Some Heteromorph Ammonites from the Cretaceous of Hokkaido : Studies of the Cretaceous Ammonites from Hokkaido and Saghalien-XXXI

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https://doi.org/10.5109/1544178

出版情報：九州大學理學部紀要 : Series D, Geology. 23 (3), pp.303-366, 1977-02-25. Faculty of Science, Kyushu University
バージョン：
権利関係：

Mem. Fac. Sci., Kyushu Univ., Ser. D. Geol., Vol. XXIII, No. 3,
pp. 303-366, text-figs. 1-12, pls. 43-61, February 25, 1977

Some Heteromorph Ammonites from the Cretaceous of Hokkaido

(Studies of the Cretaceous Ammonites from Hokkaido and Saghalien-XXXI)

Tatsuro MATSUMOTO

Abstract

Selected twenty-one species of heteromorph ammonites from the Upper Cretaceous of Hokkaido are described, in which fourteen new species and six new genera are established. Others are redescribed to improve the previous knowledge. For every species the stratigraphic occurrence is precisely recorded.

The described species are mostly referred to the Nostoceratidae and the Diplomoceratidae. They show greater diversities in shell characters beyond the previous conceptions. Some preliminary remarks are given about the implication of the various aberrant forms. Yet we need more and better material to arrive at a satisfactory and comprehensive conclusion on the natural history of the heteromorph groups.

This paper is dedicated to Mr. Tatsuo MURAMOTO who has much assisted me in providing numerous interesting specimens for study with necessary stratigraphic information.

Introduction

For my forthcoming retirement from the professorship at Kyushu University on April 1, 1977, I was asked to prepare a paper. My work on the Cretaceous ammonites would be endless and I wish to continue it even after my retirement. It seemed me impossible to publish a monumental paper on this occasion. To meet people's requirements, I have decided to dedicate a paper to Mr. Tatsuo MURAMOTO, who has constantly assisted me in the work of Cretaceous ammonites.

Mr. T. MURAMOTO (Fig. 1) living in Mikasa, central Hokkaido, is about 10 years elder than me and I was introduced to him by the late Professor Hisakatsu YABE twenty-two years ago, when I came back from my study in the United Kingdom. His hobby collection at that time was already excellent, but he was so modest that he has been willing to do field work with me to know more deeply the biostratigraphic as well as palaeontological significance of ammonites. As he lives in Hokkaido, he has assisted me in visiting localities at my suggestion even after I came back from the summer field work. Furthermore, Mr. MURAMOTO is marvelously skilful to develop specimens from the matrix of calcareous nodules. Thus in the great collections of Tatsuo MURAMOTO that of heteromorph ammonites is one of the most valuable groups. In fact, he joined

Manuscript received August 21, 1976.

Fig. 1. Mr. Tatsuo MURAMOTO

with me to report two interesting species, *Madagascarites ryu* and *Nipponites bacchus* (MATSUMOTO and MURAMOTO, 1967). This time he does not wish to be a coauthor but kindly let me study freely.

At the instruction of T. MURAMOTO, Mr. Kikuwo MURAMOTO, his eldest son, and Mr. Takemi TAKAHASHI, a friend of K. MURAMOTO, became good collectors of Cretaceous fossils and they have joined with Mr. T. MURAMOTO to provide me more specimens for study.

In this paper I describe selected twenty-one species from the Upper Cretaceous of Hokkaido mainly on the grounds of these valuable collections. Of course relevant specimens of some other collections, including my own one, are also used for the descriptions. Of the twenty-one species, fourteen (i.e. two-thirds) are entirely new and others are likewise important to improve the previous knowledge. They are mostly referred to the Nostoceratidae and partly to the Diplomoceratidae. I do not intend to treat comprehensively the taxonomy of the two families on this occasion, but I should like to show interesting species which have not yet been recorded and redefine previously incompletely known ones. Their stratigraphic occurrences will also be recorded. I hope the descriptions may contribute to enrich and improve our knowledge of the heteromorph ammonites.

The material for the present study consists of the specimens from various areas of Hokkaido, but those from the Saku area, Teshio Mountains (T), the Obira and adjacent areas in the district of Rumoi (R), the Ikushumbetsu [=Ikushumbets] and adjacent areas [Ik], the Oyubari or Shiyubari area, Yubari Mountains [Y], Hobetsu-Hetonai [=Tomiuchi] area [H] and the Urakawa area [U] are the main sources (Fig. 2). For the Cretaceous stratigraphy of these areas readers may refer to a number of reports, e. g. MATSUMOTO, 1942–43; MATSUMOTO, 1965 (especially figs. 1–5); TANAKA, 1963; KANIE, 1966; MATSUMOTO and OKADA, 1973; MATSUMOTO et al. 1977; TANABE et al., 1977 as well as

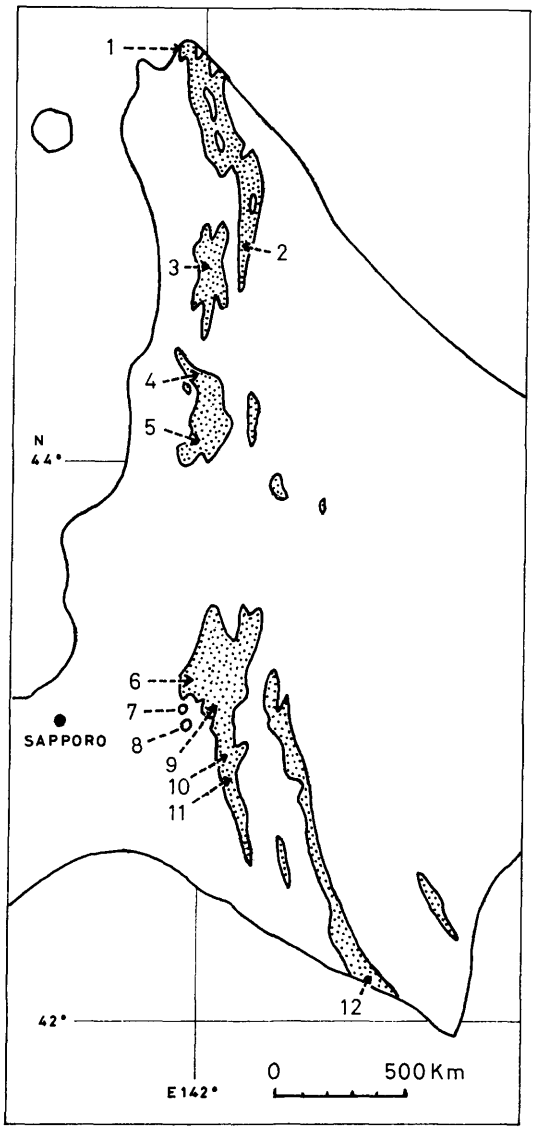


Fig. 2. Map of the main part of Hokkaido, showing post-Neocomian Cretaceous outcrops with dotted areas. The areas where described heteromorph ammonites occurred are 1=Soya, 2=Nakatombetsu, 3=Saku, 4=Haboro-Chikubetsu, 5=Obira, 6=Ikushumbetsu, 7=Manji, 8=Yubari, 9=Oyubari, 10=Hobetsu, 11=Hetonai [Tomiuchi]-Osachinai, 12=Urakawa.

the explanatory texts of the geological maps (scale 1 : 50,000) of the relevant quadrangles.

Mr. T. MURAMOTO donated many of his valuable collections partly to the National Science Museum and partly to the Department of Geology, Kyushu University, although some remain at his own MURAMOTO Museum, Mikasa. The

repositories of the described specimens are indicated by the following symbols (prefix to reg. no.):

GK.=Type-room, Department of Geology, Kyushu University, Fukuoka
HCS.=Geological Survey, Hokkaido Colliery & Steamship Co., Yubari
M.=MURAMOTO Museum, Yayoi, Mikasa
NSM.=National Science Museum, Tokyo
UMUT.=University Museum, University of Tokyo [=GT. previously stored at the Geological Institute, University of Tokyo]
Other museums (e. g. Mikasa City Museum) and private collections are recorded without abbreviation.

Acknowledgements.—In addition to Messrs. Tatsuo MURAMOTO, Kikuwo MURAMOTO and Takemi TAKAHASHI, many kind friends who have helped me in various ways have all incurred my gratitude. Among them, Dr. Suteichi NAGAO, Dr. Jun TESHIMA, Messrs. Hitomaro HONDA, Yasutaka FUJISHIMA, Kokitsu YAGI, Saburo KAWAHATA and Masanobu KIKUCHI kindly showed me some specimens for this study, Drs. Hakuyu OKADA, Hiromichi HIRANO and Kazushige TANABE and Mr. Yuichiro MIYATA did field work with me. Dr. Ikuwo OBATA has helped me in many ways especially for my study at National Science Museum, with fruitful discussions. Messrs. Takashi KOBAYASHI and Takatsugi HOSHINA took photographs of the NSM. specimens and Dr. Hiromichi HIRANO those of GK. specimens. Dr. Itaru HAYAMI and Mr. Takeo ICHIKAWA helped me for the study of UMUT. specimens. Miss Mutsuko HAYASHIDA assisted me in drafting figures and typewriting. For the publication Drs. Kametoshi KANMERA and Tsugio SHUTO have been especially concerned.

This paper is a part of my contribution to the IGCP-project, Mid-Cretaceous Events, which is being performed by the grant in aid of the Ministry of Education (No. 154280).

Systematic Descriptions

Family Nostoceratidae HYATT, 1900

Previously (MATSUMOTO, 1967) I recognized two main stocks in the Nostoceratidae. One is the group represented by *Eubostrychoceras*, which has no tubercles but may have flared ribs, and the other represented by *Hyphantoceras*, which has four or three rows of tubercles on major ribs. The origin of the former is sought in *Turrilitoides* of the Turrilitidae and that of the latter either in earlier species of *Eubostrychoceras* or directly in *Pseudohelicoceras* of the Turrilitidae. I have here no additional evidence to settle the problem of the ancestry.

In the present study I am inclined to consider that *Didymoceras* is probably a descendant of *Hyphantoceras* rather than *Eubostrychoceras*, because there are species which represent transitional features. As *Nostoceras* is evidently the descendant of *Didymoceras*, it follows that Hyphantoceratinae would fall in the synonymy of Nostoceratinae. For the first group a new subfamily name would then be required. However, in some Santonian species of *Hyphantoceras* to be

described below the tuberculated flared ribs occur only in a limited part of the shell. Moreover, *Bostrychoceras polyplocum* (ROEMER), which may be related to *Didymoceras,* has two rows of tubercles only on a limited part of the shell. The fundamental distinction between the two stocks mentioned above could be doubted.

Neocrioceras, Pseudoxybeloceras and then *Solenoceras* are coiled or uncoiled nearly on one plane. If Diplomoceratidae are distinguished from untuberculated subgroup of Nostoceratidae because of its acquirement of bilateral symmetry, these tuberculate genera with bilateral symmetry could be grouped into another family or subfamily, to which Neocrioceratinae SPATH, 1953 would be applied. In this paper I do not give decision about this, since there is still some ambiguity in this subgroup.

To sum up I feel it too early to give a definite conclusion about the classification at subfamily level. In this paper I describe various species from Hokkaido under the comprehensive family Nostoceratidae.

Genus *Hyphantoceras* HYATT, 1900

Type-species.—*Heteroceras reussianum* D'ORBIGNY, 1850

Diagnosis.—The whorls are normally helical and separated for the most part of the septate stages, but almost contiguous in some species. Some irregularity in coiling or uncoiling may occur in the early stage of some species. In the typical case the adult body-chamber forms a retroversal hook (as finely illustrated by SCHLÜTER, 1872, pl. 32, fig. 13). In other cases, however, even the probably adult body-chamber does not show such a remarkable retroversal hook but slightly or somewhat deviates from the main helical coiling, with its apertural margin facing almost sideways and slightly upward. The latter forms are provisionally included in *Hyphantoceras* in this paper.

The whorl is subcircular to oval in section. It is typically ornamented with flared, tuberculate ribs with intercalated fine ribs without tubercles. Typically the flared ribs occur periodically, although the frequency may vary between species or between growth-stages. In certain atypical species the flared ribs do not occur in a certain stage or modified to a scale like ornament without tubercles. The difference in strength between the tuberculate stronger ribs and non tuberculate finer ribs is distinct in the typical species but may not be so remarkable in some species. Constrictions are normally absent, except for the last part, but in some species they may be developed. In some cases the tubercles may be indistinctly impressed on the internal mould, although they are distinct and even spinose on the outer shell layer.

The suture consists of E, L, U and I, being finely and deeply incised. L and the saddles on either sider are bipartite, with expanded branches and a narrow stem. The siphuncle runs at or near the middle of the convex external side, although there may be a slight deviation. Some of the septa in the posterior part could be presumed to have been dissolved at the adult stage, although this may not be reckoned with confidence as an original character.

Distribution.—In Hokkaido fossils of *Hyphatoceras* occur not uncommonly in the sequences from Lower Turonian to Upper Santonian, although they are

often incompletely preserved. The type-species and its allied ones occur in the Turonian and Coniacian (?) of western Europe. I once mentioned briefly probable examples of *Hyphantoceras* from California and Oregon (MATSUMOTO, 1959 b, p. 158) but have not reexamined them recently. COLLIGNON (1965) reported incomplete specimens from the Coniacian of Madagascar. (Examples from the Lower Campanian of Madagascar illustrated by COLLIGNON (1969, p. 29, figs. 2064, 2095) may be *Ainoceras*.) Despite the great amount of collections no example of this genus has been reported from the Western Interior and the Gulf Coast provinces of North America.

Discussion.—At the date of the *Treatise* (WRIGHT, 1957) *Hyphantoceras* included a certain group of "*Bostrychoceras*," which was subsequently turned to *Eubostrychoceras* MATSUMOTO 1967. The latter has constrictions and raised ribs but no tubercles at all.

As will be described below, in some species, e. g. *Hyphantoceras oshimai* (YABE), the probably adult body-chamber does not much deviate from the preceding helical coiling, without showing a significant retroversal hook but only with its last part slightly and obliquely ascending upward. This mode of coiling is indeed "atypical" of *Hyphantoceras* body-chamber, but otherwise the shell shows characteristic features of *Hyphantoceras*. The available evidence is not sufficient to decide whether there is gradual change between species or within a species from this kind of body-chamber to the retroversally hooked one, or whether the difference is constant and represents sexual dimorphism, or even deserves generic distinction. For the time-being this kind of form is included in *Hyphantoceras*. In many cases of the fossils the shell with the adult body-chamber is found rather rarely and the too strict taxonomic discrimination on the body-chamber alone would not be practically useful.

The origin of *Hyphantoceras* is uncertain, but the resemblance between Albian *Pseudohelicoceras* and Turonian and later *Hyphantoceras* is not deniable. The most important difference may be again in the shape of the body-chamber and the orientation of the aperture. We need Cenomanian examples to conclude the true affinity.

Another possible but improbable origin could be sought in *Eubostrychoceras*. In this interpretation the tuberculation should be acquired in addition to the flared ribbing. Should we follow this interpretation, the Nostoceratidae would become monophyletic.

I previously (MATSUMOTO, 1967, p. 339) considered that *Didymoceras* was originated from *Eubostrychoceras* by way of *Bostrychoceras*, acquiring two rows of tubercles. This could remain as a possible interpretation, but I am now strongly inclined to consider that *Didymoceras* was derived from *Hyphantoceras* by the reduction of the rows of tubercles and flared ribbing. This is supported by the chronologically successive occurrence and also by the presence of certain species which can be interpreted as showing transitional characters.

Hyphantoceras oshimai (YABE)
Pl. 43, Fig. 1

1904. *Heteroceras* (?) *oshimai* YABE, *Jour. Coll. Sci., Imp. Univ. Tokyo*, **20**, art. 2, p. 12, pl. 3, fig. 5.
1935. *Hyphantoceras oshimai*, SHIMIZU, *Jour. Shanghai Sci., Inst.* [2], **1**, p. 193 (listed only).

Holotype.—UMUT. MM7553 [=I-241], from the exposure on the main course of the River Ikushumbetsu, close to the confluence with the Yoshiashi-zawa (Coll. H. YABE and designated by YABE, 1904 in the explanation of plate).

Material.—In addition to the holotype there are two better preserved specimens: one NSM.PM-7246 [=M40 of T. MURAMOTO's Coll.] (Pl. 43, Fig. 1), from loc. Ob.01p, Obira area, and the other of K. MURAMOTO's Coll. preserved at Mikasa City Museum, from Hbo.2006, Sankebetsu-gawa. Among other fragmentary specimens there are: GK.H5795 from loc. Ik 968 p2 (T. MURAMOTO Coll.) and GK.H5843, from loc. R2414 e, unit Uf (K. TANABE Coll.) which represent the body-chamber.

Diagnosis.—The shell is turreted, consisting of helically coiled free (i.e. uncontiguous), slowly enlarging whorls. It is large for the genus, about 80 mm in the basal diameter with a narrow umbilicus, and 35–40 mm in whorl-breadth. The holotype, NSM. PM-7246 and another Mikasa City Museum specimen all show a sinistral coiling. The whorl is subelliptical in section, with a more convex external side, and broader than high, i.e. elongated in parallel with the axis of coiling.

The ribs consist of tuberculate and non-tuberculate ones, but they look subequal in strength on the external surface, and the tuberculate ribs are thicker than the smooth ones on the basal (i.e. lower umbilical) surface. Normally every third rib is distinctly tuberculate, but sometimes one or even two of the intercalated ribs may bear weak bullae but they are not thickened. The upper shoulder, the mid-external and the lower shoulder tubercles are nearly equidistant, but the tubercle at the umbilical margin may be somewhat closer to the lower shoulder one. The four tubercles are subequal in size, but the umbilical one is sometime smaller than others. The ribs are oblique and more or less sinuous on the external side, occasionally with intercalated or bifurcated shorter ones so as to readjust the disposition. The bending at the upper and the lower shoulders is considerable.

The adult stage is represented by NSM. PM-7246 and the one at the Mikasa City Museum, in which the last whorl is extended and then somewhat deviates from the preceding rounded helical coiling, showing a gentler curvature in its later half with its aperture facing somewhat obliquely upward. The body-chamber occupies slightly less than a whorl in the former but two whorls in the latter. It does not form a retroversal hook or a remarkable U-turn. Although the septal sutures are discernible here and there in the preceding whorl of the former the septa themselves are not preserved for some reasons. A shallow, indistinct constriction is discernible very infrequently (one in the last and another in the preceding whorl), which is bordered by somewhat raised (but

not remarkably flared) ribs on either sides. A few strongly flared ribs are developed only on the last part of the adult body-chamber. The aperture seems to be opened simply.

The holotype consists of two whorls of a moderate size. It seems to contain the adult body-chamber, but its very apertural margin is not preserved. The body-chamber does not deviate much from the preceding helical coiling, showing only a slight change of angle in the axis of coiling. Certainly the retroversal hook was not originally present. An indistinct, shallow constriction and a flared rib in front of it are discernible near the preserved last part.

The suture is deeply and finely incised as in other *Hyphantoceras*.

Occurrence.—The type locality probably corresponds to my loc. Ik 1315 or Ik 1316 or Ik 1317, where I obtained *Inoceramus amakusensis*, exposures on the River Ikushumbetsu near the confluence of the Yoshiashizawa. This means the mudstone of the Upper Yezo Group in the Zone of *Inoceramus amakusensis*, Lower Santonian. On the other hand NSM. PM-7246 was obtained in a floated calcareous nodule of the River Obira. GK. H5843 from loc. R2414 e of the same area shows its occurrence in unit Uf, i.e. Santonian. K. MURAMOTO'S fine specimen (Mikasa City Museum) was collected from the exposure of the Santonian siltstone on the River Sankebetsu, together with *Menuites* cf. *japonicus*.

Discussion.—*Hyphantoceras reussianum* (D'ORBIGNY) is said to be considerably variable, but it is probably right to distinguish *H. oshimai* from *H. reussianum* by that the last part of its body-chamber does not show a remarkable retroversal hook but slightly deviates from the main helix facing slightly obliquely upwards and that the major tuberculate flared ribs and intervening fine ribs are not so distinctly differentiated as in that species but that all the ribs are nearly equally strong and the tuberculate ribs occur more frequently. Constrictions occur infrequently and strongly flared ribs occur on the last part of the adult body-chamber. A large size of the adult shell may be another distinction.

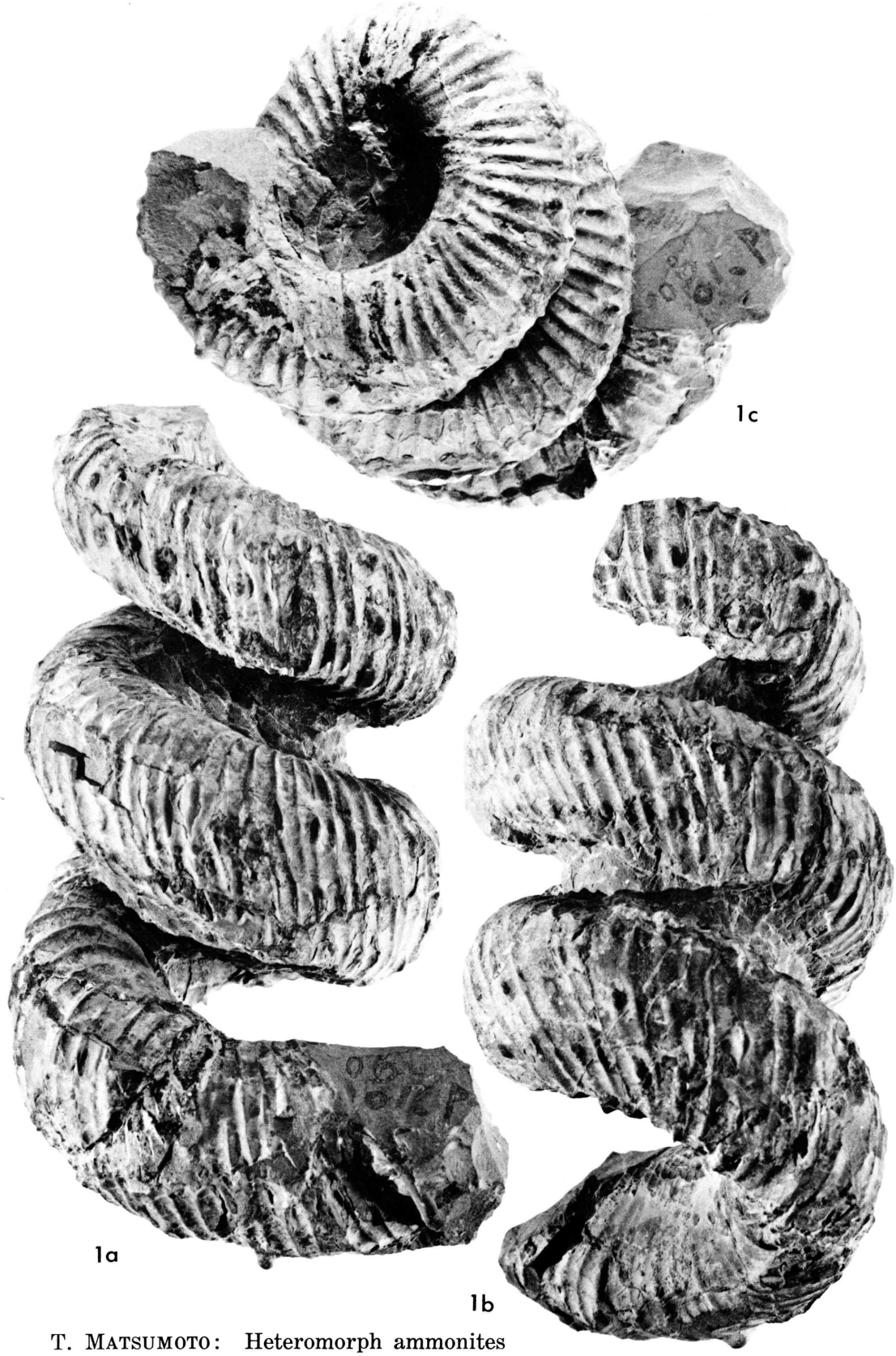
The large shell, the subequal ribbing and the development of bullae on some of the intercalated ribs may suggest some affinity with *Didymoceras*. In fact *Didymoceras awajiense* (YABE) from the Campanian Toyajo Formation of Southwest Japan was once misidentified with the present species (see YABE, 1915, p. 18, pl. 1, fig. 1), but it has two instead of four rows of tubercles.

Hyphantoceras orientale (YABE)
Pl. 44, Figs. 1–3; Text-fig. 3

1904. *Heteroceras* (?) *orientale* YABE, *Jour. Coll. Sci., Imp. Univ. Tokyo*, 18,

Explanation of Plate 43

Fig. 1. *Hyphantoceras oshimai* (YABE) ..... Page 309
NSM. PM-7246 [=M40 of MURAMOTO's Coll.], from the Obira area. Two lateral views (a, b) and upper view of the helical adult shell, ×0.9. (a is rotated 180° to b.)
Photos by T. HOSHINA, without whitening.



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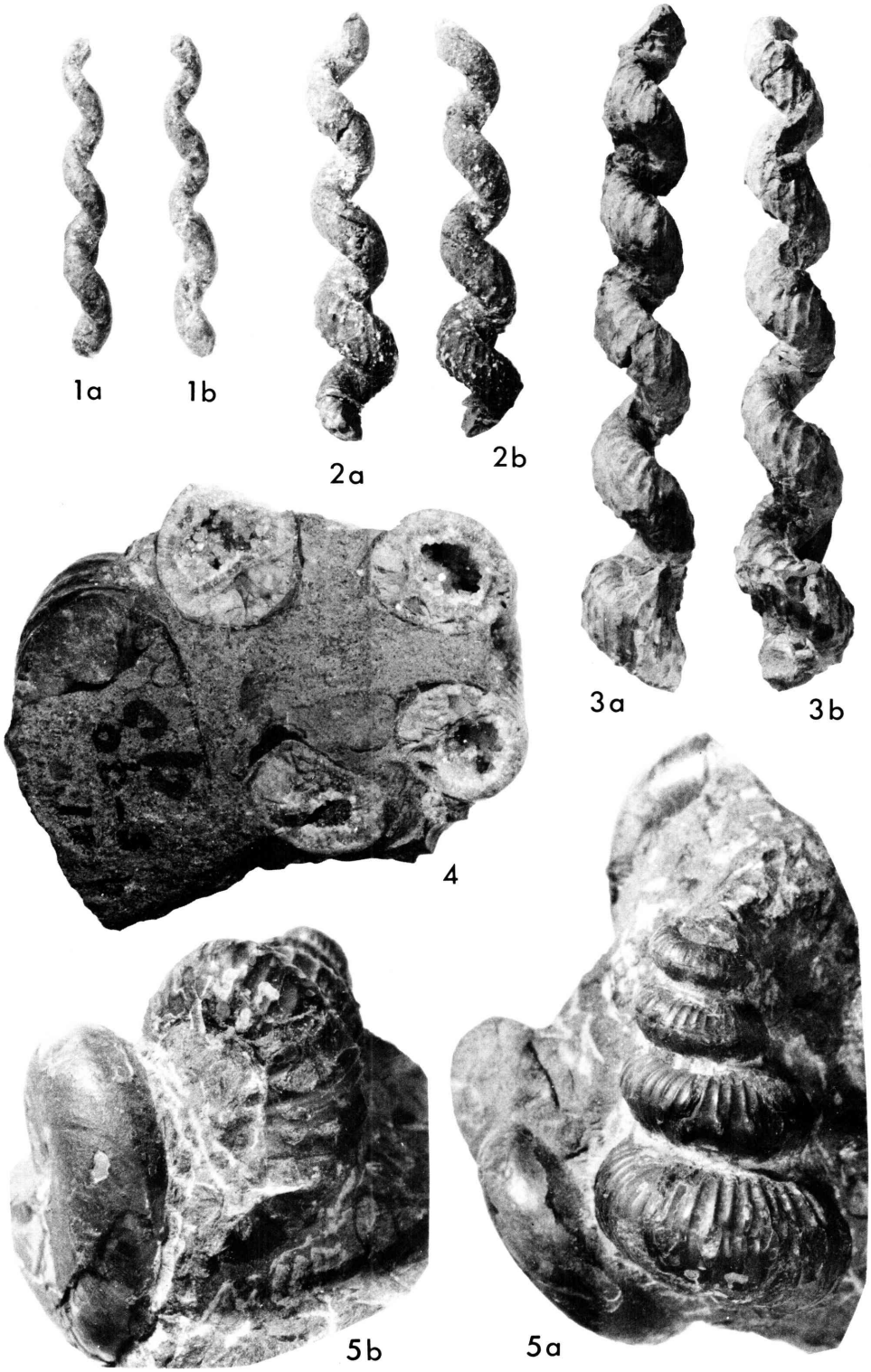


T. MATSUMOTO: Heteromorph ammonites

(2), p. 19, pl. 3, fig. 7.
1904. *Heteroceras* (?) *oshimai* YABE (pars.), *Ibid.*, p. 12, pl. 3, fig. 6 (*non* fig. 5).
1935. *Orientoceras orientale*, SHIMIZU, *Jour. Shanghai Sci. Inst.*, [2], 1, p. 198.
1954. *Hyphantoceras orientale*, WRIGHT and MATSUMOTO, *Mem. Fac. Sci., Kyushu Univ.*, [D], Geol., 4, (2), p. 114.

Types.—Holotype, UMUT. MM7572a [=GT. I-251], from Urakawa, by original designation (YABE, 1904, explanation of pl. 3, fig. 7). YABE's unillustrated smaller specimen, UMUT. MM7572b [=GT. I-252], from Ikushumbetsu, and another still smaller one illustrated as a smaller example of *Heteroceras oshimai* YABE (1904, pl. 3, fig. 6), from the Shi-kuruki, a tributary of the Yubari, are fragmentary younger specimens of this species.

Material.—In addition to YABE's original specimens, I have seen a considerable number of more or less fragmentary specimens (including my own collection), of which the better preserved examples are (1) TTC. 5004, from the Deto-futamata-gawa, floated calcareous nodule within unit U5 or YAMAGUCHI et al. (1963), a tributary of the Haboro, T. TAKAHASHI Coll. (50.9.14) (Pl. 44, Fig. 3); (2) (3) TTC. 5002 and 5003, from floated calcareous nodules from some of units Ui-j and top of Uh of TSUSHIMA et al. (1958), Aka-no-sawa, a tributary of the Obira (T. TAKAHASHI's Coll.) (Pl. 44, Figs. 1, 2); (4) No. 1058 of T. TAKAHASHI's Coll., from the same locality; (5) (6) GK. H5801 a,b, from 15 km point of the main stream of the River Ikushumbetsu (Coll. Mitsuo MIKUNIDANI 30. 7. 16, a student of Mikasa High School); (7) (8) NSM. PM-7252 [=M 48 of T. MURAMOTO's Coll.] and NSM. PM-7253 [=M 49 of T. MURAMOTO's Coll.], from Ob-MolP [=loc. R2144 p of T. MATSUMOTO et al. 1976] (together with *Inoceramus orientalis nagaoi*), Obira area; (9) Ho-0828 of TEJIMA Coll. (Ryuji TEJIMA 1966. 8. 28), from Shi-sanushibe, Hobetsu area.

