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Compiled by

Tatsuro MATSUMOTO

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Contents

Abstract

Since the descriptions of the kossmaticeratid species from Japan and other areas of the North Pacific region in the decade of 1950, an appreciable number of interesting specimens have been acquired through intensive field work by several persons. They came mostly from the mid-Cretaceous formations, ranging from the uppermost Aptian to the Turonian, in Hokkaido and other areas of Japan. They have been studied together with those described in previous papers. The results are compiled in this monograph, which consists of five parts in accordance with the contents and the authors.

Altogether 33 species are described of which 22 are new. They belong to 14 genera, of which 3 are new. The oldest of them is a new species of *Marshallites* from the uppermost Aptian and Lower Albian. The phylogenetic origin of the Marshallitinae is uncertain but could be sought in some Aptian species of *Melchiorites* or *Pseudohaploceras*. That of the Kossmaticeratinae is also uncertain. The oldest species of *Kossmaticeras* and *Yokoyamaoceras* (from the Middle Turonian) are not directly linked with any known species of *Marshallites* but seem to be allied to certain *Mesopuzosia*, on account of the close resemblance in young stages and particularly the absence of the umbilical tubercles or bullae on inner whorls.

A good many examples of homoeomorphy are recognized in this family. In addition to that between certain members of the Marshallitinae and Kossmaticeratinae, e.g. certain species of *Marshallites* and *Maorites*, those of *Eomadrasites* or *Mikasaites* and *Jacobites* and those of *Protokossmaticeras* and *Natalites*, the similarity of *Holcodiscoides* to *Holcodiscus* and that of *Wellmanites* to *Menuites* or *Pseudojacobites* are examples of homoeomorphy between different families within the Desmoceratacеae. Furthermore, the similarity of certain species of the Marshallitinae to some Jurassic ammonites is amazing. All of these examples suggest some resemblance in the mode of life.

In many species of Marshallitinae a trace of the past peristome is frequently demarcated on the flat space in front of the periodic constrictions, suggesting the basal part of the inner lateral lappet and the ocular sinus. The lappet itself remains occasionally. The trace is marked periodically from young stages onward, recording the past apertural margin developed at periodic arrests of growth.

A lappeted peristome is currently regarded as a mark of the microconch in a dimorphic pair, but no dimorphic pair has been known in the Kossmaticeratidae, except for the case of *Yokoyamaoceras* versus *Kossmaticeras* or *Kitchinites* and another recently reported, possible but uncertain example. A proposal in this paper is that the lappeted peristome in small forms is not necessarily the primary sexual feature of a male but an adaptation to a certain mode of life. Many species of the Marshallitinae, which often have spinose tubercles or sharply raised or angulated ribs, may have been less active, quiet bottom dwellers and protective against enemies. They may have had keen eyes which were protected by inner lateral lappets. Other species with streamlined shell-form with flexuous ribs and ventral projection (e.g. *Marshallites cumshewaensis*) may have been good swimmers. Still others had enlarged shells which themselves may have been favourable for survival. In short, various genera and species of this family must have been the interesting results of evolutionary processes towards various kinds of adaptation in their life.

In some species of the Kossmaticeratinae the peristome is occasionally preserved. It is gently sinuous on the flank and shows a prominent ventral projection. The difference in the apertural margin between the majorities of the two subfamilies should not be overlooked, since it suggests some anatomical dissimilarity.

As the majority of the species described in this monograph came from the Cenomanian of the Ikushumbets and other areas, a revised scheme of the Cenomanian zonation in Hokkaido by ammonites and inoceramids is concisely explained in the introductory notes of Part II. Each of the kossmaticeratid species ranges normally through more than two zones, but for a few exceptions. In several species heterochrony is recognized, as is demonstrated in the descriptions.

THE MID-CRETACEOUS AMMONITES OF THE FAMILY KOSSMATICERATIDAE FROM JAPAN

Compiled by

Tatsuro MATSUMOTO

Preface

About 35 years have passed since the ammonites of the family Kossmaticeratidae from Hokkaido and Sakhalin were described (Wright & Matsumoto, 1954; Matsumoto, 1955, 1956). In addition to the material of the above studies, more specimens of this group have been acquired from Hokkaido and other areas of Japan by several friends of mine as well as myself. I invited some of them to work with me as coauthors or to contribute their results to this volume as independent authors.

For some reasons various species of the subfamily Marshallitinae which occur mainly in the Albian and Cenomanian sediments are characteristic of Japan. This has been already shown by my previous two papers. A similar feature can be recognized furthermore in several subsequent works on Cretaceous faunas from the Pacific Coast of North America (Anderson, 1958; Matsumoto, 1959; Murphy and Rodda, 1960; McLearn, 1972).

On the other hand, a wealth of knowledge has been accumulated for these 40 years on the kossmaticeratids from the Southern Hemisphere of the Cretaceous Period, as represented by the works of Spath (1953), Collignon (1954, 1955, 1964, 1965a, 1965b, 1966, 1969, 1970, 1971, 1977), Wright (1975b), Howarth (1958, 1966), Henderson (1970, 1973), Ricardi (1983), Kennedy and Klinger (1985), Henderson and McNamara (1985), Kennedy (1986), Macellari (1986) and Olivero and Medina (1989). The kossmaticeratid ammonites described in these papers are mostly those from the post-Upper Turonian group, i.e. the subfamilies Kossmaticeratinae and Brahmaitinae, and species of the Marshallitinae are very few, if not absent.

Despite the great advances in the study of the Cretaceous ammonite faunas from the biostratigraphically standard or reference sections or places in Europe and North America, the ammonites of this family are surprisingly few in those regions, except for several species of *Pseudokossmaticeras* and *Brahmaites*, which have been recently restudied (e.g. by Thiedig and Wiedmann, 1976; Blaszkiewicz, 1980; Kennedy, 1986; Kennedy and Summesberger, 1987).

The above is a brief review of the recent works on the ammonites of the Kossmaticeratidae. In view of the necessity to make our knowledge globally balanced, the results of our recent study should be set forth on this occasion.

For the reasons of the procedures of the research works, the contributions are compiled as indicated in the contents (p. iii–v).

The references cited are listed at the end of this volume. Plates and text-figures are set in appropriate places of the descriptions concerned, but for a few exceptions.

Acknowledgements

Many interesting specimens have been supplied for this study by Mr. Takemi Takahashi (Mikasa), who kindly accepted my invitation to work with me as a coauthor in the descriptions of a considerable number of species in Part II. Likewise Mr. Kenji Sanada (Sapporo) and Dr. Rinji Saito (Kumamoto) joined me as coauthors in the descriptions of some species in Part II, with kind supply of the specimens which they collected respectively.

Dr. Akitoshi Inoma (Sapporo) who had studied preliminarily the ammonite faunas from the Shumarinai-Soeushinai area kindly worked with me as a coauthor of Part III.

At my suggestion Dr. Ikuwo Obata (Tokyo) and Dr. Masao Futakami (Abiko) kindly contributed a paper on a species from the Miyako area in Part IV and Mr. Koji Murakami (Kumamoto) kindly took coauthorship with me in the study of a species from the Tomochi area in Part V.

In addition to the gentlemen mentioned above, Professor Emeritus Wataru Hashimoto, Dr. Saburo Kanno, Dr. Keisaku Tanaka, Messrs. Yoshitaro Kawashita (Mikasa), Shigehiro Uchida (Iwamizawa), Katsujo Yokoi (Kenbuchi), Takayuki Yokoi (Nagoya) and Toshio Shimanuki (Kurisawa), as well as the late Mr. Tatsuo Muramoto, helped me in supplying a number of specimens for this study with necessary information. Professor Tamio Nishida, Ms. Yuko Kyuma, Mr. K. Yokoi and Mr. Y. Kawashita assisted me in the field work of the Soeushinai area.

Thanks are extended to Professor Itaru Hayami and Dr. Hisao Ando for their kind help in my study of the specimens held in the University Museum, University of Tokyo; also to Professor Juichi Yanagida, Professor Hakuyu Okada and Ms. Reiko Hamamoto for their generosity in offering every facility for my study in Kyushu University. Mr. Yoshio Tanaka, the Superintendent of Education of Mikasa City, Mr. Mamoru Kera and Mr. Kikuo Muramoto, the Director and the Keeper of the Museum of Mikasa City, honourably helped me in various ways, especially in keeping some of the studied specimens in the custody of the Museum.

I should like to record here my special appreciation to Dr. Masayuki Noda for his friendly help in taking photographs of the majority of the described specimens. Dr. Noda is not a professional photographer but has devised his own methods.

I am much indebted to Dr. C. W. Wright for his kindness in reading critically the whole of the manuscript; also to Drs. Seiichi Toshimitsu (now in Tsukuba) and Takashi Okamoto (now in Matsuyama), as well as Drs. Obata and Futakami, for their fruitful discussion with me; further to Miss Akiko Murakami and Miss Kazuko Hara who patiently and joyfully assisted me in preparing the typescript.

Finally the coauthors and I owe much to Professor Juichi Yanagida, the Series Editor, and the anonymous referees in setting forth the improved manuscript as Special Papers No. 33 of the Palaeontological Society of Japan, and should like to record here our debt of gratitude to the Ministry of Education, Science and Culture (Monbusho) for the subsidy which facilitated this publication.

December 10, 1990

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THE MID-CRETACEOUS AMMONITES OF THE FAMILY KOSSMATICERATIDAE FROM JAPAN

PART I
GENERAL REMARKS

By

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Introduction

The main purpose of this monograph is to give the palaeontological descriptions of the kossmaticeratid ammonites from the mid-Cretaceous (from the uppermost Aptian to the Turonian) sedimentary series of various areas in Japan, showing what kinds of forms occur in what beds of what geological ages in what places. As the offprints of previous papers have been exhausted and the series (*Japan. Jour. Geol. & Geogr.*) itself ceased to be published, most of the type specimens of already established species are illustrated on this occasion with better photographs, along with those of subsequent collections. This is of course necessary for the revised descriptions. Furthermore, there are numerous new species and also some new genera which certainly enrich knowledge of this group.

The sources of the material for the present study are in the mid-Cretaceous sedimentary series exposed in the following areas:

(1) Hokkaido. — A: the Abeshinai-Saku area in the Teshio Mountains of northern Hokkaido; B: the Shumarinai-Soeushinai area, C: the Kotanbetsu area and D: the Obirashibe Valley or simply Obira area, these three in the southern part on the Teshio Mountains, northwestern Hokkaido; E: the Ashibetsu Valley, F: the Ikushumbets [= Ikushunbetsu] Valley (recently called the Mikasa area) and G: the Shuparo [= Shi-yubari] Valley, commonly called the Oyubari area, these three in the Yubari Mountains, central Hokkaido; H: the Hobetsu area (Hobetsu Valley) southern central Hokkaido.

(2) The Miyako area on the Pacific coast of northeastern Honshu, geologically belonging to Northeast Japan.

(3) The Tomochi area of Kumamoto Prefecture in Kyushu, geologically belonging to Southwest Japan.

These are indicated in Text-figs. 1, 2 and 16.

For the stratigraphy and especially the fossil localities (often numbered), readers may refer to Matsumoto (1942) for 1A, Matsumoto and Inoma (1975) and Text-fig. 12 of this paper for 1B, Matsumoto and Okada (1973) for 1C and 1E, Tanaka (1963) for 1D, Matsumoto (1965, figs. 2–5) and Text-fig. 4 of this paper for 1F, Matsumoto (1942) and Matsumoto *et al.* (1991) for 1G and Matsumoto *et al.* (1979, fig. 3; 1989) for 1H.

For the general account of the Middle Cretaceous biostratigraphy, Matsumoto *et al.*

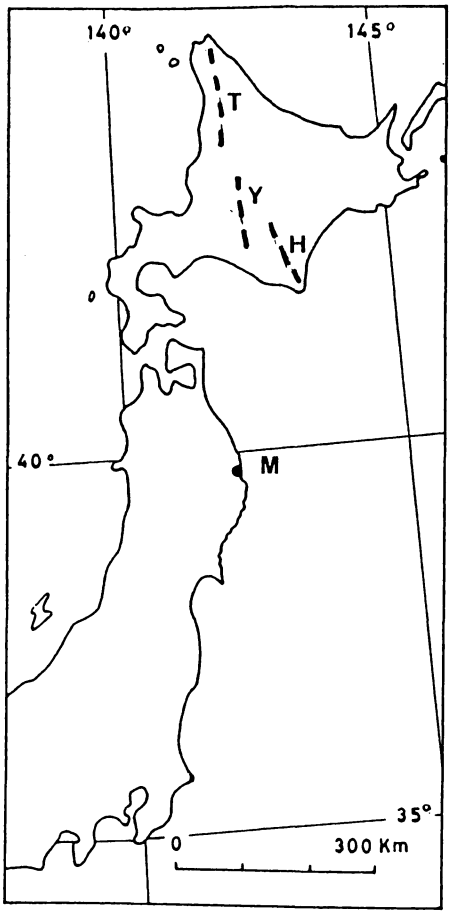

Figure 1. Outline map of Hokkaido and north-eastern Honshu. Broken lines: backbone mountains of Hokkaido — T: Teshio, Y: Yubari and H: Hidaka Mountains. M: Miyako district.

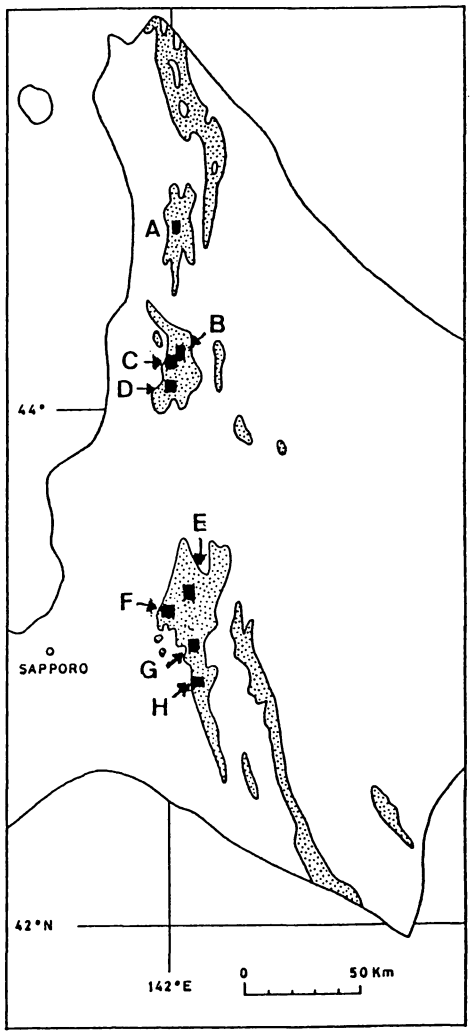

Figure 2. Map of Hokkaido showing ammonite-bearing Cretaceous outcrops (dotted). A-H: areas mentioned in the text.

(1978) may be useful but now needs some revision (see introductory notes in Part II), because of advances since 1974, when that paper was read at the conference of the Mid-Cretaceous Events (MCE) in 1975 at Uppsala.

Brief notes on the stratigraphy of the Miyako and Tomochi areas are given in Parts IV and V respectively.

The specimens described in this monograph (Parts II-V) are kept in the following institutions, with abbreviations in parenthesis:

Department of Earth and Planetary Sciences (formerly Department of Geology), Kyushu University, Fukouka (GK)

Institute of Geology and Palaeontology, Tohoku University, Sendai (IGPS)

National Science Museum, Tokyo (NSM)
Faculty of Earth Sciences, Tsukuba University (formerly Tokyo Kyoiku Daigaku) (TKD)
University Museum, University of Tokyo (UMUT)

For many of the specimens currently registered at UMUT, there are old numbers, e.g. GT. I-3233 etc., which were indicated in previous papers (e.g. Matsumoto, 1955, 1956). Both are shown in this paper for the convenience of readers who may wish to refer also to previous papers.

The collections of T. Takahashi and Y. Kawashita are numbered in this paper with the indications TTC and YKC respectively. They will be kept in the Museum of Mikasa City, except for some which have already been donated to GK. Those of T. Yokoi, personally numbered with prefix TY, are to be kept in the Toyohashi Museum of Natural History, (TMNH), except for the case of his donation to Kyushu University (GK) by way of myself (T.M.).

The morphological terms in the descriptions follow those used by Matsumoto (1988, p. 4), who generally followed those in the *Treatise* (Arkell *et al.*, 1957), except for some alteration.

The abbreviations in the Table of measurements are D = diameter of shell, U = width of umbilicus, H = whorl-height, B = whorl-breadth, h = whorl-height at 180° adapically from H, C (60°) = number of ribs in the interval of 60° at the umbilical margin/that on the venter; measured positions are indicated by E = at the preserved end, E-90° = at a point 90° adapically from E, LS = last suture, i.e. beginning of the body-chamber, LS + 60° at a point 60° adorally from LS; ~ = approximate, HT = holotype, PT = paratype, LT = lectotype.

Measurements are in millimeters and the figure in parentheses is a proportion to the diameter (1).

In connexion with the taxonomic descriptions, there are interesting palaeontological problems which are concerned with kossmaticeratid ammonites. They are (1) phylogenetic relationships, (2) homoeomorphy, (3) peristome, (4) dimorphism, (5) modes of life, (6) heterochrony, (7) palaeobiogeography etc.

Systematics

How to establish a reliable systematics is a moot problem. Scientists want to know a true genealogical relationship, that is phylogenetic relationship, but with the Kossmaticeratidae there is difficulty in reaching reliable conclusions which would be supported or confirmed by every-body. Cladistic taxonomy may be an effective way to lead to real phylogenetic systematics, but in the case of the kossmaticeratid ammonites analysis along the lines of Hennig's (1966) fundamental thought is not in practice easy. In particular, the frequent occurrences of homoeomorphic forms in considerably separated ages would make the analysis much confused.

Even in following the way of stratophenic investigation, the material available at present is still insufficient in this group of ammonites.

What is the ancestor of the earliest species of *Marshallites*? What is the phylogenetic

origin of the earliest species of *Kossmaticeras*? Has the earliest species of *Eogunnarites* a common ancestor with that of *Marshallites*? Is the subfamily Marshallitinae monophyletic or polyphyletic? These are examples of the questions which I am still unable to answer with confidence. However, the available material has been so much increased and improved that new or revised suggestions may be given on this occasion.

Although the descriptions in Parts II-V are the base of my systematics, I present in this part the definitions and remarks at generic and family levels.

Family Kossmaticeratidae Spath, 1922

The ammonites which are assigned to this family are mostly characterized by the more or less prorsiradiate periodic constrictions which normally intersect several ribs behind each of them. Constrictions are double collared and the collars (or flares) have bullate tubercles at their umbilical ends. The ribs are as a rule numerous and often arise in bundles at or near the umbilical edge forming bullate or nodose tubercles.

Exceptions to the above general characters may occur occasionally. When they are found in primitive or early members, they may be related to the phylogenetic origin of the group. Remarks along this line will be given below on certain genera or species, although I hesitate to reach a final conclusion.

Even if the phylogenetic relationships remain unsettled, many species of the family present interesting features of their respective adaptations in shell-form or ornament, which must be the results of evolutionary processes.

The pattern of septal suture is fairly constant in this family. That of *Kossmaticeras theobaldianum* (Stoliczka), as illustrated by Kossmat (1897, pl. 7, fig. 5) (Text-fig. 3A) certainly represents the kossmaticeratid pattern, in which L is nearly symmetrically tripartite and not so much enlarged as that of *Puzosia* or allied genera (see Kossmat, 1898, pl. 16, fig. 4). Many species of Marshallitinae and certain later species of Kossmaticeratinae show more ramified sutures, although they follow fundamentally the kossmaticeratid pattern (see Text-figs. 5, 6). This should be again explained as an adaptative character, e.g. to the mode of life in the particular depth of the sea-water which the respective species preferred. In some species of Marshallitinae the sutural pattern (Text-fig. 3B) (Kossmat, 1897, pl. 6, fig. 4) is similar to that of certain genera of earlier geological ages—e.g. *Melchiorites* Spath, 1923 or *Pseudohaploceras* Hyatt, 1900, which I include in the Eodesmoceratidae, instead of the Puzosiidae in my sense (Matsumoto, 1988). This may suggest a phylogenetic relationship.

Fig. 3. Kossmaticeratid sutures. Typical (A) and atypical (B) examples.
A: *Kossmaticeras theobaldianum* (Stoliczka) (external and internal, natural size);
B: *Protokossmaticeras moraviatoorense* (Stoliczka) somewhat enlarged. (After Kossmat, 1897, pl. 7, fig. 5 and pl. 6 fig. 4).

Subfamily Marshallitinae Matsumoto, 1955

I include in this subfamily the following 12 genera:

Marshallites, Matsumoto, 1955
Hulenites, Matsumoto, 1955
Yeharaites gen. nov.
Yakushiceras gen. nov.
Maccarthyites Matsumoto, 1959
Protokossmaticeras Collignon, 1965
Holcodiscoides Spath, 1922
Sounnaites gen. nov.
Eogunnarites Wright & Matsumoto, 1954
Eomadrasites Matsumoto, 1955
Mikasaites Matsumoto, 1956
Wellmanites Wright, 1957

They are nearly as numerous as the genera of the later subfamilies Kossmaticeratinae plus Brahmaitinae.

Some of the above genera are similar to some genera of the latter group in apparent morphological features, but have no direct connections at the level of species, being considerably separated in geological age. The phylogenetic origin of the oldest member of the Kossmaticeratinae can hardly be linked with any member of the Marshallitinae (see Part II). There is a gap of records in the Lower Turonian. Therefore, I think it better to maintain the subfamily Marshallitinae.

Genus *Marshallites* Matsumoto, 1955

Type species.—*Marshallites compressus* Matsumoto, 1955 (from the Cenomanian of Japan) by original designation (Matsumoto, 1955, p. 119).

Diagnosis.—Shell small to medium-sized and fairly narrowly umbilicate. Whorls fairly involute in most species but may be less so in others. Whorls of middle to late growth-stages generally higher than broad, but for a few exceptional species in which whorls are nearly as high as broad.

Periodic constrictions prorsiradiate and sometimes gently flexuous; some have an inner lateral convex parabola in front.

Surface of shell ornamented with numerous, more or less flexiradiate, fine ribs, many of which arise at the umbilical margin in bundles of two or more and form bullae or rather weak, small tubercles. Intercalated and/or branched ribs may be added on the flank.

Suture of kossmaticeratid pattern and much ramified in late growth-stages.

Remarks.—This genus contains more species than others of the subfamily. It has a fairly long range from the earliest Albian (or latest Aptian) to the late Cenomanian and occurs in both the Northern and Southern Hemispheres. Therefore, it may represent the fundamental stock of the subfamily.

According to Obata and Futakami (Part IV of this monograph), a new species, from the Lower Albian of the Miyako area, is closely allied in many characters to *Pseudohaploceras nipponicum* Shimizu, from the Upper Aptian of the same area, and differs in the presence

of bundled ribs with bullae at the umbilical edge. Their suggestion that the origin of *Marshallites* is probably in *Pseudohaploceras* should be evaluated. C. W. Wright (in a letter of December 10, 1990) also suggested me the same view.

Distribution.—Wide in the Indo-Pacific regions from the highest Aptian to Upper Cenomanian.

Genus *Hulenites* Matsumoto, 1955

Type species.—*Puzosia reesidei* Anderson, 1938 (from the Albian of California) by original designation (Matsumoto, 1955, p. 122).

Diagnosis.—Shell small and fairly narrowly umbilicate, with fairly high to moderate degree of involution. Constrictions frequent and prorsiradiate. Whorls higher than broad and ornamented with fine ribs of unequal length, some of which reach the umbilical margin. Constrictions intersect a few ribs behind.

Remarks.—I previously regarded this genus as representing the most primitive form of the Marshallitinae and thought that the type species might have derived from some species of *Melchiorites*. This is now debatable, if not completely rejected.

The specimens from the Lower Albian of the Miyako area which were tentatively referred to *Hulenites* (*in* Hanai *et al.*, 1968) are treated in Part IV of this paper as a species of *Marshallites* and the specimens from the uppermost Aptian of the Tomochi area (Part V) are comparable with the Miyako species.

It is interesting to note a homoeomorphic similarity between *Hulenites* and *Kitchinites* Spath, 1922, the latter of which has been recently regarded by H. Maeda (oral comm. 1990) as a member of the Kossmaticeratinae. On the other hand a species of *Marshallites* (to be described in Part III) is closely allied to *Hulenites jimboi* (Anderson).

It will be necessary to investigate carefully adequate material from California for clearer definition of this genus as well as for its role in the evolutionary history.

Genus ***Yeharaites*** nov.

Type species.—*Yeharaites kobayashii* sp. nov. (described in Part II), from the Cenomanian of Japan.

Diagnosis.—Shell medium-sized or fairly large, with moderate to fairly wide umbilicus. Whorls somewhat compressed and high trapezoid or subrectangular or subelliptical in cross-section, with abruptly rounded ventrolateral and umbilical shoulders; venter and flanks nearly flat or gently convex and umbilical wall low and steeply inclined or nearly vertical.

Double collared periodic constrictions somewhat oblique to the ribs behind them and normally succeeded in front by a flat space, where the inner lateral parabola may be traced.

Shell at first nearly smooth, except for periodic flares. The late young whorl has more or less dense ribs, of which longer ones may be bullate at the umbilical edge, arising singly or in twos or threes; also some intercalated shorter ones.

