. 1926. The Cretaceous formation of Futaba in Iwaki and its Fossils. *Jour. Fac. Sci., Imp. Univ. Tokyo*, [2], **1** pt. 6, p. 181–212, pls. xxvi–xxvii.

UHLIG, V. 1907. Die Cephalopodenfauna der Wernsdorfer Schichten. *Denkschr. K. Akad, Wiss., Wien., Math.-Nat. Kl.*, **46**, p. 127–290, pls. i–xxxii.

VENZO, S. 1936. Cefalopodi del Cretaceo medio-superiore dello Zululand. *Pal. Ital.*, **36**, p. 59–133, pls. v–xii.

YABE, H. 1902. Notes on three Upper Cretaceous Ammonites from Japan, outside of Hokkaido. *Jour. Geol. Soc. Tokyo*, **9**, (English pages) 1–7, pl. i.

——— 1909. Zur Stratigraphie und Paläontologie der oberen Kreide von Hokkaido und Sachalin. *Zeitschr. deutch. Geol. Gesell.*, **61**, p. 402–444.

——— 1927. Cretaceous Stratigraphy of the Japanese Islands. *Sci. Rep. Tohoku Imp. Univ.*, [2], **11**, p. 21–100, pls. iii–ix.

YABE, H. & SHIMIZU, S. 1925. Japanese Cretaceous Ammonites belonging to Prionotropidae. I. *Sci. Rep. Tohoku Imp. Univ.*, [2], **7**, p, 125–138, pls. xxx–xxxiii.

WARREN, P. S. & STELCK, C. R. 1940. Cenomanian and Turonian faunas in the Pouce Coupe district, Alberta and British Columbia. *Trans. Roy. Soc. Canada*, [3], **34**, sect. 4, p. 143–152, pls. i–iv.

WRIGHT, C. W. 1952. A Classification of the Cretaceous Ammonites. *Jour. Paleont.*, **26**, p. 213–222.

WRIGHT, C. W. & MATSUMOTO, T. 1954. Some Doubtful Cretaceous Ammonite Genera from Japan and Saghalien. *Mem. Fac. Sci., Kyushu Univ.*, [D], **4**, No. 2, p. 107–134, pls. 7–8.

WRIGHT, C. W. & WRIGHT, E. V. 1951. A Survey of the Fossil Cephalopoda of the Chalk of Great Britain. Primarily a nomenclatorial revision of Daniel SHARPE's "Description of the Fossil Remains of Mollusca found in the Chalk of England, Part I. Cephalopoda" (1853–1857). *Palaeontogr. Soc.* (1950), 40 pp.

——— & ——— 1953. Some recent acquisitions. *Exhibits at the Annual Reunion of Geol. Assoc. London* (unpublished).

T. MATSUMOTO
R. SAITO & A. FUKADA

Some Acanthoceratids from Hokkaido

Plates

Plate 1

Fig. 1. *Calycoceras asiaticum* (JIMBO) . . . . . Page 11
Lateral (a), ventral (b) and frontal (c) views, ×1/2. Holotype, GT. I-105 [=MM 7512], close to the coal mines of Ikushumbets at a gorge on the main stream of the Ikushumbets, *Trigonia* Sandstone [=Mikasa formation] on the western wing of the anticline (K. JIMBO Coll.). [=K. JIMBO, 1894, pl. iv, fig. 1]

Fig. 2. *Calycoceras* aff. *orientale* sp. nov. . . . . Page 24
Lateral view, ×1/2, of a form somewhat transitional to *Romaniceras pseudodeverianum* (JIMBO). GT. I-3178, loc. T 890, bed II d (γ), in the Shibunnai, a tributary of the Abeshinai, Teshio Province, Hokkaido (T. M. Coll.).

Fig. 3 *Romaniceras* sp. indet. . . . . Page 22
Lateral view of a fragmentary outer whorl, that shows *Calycoceras* like ribbing, ×1/2. GT. I-3179, loc. T 892, bed II d (γ), in the Shibunnai, a tributary of the Abeshinai, Teshio Province, Hokkaido (T. M. Coll.).

All the figures are reduced to a half in linear dimension.

Photos by UEKI.

1a

1b

2

1c

3

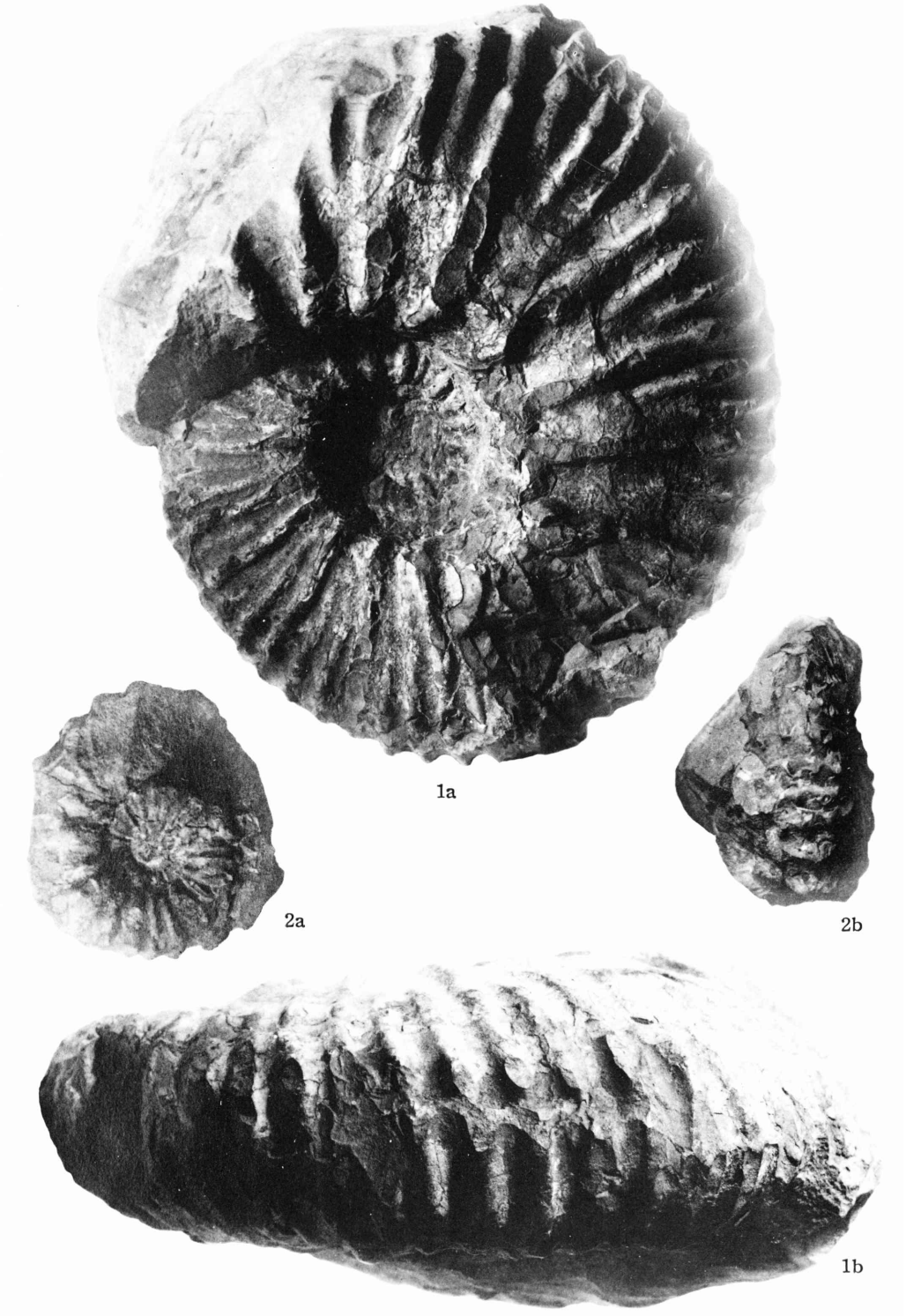
T. Matsumoto *et al.*: Acanthoceratids from Hokkaido

Plate 2

Fig. 1. *Calycoceras asiaticum* (JIMBO) . . . . . Page 11
Lateral (a) and ventral (b) views of a large specimen, ×1/2. GT. I-3175 from Teshio Province, Hokkaido (no further record of collection).