Diagnosis.—The shell is helical, mostly sinistral, encircling a straight axis, and logitudinally much elongated, consisting of more than 6 loose, slowly enlarging whorls. The whorl is diagonal to the coiling axis, with some variation in obliquity. The whorl section cut in parallel to the coiling axis is oblong but that in perpendicular to the growth axis is roughly subcircular. It is broader than high, when the height is measured from the siphonal line to the anti-

Explanation of Plate 44

Figs. 1–3. *Hyphantoceras orientale* (YABE) ..... Page 310
1. and 2. T. TAKAHASHI's Coll. TTC. 5002 and 5003, from the Aka-no-sawa, Obira area, ×1.
3. T. TAKAHASHI's Coll. TTC. 5004, from the Detofutamata, Haboro, ×1.

Fig. 4. *Nipponites mirabilis* YABE ..... Page 340
Natural whorl section of GK. H5851, from the Kami-kinembetsu, Obira area (T. MURAMOTO's Coll.), ×1.2.

Fig. 5. *Hyphantoceras transitorium* sp. nov. ..... Page 313
NSM. PM-7261 [=M57 of T. MURAMOTO's Coll.], holotype, from loc. Ik M37571, Inari-zawa, Ikushumbetsu area, lateral (a) and basal (b) views of the helical shell, ×1.5.
Kyushu Univ. (H. HIRANO) photos, without whitening.

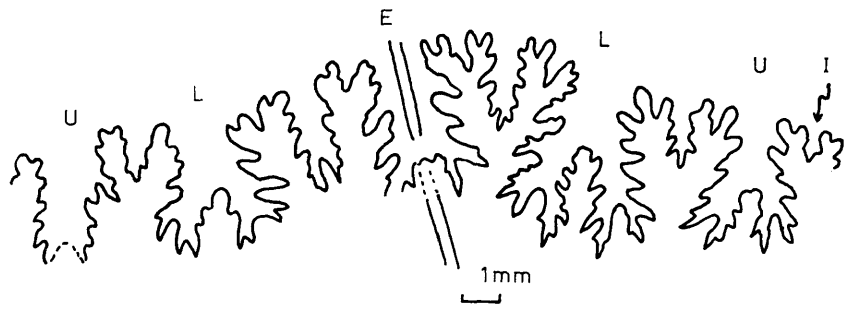


Fig. 3. *Hyphantoceras orientale* (YABE). Suture of TTC. 5003 at whorl-height=52, breadth=66 mm. (T. M. *delin.*)

siphonal one. The known maximum height is about 10 mm in the body-chamber. The length of an incomplete shell of 6 whorls is about 100 mm along the coiling axis and the diameter of its last whorl is about 20 mm. If complete, it must have been longer and more slender.

The body-chamber occupies at least one and a half whorls which are coiled in the same way as the septate ones. An example (GK. H5801 a) shows a somewhat deviation at its incompletely preserved anterior end, suggesting an incomplete hook.

The shell is ornamented with fine simple ribs and tubercles. The ribs are gently sigmoidal on the external side, running subparallel to the coiling axis, strongly bent forward on the upper (i. e. left) margin and backward on the lower (i. e. right) margin, and much weakened on the antisiphonal side. The ribs on the external side are narrow and sharp-headed (on the outer shell-layer). As a rule they are alternately provided with a set of tubercles, more or less bullate two tubercles on the lower part of the external surface and a rounded one at the lower margin. There is a little elevation of the rib at the upper margin and it can be regarded as the fourth tubercle, because it is sometimes distinct enough. Often the untuberculate rib may not be intercalated. Strongly flared ribs do not occur on the observable whorls, although the tuberculate ribs are somewhat more elevated than the non-tuberculate ones.

The suture is like that of *Hyphantoceras reussianum* (D'ORBIGNY) (see WOODS, 1896, pl. 2, fig. 5), being deeply and finely incised even in the middle stage. The siphonal line runs regularly somewhat above the middle of the external side. The sutural patterns are much different on both sides of it.

Remarks.—The holotype is a helical part of the body-chamber of about 10 mm in breadth.

Although this species is characterized by the loose, slowly enlarging whorls, some extent of variation is seen in the mode of helical coiling. T. TAKAHASHI's 1058 represents the most slender shell consisting of much elongated, very slowly enlarging oblique whorls, whereas TTC. 5004 represents a typical form. The ornamentation is somewhat weakened on the internal mould.

Occurrence.—The specimens of the present description all came from the Santonian of Hokkaido. Other fragmentary specimens which I have seen came

also from the Santonian of Hokkaido and South Saghalien. They are contained in calcareous nodules of mudstone and fine-sandy siltstone, often together with *Gaudryceras, Tetragonites, Damesites, Neophylloceras, Phyllopachyceras* and also *Polyptychoceras.*

Discussion.—Although the last retroversal hook has not been confirmed, there is no objection to assign this species to *Hyphantoceras* from all the observed characters. SHIMIZU's (1935a, p. 198) intention to establish *Orientoceras* (nom. nud.) is thus rejected (see also WRIGHT and MATSUMOTO, 1954, p. 114).

H. orientale is distinguished from other species of *Hyphantoceras* by its slender, much elongated shell, consisting of many, slowly enlarging, oblique whorls, fine ribbing, frequent occurrence of tuberculated ribs and less or no prominence of flaring in the helical part.

From the slender shape, long septate part and fine ribbing parallel to the elongation, the shell of this species may have been favourable for floating and up-and-down locomotion with rotation.

Hyphantoceras transitorium sp. nov.
Pl. 44, Fig. 5

Material.—Holotype NSM. PM-7261 [=M57 of T. MURAMOTO's Collection], from loc. Ik. M37571 of T. MURAMOTO, Inari-zawa, a tributary of the Ikushumbetsu.

Diagnosis.—The holotype is a small turreted shell, consisting of four ($+\alpha$) rather rapidly enlarging sinsitrally helical whorls, which are for the most part slightly separated from each other. The preserved last part considerably deviates from the helix, showing a somewhat obliquely descending curve. This could be a posterior part of a retroversally hooked body-chamber, but the recurved part is not preserved.

The whorl is inflated on the external (i.e. ventral) side, with a subangular top on the siphonal line at about the mid-venter.

The ribs are moderately coarse and strong. Every second or third rib is tuberculate. On the external surface the untuberculate ribs are nearly as strong as the tuberculate ones. Very rarely a fine rib is intercalated. The external tubercles are at the mid-venter and fairly strong on the later two whorls, having a radially elongated elliptical base. The tubercles number 9 or 10 per half whorl, while the ribs 20 to 22. Two ribs are sometimes looped at the external tubercle. On the lower surface of the whorl the tuberculate ribs are thickened and provided with tubercles in two rows, i. e. at the lower shoulder and at the umbilical margin. Occasionally the umbilical tubercle is developed on the otherwise untuberculate intercalated rib.

The ribs are rursiradiate on the upper umbilical margin, gently bent at the upper shoulder, running slightly obliquely on the external side with a concave and then gently sigmoid curvature, and gradually curved at the lower shoulder to run radially around the lower umbilicus.

The suture is partly exposed, showing a florid lytoceratid pattern. The siphuncle is situated at the middle of the external side. The last suture is at

the point where the whorl begins to deviate slightly from the main helical coiling.

Measurements.—

Height of helix	Basal diameter	Whorl-height	Breadth	B/H
37.0[4]	27.2	11	13.6	1.2

Occurrence.—The holotype was obtained by T. MURAMOTO from his loc. Ik. M37571 in the Inari-zawa, a tributary of the upper course of the River Ikushumbetsu, where Santonian part of the Upper Yezo Group is well exposed. Associated in the same nodule are *Damesites* cf. *damesi* (JIMBO), *Gaudryceras tenuiliratum* (YABE), *Polyptychoceras* sp. and *Inoceramus* cf. *naumanni* YOKOYAMA.

Discussion.—The absence of particularly flared ribs in external view is diagnostic of the present species. When the basal surface was concealed by rock matrix, I thought that this is a Santonian example of *Didymoceras* (MATSUMOTO, 1967, p. 339), because it looked like *D.* cf. *angolaense* (HAUGHTON) of HOWARTH (1965, p. 378, pl. 8, fig. 2) from Angola. On the basal surface, however, the tuberculate ribs are thickened and there is an additional tubercles at the umbilical margin. Accordingly I now regard this species as an atypical species of *Hyphantoceras* that may represent a transitional stage toward *Didymoceras*.

Hyphantoceras (?) *heteromorphum* sp. nov.
Pl. 47, Fig. 2; Pl. 61, Fig. 1

Material.—Holotype, NSM. PM-7244 [=M38 of MURAMOTO's Coll.], from loc. Ik-M1-p5, Kami-ichi-no-sawa, about 80 m from the conference with the main stream of the Ikushumbetsu, central Hokkaido. This is probably Coniacian.

Diagnosis.—The heteromorphous shell consists of at least four major stages of different characters. The very initial stage is unknown. The preserved first stage is an uncoiled, gently sinuous, long shell of subcircular cross-section, showing a mode of curvature and tapering like that of an elephant nose. It is about 65 mm long. It has no flared ribs and is ornamented only with dense, fine, simple ribs, which may be nearly perpendicular or slightly oblique (forward or backward) to the axis of growth.

The shell at the second stage is gently arcuate, slowly enlarging, about 45 mm long and 8.0 to 10.5 mm. in diameters of subcircular cross-section. It is ornamented with periodic major ribs in addition to the numerous fine ribs. Each major rib has four tubercles, external and marginal ones, as in typical species of *Hyphantoceras*. The fine ribs on the major rib may from a loop at the tubercle. At the transition from the first stage to the second, the shell is abruptly enlarged (i.e. showing rapid increase in diameter of the cross-section), but there is no remarkable change in the orientation of the growth axis.

The shell forms a remarkable U-turn and abruptly enlarged at the transition from the second stage to the third. The shell of the third stage itself is gently arcuate, about 70 mm long, subcircular in cross-section, slightly broader than high, with height=14.5 mm and breadth=16.2 at the middle of this stage,

slowly enlarging up to the maximum breadth of 21 mm near the anterior end of this stage. It is frequently constricted, showing a remarkable scale-like shape, with a steep or overhanging slope posteriorly and gentle inclination anteriorly. The interval between the constrictions is shorter than the whorl-height. The surface of the shell is densely ornamented with numerous, fine ribs, numbering 8 or so at each interval of the scale.

At the transition from the third stage to the fourth the shell shows a twisted U-turn to form a helical coiling in the fourth stage; the breadth of the whorl is not much enlarged here. If the axis of the helical coiling is extended backward, it comes to the point of the first U-curve at the transition between the second and the third stages. In the fourth stage the shell has at least two helical whorls; the diameter of the earlier whorl (about 70 mm) is larger than that of the later one and the two whorls are slightly separated from each other; the ventral part of the whorl of a larger diameter is about to touch the arcuate shell of the first stage. At that point the whorl is slightly higher than broad (H=23.0, B=21.0 mm). The last body-chamber could be presumed to form a retroversal coil as in the typical species of *Hyphantoceras*, but actually it is not preserved. The preserved helical whorls are still septate. It is ornamented with periodic flared ribs and numerous fine ribs. The flared ribs are 7 or so per whorl, disposed at moderate or fairly wide intervals, sharply raised and provided with four reminescent tubercles. There are 10 to 22 very fine ribs at each interval, depending on the distance of the interval.

The suture is only partly exposed, showing florid pattern as that of *Hyphantoceras*.

Remarks.—The above description is based on a single specimen. Some other fragmentary shells which can be comparable with a part of the present species are occasionally found. For example a few fragmental specimens of sigmoidal curvature, e. g. GK. H5844 (Pl. 61, Fig. 1) from Kikume-zawa, are referable to the first stage and NSM. PM-7257 [=M54 of T. MURAMOTO's Coll.], from Ob-r-p3, Obira area, to the second stage of the above description.

Discussion.—This species is very peculiar in having U-turned sinuously curved shafts before it acquires the normal helical coiling of *Hyphantoceras*. The sinuosity can be seen in such a loosely helical shell as that of *Hyphantoceras orientale* (YABE), but in that species the axis of coiling is straight throughout growth. Another peculiarity is the ornament of the first stage without flared, tuberculate ribs and that of the third stage showing a scale like form. The ornament of the second and the fourth stages closely resembles that of *Hyphantoceras reussianum* (D'ORBIGNY) and *Hyph.* (?) *venustum* (YABE) respectively.

The frequently constricted shell of the third stage resembles the feature which can be seen in the body chamber of a certain species of *Scalarites*, as represented by the specimen HSC. No. 23, from the Oyubari area. Judging from the orientation of the scale like form, the shell of this stage may have been favourable for burrowing into a muddy bottom and certainly inadequate for swimming backward. Anyhow, the mode of life must have changed in the fourth stage to that of normal *Hyphantoceras*, which is probably capable of float-

ing slowly up and down as well as resting on the bottom. The sinuously elongated shell of the first and the second stages, with a subcircular cross-section may have been adequate for living on the sea bottom rather than swimming in the sea waters. As the length of the living chamber at these stages is unknown the buoyancy of the shell is hardly estimated with any accuracy. I am, however, inclined to suppose that the animal may have been fairly long—presumably occupying the whole length of the shell of the second stage with the apertural margin at the first constriction at the beginning of the third stage. As a whole this species may have been a bottom dweller, although the mode of life may have changed to some extent from stage to stage.

I know an undescribed species, from the Santonian Zone Mh6 of the Naibuchi area, south Saghalien, which has a *Hyphantoceras venustum* like early whorls, with tuberculate flared ribs and fine ribs on the intervals, followed by densely ribbed later whorls with scale-like asymmetric flared ribs and constrictions. (They are represented by GT. I-2853, from loc. N23e, GT. I-2852, from loc. N22–23 p15, GT. I-2850, from loc. N22′, GT. I-2854, from loc. N22z, and GT. I-2855, from loc. N42 f of my collection.) It resembles the present species in the change of ornament from the *Hyphantoceras* type to the *Eubostrychoceras* type, but the mode of coiling is not so peculiar as the present species.

Genus ***Yezoceras*** nov.

Type-species.—*Yezoceras nodosum* sp. nov. (described below).

Etymology.—Yezo is the old name for Hokkaido.

Generic diagnosis.—The shell is turreted or corkscrew like, consisting of helically and more or less narrowly coiled whorls. The adult body-chamber generally follows the same coiling as the septate whorls in the type-species, but shows a distinct retroversal hook in another species.

The whorl is ornamented with numerous, more or less sinuous ribs which run somewhat obliquely to the axis of coiling on the external (i.e. ventral) side and are strongly bent at the upper shoulder and moderately so at the lower shoulder. The tubercules at the lower shoulder is distinct and coarse, where two or more ribs may be united or fasciculate. In comparatively later growth-stages major ribs run radially from the shoulder tubercles on the lower surface and smaller tubercle may or may not develop at their umbilical ends. Typically still another row of external tubercles or bullae appears in an earlier or a later growth-stage, which are generally as numerous as but occasionally more or less numerous than the shoulder tubercles. The ribs may be looped at the external tubercle. There may be periodical weak constrictions and slightly raised ribs. On the last part of the body-chamber in the type-species tubercles are much strengthened and flared ribs develop on which four tubercles are set with addition of the upper shoulder one.

The siphuncle is situated at the base of the whorl around the lower umbilicus and not at or near the middle of the external side. This results in the extremely asymmetric configuration of the sutural elements. The lateral lobe exposed on the external side of the helical whorl is extremely expanded and the first and

the second lateral saddles on either side of it are fairly so. They are bipartite and deeply and finely incised, with a much narrowed stem. The lobes and saddles on the internal side are much smaller than the external ones but they are finely incised. The small tripartite antisiphonal lobe is situated at the upper umbilical shoulder.

Remarks.—In addition to the type-species another new species is referred to this genus (see description below). *Turrilites varians* SCHLÜTER, 1972, from the Emscher Marl of Germany could be assignable to *Yezoceras*, but I cannot decide conclusively without examining the specimens.

Distribution.—The type-species occurs in the Lower Coniacian of Hokkaido. Another species is from the Upper Coniacian of Hokkaido.

The true extent of geographical and stratigraphical distribution should be determined in the future.

Discussion.—If the characters of the adult body-chamber are ignored, this genus is apparently similar to *Didymoceras* HYATT, 1894. Accordingly I was once inclined to think (MATSUMOTO 1967, p. 339) that there was an atypical example of *Didymoceras* in the Lower Senonian of Hokkaido. But if we look at more carefully the distinction is discernible even in the septate stage. In this genus the lower shoulder tubercles are prominent where ribs are united or fasciculate and the lower umbilical ribs are developed.

The distinct development of the tri- to quadri-tuberculate flared ribs in later stages suggest us the affinity of *Yezoceras* with *Hyphantoceras*, HYATT 1894. In the typical species of *Hyphantoceras* the tuberculate flared ribs persist almost throughout growth.

The position of the siphuncle at the base of the helical whorl is particular to *Yezoceras*. Although the siphuncle position may fluctuate to some extent near the middle of the convex external side in *Hyphantoceras, Didymoceras, Eubostrychoceras* and other helically coiled genera of the Nostoceratidae, I have not seen such a remarkable and constant deviation (about 90° or more) as in *Yezoceras* nor have I seen any transitional form in this respect. The position of the siphuncle must be fundamental in the life of the Ammonoidea. The present case may imply a strong influence of the twisting on the soft body including anatomically important parts. Should the funnel be opened at an abnormal position and the tentacles be disposed in an unusual way, *Yezoceras* must have had its own particular mode of life which was dissimilar to that of other helically coiled genera of Nostoceratidae.

Anyhow, *Yezoceras* should be regarded as representing a special offshoot from the main stock (probably *Hyphantoceras*) of the Nostoceratidae.

Yezoceras nodosum sp. nov.

Pl. 45, Fig. 3; Pl. 46, Figs. 3, 4; Text-fig. 4

Material.—Holotype, NSM. PM-7254 [=M50 of T. MURAMOTO's Collection], from loc. Ik 2156 b, Zone of *Inoceramus uwajimensis*, Pombetsu-go-no-sawa, a branch of the Pombetsu, which in turn is a tributary of the River Ikushumbetsu. Paratypes, NSM. PM-7255 [=M51 of T. MURAMOTO's Coll.], from the

same type-locality. GK. H5569, from a floated nodule in the River Ikushumbetsu at a point 300 m upstream of the Kumaoi Bridge (T. TAKAHASHI's Coll. 45.8.21); GK. H5845, external mould in another floated calcareous nodule at loc. Ik 1101 p, River Ikushumbetsu (Coll. T. MATSUMOTO); GK. H1393 a–d, from loc. Y103 b2, Shiyubari (Coll. T. MATSUMOTO); HCS. 24 from Shimoyubari (Coll. S. KAWAHATA).

Diagnosis.—The shell consists of more than six, regularly enlarging helical whorls, which form a moderately high turreted shell, with an apical angle of about 25–30°. The coiling is dextral (as seen in the holotype and GK. H5569) or sinistral (as in NSM. PM-7255), and rather close. The whorl embraces a fairly narrow umbilical space (less than 30 percent of diameter) and very slightly separated from the adjacent ones. It is subelliptical in cross-section, becoming rather D-shaped in the late stage with a steep internal side, moderately rounded external side and subrounded shoulders. The shoulders are subangular at the strongly tuberculate last stage. The whorl is higher than broad (B/H= 0.88), i. e. elongated nearly in parallel with the axis of coiling.

The whorl is ornamented with more or less dense, numerous fairly fine ribs, which are flexuous, with a strong forward bend at the upper shoulder, a slightly oblique and gently sinuous curve on the external side and a moderate backward bend at the lower shoulder, and run radially around the umbilicus. On the internal side they are very fine and weak.

One of the characteristic features of this species is the development of several flared ribs on the last part (for about a half whorl) of the adult body-chamber. The flared rib has three strong tubercles, one at the upper shoulder, the second at about the mid-flank or a little above it and the third at the lower shoulder. There is in addition the fourth, smaller tubercle at the umbilical margin.

On the rest main part of the helical whorls the upper shoulder tubercles are undeveloped, the external tubercles are weaker, bullate and situated somewhat below the middle of the external side, the lower shoulder tubercles are distinct, becoming coarser in later stages, and the umbilical ones very weak or almost undeveloped, but the major rib runs between the lower two tubercles. The disposition of the tubercles and the ribs on the external side of the septate whorl is similar to that of *Didymoceras nebrascense* (MEEK and HAYDEN) in that some ribs are free from tubercles and other ribs simply have tubercles or are looped at the tubercles. No flared ribs are developed on the septate whorl. There may be very faint periodic constrictions and the ribs along them may be slightly more elevated than others, but this may be regarded as slight irregularity of the ribbing.

The septal suture and the position of siphuncle are peculiar as described in the generic diagnosis.

The adult body-chamber occupies about 330° of the helical whorl and ends without any retroversal hook. The entire adult shell is of moderate size, somewhat more than 85 mm in height and 50 mm or so in basal diameter of the turreted shape.

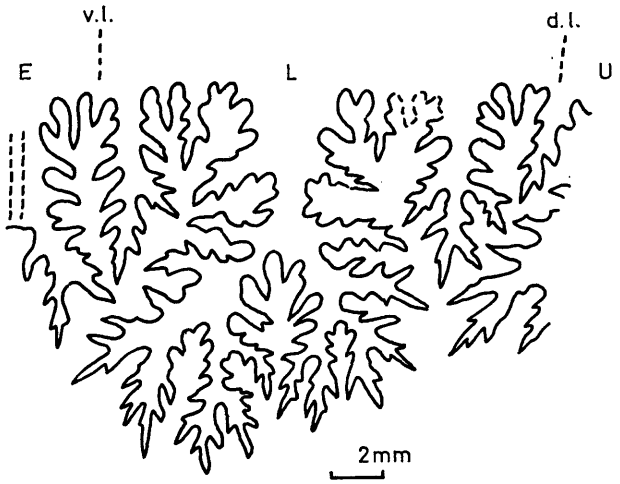


Fig. 4. *Yezoceras nodosum* gen. et sp. nov. Part of suture of GK. H5569 at whorl-height=16 mm. d.l.=dorsolateral (i.e. upper) shoulder, v.l.=ventrolateral (i.e. lower) shoulder. (T.M. *delin.*)

Remarks.—The examined characters may be somewhat different in details between individuals, but can be regarded as representing the variation of a species. The paratype, NSM. PM-7255, in which septate whorls are mostly missing, has denser and finer ribs and weaker and narrower external tubercles than the holotype but shows identical characters in the last stage with strongly nodate flared ribs.

GK. H5569 lacks in the adult body-chamber, but its septate whorls show essentially the same characters as those of the holotype. Its septate shell is slightly larger than that of the holotype. The septal suture is best exposed on this specimen.

Measurements.—

Specimen	Height of turreted shell	Diameter of whorl	Umbilicus	Height of whorl	Breadth	B/H
NSM. PM-7254(deformed)	86[6]	53	13(?)	25	19	0.76
GK. H5569(septate)	65[4]	45.0	13.0(.29)	20.7	18.4	0.88

[ ] number of preserved whorls

Occurrence.—Type-locality is Ik 2156 b, Pombetsu-go-no-sawa, in calcareous nodule of fine-sandy siltstone, upper part of the Zone of *Inoceramus uwajimensis* (Coniacian), Ikushumbetsu (Mikasa) area, central Hokkaido. The locality where GK. H5845 was obtained is within the area where *Kossmaticeras theobaldianum* occurs which suggests a Coniacian age. Loc. Y103 b2 is referred to unit IIIb of the Upper Yezo Group in the Shiyubari [=Oyubari] area, which is referred to Coniacian (MATSUMOTO, 1942–43).

Discussion.—As the characters of this species are so particular that a new genus is established for it. No transitional form has yet been found which could connect it with other previously known species.

Yezoceras miotuberculatum sp. nov.
Pl. 46, Figs. 1, 2; Pl. 61, Fig. 2; Text-fig. 5

Material.—Holotype, GK. H1391, from loc. Y112 b2, Shiyubari, central Hokkaido (Coll. T. MATSUMOTO). Paratypes, GK. H1392, from loc. Y110d, Shiyubari, and GK. H3541 from loc. U161 p, Urakawa (Coll. T. MATSUMOTO).

Diagnosis.—The shell is like a corkscrew or twisted rope in general aspect, consisting of a gradually and regularly enlarging, helically and narrowly coiled whorls, which are considerably separated in the holotype but less so in the paratypes. This is probably a variation within a species. The coiling is sinistral (in the holotype) or dextral (in a paratype). The whorl itself is subelliptical in cross-section, with a more convex external side than the internal, much higher than broad, i. e. more elongated along the axis of coiling. One of the paratypes, GK. H3541 (Pl. 61, Fig. 2) has a body-chamber which deviates remarkably from the helix, showing a thick retroversal hook.

The ribs are fine and dense, bent strongly forward at the upper shoulder, gently flexuous on the external surface, at first nearly parallel to the axis of coiling and gradually curved forward on the lower part, and then strongly bent backward at the lower shoulder, running radially on the umbilical side. There are moderately coarse bullate tubercles at the lower shoulder where several ribs are fasciculate. The tubercles become stronger as the shell grows. On the whorls of comparatively late growth-stages a major rib runs from each shoulder tubercle to the umbilical margin. The other weaker extension of the major rib may be traced on the lower part of the external surface (especially on the mould) but no distinct external tubercle is discernible on the rib. On the hooked part of the body-chamber there are strongly flared tuberculate ribs.

The siphuncle is situated at the bottom of the helical whorl. This situation is maintained even from the immature stage. The pattern of the suture is generally the same as described in the generic diagnosis.

Measurements.—

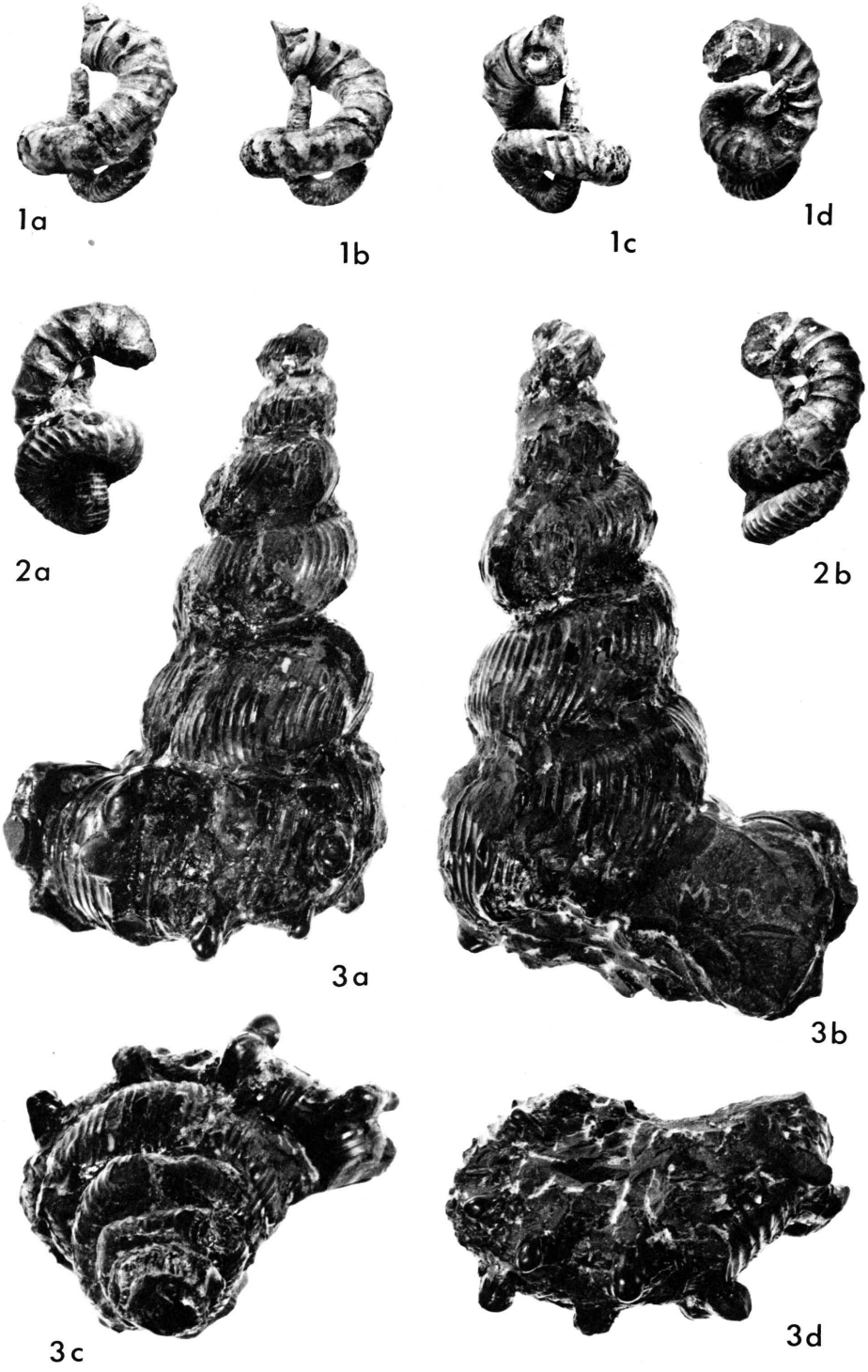
Specimen	[Tower height number of whorls]	Basal diam.	Umbilicus	Whorl-height	Whorl-breadth	B/H
GK. H1391	84[4]	20	—	13.0	10.4	0.74
GK. H1392	35[2]	25	3.8	19.0	13.0	0.68

Explanation of Plate 45

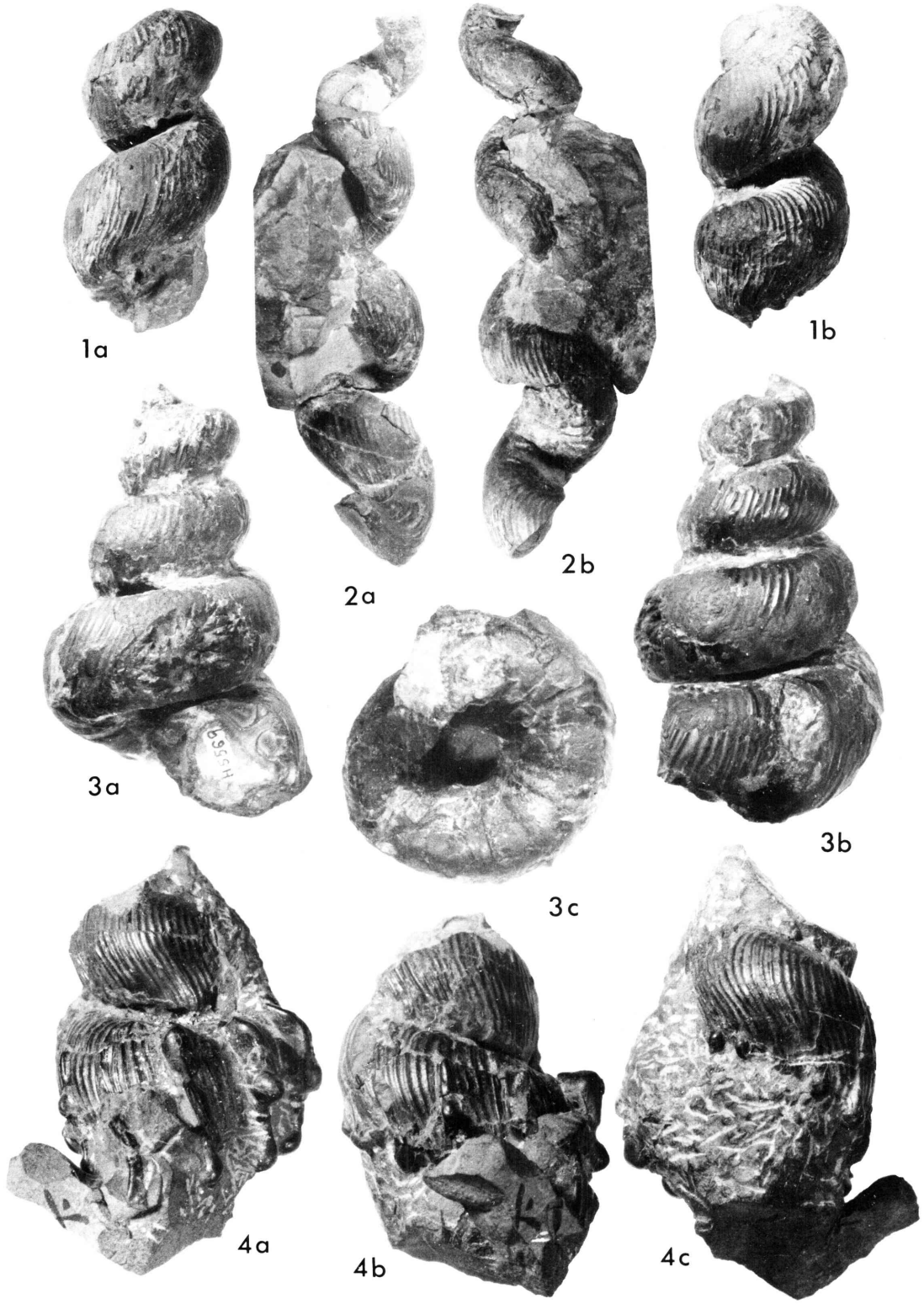
Figs. 1, 2. *Muramotoceras laxum* gen. et sp. nov. ..... Page 337
1. NSM. 7209 [=M3 of T. MURAMOTO's Coll.], from the Sato-no-sawa, Obira area. Four different views (a-d), ×1.5.
2. NSM. 7210 [=M4 of T. MURAMOTO's Coll.], from the same locality as above. Two different views (a, b), ×1.5.