On the outer whorl the ribs tend to be single, of unequal length and stronger or more elevated than those of the inner whorl. Some, if not all, of the long ribs are distinctly bullate at the umbilical end. The ribs often show a forward convexity on the inner part of flank, and are somewhat rursiradiate or gently convex on the main part of the flank, with or without

slight forward inclination at about the ventrolateral shoulder, crossing the venter almost at right angle with the siphonal line. Only the periodic flares may be gently or moderately projected on the venter.

Suture of kossmaticeratid pattern.

Etymology. —This genus commemorates the late Professor Shingo Yehara (1884–1964) who contributed much to Mesozoic palaeontology and tectonic geology.

Remarks. —In addition to the type species and another new species from the Lower Cenomanian of Japan, I refer *Kossmaticeras canadense* McLearn (1972, p. 188, pl. 26, fig. 2) and a new species established in this paper on a specimen of Dawson's collection (illustrated by McLearn, 1972, pl. 41, fig. 2 under *Mesopuzosia* ? sp.), both from the Upper Albian of the Pacific Coast of Canada, to *Yeharaites*.

Yeharaites looks somewhat similar to *Kossmaticeras* de Grossouvre, 1901. *K. theobaldianum* (Stoliczka, 1865), the type species, and most of other species of *Kossmaticeras* (s.s.), i.e. the subgenus *K.* (*Kossmaticeras*) of authors, occur mainly in the Coniacian stage of the Indo-Pacific regions and a few species of the same genus (s.s.) are recorded as forerunners from the Upper and also Middle Turonian of Madagascar and Japan. Thus, there is a considerable time gap between *Yeharaites* and *Kossmaticeras* (s.s.).

The morphological difference between the two genera does not look great at first sight but should be carefully investigated. The trace of the inner lateral parabola or ear is periodically marked in every species of *Yeharaites*.

Conforming approximately to this character, some ribs show a forward convexity on the inner flank, whereas their ventrolateral projection is absent or slight and they cross the venter nearly transversely or even with some backward curvature. In the two species from the Cenomanian of Japan some ribs are gently convex forward or slightly rursiradiate on the flank. Only the frontal collar of the periodic constriction may show a slight ventral projection in *Yeharaites*.

In many species of *Kossmaticeras* an ear like inner lateral projection is not marked and the ribs as well as the periodic constrictions are more or less prorsiradiate and often concave on the flank and distinctly projected on the venter. A completely preserved example of *K. sparsicostatum* (Kossmat) is illustrated by Collignon (1955, pl. 3, fig. 1), which shows that its apertural margin is prorsiradiate with a very gentle sinuosity on the flank and markedly projected on the venter.

The above features must reflect the anatomical as well as the ecological differences between the two genera.

So far as the available material is concerned, the phylogenetic origin of *Kossmaticeras* is uncertain. No successive species which could link typical species of *Yeharaites* with those of *Kossmaticeras* are known from the time interval from mid-Cenomanian to mid-Turonian. In our present knowledge this sort of connection is unlikely and *Yeharaites* should be treated as an independent genus.

In the tendency to have single ribs on the outer whorl this genus looks more similar to *Pseudokossmaticeras* Spath, 1922 of the Campanian and Maastrichtian ages than to *Kossmaticeras* s. str. This is evidently a homoeomorphy.

In my preliminary view, *Yeharaites* may be an offshoot from some primitive species of *Marshallites* and may have been dead ended at some time in the Cenomanian.

Lateral lappets on the apertural margin are known in several species of *Yokoyamaoceras*

Wright & Matsumoto, 1954 (p. 128, pl. 8, fig. 1) (see also Matsumoto, 1955; 1956), from the mid-Turonian to Santonian. They show a strong ventral projection of the ribs and periodic flares as in many species of *Kossmaticeras* but are much smaller and normally have ventrolateral tubercles in a limited part of the whorl.

Distribution. — Rather rare in the Upper Albian and Lower Cenomanian of the northern Pacific region.

Genus ***Yakushiceras*** nov.

Type species. — *Yakushiceras takahashii* sp. nov. (described in Part II), from the Cenomanian of Japan.

Diagnosis. — Shell small to medium-sized. Whorls fairly evolute, higher than broad, suboval in cross-section, and ornamented with nearly rectiradiate to gently rursiradiate, single ribs which are tuberculated on either side of the siphonal zone but almost devoid of umbilical bullae; periodic constrictions weakly prorsiradiate and may be gently sinuous, cutting a rib behind. Suture as that of *Yeharaites*.

Remarks. — This genus may be allied to the nearly contemporary genus *Yeharaites* established in this paper, but the exclusively predominant, single long ribs with two rows of ventral tubercles are particular to it.

It resembles *Maccarthyites* Matsumoto, 1959 in having high whorl with a suboval cross-section and gently rursiradiate ribbing on the outer whorl, but in that genus the whorl is more involute and the ribs have a single row of tubercles or angulations of ribs on the siphonal line and there are intercalated or branched ribs.

The apparent similarity to *Tmetoceras* (see Arkell *et al.*, 1957, p. L262, fig. 297) of the Aalenian stage (Jurassic) is evidently a homoeomorphy. In that genus the constrictions run in parallel to the ribs and there is a distinct groove between the two rows of ventral tubercles.

Etymology. — *Yakushi-nyorai*, a divinity (Tathagata) in Buddhism, who is believed to help people with disease and other sorts of misfortune.

Distribution. — Rare and endemic in the Lower Cenomanian of Japan so far as known.

Genus *Maccarthyites* Matsumoto, 1959

Type species. — *Maccarthyites gracilis* Matsumoto, 1959 (from the Cenomanian of Alaska) by original designation (Matsumoto, 1959, p. 67).

Diagnosis. — Shell small, compressed, rather involute and fairly narrowly umbilicate. Whorl narrowly suboval or subelliptical in more or less early growth-stage but has or tends to have fastigiate venter later.

Periodic constrictions well-marked, prorsiradiate on the inner flank and gradually curved to become nearly rectiradiate on outer part. Trace of the past peristome with inner lateral parabola well-discernible in front of some constrictions.

Ribs and umbilical tubercles are almost absent or weak on the major part of the phragmocone, except for the periodic flares and the bullae at their umbilical ends. The last part of the phragmocone and the body-chamber ornamented with distinct ribs of unequal length which are rectiradiate or slightly rursiradiate on the flank and sharply elevated on

crossing the median zone of the venter. Long ribs have bullate umbilical tubercles and the periodic flares have nodes at the umbilical edge. Single ribs predominant.

Remarks. —This genus is so peculiar that its relationships with other genera are uncertain. A new species from Japan is represented by a number of variable specimens. In its tendency to break up the bundled ribs and some other characters this genus may be allied to the nearly contemporary *Yeharaites*.

Distribution. —So far found rarely in the Cenomanian of Alaska and occasionally in the Lower Cenomanian of Japan.

Genus *Protokossmaticeras* Collignon, 1964

Type species. —*Protokossmaticeras madagascariense* Collignon, 1964 (from the Lower Cenomanian of Madagascar) by original designation (Collignon, 1964, p. 19).

Diagnosis. —Shell small to medium-sized and moderately umbilicate. Whorl subcircular in section and slightly broader than high to somewhat higher than broad. Constrictions well-marked, slightly prorsiradiate and may have a parabola in front.

On the septate whorls numerous ribs arise in bundles of two to several from prominent umbilical tubercles, which become bullate on the outer whorl. Intercalated or branched ribs may be added.

Suture of generally kossmaticeratid pattern, but it has gradually descending auxiliaries and less ramified elements (Text-fig. 3B).

Remarks. —I should like to appreciate the late General Maurice Collignon's keen insight in recognizing this genus on two small specimens from Madagascar. This is now supported by some better preserved specimens of the same species from Japan. *Ammonites moraviatoorensis* Stoliczka, 1865, from the Upper Albian of South India is probably another species of this genus.

Whether *Protokossmaticeras* had a common origin with *Marshallites* or not is uncertain. Known species of this genus cannot be the direct ancestor of the earliest species of *Kossmaticeras* of much later age.

Some *Protokossmaticeras* look similar to certain *Natalites* species of much later age. This is evidently a homoeomorphy.

Distribution. —It should be noted that *Protokossmaticeras* is known to occur in Madagascar (Lower Cenomanian), South India (Upper Albian) and Japan (Lower Cenomanian), though rarely.

Genus *Holcodiscoides* Spath, 1922

Type species. —*Ammonites cliveanus* Stoliczka, 1865 (from the Upper Albian of South India) by original designation (Spath, 1922, p. 124).

Diagnosis. —Shell small to medium-sized and moderately umbilicate. Inner whorls subcircular in section with rounded venter. Outer whorl subquadrate to subtrapezoid in section with more or less flattened venter.

Septate whorls ornamented with numerous ribs bundled at prominent umbilical tubercles. On the outer whorl ribs bifurcate at the umbilical bullae or even become single and coarsen; ventrolateral tubercles added where ribs may be looped. The tubercles may be originally

spinose. Ribs nearly rectiradiate, whereas constrictions are weakly prorsiradiate and may be accompanied in front by a parabola.

Suture similar to that of *Protokossmaticeras*.

Remarks.—This genus is certainly allied to *Protokossmaticeras*. Beside the type species, interesting small forms are newly found from the Lower Cenomanian of Japan (see Part II).

This genus is apparently similar to *Yokoyamaoceras* Wright & Matsumoto in having the ventrolateral tubercles on the outer whorl and also the lappeted peristome. In *Yokoyamaoceras* the ribs are flexuous or concave on the flank and projected on the venter; there is no umbilical tubercles throughout life or at least in youth. In *Holcodiscoides* the ribs are nearly rectiradiate, crossing the venter vertically, except for the periodic flares which are somewhat prorsiradiate, showing a slight ventral projection; there are prominent umbilical tubercles on the inner whorls. On the above criteria *Ammonites paravati* Stoliczka, 1865, from the Trichinopoly Group of South India, may be a species of *Yokoyamaoceras*.

As in the case of *Yokoyamaoceras*, someone may consider the possibility of dimorphism between *Protokossmaticeras* and *Holcodiscoides*. I deny this possibility, because there is no good example of dimorphic pair (i.e. macro- and microconchs) in the available material and because parabolae, i.e. traces of the lappeted peristome, are recognized in both *Protokossmaticeras* and *Holcodiscoides*.

As the generic name tells, *Holcodiscoides* looks similar to *Holcodiscus* Uhlig, 1883 of Barremian age in shell-form and the existence of ventrolateral tubercles. This is a homoeomorphy between members of different families within the same superfamily Desmoceratacеae.

Umsinenoceras Kennedy, Wright & Klinger, 1979, from the Middle Albian of South Africa, has ventrolateral clavi in middle and later growth. Its distinction from *Holcodiscoides* has been discussed by Kennedy *et al.* (1979, p. 36), who did not assign it to the Marshallitinae. Without examining the original specimens of the type species and allied ones, I hesitate to give further comments.

Distribution.—So far, South India (Upper Albian) and Japan (Lower Cenomanian).

Genus *Eogunnarites* Wright & Matsumoto, 1954

Type species.—*Olcostephanus unicus* Yabe, 1904 (from the Cenomanian of Japan) by original designation (Wright and Matsumoto, 1954, p. 124).

Diagnosis.—Shell small but thick; umbilicus fairly narrow or of moderate width and more or less deep. Whorl typically depressed, with broadly rounded venter, inflated flanks, subangular umbilical edge and high umbilical wall, especially so in early growth-stages.

I include in this genus some species whose outer whorl is not so much depressed as that of the type species but whose inner whorls are more or less depressed.

Numerous sharp-headed ribs arise in bundles of two to several from prominent umbilical tubercles on the inner whorl. In some species this character may persist to the outer whorl but in others the bundles may break up to bifurcation from bullate tubercles or give rise to single long ribs and the ribs may be coarsen.

Suture of typical kossmaticeratid pattern. Its ontogenetic development in the type species in my previous study is reproduced in this paper (Text-fig. 9).

Remarks.—Three new species are added in this monograph under this genus, whereas

E. alaskaensis Matsumoto, 1959 is transferred to a new genus, *Sounnaites*, which is established in Part III.

Eogunnarites matsumotoi Murphy & Rodda (1960, p. 855, pl. 104, figs. 1–3), from the Albian of California, seems to be referred to *Moffitites* Imlay, 1959, because it lacks the umbilical tubercles and is similar to a small form of *M. robustus* Imlay (1960, pl. 13, figs. 11–12) (see also Jones, 1967, p. 41, pl. 4, figs. 24–25).

The phylogenetic origin of *Eogunnarites* is uncertain. *Protokossmaticeras madagascariense* or an unknown, more depressed species of *Protokossmaticeras*, if existent, could be the source. On the other hand, a new species of this genus which has less depressed whorl and moderately wide umbilicus looks apparently similar to *Natalites africanus* (van Hoepen, 1920) of much later age. As there is no direct phylogenetic connexion, this is regarded as homoeomorphy.

Distribution.—Not uncommon in the Cenomanian of Japan.

Eogunnarites vereshagini Terechova (1980, p. 100, pl. 16, fig. 9) is an example of this genus from the Middle Cenomanian *Turrilites acutus* Zone of the Anadyr Basin in the Pacific region of the USSR.

Genus *Sounnaites* nov.
(established in Part III)

Genus *Eomadrasites* Matsumoto, 1955

Type species.—*Eomadrasites nipponicus* Matsumoto, 1955 (from the Cenomanian of Japan) by original designation (Matsumoto, 1955, p. 132).

Diagnosis.—Shell small, moderately involute and fairly narrowly umbilicate. Inner whorls more or less broader than high and somewhat depressed to subrounded in section. Outer whorl tends to be less depressed with less convex flanks or even somewhat higher than broad, with bluntly fastigiate venter at least in some forms.

Periodic constrictions and flares weakly prorsiradiate, showing slight to moderate ventral projection. Trace of past peristome with inner lateral subangular projection may be recognized in front of the constriction.

Numerous radial ribs crowded, typically fine and sharp but may be somewhat coarser in some species. Inner lateral (i.e. supra-umbilical) nodes disposed at wide intervals, at each of which several of the fine ribs are looped; more frequent ventrolateral and siphonal nodes persistent in the type species but may occur in a limited interval of the outer whorl in some species. The nodes form septate bases of the spines.

Remarks.—This genus is somewhat allied to a finely ribbed species of *Eogunnarites* but is not so depressed and the tubercles are not situated at the umbilical edge but on the inner flank. The nodeless fine ribs arise from the umbilical seam and several of them are looped at each of those supra-umbilical tubercles and others run straight in the interspace between the tubercles, although some are looped at the ventrolateral or siphonal tubercles.

Only the periodic flares have narrowly bullate weak tubercles at the umbilical edge.

Distribution.—So far, found rarely in the Cenomanian of Japan.

Genus *Mikasaites* Matsumoto, 1956

Type species.—*Mikasaites orbicularis* Matsumoto, 1956 (from the Lower and Middle Cenomanian of Japan) by original designation (Matsumoto, 1956, p. 174).

Diagnosis.—Shell small to medium-sized and fairly narrowly umbilicate, with moderate involution. Whorl in early growth-stage depressed and thickly cordate in cross-section, with obtusely triangular venter, fairly inflated flanks, subrounded umbilical edge and fairly deep umbilicus. Whorl in more or less late growth-stage higher than broad, roughly suboval to subtrapezoid in section with obtusely subtriangular mid-venter and then shouldered at the ventrolateral part.

Trace of the past peristome in front of the periodic constrictions shows a projection at the umbilical edge in youth which shifts on the inner flank later; its ventral projection weak to moderate but subangular.

On inner whorl numerous, fine and sharp ribs forming bundles at prominent umbilical nodes, together with some nodeless ones intercalated between the nodes, running radially on flank with further occasional branching on the ventrolateral part. All the ribs looped in twos or threes at each of fairly densely disposed siphonal nodes, which were once spinose but remain as septate bullate bases.

On the outer whorl ribs coarsen somewhat, arising from bullate umbilical tubercles in twos or threes, gently flexuous around the umbilicus, with convexity on the inner flank and nearly rectiradiate on the rest main part. Siphonal spines remain and the ribs are looped in twos at each of the bullate base of the spinose tubercles.

Remarks.—This genus resembles certain less depressed species group of *Eogunnarites* in early growth-stage. The development of the spinose tubercles along the siphonal line is characteristic. In the type species no ventrolateral tubercles occur, but in a new species (*M. robustus*) the ventrolateral tubercles occur in a limited part of the outer whorl.

Distribution.—Not uncommon in the Lower and Middle Cenomanian of Japan. This genus is represented by *M. matsumotoi* Verechagin (1965, p. 38, pl. 26 fig. 2; pl. 27. fig. 1) in the Pacific region of the USSR.

Genus *Wellmanites* Wright, 1957

Type species.—*Wellmanites zelandicus* Wright, 1957 by original designation (Wright, 1957b, p. 808).

Diagnosis.—Shell small to medium-sized. Whorls rather evolute to moderately involute, fairly depressed and broadly rounded in cross-section.

Periodic constrictions well marked, double collared on the test, nearly radial on the flank and gently to moderately projected on the venter. The collars (or flares) may be weakly bullate at the umbilical edge.

On each interspace between constrictions in the phragmocone there are one to three, rather coarse nodes, which are aligned at more or less wide intervals somewhat outside the umbilical edge or nearly on the middle of flank. In addition, ventrolateral and median ventral nodes appear on the adult body-chamber. The nodes originally all extended as spines with a septate base. They may be faintly extended radially, if not forming distinct ribs. Otherwise, dense and very fine, radial lirae on the surface of the shell; the internal

mould looks nearly smooth.

Suture of kossmaticeratid pattern and much ramified with fine and deep incisions in spite of the small size of the shell.

Remarks.—This genus was originally proposed for a single species which was erected on several, incomplete specimens from the probable Cenomanian of New Zealand (Wright, 1957b, p. 808, pl. 54, figs. 3, 4, 5). In subsequent work by Henderson (1973, p. 105, fig. 14, nos. 4, 6, 7) no additional specimens to those described by Wright were reported. Thus, the characters of the adult whorl, including those of the body-chamber, have remained unknown.

Now, the species from Japan described below, which is based on well preserved specimens from undoubted Cenomanian strata, has the characters of the septate stage which are in the gross similar to those of *W. zelandicus*. Therefore, it can be certainly referred to *Wellmanites*, although it may be distinguished specifically. Moreover, it does show the characters of the adult body-chamber. Taking into considerations this Japanese species, as well as the type species from New Zealand, I have given above a revised generic diagnosis.

As Wright remarked, *Wellmanites* is closely allied to *Eogunnarites* but is devoid of the substantial ribs and its shell surface has numerous, dense and very fine lirae, and has spinose tubercles at about mid-flank or somewhat outside the umbilical edge. The median ventral, ventrolateral and supra-umbilical, spinose tubercles occur nearly throughout or in some part of the whorl in *Eomadrasites*, but the latter has less depressed and somewhat more involute whorls and also more distinct but irregular ribs which are looped at the tubercles.

The geological age of *W. zelandicus* was inferred by Wright as probably Cenomanian. This is now supported by another allied species of the same genus from Japan.

Some similarity of *Wellmanites* to *Menuites* Spath, 1922, a Santonian to Maastrichtian genus of the family Pachydiscidae, or to *Pseudojacobites* Spath, 1922, a Turonian to Coniacian pachydiscid genus, is evidently a homoeomorphy. Nearly contemporary (late Albian-Cenomanian) species of the Pachydiscidae, e.g. those of *Eopachydiscus* and *Lewesiceras*, have less depressed whorls, stronger ribs on phragmocones with tubercles at the umbilical edge and less ramified sutures with widely open elements and shallower incisions.

Distribution.—This genus is so far recorded in the Cenomanian of New Zealand and Japan.

Subfamily Kossmaticeratinae Spath, 1922

This subfamily contains numerous genera and species of later ages which show various features in shell-form and ornamentation. This is amply demonstrated by a number of recently published papers (see Preface).

In this paper I consider a few Turonian species which represent the early members of the subfamily. They are known by a small number of specimens but are important for the problem of systematics. They belong to only two genera, *Kossmaticeras* de Grossouvre, 1901 (in a strict sense) and *Yokoyamaoceras* Wright & Matsumoto, 1954, both of which begin to occur in the Turonian and become more common in the Coniacian.

In a new species of *Kossmaticeras* (see Pl. 22, Figs. 1, 2; Pl. 23, Fig. 3), from the

Middle Turonian of Japan, as well as the already known *K. recurrens* (Kossmat, 1897), *K. japonicum* Matsumoto, 1955 (see Pl. 23, Figs. 4, 5), *K. theobaldianum* (Stoliczka, 1865) (see Pl. 24, Fig. 1) etc., the ribs on the whorl of young stages have no tubercles or bullae at their umbilical end, except for a faint bulla at the end of the periodic flares. In the new mid-Turonian species the fine ribs or subcostae on the inner whorls scarcely reach the umbilical margin. With respect to the shell-form, pattern of suture and ornamentation, the young shell of this species is more closely similar to that of certain Turonian species of *Mesopuzosia* (e.g. *M. pacifica* Matsumoto, 1954b) than to that of any known late Cenomanian species of *Marshallites* or other genera of Marshallitinae.

Likewise, *Yokoyamaoceras kotoi* (Jimbo, 1894) (Pl. 22, Fig. 4) and a new mid-Turonian species of the same genus have no umbilical tubercles at the end of the weak subcostae on the immature shell, except for the faint bulla at the end of the periodic flare. On the adult shell the long ribs have umbilical bullae at their end, where branching or bundling may be seen and the periodic flares have bullate umbilical tubercles. For this reason and for the intersection of ribs by the projected periodic constrictions, as well as the pattern of suture, I keep *Yokoyamaoceras* in the family Kossmaticeratidae. The possibility of dimorphism is discussed below.

In connextion with the above observation, I think it better to regard *Natalites* Collignon, 1954 (with type species *Madrasites natalensis* Spath, 1922 = *Holcodiscus africanus* van Hoepen, 1920) as an independent genus, because the umbilical tubercles are well developed from its young stage onward and its geological age may be Coniacian in a few species but is Santonian to Campanian in most species, being younger than that of *Kossmaticeras* (Turonian and/or Coniacian).

In this paper I do not give remarks on specialized genera of later ages, such as *Karapadites, Grossouvrites, Gunnarites, Maorites, Caledonites, Jacobites, Neomadrasites* and *Tainuia*.

Brahmaites Kossmat, 1897, one of the last genera of the family, deviates considerably from the general characters of the family. On this account the subfamily Brahmaitinae Collignon, 1977 can be justified. As Spath (1953) and other authors suggested, *Brahmaites* was probably derived from a certain species of *Pseudokossmaticeras* Spath, 1922. Incidentally, I have recently remarked (Matsumoto, 1990) that *Neograhamites* Spath, 1953 could be a synonym or can remain at least as a subgenus of *Pseudokossmaticeras*. I presume on the ground of ontogenetic change of characters as well as stratigraphic occurrences that *Pseudokossmaticeras* is probably derived from some species of *Natalites* Collignon, 1954. If this is justified Brahmaitinae can be phylogenetically linked with a member of the Kossmaticeratinae.

Homoeomorphy

As I have already pointed out (Matsumoto, 1955), apparent similarities are found in several species or genera between the Marshallitinae of Albian-Cenomanian ages and the Kossmaticeratinae of later ages. For example, some species of *Marshallites* (e.g. *M. olcostephanoides* Matsumoto and *M. involutus* sp. nov. described in Part II), from the Cenomanian of Japan, look similar in the mode of ribbing to *Maorites densicostatus* (Kilian & Reboul), from the Upper Campanian-Maastrichtian of Antarctica and other places in the Southern

Hemisphere. They are much separated in age and there is no direct phylogenetic connexion between the two genera.

The apparent similarity between *Eomadrasites* and *Jacobites* in having spinose tubercles in siphonal and ventrolateral rows is likewise a homoeomorphy.

There are a few species of ammonites in the Albian and Cenomanian of the North Pacific region which look somewhat similar to the typical Coniacian *Kossmaticeras* in their less involute shell with moderately wide umbilicus and ribs of moderate strength. As there are differences in the ontogenetic development, running course of the ribs and also in the character of the peristome, the former group of species are regarded as a new genus (i.e. *Yeharaites*) not directly linked with *Kossmaticeras*.

Similarity between *Holcodiscoides* and *Yokoyamaoceras* in the presence of ventrolateral tubercles in a limited part of the outer whorl is also an example of homoeomorphy. The former has from young stage onward prominent umbilical tubercles where ribs arise in bundles, whereas on the inner whorl of the latter the ribs (except for the periodic flares) have no umbilical tubercles.

Aside from the homoeomorphy between some members of the subfamilies Marshallitinae and Kossmaticeratinae, there are examples of homoeomorphic similarity between some genera of the Kossmaticeratidae and those of other families. The two species of *Wellmanites* from the Cenomanian of New Zealand and Japan look similar to some Santonian to Maastrichtian species of *Menuites* or Turonian-Coniacian ones of *Pseudojacobites* of the Pachydiscidae in having a broadly inflated body-chamber on which spinose tubercles are disposed in 4 or 5 rows, supra-umbilical and ventrolateral; and also siphonal rows in some forms. In this case the two families belong to the same superfamily Desmoceratacеae.

In still other cases, some species of the Kossmaticeratidae show superficial similarity to other species of quite unrelated families of the Jurassic Period. Examples are shown in the descriptions of the species (Part II).

In all the above cases, the resemblance does not imply a phylogenetically intimate relationship but suggests some similarity in the mode of life or in the ecological conditions.