Fig. 2. *Romaniceras* (?) *otatumei* sp. nov. . . . . Page 25
Lateral (a) and ventral (b) views, natural size. GT. I-3185 from Nutappomai, Kami-hobets, Iburi Province, Hokkaido (K. OTATUME Coll.).

Photos by C. UEKI.

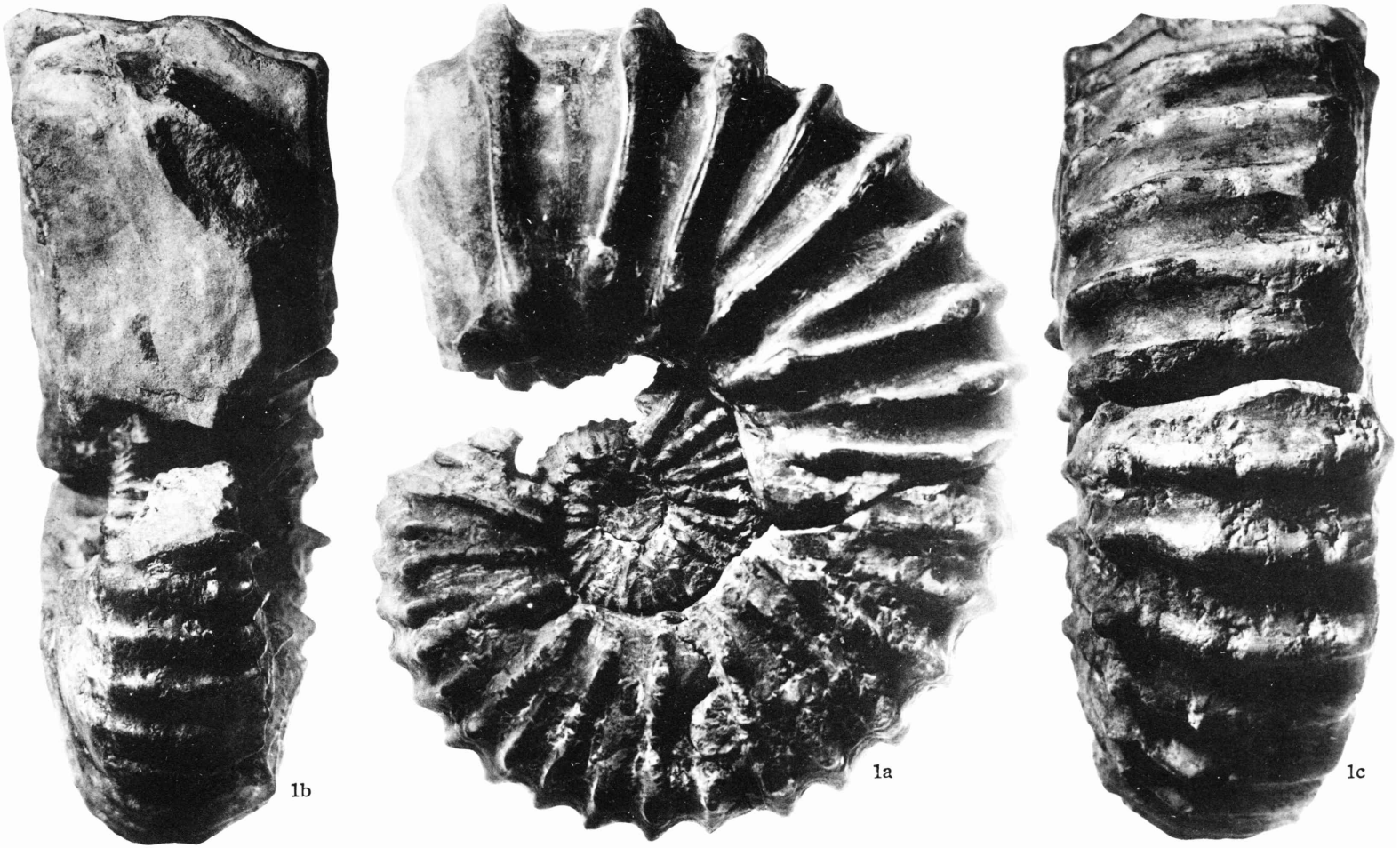


T. MATSUMOTO *et al.*: Acanthoceratids from Hokkaido

Plate 3

Fig. 1. *Calycoceras spinosum* (KOSSMAT) . . . . . Page 13
Lateral (a), apertural (b) and ventral (c) views of a full-grown example, ×1/2. GH. No. 12436, Nionosawa, the Saku area, Teshio Province, Hokkaido (S. SATO Coll.).

Photos by C. UEKI.



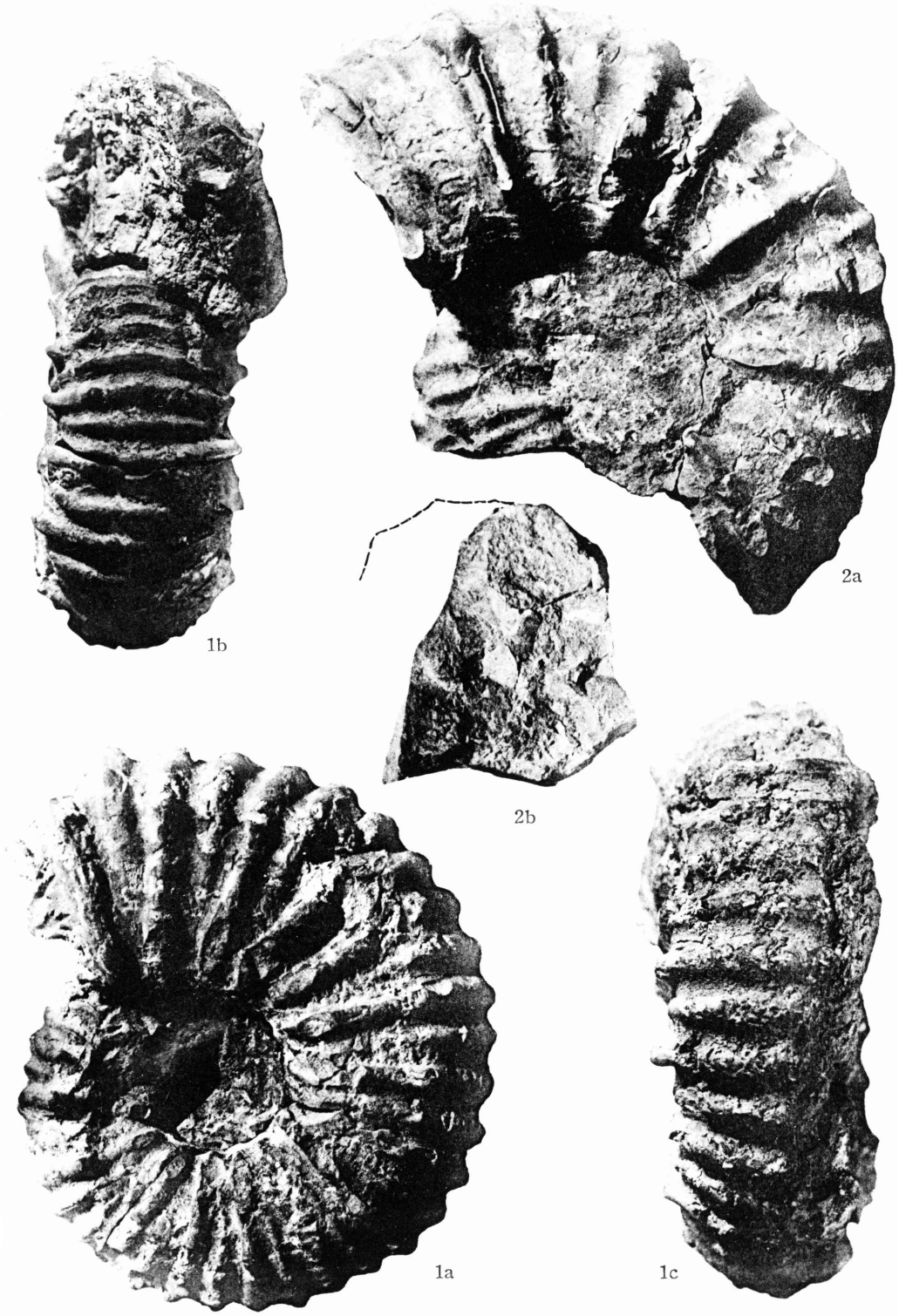
T. MATSUMOTO *et al.*: Acanthoceratids from Hokkaido