Fig. 3. *Yezoceras nodosum* gen. et sp. nov. ..... Page 317
NSM. PM-7254 [=M50 of T. MURAMOTO's Coll.], holotype, from loc. Ik 2156b, Pombetsu-go-no-sawa, Ikushumbetsu area. Two lateral (a, b, 180° rotated), apical (c) and basal (d) views, ×1.

Photos by T. HOSHINA, without whitening.



T. MATSUMOTO: Heteromorph ammonites



T. MATSUMOTO: Heteromorph ammonites

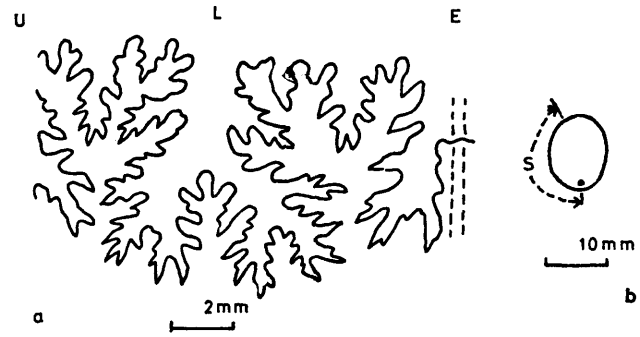


Fig. 5. *Yezoceras miotuberculatum* gen. et sp. nov. Part of suture (a) and whorl-section (b) of GK. H1391 at whorl-height=11.5 mm. A dot in b indicates the position of siphuncle. (T. M. *delin.*)

Occurrence.—The type-locality is Y112 b2, southern bank of the Shiyubari (upper course of the stream of the River Yubari), Zone of *Inoceramus uwajimensis*, Coniacian. Another locality is Y110d', cutting of the forestry railway (now abandoned) along the Shiyubari, a little above the main zone of *Inoceramus uwajimensis*, where *Inoceramus mihoensis* and *Inoceramus naumanni* occur, probably Upper Coniacian. The two localities are in the mudstone of the Upper Yezo Group. Loc. U161p is in unit Urlα (near the Coniacian-Santonian boundary) in the Urakawa area. This species was once listed as *Hyphantoceras miotuberculatum* (nom. nud.) (MATSUMOTO, 1942, p. 235, 261).

Discussion.—This species is closely allied to *Yezoceras nodosum* sp. nov., the type-species, but has a narrower shell consisting of more narrowly coiled whorls with more elongate whorl section and denser and finer ribbing. It has no external tubercles which characterize *N. nodosum*.

The body-chamber of *Y. miotuberculatum* shows a remarkable retroversal hook, with its apertural end facing upward, but that of *Y. nodosum* occupies the last whorl of the helical spire without showing a retroversal hook. Their mode

Explanation of Plate 46

Figs. 1, 2. *Yezoceras miotuberculatum* gen. et sp. nov. ..... Page 320

1. GK. H1392, paratype, from loc. Y110d', the Shiyubari, Oyubari area (T. MATSUMOTO's Coll.). Two lateral views (a, b 180° rotated) of a spiral shell, ×1.

2. GK. H1391, holotype, from loc. Y112b2, the Shiyubari, Oyubari area (T. MATSUMOTO's Coll.). Two lateral views (a, b 180° rotated) of a spiral shell, ×1.

Figs. 3, 4. *Yezoceras nodosum* gen. et sp. nov. ..... Page 317

3. GK. H5569, paratype, from the upper course of the Ikushumbetsu, above the Kumaoi bridge (T. TAKAHASHI's Coll.). Two lateral (a, b 90° rotated) and basal (c) views of a helical shell, ×1.

4. NSM. PM-7255 [=M51 of T. MURAMOTO's Coll.], from loc. Ik 2156b, Pombetsu-go-no-sawa, Ikushumbetsu area. Three lateral views (a, b, c, each 90° rotated) of the body-chamber, ×1.

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

of life may have been somewhat different. The upward facing apertural end of a hooked body-chamber suggests the ability of up-and-down locomotion of this species.

The screw like shape of the holotype of the present species resembles that of *Hyphantoceras orientale* (YABE), but the latter has distinctly four rows of tubercles on somewhat coarser ribs. Moreover, the siphuncle is situated at or near the middle of the external side in *H. orientale*.

Genus *Nostoceras* HYATT, 1894

Type-species.—*Nostoceras stantoni* HYATT, 1894.

Remarks.—This genus was clearly redefined by STEPHENSON (1941, p. 407) and HOWARTH (1965, p. 374) whom I follow.

Distribution.—Numerous species of *Nostoceras* occur in the Lower Maestrichtian of both the Gulf-Atlantic and the Pacific provinces of North America (HYATT, 1894; STEPHENSON, 1941; ANDERSON and HANNA, 1935; ANDERSON, 1958; MATSUMOTO 1960). Several species have been reported from Angola (HAAS, 1943; HOWARTH, 1965) and Madagascar (COLLIGNON, 1971), some of which are identical with the Americans, and a few poorly preserved examples from Europe and the Middle East.

A few specimens from Hokkaido deserve description, since no example of the genus has hitherto been reported from Japan.

Discussion.—From the morphological similarity and the successive stratigraphic occurrence *Nostoceras* was probably descended from *Didymoceras* HYATT, 1894, acquiring a closely coiled septate spire and an elongated U-shaped body-chamber which consists of a suddenly hanging down long shaft followed by a retroversal hook. This shape may have been more favourable for resting at or near the bottom and also for floating up and sinking down locomotion. The tuberculation in two rows may have been hereditary from that of *Didymoceras*.

Nostoceras hetonaiense sp. nov.

Pl. 54, Fig. 2; Pl. 55, Fig. 1

Material.—Holotype GK. H5798 a, from loc. H1091 p, Lower Sandy Siltstone of the Hakobuchi Group exposed in the eastern branch of the Tonai-no-sawa, a branch of the River Saru-gawa near Osachinai, southern central Hokkaido. Paratypes GK. H5798 b (crushed), from the same nodule as the holotype, and GK. H5804, from loc. H122po, the same formation as above exposed in a small stream south of the River Mukawa, near Tomiuchi [=Hetonai] (all T. MATSUMOTO Coll.).

Diagnosis.—The shell is of medium to large size for the genus, with the diameter of the last spiral whorl about 55–60 mm and the length of the longer shaft of the last U about 85–95 mm.

The spire is low, with the later whorl embracing the earlier one with a slight touch or in some part with a slight separation (?). The spiral whorl is almost circular in cross-section. The abrupt bending to the straightly elongated

U-shape of the body-chamber is as in typical *Nostoceras*. The last suture is at this bending point and accordingly the body-chamber is confined to the U-shaped part.

The ribs are fine, crowded and numerous on the septate whorl, numbering 11 to 14 in the distance as long as the whorl-breadth. The intercalation or branching of the rib occurs frequently. The bullate tubercles are developed at every third to fifth rib in two rows; the upper row somewhat below the mid-line of the external surface and the lower one at the lower margin. The two tubercles are not always on the same rib but sometimes disposed alternately. The looping or branching at the tubercle occur frequently. The ribs are only slightly oblique and very gently sinuous, showing a gentle bending on the upper and the lower margins.

On the main part of the body-chamber the ribs are fairly numerous and the branching or looping of the ribs occur at the tubercles. On the last shaft the ribs become moderately coarse and simple.

The suture is very finely and deeply incised.

Occurrence.—All the described specimens came from the Lower Sandy Siltstone of the upper subgroup of the Hakobuchi Group in the Tomiuchi [Hetonai] —Osachinai area, southern central Hokkaido. This member is the stratotype of the lower unit (K6b1) of the Upper Hetonaian, which is probably correlated with the Lower Maestrichtian.

Discussion.—This species is similar to *Nostoceras draconis* STEPHENSON, 1941 (p. 413, pl. 82, figs. 5–9), from the Neylandville Marl of the Navarro Group of the Gulf Coast, in the shell size, shape and ribbing, but distinguished by distinctly more numerous ribs and frequent branching and looping of the ribs at the tubercles.

This species is allied to *Didymoceras awajiense* (YABE, 1901), from the Campanian of Southwest Japan, in the characters of the spiral whorls. Although *D. awajiense* needs a revised description, it is larger, its spire is higher and consists of slightly (but always) separated whorls, and its retroversal hook is not so straight and so elongated as in the present species.

Nostoceras sp. cf. *N. stantoni* HYATT

Pl. 61, Fig. 3

Compare.—

1894. *Nostoceras stantoni* var. *retrosus* HYATT, *Amer. Phil. Soc. Proc.*, **32**, p. 570.
1941. *Nostoceras stantoni*, STEPHENSON, *Univ. Texas Publ.* **4101**, p. 407, pl. 80, fig. 1–5.

Material.—GK. H5799, from loc. K83, Heitaro-zawa, west of Nakatombetsu, from the greenish sandstone of unit H3b of this area, coll. T. MURAMOTO and T. MATSUMOTO, 1960.

Descriptive remarks.—This poorly preserved specimen shows two spiral whorls of which the second one is suddenly bent downward to form a retroversal hook. The hook itself is unfortunately missing, except for the last straight shaft.

In the moderately dense and coarse ribbing and two rows of tubercles which appear frequently as well as the size and mode of coiling of the shell, the specimen is comparable with *Nostoceras stantoni* HYATT (redefine by STEPHENSON, 1941), from the Nacatoch Sand of the Navarro Group. The last part is also well comparable with that of *N. stantoni* on which ribs are stronger and more widely separated than those of the spiral part and tubercles tend to be reduced.

As the specimen is so poorly preserved that the identification is provisional. I describe it to notify that another species occurs in the upper part of the Upper Hetonaian.

Genus *Eubostrychoceras* MATSUMOTO, 1967

Type-species.—*Eubostrychoceras indopacificum* MATSUMOTO, 1967 (from the Coniacian of Japan, India and Madagascar).

Generic diagnosis.—Main part of the septate whorls are helically coiled and the adult body-chamber deviates slightly or remarkably from this helix, with its apertural end facing obliquely or nearly straight upward or "backward", i. e. in more or less reversed orientation against the orientation of the axis of helical coiling. The whorls may be tightly contiguous or slightly or considerably separated, depending on species or in some cases even on individuals. Periodic constrictions, with accompanied flared ribs, may be present or absent, again depending on species and also on growth-stages. Even in the species without periodic constrictions the adult body-chamber is generally provided with one or more constrictions at or near its peristome. The length of the body-chamber is apparently variable.

The whorl is ornamented with numerous ribs which are mostly simple, occasionally branched or inserted, more or less oblique and gently sinuous on the external part (i. e. on the convex side), with bending at the shoulders. No tubercles are developed at any stage.

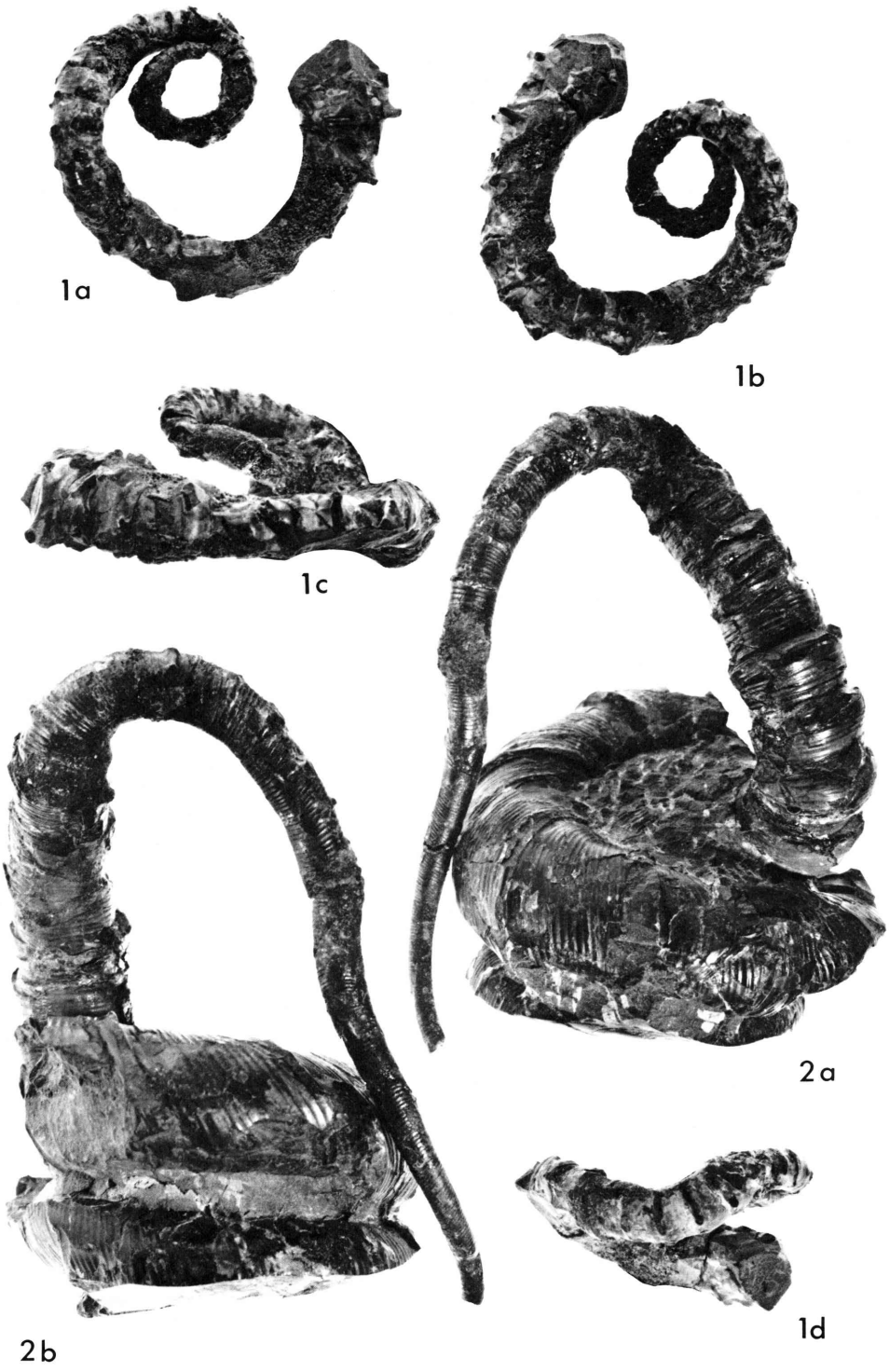
The siphuncle runs approximately at the middle of the external side of the helical whorl but may somewhat deviate from that position. The suture is of modified lytoceratid type, deeply and finely incised, with much narrowed stems and expanded branches of bifid L, U, and lateral saddles.

Remarks.—For the reasons discussed below, *Eubostrychoceras* MATSUMOTO, 1967 is so much enlarged in this paper to include "*Bostrychoceras* HYATT, 1900

Explanation of Plate 47

Fig. 1. *Neocrioceras* (?) *undulosum* sp. nov. .....Page 343
NSM. PM-7221 [=M15 of T. MURAMOTO's Coll.], holotype, from the Sato-no-sawa, Obira area. Upper (a), lower (b), and two lateral (c, d 180° rotated) views of a low undulating spiral shell, ×1.2

Fig. 2. *Hyphantoceras* (?) *heteromorphum* sp. nov. .....Page 314
NSM. PM-7244 [=M38 of T. MURAMOTO's Coll.], holotype, from the Kami-ichi-no-sawa, Ikushumbetsu area. Two lateral views (a, b 180° rotated) of a helical shell with a sigmoidal earlier part, ×1.
Photos by T. HOSHINA, without whitening.



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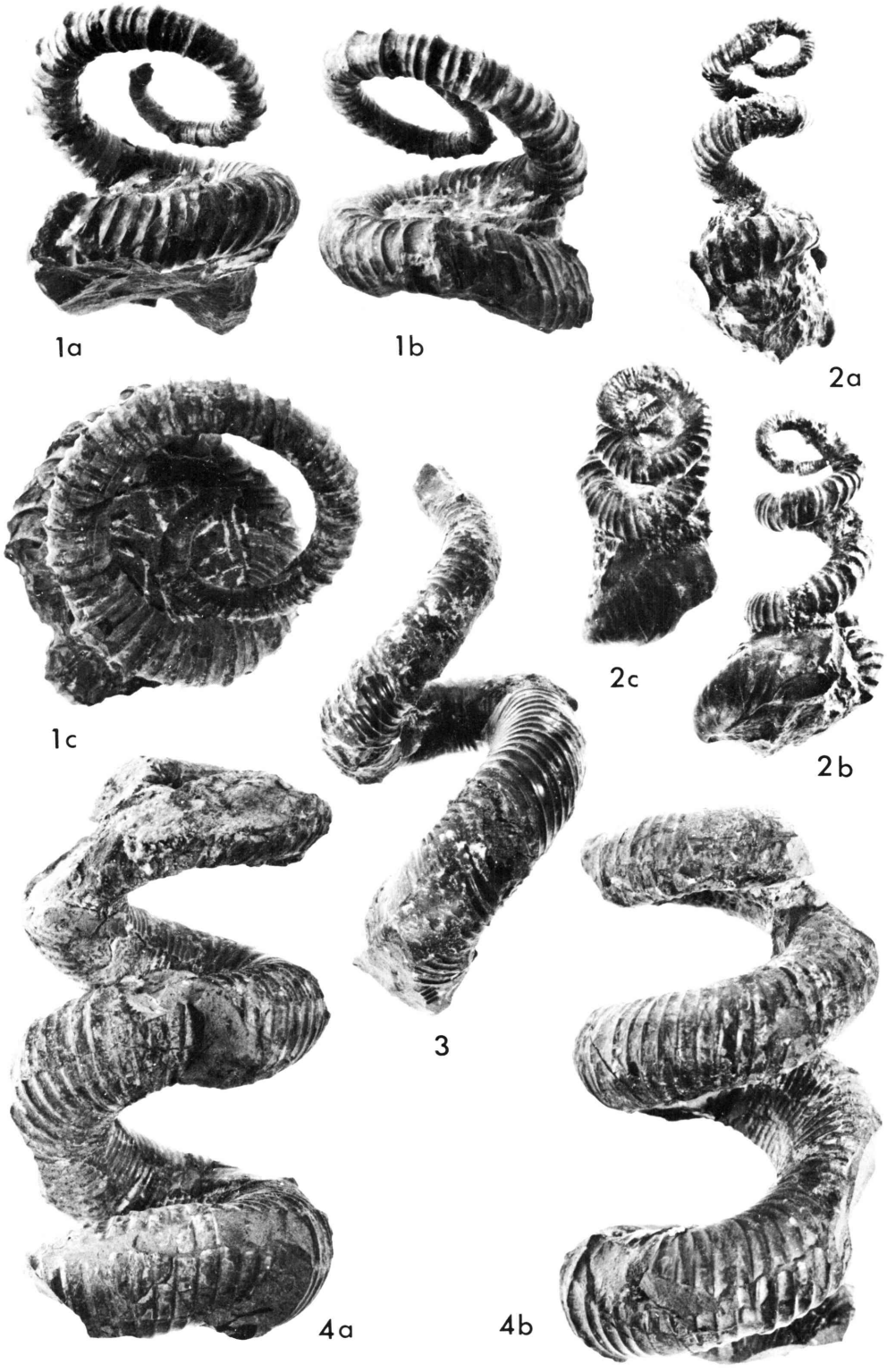

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without tubercles." This treatment may be temporary but indispensable until *Turrilites polyplocus* ROEMER, 1841 be clearly redefined.

Distribution.—*Eubostrychoceras* in this definition comprises a number of species from various areas of the world and ranges from Cenomanian to Campanian. Aside from a doubtful example from Upper Albian, several species occur in the Turonian to Campanian sequences of Japan. An example (GK. H5083), from Yb 423, Lower Turonian of Yubari area, is already fairly large and has coarse ribs and frequent flared ribs, although I do not give a specific name. Despite the hetermorph shell-form and presumably less active lecomotion of the grown animals, certain species of *Eubostrychoceras* show a "trans-oceanic" wide geographical distribution.

Discussion.—When I (MATSUMOTO, 1967, p. 332) proposed *Eubostrychoceras* I excluded from it the species which show a loose retroversal hook in the adult body-chamber. The latter group of species was referred to *Bostrychoceras* HYATT, 1900 in the sense of HOWARTH, 1965 (p. 373). Subsequently I have examined more specimens from Japan and also received new information from Mr. P. WARD on some examples from British Columbia as well as that in recent publications (e. g. COLLIGNON, 1969). As a result it has become clear that there is a considerable extent of variation within a species and that a transitional change is observable between species as to the mode of coiling of the septate whorls, the adult living chamber and the frequency or presence or absence of periodic constrictions and/or flared ribs. Accordingly I once considered to suppress my *Eubostrychoceras* as a synonym of *Bostrychoceras*. However, as was discussed previously (WIEDMANN, 1962, p. 197; HOWARTH, 1965, p. 372; MATSUMOTO, 1959, p. 161; 1967, p. 337), there is a serious ambiguity in the definition of *Bostrychoceras* HYATT, 1900. This is concerned with the unsettled problem in the definition of *Turrilites polyplocus* ROEMER, 1841 (from Germany), the type-species of *Bostrychoceras* designated by HYATT. Should we follow WIEDMANN (1962), who must be best acquainted with German material, *Bostrychoceras* would fall in the synonym of *Cirroceras* CONRAD, 1868 (another unfortunate *nomen dubium*) or *Didymoceras* HYATT, 1894 (a better defined "*Bostrychoceras*"

Explanation of Plate 48

Figs. 1–4. *Eubostrychoceras japonicum* (YABE) ..... Page 329
Various forms in T. MURAMOTO's Collection from the Sato-no-sawa, Obira area (1, 2, 4) and Ikushumbetsu area (3).
1. NSM. PM-7233 [=M27]. Two lateral (a, b 180° rotated) and upper (c) views of a helical shell, whose early half resembles *Scalarites scalaris* (YABE), ×1.
2. NSM. PM-7220 [=M14]. Two lateral (a, b 180° rotated) and upper (c) views of a small helical shell, with an irregular early whorl, ×1. (*Inoceramus* sp. is associated.)
3. NSM. PM-7234 [=M28], from loc Ik 1320, Kami-ichi-no-sawa, Ikushumbetsu area. Lateral view of a helical shell with much separated whorls, ×1.
4. NSM. PM-7231 [=M25]. Two lateral (a, b 180° rotated) views of a helical shell which resembles the holotype, ×1.
Photos by T. HOSHINA, without whitening.

like heteromorph with two rows of tubercles). HOWARTH (1965), however, attempted to revive HYATT's intention, whom I followed in my previous paper (MATSUMOTO, 1967). On that occasion I regarded *Bostrychoceras* as a subgenus of *Didymoceras* in which tuberculation was probably going to be reduced. This reduction, if ever occurred, took place in late Campanian. There are more numerous species of "non-tuberculate *Bostrychoceras*" in Campanian, Santonian, Turonian and even Cenomanian, but I have seen no example in them which could be regarded as transitional or intermediate between "*Bostrychoceras*" and *Didymoceras* and, on the contrary, I have found an example which can be regarded as representing a transitional stage from *Hyphantoceras* to *Didymoceras*. Even if there was a species in which *Didymoceras* type bituberculation is going to be reduced, it should have no direct relation with the originally non-tuberculate species of *Eubostrychoceras*. Anyhow, as HOWARTH has pointed out, "further work on much larger collections from Germany is necessary to determine the limits of variation in *B. polyplocum*" and its relationships with other species. Until a clear definition be given to *Turrilites polyplocum* I have to set aside *Bostrychoceras* as at least a temporary *nomen dubium* and would like to use better defined *Eubostrychoceras* (emended above) to describe the species from Japan and elsewhere. I should be happy, if my redefined *Eubostrychoceras* could fall in a synonym of better defined *Bostrychoceras* in some future work. Incidentally *E. indopacificum* MATSUMOTO is regarded by some authors (e. g. TOKUNAGA and SHIMIZU, 1926; COLLIGNON, 1970, p. 17) as specifically identical with *Heteroceras indicum* STOLICZKA, 1865. It could be so, but this would not give serious alteration to the definition of *Eubostrychoceras*. As I mentioned previously (MATSUMOTO, 1967, p. 334), *H. indicum* is ambiguous on account of poorly preserved types but has characters which enable us to distinguish it from *E. indopacificum*. I avoided to designate the incompletely defined species as the type-species.

Aside from this discussion about the typological uncertainty, it is more interesting to note the variable or flexible characters shown in *Eubostrychoceras* of the present redefinition. I expected to find a successive change of characters with time, but the actual situation does not seem to be so simple. Although the available material is not sufficient, some examples are taken here to demonstrate variously changing characters.

In *E. indopacifica* MATSUMOTO, 1967 the whorls are mostly helical and tightly contiguous and only the apertural part of the living chamber slightly deviates from the helical coiling, facing obliquely upward. This is well shown by the holotype (MATSUMOTO, 1967, pl. 18, fig. 1), from the Coniacian of northeastern Honshu (Japan), and also by the fine example from the Lower Senonian of Madagascar (BOULE et al., 1907, pl. 7 [14], fig. 1), the latter of which was erroneously referred to *Turrilites polyplocus*.

The same feature is also shown by *E. saxonicum* (SCHLÜTER, 1872) as exemplified by an example from the Coniacian of Madagascar (COLLIGNON, 1965, pl. 418, fig. 1724) and another from the Turonian of Hokkaido (recently collected by Y. MIYATA, a student with me). These characters suggest a close

affinity of *Eubostrychoceras* with Albian *Turrilitoides* and the only distinction may be in that the whorls are helically coiled throughout life in *Turrilitoides* without deviation of the last part.

The very apical portion of the helix is not preserved in the above specimens, but in another allied species *E. muramotoi* MATSUMOTO, from the Coniacian of Japan, the probably in *E. woodsi* (KITCHIN), from the Upper Turonian of England, the youngest part is much deviated from the main helical coiling, as was explained at length in my previous paper (MATSUMOTO, 1967, p. 335). This character, which did not occur in *Turrilitoides*, may be important in that it suggests a possible potentiality of *Eubostrychoceras* to give rise to extremely aberrant *Nipponites* and *Muramotoceras*. I do not know at present whether the same character is maintained in all the species of *Eubostrychoceras* or occurs in a particular species group. Closely or almost contiguously coiled helical form is also exemplified by the septate stage of *E. elongatum* (WHITEAVES, 1903) (see USHER, 1952, p. 105, pl. 28, figs. 3, 4; pl. 31, fig. 24), from the Campanian of British Columbia, Japan and Madagascar, but in this species the last body-chamber shows an abrupt bending so as to produce an upward extending last part. This character is well shown by examples from Madagascar (see COLLIGNON, 1969, p. 27, pl. 522, figs. 2060, 2061). Although I once doubted the specific identity between the lectotype (USHER, 1952, pl. 28, fig. 3) and another somewhat loosely coiled example with denser ribs and the retroversally hooked last part (USHER, 1952, pl. 28, fig. 4), P. WARD kindly has informed me that there is gradation between these forms on the ground of his recent study of the ammonites from the Nanaimo Group. Even if they are of identical species, I would expect some evolutional change within the species.

In addition to *E. elongatum*, I have recently seen a specimen (Mr. Kazuo TAKEDA's private collection from Hobetsu) of another, unnamed species from the Turonian or Lower Senonian of Hokkaido, which has a similarly straight upward elongated last shaft abruptly retroversed from the helix. Unlike *E. elongatum* it has loosely helical whorls and periodic flared ribs and numerous finer ribs.