Peristome

As the body-chamber is apt to be destroyed, the apertural margin is rarely preserved. *Yokoyamaoceras kotoi* (Jimbo), *Y. jimboi* Matsumoto and *Y.* aff. *minimum* Matsumoto, among others, present rare examples in which the lappeted peristomes are preserved (Matsumoto, 1955, figs. 12, 13; Obata *et al.*, 1978, fig. 8). It has been, however, noted that a kind of parabola can sometimes be traced in front of the periodic constrictions or on the interspaces between them (Matsumoto and Inoma *in* Matsumoto *et al.*, 1972; Obata *et al.*, 1978; Matsumoto, 1988). It is interpreted recording the basal outline of the lappeted peristome produced at the time of periodic arrest in growth.

In many species of Marshallitinae described in this monograph such a parabola occurs frequently from a fairly young stage onward. There is often a nearly flat band in front of the collared constriction and the parabola is marked on this flat space. In one case (see Pl. 8, Fig. 1 and Text-fig. 7) the outline of the once existing lappet itself with a parabola at its base is preserved, although it is superimposed by the ribs which were formed in the next step of

growth. This fine example justifies the above interpretation.

In most species of the Kossmaticeratinae, except for those of *Yokoyamaoceras*, such a pronounced parabola is not discernible. An exception in the available literature is BMNH C83330, which was illustrated by Kennedy and Klinger (1985, fig. 3) under *Kossmaticeras theobaldianum crassicostatum* Collignon but is similar to *Yokoyamaoceras ornatum* Matsumoto, 1956 in my view. The apertural margin is preserved in Collignon's (1955, pl. 3, fig. 1) specimen of *Kossmaticeras sparsicostatum* (Kossmat), *Karapadites besairiei* Collignon (1955, pl. 8, fig. 2) (which I examined in Paris) and probably in *Karapadites planissimus* Collignon in the Peabody Museum (Kennedy and Klinger, 1985, figs. 25–26). In all of these examples the peristome shows a very gently flexuous outline in lateral view with a slightly forward broad convexity on the middle of flank and a prominent projection on the venter. In some of these and other specimens, including those of *Maorites*, a trace of the past peristome may be discernible in front of a constriction and its outline is quite similar to the final peristome mentioned above.

The morphology of the apertural margin must have intimate relations with that of the soft parts of cephalopods, such as the hyponomes, mantle margin, tentacles, eyes etc. Therefore I should regard the difference in the character of peristome as important, if it is constantly recognized between two taxonomic groups. In this case the shell aperture is generally important in distinguishing the Marshallitinae from the Kossmaticeratinae, except for a special instance of dimorphism, if indeed that is the case.

Dimorphism

Small shells with lappeted peristomes are usually regarded as representing microconchs in the dimorphic pair of ammonites, while the larger macroconchs have no lappets. Currently this has been approved by many palaeontologists specializing in Jurassic and Cretaceous ammonites. I myself have recently endeavoured, together with coworkers, to describe such dimorphic pairs in the family Puzosiidae (Matsumoto, 1988; Matsumoto *et al.*, 1990).

However, does the possession of a lappeted peristome always imply the existence of dimorphs in the ammonites under investigation? My answer is no or not necessarily so. I have examined a considerable number of ammonites which are referable to the family Kossmaticeratidae. Indeed many specimens of the Marshallitinae are small, even if they are regarded as adult, but there are also medium-sized or large specimens. I have recognized, however, no examples which could form a dimorphic pair. The trace of parabola is discernible clearly in many immature shells of the investigated ammonites of the Marshallitinae.

I can state, therefore, that the lappeted peristome is not necessarily the mark of a male. Likewise a large shell without lappets on its apertural margin is not necessarily the mark of the female.

Even if microconchs have lappeted peristomes and much larger macroconchs are free from the lappets, as in the cases of the Puzosiidae and many other well-known examples of dimorphs, the difference in the peristome characters may imply dissimilar modes of life between male and female adult ammonites.

In the ammonites of the family Kossmaticeratidae examples of dimorphic pairs are so far very few.* The only exception which may form a dimorphism is concerned with

Yokoyamaoceras. Kennedy (1986, p. 25) has suggested that at least some *Yokoyamaoceras* are puzosiid microconchs. H. Maeda (oral comm., February 2, 1990) has another view that some *Kitchinites* (including *Neopuzosia*) are kossmaticeratids and may be synonymous with *Yokoyamaoceras*. In this paper (Part II) I suggest in the description of species that *Yokoyamaoceras kotoi* and another example may form dimorphic pairs with certain species of *Kossmaticeras*. My view is connected with my working hypothesis that the primitive species of *Kossmaticeras* may have been derived from some species of *Mesopuzosia*. Consequently the dimorphism of the Puzosiidae may have remained in the early members of the Kossmaticeratinae. The problem may look somewhat entangled, although I do not think my view unreasonable. Anyhow, this and related problems should be investigated further.

Mode of life

If my foregoing remarks on the peristome and the dimorphism are warrantable, I should give my interpretation as to the implications of the characteristic features of the apertural margin in the Marshallitinae.

Many species of the subfamily are small but their shells are normally ornamented with numerous, often sharp-headed ribs and also with umbilical tubercles. In many, if not all of the species the tubercles on young shells are relatively prominent and spinose for their small shells. In some species the spinose tubercles develop on the siphonal line from considerably young stage onward which are septate on their basal nodes. In others the venter is roughly fastigiate and the ribs are somewhat raised and sharpened on the venter. In still other species spines may be added on the ventrolateral shoulders.

All of these characters suggest generally protective, less active and rather quiet modes of life at the bottom of the sea-waters. They may have keen eyes to watch enemies and the considerable projection on the inner flank immediately outside the ocular sinus of the apertural margin may have worked as a covering to protect the eye. It is noted, furthermore, that many species of this protective group have less flexuous, roughly rectiradiate ribs without or with only slight ventrolateral sinus and ventral projection. This suggests poor ability in quick swimming of these ammonites, although they may have done up and down locomotion to some extent.

In certain species of *Marshallites*, in which bullate tubercles are weak, the ribs, constrictions and peristomes are fairly, flexuous, showing ventrolateral sinuses and a considerable projection on the venter, and their shell forms are more or less compressed and streamlined. They may have a better ability of quick swimming than the protective group mentioned above.

A few large species, for which a new genus is established in Part III, have rather broadly rounded whorls, less flexuous ribs and constrictions and almost no tubercles, except for bullate ones at the umbilical ends of periodic flares. They may have been less protective and less locomotive but their great size may have substituted for these disadvantages.

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* Olivero and Medina (1989) have shown examples of dimorphism in *Grossouvrites gemmatus* (Huppe), a Campanian and Maastrichtian species, on the evidence of bimodal distribution of characters in the adult stage only. They did not, however, recognized a lappeted peristome in their microconchs (in *lit.*21.3.1991).

Palaeobiogeography

As I mentioned briefly in the Preface, despite the active researches in ammonitology in the last 20 years, the distribution of known kossmaticeratid ammonites in space and time is not uniform. This may be due to generally less active modes of life in many species of Marshallitinae and possibly to stenothermal habitats in the latest Cretaceous species of Kossmaticeratinae and Brahmaitinae, as Macellari (1987) has suggested.

Incidentally, I interpret the characteristic distribution of several species of *Pseudokossmaticeras* and *Brahmaites* in the northern Tethys and northerly adjacent shelf seas of Europe and central Asia as due to their coming from their Indo-Pacific native realm at the time of the maximum transgression in the late Campanian-early Maastrichtian (Hancock, 1975; 1976) and their further dispersal to the north to accommodate themselves in the seawaters of their favourite, probably lower temperatures (see Savin, 1977).

As to the distribution of Albian and Cenomanian Marshallitinae, I think it still too early to reach a general conclusion. *Wellmanites* which was solely known in New Zealand has been discovered in Japan. *Protokossmaticeras* which was reported from Madagascar has been found also in Japan. *Holcodiscoides* was represented by a species from South India but is now known to occur in Japan. *Marshallites* was thought to be characteristic of the North Pacific region, but probable examples exist in South India, New Zealand and South Africa ("*Gunnarites kalika*" by Kennedy and Klinger 1985, fig. 34A-C and *M.* cf. *cumshewaensis* of ditto, fig. 1B, C). We should endeavour to increase more discoveries.

THE MID-CRETACEOUS AMMONITES OF THE FAMILY KOSSMATICERATIDAE FROM JAPAN

PART II

DESCRIPTIONS OF THE SPECIES FROM HOKKAIDO, EXCLUDING THE SHUMARINAI-SOEUSHINAI AREA

(Studies of the Cretaceous Ammonites from Hokkaido—LXX)

By

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Introductory notes

The sources of the material, locality records and notes on stratigraphy have been explained briefly in Part I. I mentioned there that the mid-Cretaceous biostratigraphy in Japan explained by Matsumoto *et al.* (1978) should be revised in the light of recent advances in knowledge. The revision is especially necessary for the Cenomanian in view of the fact that the majority of the material in Part II came from this stage. I depend on the results of recent investigations of the acanthoceratacean ammonites (e.g. Matsumoto, 1975; Matsumoto and Kawano, 1975; Matsumoto and Obata, 1982; Matsumoto *et al.*, 1985; Matsumoto, 1986; Matsumoto and Suekane, 1987; Matsumoto *et al.*, 1989; Matsumoto and Toshimitsu, 1991; Matsumoto, 1991) and also on a number of inoceramid species published in series (Matsumoto and Noda, 1986; Matsumoto *et al.*, 1987; Matsumoto *et al.*, 1988; Matsumoto and Tanaka, 1988; Matsumoto, 1989; Matsumoto and Asai, 1989).

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I give here summarized results of the Cenomanian zonation in Hokkaido derived from the reference sections in the Ikushumbets Valley (the Mikasa area) (Text-fig. 4) (also Matsumoto *et al.*, 1978, figs. 6–8) supplemented by those in the adjacent Oyubari and Ashibetsu areas (these three in the western part of the Yubari Mountains, central Hokkaido) and those of the Saku-Abeshinai, Shumarinai-Soeushinai-Kotanbetsu and Obira [Obirashibe] areas in the Teshio Mountains, northern to northwestern Hokkaido.

The zonal sequence is as follows in ascending order:

(1) Zone of *Desmoceras kossmati-Graysonites adkinsi*: This was originally represented by Member IIa, sandy siltstone (40 m) in the basal part of the Mikasa Formation on the eastern wing of the anticline in the main section of the River Ikushumbets. Since the construction of the Katsura-zawa Dam its outcrop has become unfavourable. The assemblage of characteristic species is better shown in the Shumarinai-Soeushinai area (see Matsumoto and Inoma, 1975; Inoma, 1980; Part III of this monograph). An undescribed species, allied to *Inoceramus virgatus* Schlüter but very small, is a characteristic associate. The zone is represented also by Member IId of the Middle Yezo Group in the upper reaches of the River Shuparo [Shuyubari or Shiyubari or Siyubari] (Matsumoto, 1942).

(2) Zone of *Mantelliceras japonicum-Sharpeiceras kongo*: This is represented by the silty sandstone (20 m) in the lower part of Member IIb (lower unit) of the Mikasa Formation in the main section of the Ikushumbets (loc. Ik 1054, Ik 1055, Ik 1100, Ik 1101) and extends to the northeast and also to the southwest. Its correlative is recognized at loc. S 901 in the Hakkin-zawa section of Oyubari (Matsumoto and Suekane, 1987) and at loc. 52 of Tanaka (in Shimizu *et al.*, 1953) in the Hachigatsu-zawa section of Ashibetsu. *Forbesiceras mikasaense* Matsumoto, *Mantelliceras cantianum* Spath, *M. couloni* (d'Orbigny), *Turrilites costatus* Lamarck and *Hypoturrilites gravesianus* (d'Orbigny), among many others, occur in

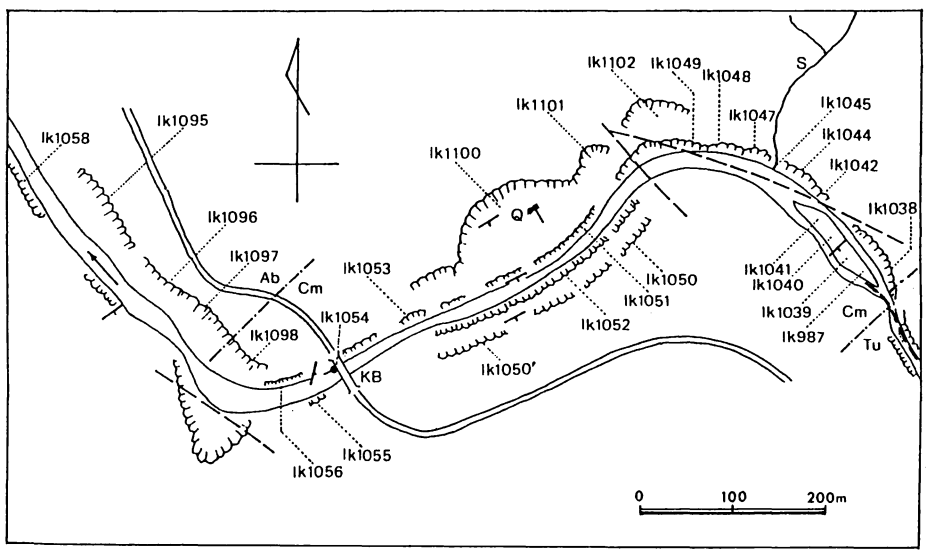


Fig. 4. Route map of the Ikushumbets main section. This map was prepared at the time when the Katsurazawa quarry (Q with a mark of hammer) was in operation and exposures were continuous and excellent. Ab: Albian, Cm: Cenomanian, Tu: Turonian, KB: Bridge, called Katsura-Ohashi, s: Suido-no-sawa. (Adapted from Matsumoto *et al.*, 1969, fig. 9 by permission).

this zone. *Inoceramus tenuis* Mantell and *I. virgatus* begin to appear and are locally characteristic of this zone.

(3) Ammonite poor part occupied by beds of sandstone bearing trigonians exposed at loc. Ik 1053 above the Zone of *M. japonicum* in Member IIb of the Mikasa Formation in the Ikushumbets main section. *Acompsoceras renevieri* (Sharpe), which has been recently found by T. Takahashi from a locality at some distance from Ik 1053, may represent the same horizon with a lateral change of facies. *Mantelliceras* sp. and *T. costatus* are its associates among others. The upper part of Member Mf (Tanaka, 1963) of the Obirashibe Valley, in which *Inoceramus tenuis* and *I. virgatus* occur commonly, may be a correlative, for it is below Member Mg with *Turrilites acutus*.

(4) Zone of *Cunningtoniceras takahashii* (formerly called *Acanthoceras takahashii*)-*Cunningtoniceras meridionale*, represented by the sandstone exposed at loc. Ik 1052–1051 in the middle part of Member IIb of the Mikasa Formation in the Ikushumbets main section. *Turrilites acutus* Passy is an associate among others. The zone can be traced to the Oyubari area (loc. Y5103 etc.) and also to the Obira area (Member Mg). *Inoceramus reduncus* Pergament begins to appear from this zone.

(5) Zone of *Calycoceras* (*Newboldiceras*) *orientale*, represented by silty fine-grained sandstone in the upper part of Member IIb of the Mikasa Formation in the Ikushumbets main section. *Desmoceras* (*Pseudouhligella*) *japonicum* Yabe is found commonly, although it begins to appear earlier (in the second zone). *Birostrina tamurai* Matsumoto & Noda is a characteristic associate; *Inoceramus gradilis* Pergament, *I. pennatulus* Pergament and *I. reduncus* may occur locally. Correlatives of this zone are recognized in various areas in Hokkaido, Shikoku and Kyushu.

(6) Zone of *Eucalycoceras pentagonum-Birostrina nipponica* represented by the mudstone in the main part of Member IIc of the Mikasa Formation in the main section of the Ikushumbets. *E. pentagonum* (Jukes-Browne) is not found commonly but is important for the inter-regional correlation. I saw examples also in the Oyubari and Obira areas but they were not in situ. *B. nipponica* (Nagao & Matsumoto) has been misunderstood and confused with *Inoceramus tenuis* or other species, until the recent revision by Matsumoto and Asai (1989). In addition, *I. nodai* Matsumoto & Tanaka, *I. ginterensis* Pergament, *I. reduncus*, *I. pennatulus* and *I. pictus minus* Matsumoto occur in this zone, although they have longer ranges.

(7) Zone of *Euomphaloceras septemseriatum-Sumitomoceras faustum*, represented by the uppermost 20 m mudstone of Member IIc of the Mikasa Formation in the main section of the Ikushumbets. *Pseudocalycoceras dentonense* (Moreman) and *Sciponoceras kossmati* (Nowak) are characteristic associates among others. *Inoceramus pictus minus*, *I. nodai* and *Mytiloides mikasaensis* Matsumoto & Noda occur in this zone.

(8) Overlying are thick beds of coarse-grained sandstone which form the lower part of Member IId of the Mikasa Formation, with the key beds of tuffite 20 m above the base of IId, in the main section of the Ikushumbets. As there are lateral changes in lithofacies, correlatives of this part may be fossiliferous in adjacent areas. So far, however, I have not been successful in finding good zonal indices such as *Burroceras clydense* Cobban, Hook & Kennedy, *Neocardioceras juddii* (Barrois & Guerne) etc. (see Wright and Kennedy, 1981; Cobban, 1988; Cobban *et al.* 1989) from this part.

Member IIm in the Oyubari area consists of mudstone with frequent interbeds of

sandstone. It is fossiliferous and I obtained from its upper part numerous specimens of *Inoceramus nodai* (small form). This may represent the uppermost part of the Cenomanian in Hokkaido, because *Pseudaspidoceras flexuosum* Powell, a Basal Turonian index, was obtained from the immediately overlying part, i.e. low in Member IIn. The middle part of IIn is characterized by layers with abundant *Mytiloides mytiloides* (Mantell) and key beds of tuffite. Likewise, *I. nodai* (small form) has been found recently in the Kotanbetsu section below the *Mytiloides*-bearing unit with interbeds of the key tuffite. The latter can be traced in Member Mj of the Obira areas. I should endeavour to look for more reliable species (see Kennedy *et al.*, 1987) from these and other promising parts.

The above zones can be assigned to the international scale as follows*:

(1) + (2): Lower Cenomanian
(3) : high Lower Cenomanian
(4) + (5): Middle Cenomanian
(6) + (7): Upper Cenomanian
(8) : high Upper Cenomanian—Basal Turonian

Palaeontological Descriptions

Family Kossmaticeratidae Spath, 1922

Subfamily Marshallitinae Matsumoto, 1955

Genus *Marshallites* Matsumoto, 1955

Marshallites compressus Matsumoto, 1955

(By T. Matsumoto and T. Takahashi)

Plate 1, Figs. 1–4; Plate 2, Figs. 1–7;
Plate 3, Figs. 1–3; Text-figs. 5, 6

1955. *Marshallites compressus* Matsumoto, p. 123, pl. 8, figs. 1, 2; text-figs. 1, 2.
1955. *Marshallites compressus puzosioides* Matsumoto, p. 125, pl. 8, figs, 3, 4.

Material.—Holotype, GK. H2751 (transferred from UMUT. MM6863 [= GT. I-3231] (Pl. 1, Fig. 1; Text-fig. 6), collected by T. Matsumoto from Member IIb at loc. T608 on the left bank of the Saku-gawa, a tributary to the River Teshio, northern Hokkaido. Paratypes, UMUT. MM6866 [= GT. I-3236] (Pl. 1, Fig. 4), GK. H2753 (Text-fig. 5), UMUT. MM6865 [= GT. I-3233] (Pl. 2, Fig. 3), UMUT. MM6864a [= GT. I-3234a] (Pl. 2, Fig. 1), and UMUT. MM6864b [= GT. I-3234b] (Pl. 2, Fig. 2) collected by T. Matsumoto from the type locality. There are more specimens from the same outcrop.

The holotype and paratypes of *M. compressus puzosioides*, UMUT. MM6867 [= GT.

* Matsumoto *et al.* (1991) have recently attempted to integrate the Cenomanian and Turonian zonation by ammonites and inoceramids with that by planktonic foraminifers. Our results are generally good in supporting the scheme revised by the working group of the MCE (IGCP No. 58) (see Reyment and Bengtson, comp., 1986, fig. 53).

I-3240] (Pl. 2, Fig. 4) and MM6868a, b [= GT. I-3239a, b] (Pl. 2, Figs. 5, 6) collected by T. Matsumoto from the uppermost part of Member IIa at loc. T863 on the left side of the Abeshinai, a tributary to the River Teshio, are regarded in this paper as being within the extent of variation of this species; also GK. H2752a (Pl. 1, Fig. 2), GK. H2752b (Pl. 1, Fig. 3) and several secondarily compressed specimens collected by T. M. at loc. T863.

The following specimens in subsequent collections are examples of this species from the Ikushumbets Valley (Mikasa district) in central Hokkaido: — TTC. 360522A (Pl. 3, Fig. 1) and TTC. 360522B from 5066p of the Torii-zawa; TTC. 410905 (Pl. 3, Fig. 2) from 5077p of the Torii-zawa; TTC. 490210 (Pl. 3, Fig. 3) from loc. Ik 1103, Nishi-katsura-zawa, collected by T. Takahashi from Member IIb of the Mikasa Formation. GK. H8273E (T. M. Coll.) from Member IIm at loc. Y5113 of the Taki-no-sawa (Oyubari area) is comparable with this species.

Diagnosis. — Shell rather small and flatly discoidal, with moderate involution and moderate to fairly high ratio of whorl expansion. Umbilicus fairly narrow and shallow, being surrounded by low and vertical wall. Whorls in late growth stages compressed, with narrowly arched venter, very gently convex to nearly flat, subparallel flanks and abruptly bent, subrounded umbilical edges.

Periodic constrictions of normally moderate but sometimes irregular frequency, narrow but distinct, with flares on the test, somewhat oblique forward and gently sinuous or nearly straight on the flank and considerably projected on the venter. Often in front of the constriction the inner lateral parabola is marked and extends inward to an umbilical sinus and outward to a broader lateral sinus and then to a ventral projection.

Shell in more or less late growth stages ornamented with numerous fine ribs, which are narrow and sharp-headed on the test, being separated by slightly wider interspaces, but blunt and weak on the internal mould; gently flexuous on the flank and moderately projected on the venter. Long ribs arise from weak umbilical bullae, may branch to twos or threes on inner flank and may have also a few intercalated short ribs. Several ribs are cut by each oblique constriction. The bulla at the umbilical end of the periodic flare is more distinct and appears earlier than those of the normal ribs.

The surface of shell in more or less early growth stages looks nearly smooth, except for periodic constrictions and associated flares, showing in favourable preservation fine and dense lirae or subcostae mainly on outer part of the whorl. Faint umbilical bullae may begin to appear at the end of bundled lirae.

Suture of kossmaticeratid pattern and finely and deeply incised despite small size of the shell. In more or less late growth stages L somewhat asymmetrically tripartite and deeper than E; U2 and auxiliaries descending rather steeply (Text-fig. 6).

Measurements. — See Table 1.

Observation. — In the holotype the body-chamber is preserved only for about 30°. Should it be assumed at least 210° in a complete state, the original shell diameter would be 77 mm. This is the largest size of the restored outline among the available specimens. Those from the Ikushumbets Valley (Mikasa area) seem to exemplify small forms, for they show already the distinct ornaments of the middle aged to mature type in about later half of their preserved outer whorl, i.e. the late part of the phragmocone and the beginning of the body-chamber with diameters, for instance, from 25 mm to 35 mm.

The extent of variation in the umbilical ratio (U/D) is not great, ranging from 21 to 29

Table 1. Measurements of *Marshallites compressus*.

Specimen, position	D	U	H	B	B/H	H/h	C(60°)
HT, LS + 30°	51.4 (1)	13.4 (.26)	22.2 (.43)	14.6 (.28)	0.66	1.40	5/15
" LS	48.8 (1)	12.7 (.26)	21.5 (.44)	14.3 (.29)	0.67	1.47	—
" LS − 180°	32.4 (1)	8.3 (.26)	15.0 (.46)	10.3 (.32)	0.69	1.65	5/18
H2752a, E − 90°	26.6 (1)	6.5 (.24)	12.4 (.47)	8.4 (.32)	0.68	1.61	—
H2752b, E − 30°	27.0 (1)	7.2 (.27)	11.6 (.43)	8.6 (.32)	0.74	1.41	×/23
I-3234a, E − 180°	28.2 (1)	7.7 (.27)	12.0 (.43)	8.4 (.30)	0.70	1.41	×/20
I-3234b, E − 90°	23.3 (1)	6.3 (.27)	~10 (.43)	~8 (.34)	~0.8	1.43	×/22
I-3236	~24.5 (1)	—	11.6 (.47)	8.2 (.33)	0.71	—	—
I-3240, E	42.0 (1)	9.3 (.22)	18.5 (.44)	11.4 (.27)	0.62	~1.39	—
I-3239a, E	31.4 (1)	6.5 (.21)	13.5 (.43)	9.7 (.31)	0.72	1.42	—
I-3239b, E	22.3 (1)	5.4 (.24)	9.8 (.44)	7.7 (.35)	0.78	1.38	—
TTC. 360522A	29.4 (1)	7.4 (.25)	13.5 (.46)	9.0 (.31)	0.67	1.59	5/15
" 410905, E − 30°	35.0 (1)	10.4 (.29)	14.8 (.42)	10.8 (.31)	0.72	1.51	6/18
" " E − 120°	—	—	12.2	9.6	0.79	—	—
" 490210, E	22.7 (1)	6.1 (.27)	10.4 (.46)	7.6 (.33)	0.73	1.60	5/16

percent in measured examples. That in the degree of compression is moderate, ranging from 0.80 to 0.62 in the measured ratio of B/H. The ontogenetic change from depressed to compressed whorl is illustrated in Text-fig. 5. The flanks are variably flat or slightly convex. In the holotype, for example, the flanks are gently convex in the last 120° of the preserved outer whorl but are flat in the preceding full one whorl. The degree of flatness does not

General remarks on the Explanation of Plate

In the explanations of plates a figure number is given for each specimen, which is photographed normally in four views, i.e. right lateral, ventral (or rear), left lateral and frontal, sometimes in three or two views or only in one view in accordance with the state of preservation. These views are not listed repeatedly, when they are self-explanatory.