Plate 4

Figs. 1, 2. *Calycoceras spinosum* (KOSSMAT). . . . . Page 13

1. Lateral (a), frontal (b) and ventral (c) views of the inner whorl ×1. GH. No. 12436, the same individual as illustrated in pl. 3, fig. 1, Nionosawa, the Saku area, Teshio Province, Hokkaido (S. SATO. Coll.).
2. Lateral view (a) and an imperfect whorl section (b), ×2/3. GT. I-3167, loc. T 26, bed II b, the Abeshinai valley, Teshio Province, Hokkaido (T. M. Coll.).

Photos by C. UEKI.

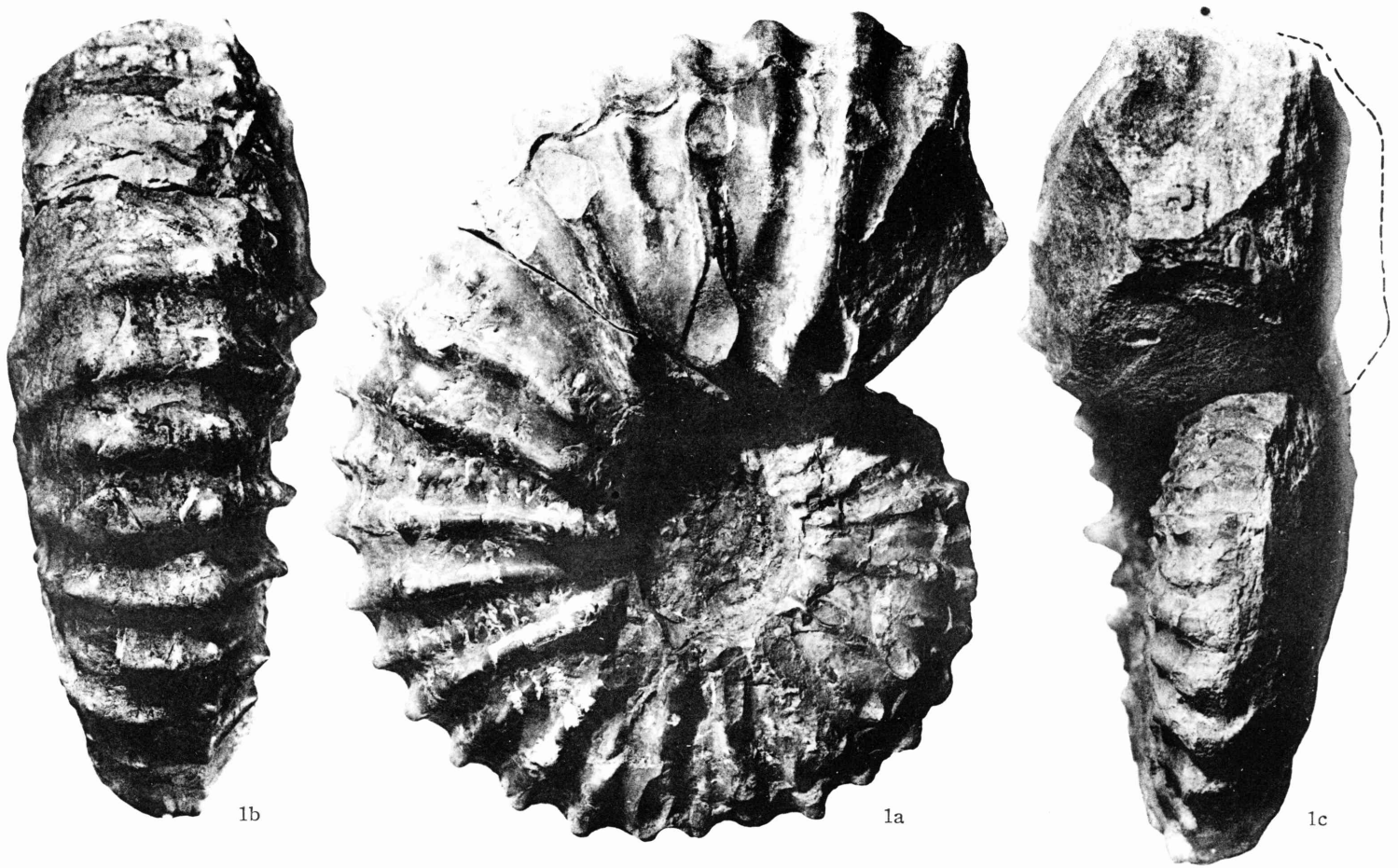


T. Matsumoto *et al.*: Acanthoceratids from Hokkaido

Plate 5

Fig. 1. *Calycoceras orientale* sp. nov. . . . . Page 16
Lateral (a), ventral (b) and frontal (c) views, ×2/3. Holotype, GT. I-3168, loc. T 711 b, bed II b (upper part), Nionosawa, the Saku area, Teshio Province, Hokkaido. (T. M. Coll.).

Photos by C. UEKI.