A new species (*E. densicostatum*) to be described below, from the Santonian of Hokkaido, has slightly or moderately separated helical whorls, but otherwise is fairly similar to *E. saxonicum* (SCHLÜTER). It is also characterized by considerably frequent periodic constrictions and accompanied flared ribs. Similarly frequent constriction and/or flared ribs appear in *E. punicum* (PERVINQUIÈRE, 1907), from the Santonian of Tunisia, represented by the small, probably immature holotype (PERVINQUIÈRE, 1907, p. 105, pl. 4, figs. 20, 21) and also in *E. cenomanense* (WIEDMANN, 1962) [=*Bostrychoceras thomasi* PERVINQUIÈRE, 1910, pl. 5, fig. 34) from the Cenomanian of Algeria, represented again by a small, probably immature specimen. On account of the flared ribbing some species of *Eubostrychoceras* were misidentified with *Hyphantoceras*, but the latter has tuberculated flared ribs.

In *E. japonicum* (YABE, 1904), greatly emended below, from the Turonian of Hokkaido, shows extreme change in the frequency of the periodic constric-

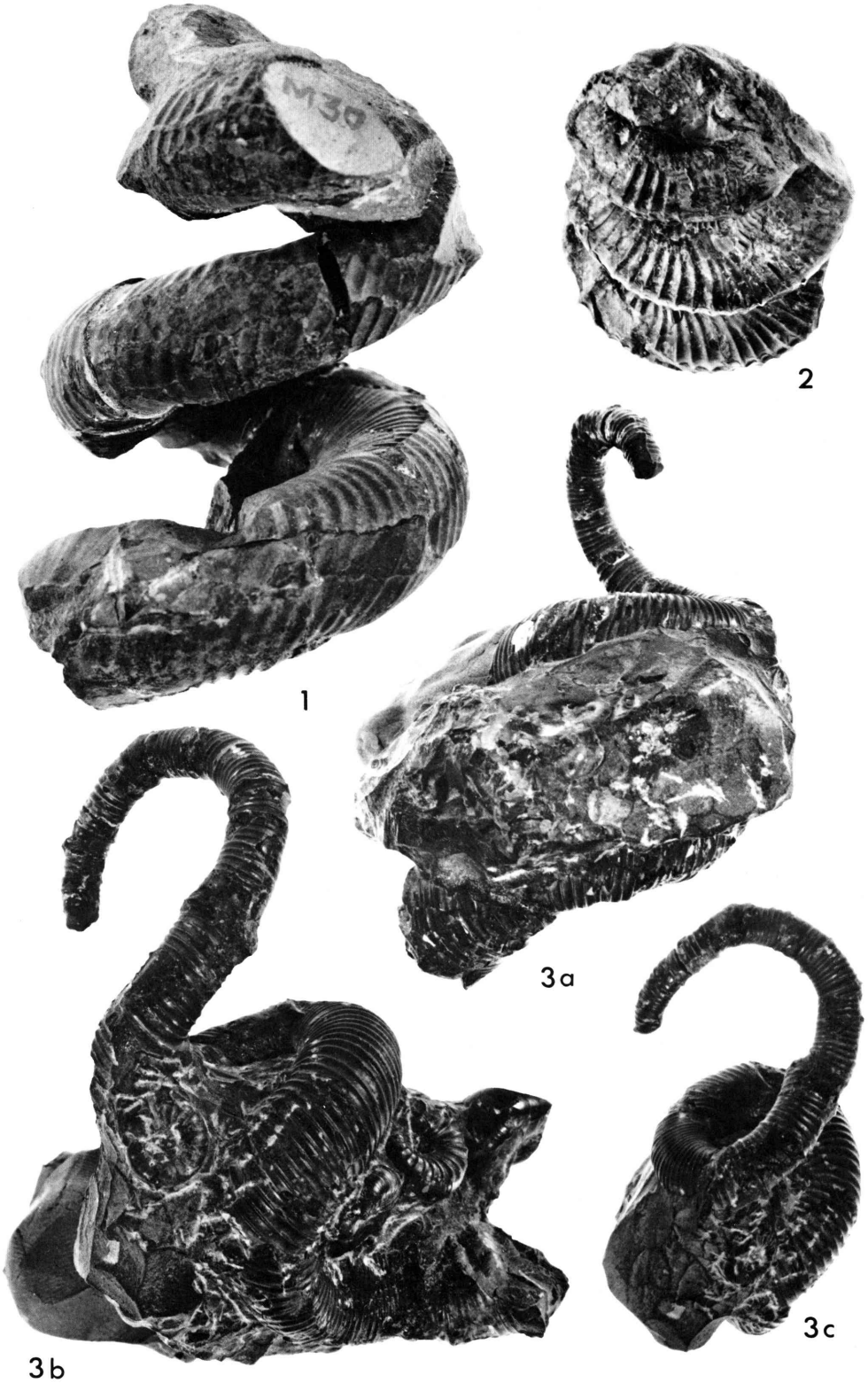
tions and flared ribs with growth (see descriptions for details). That species exemplifies a considerable irregularity in the mode of coiling in the early stage and also considerably separated whorls in the helical stage. The widely open whorl with frequent constrictions in an early stage of this species suggests us a possible affinity with *Scalarites* WRIGHT and MATSUMOTO, 1954.

Presumably the constrictions must have a significant role in the mode of life of ammonoids and the character cannot be neglected in the taxonomy, even if there is apparent variability. *E. elongatum*, mentioned above, is almost free from constrictions, but in its later stage including the retroversal body-chamber a few constrictions appear. Incidentally HOWARTH (1965, p. 373) was not probably correct in regarding *Turrilites saundersorum* STEPHENSON, 1941 as a constricted "*Bostrychoceras*". Its holotype (STEPHENSON, 1941, p. 416, pl. 83, figs. 6–8), from the reworked Kemp clay, is probably a turreted septate shell of *Nostoceras* or *Anaklinoceras* and not referable to *Eubostrychoceras*, because it has tubercles though much weakened.

I have not yet arrived at a definite conclusion about the length of the living-chamber of *Eubostrychoceras*. This may have changed with growth. Even in the probably adult living-chamber the length of the retroversal part is short or long, depending on species and sometimes on individuals. In addition to the retroversal part at least the last full whorl was probably occupied by the living-chamber, so far as several examined examples (of *E. indopacificum*, *E. japonicum*, *E. densicostatum* and *E. elongatum*) are concerned. COLLIGNON (1969, p. 27) has already pointed out on Madagascar example of *E. elongatum* that the last two of the helical whorls were occupied by the living-chamber in addition to the retroversed last part. This may have given a considerable weight to the entire shell, which may have been favourable for a benthic or sub-benthic mode of life. The upward opened aperture seems to suggest the ability of occasional up-and-down locomotion in the sea water, but straight elongated last part, together with the two last whorls of the helix, may have been embedded in the bottom sediments when the animal reposed itself under the water. Such a supposed mode of life in *E. elongatum* may be an extreme case, to which other more freely movable species may have evolved. There would certainly be diversity in the mode of life between the species which have a shell form like *E. elongatum* with an elongated retroversal last part and that like *E. indopacificum* with a short, obliquely upward facing last part, even if no significant difference exist

Explanation of Plate 49

Figs. 1–3. *Eubostrychoceras japonicum* (YABE) ..... Page 329
Various forms in T. MURAMOTO's Collection from the Sato-no-sawa, Obira area. All figures of natural size.
1. NSM. PM-7236 [=M30]. Lateral view of a form which resembles in ribbing the holotype of *Heteroceras* (?) *otsukai* var. *multicostatum* YABE.
2. NSM. PM-7231 [=M25]. Upper view. See Pl. 48, Fig. 4 for the lateral views.
3. NSM. PM-7229 [=M23]. Three different views (a-c).
Photos by T. HOSHINA, without whitening.



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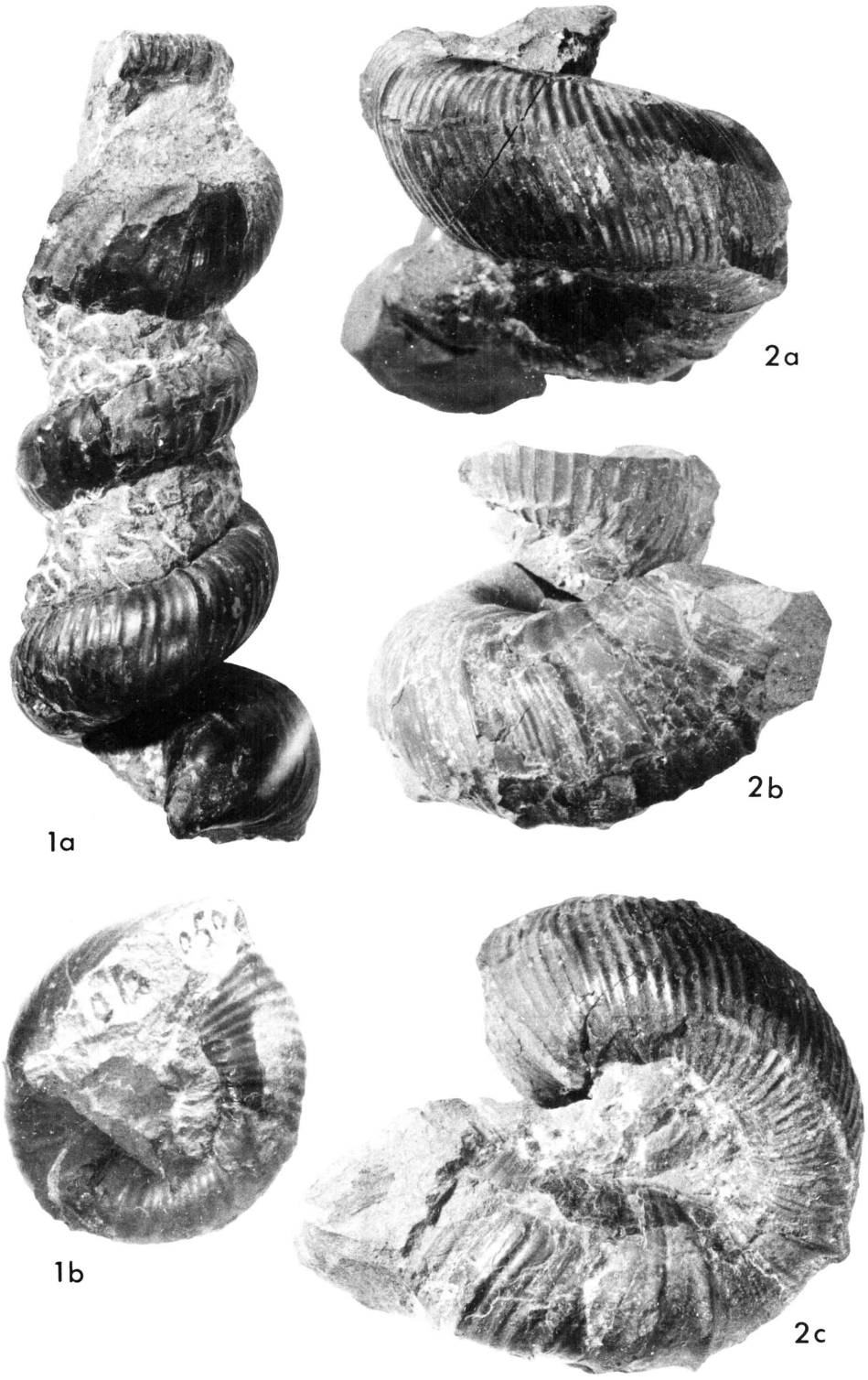

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in the helical part. Species with such freely coiled whorls like *E. japonicum* should have had another mode of living, although I do not know how it was.

Another interesting feature is that in some examined specimens the septa of the whorl of later growth-stages are often dissolved away even if the sutures remain. Whether this happened to occur secondarily or is concerned with a particular ability of this kind of sub-benthic hetermorph ammonoids (*Eubostrychoceras, Nipponites, Hyphantoceras,* etc.) is a problem to be worked out. Anyhow, on this account the true length of the adult living chamber apparently looks very long, even if the last suture be situated at about a half whorl behind the shell aperture.

Despite the apparently aberrant shell-form, *Eubostrychoceras* was a successful group of creatures which lived for a long period from Cenomanian to Campanian, giving rise to various species of a wide distribution which adapted themselves to certain ways of living. Moreover it probably was a root stock from which other aberrant forms like *Nipponites* and *Scalarites* were off-shooted.

Two species from Hokkaido with more or less freely coiled whorls are described below, in addition to the already described two species (i. e. *E. indopacificum* MATSUMOTO, 1967 and *E. muramotoi* MATSUMOTO 1967).

Eubostrychoceras japonicum (YABE)
Pl. 48, Figs. 1–4; Pl. 49, Figs. 1–3; Pl. 50, Figs. 1, 2;
Pl. 51, Figs. 1, 2; Pl. 52, Fig. 3

1904. *Heteroceras* (?) *japonicum* YABE, *Jour. Coll. Sci., Imp. Univ. Tokyo,* **20,** (2), p. 17, pl. 3, fig. 8.
1904. *Heteroceras* (?) *otsukai* var. *multicostatum* YABE, *Ibid.,* p. 16, pl. 3, fig. 9.

Holotype.—UMUT. MM7559 [=GT. I-249] (YABE, 1904, pl. 3, fig. 8) (original designation), from a floated calcareous nodule in the River Yubari.

Material.—In addition to YABE's original specimens, there are numerous specimens in subsequent collections. Especially the following specimens in T. and K. MURAMOTO's Collections (with prefix M) and certain others give a basis of a revised description: M14 [=NSM. PM-7220]* from Ob-S-pl, M23 [=NSM. PM-7229]* from Ob-S-Rp3, M24 [=NSM. PM-7230] from Ob-S-4p2, M25 [=NSM. PM-7231]* from Ob-S-Rp1, M26 [=NSM. PM-7232] from Ob-S-4p2,

* Illustrated

Explanation of Plate 50

Figs. 1–2. *Eurostrychoceras japonicum* (YABE) .....Page 329
1. NSM. PM-7251 [=M46 of T. MURAMOTO's Coll.], from loc. Ob-050-p6, main stream of the Obira. Lateral view of a helical shell, with *Inoceramus hobetsensis nonsulcatus,* ca ×1 (slightly reduced).
2. GK. H5796, from the Hakkin-zawa, Oyubari area (S. NAGAO and OSANAI's Coll. loc. 107B). Two lateral (a, b 180° rotated) and basal (c) views of the body-chamber, ×1.
Kyushu Univ. (H. HIRANO) photos, without whitening.

M27 [=NSM. PM-7233]* from Ob-S-1p, M30 [=NSM. PM-7236]* from Ob-S-3p5, M31 [=NSM. PM-7237]* from Ob-S-R1, M32 [=NSM. PM-7238] from Ob-S-4p2, M34 [=NSM. PM-7240] from Ob-S-p3, and M46 [=NSM. PM-7251] from Ob-050-p6, M84 from Ob-S-p2, M85 from Ob-S-p5, M86 from Ob-S-p4, M87 from Ob-S-p5, M88 from Ob-S-p2, M89 from Ob-S-p3, GK. H5797 from Ob-S-6p1, all T. MURAMOTO's Collection from the Obira area (those with Ob-S from a small tributary called the Sato-no-sawa). M28 [=NSM. PM-7234] from loc. Ik 1420, Ikushumbetsu, GK. H5796, from loc. 107B, Hakkin-zawa of Oyubari area (Coll. S. NAGAO and H. OSANAI, 1951), GK. H1400, from loc. Y132p1, Saku Formation of Shiyubari area (Coll. T. MATSUMOTO, 1939).

Diagnosis.—The shell in the main growth stages consists of helically coiled free whorls, with a fairly narrow umbilical perforation around the axis of coiling. The whorl enlarges gradually and accordingly the entire tower is tall, at least 2.5 times as high as the basal diameter. In more or less early growth stages** the axis of coiling deviates considerably from that of the main stage, showing about 40° (e. g. in M85) or even 90° (e. g. in M14) deviation, and a sinuous or semi-elliptical form may be seen at the intervening stage. The mode of coiling is fairly variable in the early stage as seen in some illustrated examples. Some have widely open whorl with a large diameter but others less so.

The last part of the body-whorl does not show a distinctly retroversal hook, but it generally follows and then gradually deviates from the main helical coiling, facing its end somewhat obliquely upward (as seen in M31 and GK. H5796).

The coiling is dextral or sinistral. In the examined specimens the dextral coiling is somewhat more abundant than the sinistral.

The whorl is subcircular in section. It is ornamented with numerous simple ribs which are separated by somewhat wider interspaces on the external side but very dense on the inner (i. e. dorsal) side. There is a certain extent of variation in rib density between individuals and also between different growth stages. The visible earliest half whorl (with height of 1.5–3.0 mm) has only simple ribs without flares. The obliquity of the ribs on this part is opposite to that of the later main part, showing a change at the intervening sinuous portion (see M14 for example). Flared ribs are frequent in the rest of the early growth-stages, becoming less frequent at various degrees in the main helical part, and finally very frequent and strong in the last part of the adult body-chamber. Near the very apertural margin even the flared ribs and the intervening finer ribs are all weakened (see GK. H5797). Constrictions are usually discernible along the flared ribs. No tubercles occur at all.

The siphuncle runs at about the middle of the external side or somewhat above that. The last suture is seen at about a half whorl or even less distance behind the apertural end, but the septa of the last one or two whorls are not preserved. This may be secondary but they might have been dissolved away in the adult stage. If so the animal body itself might have been long. Suture is of lytoceratid pattern and florid. L, U and the lateral saddles are bifid, deeply incised and narrowed at the stem.

** A shell of the very initial stage is not preserved in any of the examined specimens.

Occurrence.—The holotype is of uncertain horizon in the Oyubari area. Examples from the same and other areas in subsequent collections (Obira, Ikushumbetsu) show a Turonian age and some of them came together with *Inoceramus hobetsensis nonsulcatus*, an index of the lower part of Middle Turonian. The true range should be worked out.

Discussion.—YABE's holotype of this species is unfortunately fragmentary, consisting of only one and a half whorl of a middle growth-stage. It has a distinct flared rib, associated with a constriction and another indistinct, somewhat stronger rib. Some of the better preserved specimens in subsequent collections, including those from the type Oyubari area (e. g. GK. H1400, GK. H5796) show characters as those of the holotype in the middle growth-stage and I regard them specifically identical with the holotype. To use one of YABE's specific name with revised definition is better than to disregard the incomplete holotype and introduce a new name, unless a clear distinction be found.

The variation shown in the middle growth-stage is not so great as that in the early stage, although some range is found in the whorl diameter, narrowness of umbilicus, degree of separation between whorls, and frequency of flared ribs. In some examples (e. g. M25) the flared ribs temporarily stop to occur for nearly a full whorl of the middle stage, although they do occur in earlier and later growth-stages.

The variation in the early growth-stage is remarkable and this may suggest a plasticity which could give rise to *Scalarites scalaris* (YABE). In fact many examples with widely open whorl and frequent flared ribs in an early stage (e. g. M26, M27, M85, etc.) show a form similar to that of *S. scalaris*, although they turn to a narrower helical coiling in the main part (Pl. 50, Fig. 1). Some others show a subelliptical and twisted whorl (e. g. M14, Pl. 51, Fig. 2).

Although completely preserved specimens are few, there are several examples (e. g. GK. H5796 and M31) (Pl. 52, Fig. 2; Pl. 53, Fig. 2) which certainly represent the last growth-stage. Another specimen (Pl. 53, Fig. 1), J. TESHIMA's No. Ho-0604, which is larger but similar to M31, is probably another example of the last stage. They show the characters described in the diagnosis and no distinctly retroversal hook has been recognized in any example of the present species. In the above specimens no septum is discernible for more than one whorl, but in M31 sutures without preserved septa are observable at about 2/3 whorl (and more) behind the aperture.

The distinction of *E. japonicum* from *E. otsukai* (YABE) is not clear. The holotype (UMUT. MM7551 [=GT. I-243]), from the Santonian of Kikumezawa, Ikushumbetsu, of *E. otsukai* (YABE, 1904, p. 14, pl. 4, fig. 1) is incompletely preserved and was much restored in YABE's illustration. It consists of two narrowly coiled, slightly separated helical whorls and the last part of the second whorl with flared ribs approaching more closely to the first with its aperture facing somewhat obliquely upwards. This holotype has numerous, fairly sinuous and oblique ribs in which bifurcation and insertion occur frequently. This mode of ribbing seems to be outside the extent of variation of *E. japonicum*. If this distinction is admitted, YABE's paratype (UMUT. MM7556 [=GT. I-244]) from

the Yubari and the holotype (UMUT. MM7558 [=GT. I-246]) and the paratype (UMUT. MM7557 [=GT. I-245]) of *Heteroceras otsukai* var. *multicostatum* YABE (1904, p. 16, pl. 3, fig. 9; pl. 4, fig. 3; pl. 6, fig. 8) are better ascribed to *E. japonicum*.

The specimen from the Campanian Toyajo Formation described under *Bostrychoceras japonicum* by YABE (1915, p. 17, pl. 1, figs. 4–6) is not referable to *E. japonicum* defined here but probably a young shell of *E. elongatum* (WHITEAVES) because of its contiguous or almost contiguous whorls and distant prominent ribs.

Eubostrychoceras densicostatum sp. nov.
Pl. 52, Fig. 2

Material.—Holotype, M90 of T. MURAMOTO's Collection found by SUZUKI at loc. 1172, a small southern tributary near "9 km point" of the Ikushumbetsu and then transferred to T. MURAMOTO. There are a few other fragmentary specimens which are comparable with this species.

Diagnosis.—The holotype is a large turreted shell containing at least four helical whorls, but the initial part is missing and only a portion of the last whorl is preserved. The coiling is sinistral in this specimen.

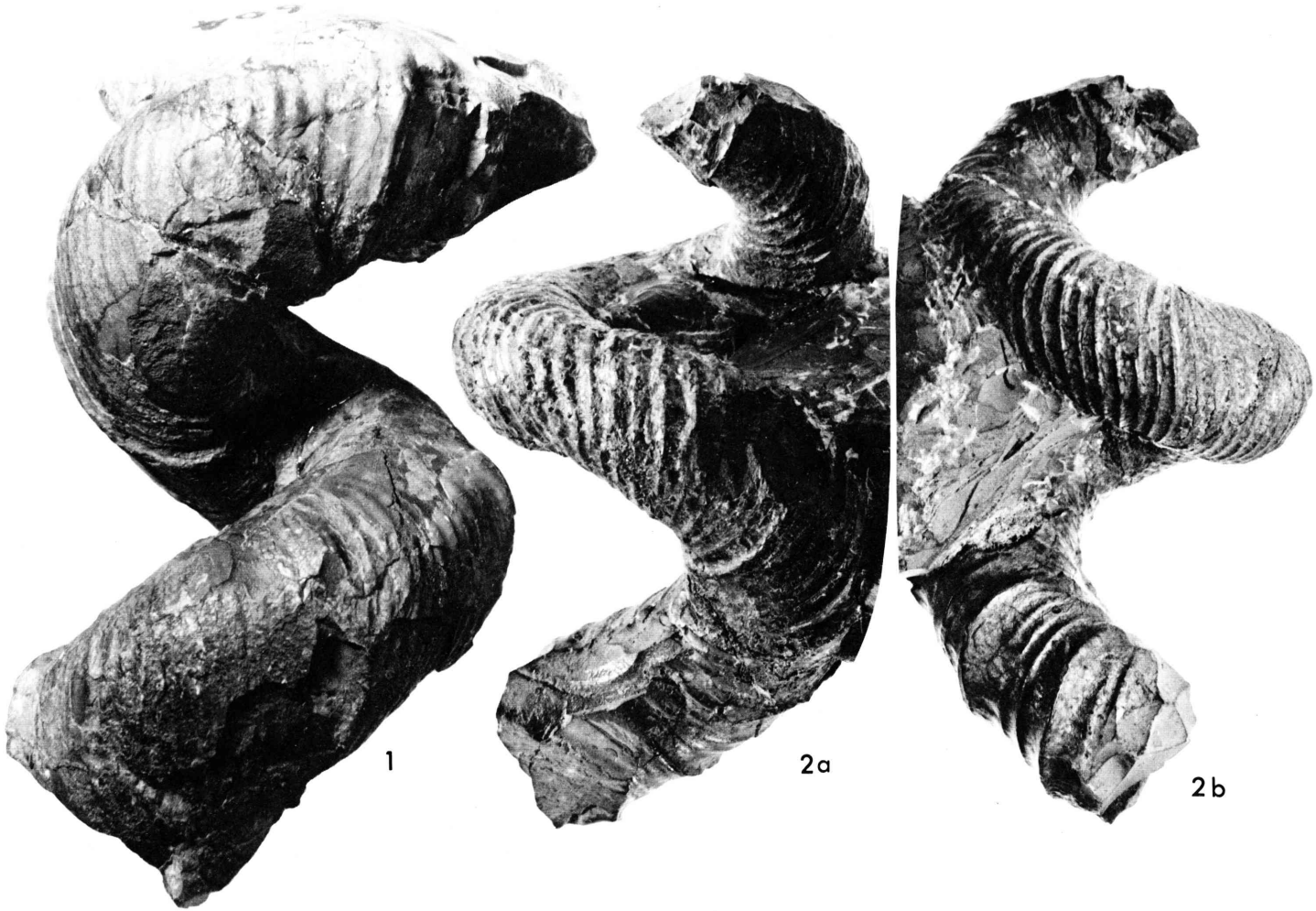
At a comparatively earlier stage of the preserved shell the whorl shows a moderately open spire and is separated considerably from the next one. It is subcircular in cross-section. The whorl enlarges considerably with growth, especially in breadth (i. e. along the axis of coiling) and the separation of adjacent whorls becomes relatively narrower. On the other hand the whorl increases slightly in diameter at later growth-stages and the umbilicus becomes narrower. The whorl-section in later stages is oval and elongated in parallel with the axis of the helix.

The body-chamber occupies somewhat more than one volution and its last part does not seem to be much separated to form a retroversal hook, although the last part is only insufficiently preserved.

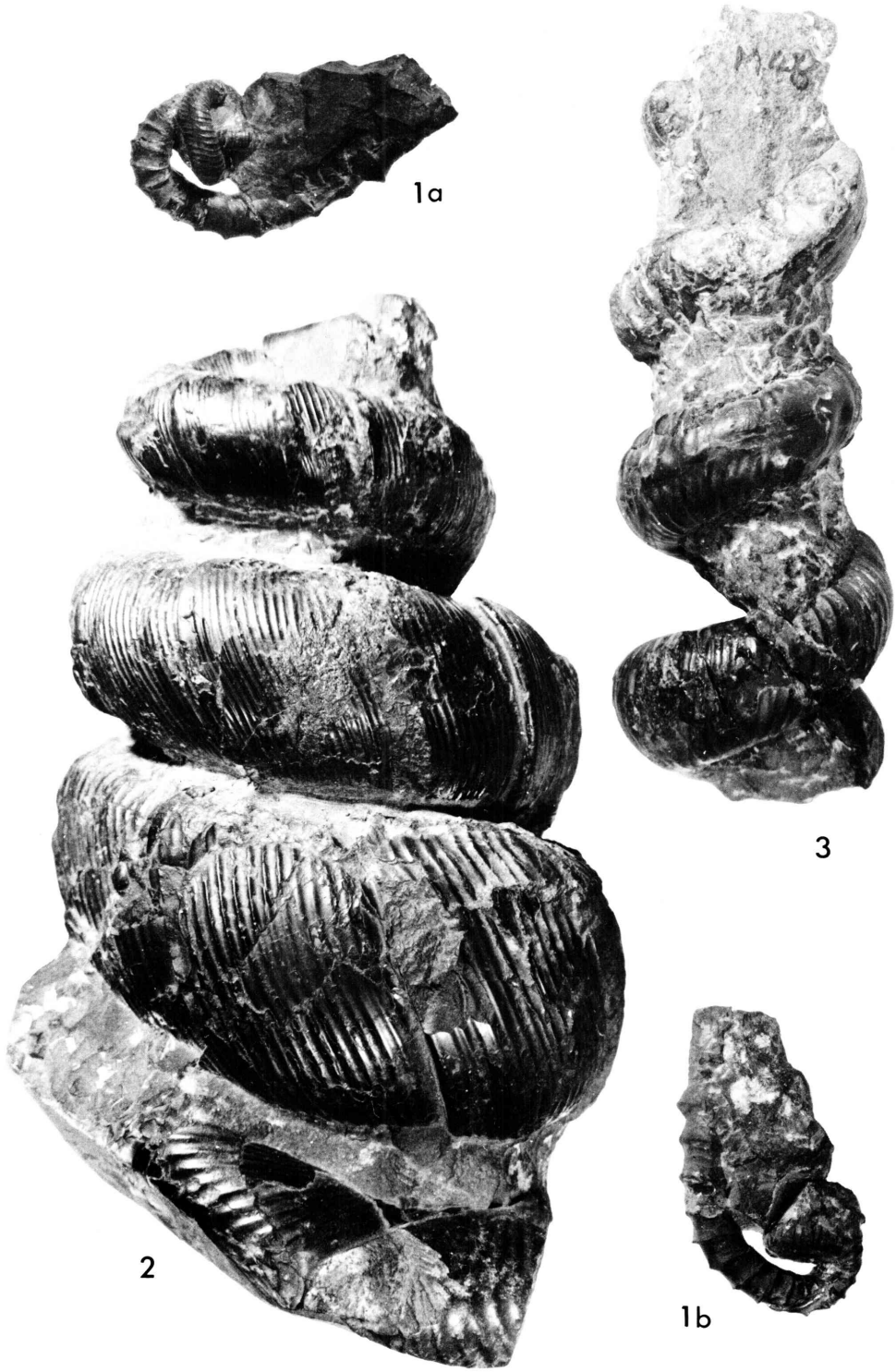
The rounded external surface of the whorl is ornamented with numerous dense ribs and periodic constrictions. The ribs are mostly simple but occasionally bifurcated or inserted near the upper shoulder. They are oblique and gently sinuous on the external surface and gradually bent at the upper and the lower shoulders. They are rursiradiate on the upper umbilical margin. The number of the ribs within the distance as long as the whorl-breadth is 18 (average)

Explanation of Plate 51

Figs. 1, 2. *Eubostrychoceras japonicum* (YABE) ..... Page 329
Two examples of the last part (body-chamber) of a cork-screw like form, ca. ×1 (slightly reduced).
1. Ho-0604 of J. TESHIMA's Coll., from Inasato, Hobetsu area.
2. NSM. PM-7237 [=M31 of T. MURAMOTO's Coll.], from the Sato-no-sawa, Obira area. a, b 180° rotated.
Kyushu Univ. (H. HIRANO photos), without whitening.



T. MATSUMOTO: Heteromorph ammonites



T. MATSUMOTO: Heteromorph ammonites

on the preserved first whorl, 20 in the second, and 22 in the third. The ribs are as narrow as or slightly narrower than the interspaces. They are as a rule regularly disposed; at one place there is a disorder which may have been caused by injury.