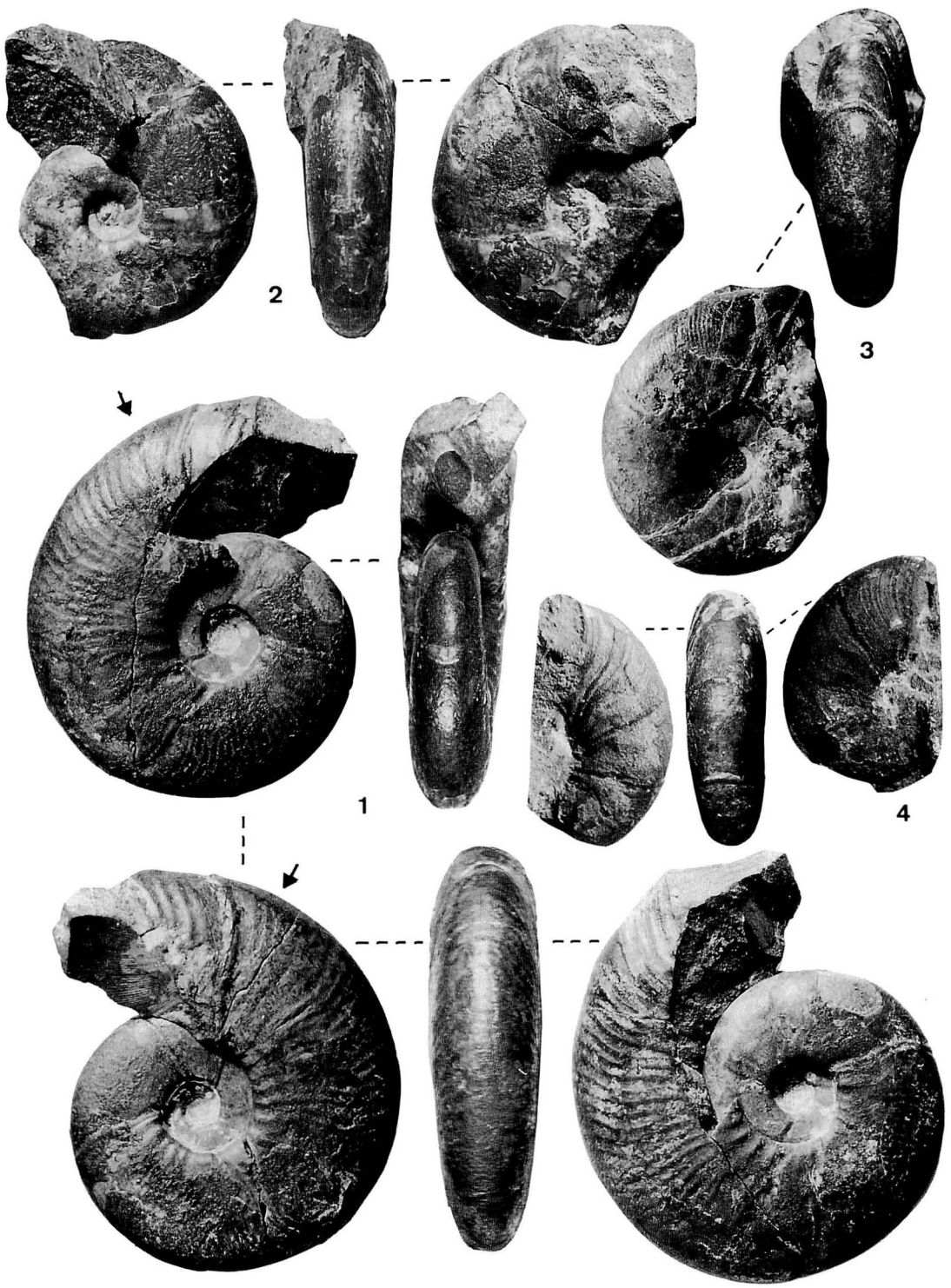
Two complemental photos of a specimen in the same view under dissimilar lights may be occasionally given to show some particuåar characters. Anyhow, the photos of a specimen under the same figure number are linked by a dotted line without giving a, b, c etc.

In the explanation, the specific name, page of the text concerned, specimen number or other indication, category of types and rate of magnification or reduction are written. The locality records, including loc. number, place name, general area or region, stratigraphic position and collector(s), are omitted for brevity. They are described under *Material* in the text. An arrow indicates the beginning of the body-chamber, except for Plate 31.

The photographs have been taken mostly by Masayuki Noda, without whitening, unless otherwise stated.

Explanation of Plate 1

Figs. 1–4. *Marshallites compressus* Matsumoto..... Page 24
1: GK. H2751, holotype, × 1.2. 2: GK. H2752a, paratype, × 1.5. 3: GK. H2752b, paratype, × 1.5. 4: UMUT. MM6866 (= GT. I-3236), paratype, × 1.5.



T. Matsumoto & T. Takahashi: *Marshallites*

necessarily conform with the ratio of B/H (see Table 1).

There is also some variation in the density, fineness and sharpness or bluntness of the ribs. Apart from the condition of preservation, this feature of the ribbing evidently changes with growth. It is interesting to see examples in which sharp-headed distinct ribs appear early in growth-stage in contrast to those in which fine and dense ribs persist later.

From the above observations we cannot maintain *M. compressus puzosioides* as a subspecies. It should be included within the variation of *M. compressus*.

Comparison and discussion.—As Matsumoto (1955, p. 125) has already pointed out, this species is allied to some species of *Hulenites*. In fact the immature shell of *M. compressus* resembles *H. ononus* (Anderson) (1938, p. 188, pl. 42, fig. 8), from the uppermost part of the Horsetown Group in California, and some middle-aged examples are similar to *H. reesidei* (Anderson) (1938, p. 187, pl. 37, figs. 2, 3), from the upper part of the Horsetown Group.

M. compressus at the corresponding size or growth-stage in comparison with the above

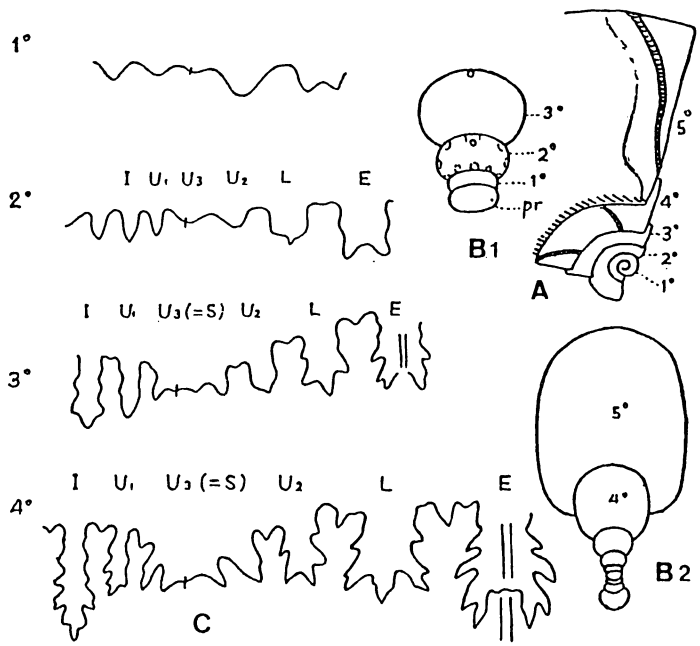
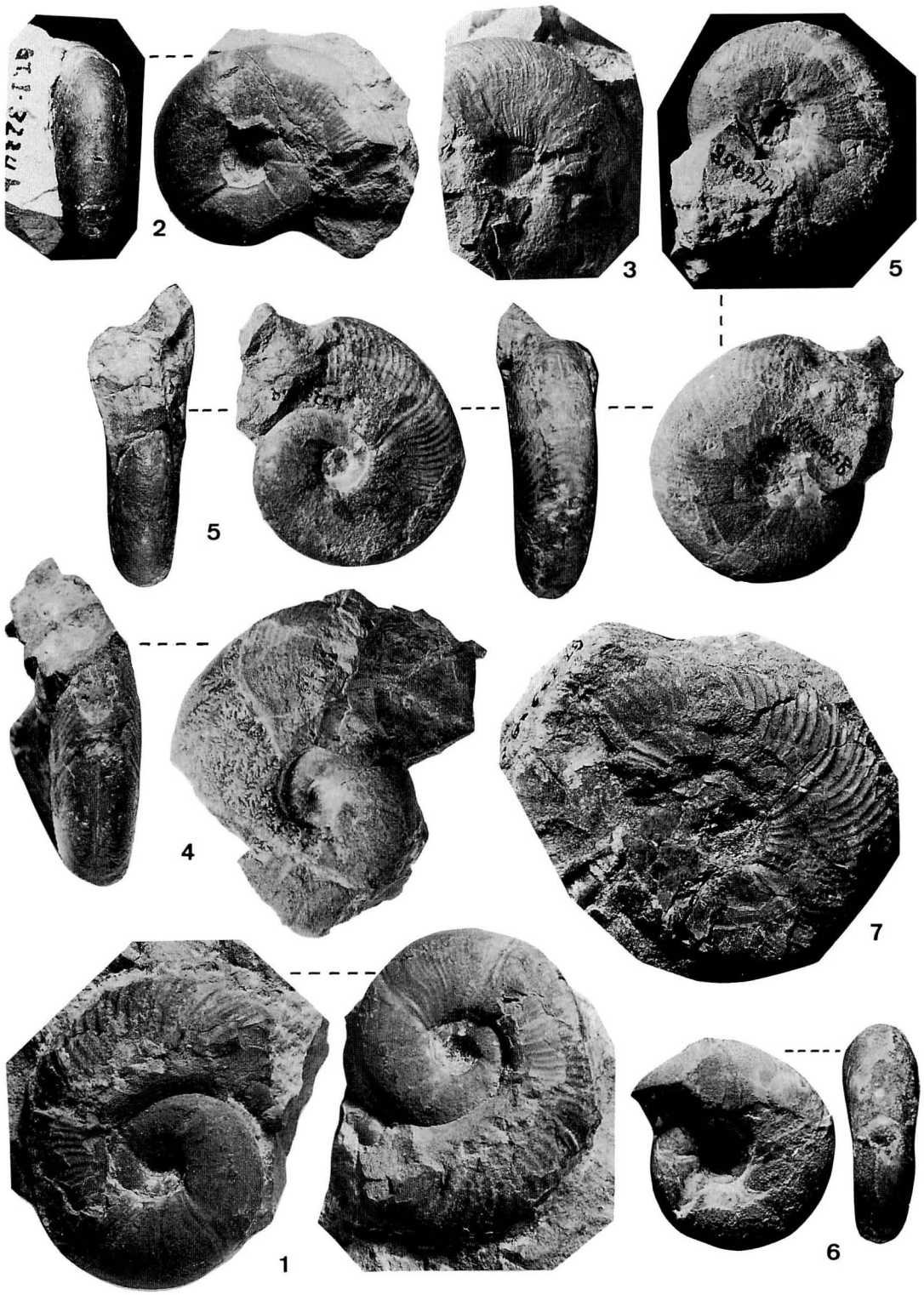


Fig. 5. Ontogenetic development of *Marshallites compressus* Matsumoto. GK. H 2753. pr, 1°, 2°, ...: protoconch, 1st, 2nd etc. .... whorls. A. Sketch in lateral view; B1, B2: whorl sections; C: sutures. Radius is 10.0 mm at the 5th whorl. (Reproduced from Matsumoto, 1955, fig. 1 by permission).

Explanation of Plate 2

Figs. 1–7. *Marshallites compressus* Matsumoto..... Page 24
All the specimens held in UMUT (= GT). Photos all × 1.25 (= 5/4). 1: MM6864a (= I-3234a), paratype. 2: MM6864b (= I-3234b), paratype. 3: MM6865 (= I-3233), paratype. 4: MM6867 (= I-3240), holotype of *M. compressus puzosioides* Matsumoto, but the subspecies is now suppressed. 5: MM6868a (= 3239a). 6: MM6868b (= I-3239b). 7: MM6868c (= I-3239c).



T. Matsumoto & T. Takahashi: *Marshallites*

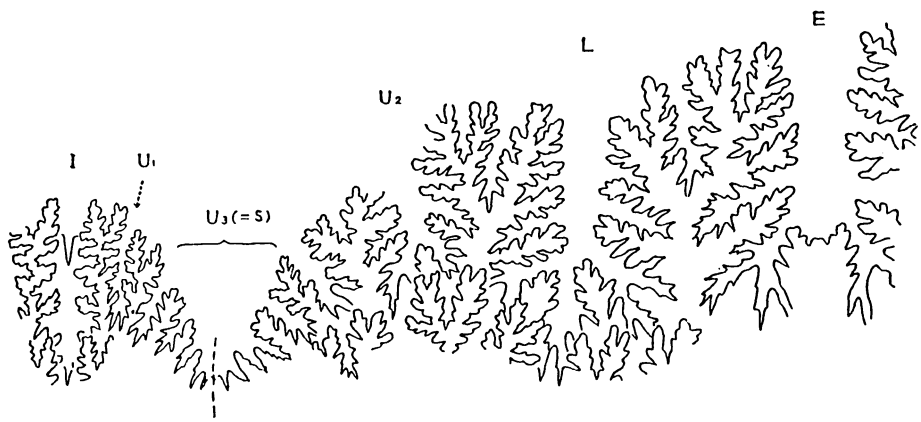


Fig. 6. Suture of *Marshallites compressus* Matsumoto at maturity. Holotype, GK. H 2751 at D = 47 mm. (Reproduced from Matsumoto, 1955, fig. 2 by permission).

species of *Hulenites* has more numerous and denser ribs (or subcostae) which are bundled into or branching from the umbilical bullae (see Pl. 1, Fig. 4 and Pl. 2, Figs. 2–5). Its characters in the late stage are distinct enough.

The parabola markings in front of some constrictions are probably traces of the peristome formed at periodic pauses in the shell growth. The inner lateral convexity is considerably pronounced even in early growth-stages and extend to a probably ocular umbilical sinus. The same feature has not been recognized in the hitherto studied species of *Hulenites*, although a somewhat flexuous ribs may occur occasionally in *H. reesidei*, showing a gently convex curve at about the middle of flank.

Comparison with other species of *Marshallites* is given in the respective descriptions.

Occurrence.—This species have been found from the Middle Cenomanian silty sandstone of the Abeshinai-Saku area and the Ikushumbets Valley (Mikasa district). *M.* cf. *compressus* was found rarely from the Upper Cenomanian siltstone of the Oyubari area. The true range has yet to be worked out.

Marshallites hendersoni sp. nov.

(By T. Matsumoto and T. Takahashi)

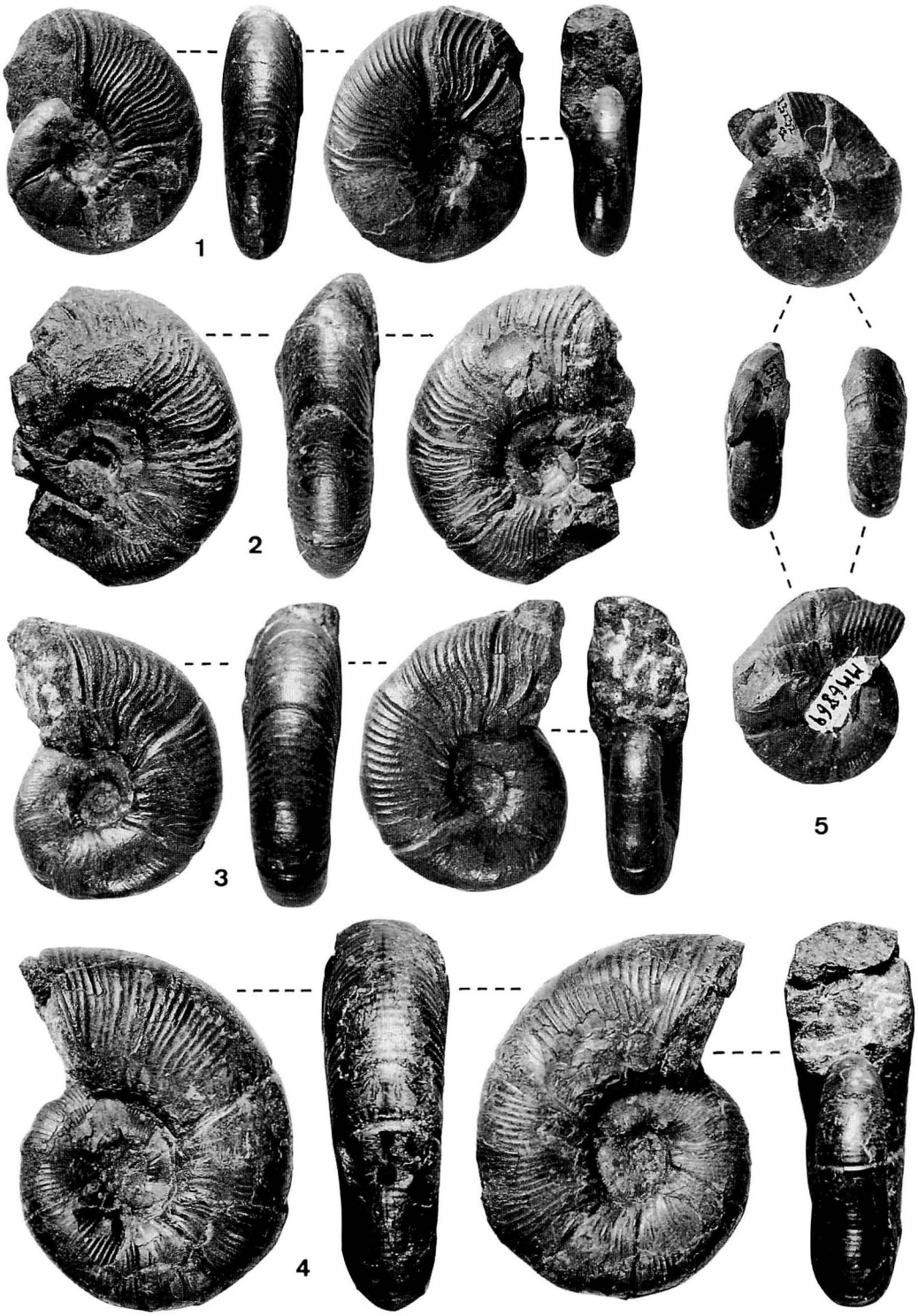
Plate 3, Figs. 4, 5

1955. *Marshallites* sp. aff. *M. compressus* Matsumoto, p. 127, fig. 3.

Explanation of Plate 3

Figs. 1–3. *Marshallites compressus* Matsumoto..... Page 24
1: TTC. 360522A, hypotype, × 1.25. 2: TTC. 410905, hypotype, × 1.25. 3: TTC. 390210, hypotype, × 1.75.

Figs. 4, 5. *Marshallites hendersoni* Matsumoto & Takahashi, sp. nov. ..... Page 30
4: TTC. 450422, holotype, × 1.25. 5: UMUT. MM6869 [= GT. I-3232a], paratype, × 1.25 (Photo 5 only by H. Ando; others by M. Noda).



T. Matsumoto & T. Takahashi: *Marshallites*

1973. *Marshallites* (?) sp. nov., Henderson, p. 103, fig. 14, nos. 1a–c.

Material.—Holotype, TTC. 450422 (Pl. 3, Fig. 4) collected by T. Takahashi from the correlative of the middle part of Member IIb of the Mikasa Formation at loc. Ik 1103, Nishi-katsura-zawa, Ikushumbets Valley. Paratype, UMUT. MM6869 [= GT. I-3232a] (Pl. 3, Fig. 5) collected by T.M. from Member IIb at loc. T608 on the left bank of the Saku-gawa, a branch of the Middle Valley of the Teshio.

Etymology.—Dedicated to Dr. R. A. Henderson of James Cook University of North Queensland, Townsville.

Diagnosis.—Shell small to medium-sized, with a little involution. Umbilicus moderately wide and shallow, with low but steep wall and subrounded edge. Young to middle-aged whorls somewhat broader than high to nearly as high as broad and subcircular in section, with more or less convex flanks. Outer whorl somewhat compressed, with flat and nearly parallel flanks.

Periodic constrictions fairly frequent, 5 to 6 per whorl, somewhat prorsiradiate, intersecting several ribs behind, and slightly projected on the venter; also inner lateral parabola may be marked in front.

Ribs fine, dense and subradial or weakly flexuous; more or less prorsiradiate around the umbilicus, gently convex on the inner flank and nearly radial on the main flank, with a slight or no ventrolateral projection, running across the venter almost vertically. Two or three ribs are bundled into a weak bulla at the umbilical edge. There may be also intercalated or branched ribs on the flank.

Suture similar to that of *M. compressus*.

Measurements.—See Table 2.

Table 2. Measurements of *Marshallites hendersoni*.

Specimen, position	D	U	H	B	B/H	H/h	C(60°)
HT, E	45.0 (1)	14.4 (.32)	19.4 (.43)	15.8 (.35)	0.81	1.59	6/19
" E – 90°	35.5 (1)	9.8 (.28)	14.6 (.41)	12.8 (.36)	0.88	1.35	5/17
PT, LS	18.3 (1)	5.8 (.32)	7.2 (.39)	6.9 (.38)	0.96	1.44	4/15
Henderson's	60.0 (1)	19.8 (.33)	23.5 (.39)	18.2 (.30)	0.77 (sec. compr.)		

Observation.—The holotype shows very gradual increase in the intensity of ribbing from the late septate stage to the beginning of the body-chamber. Therefore the above diagnosis was probably maintained to the missing main part of body-chamber. The original diameter of the holotype is assumed to have been about 75 mm.

?*Marshallites* sp. nov. of Henderson (1973, p. 103, fig. 14, nos. 1a–c), from New Zealand, is probably identified with this species. It was described as having no umbilical tubercles, but at least some of its ribs seem to be weakly bullate as in the holotype of our species. Owing to its somewhat water worn condition of preservation, the ribs and bullae must have been secondarily weakened. It may have been slightly distorted secondarily.

Comparison and discussion.—This species resembles *M. compressus* in the compressed outer whorl, fine and dense ribs and mode of rib bundling into weak umbilical bullae, but is distinct in its less involution, wider umbilicus, and less flexuous or subradial ribs with less or

almost no ventral projection. In the shell-form it may be better comparable with such species as *M. virgatoides* sp. nov. (described below) but differs in the mode of ribbing.

Occurrence.—Found rarely in the Middle Cenomanian muddy sandstone in the Ikushumbets Valley (Mikasa district) and the Mid-Valley of the Teshio (Abeshinai-Saku area).

Marshallites olcostephanoides Matsumoto, 1955

(By T. Matsumoto, T. Takahashi and K. Sanada)

Plate 4, Figs. 1–7; Plate 5, Figs. 1–3; Plate 7, Fig. 8

1955. *Marshallites olcostephanoides* Matsumoto, p. 129, pl. 8, figs. 5–7; text-fig. 4.

Material.—Holotype GK. H1552 (Pl. 4, Figs. 1–2) from Member IIm (Upper Cenomanian) of the Middle Yezo Group at loc. Y140d on the Hikage-no-sawa, a branch of the River Shuparo. Paratype (1) GK. H1553 (Pl. 4, Fig. 4) from Member IIj at loc. Y235 on the River Shuparo. These two and several referable (cf.) specimens were collected by T. Matsumoto in the Shuparo (= Shiyubari) Valley of the Oyubari area, central Hokkaido.

Paratype (2) UMUT. MM6870 (= GT. I-3710) (Pl. 4, Fig. 5) collected by T. Matsumoto from Zone Kz-Mh at loc. N44d on the Kamo-gawa, an eastern small branch in the Mid-Valley of the Naibuchi (Naibu), South Sakhalin.

Paratype (3) UMUT. MM6872 (= GT. I-3237) (Pl. 4, Fig. 6), loc. T225c on a small branch No. 9 of the River Abeshinai; paratype (4) UMUT. MM6871 (= GT. I-3232b) (Pl. 4, Fig. 7), loc. T608 on the Saku-gawa; paratype (5) UMUT. MM6875 (= GT. I-3244) (Pl. 4, Fig. 3), loc. T229 p3 on the small branch No. 9 of the River Abeshinai. These three were collected by T. Matsumoto from Member IIb in the Mid-Valley of the Teshio (i.e. the Abeshinai-Saku area), northern Hokkaido.