T. MATSUMOTO *et al.*: Acanthoceratids from Hokkaido

Plate 6

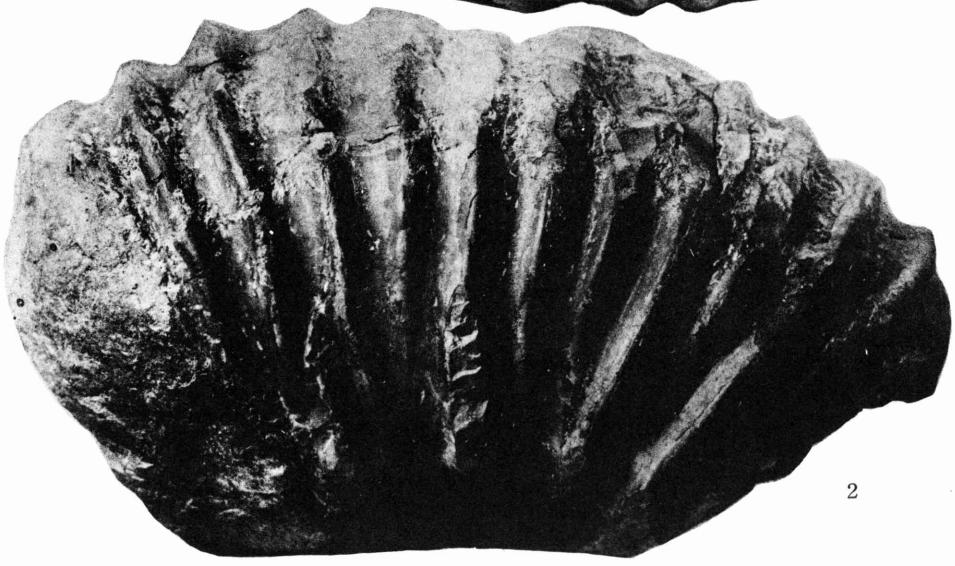
Fig. 1. *Calycoceras* cf. *stoliczkai* COLLIGNON . . . . . Page 19
Lateral (a) and ventral (b) views, ×3/5. GK. H 1523, loc. Y 143 d, bed II j, the Shiyubari valley, Ishikari Province, Hokkaido (T. M. Coll.).

Fig. 2. *Calycoceras* sp. indet *α* . . . . . Page 20
Lateral view of a fragmentary whorl, ×2/3. GK. H 1522, loc. Y 510, bed II k, the Shiyubari valley, Ishikari Province, Hokkaido (T. M. Coll.).

Photos by T. MATSUMOTO & I. OBATA.

1a

1b



2

T. MATSUMOTO *et al.*: Acanthoceratids from Hokkaido

Plate 7

Fig. 1. *Calycoceras orientale* sp. nov. . . . . Page 16
Lateral view of a fragmentary outer whorl, ×2/3. GK. H 1520, loc. Y 232 p, II j or possibly II k, the Shiyubari valley, Ishikari Province, Hokkaido (T. M. Coll.).

Fig. 2. *Calycoceras* sp. nov. (?) . . . . . Page 17
Lateral view, slightly reduced. GH. 12009, Kitanosawa, a tributary of the Abeshinai, Teshio Province, Hokkaido (R. S. Coll.).

Photos by S. KUMANO (2) and T. M. (1).

1

2

T. MATSUMOTO *et al.*: Acanthoceratids from Hokkaido

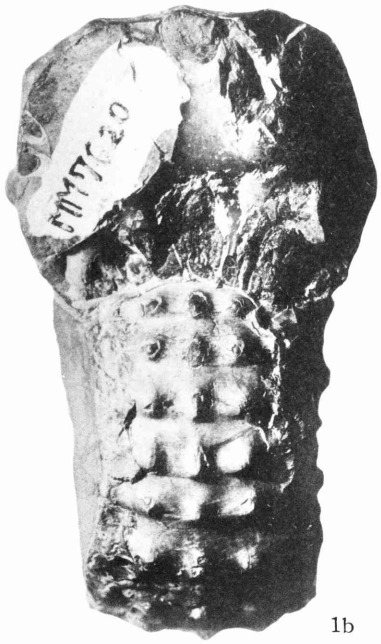
Plate 8

Fig. 1. *Yubariceras yubarense* (*ex* YABE MS.) sp. nov. . . . . Page 27
Lateral (a) and frontal (b) views of a shell of the middle growth-stage, ×1. Holotype, GT. I-343 [=MM 7620], a pebble of the Pankemoyuparo near the mouth of the Kaneobets, the Oyubari area, Ishikari Province, Hokkaido (H. YABE Coll.).

Fig. 2. *Yubariceras* [*Romaniceras*?] *japonicum* (*ex* YABE MS.) sp. nov. . . . . Page 31
Lateral view, ×1. Holotype, GT. I-345 [=MM 7622], a pebble of the Yubari, Ishikari Province, Hokkaido (H. YABE Coll.).

Fig. 3. *Romaniceras pseudodeverianum* (JIMBO) . . . . . Page 22
Lateral view, ×2/5. Holotype, GT. I-106 [=MM 7516], a pebble of the Opirashibets, Teshio Province, Hokkaido (K. JIMBO Coll.) [=JIMBO, 1894, pl. v, fig. 1].

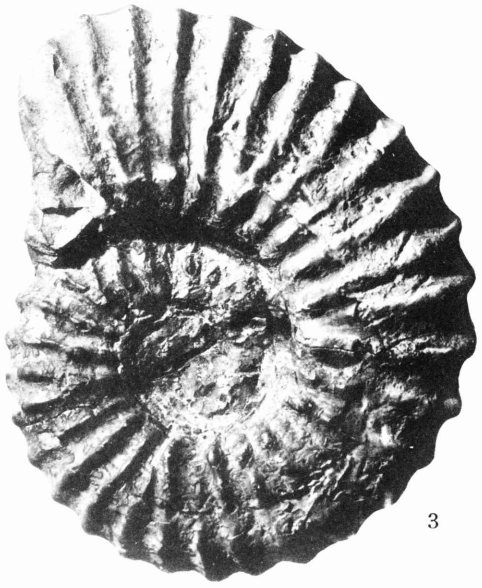
Photos by C. UEKI.



1b

1a

2



3

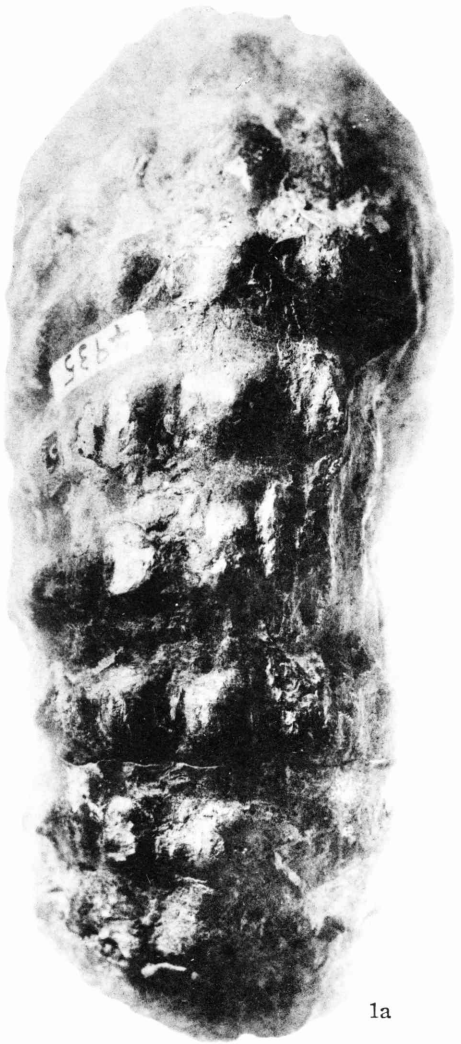
Plate 9

Figs. 1, 2. *Romaniceras* aff. *uchauxiense* COLLIGNON . . . . . Page 24

1. Ventral (a) and lateral (b) views and a whorl-section (c), ×1. GH. No. 4935, loc. 19, Bannosawa, the Pankemoyuparo, Ishikari Province, Hokkaido (K. OTATUME Coll.).