The constrictions are considerably frequent on the preserved first and the second whorls, five or so per half whorl, but less frequent in the third and probably also in the fourth. Each of them is extremely asymmetric in section, with a very gentle posterior inclination and a steep, almost vertical or even overhanging anterior wall. The latter is accompanied with an asymmetric flare. This gives rise to a posteriorly overlapping scale-like aspect. The constriction and the accompanied flare are slightly less oblique than the ribs, cutting a few of the adjacent ribs.

No tubercle is developed on any flare and any rib, as far as the preserved part is concerned.

A partly exposed suture shows a florid, lytoceratid pattern.

Measurements.—

Stage	Diameter	Height	Breadth
Preserved 1st	75.0×60.0	20	22.5
〃 2nd	105.0	—	41.0
〃 3rd	122	—	59.0

Occurrence.—The locality record indicates that the holotype came from the Santonian main part of the Upper Yezo Group of the Ikushumbetsu area, central Hokkaido. No other mega-fossils, except for a very small bivalve, are contained in the rock matrix of calcareous mudstone.

Discussion.—This species is somewhat allied to *Eubostrychoceras saxonicum* (SCHLÜTER), from the Turonian Scaphitenpläner of Germany (SCHLÜTER, 1872, p. 135, pl. 35, fig. 10), the Coniacian of Madagascar (COLLIGNON, 1965, p. 10, pl. 418, fig. 1724) and the Turonian of Japan in its dense numerous ribbing and rapidly growing whorl-breadth, but is distinguished by its uncontiguous whorls, wider coiling in an early growth-stage and remarkable constrictions and flared ribs occurring frequently throughout growth. The holotype is evidently outside the extent of variation of *Eubostrychoceras japonicum* (YABE) emended above.

Explanation of Plate 52

Fig. 1. *Muramotoceras laxum* gen. et sp. nov. ..... Page 337
NSM. PM-7239 [=M33 of T. MURAMOTO's Coll.], hototype from Ob-S-1-pl, Sato-no-sawa, Obira area, ×1.

Fig. 2. *Eubostrychoceras densicostatum* sp. nov. ..... Page 332
Holotype, T. MURAMOTO's Coll. from Ik 1172, near 9 km point (abandoned forestry railway), Ikushumbetsu, ×0.75.

Fig. 3. *Eubostrychoceras japonicum* (YABE) ..... Page 329
NSM. PM-7251 [=M46 of T. MURAMOTO's Coll.], from loc. Ob-050-p6, main stream of the Obira. Another lateral view (rotated 180° from Pl. 50, Fig. 1), ca. ×1 (slightly reduced).

Kyushu University (H. HIRANO) photo, without whitening.

It cannot be overlooked that this species resembles an undescribed, unusual species of *Hyphantoceras* from the Santonian of the Naibuchi area, South Saghalien, which I mentioned in the discussion of *H. heteromorphum*. In that species the later whorls have numerous dense ribs and scale like constriction and look similar to the whorls of the present species, but the early whorls are more widely opened and have finer ribs and tuberculate flared ribs as in the holotype of *Hyphantoceras venustum* (YABE) (1904, pl. 5, fig. 1). As no tubercle is developed in the present species, I should refer it to *Eubostrychoceras*. Its whorl of the early stage is less widely opened and its entire shell is much larger than that nearly contemporary species. As the character of the earliest stage is unknown and as the material from Hokkaido is not sufficiently numerous, the true relationship of the two species should be worked out in the future.

Genus ***Muramotoceras*** nov.

Type-species.—*Muramotoceras yezoense* sp. nov. (described below).

Etymology.—This genus is dedicated to Mr. Tatsuo MURAMOTO.

Generic diagnosis.—The shell is at first nearly straight, gently sinuous or arcuate and then abruptly turns to a helical coiling with the axis at about the first straight arm. Sooner or later the helical coiling goes in such a way as to have the orientation of its axis reversed against that of the preceding helical coiling. The body-chamber is on the extension of the second helical coiling (in the type-species), or is so loosen as to form an arcuate (or possibly hamitoid) arm (in another species).

The ribbing is fine and simple in the earlier half (on the nearly straight part and on the early part of the helical whorl), with some intercalated shorter ones on the strongly bent part. In the later half distant flared ribs with ventrolateral tubercles are diagnostic and in addition there are several faint riblets on each interspace. Indistinct umbilical (or inner lateral) tubercles may be discernible on the flared rib, whereas the ventrolateral ones may be sharply spinose, with a septate base.

The whorl section at the intercostal part is subcircular. The suture consists of E, L, U and I. I is small and trifid. Other lobes and saddles are bifid. L, U and the first and the second lateral saddles are narrowed at their stem. In the late growth-stages the suture is finely and deeply incised and looks florid.

Remarks.—So far as the available material is concerned, this genus contains two species (described below), from the Middle Turonian of Hokkaido.

Discussion.—The helical coiling and the characteristic ornamentation of the late growth-stage suggest the similarity of this genus to *Hyphantoceras* but its last whorl does not show a retroversal hook and the tuberculation is not of the same type as that genus.

With respect to the same diagnostic characters in the late growth-stage of the type-species, the present genus is closely allied to Santonian *Jouaniceras* BASSE, 1939, and Campanian *Ainoceras* MATSUMOTO, 1967, but differs from them in the mode of coiling and ornamentation of the early growth-stages. The peculiar mode of coiling and simple ribbing without tubercles in the early

growth-stage of this genus remind us of the young part of *Eubostrychoceras*, as represented by *E. muramotoi* MATSUMOTO and *E. woodsi* (KITCHIN) and also a high plasticity in youth of *E. japonicum* (YABE) emend.

Whether *Yezoceras* is a derivative of *Hyphantoceras* or that of *Eubostrychoceras* is hardly decided, but I am inclined to the latter interpretation.

Although there are considerably numerous specimens which are referable to the type-species, I have seen no example which shows a transitional character between that type-species and its possible ancestral species.

Muramotoceras yezoense sp. nov.
Pl. 53, Figs. 1–5; Pl. 54, Fig. 1; Text-figs. 6, 7

Material.—Holotype, NSM. PM-7207 [=M1 of T. MURAMOTO's Collection], from loc. Ob-S-R1-2p (Sato-no-sawa), Obira area, northwestern Hokkaido. Paratypes, NSM. PM-7208 [=M2], NSM. PM-7211, 7212 [=M5, M6] NSM. PM-7213 [=M7], NSM. PM-7214 [=M8], NSM. PM-7215 [=M9], NSM. PM-7216 [=M10], NSM. PM-7217 [=M11], NSM. PM-7218 [=M12] and NSM. PM-7219 [=M13], all T. MURAMOTO's Coll., from loc. Ob-S-R1-2p (Sato-no-sawa), Obira area; NSM. PM-7263 [=M60], from Yy 050p, and NSM. PM-7274 [=M71] both T. MURAMOTO's Coll., Isojiro-no-sawa, Oyubari area, central Hokkaido. GK. H5652 from loc. Ob-S-R1-2p, Obira area (T. MURAMOTO's Coll.). There are other probably identifiable examples in Y. FUJISHIMA's collections from loc. YF 7403 (=Y5501), the Isojiro-zawa, Oyubari area, preserved at the Geological Museum of the Hokkaido Colliery and Steamship Co. (e. g. HCS. No. 54).

Diagnosis.—The shell is rather small, about 50 mm in diameter at the preserved last whorl of the holotype, which probably represents the adult stage. The known maximum diameter is 65 mm in an example (HCS. No. 96) from the Isojiro-zawa. Many other paratypes are smaller and probably immature.

This species shows a peculiar but fairly constant shell form, which is subdivisible into at least three stages (probably four stages) in addition to the unknown very initial one.

The shell of the preserved first stage is nearly straight, slightly sinuous, or gently curved in an inverse J-form up to the shell breadth of about 2.0–2.5 mm. It is about 10–12 mm along the longer arm, showing moderate tapering, and nearly circular in cross-section. It is ornamented with fine, rather crowded annular ribs.

At the next stage the shell is abruptly turned to a helical coiling. The first whorl up to the diameter of 12–17 mm is ornamented with numerous, oblique, fine ribs, with intercalated shorter ones at the strongly bent transitional substage. The extent of this finely ribbed stage may be somewhat variable, for slightly less than 300° (in the holotype and several of the paratypes) to nearly 360° (or more ? in an extreme case) but is sooner or later followed by a more or less short intermediate substage at which the ribs become moderately distant and moderately strong, showing slight flares at the ventrolateral parts. A few fine minor ribs may be inserted on the interspace.

The shell of the third stage consists of at least two helical whorls which

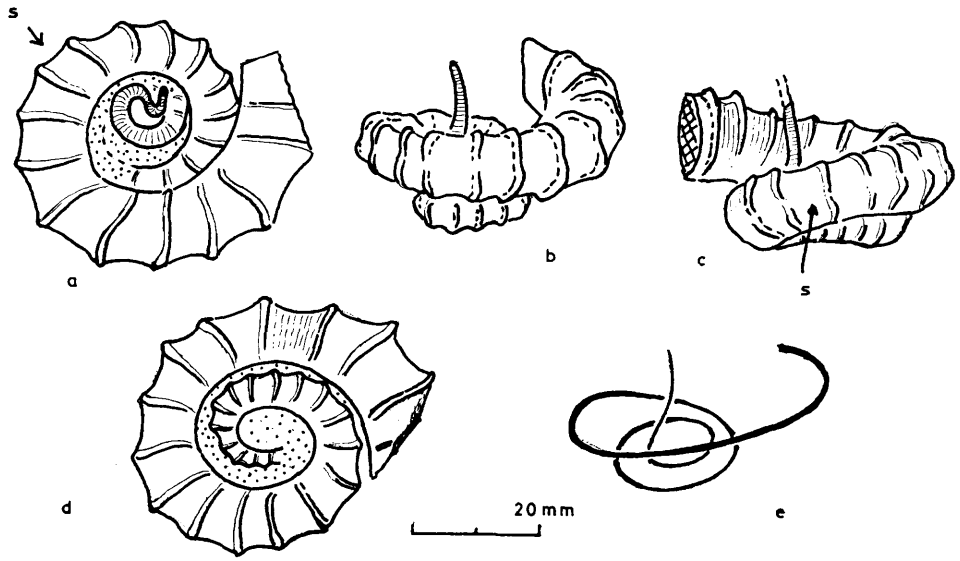


Fig. 6. *Muramotoceras yezoense* gen. et sp. nov. Diagrammatic sketch of the holotype, NSM. PM-7207, showing four different views (a-d) and the mode of coiling (e). s=position of the last suture. (T. M. *delin.*)

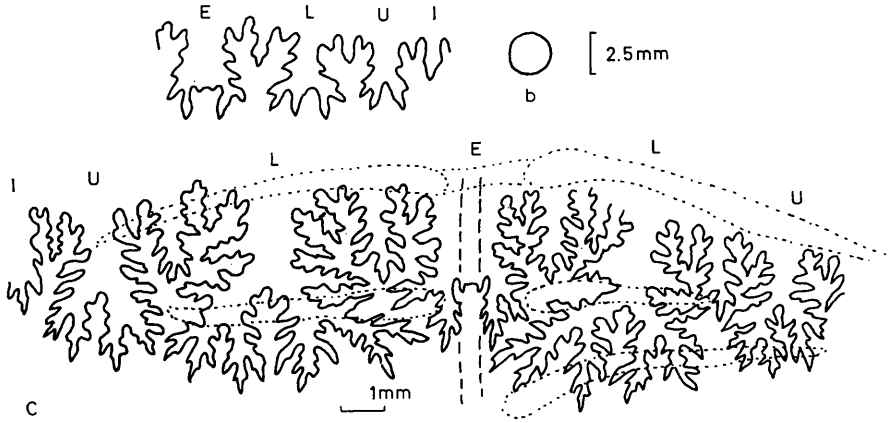


Fig. 7. *Muramotoceras yezoense* gen. et sp. nov. Suture (a) and whorl-section (b) of an immature stage at whorl-height=2.5 mm; suture of a late growth-stage at whorl-height=6 mm of NSM. PM-7219. (T. M. *delin.*)

roughly follow the whorl of the preceding stage, coiling around the nearly straight arm of the first stage, but the three helical whorls are not strictly parallel. In the holotype they are coiled in such different curved planes as to make the second whorl to be disposed at the highest level and the last part of the third whorl at the lowest level, being nearly as low as the beginning of the straight arm. In other specimens the mode of coiling is essentially similar to

but not exactly the same as that of the holotype. For instance, in some specimens (e. g. M2, M5 and GK. H5652) the first helical whorl (of the second stage) occupies the highest part of the turreted shell. At any rate the adjacent helical whorls are not much separated and may be very close to or about to touch each other at one point. The whorl is subcircular to thick elliptical (slightly H>B) in the intercostal section. It enlarges moderately with growth. The living chamber forms a part of the last helical whorl, occupying at least 240° in the holotype. The character of the very apertural margin is not known.

The ornamentation of the third stage (including the living chamber) is diagnostic. It consists of distant strong ribs, 15 or so per whorl, and very fine minor ribs on the interspaces. The major ribs are coarse on the internal mould but sharply raised on the test. They have ventrolateral flares which may be strongly spinose in some cases and the ribs are somewhat lowered between a pair of ventrolateral tubercles. In addition to them lower lateral or umbilical weaker flares may be discernible on some specimens. They may not be symmetrically disposed. The ribs run somewhat obliquely around the whorl, although narrowed and lowered on the dorsal side. The minor ribs are so fine that they may be scarcely discernible on the internal mould.

The suture is as described in the generic diagnosis.

Occurrence.—The fossils of this species are found at two localities. The type-locality is in a small right branch of the Sato-no-sawa, a tributary of the Kami-kinembetsu, a main tributary of the River Obira. It is assignable to the lower part of the zone of *Inoceramus hobetsensis*, with which *Inoc.* (*Mytiloides*) *teraokai* and *Yubariceras* cf. *yubarense* are associated (see also MATSUMOTO et al. 1977). The other locality is at loc. Y5501 in the Isojiro-no-sawa, a tributary of the River Yubari, in the Oyubari area. It is assignable again to the lower part of the zone of *Inoceramus hobetsensis*. A large form of *I. hobetsensis* characterizes the upper part of the same zone in which *Romaniceras yezoense* MATSUMOTO (GK. H5854 from loc. Y5509, K. TANABE Coll.) was obtained.

Discussion.—This species is so peculiar that a new genus is established for it. Judging from its characters, it can be presumed to have been derived from some species of *Eubostrychoceras*, but it seems to have appeared so suddenly without recognizable transitional form.

When the animal was alive, the shell may have been disposed to let the living chamber be in the lower part and the septate gas chambers in the upper part. The spinose flared ribs may have been useful for setting the shell on the bottom during the resting time. The up-and-down locomotion may have been possible by adjusting the gas in the septate part, although the peculiar shell-form may have been unfavourable for rapid swimming. The mode of occurrence in cluster in muddy sediments also suggests a mainly benthic life.

Muramotoceras laxum sp. nov.

Pl. 45, Figs. 1, 2; Pl. 52, Fig. 1; Text-fig. 8

Material.—Holotype, NSM. PM-7239 [=M33 of T. MURAMOTO's Coll.], from loc. Ob-S-1-p1, Obira area, northwestern Hokkaido. Paratypes, NSM. PM-7209

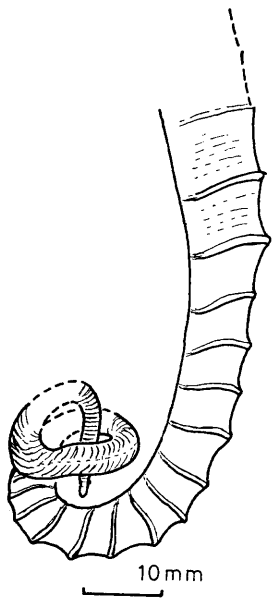


Fig. 8. *Muramotoceras laxum* gen. et sp. nov. Diagrammatic sketch of the holotype, NSM. PM-7239. (T.M. *delin.*)

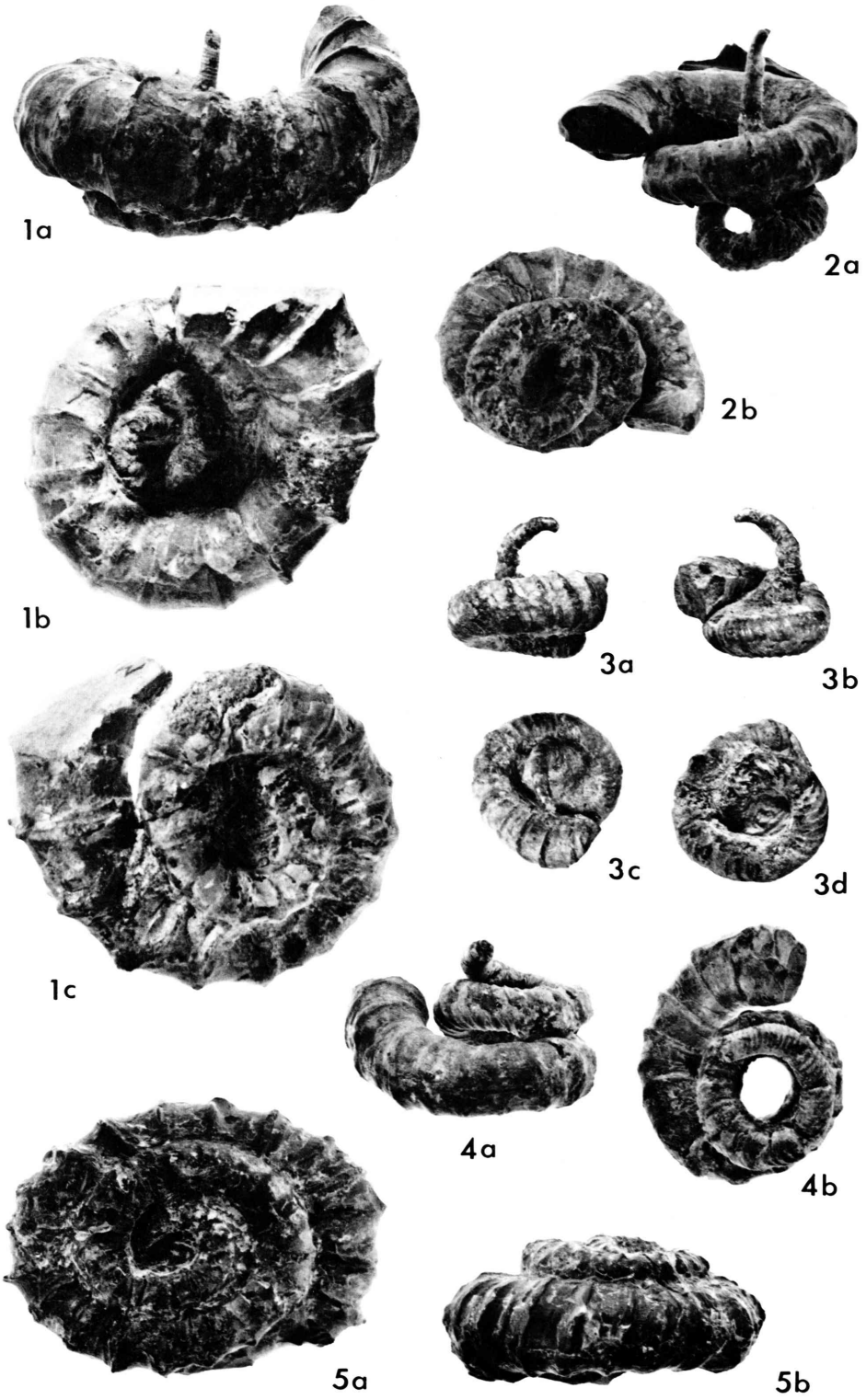
and PM-7210 [=M3 and M4 of T. MURAMOTO's Coll.], from loc. Ob-S-R2p of the same area. Probably identifiable examples, NSM. PM-7223 and PM-7224 =[M17 and M18], from loc. Ob-S-R1-p3 of the same area.

Diagnosis.—The characters of the shell change with growth and can be described under at least three stages, apart from the unpreserved very initial stage.

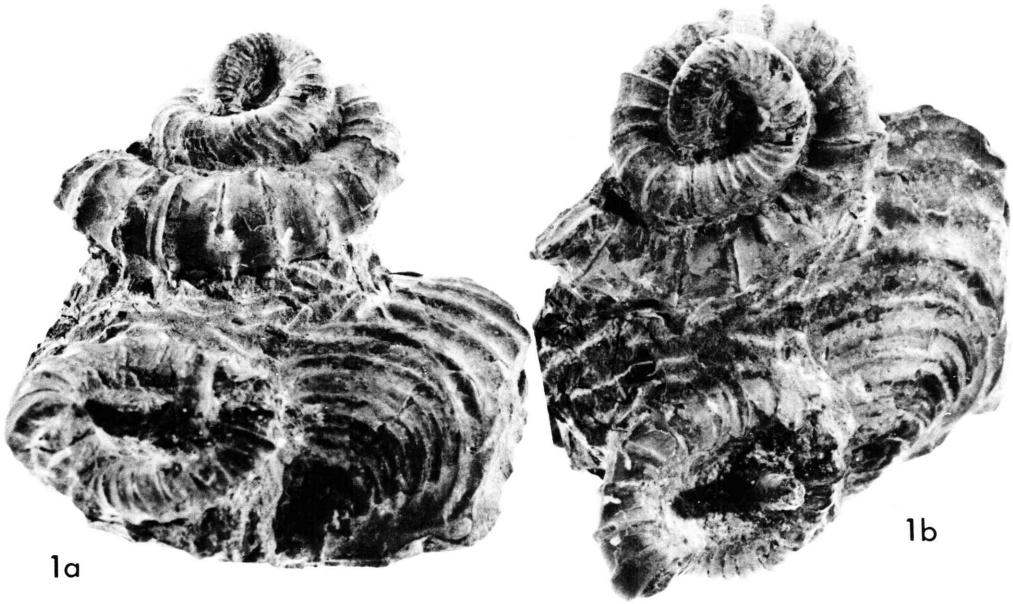
At the preserved first stage, up to the shell-breadth of 2.5 mm or so the shell is nearly straight or gently sigmoidal, with a circular cross-section and a moderate tapering. The ribs at this stage are fine, rather crowded and annular,

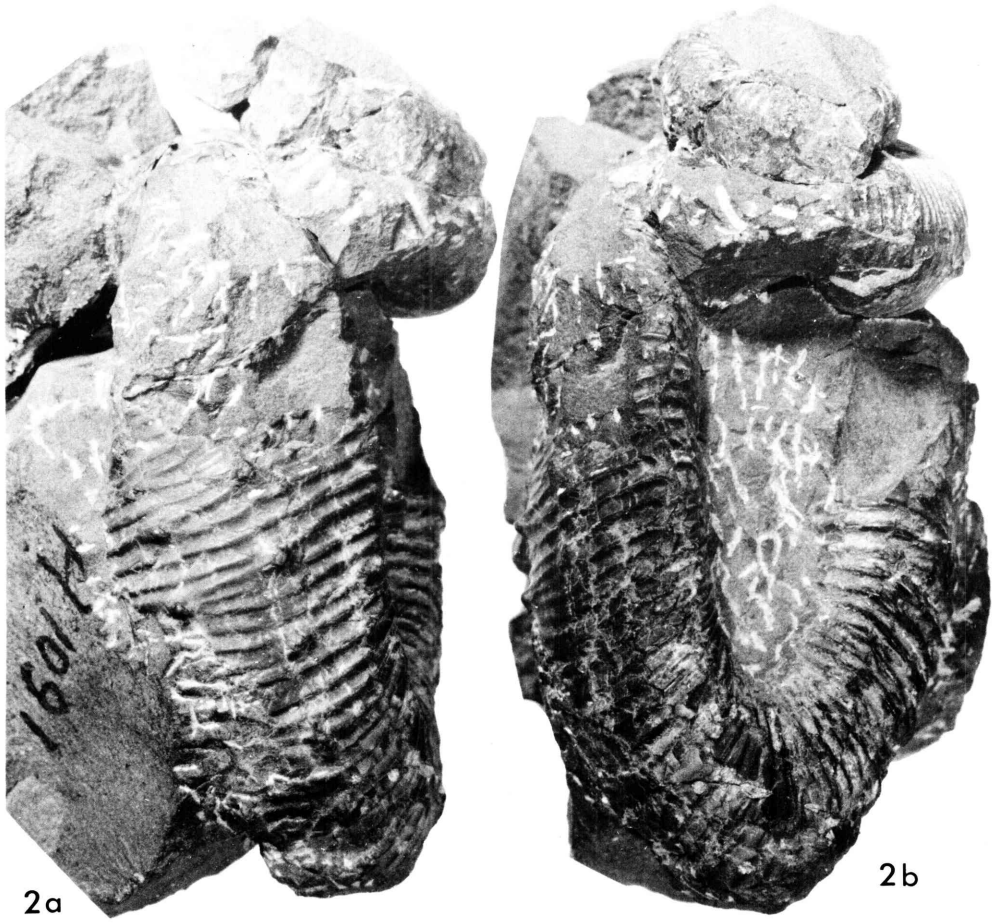
Explanation of Plate 53

Figs. 1–5. *Muramotoceras yezoense* gen. et sp. nov. .....Page 335
All T. MURAMOTO's Collection.
1. NSM. PM-7207 [=M1 of MURAMOTO], holotype, from loc. Ob-S-R1-2p, Sato-no-sawa, Obira area, Lateral (a), lower (b) and upper (c) views, ×1.2.
2. NSM. PM-7208 [=M2], from the type-locality. Lateral (a) and upper (b) views, ×1.5.
3. NSM. PM-7213 [=M7], from the type-locality. Two lateral (a, b 180° rotated), lower (c) and upper (d) views, ×1.5.
4. NSM. PM-7219 [=M13], from the type-locality. Lateral (a) and upper (b) views, ×1.5.
5. NSM. PM-7264 [=M60], from loc. Yy 050p. Isojiro-no-sawa, Oyubari area. Lower (a) and lateral (b) views, ×1.
The position of the adult body-chamber is conventionally called here lower. It follows that the specimens of Figs. 1–4 are placed upside down.
Photos by T. HOSHINA, without whitening.



T. MATSUMOTO: Heteromorph ammonites





T. MATSUMOTO: Heteromorph ammonites

running vertically to the axis of growth.

At the next stage the shell shows a remarkable U-turn and then rapidly changes to form a helical coil around the nearly straight shaft of the first stage. The coiling is sinistrally (holotype) or dextrally (paratypes) downward. The ribs are fine, fairly crowded and highly oblique at this stage. The whorl-breadth ranges from about 2.5 mm to 4.5 mm at this helical stage.

Then the shell forms another strong U-turn and then merges to a gently arcuate form. It may finally end with a hamitoid shaft, but such a presumed last part is not preserved in the holotype and should be sought in future collections. The gently arcuate arm, which represents the main part of the living chamber, is about 50 mm in length in the holotype, enlarging fairly rapidly in breadth and height with growth. The gently arcuate main part of the living chamber is missing in the paratypes, although its posterior portion is preserved. Anyhow at this stage crowded fine ribs are faintly perceptible on the test or almost imperceptible or lost on the internal mould, but in stead, raised major ribs are developed at more or less great distance. The major ribs are somewhat flared to form three rows of tubercle like elevations, two on the venter and a weaker one on the midflank of one side.

Occurrence.—Sato-no-sawa, Obira area, probably Middle Turonian.

Discussion.—This species is distinguished from *Muramotoceras yezoense* by its poor development of the helical whorls and its elongate arcuate body-chamber.

As the two species occur in generally the same place, if not at the identical spot, the specific distinction could be doubted. Although a considerable variability is observable in *M. yezoense*, no gradation is found between the two forms.

Genus *Nipponites* YABE, 1904

Type-species.—*Nipponites mirabilis* YABE, 1904.

Generic diagnosis.—A few helically coiled small whorls at the initial stage are followed in the main part by succession of U's in three dimensions, forming an apparent tangle. The adult body-chamber ends in the last U (in the type-species) or descends to form a retroversal hook (in another species, i. e. *N. bacchus*).

The whorl is ornamented with single regular, more or less oblique ribs and constrictions or flared ribs as in *Eubostrychoceras*.

Explanation of Plate 54

Fig. 1. *Muramotoceras yezoense* gen. et sp. nov. ..... Page 335
NSM. 7215 [=M5 of T. MURAMOTO's Coll.], from loc. Ob-S-R1-2p, Sato-no sawa, Obira area. Lateral (a) and upper (b) views, ×1.5. NSM. 7216 [=M6] and *Inoceramus* (*Mytiloides*) *teraokai* are associated.

Fig. 2. *Nostoceras hetonaiense* sp. nov. ..... Page 322
GK. H5798a, holotype, from loc. H1091p, Tonai-no-sawa, near Osachinai (T. MATSUMOTO's Coll.), ×1.

Photos by T. HOSHINO (1) and H. HIRANO (2), without whitening.

The siphuncle runs at about the middle of the external side. The suture of E, L, U, I type, bifid (except for I), and deeply and finely incised, resulting in a narrowed stem of the elements.

Distribution.—The genus is found occasionally in the Turonian and the Coniacian of Japan. Fine examples have been reported also in Saghalien and Kamchatka (KAWADA, 1929; DURCZIC and PERGAMENT, 1963; VERECHAGIN et al., 1965). Although the occurrence in England and Madagascar is recorded, I have not yet confirmed it with unmistakable examples.

Remarks.—Two species are distinguished, *N. mirabilis* YABE, 1904 from the Middle Turonian and *N. bacchus* MATSUMOTO et MURAMOTO, 1967, from the Upper Turonian and the Coniacian.

Discussion.—Judging from the general characters, *Nipponites* can be interpreted to have been offshooted from *Eubostrychoceras*, but I have found no example which shows a transitional stage. The evolution from *N. mirabilis* to *N. bacchus* could be considered but has not yet been confirmed with sufficient evidence.

Nipponites mirabilis YABE

Pl. 44, Fig. 4; Pl. 55, Figs. 2, 3; Pl. 56, Figs. 1, 2; Text-fig. 9

1904. *Nipponites mirabilis* YABE, *Jour. Coll. Sci., Imp. Univ. Tokyo*, **20**, (2), p. 20, pl. 4, figs. 4–7; pl. 6, fig. 6.
1926. *Nipponites mirabilis*, SHIMIZU, *Proc. Imp. Acad.*, Tokyo, **2**, (10), p. 548.
1929. *Nipponites mirabilis* var. *sachaliensis* KAWADA, *Jour. Geol. Soc. Tokyo*, **36**, p. 5, pl. 14, figs. 1, 5.
1963. *Nipponites mirabilis*, DRUCZIC and PERGAMENT, *Paleont. Jour.*, **2**, p. 39, text-figs. 1–3.

Holotype.—UMUT. MM7560 [=GT. I-253], from the Obira [=Opiraushibets], northwestern Hokkaido.