Examples in subsequent collections by T. Takahashi (TTC) and K. Sanada (KSC) in the Ikushumbets Valley are TTC. 390600 (Pl. 5, Fig. 2) probably from Member IIb of the Mikasa Formation at his loc. 5055p on the stream Torii-zawa (Shimo-ichi-no-sawa), TTC. 470429 A, B (Pl. 5, Fig. 3), C and D from the correlative of Member IIb of the same formation at loc. Ik 1103, Nishi-katsura-zawa and GK. H8338 (KSC donation) (Pl. 5, Fig. 1) from the uppermost part of Member IIc (Zone of *Euomphaloceras septemseriatum*) at loc. Ik 1038 on the right bank of the River Ikushumbets, about 400 m downstream from the Katsura-zawa Dam. Also GK. H8347 (Pl. 7, Fig. 8) (T. Yokoi's collection and donation), from the uppermost reaches of the Tsukimi-zawa in the Ashibetsu Valley is probably a tiny juvenile of this species.

Diagnosis.—Shell of moderate size in the mature stage and fairly narrowly umbilicate, with considerable involution and moderate to somewhat high expansion ratio of whorl.

Whorls in the middle to late growth-stages slightly higher than broad and suboval in cross-section, broadest at a point slightly outward from the umbilical edge, with gently convex flanks and moderately to narrowly arched venter. Whorls in young stages broader than high with more inflated flanks.

Periodic constrictions of moderate or irregular frequency, prorsiradiate, nearly straight or gently flexuous on the flank and more or less projected on the venter. Each of them double collared, oblique to numerous fine ribs behind the stronger adapical flare and in

some with an inner lateral parabola in front.

Shell ornamented with numerous, closely set, fine ribs (or subcostae) which persist to the adult body-chamber. Two or three of them branch from (or are bundled into) a weak umbilical bulla and there may be further branching or intercalation on the flank at some distance from the umbilical edge. The ribs may be gently flexuous, at first somewhat oblique forward around the umbilicus, passing to a gentle convexity on the inner flank, then to a slightly concave curve on the outer flank and finally to a weak or sometimes almost imperceptible ventral projection.

Suture similar to that of *M. compressus*, being much ramified in the late stage.

Measurements.—See Table 3.

Table 3. Measurements of *Marshallites olcostephanoides*.

Specimen, position	D	U	H	B	B/H	H/h	C(60°)
HT, near E	50.4 (1)	~14 (.28)	22.2 (.44)	~20 (.40)	0.90	1.56	7/24
" E – 90°	—	—	19.3	17.7	0.92	—	5/22
I-3237	15.5 (1)	3.3 (.21)	7.9 (.51)	6.8 (.44)	0.86	—	5/24
I-3710	25.0 (1)	7.3 (.29)	10.4 (.42)	9.3 (.37)	0.89	1.42	5/21
TTC. 470429B	21.4 (1)	4.3 (.20)	10.2 (.48)	9.1 (.43)	0.89	1.48	7/27
TTC. 390600	32.0 (1)	7.0 (.22)	14.6 (.46)	11.8 (.37)	0.81	1.40	5/24
TTC. 360700	28.6 (1)	5.8 (.20)	13.8 (.48)	12.6 (.44)	0.91	1.53	—
KSC. 370900	30.0 (1)	5.4 (.18)	~15 (.50)	12.4 (.41)	0.83	1.56	5/25
GK. H1553*	—	—	~36	>28	>0.74	—	7/35
I-3232b	12.3 (1)	3.0 (.24)	6.4 (.52)	5.5 (.45)	0.86	—	—

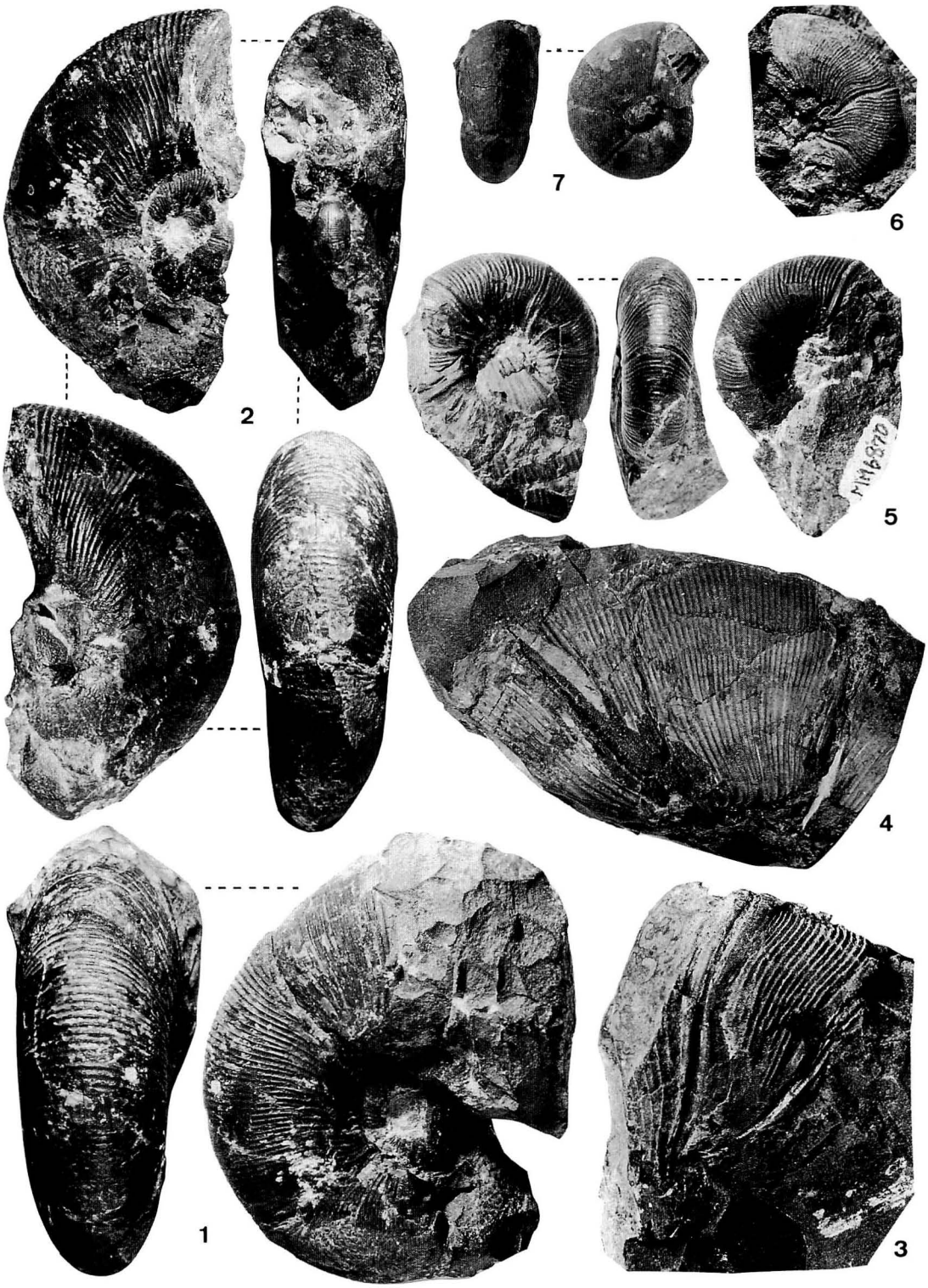
* secondarily compressed piece of body-chamber

Observation.—A completely preserved adult shell is not at our disposal. The holotype is septate at D = 50 mm. The body-chamber of probably adult shell is represented only by two fragmentary specimens, UMUT. MM6875 and GK. H1553 (Pl. 4, Figs. 3, 4), the latter of which show a secondary compressed whorl section, with H = 40 mm and B = 31 mm, suggesting a moderate size of the original shell.

In the collections of T. Takahashi and K. Sanada, subsequent to Matsumoto (1955), there are well preserved smaller specimens (see Pl. 5, Figs. 1–3), which are well comparable with some smaller ones of previous collections (see Pl. 4, Figs. 5–7). They may be immature. The inner lateral parabola is well marked, showing a moderate convexity on some of these smaller specimens (e.g. Pl. 4, Fig. 6; Pl. 5, Fig. 1), whereas that on some whorl of later stage looks more gentle (e.g. Pl. 4, Figs. 3, 4). TTC. 390600 (Pl. 5, Fig. 2),

Explanation of Plate 4

Figs. 1–7. *Marshallites olcostephanoides* Matsumoto. Page 33
1 and 2: GK. H1552, holotype, ×1.25, of which 2 is the part younger than the preserved last constriction, where the later part is detached and the whorl section is observable. 3: UMUT. MM6875 (= GT. I-3244), paratype, ×1.2 4: GK. H1553, paratype, ×1. 5: UMUT. MM6870 (= GT.I-3710), paratype, ×1.25. 6: UMUT. MM6872 (= GT. I-3237), paratype, ×2. 7: UMUT. MM6871 (= GT.I-3232b), paratype, ×2. (Photo 7 by H. Ando; others by M. Noda.)



T. Matsumoto, T. Takahashi & K. Sanada: *Marshallites*

which is as small as KSC. 370900 (Pl. 5, Fig. 1), however, shows a rather gently convex parabola. This may be due to the state of preservation, since the parabola is a trace of the basal part of the original ear or lappet. In the holotype (Pl. 4, Figs. 1, 2) the convexity of the parabola is considerable on the inner whorl but more gentle on the outer whorl.

Apart from this character, the dense and numerous ribs, with bundling at weak umbilical bullae, is diagnostic of every specimen of this species. The variability in the width of umbilicus as expressed by U/D is moderate as is that of the expansion ratio of the whorl. The proportion B/H generally decreases with growth but it varies to some extent between individuals.

Comparison and discussion.—*M. olcostephanoides* is clearly distinguished from *M. compressus* by its less compressed whorl, with more convex flanks and more ovoid section, and denser, more numerous, multipartite ribs with less ventral projection, which persist from early middle growth-stage to the adult body-chamber.

With respect to the shell-form, oblique constriction and ornament this species looks similar to such species as *Olcostephanus asterianus* (d'Orbigny, 1840) of Valanginian age, from which the specific name was taken. As the latter belongs to the family Olcostephanidae of the superfamily Perisphinctaceae, the similarity is evidently a homoeomorphy. Another homoeomorphy in the ornamentation is seen between this species and *Maorites densicostatus* (Kilian & Reboul, 1909) (emended by Macellari, 1986) of the same Kossmaticeratidae. The latter has clearly more involute and more compressed whorls and occurs in the Maastrichtian of the Southern Hemisphere No species has been found which could link the two similar species of much separated ages.

Occurrence.—This species has been found so far in the mudstone and muddy fine-grained sandstone of the upper and middle parts of the Cenomanian in the Oyubari-Ikushumbets area of the Yubari Mountains (central Hokkaido) and the Saku-Abeshinai area of the Teshio Mountains (northern Hokkaido). A tiny juvenile (GK. H8347) referable to this species came from Member UE1 of K. Tanaka (*in* Shimizu *et al.*, 1953), upper part of the Cenomanian in the Ashibetsu Valley.

Marshallites virgatoides sp. nov.

(By T. Matsumoto and T. Takahashi)

Plate 5, Figs. 4, 5

Material.—Holotype, TTC. 490224 (Pl. 5, Fig. 5), collected by T. Takahashi from a bed of silty fine-grained sandstone, the correlative of Member IIb of the Mikasa Formation at loc. Ik 1103, Nishi-katsura-zawa in the Ikushumbets Valley. This bed is below the bed characterized by *Calycoceras (Newboldiceras) asiaticum* (Jimbo) and itself contains *Cunningtoniceras meridionale* (Stoliczka). Paratype, TTC. 350900, collected by T.T. from the same bed as above at loc. Ik 1103.

Diagnosis.—Shell fairly small, with moderate involution (about half of the inner whorl overlapped by the outer whorl), rather low ratio of whorl expansion and fairly narrow umbilicus.

Whorl slightly higher than broad in the late growth-stage but somewhat broader than high earlier, subrounded in section with moderately rounded venter, gently convex flanks

and broadest at a point a little outside the subrounded umbilical edge.

Body-chamber ornamented with raised major ribs arising from the umbilical seam, gently concave on passing across the umbilical edge to the inner flank and recurved to form a gentle convexity at about the middle of flank, where they branch into or are intercalated with dense and very fine secondary subcostae which cross the venter almost vertically or with slightly forward curve. The major ribs slightly strengthen at about the umbilical edge but are free from distinct tubercles, except at the point behind the constriction where two or three ribs are united in a bullate tubercle.

The ornamentation of the phragmocone is essentially similar to that of the body-chamber but much finer and weaker. The subcostae on the shell surface of the middle and younger stages may be fine enough to be called lirae and the internal mould looks smooth.

Periodic constrictions well-marked, of moderate frequency (5 per whorl), weakly prorsiradiate and double-collared. The posterior flare intersects several subcostae behind it on the outer part but is subparallel to the bundled ribs on the inner flank. The anterior collar narrower than the posterior flare on the main part but bullate at the umbilical edge. In front of the constriction there may be a narrow smooth space where a gently convex lateral parabola and a weak ventral projection may be marked.

Suture similar to that of *M. compressus*.

Measurements.—See Table 4.

Table 4. Measurements of *Marshallites virgatoides* (above mid-line) and *M. voyanus* (below).

Specimen, position	D	U	H	B	B/H	H/h	C(60°)
HT, LS + 180°*	60.5 (1)	16.5 (.27)	25.2 (.42)	23.5 (.39)	0.93	1.34	9/37
PT, E	28.0 (1)	6.3 (.23)	12.4 (.44)	13.0 (.46)	1.05	1.33	9/29
HT, E	60.0 (1)	16.0 (.27)	26.0 (.43)	22.0 (.37)	0.85	1.44	9/23

* Probably due to secondary distortion U and H differ between left and right sides. The indicated dimension is the mean.

Observation.—In the holotype the last suture is at D = 43 mm and the body-chamber is preserved for half a whorl. The basal part of the inner lateral lappet is incompletely preserved in front of the last constriction. A parabola of similar curvature is discernible in front of some other constrictions.

The paratype is regarded as an immature example of this species because it is essentially similar to the inner whorl of the holotype in every character.

Comparison and discussion.—The holotype of this species is similar to that of *Kossmaticeras (Madrasites) voyanum* Anderson (1958, p. 241, pl. 37, figs. 5, 5a, 5b) (= Anderson, 1902, pl. 5, figs. 126, 127; pl. 10, fig. 197), from near the Albian/Cenomanian boundary in the Cottonwood district of California. The former has somewhat broader whorls and more numerous and finer secondary subcostae as compared with simply bifurcated ribs in the latter.

The two species are devoid of distinct umbilical tubercles, but the raised major ribs on the outer whorl tend to thicken slightly at the umbilical end and those along the constrictions are bluntly bullate on the umbilical margin. This is unusual for species of *Marshallites* and

might be comparable with the ribbing of *Sounnaites*, established in Part III of this monograph. However, with respect to the shell-form in gross and general mode of ribbing and constrictions, the two species mentioned above are allied to such species as *M. olcostephanoides* and *M. hendersoni* sp. nov. (established in this paper). In fact the umbilical bullae at the end of the bundled ribs in the latter two species are by no means strong and can be comparable with the umbilical ends of primary ribs in *M. virgatoides*.

Even in *M. compressus*, the type species of *Marshallites*, the umbilical bullae are weakly elevated and narrow, extending gradually to the long ribs. In other words, this species is somewhat similar to *M. compressus* and differs from the latter by the point of branching and intercalation at the middle of the flank, where primary ribs are replaced by very fine and closely set secondaries which do not show so much ventral projection as the ribs of *M. compressus*. Another distinction is the less compressed whorl with more convex flanks and moderately, instead of narrowly arched venter.

On the basis of the above comparisons we refer this species and *K. voyanum* to the genus *Marshallites*.

Occurrence.—This species is found rarely in the silty sandstone of the middle part of the Cenomanian in the Ikushumbets Valley (central Hokkaido).

Marshallites involutus sp. nov.

(By T. Matsumoto and R. Saito)

Plate 6, Figs. 1–5

Material.—Holotype: GK. H8338 (Pl. 6, Fig. 1) collected by Y. Morita from the "Cenomanian Shibunnai-toge Formation" (see Shimizu, 1932, p. 4) on the Kurumi-zawa, a branch stream in the upper reaches of the River Abeshinai, a tributary to the mid-valley of the Teshio in the Teshio Mountains, northern Hokkaido.

Paratypes: (1) GK. H5218 (Pl. 6, Fig. 3) collected by K. Tanaka from Member Mf (Middle Cenomanian) of the Middle Yezo Group at his loc. NH619 (see Tanaka, 1963), on the Shinonome-zawa, a branch in the upper reaches of the River Obirashibe, in the southern part of the Teshio Mountains, northwestern Hokkaido. (2) GK. H8337A (Pl. 6, Fig. 2) collected by R. Saito from Member IIc (Upper Cenomanian) on the main stream of the River Ikushumbets. In the same rock several young specimens of *Inoceramus pictus minus* (see Pl. 6, Fig. 6) occurred. (3) GK. H5423 (Pl. 6, Fig. 4) collected by T. Muramoto from Member IIb of the Mikasa Formation at loc. Ik 1103 (Nishi-katsura-zawa). (4) TTC. 370915 (Pl. 6, Fig. 5), a malform collected by T. Takahashi from the Middle Cenomanian silty sandstone of the Zone of *Calycoceras (Newboldiceras) asiaticum* at loc. Ik 1103, Nishi-

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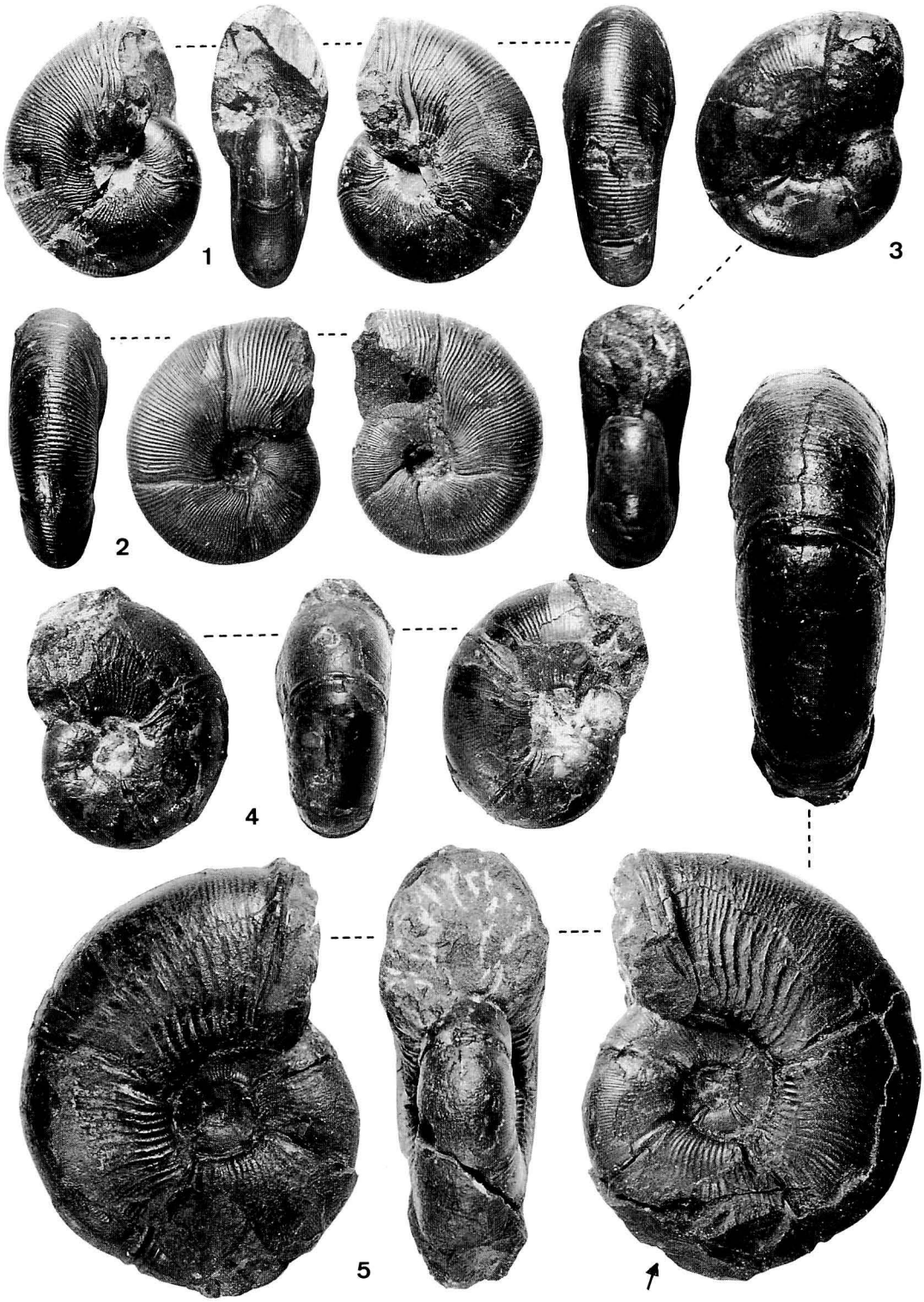
Explanation of Plate 5

Figs. 1–3. *Marshallites olcostephanoides* Matsumoto. ..... Page 33
1: GK. H8338[KSC], hypotype, × 1.25. 2: TTC. 390600, hypotype, × 1.25. 3: TTC. 420429B, hypotype, × 1.75. 1–3 all immature.

Figs. 4, 5. *Marshallites virgatoides* Matsumoto & Takahashi, sp. nov. ..... Page 36
4: TTC. 350900, paratype, × 1.25. 5: TTC. 490224, holotype, × 1.1.



T. Matsumoto, T. Takahashi & K. Sanada: *Marshallites* (1–3)
T. Matsumoto & T. Takahashi: *Marshallites* (4, 5)

katsura-zawa. The last three are in the Ikushumbets Valley, central Hokkaido. The GK. specimens are donations from the collectors.

Diagnosis.—Shell small and narrowly umbilicate, with very involute whorls of high rate of expansion. Whorl much higher than broad, with narrowly arched venter, rather flat and converging flanks, subangular umbilical edge and low but vertical or overhanging umbilical wall.

Periodic constrictions narrow, bordered by narrow collars, as a whole prorsiradiate and gently or somewhat sigmoidal; viz. slightly concave near the umbilicus and on the outer flank, with a gentle convexity in between and considerably projected on the venter.

The late part of the outer whorl ornamented with numerous, fine ribs, most of which arise in twos or threes from bullate umbilical tubercles, at first somewhat prorsiradiate on the inner flank, gently or occasionally moderately recurved on the middle flank and gradually curved forward on the outer flank, crossing the venter with slight projection or almost vertically. The ribs may bifurcate or shorter ribs may intercalate at or near the bending point. On the surface of shell the ribs are sharp-headed and narrower than the interspaces, numbering 20 ± 1 on the outer part in the interval of 60° *versus* 5 ± 1 of the bundling umbilical bullae.

On the younger part of the preserved outer whorl the ribs are so fine that they may be better called lirae and the umbilical bullae are also very weak, but the construction of the ornament is fundamentally similar to that of the later part described above.

As the constriction is more oblique than the ribs behind it, several ribs are intersected by (or branched from) the posterior flare, whereas the ribs in front of the parabolic trace tend to follow roughly that curvature.

Suture of kossmaticeratid pattern and florid despite the small size of the shell.

Measurements.—See Table 5.

Table 5. Measurements of *Marshallites involutus*.