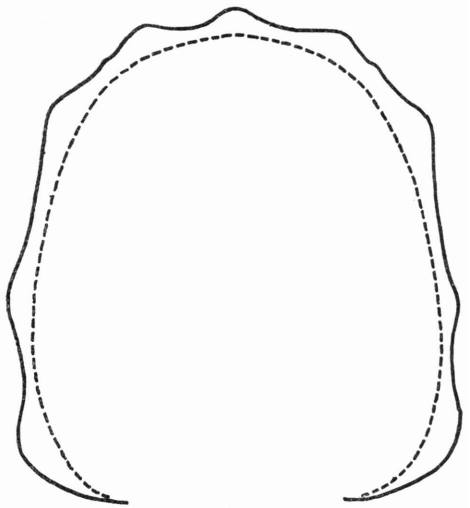
2. Whorl-section, ×1. GT. I-344, Popets [Hobetsu], Iburi Province, Hokkaido (H. YABE Coll.) (see pl. 14, fig. 1 a, b; pl. 15, fig. 2).

Photos by C. UEKI; T. M. *del.*

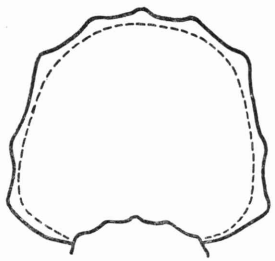


1a

1b



1c



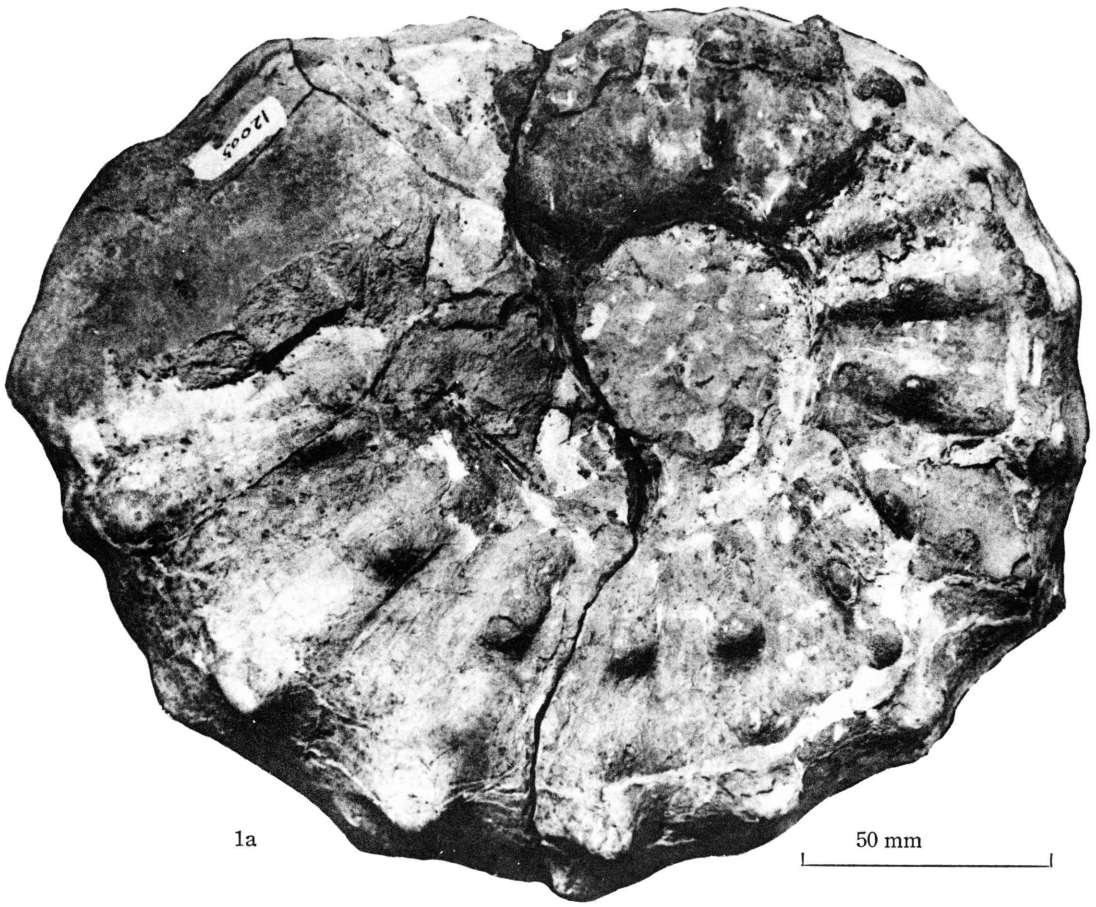
2

T. MATSUMOTO *et al.*: Acanthoceratids from Hokkaido

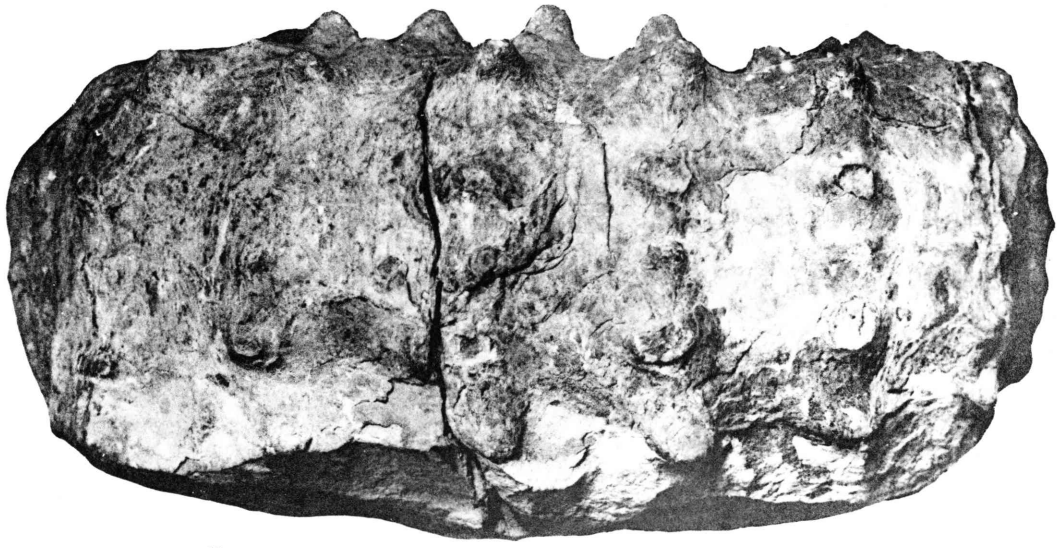
Plate 10

Fig. 1. *Yubariceras yubarense* (*ex* YABE MS.) sp. nov. . . . . Page 27
Lateral (a) and ventral (b) views, Ca ×3/5. Paratype, GH. No. 12005, Uesugi-zawa, Nakahobets, Yufutsu-gun, Iburi Province (K. OTATUME Coll.).

Photos by S. KUMANO.



1a



1b

T. MATSUMOTO *et al.*: Acanthoceratids from Hokkaido

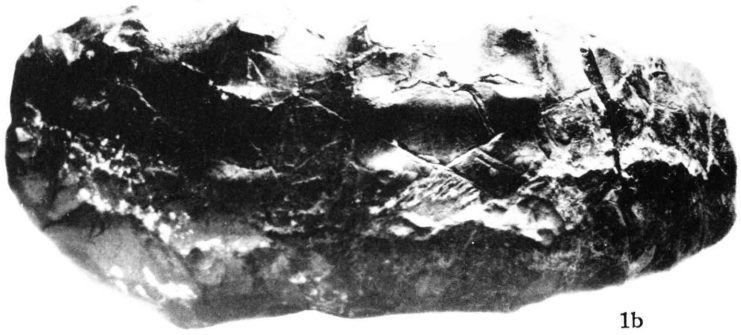
Plate 11

Fig. 1. *Yubariceras yubarense* (*ex* YABE MS.) sp. nov. . . . . Page 27
Lateral (a) and ventral (b) views. ×3/5. Paratype, GK. H 1531, loc. Y 462, bed II q-r, zone of *Inoceramus hobetsensis*, the Shiyubari valley, Ishikari Province, Hokkaido (T. M. Coll.).