Material.—GK. H5846, from loc. T1022p, Saku-gakko-no-sawa, Saku Formation, Saku area (K. MURAMOTO Coll.) and HCS. No. 52, from Oyubari-gakko-no-sawa, Oyubari area (Y. FUJISHIMA Coll.) are the specimens as finely preserved as the holotype. Other examples are GK. H5847, from loc. T1029p. (T. MURAMOTO's Coll.), GK. H5848, from loc. T42, GK. H5849 from loc. T1022p4 (T. MATSUMOTO Coll.) and GK. H5850 of I. HAYAMI's Coll. 3534 from the Saku Formation, Saku area; GK. H5852 from loc. R2105e, main stream of the Obira (Coll. T. MATSUMOTO and H. HIRANO) and GK. H5653 from loc. R4525, Nakakinembetsu (Coll. T. TAKAHASHI) from the Obira area. I have seen some other specimens in the private collections of several persons.

Description.—The whorls of the early low helix are uncontiguous, dextral or sinistral, and sooner or later followed by the succession of U-curved whorls which are disposed in three dimensions around the early helix. There are at least 5 U's in smaller examples of about 40–50 mm in shell diameters and 8 or more in larger examples of about 70 to 75 mm in the maximum diameter of the shell. The limbs of the U-curve are closer to each other in the distal part than the proximal part of U. The adjacent U-curved whorls are about to touch

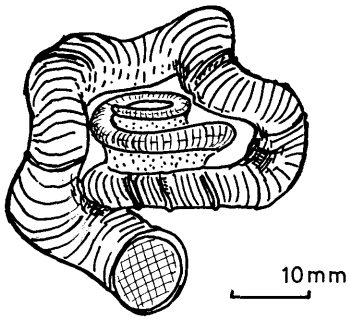


Fig. 9. *Nipponites mirabilis* YABE. Diagrammatic sketch of a small, probably immature, somewhat loosely coiled example, GK. H5853 (T. TAKAHASHI's Coll.), in which helical early whorls are well developed. Dotted=rock matrix; thin broken-line=siphonal line. (T.M. *delin.*)

or even distinctly touch each other in some specimens, but somewhat separated in others (e. g. GK. H5853), showing variation in this respect. The holotype and GK. H5846 (illustrated in this paper) represent the mean. Typically the entire shell looks fairly compact, leaving the least space between the U-curved whorls.

The body-chamber occupies the entire part of the last U plus alpha.

The whorl-section is subcircular or subelliptical; somewhat broader than high (e. g. H=24, B=28 mm) in the latter case.

The ribs on the early helical whorl are very fine and dense, but soon become moderately distinct on the later part of the helix. On the main part of the shell the ribs are moderately distinct, sharp-headed on the test and of moderate density, numbering 6 on the siphonal side within the interval as long as the whorl-breadth. On the internal mould and on the antisiphonal side they look weak. They are more or less oblique and sinuous, depending on the curvature of the whorls.

Constrictions may occur infrequently on the septate shell and are accompanied by flared ribs. In a few specimens (e. g. GK. H5853) they are more frequent than other typical ones. On the adult body-chamber the flared ribs are distinct and frequent.

The suture is of E, L, U, I lytoceratid type. L and the external saddles on either side are bipartite, deeply and finely incised and narrowed at their stem.

Occurrence.—The available records in Hokkaido show that *Nipponites mirabilis* occurs in the Zone of *Inoceramus hobetsensis*, approximately Middle Turonian. In the Obira area, where YABE's original specimen came, the species occurs in the lower part of the Zone of *Inoc. hobetsensis*, although the type-locality was not precisely recorded. The fossils are found not only in the silty mudstone but also in the silty sandstone.

Discussion.—In the subcircular to subelliptical whorl-section, the mode of ribbing, the appearance of flared ribs and the pattern of the suture, and especially in the characters of the early stage, *Nipponites mirabilis* is somewhat allied to

contemporary *Eubostrychoceras japonicum* (YABE) whose early whorls are variably irregular as described in another page. I have seen, however, no transitional form which could link the former with the latter.

Through the study of a number of specimens, I conclude that YABE's (1904) original description was essentially correct. Although there is a certain extent of variation as described above, there is a regularity in the aberrant shell form which is particular to the present species.

The distinction of *N. mirabilis* from *N. bacchus* was described previously (MATSUMOTO and MURAMOTO, 1967, p. 365). What was illustrated under *Nipponites mirabilis* by VERECHAGIN et al. (1965, pl. 37, fig. 1) from Saghalien is probably *N. bacchus* as is an example (NSM. PM-7350) from loc. Ik 963b (T. OMORI's Coll.), Zone of *Inoceramus uwajimensis* of the Ikushumbetsu area.

The mode of life or the functional meaning of the peculiar form of *Nipponites mirabilis* would be an interesting problem to be worked out. Although this is outside the main scope of the present paper, my preliminary observation is briefly given here.

The peculiar shell form denies the ability of active swimming and the strongly flared ribs on the body-chamber may have been favourable for creeping on or even burrowing in the bottom sediments. I hesitate to agree with ABEL (1929, p. 240) to compare *Nipponites* with *Vermetus*, because it has air-chambers. *N. mirabilis* has more regular mode of coiling than *Vermetus*. If the animal was in the body-chamber of the last U-form (plus alpha) and the rest septate whorls are filled with gas, the entire shell could have been light enough to become buoyant. In the case of *Nipponites bacchus* in which the body-chamber with a retroversal hook is below and the septate tangled whorls above, the shell form may have been more favourable for floating. The complex suture seems to suggest the strengthening of the shell to be competent enough for the living at a considerable depth and it might have been also favourable for the up-and-down locomotion. For the last point the strength of the siphuncle should be examined in more detail.

In connexion with this problem I consider another point. I had an idea that this species might have had an ability to secrete calcareous deposits in the septate chambers to make the shell heavy enough against floating as in certain

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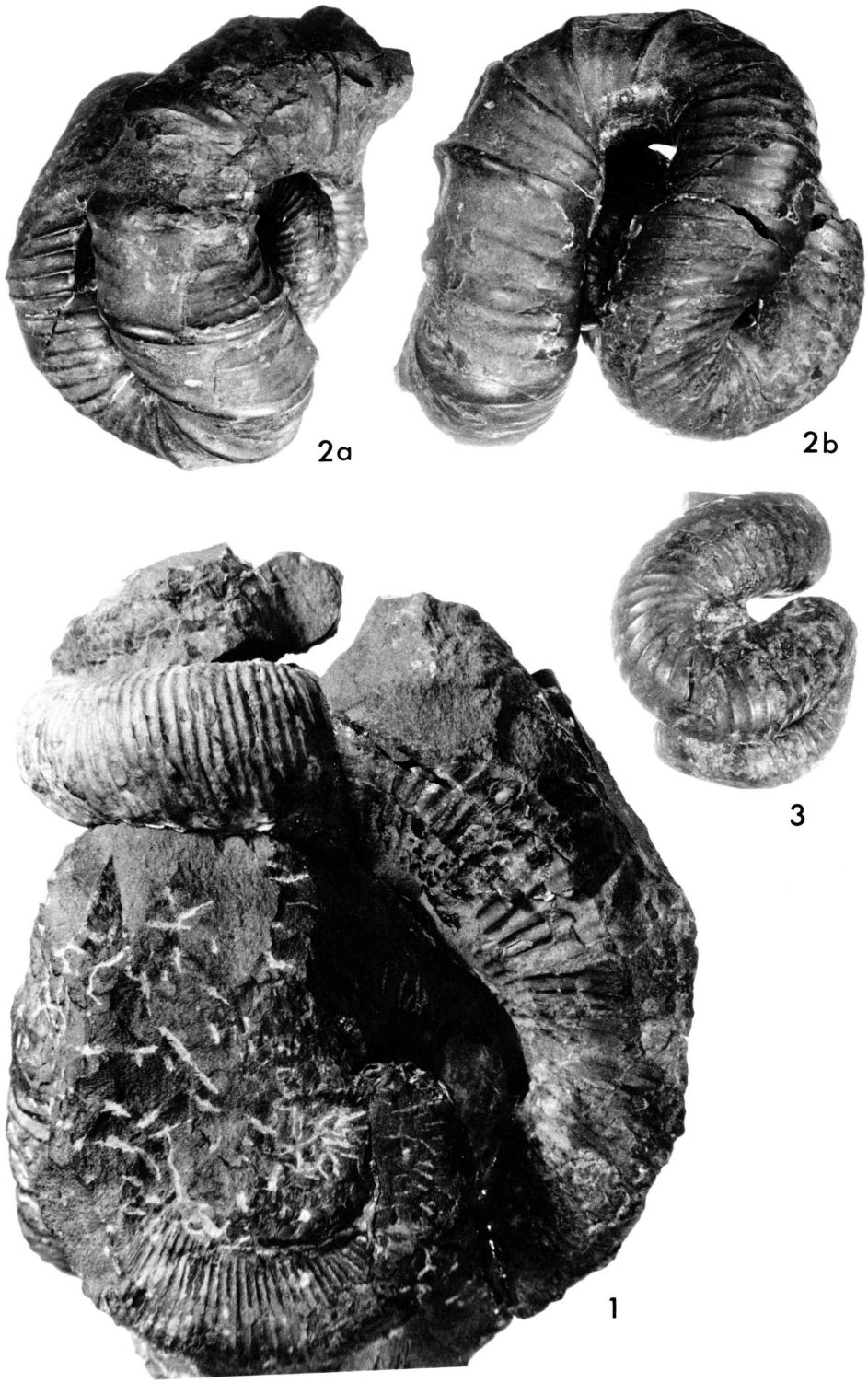
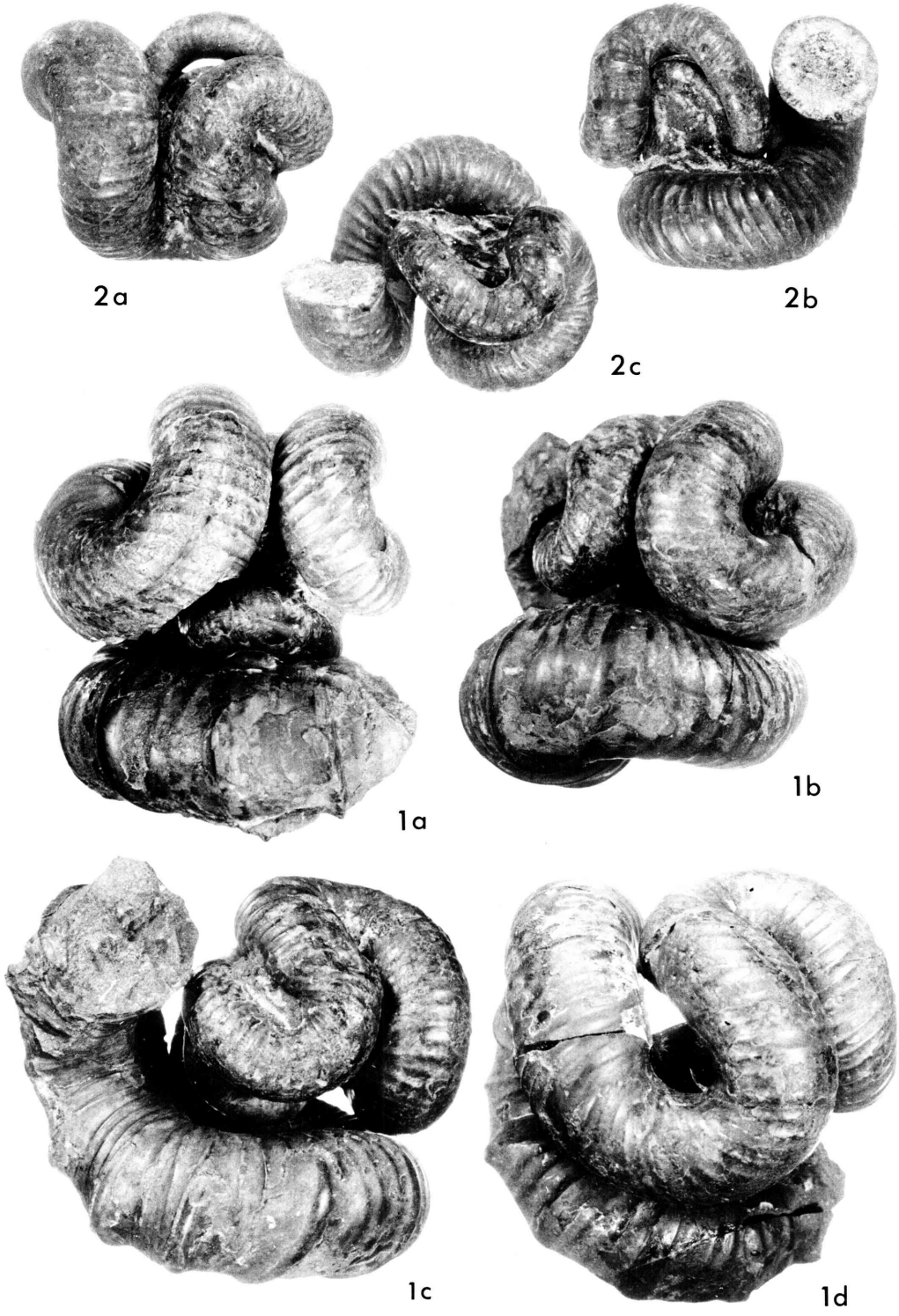
Explanation of Plate 55

Fig. 1. *Nostoceras hetonaiense* sp. nov. ..... Page 322
GK. H5798 a (right), holotype, showing the other side of Pl. 54 Fig. 2 and H5798 b, from loc. H1091 p, Tonai-no-sawa, showing the upper view of a helical whorl (lower) and the lateral view of a detached body-chamber (left) (T. MATSUMOTO's Coll.), ×1.

Figs. 2, 3. *Nipponites mirabilis* YABE ..... Page 340
2. GK. H5846, from loc. T1022 p, Saku-gakko-no-sawa, Saku area (K. MURAMOTO's Coll.), showing mainly the living chamber, ×1.
3. Inner whorls of GK. H5846, ×1.
Kyushu Univ. Photos (H. HIRANO [1] & I. HAYAMI [2, 3]), without whitening.



T. MATSUMOTO: Heteromorph ammonites



T. MATSUMOTO: Heteromorph ammonites

nautiloids. If so, the species would be exclusively benthic. To prove or disprove this idea, we have to cut the shell to inspect the internal structure. Although the available specimens are not sufficiently numerous, one of them in Mr. T. MURAMOTO's Collection (now in Kyushu University, GK. H5851) shows an interesting feature in natural section as illustrated in Pl. 44, Fig. 4. In every whorl the septa are preserved only on the dorsal side and the rest main or ventral part is empty (now partly filled with secondary calcite). I have also seen a few other fragmentary specimens which show a similar feature. The observed feature may be merely secondary, but it could suggest that the septa were partly dissolved away when the animal was alive and the septate whorls were partly filled by the posterior extention of the soft body. This could be another way to make the entire shell heavy. The same possible interpretation has been mentioned in the description of *Hyphantoceras* and *Eubostrychoceras*. Whether this was true or misinterpreted should be determined by further study.

Genus *Neocrioceras* SPATH, 1921

Type-species.—*Crioceras spinigerum* JIMBO, 1894.

Remarks.—Although specimens of *Neocrioceras spinigerum* occur not infrequently in the Santonian (not Campanian as written in the *Treatise*, p. L224) of Hokkaido, I am not successful to figure out completely its shell characters at successive growth-stages. The generic diagnosis given by WRIGHT, 1957 (in the *Treatise*, p. L224) is sufficiently comprehensive and at present I have not enough material to revise it, except for the geological age. The genus seems to be widespread and range from Turonian to Campanian, but the species referable to it are represented by more or less incomplete specimens. Only a species is described below, because it gives a suggestion about the origin of the genus.

Neocrioceras (?) *undulosum* sp. nov.
Pl. 47, Fig. 1

Material.—Holotype, NSM. PM-7221 [=M15 of T. MURAMOTO's Coll.], from loc. Ob-S-R1, eastern branch of the Sato-no-sawa, a tributary of the Kami-kinembetsu River, Obira area. Paratypes NSM. PM-7222, PM-7224, PM-7225 [=M16, M18, M19 of T. MURAMOTO's Coll.] from loc. Ob-S-R1p3, Obira area, northwestern Hokkaido.

Diagnosis.—The characters of the very initial stage is unknown. The observable early whorl forms a low helix and the whorl of the middle-stage somewhat deviates from this helix with ascending sinuosity but roughly follows the

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Explanation of Plate 56

Figs. 1, 2. *Nipponites mirabilis* YABE ..... Page 340

1. GK. H5846, from loc. T1022p, Saku-gakko-no-sawa, Saku area (K. MURAMOTO's Coll.). Four views (a-d) of the entire shell, ×1.
2. Inner whorls of the same specimen, in three (a-c) different views, ×1.

Kyushu University (I. HAYAMI) photos, without whitening.

open spire on an undulating plane. The body-chamber, as far as observable, is about a half whorl and situated on a plane somewhat above the early helix, showing a J-shape rather than a spire of a constant angle. Probably no retroversal hook exists at the last stage. The whorl is subcircular in the intercostal section and polygonal in the costal section.

In the holotype the diameter of the last whorl is about 40 mm and the whorl-height about 10 mm.

Major ribs are developed at regular intervals, i. e. at a distance measured on the venter slightly shorter than the whorl-height. They are provided with four spinose tubercles, two on the venter at a considerable distance and two others on the flanks. Fine and weak riblets are on the interspaces and also on the major ribs. They are looped at the tubercle.

Partly observable suture is finely and deeply incised as in *N. spinigerum*.

Occurrence.—The locality indicated above is referred to the Turonian (probably Middle Turonian) of the the Obira area, northwestern Hokkaido.

Discussion.—Although the specimens are not sufficiently numerous nor well preserved, they can be regarded as representing a species of *Neocrioceras*, because the observed characters agree with the generic diagnosis. This species differs from *N. spinigerum* (JIMBO, 1894) in its irregularly coiled whorls which are on an undulating plane. Typically the whorl of *N. spinigerum* is more depressed, but I know exceptional examples with a subcircular section.

The present species is somewhat allied to *Hyphantoceras reussianum* (D'ORBIGNY) in the shell-form and the ornamentation but the latter has a more distinctly helical higher spire, a U-turned body-chamber and more oblique ribs. It is also similar to some form of a variable species *Madagascarites ryu* MATSUMOTO and MURAMOTO, 1967 in the general aspects, but the extremely aberrant coiling of that species is not seen in this species. Incidentally in the Obira area *M. ryu* occurs in the same bed as the present species.

Genus *Pseudoxybeloceras* WRIGHT et MATSUMOTO, 1954

Type-species.—*Hamites quadrinodosus* JIMBO, 1894.

Diagnosis.—The shell is nearly but not strictly in one plane, coiled in a compressed elliptical form, consisting of gently arcuate to nearly straight shafts connected by U-curved parts, with some space left between the shafts.

The whorl-section is subcircular to subelliptical or subrectangular and more or less higher than broad.

Numerous ribs are mostly simple, occasionally bifurcated, more or less prorsiradiate or nearly rectiradiate, crossing across the entire whorl. Two or four small tubercles on each rib; two on the venter on either side of the somewhat flattened siphonal zone, with or without additional two at the ventrolateral shoulders or on the outer part of the flanks. Sometimes stronger ribs provided with stronger tubercles may occur at intervals.

The suture consists of E, L, U and I. All the elements, except for I, are bipartite and narrowed at their stem.

Distribution.—The genus ranges from Coniacian to Campanian and may

extend down to Upper Turonian and up to Maestrichtian. The species referable to this genus are known in Japan, Sakhalin, west coast of North America (MATSUMOTO, 1960; WARD personal comm.), New Zealand (HENDERSON, 1970), Madagascar (COLLIGNON, 1965) and probably Europe (C. W. WRIGHT's collection from the *Holaster planus* Zone of England, *in lit.*, 1958).

Discussion.—Because of the incomplete material the definition of this genus is still provisional. In the mode of coiling it is similar to some species of *Scalarites* WRIGHT et MATSUMOTO, 1954, but is distinguished by the presence of tubercles. In my provisional view it may have originated in *Neocrioceras* (and ultimately in *Hyphantoceras*) and given rise to *Solenoceras*. More comprehensive discussion will be given by P. WARD who kindly showed me his first draft of the description of the Nanaimo species.

I give here a revised description of the type-species from Hokkaido.

Pseudoxybeloceras quadrinodosum (JIMBO)
Pl. 57, Fig. 2; Pl. 61, Fig. 4

1894. *Hamites quadrinodosus* JIMBO, *Palaeont. Abh.*, 6, (3), p. 39 [185], pl. 7 [23], figs. 3, 4.
1954. *Pseudoxybeloceras quadrinodosum*, WRIGHT and MATSUMOTO, *Mem. Fac. Sci., Kyushu Univ.*, [D], 4, (2), p. 120, pl. 7, fig. 6; text-figs. 6, 9–12.
1963. *Pseudoxybeloceras quadrinodosum*, MATSUMOTO, *A Survey of the Fossils from Japan Illustrated in Classical Monographs*, pt. 10, p. 45, pl. 66, figs. 3, 4.

Material.—Lectotype UMUT. MM7524-1 [=GT. I-125]; other syntypes of JIMBO, 1894, from a marl-nodule in the shale near Chupitaushunai [=Tsiptaushbets], a left tributary of the River Tombetsu [=Tumbets], northern Hokkaido. GT. I-341 of YABE's collection from the *Anapachydiscus* beds in the valley of the Ikushumbetsu. GK. H5447 of T. MURAMOTO's Coll. 419, main stream of the Ikushumbetsu; NSM. PM-7262 [=M59 of T. MURAMOTO's Coll.], from Ik 1746, branch A of the Ban-no-sawa, and GK. H5805 of my collection from the Kikumezawa, all from the Upper Yezo Group of the Ikushumbetsu area, central Hokkaido.

Remarks.—The last three specimens obtained after the description of WRIGHT and MATSUMOTO (1954) allow me to give a clearer diagnosis, although there is still some ambiguity in the character of the earliest stage and also with respect to the variation. The lectotype probably represents a shell of the middle growth-stage, because it is septate and because it resembles the portion of the middle growth-stage in a larger example, GK. H5447.

Diagnosis.—The shell is considerably large at the adult stage, measuring about 100 mm in the maximum breadth of the last U-form and at least 150 mm in the length of the last shaft.

The shape of the earliest part is not yet exactly known. It may be simply arcuate or coiled in a compressed elliptical form or could be otherwise. The main part consists of nearly straight or gently arcuate longer shafts connected by abrupt U-curves, and coiled twice or more in a compressed elliptical form, with shafts separated from each other. The outward arcuate curvature of the

last shaft in GK. H5447 may be to accommodate the inner whorls. The coiling is nearly but not strictly in a plane.

The section is subelliptical to subrectangular, more or less higher than broad, depending on individuals and also on growth-stages (e. g. H.=6.5, B.=5.3 in GT. I-126b; H.=16.5, B.=15.0 in the lectotype, H.=35.0, B.=30.0 in GK. H5447). The siphonal area between the rows of tubercles is somewhat flattened; the flanks are gently convex.

The ribs are dense and mostly simple, numbering 8–9 at the interval as long as the whorl height in the smaller specimens (JIMBO's specimens and GK. H5805) and 10–12 then 15–16 in the larger ones of later growth stages (e. g. GK. H5447), becoming denser in the last part, where branching or intercalation sometimes occurs. They are somewhat prorsiradiate in lateral view in earlier growth-stages, showing a gentle concavity on the dorsum but running at a right angle across the siphonal zone. On the last U-curved part and the last shaft the ribs run nearly radially.

Each rib is provided with two small tubercles on either side of the siphonal zone. At first the ventrolateral tubercles are not developed and at the stage with whorl-height of 10 mm or so weak shoulder tubercles begin to appear and thus each rib bears four small tubercles in the middle and later growth-stages.

At intervals ribs and the tubercles on them are slightly stronger than others, but the differentiation is not so great as in an undescribed species from the Turonian of England.

Occurrence.—The exact stratigraphic position of JIMBO's original locality is uncertain. Judging from the lithology, associated inocerami (*I.* cf. *naumanni*) and the place name, it is probably somewhere in the Upper Urakawan (Santonian) but could be Campanian. Subsequent collections are from the Urakawan (Coniacian and Santonian) of the Ikushumbetsu area. GK. H3543 (Pl. 61, Fig. 5), from Urakawa, which was recorded under this specific name (WRIGHT and MATSUMOTO, 1954, p. 121) should be removed from the present species to *Neocrioceras*, because its ribs are looped at stronger tubercles.

Discussion.—The shell form of the present species resembles that of *Scalarites densicostatus* sp. nov. and *Polyptychoceras obstrictum* (JIMBO), but the prorsiradiate ribs in the main part and the tuberculation in four rows are distinctive.

The presence of the periodic stronger ribs, though indistinct, suggests a

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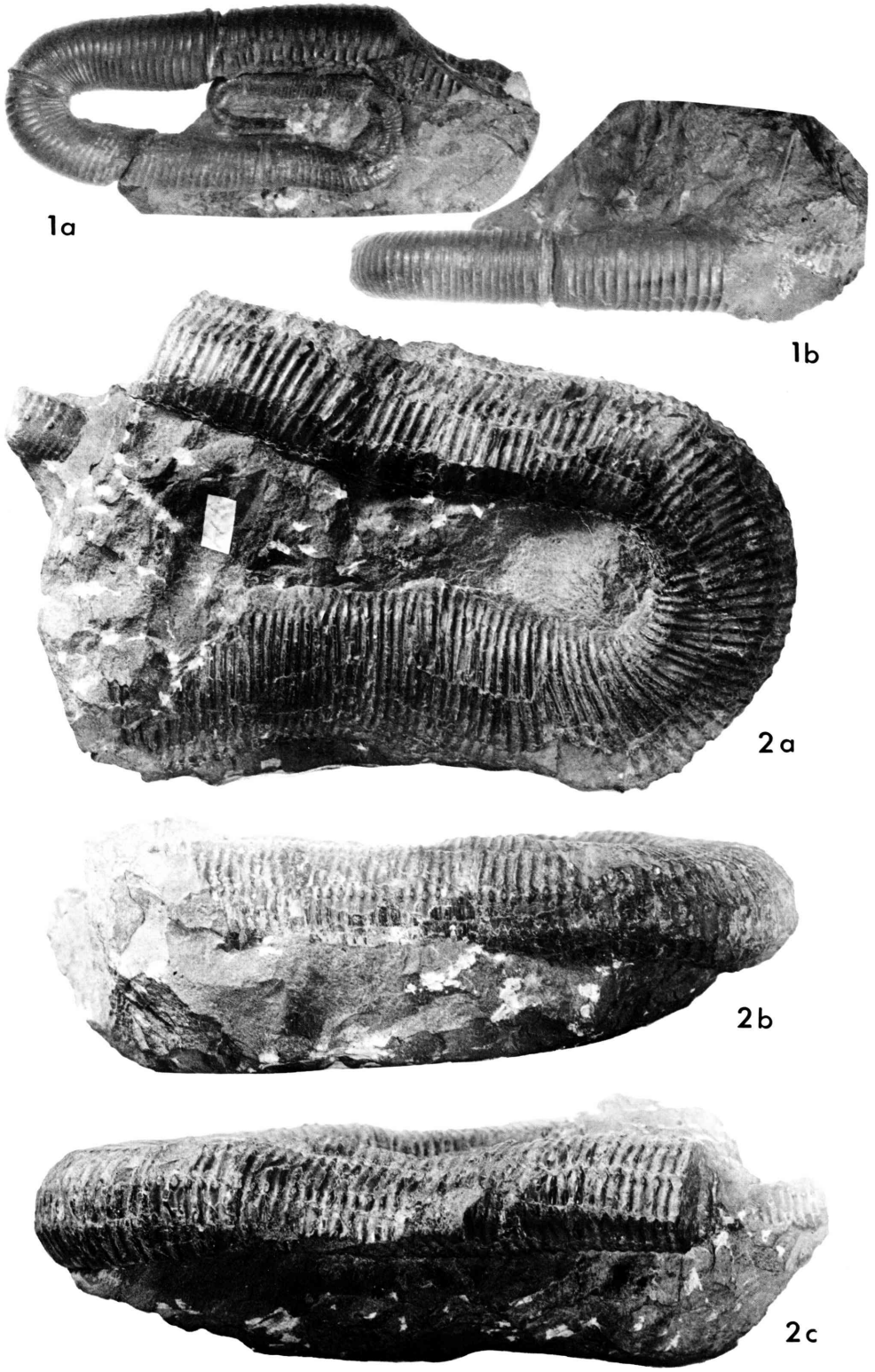
Explanation of Plate 57

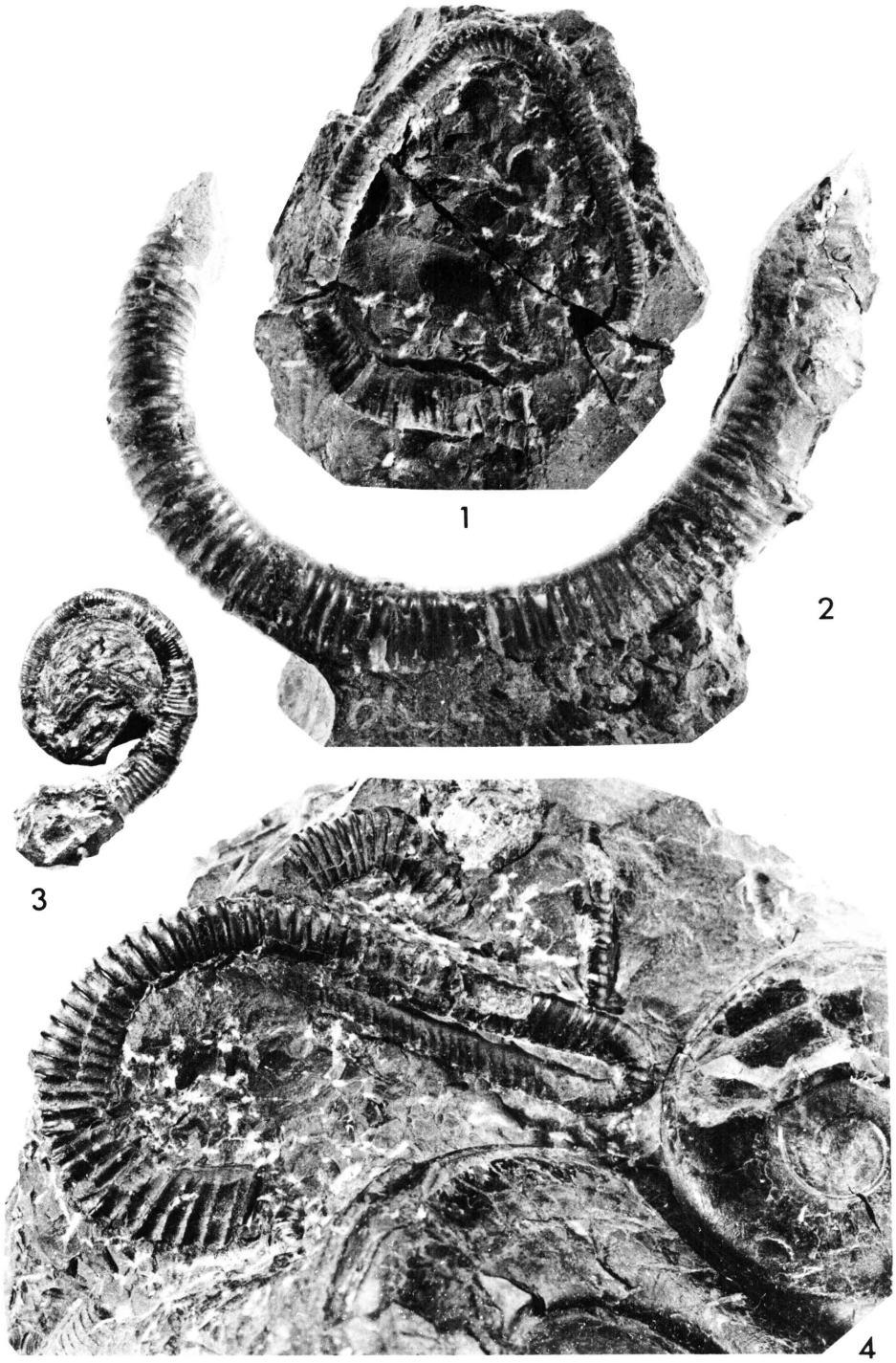
Fig. 1. *Scalarites densicostatus* sp. nov. ..... Page 349
GK. H5806[=Mikasa High School 213], holotype, from loc. Ik 2013, the Pombetsu, Ikushumbetsu area, collected by YOSHIMOTO. Lateral view (a) of the entire shell and the ventral view (b) of the last shaft, ×1.5

Fig. 2. *Pseudoxybeloceras quadrinodosum* (JIMBO) ..... Page 345
GK. H5447 [=T. MURAMOTO's Coll. 419], from the main stream of the Ikushumbetsu. Lateral (a) and ventral (b, c) views of the two shafts, with a little cropping earlier shaft, ×2/3.