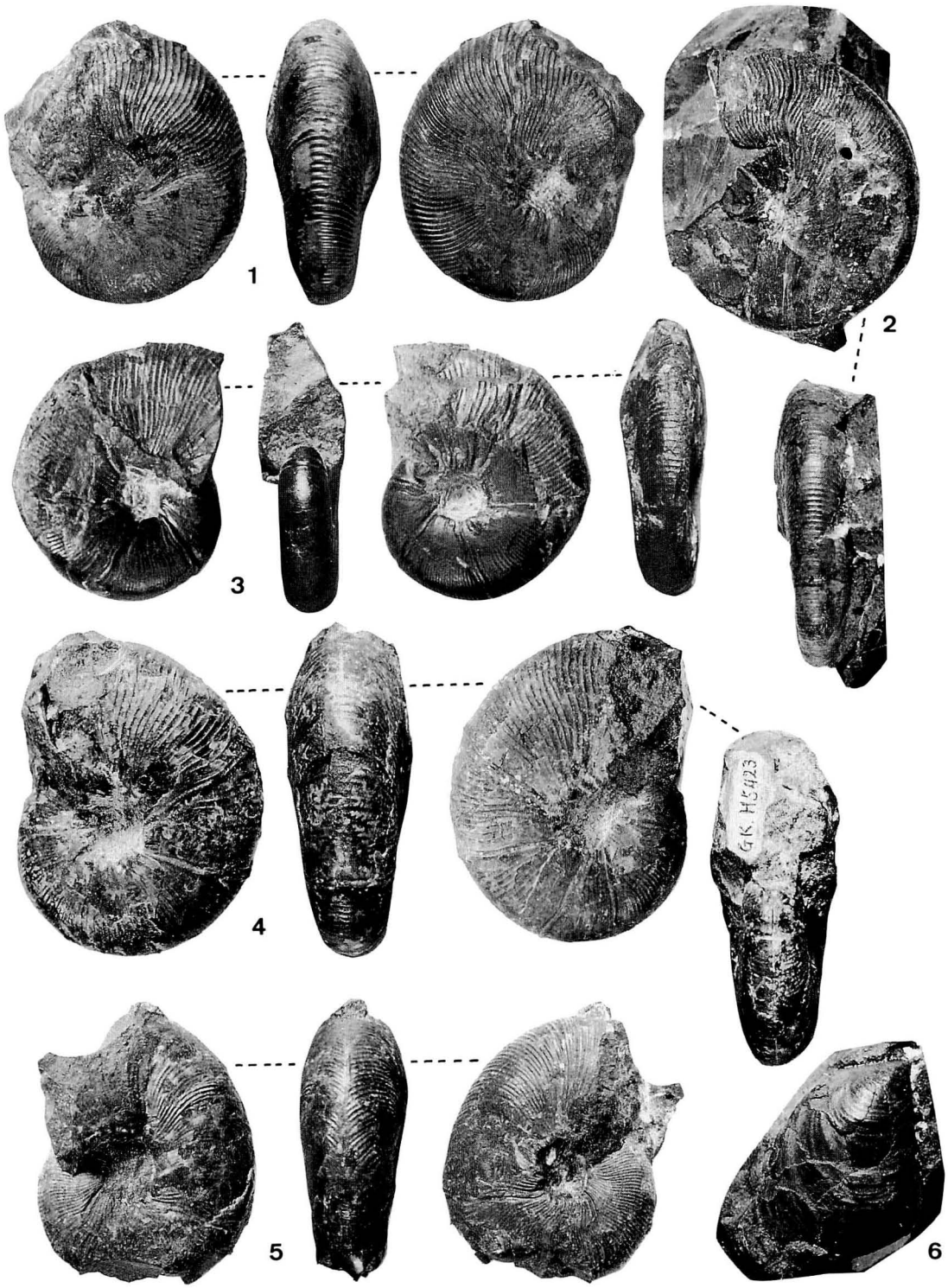
Specimen, position	D	U	H	B	B/H	H/h	C(60°)
HT, E	23.0 (1)	2.8 (.12)	12.7 (.55)	8.2 (.36)	0.65	1.69	5/20
GK. H8337A, E	27.6 (1)	3.3 (.12)	15.1 (.55)	>7.6	>0.50	1.66	4/21
GK. H5218, E	23.4 (1)	2.8 (.12)	13.1 (.56)	>7.4	>0.58	1.75	6/21
" E−180°	—	—	7.8	5.6	0.72	—	—
GK. H5423, E	36.6 (1)	6.2 (.17)	19.2 (.52)	14.3 (.39)	0.74	1.70	4/20
" E−90°	29.8 (1)	4.8 (.16)	15.4 (.52)	11.4 (.38)	0.74	1.60	5/19

>: The dimension of B should be originally somewhat larger than the indicated figure, for the secondarily compressed specimen is measured as it is.

Explanation of Plate 6

Figs. 1–5. *Marshallites involutus* Matsumoto & Saito, sp. nov. ..... Page 38
1: GK. H8338, holotype, ×1.87. 2: GK. H8337A, paratype, ×1.75. 3: GK. H5218, paratype, ×1.75. 4: GK. H5423, paratype, ×1.2. 5: TTC. 370915, malform, ×1.2.

Fig. 6. *Inoceramus pictus minus* Matsumoto ..... Page 38
GK. H8337B, young right valve, ×2, associated with GK. H8337A.



T. Matsumoto & R. Saito: *Marshallites*

Observation.—The holotype is small, wholly septate and undeformed. The paratypes (1) and (2) are nearly as small as the holotype but their late parts are secondarily compressed. Paratype (3), which is larger than the others, has the last suture at D = 32 mm and preserves the posterior part of the body-chamber. TTC. 370915 shows likewise the last suture at D = 30 mm, although it is severely injured on the venter. On the assumption that the body-chamber was at least 180° in length, the entire shell diameter of paratype (3) would be about 50 mm.

As far as the studied material is concerned, the variation of this species does not seem great (see Table 5 and Plate 6). The small holotype is magnified in the photos of Pl. 6 to show its close similarity to the other specimens, in particular to the larger paratype (3) in the density and curvature of ribs and mode of bundling into bullate umbilical tubercles as well as the shell-form.

Comparison and discussion.—This species is allied to *M. olcostephanoides* described above. As the two species are contemporary, it might be suggested that they could be two morphotypes in an extremely variable species. On the basis of the available material we are inclined to deny this.

In this species the shell is much smaller with narrower umbilicus and higher rate of expansion and the whorl is more compressed with flat instead of convex flanks as compared with *M. olcostephanoides*. As to the mode of ribbing, especially the branching of ribs from the umbilical bullae with some intercalation or further branching on the flank, the two species are similar. While the ribs are gradually spaced with growth in this species, showing little change in the number of the ribs in a given interval, they are persistently dense in *M. olcostephanoides*. Generally the ribs show clearer projection at the ventrolateral shoulder in this species than in *M. olcostephanoides*, but there is some variation with growth and also between individuals in the latter.

In the sigmoidal curvature of the ribs with ventrolateral projection and the compressed whorl with rather flat flanks, this species resembles *M. compressus*, but the former has distinctly narrower umbilicus, more involute whorl of higher expansion rate. The ribs in the late growth-stage are finer and denser in the former than in the latter.

In its compressed and involute shell-form and numerous ribs this species looks similar to *Maorites densicostatus* (Kilian & Reboul, 1909), emended by Henderson and McNamara (1985, p. 54) and further by Macellari (1986, p. 25), with which *M. tenuicostatus* (Marshall, 1917) and also *M. suturalis* Marshall, 1926 are now synonymized. That species occurs in the Antarctica, southern Argentina, New Zealand, New Caledonia and western Australia and its age is currently regarded as Maastrichtian.

The difference in apparent morphological characters between the two species is not great. The former is much smaller and on the average more narrowly umbilicate and more involute than the latter. We thought that the ribs are denser and more numerous in *M. densicostatus* than those in this species, but now a form of that species, i.e. morphotype γ of Macellari (1986, p. 33), of which *M. suturalis* Marshall, 1926 is a synonym, has less numerous ribs than the other forms (i.e. morphotypes α and β). Although the number of ribs in a given interval is similar to that of our species, the ribs in the latter are narrower and separated by wider interspaces. Thus the two species can be discriminated.

Anyhow, no species is known which could link *Marshallites involutus* from the Cenomanian of Japan with *Maorites densicostatus* from the Maastrichtian of the Southern Hemi-

sphere. The similarity should be regarded as a homoeomorphy.

Occurrence.—This species is found occasionally in the mudstone and silty sandstone of the upper and middle parts of the Cenomanian Stage in the Abeshinai-Saku and Obirashibe areas of northern to northwestern Hokkaido and in the Ikushumbets Valley of central Hokkaido.

Marshallites rotundatus sp. nov.

(By T. Matsumoto and T. Takahashi)

Plate 7, Figs. 1–5

Material.—Holotype, GK. H8268 (Pl. 7, Figs. 1, 2) collected by T. Matsumoto from a nodule of silty fine-grained sandstone loose at loc. Ik 1066p3 at the entrance of the Torii-zawa (Shimo-ichi-no-sawa), a tributary to the River Ikushumbets. The nodule contains *Mantelliceras* sp. and was certainly derived from the Zone of *Mantelliceras japonicum*, Member IIb of the Mikasa Formation exposed along the Torii-zawa.

Paratypes (1), (2): TTC. 370427 A, B (Pl. 7, Figs. 4, 3) and (3): GK. H8356 (Pl. 7, Fig. 5) (K. Sanada's collection and donation) from the same Zone at loc. Ik 1100, Katsura-zawa quarry (now abandoned) on the right side of the River Ikushumbets near the bridge called Katsura-Ohashi.

Diagnosis.—Shell small and narrowly umbilicate, consisting of fairly involute whorls with high expansion ratio. Whorl in the late stage slightly higher than broad or nearly as high as broad and subcircular in section, showing well rounded venter, somewhat convex, slightly divergent flanks, with the maximum breadth at some distance outward from the mid-height, abruptly bent but subrounded umbilical edge and nearly vertical wall.

Periodic constrictions and flares of irregular frequency, fairly prorsiradiate and very gently sigmoidal, showing a concave curve near the umbilical edge, very gentle convexity on the middle of flank and another weak to moderate convexity on the venter. In front of some constrictions a lateral parabola can be traced.

Surface of shell in relatively later stage of growth ornamented with fine but sharp headed ribs, some of which arise from the umbilical seam, slightly strengthen or curve with accent at the umbilical edge, run obliquely forward on the inner flank, recurve at about the mid-flank with some convexity, extend on the outer flank almost radially or with slight concavity and cross the venter with a gently convex curvature. Shorter ribs are added by branching and intercalation at or near the mid-lateral recurved points. Thus the ribs on the outer part of the whorl are roughly three times as numerous as those around the umbilicus. They are uniform in intensity and spacing.

On the shell surface of the younger part of the outer whorl the subcostae or lirae are very fine, dense and numerous, but the fundamental construction of the ribbing is similar to that of the later part. The bundling of several outer subcostae into the umbilical bulla is discernible when the preservation is favourable.

Suture similar to that of *M. compressus*, being much ramified despite the small size of shell.

Measurements.—See Table 6.

Table 6. Measurements of *Marshallites rotundatus*.

Specimen, position	D	U	H	B	B/H	H/h	C(60°)
HT, E	24.4 (1)	4.2 (.17)	13.0 (.53)	12.4 (.51)	0.95	1.81	5/16
" E – 120°	17.0 (1)	2.4 (.14)	8.5 (.50)	8.0 (.47)	0.94	–	5/20
PT 1, E	21.0 (1)	3.1 (.15)	11.5 (.55)	10.3 (.49)	0.90	1.80	5/14
PT 2, E	19.0 (1)	2.9 (.15)	10.5 (.55)	9.8 (.52)	0.93	1.87	4/14
PT 3, E – 45°	17.5 (1)	3.0 (.17)	9.0 (.51)	8.6 (.49)	0.96	1.54	4/14
TKD. 30161, E	17.1 (1)	3.1 (.18)	8.9 (.52)	8.7 (.51)	0.98	1.75	4/16
GK. H8380, E	18.2 (1)	3.2 (.18)	9.6 (.53)	9.3 (.51)	0.97	1.78	6/16

The last two specimens are described in Part III.

Observation.—The holotype is nearly wholly septate. If the preserved end is regarded as the last septum and the body-chamber is assumed to be at least 180° in length, the original shell would be at least 45 mm in diameter.

The change of ornament from the young to the late type in the above description is rather abrupt. It occurs at D = 21 mm in the holotype and at D = 17 or 18 mm in the two paratypes. We do not know at present the characters of the adult body-chamber of this species.

Comparison and discussion.—This species is allied to *M. olcostephanoides* with respect to the shell-form and mode of ornamentation. The difference is its more rounded whorl, with somewhat larger ratio of B/H and the maximum breadth at some distance outward (in stead of inward) from the mid-height, deeper involution, larger ratio of whorl expansion and narrower umbilicus. The ribs are persistently dense up to the body-chamber in *M. olcostephanoides*. The change of very fine and dense subcostae or lirae of young whorl to the fine but well-spaced and sharply defined ribs of later (i.e. middle-aged) whorl suggests that somewhat coarser ribs may appear in the adult body-chamber. Even at the middle stage with diameters of 20–25 mm, the ribs in a given interval (e.g. 60°) are less numerous in this species that those of *M. olcostephanoides* (compare Tables 3 and 6).

Although the body-chamber of this species is unknown, in the density and mode of branching or bifurcation of the ribs and also the weakness of the umbilical bullae this species is similar to *M. compressus*, but the latter has evidently more compressed and less involute whorls and shows a stronger ventral projection of the ribs.

Occurrence.—This species occurs rarely in the silty sandstone of the upper Lower

Explanation of Plate 7

Figs. 1–5. *Marshallites rotundatus* Matsumoto & Takahashi, sp. nov. ..... Page 43
1: GK. H8263, holotype, whose last portion is detached, × 1.5. In the 5 photos 2 right laterals are in different lighting. 2: GK. H8263, holotype as it is, × 1.5. 3: TTC. 370427B, paratype, × 1.75. 4: TTC. 370427A, paratype, × 1.75. 5: GK. H8356, paratype (K. Sanada's coll. & donation), × 1.75.

Figs. 6, 7. *Marshallites rotundatus* Matsumoto & Takahashi ..... Page 110
6: GK. H8379 [= K. Yokoi's No. 738, donated], × 1.5. 7: TKD 30161, × 1.85 (photo partly by A. Inoma).

Fig. 8. *Marshallites* cf. *olcostephanoides* Matsumoto ..... Page 33
GK. H8347 (T. Yokoi's donation), juvenile, × 2.

T. Matsumoto & T. Takahashi: *Marshallites* (1–5, 8)
T. Matsumoto & A. Inoma: *Marshallites* (6, 7)

Cenomanian (Zone of *Mantelliceras japonicum*) in the Ikushumbets Valley of central Hokkaido. It is found also in the Basal Cenomanian (Zone of *Desmoceras kossmati-Graysonites adkinsi*) of the Shumarinai-Soeushinai area of northwestern Hokkaido (see Part III).

Genus *Yeharaites* nov.

Yeharaites kobayashii sp. nov.

(By T. Matsumoto and T. Takahashi)

Plate 8, Fig. 1; Text-fig. 7

Material.—A single specimen at our disposal is the holotype, i.e. GK. H8334 collected by T. Takahashi from a nodule at a locality in the stream Shimo-ichi-no-sawa (maybe called Torii-zawa by some people), a branch of the River Ikushumbets, probably Lower Cenomanian.

Diagnosis.—The last suture is located at H = 28 mm or at D = approximately 70 mm and the body-chamber is preserved for about 210°, although its last part is somewhat crushed and distorted.

The whorl expands at rather a moderate rate, but for the last part, where the rate seems to decrease. The umbilicus is of moderate width, about 30% of D.

The whorl is somewhat higher than broad, with B/H = 0.82 in the middle of the body-chamber and slightly more compressed (B/H = 0.73) in the last part of the phragmocone. The outer whorl is high trapezoid in section, with abruptly rounded ventrolateral and umbilical shoulders; the flanks are flat and slightly convergent; the venter is at first moderately arched, then gently convex and nearly flat later. The umbilical wall is low but nearly vertical or even tends to overhang.

The inner whorl has gently convex flanks, rounded umbilical edge and steeply inclined wall.

In early growth-stage the inner flank looks nearly smooth, but for marked constrictions, 3 to 4 per whorl, with associated flares in front, which may be bullate at the umbilical edge. Then in the next stage for nearly one whorl the observable part of the flank shows long ribs, which are moderately separated and sometimes have branched or intercalated shorter ribs. At the umbilical edge the long ribs are bluntly bullate and the flares along the periodic constrictions are more distinctly tuberculate. There are no bundled ribs, but whether some ribs bifurcate on the outer flank or not is not observable.

The outer whorl, which consists of the last part of the phragmocone and the body-chamber, is ornamented with numerous, narrow but fairly raised ribs of unequal length,

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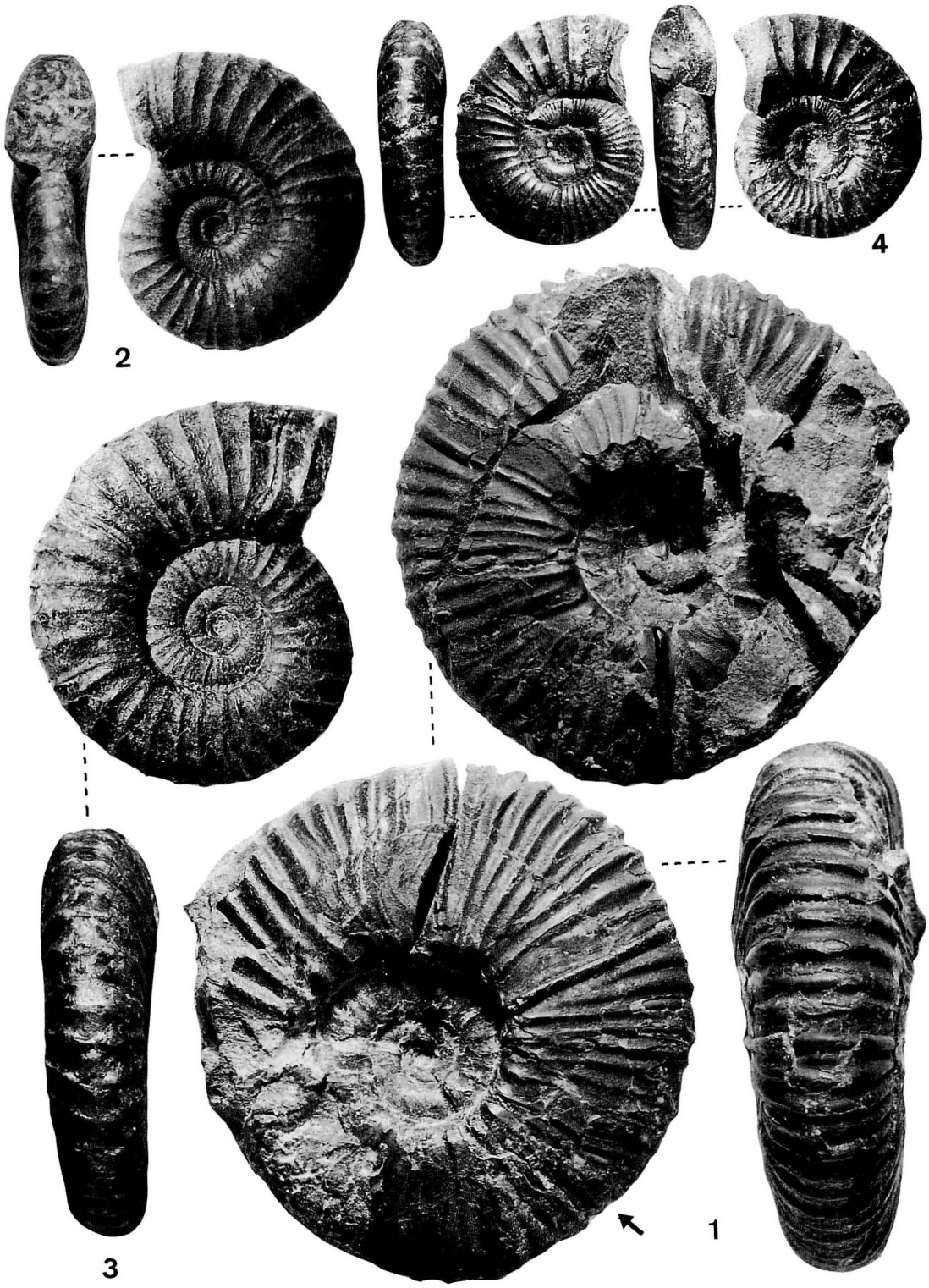
Explanation of Plate 8

Fig. 1. *Yeharaites kobayashii* Matsumoto & Takahashi, sp. nov. ..... Page 46
6K. H8334, holotype, × 1.

Figs. 2–4. *Yakushiceras takahashii* Matsumoto, sp. nov. ..... Page 53
2: GK. H8335, holotype, × 1. 3: Ditto, × 4/3. 4: GK. H8336, paratype, × 1.5.



T. Matsumoto & T. Takahashi: *Yeharaites*
T. Matsumoto: *Yakushiceras*

which are separated by slightly wider interspaces. There are 33 ribs (flares included) in half a whorl of which 14 are long and tuberculated at the umbilical edge. The shorter ribs are intercalated (instead of branched) and of unequal length, some of which reach the inner flank but others not.

The periodic flares are somewhat stronger than the normal ribs, nearly rectiradiate or slightly prorsiradiate and somewhat oblique to several normal ribs behind each of them. The normal ribs are slightly rursiradiate or gently convex on the inner flank. They gradually coarsen outward and are moderately strong and crowded on the venter, where they run almost vertically or with a very shallow backward sinus, except for the periodic flares which show a slight projection on the venter. The ribs coarsen also adorally and are fairly strong even on the inner flank, with tubercles at the umbilical edge.

There is a flat space in front of each periodic flare. On this space a sinuous line may be traced, showing the inner lateral ear-like convexity, and on that of the late part an outline of lappet remains. The ribs on this part show some convexity on the inner part of flank and are rursiradiate on the outer part, whereas an ocular sinus is evidently shown at about the umbilical edge. Regrettably the final peristome is not preserved in the holotype.

Etymology.—This species is dedicated to Professor Emeritus Teiichi Kobayashi, who was once a student with Professor Shingo Yehara in Kyoto.

Measurements.—See Table 7.

Table 7. Measurements of *Yeharaites kobayashii*.

Specimen, position	D	U	H	B	B/H	H/h	C(180°)
HT, LS + 90°	81.6 (1)	24.4 (.30)	33.0 (.40)	27.0 (.33)	0.82	1.36	14/33
" LS	—	19.8	30.6	22.4	0.73	—	—

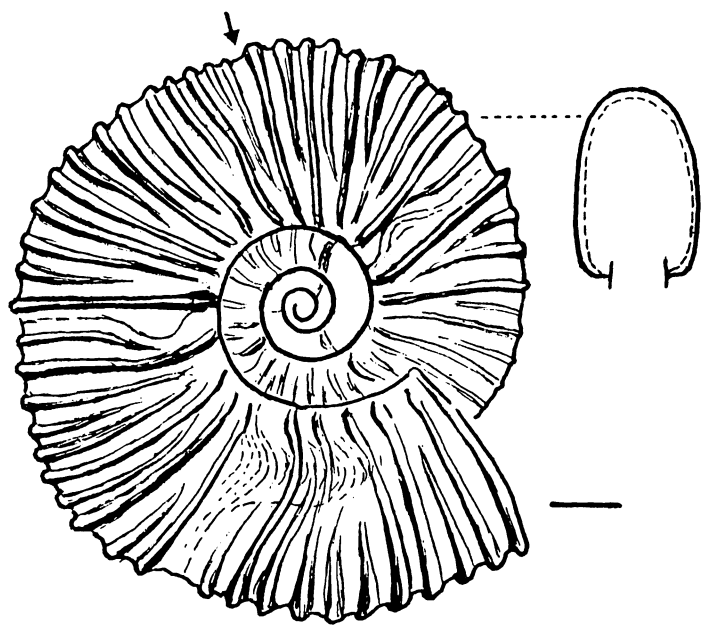


Fig. 7. *Yeharaites kobayashii* sp. nov.
Drawing of the holotype with some restoration. Arrow: beginning of the body-chamber. Scale bar: 10 mm. (T. M. *delin.*)

Comparison and discussion.—This species shows unique morphological characters and cannot be referred to any previously known genus, such as *Marshallites*, *Eogunnarites*, *Kossmaticeras* and *Natalites*. As to the predominance of single ribs, it is comparable with such species as *Pseudokossmaticeras galicum* (Favre, 1869), but in the latter long ribs predominate on the outer whorl and the ribs are bundled at umbilical tubercles on the inner whorl (see Thiedig and Wiedmann, 1976, p. 17, pl. 2, figs. 1, 3; Blaszkiewicz, 1980, p. 41, pl. 56, figs. 1–3; Kennedy and Summesberger, 1987, p. 28, pl. 2, fig. 6; pl. 3, figs. 7–9). Species of *Pseudokossmaticeras* occur in the Campanian and Lower Maastrichtian and the similarity is a homoeomorphy.

Kossmaticeras canadense McLearn (1972, p. 55, pl. 26, fig. 2), from the Upper Albian of western British Columbia, is allied to this species in its general shell-form, ribbing with some convexity on flank and little or almost no ventral projection, predominance of long and short single ribs on the outer whorl, and especially the presence of the parabola marked on the inner lateral part in front of the periodic flares or constrictions. Therefore, this Albian species has been transferred from *Kossmaticeras* to *Yeharaites* (see Part I).

Marshallites columbianus McLearn (1972, p. 54, pl. 3, fig. 3), from the Upper Albian of western British Columbia, shows some characters which could be regarded as transitional from some species of *Marshallites* to *Yeharaites canadensis* (McLearn). Its ribs on the outer whorl are as coarse as those of the latter, curved to form a forward convexity on the inner flank and rectiradiate on the main flank, crossing the venter in perpendicular to the siphonal line. It is, however, more involute and its branching ribs persist to the outer whorl. Hence it is kept in the genus *Marshallites*.

A plastercast of the holotype of *Y. canadensis* is GK. H9483 and that of *M. columbianus* GK. H9482.

Occurrence.—As for *Material*.

Yeharaites kawashitai sp. nov.

(By T. Matsumoto)

Plate 9, Fig. 1

Material.—Holotype, YKC. 010718, collected by Y. Kawashita from locality S-901 on the left bank of the upper course of the Hakkin-zawa, Oyubari area. This is the only specimen available at present.

Diagnosis.—Shell fairly large, consisting of rather evolute whorl with a little overlap and moderate ratio of expansion; hence fairly widely umbilicate. Whorl somewhat higher than broad and subelliptical in cross-section, with subrounded ventrolateral and umbilical shoulders, gently convex venter and flanks and low but steeply sloping umbilical wall.

Periodic constrictions narrow, double collared, slightly oblique to the ribs behind them; on the outer whorl rather indistinct.

Numerous ribs of unequal length, asymmetrically convex on the inner flank, slightly rursiradiate or almost rectiradiate on the outer flank, crossing the venter at right angle with the siphonal line, crowded in young stage, becoming less crowded with growth, and separated by somewhat wider interspaces on the body-chamber.

The long ribs on the outer whorl are bullate around the umbilicus and one or two, more

or less shorter ribs intercalated between the long ones. No distinct bifurcation occur at the umbilical bullae, although a few of the intercalated rib may approach the bullae as if they break up from the original bifurcation.