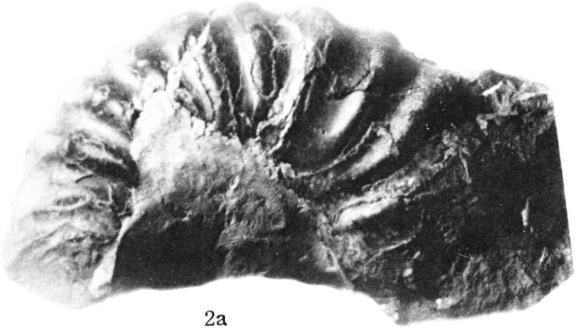
Fig. 2. *Eucalycoceras* sp. indet . . . . . Page 38
Lateral (a) and ventral (b) views, ×1. GH. No. 12434, Middle member of the Mikasa formation in the Ikushumbets valley on the eastern wing of an anticline (R. S. Coll.).

Photos by C. UEKI (2) and T. M. (1).

1a



1b



2a

2b

T. MATSUMOTO *et al.*: Acanthoceratids from Hokkaido

Plate 12

Fig. 1. *Mantelliceras* (?) *nagaoi* sp. nov. . . . . Page 6
Lateral view, much reduced (Ca ×0.45). Holotype, GH. No. 12007, upper valley of the Abeshinai, MORITA's 'Shibunnai-toge group,' Teshio Province, Hokkaido (Coll. Y. MORITA) (see pl. 13, fig. 2).

Photo by S. KUMANO.

1

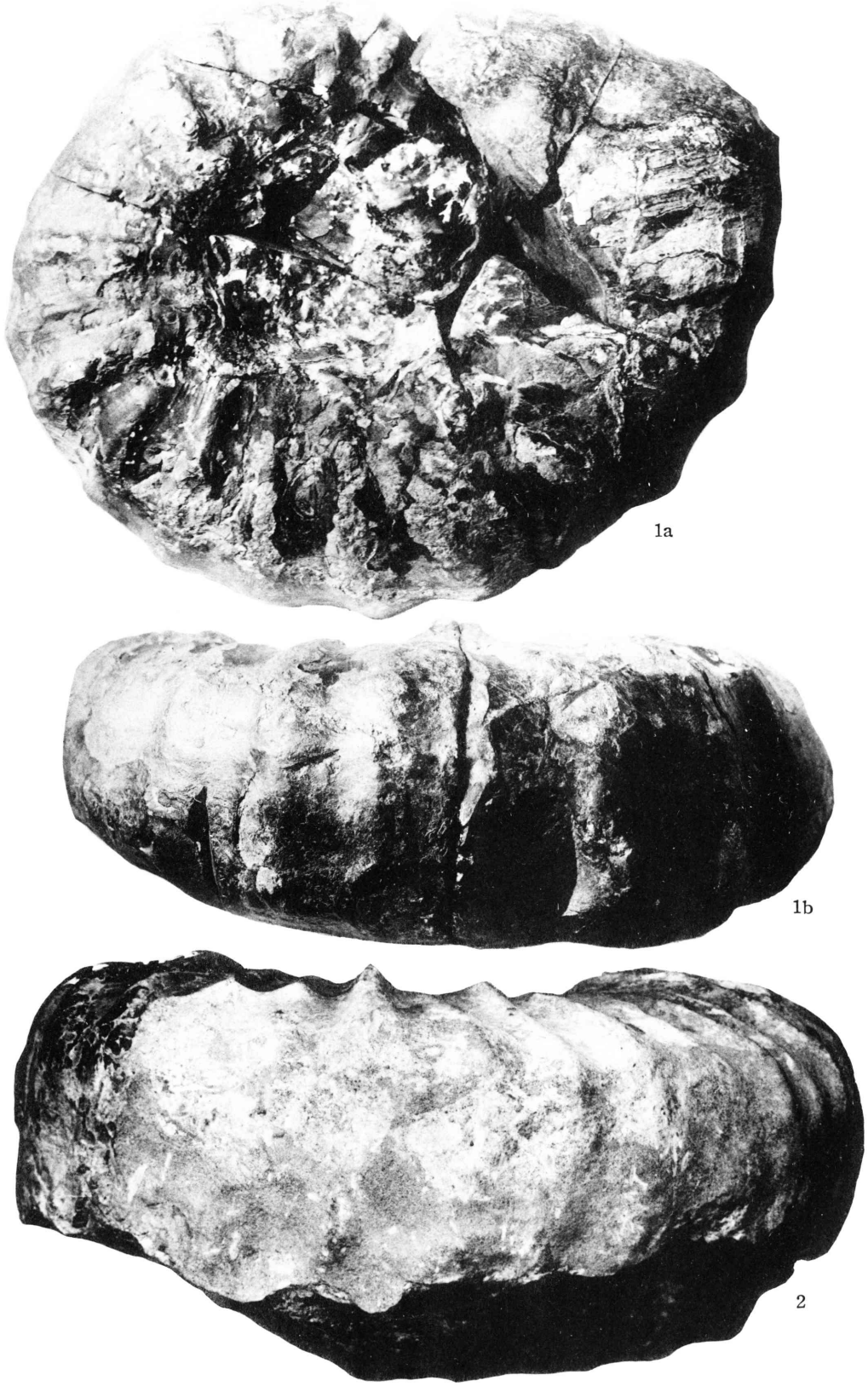
T. MATSUMOTO *et al.*: Acanthoceratids from Hokkaido

Plate 13

Fig. 1. *Yubariceras yubarense* (*ex* YABE MS.) sp. nov. . . . . Page 27
Lateral (a) and ventral (b) views, ×2/3. Paratype, GK. H 1532, loc. Y 469, bed II r or II s, Saku formation, the Shiyubari valley. Ishikari Province (T. M. Coll.).

Fig. 2. *Mantelliceras* (?) *nagaoi* sp. nov. . . . . Page 6
Ventral view, much reduced (×0.45). Holotype, GH. No. 12007, upper valley of the Abeshinai, MORITA's 'Shibunnai-toge group', Teshio Province, Hokkaido (Coll. Y. MORITA) (see pl. 12, fig. 1).

Photos by S. KUMANO (2) and T. M. & I. OBATA (1).