Kyushu Univ. (I. OBATA & T. MATSUMOTO) photos, without whitening.



T. MATSUMOTO: Heteromorph ammonites



T. MATSUMOTO: Heteromorph ammonites

possible affinity with such species as *Neocrioceras kossmati* (SIMIONESCU, 1899) (p. 21 [257], pl. 1, figs. 6–8), but in that species the coiling is rounded elliptical and the minor ribs have no tubercles. I have seen in Mr. K. YAGI's Collection of HCS. No. 104 from Shimo-yubari, four incomplete specimens which have *Hyphantoceras*-like ornament but show elliptical coiling.

The holotype of *Pseudoxybeloceras matsumotoi* COLLIGNON, 1965 (p. 12, pl. 419, fig. 1731), from the Coniacian of Madagascar, resembles the earlier shaft of the last U of the illustrated specimen (GK. H5447) from Hokkaido, but its ribs are coarser, less dense and nearly radial.

The shell of the middle growth stage, as represented by GK. H5805 (Pl. 61, Fig. 4), from the Santonian of Ikushumbetsu, resembles the holotype of *Parasolenoceras splendens* COLLIGNON, 1969 (p. 44, pl. 530, fig. 2087), from the Lower Campanian of Madagascar, but in our specimen the two shafts are more separated and the weak inner ventrolateral tubercles begin to develop. That species may represent a transitional stage from *Pseudoxybeloceras* to *Solenoceras*.

Family Diplomoceratidae SPATH, 1926

I follow generally WRIGHT (1957, p. L224) for the definition of the Diplomoceratidae, but exclude from them the tuberculate genera *Pseudoxybeloceras*, which has affinity with *Neocrioceras*, and *Pravitoceras* YABE, 1902, which is probably an offshoot of *Didymoceras*. (*Pravitoceras* occurs in the Campanian of Southwest Japan.)

The genera of this family are more or less incompletely known, because fossils occur fragmentarily. *Polyptychoceras* and *Subptychoceras* which occur commonly in the Senonian of Hokkaido are excluded from the present description, because I need more material to get a proper concept of various species. Some others, e. g. *Diplomoceras*, *Glyptoxoceras* and *Ryugasella*, whose examples are occasionally found in Hokkaido, are likewise excluded. On the other hand four new species of new genera are described in addition to two species of *Scalarites*.

Explanation of Plate 58

Fig. 1. *Trianglites antiqus* gen. et sp. nov. ..... Page 350
NSM. PM-7260 [=M56 of T. MURAMOTO's Coll.], holotype, from the Sakugakko-no-sawa, Saku area, ×1.

Fig. 2. *Scalarites scalaris* (YABE) ..... Page 348
NSM. PM-7228 [=M22 of T. MURAMOTO's Coll.], from loc. Ob-S-R1-p2, Sato-no-sawa, Obira area, ×1.

Fig. 3. *Scalarites* sp. aff. *S. scalaris* (YABE) ..... Page 350
NSM. PM-7227 [=M21 of T. MURAMOTO's Coll.], from the Sato-no-sawa, Obira, ×1.5.

Fig. 4. *Heteroptychoceras obatai* gen. et sp. nov. ..... Page 357
NSM. PM-7243 [=M37 of T. MURAMOTO's Coll.], holotype, from the Isojiro-no-sawa 103p, Oyubari area, with *Hauericeras* (*Gardeniceras*) *angustum* YABE, ×1.

Photos by T. HOSHINA, without whitening.

Genus *Scalarites* WRIGHT et MATSUMOTO, 1954

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

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

Remarks.—In this genus a species with more compressed elliptical coiling, with nearly straight shafts is also included. Therefore the distinction from *Diplomoceras* would become open to question, although flared ribs and constrictions can be taken in the diagnosis of *Scalarites*.

I omit here to give survey on the so-called *Scalarites* from several areas outside Japan.

Scalarites scalaris (YABE)

Pl. 58, Fig. 2

1894. *Hamites sp.*, JIMBO, *Palaeont. Abh.*, **6**, (3) p. 40 [186], pl. 9 [25], fig. 1; also (?) pl. 7 [23], fig. 7.
1904. *Helicoceras scalare* YABE, *Jour. Coll. Sci., Imp. Univ. Tokyo*, **18**, (2), p. 9, pl. 3, fig. 2 (only).
1954. *Scalarites scalaris*, WRIGHT and MATSUMOTO, *Mem. Fac. Sci., Kyushu Univ.*, [D], **4**, (2), p. 117, pl. 7, fig. 3; text-fig. 1.

Material.—Holotype, originally designated, is GT. I-233 [=UMUT. MM7548] (YABE, 1904, pl. 3, fig. 2), from the *Scaphites* beds of the Obira area. In addition to other examples listed by WRIGHT and MATSUMOTO (1954, p. 117), some more examples in the subsequent collections are added here: NSM. PM-7228 [=M22 of T. MURAMOTO's Coll.] (Pl. 58, Fig. 2), from loc. Ob-S-R1p3; NSM. PM-7241 and 7242 [=M35 and M36], from loc. Ob-Sp4 (together with *Scaphites planus*), NSM. PM-7248 [=M42], from loc. Ob-S-4p6 (with *Inoc. hobetsensis*), NSM. PM-7264 and 7265 [=M61 and 62], from los. Ob-S4p3 (with *Scaphites planus* and *Otoscaphites puerculus*) all T. MURAMOTO's Coll. from the Obira area. Two other examples in the private collection of K. MURAMOTO (Ob-S-AR1001) and T. TAKAHASHI (48. 5. 13) from the same area. GK. H5839, H5840, H5841 a–c, from loc. T1083p and GK. H5842, from loc. T1079 p2, from the Zone of *Inoceramus hobetsensis*, Saku Formation, Saku-gakko-no-sawa, Saku area (T. MATSUMOTO Coll.).

GT. I-234 [=UMUT. MM7549], another specimen of YABE (1904, pl. 3, fig. 3) is a fragment of *Eubostrychoceras*.

Diagnosis.—See WRIGHT and MATSUMOTO, 1954, p. 117.

Remarks.—Diagnosis given by WRIGHT and MATSUMOTO (1954) is still available even for the additional material. An illustrated example may be typical, although incomplete. There are still larger fragments. On the other hand T. TAKAHASHI's specimen can be regarded as adult, because it has a body-chamber of about a half whorl and because the ribs are weakened and become unusually dense near the apertural end. It is 78 mm in diameter of the elliptical coil and 14 mm in whorl-height of the preserved last part, and accordingly a small example.

The coiling is not strictly in a plane and the early whorls may form a very

low helix, but the character is variable. It is likewise variable from typical spiral to elliptical and a gently arcuate fragment can be assigned to the latter.

The ribs are moderately strong, sharp-headed and normally moderately distant and the periodic constrictions with flared ribs are normally frequent. These characters again vary to a considerable extent. K. MURAMOTO's specimen is an example in which irregular variation is seen in the intensity and density of the ribs from part to part within a single specimen.

Scalarites densicostatus sp. nov.
Pl. 57, Fig. 1; Pl. 61, Fig. 6

Material.—Holotype GK. H5806, from loc. Ik 2013, Pombetsu, Zone of *Inoceramus tenuistriatus*, found by Mr. YOSHIMOTO when he was a student of Mikasa High School. Other referable examples: GK. H1452, from los. Y112b and GK. H1453 from loc. Y121b–c, Shiyubari, Zone of *Inoceramus uwajimensis*. GT. I-2940 from loc. N362a, GT. I-2941 from loc. N 30f, GT. I-2943 from loc. N30a, Zone Mh3 and GT. I-2942 from loc. N26b, GT. I-2944 from loc. N27a, Zone Mh4, Naibuchi area (S. Saghalien) (all. T. MATSUMOTO Coll.); GT. I-2946 (2nd tributary) and GT. I-2948 (Juhachi-rinpan-ni-no-sawa) of the same area (M. KAWADA Coll.), are also referable to this species.

Diagnosis.—The shell consists of nearly straight shafts connected by abrupt U-curved parts, coiled at least twice in a compressed elliptical form. The shafts in the early coils are moderately separated but the dorsal part of the fifth shaft is almost in contact with the ventral part of the third. The distance between the second and the third U is nearly twice as long as that between the third and the fourth. The cross-section is nearly circular.

The shell is ornamented with numerous, dense, fine and sharp-headed ribs which run as a rule nearly radially (i. e. annularly) around it but may be slightly prorsiradiate on some part. Periodic constrictions and associated flared ribs are well marked, occurring at long intervals, either on the straight shaft and on the U-curved part.

The body-chamber is fairly long. In the holotype it occupies the whole length of the last shaft plus the last U-curved part. In a larger example of GK. H1452, the last suture is in the posterior part of the long shaft.

The suture is of E, L, U, I type; all the elements, except for I, are bifid, deeply and finely incised and narrowed at their stem, showing a reversed trigonal general outline.

Remarks.—Although the holotype is small, there are much larger examples, e. g. GT. I-2940 and GT. I-2941 over 33 mm in cross-section and 140 mm long.

Occurrence.—The type-locality is Ik 2013, fine-sandy siltstone of the lower part of the Upper Yezo Group, Zone of *Inoceramus tenuistriatus-Inoc. teshioensis*. Other examples show that the species ranges from the Middle Turonian to the Coniacian (Zone of *Inoc. uwajimensis*.) The occurrence is not so frequent as *Scalarites mihoensis*.

Discussion.—This species resembles nearly contemporary *Scalarites mihoensis* WRIGHT et MATSUMOTO, 1954, but is distinguished by a more compressed

elliptical coiling which consists of straighter shafts and more abrupt U-curves, more circular whorl-section and denser ribs.

S. densicostatus is close to and could possibly be ancestral to *Polyptychoseras obstrictum* (JIMBO, 1894) in the general shell-form, circular section and dense ribbing, but the latter is not so polygyrally coiled as the former and the first shaft of the latter is longer and has distinctly prorsiradiate ribs.

A specimen (NSM. PM-7227 [=M21]) (Pl: 58, Fig. 3), from the Middle Turonian Zone of *Inoceramus hobetsensis*, has as dense and as fine ribs as the present species but it is similar to *S. scalaris* (YABE) in the rounded elliptical coiling and the frequently appearing flared ribs. Although I hesitate to give a definite specific name and should like to call it provisionally *Scalarites* sp. aff. *S. scalaris*, it suggests an ancestry of the present species.

Scalarites matsumotoi COLLIGNON (1966, p. 47, pl. 28, figs. 3, 4), from the Coniacian of Tarfaya, Morocco, is as densely costate as the present species but shows an arcuate curvature as in *S. mihoensis* or *S. scalaris*.

Genus ***Trianglites*** nov.

Type-species.—*Trianglites anitqus* sp. nov. (described below), from the Turonian of Hokkaido.

Generic diagnosis.—The spirally coiled free whorl of the first stage is bent strongly and followed by a nearly straight long shaft, which in turn is bent strongly to another nearly straight long shaft of a different orientation. This shaft is again bent strongly to the last nearly straight arm. The three straight shafts form a roughly triangular shape in one plane like that of a musical instrument.

The shell is subcircular to elliptical in section. It is periodically constricated and ornamented with numerous simple ribs which are nearly rectiradiate or slightly prorsiradiate.

The suture is similar to that of *Scalarites* or *Polyptychoceras*. The body-chamber occupies the third strong bending part and the last straight shaft.

Remarks.—See discussion in the type-species.

Trianglites antiqus sp. nov.
Pl. 58, Fig. 1; Text-fig. 10

Material.—Holotype, NSM. PM-7259 [=M56 of T. MURAMOTO's Collection], from Gakko-no-sawa, Saku, northwestern Hokkaido.

Diagnosis.—The shell of the initial stage is unknown. The observable early shell, with height less than 4.0 mm, is spirally coiled in one plane and subcircular in cross-section. It is ornamented with numerous, radial (i. e. perpendicular to the axis of shell growth), fine, simple ribs. There is a weak constriction at the middle.

At the next stage the shell is strongly curved, where there are ring like radial ribs and two constrictions. The constriction is accompanied with a broader interspace of ribs, suggesting a rest of growth. Then follows the gently arcuate,

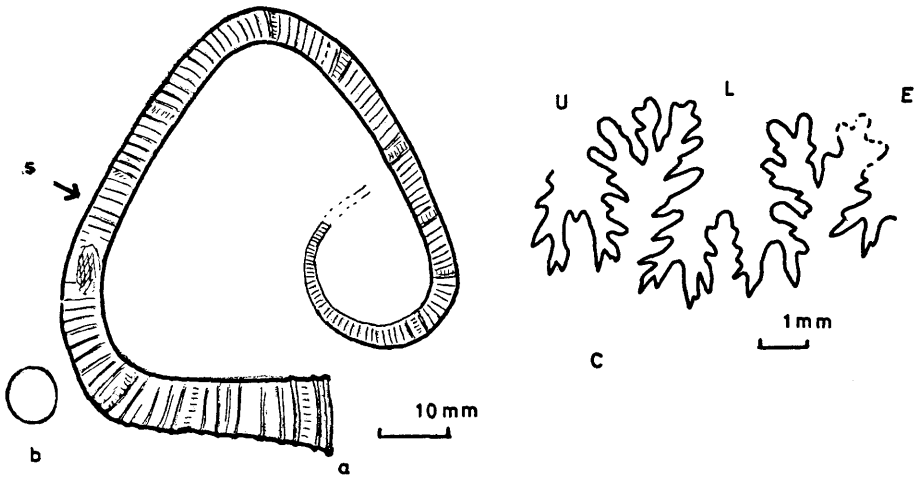


Fig. 10. *Trianglites antiqus* gen. et sp. nov. Holotype, NSM. PM-7259, diagrammatic sketch of lateral view (a), whorl-section (b) and a part of suture (at s in a). (T.M. *delin.*)

almost straight shell. It is thick elliptical in cross section, with slow increase of diameters (from 4.0 to 5.0 mm in diameter in the distance of about 50 mm). It is periodically constricted and has numerous, simple ribs, which are at first nearly radial and gradually become to be somewhat prorsiradiate. Seven to eleven ribs are counted in an interval between the constrictions; or four ribs in the interval equal to the whorl-height.

At the next stage comes the second strong bending. It is about 50 mm apart from the first bending. Then follows another gently arcuate, almost straight shell for a distance of 50 mm or so. Constrictions are discernible at irregular intervals. The simple ribs are slightly prorsiradiate. The shell is thick elliptical in section (height=6.5, breadth=5.5 mm at the last third septum), and slowly enlarged. The last septum is near the anterior end of this second arcuate part of the shell.

The third strong bending is about 55 mm apart from the second. This takes place at about the middle of the body chamber, where the shell is elliptical in section, with height=8.0, breadth=6.5 mm. The last part is nearly straight, about 30 mm long and ends immediately before it reaches the point below the first bending point. The ribs on the body-chamber are simple, radial or slightly prorsiradiate, narrow, and separated by slightly broader interspaces. There are two shallow constrictions, showing the sign of arrest of growth before and after the bending part and another constriction at the apertural margin, bordered by somewhat raised ribs.

The suture consists of E, L, U and I. Each elements are trapezoidal in rough outline with a narrowed stem. E, L and U are bipartite. The pattern is similar to that of *Scalarites*.

Remarks.—Only a single specimen is available for this species in the present collection, but the characters are so diagnostic that I dare to establish a new

species under a new genus.

Occurrence.—Turonian (?) of the Saku area, northwestern Hokkaido.

Discussion.—The early spiral part of the shell resembles that of such species as *Scalarites scalaris* (YABE) and *S. mihoensis* WRIGHT and MATSUMOTO from the Turonian and Coniacian of Hokkaido and other areas.

In the species of *Scalarites* the shell in later growth stages are coiled spirally or elliptically without contact or overlap of the whorls. The arm of the elliptical form may be gently arcuate or nearly straight in some cases, but a triangular mode of bending and an elliptical section are particular to the present species. The pattern of the suture is similar to that of *Scalarites scalaris*.

The stratigraphical range of the present species has not yet been precisely known, but the described specimen probably came from the Turonian.

To sum up, it can be concluded as a possible interpretation that this species may be a specialized offshoot of such species as *S. scalaris*. It is interesting to note that a triangular form which occasionally occurred in certain closely coiled ammonoids (e. g. *Wocklumeria, Paralegoceras*, etc.) is manifested by a Cretaceous heteromorph ammonite.

Genus ***Rhyoptychoceras*** nov.

Type-species.—*Rhyoptychoceras mikasaense* sp. nov. (described below).

Generic diagnosis.—The shell consists of at least five nearly straight shafts which show U-turns at four times. In the septate stages the shafts are not strictly straight but gently sinuous and the hamitid plane of the late stage becomes perpendicular to that of the early stage. The adjoining shafts are separated from each other with a distance as narrow as the whorl-breadth of the early one. The sinuous second shaft is in contact with the third at one point and also with the fourth at another. The living chamber is hooked (i. e. hamitoid). The whorl-section is subcircular.

The shell is ornamented with numerous annular simple ribs which are rectiradiate and on some part slightly prorsiradiate. There are infrequent constrictions.

The suture is of lytoceratid type, consisting of E, L, U, I. L, U and the 1st and the 2nd lateral saddles are bifid, with narrowed stems and expanded branches.

Distribution.—At present only a single species from the Coniacian of Hokkaido is known.

Discussion.—The genus is probably derived from *Eubostrychoceras* and in sisterhood relationship with *Scalarites*. For details see the discussion in the description of the type-species.

Rhyoptychoceras mikasaense sp. nov.

Pl. 59, Fig. 1; Text-fig. 11

Material.—Holotype, No. TTC. 5000 of T. TAKAHASHI's Collection (June 1968), from loc. Ik 2710, Pombetsu-go-no-sawa. Another specimen from the same locality.

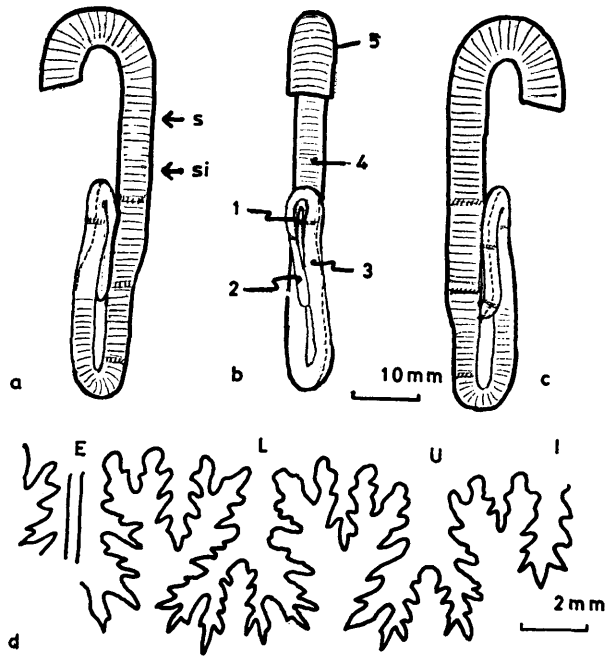


Fig. 11. *Rhyoptychoceras mikasaense* gen. et sp. nov. Holotype, TTC. 5000 (T. TAKAHASHI's Coll.). Diagrammatic sketch in three views (a, b, c). Dotted line=siphonal line, s=last suture, si=illustrated suture (d). (T.M. *delin.*)

Diagnosis.—As for generic diagnosis.

Description.—In the holotype the very apertural margin of the living chamber is missing, and accordingly, the fifth shaft is short. At the preserved end the whorl section is nearly circular, with height=breadth=6.4 mm. The fourth shaft is about 56 mm long with a gentle sinuosity in posterior part which is 5.0 to 4.4 mm in whorl-breadth. The last suture is at a point 17 mm backward from the last U-turn. Therefore the living chamber is not long. No constriction in the preserved last part, except for the missing apertural margin; two weak ones on the middle of the fourth shaft and a well marked ones immediately after the third U-turn.

The third shaft is 31 mm long, sinuous and gently twisted in its posterior half, where three weak constrictions occur. The second shaft is 17 mm long and gently sinuous, with at least two weak constrictions. As is clearly shown by the position of the siphuncle, the whorl at this stage is twisted to nearly 90° from that of the fourth shaft; its left side is in contact with that of the fourth shaft at its anterior point and its right side is so with that of the third shaft at its posterior point. The first shaft intervenes between the third and the fourth, with its siphonal side to the left side of the adult shell. It is almost smooth or faintly ribbed. Its suture already shows the reversed trigonal general outline of the elements. The shell of the initial stage is unpreserved.

Occurrence.—The holotype and another example were found by Takemi TAKAHASHI from the Zone of *Inoceramus uwajimensis* exposed at Ik 2710 in the Pombetsu-go-no-sawa, a small tributary of the Pombetsu, a branch of the River Ikushumbetsu, Mikasa, central Hokkaido. *Scaphites* specimens are associated with them.

Discussion.—The peculiar twisting of the shaft in this species could be considered as pathologic, but the character is not accidental and has some regularity, occurring in more than one specimen. Therefore I am inclined to regard it a diagnostic character.

The tendency toward this character is recognized in a certain form of highly variable coiling in the early stage of *Eubostrychoceras japonicum* (YABE), as represented by NMS. PM-7220 [=M14] (Pl. 48, Fig. 2) from the Zone of *Inoc. hobetsensis*, Middle Turonian.

R. mikasaense resembles *Scalarites densicostatus*, but is distinguished by its twisted shafts and weaker constrictions.

Genus ***Dihamites*** nov.

Type-species.—*Dihamites obiraensis* sp. nov. (described below).

Generic diagnosis.—The shell of the early stage is unknown. The shell in the middle stage is nearly straight but gently sinuous. Its cross-section is subcircular. This shaft is then followed by a retroversal U which passes to a gently arcuate shaft, which, in turn, is curved into another asymmetric U. The last two shafts are nearly parallel to each other but the early shaft is oblique to them, dividing obliquely a fairly wide interspace between them. Thus the shell shows two hooks, from which the generic name is derived.

The last suture is at about the middle of the last second arcuate shaft. The living chamber is higher than broad, with a subelliptical cross-section. The increase of whorl-height is moderate.

The shell of the septate stages and the posterior part of the living chamber are ornamented with simple annular ribs of moderate intensity and density. Weak constrictions occur at irregular intervals. The late part of the living chamber has rursiradiate, coarse, scale-like ribs, which are pronounced on the venter. A constriction is marked at the last U-curve. The character of the apertural margin is not precisely known.

The suture is of lytoceratid type, with E, L, U and I. Elements are mostly bifid and reversed-trigonal in rough outline, with a narrow stem and expanded branches, except for the small I. The incisions are moderately deep and fine.

Distribution.—This genus is represented at present by a single species from the Santonian of Hokkaido.

Discussion.—The available material is not sufficient to determine conclusively the systematic position of the genus. It is similar in the mode of uncoiling to some form of *Hamites* PARKINSON, 1811 (see SPATH, 1941) and in the scale-like ribbing of the last part to *Hemiptychoceras* SPATH, 1925, but those two genera of the Hamitidae occur in the Albian (Up. Aptian-Low. Cenomanian for *Hamites*). As no form is found which could connect them with the present

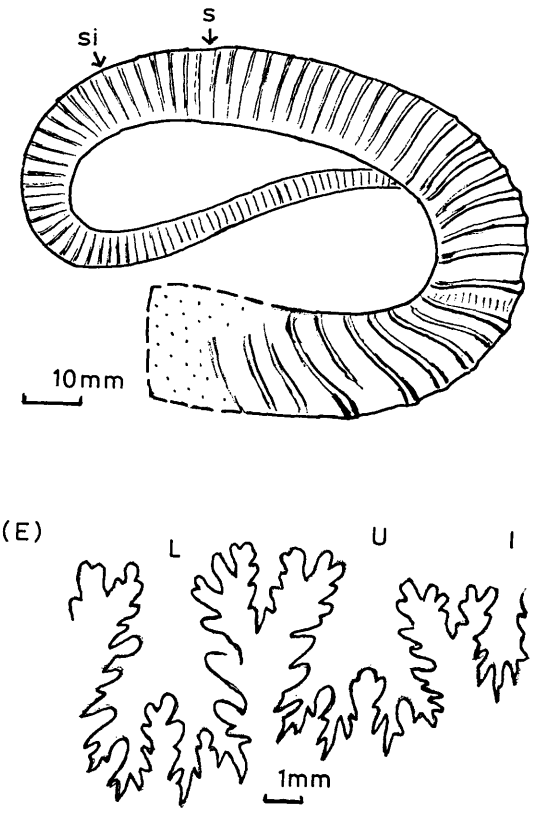


Fig. 12. *Dihamites obiraensis* gen. et sp. nov. Diagrammatic sketch (a) and part of suture (b) of the holotype. s=position of the last suture, si=that of a illustrated suture. (T. M. *delin.*)

genus, the similarity may be homoeomorphy.

I prefer to refer it provisionally to the Diplomoceratidae, because it is allied to *Scalarites* in the early to middle growth-stages and to *Heteroptychoceras* (to be described later) in the late stage.

Dihamites obiraensis sp. nov.
Pl. 59, Fig. 2; Text-fig. 12

Material.—Holotype, figured specimen in a fallen or floated calcareous nodule at loc. Ob. 1006, Aka-no-sawa, a branch of the River Obira, collected by K. MURAMOTO (46. 5. 30).

Diagnosis.—As for generic diagnosis.

Description.—In the holotype the preserved first shaft is about 60 mm long and 6.0 to 10.0 mm in whorl-height at its posterior and anterior ends. Still earlier part is mostly missing, but seems to lie underneath the right side of the second shaft. In other words the shell is nearly but not strictly on a flat plane. The ribs at this stage is of moderate intensity, separated by interspaces as narrow as or sometimes slightly narrower than the ribs. The suture near

its anterior end already shows narrow reversed trigonal lobes and saddles. A weak constriction is slightly ahead of the middle of this shaft.

The first U-curve is asymmetric, with a gentler curve on its anterior limb, where the ribs are slightly rursiradiate. Two indistinct constrictions are on the curved whorl.

The second shaft is long and gently arcuate with its concave side facing the first. The ribs are moderately strong and crowded. A weak constriction is near the end of the septate stage.

The second U-curve is again asymmetric with a steeper anterior part. The last shaft, which has acquired a subelliptical cross-section, is straight for about 40 mm and nearly parallel to the main part of the second, forming a subelliptical shape of the entire shell, with 62 mm breadth and 87 mm length (i. e. distance between the two U-curves). The aperture is opened immediately outside and somewhat below the first U-curve. The living chamber occupies more than half of this elliptical outline.

Occurrence.—Loc. Ob 1006 of K. MURAMOTO, Aka-no-sawa, a branch of the River Obira. The fossil is contained in a nodule of dark coloured sandy siltstone, fallen or floated within the exposures of unit Uh or higher. It certainly came from the Upper Santonian.

Discussion.—The septate part of this species resembles *Scalarites mihoensis* WRIGHT and MATSUMOTO, 1954, in the subelliptical coiling, annular ribbing and circular whorl-section, but its early part changed to be nearly straight.

As the character of the missing early part is not known, the affinity with *Polyptychoceras* YABE, 1927 (ex. SHIMIZU, 1935) is not precisely known. If this species had another earlier straight shaft in parallel to the observable one, its affinity with *Polyptychoceras* and also with *Heteroptychoceras* (described below) would be close. We need more material to give a definite conclusion.

A preliminary remark is given below on the mode of life of the present species. The characters of the shell described above would result in a balanced condition for the buoyancy at or near the bottom of the sea-water. The strong scale like rursiradiate ribs at the last U may be favourable for burrowing into the bottom sediments to settle a part of the shell while the animal takes a rest. An up-and-down locomotion (i. e. floating and sinking) may have been taken instead of a quick swimming.

Genus ***Heteroptychoceras*** nov.