On the inner whorl indistinct bifurcation at the umbilical edge may remain, but the umbilical bullae are very weak and no bundling nor distinct umbilical tubercles developed, except for those on flared collars along the constrictions.

Suture of kossmaticeratid pattern. L somewhat deeper than E. U2 and auxiliaries descending abruptly.

Etymology.—This species is dedicated to Mr. Yoshitaro Kawashita who has contributed much to our ammonitology through his laborious field work.

Measurements.—See Table 8.

Table 8. Measurements of *Yeharaites kawashitai*.

Specimen, position	D	U	H	B	B/H	H/h	C(180°)
HT, LS + 105°	141.0 (1)	59.0 (.42)	48.0 (.34)	~35.0 (.25)	~0.73	1.41	12/27
" LS + 40°	119.0 (1)	50.4 (.42)	40.5 (.34)	~29.5 (.25)	~0.73	1.44	11/23
" LS	~110	46.5 (.42)	37.5 (.34)	—	—	1.44	—
" LS − 75°	—	—	34.0	26.0	0.76	—	—

Observation.—The specimen is an internal mould, with its right side dissolved in the rock matrix, and the venter is partly destroyed. The siphonal line is, however, exposed on the early half of the outer whorl.

The preserved end is at about 210° from the last septum and the shell diameter in a restored outline calculated from the umbilical ratio is about 170 mm.

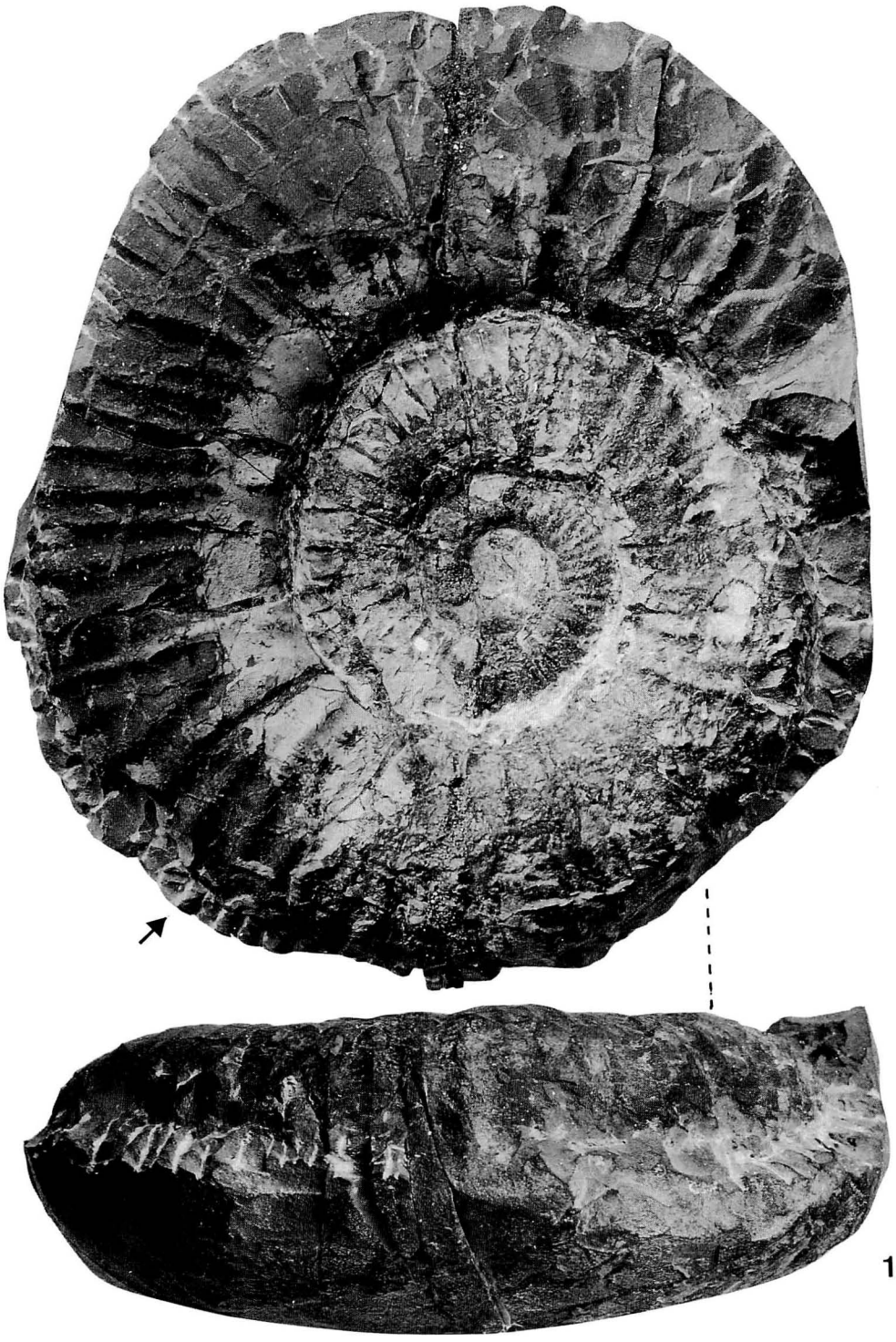
The constrictions on the outer whorl are narrow and indistinct but discernible by their oblique disposition to a few ribs behind them and also by the bullate elevations which extend down to the umbilical seam. A trace of parabola (inner lateral convexity and umbilical sinus) is recognized at the site of the last suture and another point about 130° adaptically from that site. Some of the periodic flares on the late part of the body-chamber are unusually flexuous, showing an inner lateral convexity and a gentle outer lateral concave sinus. This suggests roughly the outline of a previous peristome.

Comparison and discussion.—This species is distinct from *Y. kobayashii* described above in its larger size (with D twice as large as that of *Y. kobayashii*), smaller degree of involution, much wider umbilicus (U 42% of D as compared with 30% in that species), subelliptical instead of high trapezoid whorl-section and less rigid ribs with more frequently intercalated shorter ones. A parabola, which probably records the base of a previous, lappeted peristome, is discernible at least at two points on the outer whorl. The holotype of *Y. kawashitai*, then, cannot be a macroconch of *Y. kobayashii*.

It may be allied to *Y. canadensis* (McLearn, 1972), mentioned in the description of

Explanation of Plate 9

Fig. 1. *Yeharaites kawashitai* Matsumoto, sp. nov. ..... Page 49
YKC. 010718, holotype, × 1.



T. Matsumoto: *Yeharaites*

Y. kobayashii, in shell-form and ornamentation, but the former is larger and more widely umbilicate (U is 42% of D in the former but 36 or 37% in the latter). In *Y. canadensis* bifurcating ribs remain, though occasionally, even on the outer whorl and the flexuous ribs showing inner lateral and ventrolateral projections occur more frequently.

Although only a single specimen is before me, it is distinct enough for establishing another new species under the new genus *Yeharaites*.

Occurrence.—The locality of the holotype, numbered S 901, on the left bank of the upper course of the stream Hakkin-zawa is indicated in text-fig. 1 by Matsumoto and Suekane (1987), who described another ammonite from the same locality as *Sharpeiceras* aff. *vohipalense* Collignon (ditto, p. 3, pl. 1, figs. 1–3) that indicates Lower Cenomanian.

Yeharaites dawsoni sp. nov.

(By T. Matsumoto)

1884. *Haploceras planulatum* (Sowerby); Whiteaves (pars), p. 207, pl. 28, fig. 1.
1972. *Mesopuzosia* ? sp.; McLearn, p. 39, pl. 41, fig. 2A–C.

Material.—Holotype, GSC 4974, collected by M. M. Dawson in 1878 from the north shore of the Cumshewa Inlet, Queen Charlotte Islands, British Columbia, Canada. A plaster cast donated from GSC through the late Dr. J. A. Jeletzky to Kyushu University is GK. H9477.

Diagnosis.—Shell medium-sized and rather evolute, with roughly one third involution and umbilicus of moderate width. Septate whorl slightly higher than broad, subrectangular in section, with rather flat or only slightly convex venter, abruptly bent ventrolateral shoulders, nearly flat or very gently convex, subparallel flanks, subrounded umbilical edge and low but steeply inclined umbilical wall.

Constrictions normally of moderate frequency, 4 to 5 per whorl, but irregularly frequent in the last part of the phragmocone and the beginning of the body-chamber, well-marked on the internal mould, somewhat prorsiradiate and oblique to the ribs. In front of the constriction there is a flat space, where an ear-like parabola may be marked with a trace of ventrolateral sinus and ventral projection on its outward extension and a semi-sinus on the umbilical margin.

The ribs on the outer whorl mostly long, single and nodeless, but for a few intercalatories and an exceptional bullate long one showing bifurcation; narrow, sharp-headed and separated by wider interspaces, nearly radial or very gently sigmoidal on the flank, with a slight convexity on inner flank and somewhat forward bend at the ventrolateral shoulder, where they thicken slightly, and then run across the venter nearly perpendicular to the siphonal line with much weakening. Only the elevated collars on either sides of the constriction show a moderate projection on the venter; they may be weakly bullate at the umbilical margin. On the inner whorl the ribs are finer, denser and may be bundled at the weak umbilical bullae. Still younger part looks nearly smooth on the internal mould.

Suture of kossmaticeratid, instead of puzosiid, pattern.

Measurements.—See Table 9.

Comparison.—Although only a single specimen is available, it does show specific distinctness. By its finer ribs, their curvature, slight thickening at the ventrolateral shoulders

Table 9. Measurements of *Yeharaites dawsoni* (above mid-line) and *Y. canadensis* (below).

Specimen, position	D	U	H	B	B/H	H/h	C(180°)
HT, E – 270°	~45.0 (1)	15.4 (.34)	18.4 (.41)	17.2 (.38)	0.93	—	—
HT, near E	95.8 (1)	35.2 (.37)	36.0 (.38)	32.0 (.33)	0.89	1.46	18/40
" E–90°	80.3 (1)	29.0 (.36)	30.4 (.38)	29.8 (.37)	0.98	1.45	15/35

and weakening on the venter this species is discriminated from the other three species of *Yeharaites*.

Occurrence.—"North shore of Cumshewa Inlet", presumably Albian, as suggested by other species from generally the same area.

Genus ***Yakushiceras*** nov.

Yakushiceras takahashii sp. nov.

(By T. Matsumoto)

Plate 8, Figs. 2–4

Material.—Holotype: GK. H8335 (Pl. 8, Figs. 2, 3) and paratype: GK. H8336 (Pl. 8, Fig. 4), both collected by T. Takahashi from the same nodule loose at locality Ik 6018p, in the stream Shimo-ichi-no-sawa (= "Torii-zawa"), a branch of the River Ikushumbets.

Diagnosis.—As for the genus (see p. 10 in Part I).

Measurements.—See Table 10.

Table 10. Measurements of *Yakushiceras takahashii*.

Specimen, position	D	U	H	B	B/H	H/h	C(180°)
HT, E – 20°	46.0 (1)	18.2 (.40)	17.0 (.37)	13.2 (.29)	0.78	1.57	16
" E – 160°	34.8 (1)	14.2 (.41)	12.0 (.34)	10.0 (.29)	0.83	1.40	16
PT, E	24.6 (1)	9.2 (.37)	8.8 (.36)	7.2 (.29)	0.82	1.33	17
" E – 150°(c)	19.3 (1)	7.2 (.37)	7.1 (.37)	6.1 (.32)	0.86	1.42	21

Description.—The two specimens are well preserved and finely prepared by T. Takahashi from the host rock. The holotype is nearly wholly septate. Assuming that it is a complete phragmocone and that the body chamber was as long as 240°, the entire shell diameter would be at least 75 mm. Therefore the size of this species was small to moderate. The paratype is small but preserves the body-chamber for about a quarter whorl. It is regarded as immature because of the position of abrupt change in the rib density as explained below.

So far as the measurable part is concerned, the whorl expands with a moderate rate, which may increase to some extent later, as indicated by the measurements. The involution of whorl is nearly one third. The umbilicus is moderately wide.

The whorl is suboval in section, broadest between mid-height and the umbilical edge, with a narrowly arched venter, gently convex flanks, rounded umbilical edges and sloping umbilical walls.

Constrictions are moderately frequent, 5 per whorl, narrow and bordered by a fine but sharply raised rib-like elevation (i.e. a kind of flare) behind each. They may be double collared on the shell of late growth-stage, although the two collars may not be equally elevated, and are slightly prorsiradiate, cutting one rib immediately behind and succeeded adorally by a flat space followed by the next rib. On this space a trace of inner lateral convexity and a gentle ventral projection may be discernible. This must be a trace of a previous peristome. At late growth stages the constriction itself is gently sinuous, showing an ocular or umbilical sinus, inner lateral convexity, very shallow and broad outer lateral sinus and a weak ventral projection.

The whorls in the middle to late growth-stages are regularly ornamented with narrow but distinct, long ribs separated by interspaces somewhat wider than the ribs, numbering 16 or 17 to half a whorl. They arise from the umbilical seam, run on the rounded umbilical edge with a weak convexity, and are gently rursiradiate on the main part of the flank, crossing the venter nearly vertically to the siphonal line or with a weak backward sinus. They have small, bullate tubercles on either side of the siphonal zone, where some ribs weaken but others do not. The siphonal zone gradually widens with growth and the tubercles at the late stage become ventrolateral. All the ribs are nodeless at the umbilical edge and there is no shorter ribs, except for the one behind the constriction.

In the young stage at diameters below 16 mm or so, the ribs are much finer, denser and more numerous than those of the middle growth-stage. The change in the rib density is rather abrupt, occurring in both specimens at about D = 16 mm. At this stage tiny ventral tubercles are discernible. As the venter is not exposed in still earlier stage, the presence or absence of the tubercles is unknown. There is no umbilical bulla nor intercalated shorter ribs.

The shell of still younger stage looks nearly smooth or may have very fine lirae on its surface, whereas constrictions are comparatively well-marked and the collars may be somewhat elevated or bullate at the umbilical edge.

The suture is of general kossmaticeratid pattern. Despite the small size of the shell, the suture is much ramified, showing deep and fine incisions like that of *Marshallites compressus* described above.

Comparison.—This species is unique for its diagnostic characters. *Yokoyamaoceras kotoi* (Jimbo, 1894) of later ages (Turonian-Coniacian) is somewhat similar to this species in the small shell, development of lateral lappets and the presence of ventrolateral tubercles, but its tubercles occur only in a limited part of the outer whorl.

Holcodiscoides cliveanus (Stoliczka, 1865) has sparse tubercles at the ventrolateral edge of much broader outer whorl and denser, more numerous, often bipartite ribs which have small umbilical tubercles.

Occurrence.—As for *Material.* The same nodule contains *Zelandites inflatus* Matsumoto, *Hypoturrilites komotai* (Yabe), *Sciponoceras baculoides* (Mantell), *Desmoceras* (*Pseudouhligella*) *japonicum* (Yabe), *Mikasaites orbicularis* Matsumoto, *Mantelliceras* sp., *Inoceramus tenuis* Mantell etc. This assemblage indicates the Zone of *Mantelliceras japonicum* of the Lower Cenomanian.

Genus *Maccarthyites* Matsumoto, 1959

Maccarthyites mikasaensis sp. nov.

(By T. Matsumoto, T. Takahashi and K. Sanada)

Plate 10, Figs. 1–3; Plate 11, Figs. 1–4; Plate 12, Figs. 1, 2; Text-fig. 8

Material.—Holotype; TTC. 380415 (Pl. 10. Figs. 1, 2) (Text-fig. 8) from loc. Ik 1054, sandstone of the Zone of *Mantelliceras japonicum*, at the foot of the bridge "Katsura-Ohashi", on the right side of the River Ikushumbets.

Paratypes: (1) TTC. 370600 (Pl. 10, Fig. 3) from loc. Ik 1054; (2) GK. H8339 (Pl. 12, Fig. 2) collected by K. Sanada from the extension of the bed of Ik 1054 at loc. Ik 1055, on the left side of the River Ikushumbets; (3) TTC. 441019 (Pl. 11, Fig. 2), 7th branch of the stream Kami-ichi-no-sawa; (4) TTC. 510704 (Pl. 11, Fig. 1; Pl. 12, Fig. 1), from the same locality as above; (5) TTC. 501101 (Pl. 11, Fig. 4), from a locality close to the above; the specimens numbered with prefix TTC were obtained by T. Takahashi; (6) USR-CM-103a (Pl. 11, Fig. 3) and (7) USR-CM-103b, both collected by S. Uchida (SUC. 631024) from his loc. Ik-1402r, upper reaches of the left branch of the Suido-no-sawa. All from the Ikushumbets Valley, Mikasa area.

Diagnosis.—Shell small, with fairly narrow umbilicus. Whorl more or less involute, with rather high rate of expansion, and higher than broad. Septate whorl of the middle growth-stage subelliptical in cross-section, broadest at about the mid-flank, with narrowly arched venter, gently convex flanks and rounded umbilical shoulder.

Body-chamber of the adult stage suboval in section, broadest at one third of whorl-height in the dorso-lateral part, from where slightly convex flanks converge to a very narrow venter; umbilical edge abruptly bent to low but steep or nearly vertical or even incurved umbilical wall.

Constrictions, with flares on the test, normally 4 to 5 per whorl, prorsiradiate or nearly

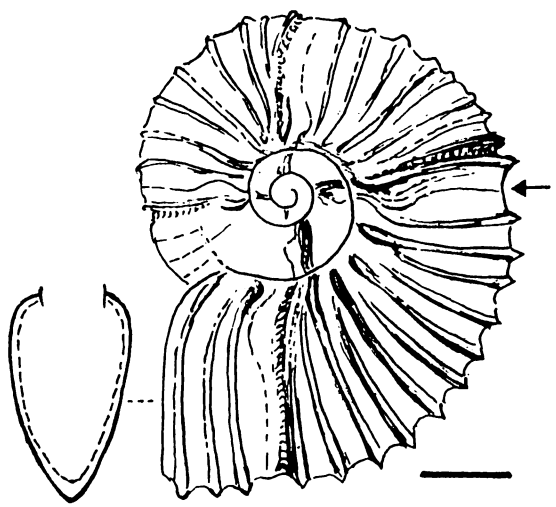


Fig. 8. *Maccarthyites mikasaensis* sp. nov.
Drawing of the holotype. Arrow: beginning of the body-chamber. Scale bar: 10 mm. (T. M. *delin.*)

rectiradiate or gently flexiradiate and slightly oblique to a few ribs behind each of them. A trace of apertural margin, with a moderate inner lateral convexity, umbilical sinus, broad and shallow outer lateral sinus and weak or moderate ventral projection, may be marked in front of some constrictions.

Young shell nearly smooth, but for extremely fine radial lirae on the surface of the test and periodic flares which are nodose at the umbilical edge. Sooner or later in the middle-growth-stage appear weak and narrow ribs of unequal length, which are disposed at regular intervals, separated by interspaces somewhat wider than the ribs, and gently sigmoidal, showing a forward inclination on the inner flank and another slight projection at the ventrolateral shoulder, and cross the venter vertically. Some of the long subcostae may be faintly bullate at the umbilical edge.

The last part of the septate whorl and the body-chamber of the adolescent to adult stages ornamented with fairly strong, distinct ribs of unequal length, which are gently rursiradiate or nearly rectiradiate on the flank, with bullate umbilical tubercles at the end of the longer ribs and shorter ones branched there or intercalated, arising at some distance from the umbilical edge. All the ribs separated by more or less wider interspaces, sharp-headed and especially sharply elevated on crossing vertically the narrow venter, forming almost spinose bullae in the late part of the body-chamber. The periodic flares are somewhat thicker and nodose at the umbilical edge.

The suture is of kossmaticeratid pattern. L somewhat deeper than E but nearly symmetrically tripartite and never so much expanded as that of *Puzosia*; U2 and auxiliaries gradually descending.

Measurements.—See Table 11.

Observation.—There are some variations in the characters of this species. Measurements in Table 11 as well as the figures may be useful for understanding the actual state.

As the body-chamber is incompletely preserved, the variation in the shell size can be inferred from the diameter at the last suture (LS in the Table), that is the beginning of the body-chamber mostly with adult type ornaments. Six of the eight specimens are 35–37 mm in D at LS. On the assumption that the body-chamber should be at least 210°, the original diameter of the restored outline would be 62–65 mm for these six specimens.

Paratype (4) is the smallest, but its LS does not seem to indicate the beginning of the adult stage, which should have started at D = 32 mm, as judged from the change in the style of ribbing. This is roughly the same size as paratype (1). The diameter of the restored shell would be about 58 mm for these two specimens, which represent a somewhat smaller form of the same species.

There is some variation in the rib density. This is demonstrated by the number of ribs in a given interval (e.g. 120°) of the body-chamber, ranging from 12 to 19 on the ventral part. The holotype and paratype (3) are average, paratypes (1) and (6) have much crowded ribs

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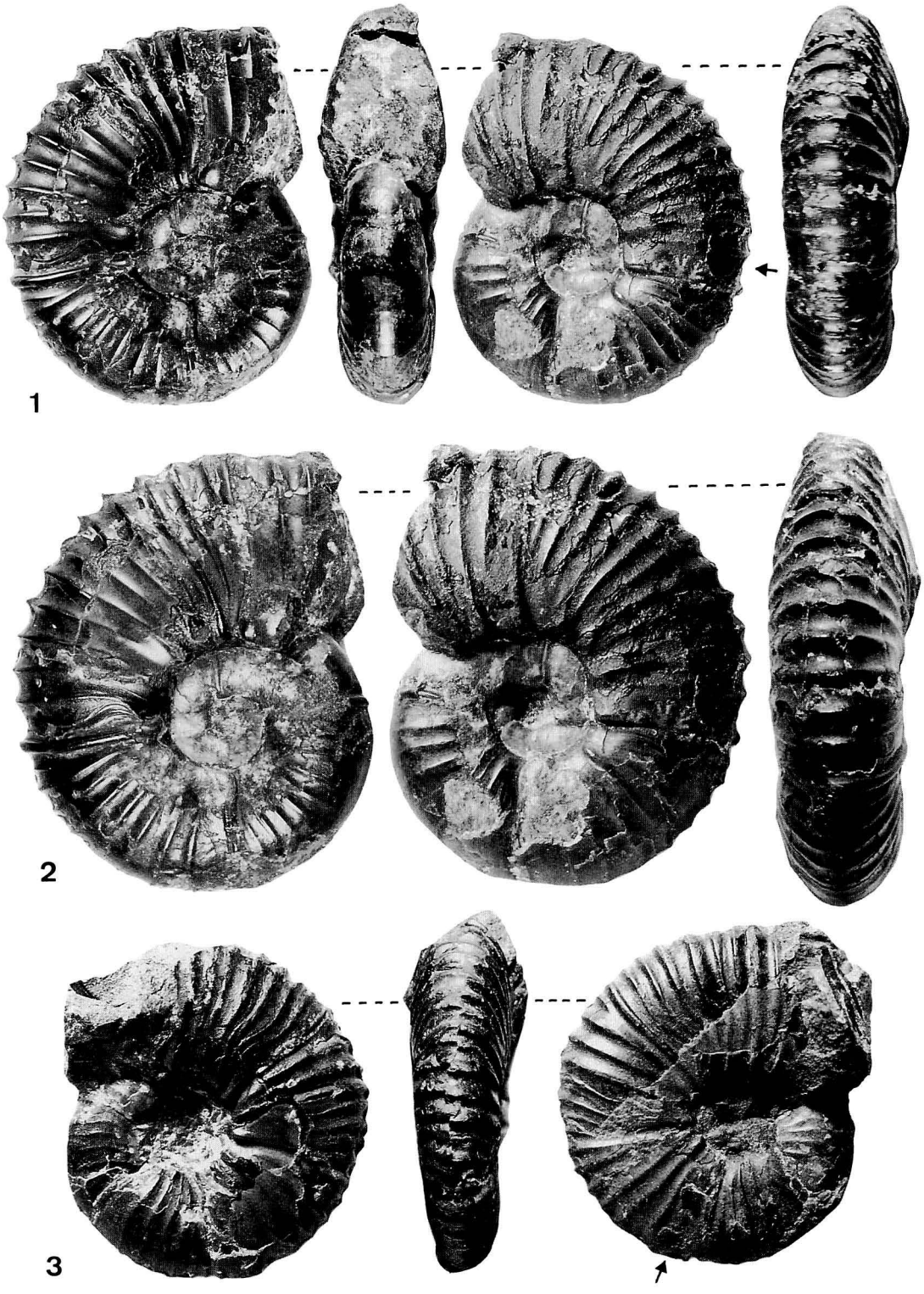
Explanation of Plate 10

Fig. 1–3. *Maccarthyites mikasaensis* Matsumoto, Takahashi & Sanada, sp. nov. ..... Page 55
1: TTC. 380415, holotype, × 1.25. 2: Ditto, still enlarged (× 1.5) to show the parabola and some other characters.
3: TTC. 370600, paratype (1), × 1.25



T. Matsumoto, T. Takahashi & K. Sanada: *Maccarthyites*

Table 11. Measurements of *Maccarthyites mikasaensis* and allied species.