T. MATSUMOTO *et al.*: Acanthoceratids from Hokkaido

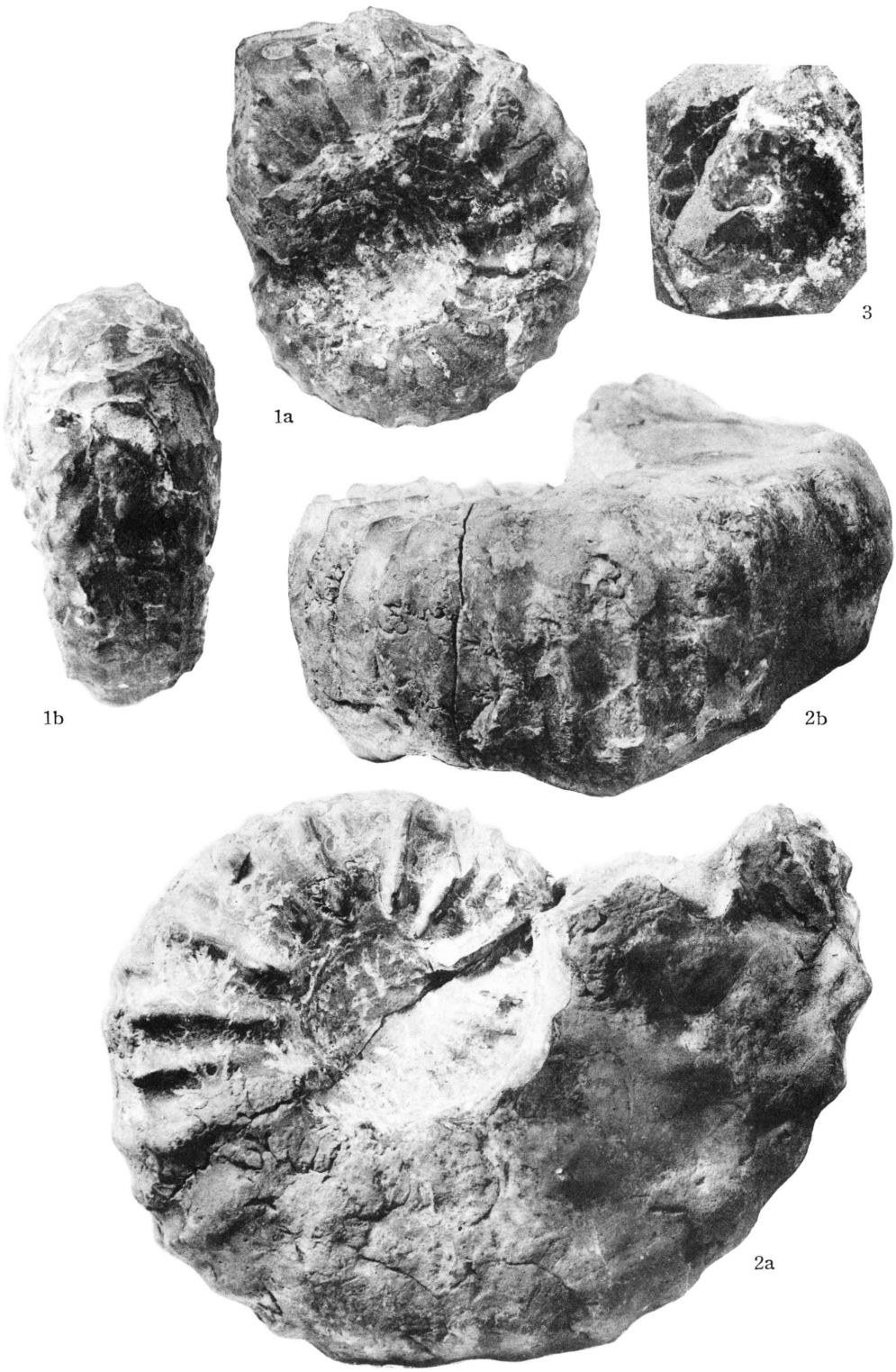
Plate 14

Fig. 1. *Romaniceras* aff. *uchauxiense* COLLIGNON . . . . . Page 24
Lateral (a) and ventral (b) views, ×1. GT. I-344, Popets [Hobetsu], Iburi Province, Hokkaido (H. YABE Coll.) (see pl. 15, fig. 2).

Fig. 2. *Acanthoceras* aff. *evolutum* SPATH . . . . . Page 33
Lateral (a) and ventral (b) views, ×2/3. GT. I-3165, loc. T 25 p, the Abeshinai area, Teshio Province, Hokkaido (T. M. Coll.).

Fig. 3. *Protacanthoceras* sp. nov. (?). . . . . Page 39
Lateral view, ×1.5. GH. No. 7874 from the *Trigonia* Sandstone at Katsurazawa, the Ikushumbets valley (NEMOTO Coll.).

Photos by T. MATSUMOTO & I. OBATA.



T. Matsumoto *et al.*: Acanthoceratids from Hokkaido

Plate 15

Fig. 1. *Yubariceras yubarense* (*ex* YABE MS.) sp. nov. . . . . Page 27
Lateral view of the inner whorl, ×2/3. Paratype, GK. H 1532, loc. Y 469, bed II r or II s, Saku formation, the Shiyubari valley, Ishikari Province (T. M. Coll.) (see pl. 13, fig. 1).

Fig. 2. *Romaniceras* aff. *uchauxiense* COLLIGNON . . . . . Page 24
Apertural view, ×1. GT. I-344, Popets [Hobetsu], Iburi Province, Hokkaido (H. YABE Coll.) (see pl. 14, fig. 1 a, b).

Fig. 3. *Euomphaloceras* cf. *euomphalum* (SHARPE) . . . . . Page 34
Lateral view, ×1. GT. I-3186, loc. T 621, bed II b, the Chirashinai, a tributary of the Teshio in the Saku-Abeshinai area, Teshio Province, Hokkaido (T. M. Coll.).

Photos by T. MATSUMOTO & I. OBATA.