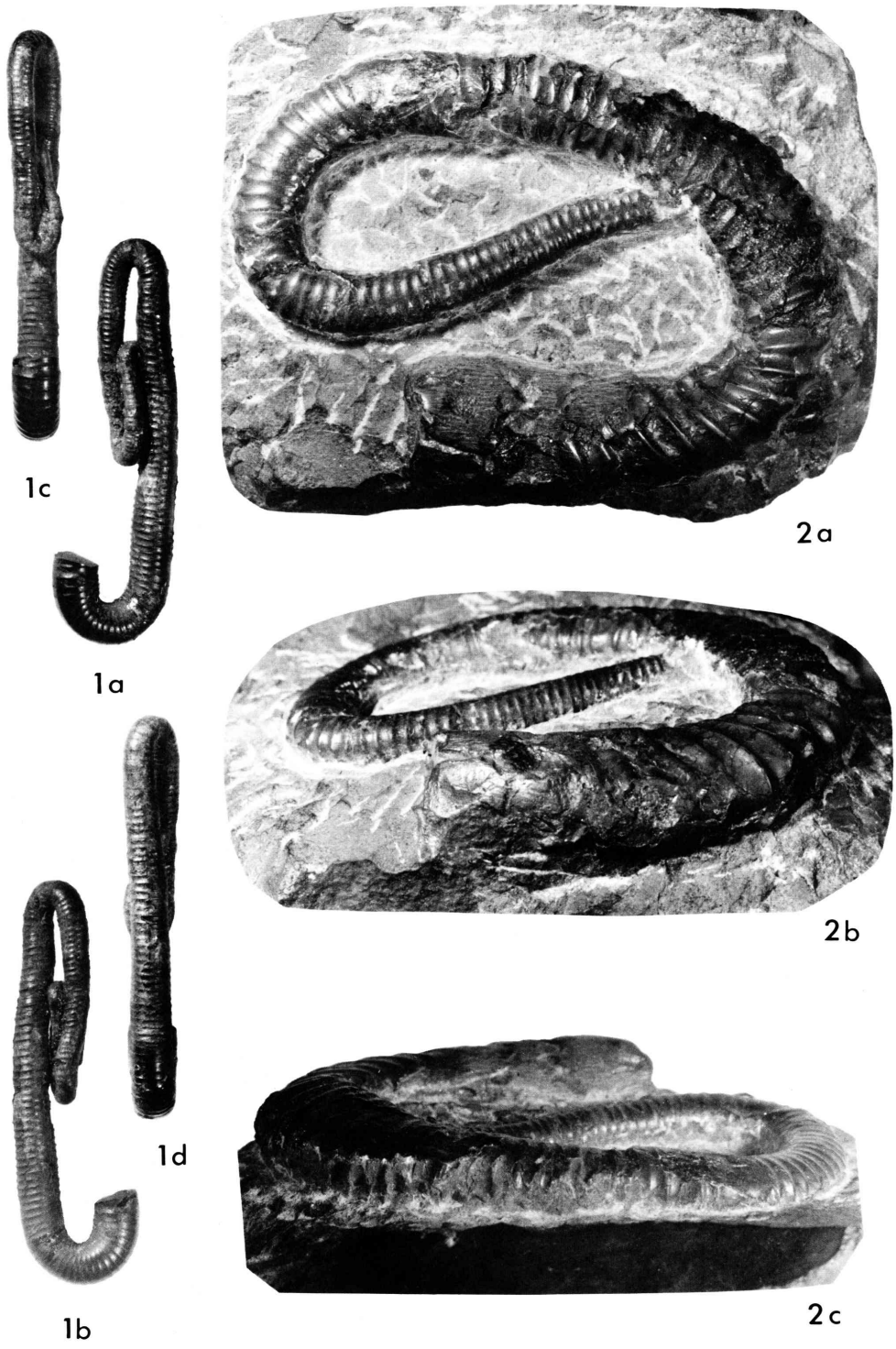
Type-species.—*Heteroptychoceras obatai* sp. nov (described below).

Explanation of Plate 59

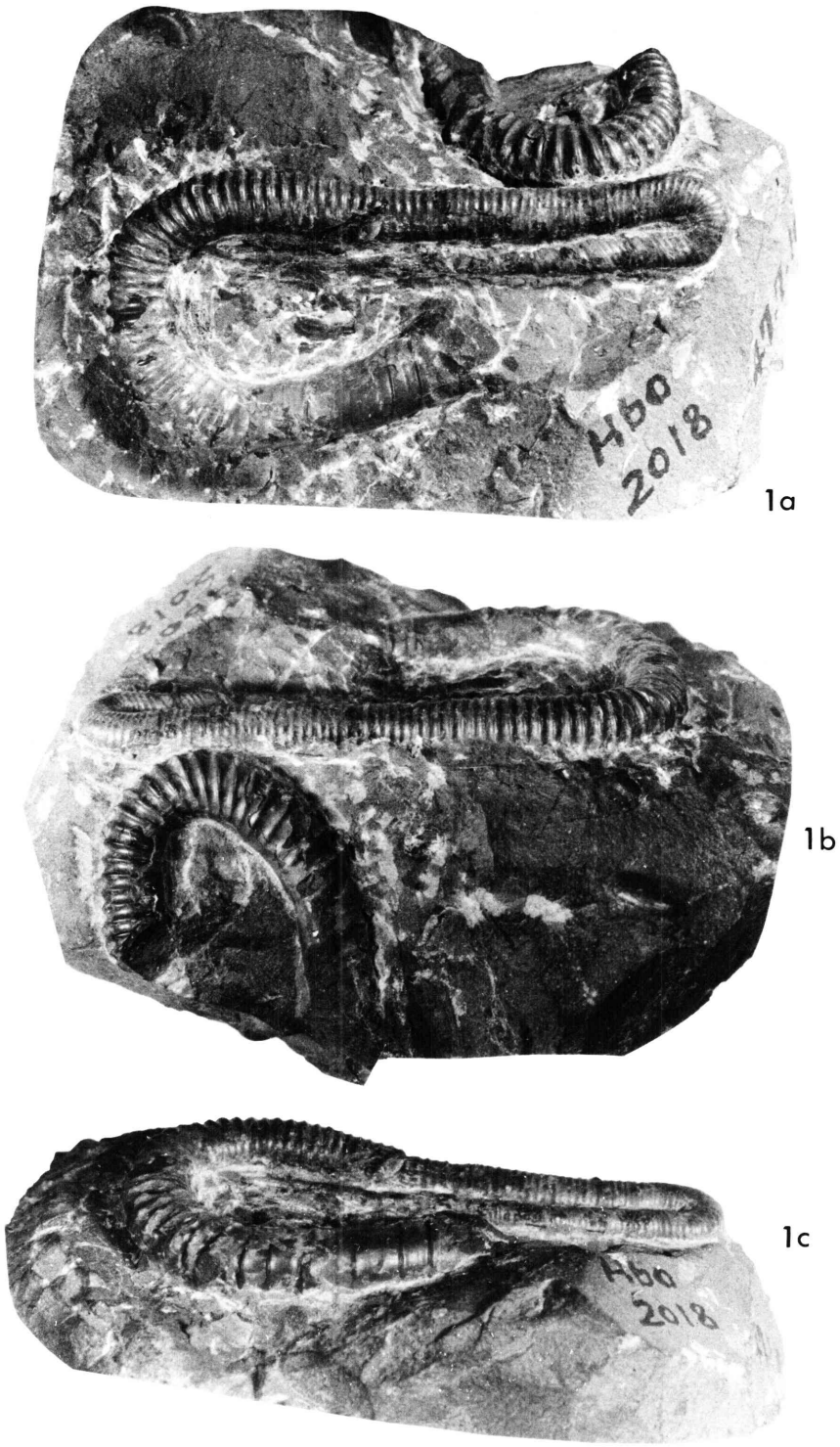
Fig. 1. *Rhyoptychoceras mikasaense* gen. et sp. nov. ..... Page 352
TTC. 5000 of T. TAKAHASHI's Coll., holotype, from loc. Ik 2710, Pombetsu-go-no-sawa, Ikushumbetsu area, showing four (a-d) different views, ×1.

Fig. 2. *Dihamites obiraensis* gen. et sp. nov. ..... Page 355
Ob 1006 of K. MURAMOTO's Coll., holotype, from the Aka-no-sawa, Obira area, Lateral (a) and two ventral (b, c) views, ×1.

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



T. MATSUMOTO: Heteromorph ammonites



T. MATSUMOTO: Heteromorph ammonites

Generic diagnosis.—Septate two shafts are nearly straight, parallel, connected by an abrupt U-form bending, and barely or not touching each other. The body-chamber follows the straight second shaft, soon arcuates, crossing over the first, and then widely opened. The last part of the hook is obliquely straight, approaching toward the two septate shafts.

Ribs are simple, prorsiradiate in the first shaft, nearly rectiradiate and annular in the second shaft and the early part of the body-chamber and finally rursiradiate on the last part. Constrictions occur at intervals.

The suture is like that of *Polyptychoceras*.

Distribution.—Rarely found in the Santonian of Hokkaido. Further works would clarify the distribution.

Discussion.—*Heteroptychoceras* resembles *Polyptychoceras* YABE, 1927 (ex. SHIMIZU, 1935a, p. 271) especially in the characters of the septate shell, but is distinguished by a widely open hook of its body-chamber. The rursiradiate ribbing in the last part is another criterion, although a tendency to this occasionally but not distinctly occurs in *Polyptychoceras*.

Polyptychoceras occurs abundantly in the Santonian of Japan and Sakhalin, but seems to appear earlier. *Heteroptychoceras* can be interpreted as a lateral offshort of *Polyptychoceras*. Its similarity to *Dihamites* in the body-chamber suggests a similar mode of life.

Heteroptychoceras obatai sp .nov.
Pl. 58, Fig. 4; Pl. 60, Fig. 1

Material.—Holotype NSM. 7243 [=M37 of T. MURAMOTO's Collection], from his loc. Y103p, Isojiro-no-sawa, Oyubari area, central Hokkaido. Paratypes (1) NSM. 7249 [=M43 of T. MURAMOTO's collection, from his loc. Ob-02, Obira area, northwestern Hokkaido, (2) K. MURAMOTO's collection, Hbo 2018, from the Ohtodo-sawa a branch of the River Haboro, northwestern Hokkaido; (3) another fragmentary specimen from the same nodule as (2); (4) T. MIYAUCHI's private collection from Chiyenaibo, near Momoshiri, east of Cape Soya, northern Hokkaido.

Diagnosis.—The shell characters which change with growth can be described under at least three stages. The very initial stage is unpreserved. The shell of the visible first stage is straight, long (at least 60 mm in the holotype), gradually enlarging, showing a gentle tapering, elliptical in cross-section, somewhat higher than broad, ornamented with numerous oblique (i. e. prorsiradiate), simple ribs, which number 3 to 4 in a distance equal to the whorl-height, and periodically constricted in parallel to the ribs.

Explanation of Plate 60

Fig. 1. *Heteroptychoceras obatai* gen. et sp. nov. ..... Page 357
Hbo. 2018 of K. MURAMOTO's Coll., paratype, from the Haboro area. Lateral (a) and two ventral (b, c) views, with a body-chamber of another specimen, ×1.
Kyushu Univ. (H. HIRANO) photos.

In the second stage the shell shows an abrupt U-turn and then runs straight to form a nearly parallel shaft with the first, with a very narrow interspace between them. At the bending portion of the U-turn the interspace slightly broadens and the shell is abruptly enlarged immediately after the bending. The second straight shaft is elliptical in cross-section, somewhat higher than broad, with height=6.6 mm and breadth=5.5 mm at the beginning of the shaft and slowly enlarges for about 50 mm in length in the holotype. It has more or less crowded annular (i. e. rectiradiate) ribs and at least two constrictions, one immediately after the bending and the other at about 35 mm distant from the former in the late part where the last suture is observable in the holotype. The ribs are slightly rursiradiate near the earlier constriction.

The shell of the third stage, which corresponds roughly to the body-chamber, is broadly hooked, consisting of a semi-elliptically curved posterior part and a straight anterior part. The last shaft is short and oblique to the first and the second shafts, inclining inward, i. e. approaching to but not in contact with them as it grows. The shell of the third stage is not strictly on the same plane as the first so that the early part of the first shaft lies immediately on the left side of the early part of the last hook. The shell itself is higher than broad and elliptical in cross-section. In the holotype it is about 10 mm in height near the apertural margin and the last straight shaft is about 25 mm long. The length of the entire body-chamber is about 85 mm.

The ribs are rectiradiate, coarse and more or less crowded in the early part of the third stage, and in the last part they are rursiradiate, more distant and asymmetric in section, showing a scale-like shape with a gentle forward and a steep backward slopes. There is a shallow constriction near the apertural margin which is bordered by a somewhat raised rib.

The suture is similar to that of *Scalarites obstrictum* (JIMBO).

Remarks.—Minor differences observed among specimens are regarded as variation within a species. For instance the last hook is somewhat more widely opened in the holotype than in the paratypes (1) and (2); accordingly the distance between the apertural end of the last shaft and the first shaft is about 20 mm in the former as compared with 10 mm or so in the latter.

The ribbing of the second shaft is not so dense in the holotype as in the paratypes; that of the third is not so distant in the holotype as in the paratypes (1) and (2).

The paratype (4) is represented only by a body-chamber with the last suture at its posterior end. It is quite similar to the body chamber of the paratype (2) in shape and ribbing but is somewhat shorter. The paratype (3) which is again a body-chamber, resembles that of the holotype.

Occurrence.—The holotype came from loc. Y103 p of T. MURAMOTO, Isojiro-no-sawa, Oyubari area. It is contained in a marlstone nodule along with *Gaudryceras tenuiliratum* YABE, *Hauericeras angustum* YABE, and *Inoceramus naumanni* YOKOYAMA, which evidently indicate the Santonian part of the Upper Yezo Group. Paratypes (1), from Ob-02, Obira area is associated with *Polyptychoceras* cf. *haradanum* (YOKOYAMA) (M44=NSM. 7250); (2) (3) from K. MURAMOTO's

Hbo 2018, Ohtodo-sawa, a branch of the Haboro, probably derived from unit U5 (fine sandy siltstone) of the Upper Yezo Group; (4) from Chiyenaibo, in a calcareous concretion from the mudstone, where Santonian fossils occur commonly. They all came from the Santonian.

Discussion.—This species is similar to *Polyptychoceras haradanum* (YOKOYAMA) (1890, p. 182, pl. 46, fig. 5) and also to *P. pseudogaultinum* (YOKOYAMA) (1890, p. 181, pl. 46, fig. 1–3) from the Santonian of Hokkaido, up to the second shaft. In addition to the distinct difference in the body-chamber, the cross-section of the shell is elliptical in this species instead of a dorsad thickening ovoid shape of *P. haradanum* and a subcircular one of *P. pseudogaultinum*.

Concluding Remarks

The results of the present study are summarized below, with some remarks on further problems.

(1) *Classification.*—The following species are described and illustrated under the indicated genera. Those printed in bolds are new. Some of the others are revised to a considerable extent.

Family Nostoceratidae HYATT, 1900

Genus *Hyphantoceras* HYATT, 1900 (p. 307)

Hyphantoceras oshimai (YABE) (p. 309, Pl. 43, Fig. 1)

H. orientale (YABE, 1904) (p. 310, Pl. 44, Figs. 1–3; Text-fiig. 3)

*H. **transitorium*** sp. nov. (p. 313, Pl. 44, Fig. 5)

H. (?) ***heteromorphum*** sp. nov. (p. 314, Pl. 47, Fig. 2; Pl. 61, Fig. 1)

Genus ***Yezoceras*** nov. (p. 316)

*Yezoceras **nodosum*** sp. nov. (p. 317, Pl. 45, Fig. 3; Pl. 46, Fig. 3, 4; Text-fig. 4)

*Y. **miotuberculatum*** sp. nov. (p. 320, Pl. 46, Figs. 1, 2; Pl. 61, Fig. 2; Text-fig. 5)

Genus *Nostoceras* HYATT, 1894 (p. 322)

*Nostoceras **hetonaiense*** sp. nov. (p. 322, Pl. 54, Fig. 2; Pl. 55, Fig. 1)

N. sp. cf. *N. stantoni* HYATT (p. 323, Pl. 61, Fig. 3)

Genus *Eubostrychoceras* MATSUMOTO, 1967 (p. 324)

Eubostrychoceras japonicum (YABE) (p. 329, Pl. 48, Figs. 1–4; Pl. 49, Figs. 1–3; Pl. 50, Figs. 1, 2; Pl. 51, Figs. 1, 2; Pl. 52, Fig. 3)

*E. **densicostatum*** sp. nov. (p. 332, Pl. 52, Fig. 2)

Genus ***Muramotoceras*** nov. (p. 334)

*Muramotoceras **yezoense*** sp. nov. (p. 335, Pl. 53, Figs. 1–5; Pl. 54, Fig. 1; Text-figs. 6, 7)

*M. **laxum*** sp. nov. (p. 337, Pl. 45, Figs. 1, 2; Pl. 52, Fig. 1; Text-fig. 8)

Genus *Nipponites* YABE, 1904 (p. 339)

Nipponites mirabilis YABE (p. 340, Pl. 44, Fig. 4; Pl. 55, Figs. 2, 3; Pl. 56, Figs. 1, 2; Text-fig. 9)

Genus *Neocrioceras* SPATH, 1921 (p. 343)

Neocrioceras (?) ***undulosum*** sp. nov. (p. 343, Pl. 47, Fig. 1)
Genus *Pseudoxybeloceras* WRIGHT et MATSUMOTO, 1954 (p. 344)
Pseudoxbeloceras quadrinodosum (JIMBO) (p. 345, Pl. 57, Fig. 2; Pl. 61, Fig. 4)
Family Diplomoceratidae SPATH, 1926
Genus *Scalarites* WRIGHT et MATSUMOTO, 1954 (p. 348)
Scalarites scalaris (YABE) (p. 348, Pl. 58, Fig. 2)
S. ***densicostatus*** sp. nov. (p. 349, Pl. 57, Fig. 1; Pl. 61, Fig. 6)
Genus ***Trianglites*** nov. (p. 350)
Trianglites ***antiqus*** sp. nov. (p. 350, Pl. 58, Fig. 1; Text-fig. 10)
Genus ***Rhyoptychoceras*** nov. (p. 352)
Rhyoptychoceras ***mikasaense*** sp. nov. (p. 352, Pl. 59, Fig. 1; Text-fig. 11)
Genus ***Dihamites*** nov. (p. 354)
Dihamites ***obiraensis*** sp. nov. (p. 355, Pl. 59, Fig. 2; Text-fig. 12)
Genus ***Heteroptychoceras*** nov. (p. 356)
Heteroptychoceras ***obatai*** sp. nov. (p. 357, Pl. 58, Fig. 4; Pl. 60, Fig. 1)

There are many other heteromorph ammonites from the Cretaceous of Hokkaido, which were partly described in previous papers (YOKOYAMA, 1890; JIMBO, 1894; YABE, 1904, 1910; SHIMIZU, 1935a; WRIGHT and MATSUMOTO, 1954; MATSUMOTO and OBATA, 1963; MATSUMOTO, 1967; MATSUMOTO and KANIE, 1967; MATSUMOTO and MURAMOTO, 1967; TANABE, 1975, 1977) and are partly awaiting description.

In the above described species some are represented by a considerable number of specimens. For instance *Eubostrychoceras japonicum*, including a fossil population from a locality in the Obira area, shows a considerable variation, with a remarkable plasticity in youth. For *Nipponites mirabilis* I have examined more than ten specimens with a result that the peculiar mode of coiling is essentially constant and regular in this species. As to the four new species of the new genera of the Diplomoceratidae, only a few specimens are available, but the characters are certainly outside the extent of the variability of previously known species. It is of course desirable to treat more specimens for an adequate definition of these species, but this is a favourable occasion to introduce them.

(2) *Evolutionary history.*—WIEDMANN (1969) discussed comprehensively about the evolutionary history of the heteromorph ammonites. The species described in this paper can be alloted only at a portion of the entire history. Yet it is clearly indicated that the Nostoceratidae and the Diplomoceratidae are successful groups like other normally coiled ones. They should not be regarded merely as degenerated phylogenetic end-forms.

Among the genera of the Nostoceratidae *Eubostrychoceras* and *Hyphantoceras* are long-ranging and represent the fundamental stocks. It is discussed in this paper that *Hyphantoceras* may have given rise to *Didymoceras* which, in turn, may have given rise to *Nostoceras* along the main line.

Eubostrychoceras and *Hyphantoceras* themselves are extremely variable and seem to have offshooted certain specialized genera, e. g. *Nipponites* and *Yezoceras*

from the former and *Madagascarites* from the latter. They also gave rise to a subgroups which tend to recover bilateral symmetry, i. e. probably from *Eubostrychoceras* to *Scalarites* and other genera of the Diplomoceratidae and from *Hyphantoceras* to *Neocrioceras, Pseudoxybeloceras* and others. The above explained differentiation mostly took place in the Turonian and some more genera of peculiar forms, e. g. *Muramotoceras* and *Trianglites,* offshooted in the same age. In the Senonian several specialized offshoots were added, among which *Rhyoptychoceras, Dihamites* and *Heteroptychoceras* are described in this paper under the Diplomoceratidae. In general specialized offshoots have comparatively shorter ranges and the genera on the main lines are long-ranging. The longest range is shown by *Eubostrychoceras* from Cenomanian to Campanian. The specialized genera appear rather suddenly and no transitional forms from the presumed ancesters have been found.

The evolution from a species to another or at intraspecific level has not been studied satisfactorily in this work. To examine it at population level would be required in the future. At present there is difficulty to get suitable material for the Nostoceratidae and the Diplomoceratidae, but TANABE (1975, 1977)'s recent attempt to the Scaphitidae is giving successful results.

(3) *Mode of life.*—Although this is not included in the main purpose of the present paper, some preliminary remarks have been given on the mode of life of the described genera or species in connexion with the observed characters. Generally speaking the described species of the Nostoceratidae and the Diplomoceratidae can be interpreted to have been mainly of benthic life at the adult stage, adapting themselves in variously ways as bottom dwellers. Some species may have had ability of occasional up-and-down locomotion, whereas some others may have creeped on or burrowed in the bottom sediments. Almost all the species have complex florid suture, although the fundamental formula is E, L, U, I. How this implies for their mode of life is a question to be worked out. The adult body-chamber is not so long as expected, but for a few exceptional species. It is noted, however, that the septa of the later whorls are often dissolved away in certain species of *Eubostrychoceras, Hyphantoceras* and *Nipponites,* although the suture-lines are preserved. Whether this was primary or secondary is open to question.

(4) *Stratigraphical implications.*—The stratigraphical occurrence of heteromorph ammonites seems to be controlled by both the environmental and chronological factors. It has been already pointed out (MATSUMOTO and OBATA, 1963, p. 104) that in the Cretaceous of Hokkaido the heteromorph ammonites occur commonly in a particular facies which occupies the intermediate position between the near shore and shallow sandstone facies and the offshore and probably deeper claystone facies. We called it conventionally the *Baculites*-facies or the *Scaphites*-facies, although the baculitids and/or scaphitids may not have the same habitat or mode of life as other heteromorpha and they themselves may have changed with time. Although the statement was approximate and preliminary, this seems still to be applicable in general. As will be explained in more detail in stratigraphical papers (e. g. TANABE et al. 1977) the heteromorpha (nostoceratids

and diplomoceratids) occur most commonly in the lower part of the Zone of *Inoceramus hobetsensis* (Middle Turonian) in the Obira area, but in the Zone of *Inoc. teshioensis* (Upper Turonian) and that of *Inoc. uwajimensis* (Coniacian) in the Ikushumbetsu area. This probably implies that the optimal conditions for the heteromorpha shifted with time from place to place in accordance with the detailed geological history in the Cretaceous sedimentary basin of Hokkaido.

As there is diversity in the hetermorpha, their actual occurrences are more complex than the above generalization. In the Santonian, for instance, where fossils of "nektic" or "pelagic" phylloceratids, tetragonitids and desmoceratids prevailed in the mudstone, some heteromorpha do occur not infrequently, e. g. *Hyphantoceras orientale, Polyptychoceras* spp., and *Subptychoceras* spp. *Heteroptychoceras* and *Dihamites* were found in such a "biofacies".

We do know that certain heteromorph species are world wide and good indices for the interregional correlation, e. g. *Turrilites costatus* in the Lower to Middle Cenomanian. Even if the adult animal is mainly benthic, wider geographic distribution can be achieved by immature or larval ones.

The species described in this paper are mostly confined to the Cretaceous province of Hokkaido-Saghalien or at most the northwestern Pacific province. Within this province some species may be useful for indicating a particular age. So far as the province of Hokkaido is concerned the following species seem to indicate a limited geological age:

Nipponites mirabilis: Middle Turonian
Nipponites bacchus: Upper Turonian-Coniacian
Muramotoceras yezoense: Middle Turonian
Madagascarites ryu: Middle and Upper Turonian
Yezoceras nodosum: Coniacian (rather lower part)
Yezoceras miotuberculatum: Coniacian (rather upper part)
Hyphantoceras orientale: Santonian
Heteroptychoceras obatai: Santonian
Ainoceras kamuy: Lower Campanian

These are regarded as endemic specialized species and how far they are useful for wider correlation should be examined in the future work. Other better known species, e. g. *Hyphantoceras reussianum, Eubostrychoceras woodsi, E. saxonicum, E. indopacificum, Scalarites scalaris* etc. seem to be long-ranging and the stratigraphic position of their abundant occurrence may not be of the same age between different provinces. We need further work for the proper evaluation of them as age indicators.

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Postscript In connexion with the locality record of the described species I add here the following information. Along with an illustrated specimen (NSM. PM-7237=M31) (Pl. 51, Fig. 2) of *Eubostrychocers japonicum,* from loc. Ob-S-RlP, Sato-no-sawa, Obira area, occurs a fragmentary ammonite. Owing to the kindness of Mr. T. MURAMOTO I reexamined this ammonite. It is referable to a body-chamber of *Kamerunoceras* (*Ampakabites*) sp., although it apparently resembles that of *Reesidites minimus.* It suggests a lower part of the Middle Turonian. In this connexion I should revise a locality record of *Yubariceras otatumei.* What I (MATSUMOTO, 1975, *Mem. Fac. Sci. Kyushu Univ.,* [D], **22**, (2), p. 146) indicated as Ob-A-p3 is not in the same Sato-no-sawa, but in another small eastern tributary of the Kamikinembetsu, probably on the southern extension of the same member (unit Mk of TANAKA) as the Sato-no-sawa. The record that it occurred together with *Reesidites minimus* was completely wrong.

Accordingly *Yubariceras otatumei* does not range up to the Upper Turonian but is probably confined to the Middle Turonian.

Explanation of Plate 61

Fig. 1. A fragmentary shell comparable with the early part of *Hyphantoceras heteromorphum* sp. nov. ..... Page 314
GK. H5844 from the Kikume-zawa, Ikushumbetsu (T. OMORI Coll.), ×1.

Fig. 2. *Yezoceras miotuberculatum* gen. et sp. nov. ..... Page 320
Paratype, GK. H3541, from loc. U161p, Urakawa area (T. MATSUMOTO Coll.), ×1.

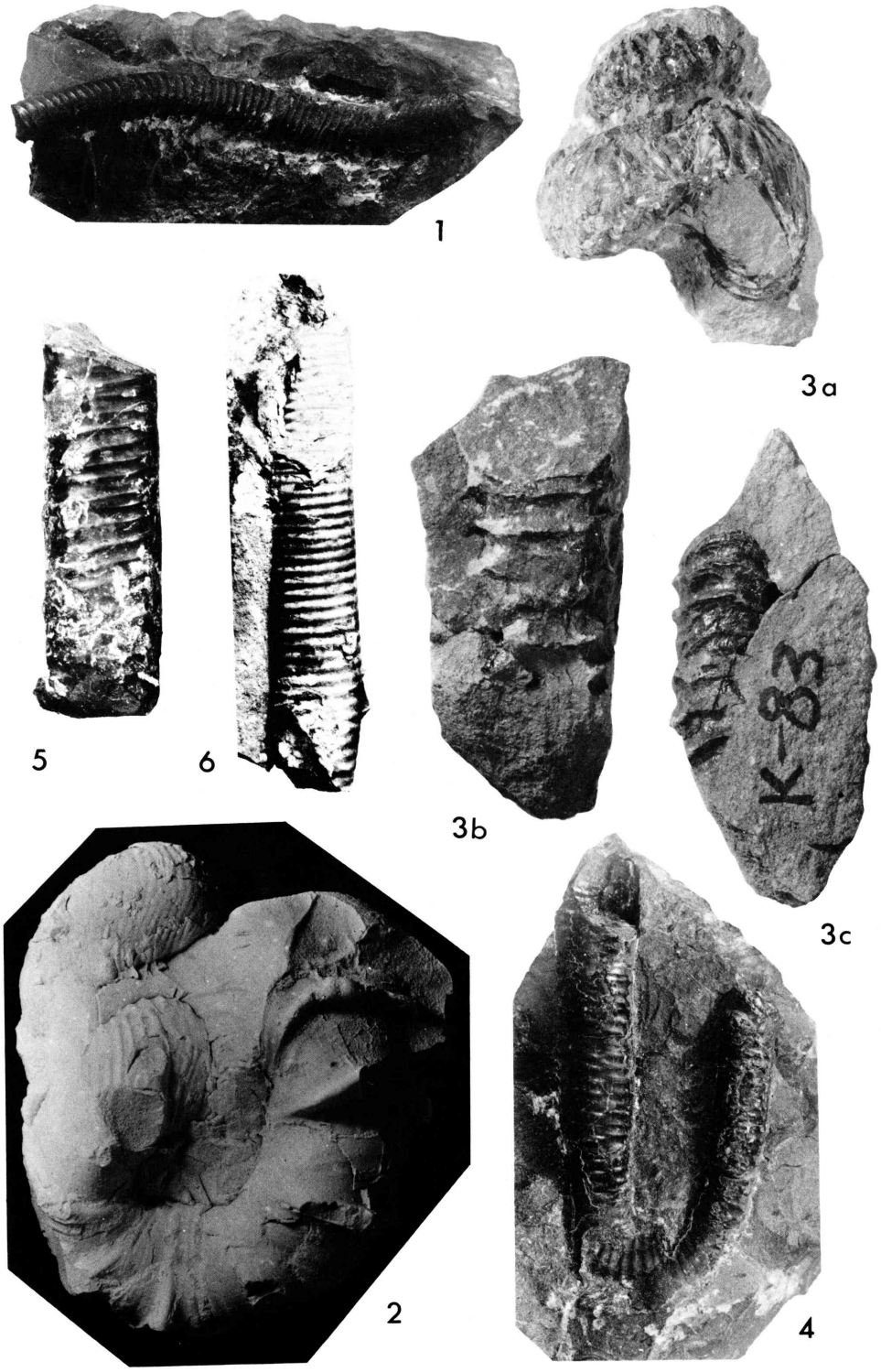
Fig. 3. *Nostoceras* sp. cf. *N. stantoni* HYATT. ..... Page 323
An example from loc. K83, Heitaro-zawa, west of Nakatombetsu (T. MATSUMOTO Coll.). Helical part (a) and two view (b, c) of last shaft, ×1.

Fig. 4. *Pseudoxybeloceras quadrinodosum* (JIMBO) ..... Page 345
GK. H5805, from the Kikume-zawa, Ikushumbetsu (T. MATSUMOTO Coll.). An example of an early to middle growth-stage, lateral view, ×1.

Fig. 5. *Neocrioceras* sp. ..... Page 346
GK. H3543, a fragmentary shell which was misidentified with *Pseudoxybeloceras quadrinodosum* (JIMBO), ×1.

Fig. 6. *Scalarites densicostatus* sp. nov. ..... Page 349
GK. H1452, from loc. Y112b2, Shiyubari, Oyubari area (T. MATSUMOTO Coll.), ×1.

Kyushu Univ. (H. HIRANO) photos, with whitening for Fig. 2 and without whitening for others.



T. MATSUMOTO: Heteromorph ammonites