1

2

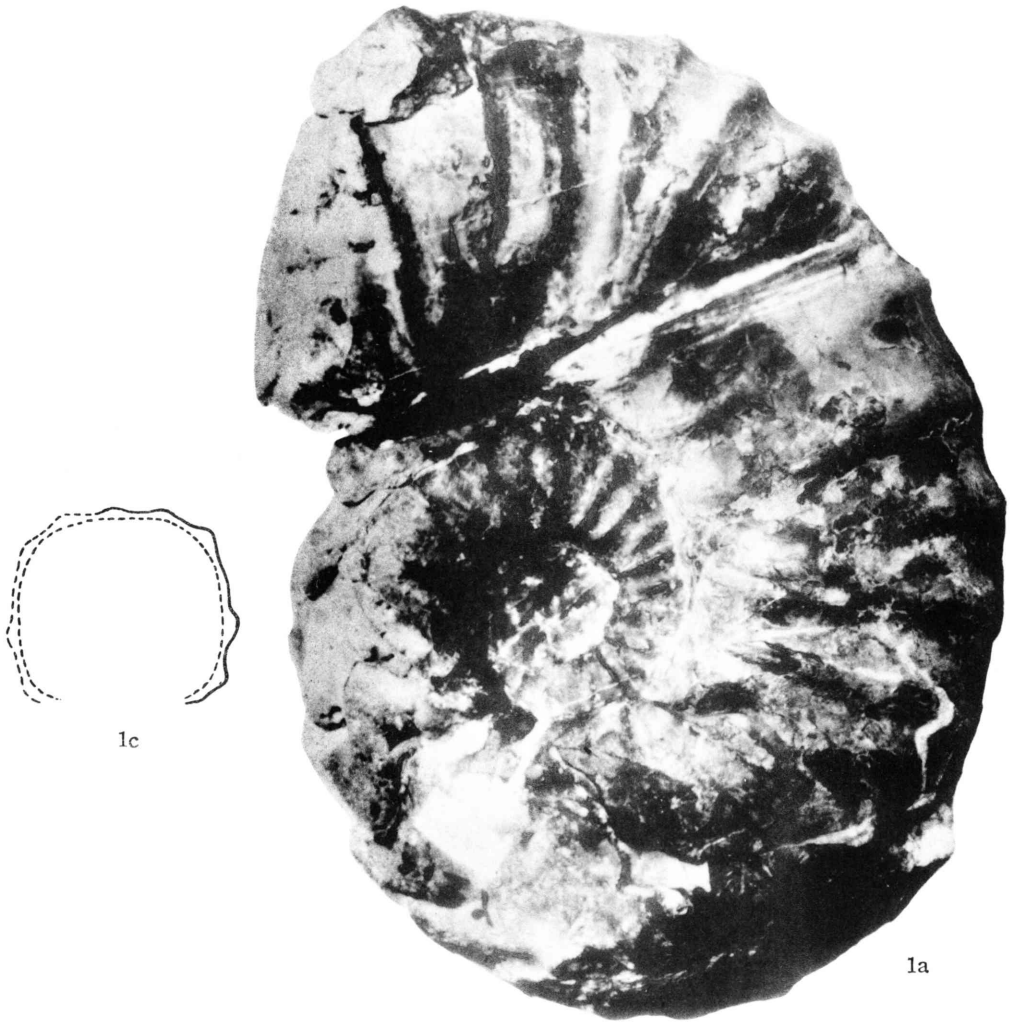
3

T. MATSUMOTO *et al.*: Acanthoceratids from Hokkaido

Plate 16

Fig. 1. *Yubariceras* n. sp. (?) aff. *Y.* (?) *adkinsi* (JONES). . . . . Page 29
Lateral (a) and ventral (b) views, ×3/5; whorl section (c), ×1. GK. H 1533, loc. Y 216 p, Saku formation, the Shiyubari valley, Ishikari Province, Hokkaido (T. M. Coll).

Photos by T. M.



1c

1a

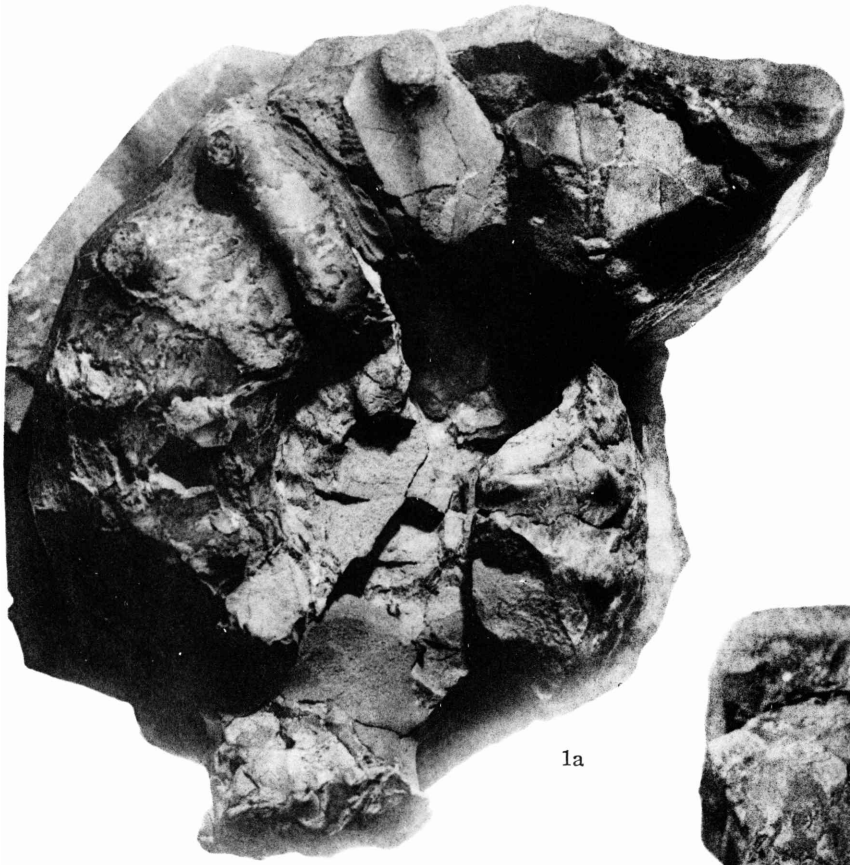
1b

T. Matsumoto *et al.*: Acanthoceratids from Hokkaido

Plate 17

Fig. 1. *Euomphaloceras* [*Acanthoceras*?] sp. indet. . . . . Page 35
Lateral (a), ventral (b) and frontal (c) views, ×1. GH. No. 12439, loc. Oy 58, the Hakkin-zawa, a tributary of the Yubari, the Oyubari area, Ishikari Province, Hokkaido (S. NAGAO & A. OSANAI Coll.).

Photos by C. UEKI.



1a

1b

1c

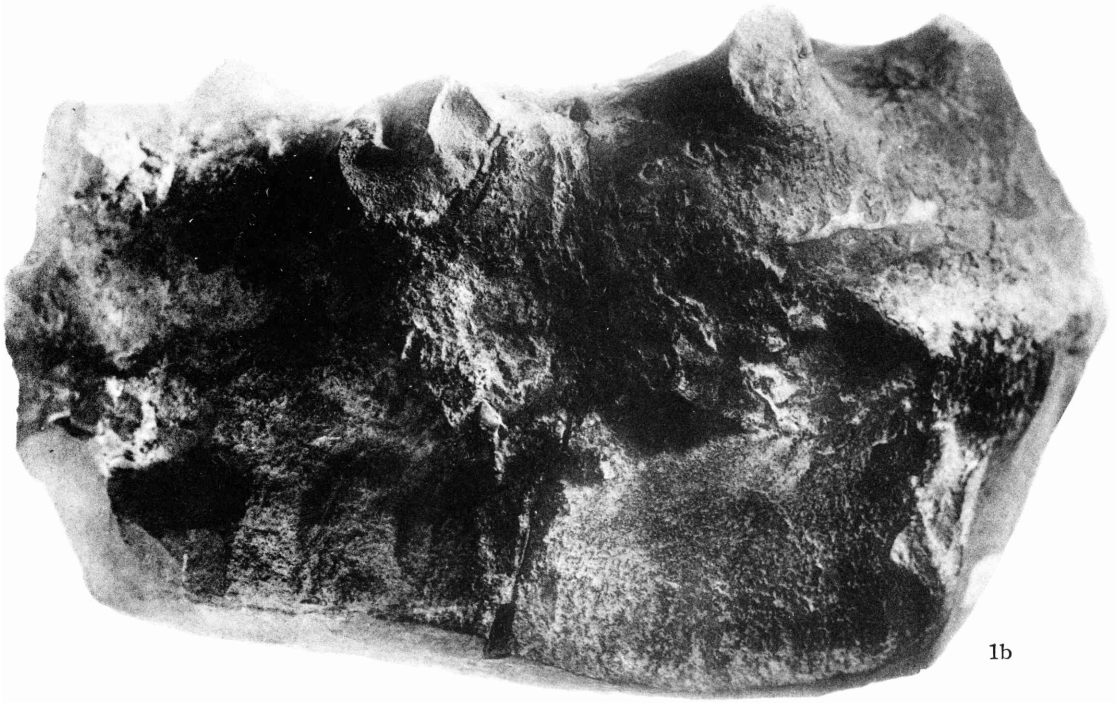
T. MATSUMOTO *et al.*: Acanthoceratids from Hokkaido

Plate 18

Fig. 1. *Euomphaloceras* [*Acanthoceras*?] sp. indet.. . . . . Page 35
Lateral (a) and ventral (b) views, ×1. GH. No. 12438, loc. Oy 58, the Hakkin-zawa, a tributary of the Yubari, the Oyubari area, Ishikari Province, Hokkaido (S. NAGAO & A. OSANAI Coll.).

Photos by C. UEKI.

1a



1b

T. MATSUMOTO *et al.*: Acanthoceratids from Hokkaido