Specimen, position	D	U	H	B	B/H	H/h	C(120°)
HT, LS + 120°	45.6 (1)	12.8 (.28)	20.8 (.46)	14.4 (.32)	0.69	1.73	5/14
" LS	37.0 (1)	10.2 (.28)	16.8 (.45)	13.4 (.36)	0.80	1.68	—
" LS − 90°	—	—	14.7	10.9	0.89	—	—
PT1, LS + 150°	42.6 (1)	10.9 (.26)	19.8 (.46)	12.7* (−)	0.64*	1.66	6/18
" LS	~30 (1)	—	14.8 (.49)	9.5* (−)	0.64*	—	—
PT2, LS + 180°	45.8 (1)	12.0 (.26)	20.7 (.45)	14.5 (.32)	0.70	1.58	6/12
" LS	33.3 (1)	8.8 (.26)	14.2 (.43)	11.7 (.35)	0.82		—
PT3, LS + 180°	48.2 (1)	13.6 (.28)	21.2 (.44)	17.0 (.35)	0.80	1.58	6/15
" LS	35.0 (1)	9.1 (.26)	16.0 (.46)	12.2 (.35)	0.76		—
PT4, LS + 200°	39.2 (1)	7.3 (.19)	18.8 (.48)	~13 (.33)	0.69		6/13
" LS	26.5 (1)	5.0 (.19)	13.4 (.50)	9.8 (.37)	0.73	1.65	—
PT5, LS + 150°	~52.5 (1)	~15 (.28)	~22 (.42)	~17 (.32)	0.77	1.57	7/13
" LS	35.6 (1)	8.7 (.25)	16.6 (.47)	12.6 (.35)	0.76	1.61	—
PT6, LS + 120°	49.1 (1)	13.3 (.27)	22.3 (.45)	~16* (.33)	0.72	1.65	6/19
" LS	36.0 (1)	9.3 (.26)	16.0 (.44)	12.0 (.33)	0.75	1.50	—
PT7, LS + 90°	~45.0 (1)	11.0 (.24)	~21 (.47)	crushed		1.62	6/17
" LS	37.0 (1)	9.3 (.25)	17.3 (.47)	12.4 (.34)	0.72	1.66	—
*M.*aff. LS + 60°	60.0 (1)	16.0 (.27)	25.6 (.43)	18.4 (.31)	*0.72	1.49	6/17
mikasa., LS	54.5 (1)	14.8 (.27)	23.2 (.43)	17.6 (.32)	0.76	1.41	5/14
M. gracilis	21.4	5.0 (.23)	10.7 (0.5)	6.9 (.32)	0.64	1.88	

* = secondarily compressed; calculated from less deformed half in PT6.

and paratypes (2) and (5) have fairly widely spaced ribs.

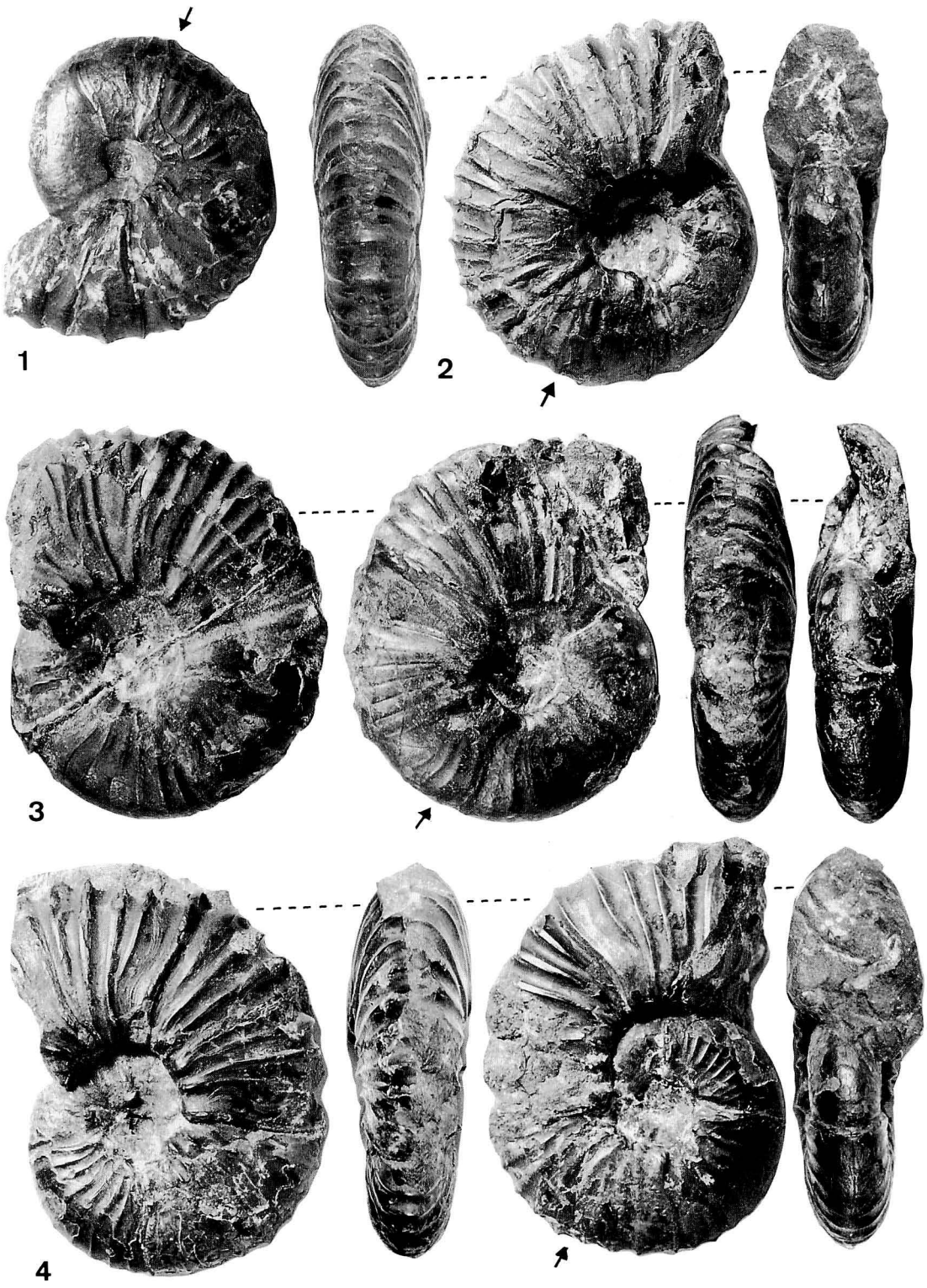
As the body-chamber is incomplete in every specimen, the peristome is not preserved, but a trace of the past apertural margin at the periodic arrest of growth is demarcated in front of some constrictions. This is discernible in every specimen, occurring not only on the whorl of the mature stage but also on the early part of the outer whorl, i.e. the middle stage, and even on the inner whorl of the immature stage.

In some specimens, including the holotype, the constrictions may cut deeply and thickly the umbilical wall and the flares in front of them may be markedly nodose and tend to be twisted at the umbilical edge. For this reason the umbilical margin may become somewhat zigzag. Such a modified outline is often noticeable on the inner whorls.

The degree of involution is roughly 1/2 in the holotype and several other specimens, but somewhat more involute (about 3/5) in one specimen (paratype 4). The rate of whorl expansion is rather high but varies to some extent (H/h in 180° ranges from 1.50 to 1.73 as recorded in Table 11). The width of umbilicus is generally 26 ± 2% of the shell diameter, except for 19% in the very involute example. The ratio of B/H varies also to some extent (0.69−0.89), although it may be modified by secondary deformation.

Explanation of Plate 11

Figs. 1−4. *Maccarthyites mikasaensis* Matsumoto, Takahashi & Sanada, sp. nov. ..... Page 55
1: TTC. 510704, paratype (4), × 1.25. 2: TTC. 441019, paratype (3), × 1.2. 3: USR-CM-103a (SUC. 631024), paratype (6), × 1.2. 4: TTC. 501101, paratype (5), × 1.2.



T. Matsumoto, T. Takahashi & K. Sanada: *Maccarthyites*

Comparison and discussion.—This species can be referred to the genus *Maccarthyites* on account of its rather involute, fairly narrowly umbilicate, compressed and small shell, with oblique constrictions and sharply raised ribs on the narrow venter of the adult whorl.

It is distinguished from *M. gracilis* Matsumoto (1959, p. 67, pl. 23, fig. 6), from the Cenomanian *Desmoceras* (*Pseudouhligella*) *japonicum* bearing rock of Alaska, in that the latter has a still smaller and more involute shell, more compressed and flatter whorl with rather fastigiate venter, and shorter ribs which extend from the spinose bullae on the venter but weaken on the inner flank with much weaker bullae at the umbilical end of the long ones, although the bullate tubercles on the venter begin to develop in much earlier growth-stage, as compared with our species. As *M. gracilis* was established on a single specimen, more specimens are wanted to know the variation in that species and to make clear more precisely the relationship between the two species.

Occurrence.—The holotype and two paratypes occurred in the silty sandstone of the Zone of *Mantelliceras japonicum* at loc. Ik 1054 and nearby locality on the River Ikushumbets. Other paratypes were obtained from the northeasterly extension of the same zone in the Suido-no-sawa and the 7th branch of the Kami-ichi-no-sawa. All in the upper part of the Lower Cenomanian of the Ikushumbets Valley, Mikasa area, central Hokkaido.

Maccarthyites aff. *mikasaensis* sp. nov.

(By T. Matsumoto and T. Takahashi)

Plate 12, Fig. 3

Material.—A single specimen, TTC. 510901 found by T. Takahashi from a nodule at loc. Ik 1155p. loose in the Shimo-ichi-no-sawa (also called Torii-zawa), derived from the lower or middle part of the Cenomanian.

Descriptive remarks.—This form is similar in the gross to *Maccarthyites mikasaensis* described above, but is peculiar in its larger size, moderate instead of high rate of whorl expansion, long continued middle-aged characters such as subelliptical whorl-section and weak and narrow ribbing with some ventrolateral projection and much delayed appearance of the sharp headed, strong ribs of the adult stage, as compared with the holotype and paratypes of that species.

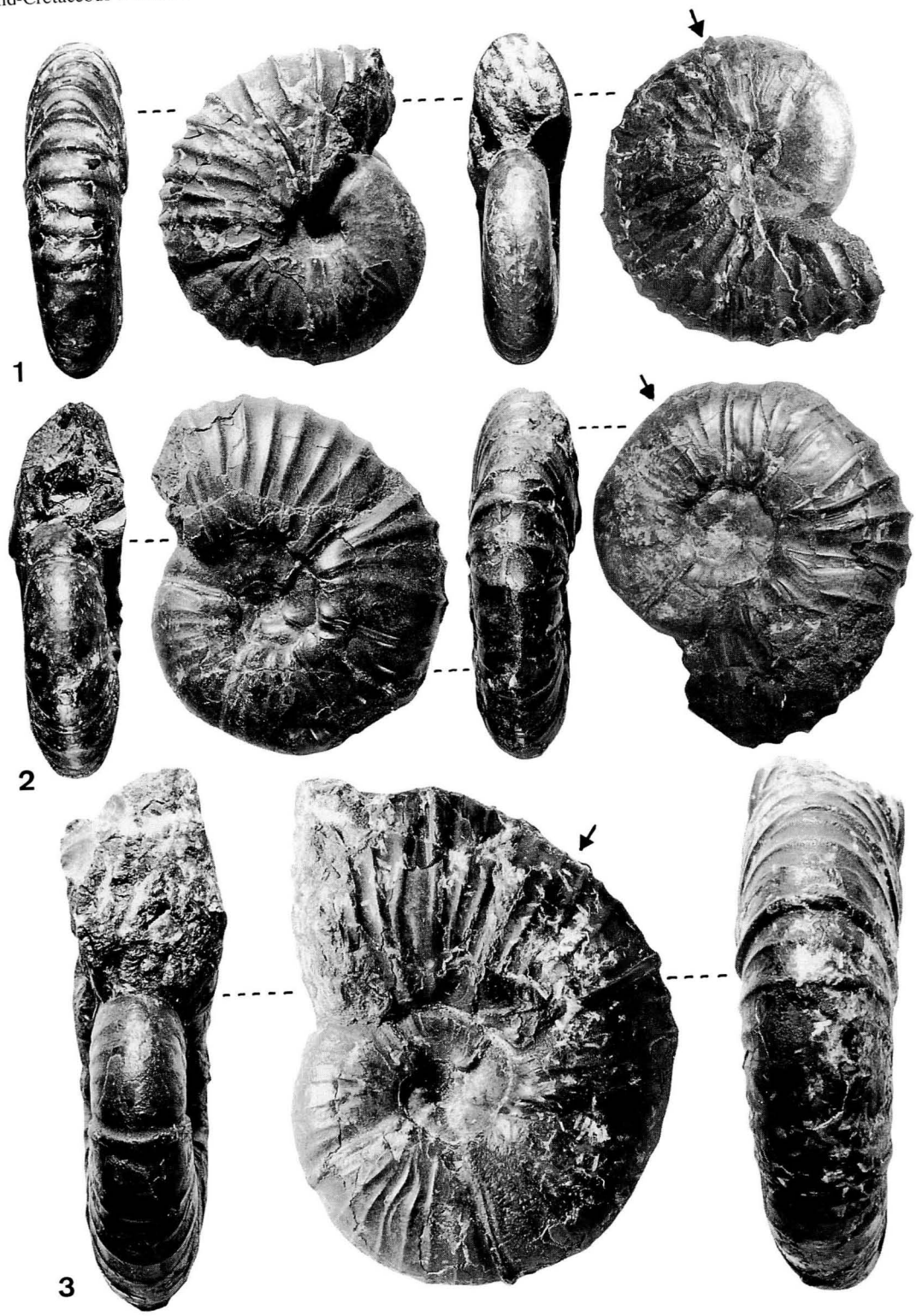
The body-chamber begins at D = 54.5 and the entire shell in restored outline would be slightly over 100 mm in diameter, that is medium-sized. The above features may imply heterochrony (possibly hypermorphosis), if this species was derived from *M. mikasaensis*. As the body-chamber is incomplete, it is difficult to reach a definite conclusion.

Occurrence.—As for *Material*.

Explanation of Plate 12

Figs. 1, 2. *Maccarthyites mikasaensis* Matsumoto, Takahashi & Sanada, sp. nov. ..... Page 55
1: TTC. 510704, paratype (4), × 1.25. 2: GK.H8339, paratype (2), × 1.25.

Fig. 3. *Maccarthyites* aff. *mikasaensis* Matsumoto, Takahashi & Sanada, sp. nov. ..... Page 60
TTC. 510901, × 1.2.



T. Matsumoto, T. Takahashi & K. Sanada: *Maccarthyites*

Genus *Protokossmaticeras* Collignon, 1964

Protokossmaticeras madagascariense Collignon, 1964

(By T. Matsumoto and T. Takahashi)

Plate 13, Figs. 2, 3

1964. *Protokossmaticeras madagascariense* Collignon, p. 19, pl. 321, figs. 1407, 1408.

Material.—The following two specimens were collected by T. Takahashi in the Ikushumbets Valley: (1) TTC. 370427C (Pl. 13, Fig. 2) from the silty fine-grained sandstone, Zone of *Mantelliceras japonicum* in the lower part of Member IIb of the Mikasa Formation at loc. Ik 1100, an abandoned quarry on the right side of the River Ikushumbets; (2) TTC. 510704 (Pl. 13, Fig. 3) from the same Zone on the northeastward extention at a locality on the Migi-no-sawa of the Hachi-no-sawa (= Ganseki-zawa), a branch of the Kami-ichi-no-sawa, a tributary to the River Ikushumbets.

Diagnosis.—Shell small, with moderate involution of whorl, rather high ratio of whorl expansion and fairly narrow or moderately wide umbilicus. Whorl a little broader than high, broadest near the umbilical edge and subrounded in section, with moderately arched venter, somewhat convex flanks, abruptly bent umbilical edge and moderately high, steeply inclined or vertical wall around the umbilicus.

Periodic constrictions well-marked, 5 to 6 per whorl, weakly prorsiradiate and double-collared, with stronger anterior flare.

Umbilical edge ornamented with prominent tubercles, to each of which 2 to 5 ribs are bundled. There are also intercalated or branched ribs, some of which may be long, arising from near the umbilical edge with or without narrow bullae. Ribs nearly rectiradiate, with some convexity at or near the umbilical edge and slightly forward curve on the outer part; narrow but moderately raised on the late part of the phragmocone and the body-chamber.

Suture of generally kossmaticeratid pattern, but for gradually descending auxiliaries.

Measurements.—See Table 12.

Table 12. Measurements of *Protokossmaticeras madagascariense*.

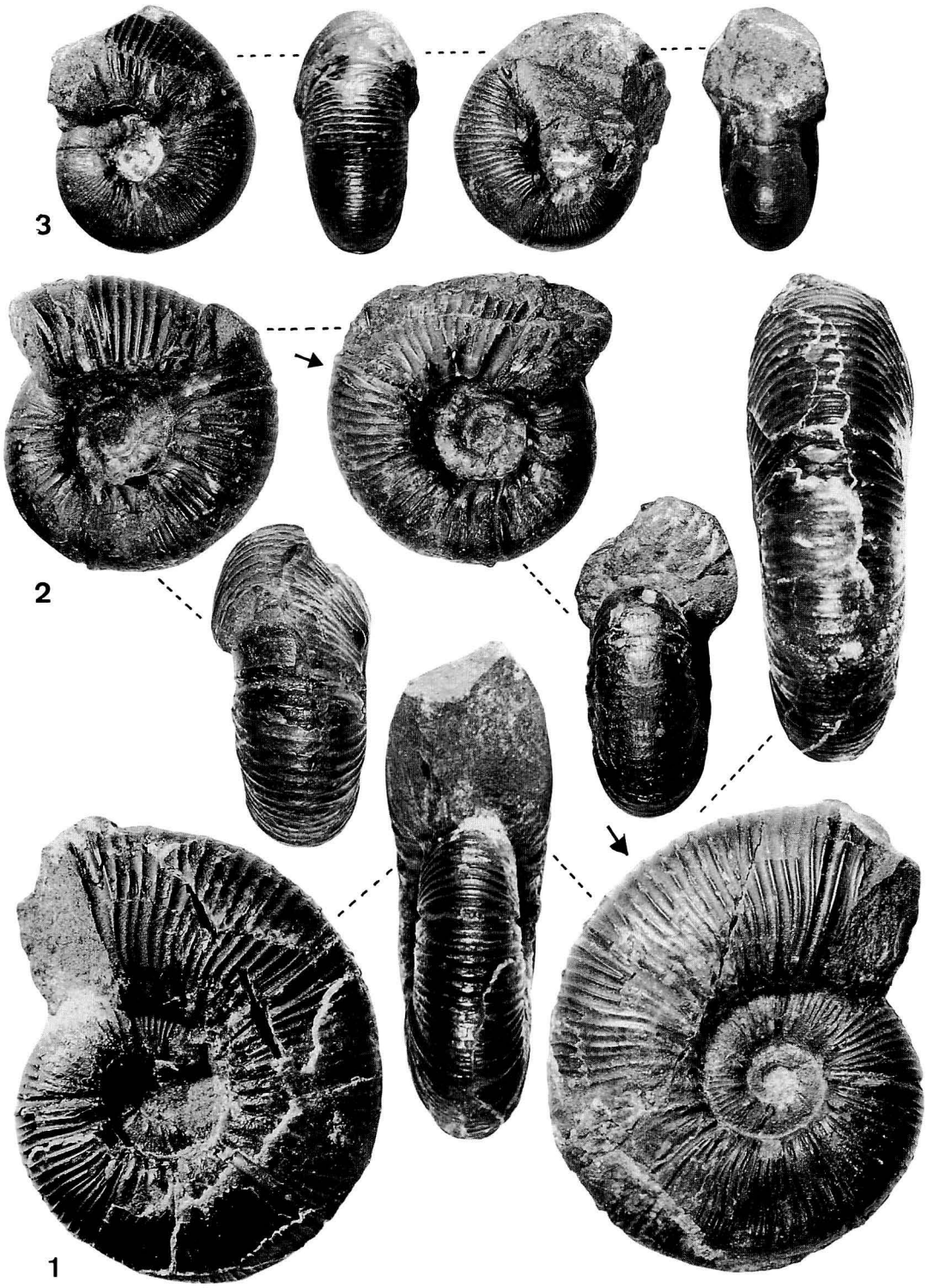
Specimen, position	D	U	H	B*	B/H	H/h	C(60°)
HT, E	13.6 (1)	5.0 (.38)	5.3 (.39)	6.2 (.46)	1.17	1.61	4/16
PT, E	16.5 (1)	5.8 (.35)	6.5 (.39)	7.0 (.42)	1.08	1.55	4/16
TTC. 370427C, E	25.3 (1)	6.8 (.27)	11.9 (.47)	12.9 (.51)	1.08	1.63	3/16
" E – 90°	21.5 (1)	5.6 (.27)	9.8 (.46)	10.5 (.49)	1.07	1.61	4/16
" 510704	35.6 (1)	12.4 (.35)	14.8 (.42)	15.2 (.43)	1.03	1.76	4/12

B* = Whorl breadth measured on the nodeless rib.

Explanation of Plate 13

Fig. 1. *Protokossmaticeras yezoense* Matsumoto & Takahashi, sp. nov. ..... Page 64
TTC. 570523, × 1.25.

Figs. 2, 3. *Protokossmaticeras madagascariense* Collignon ..... Page 62
2: TTC. 510704, hypotype, × 1.25. 3: TTC. 470427C, hypotype, × 1.5.



T. Matsumoto & T. Takahashi: *Protokossmaticeras*

Observation.—Regrettably the dimensions of the holotype recorded by Collignon (1964, p. 19) do not conform with the illustration (*op. cit.*, pl. 321, fig. 1407). Those of the holotype and paratype in Table 12 are based on his photographs.

If this is admitted, our two specimen are generally similar to the types in the ratios U/D, H/D, B/D, B/H and H/h, except for a smaller umbilical ratio of TTC. 370427C, which we regard as a variation.

The ornament of our specimens conforms quite well that of the types described by Collignon as diagnostic of this species.

TTC. 510704, a larger specimen, has the last suture at D = 35.8 mm and the succeeding body-chamber is preserved for about 90° in a squashed condition, giving a secondarily depressed whorl-section. The ribs and tubercles are well-preserved on this body-chamber, showing the construction of ornament essentially similar to that of the septate whorl, with gradually increasing strength of the ribs. Therefore, we regard this specimen as representing the adult shell of *P. madagascariense*. Should the complete body-chamber be assumed as 210° in length, the shell diameter in restored outline would be about 60 mm.

In our specimens a smooth space exists in front of the anterior flare of the constriction, where very fine striae show a backward semi-sinus on the umbilical wall, a convex curve at about the umbilical edge, a very gentle flexure on the flank and a broadly forward convex curve on the venter. As the holotype is very small and its photograph is dark, we cannot ascertain this feature in that specimen. Collignon mentioned nothing about the trace of apertural margin.

The suture was not illustrated by Collignon. It is exposed here and there in our specimen, although no complete suture can be traced at one point. The elements descend gradually from mid-flank to the umbilical seam, as Collignon described in his text.

Comparison.—*Ammonites moraviatoorensis* Stoliczka (1865, p. 158, pl. 77, fig. 4, 4a, 4b), the illustrated specimen of which is designated here as the **lectotype**, from the Lower Ootatoor (= Utature or Uttattur) Formation (Upper Albian) of South India, is probably another species of *Protokossmaticeras*, because of its characteristic ornament on the rounded whorls and pattern of suture (see the fine illustration in Kossmat, 1897, pl. 6, fig. 4). It differs from *P. madagascariense* by its somewhat larger shell with wider umbilicus and more evolute and somewhat compressed whorl (see Table 13).

It is also noted that the septate part of this species resembles that of a certain species of *Holcodiscoides* (see the description of *H. aquarius*).

Occurrence.—This species was obtained rarely from the upper part of the Lower Cenomanian in the Ikushumbets Valley, central Hokkaido. The type locality is in the Lower Cenomanian Zone of "*Mantelliceras martimpreyi*" in Madagascar.

Protokossmaticeras yezoense sp. nov.

(By T. Matsumoto and T. Takahashi)

Plate 13, Fig. 1

Material.—Holotype: TTC. 570523 (Pl. 13, Fig. 1), a fairly well preserved specimen collected by T. Takahashi from the bed of silty sandstone with *Calycoceras (Newboldiceras) asiaticum* (Jimbo) in the Mikasa Formation on the western wing of the Ikushumbets

anticline at a locality in the upper reaches of the Takambets (Takanbetsu), a tributary to the River Ikushumbets.

Diagnosis.—Shell medium-sized. Whorl expands with a moderate ratio, overlapping slightly more than one third of the next inner one. Umbilicus of moderate width. The outer whorl somewhat higher than broad, broadest at about mid-height, subelliptical in section, with moderately rounded venter, gently convex flanks, abruptly bent umbilical edge and low but nearly vertical umbilical wall. The next inner whorl nearly as high as broad, with rather narrowly rounded venter and very gently convex flanks.

Periodic constrictions well-marked, 5 to 6 per whorl, double-collared and weakly prorsiradiate with a slight ventral projection, intersecting a few ribs behind.

On the body-chamber and the preceding full one whorl of the phragmocone ribs are narrow but moderately raised and separated by interspaces slightly or somewhat wider than the ribs themselves, numbering 15 to 18 in the interval of 60° (i.e. the main part of the interspace between two periodic constrictions). The ribs are bundled in twos or threes (or occasionally fours) at the bullate umbilical tubercles; some of which may form rounded nodes of moderate intensity in the middle growth-stage. A few single but nodeless ribs may be intercalated between bundled ones; also a few short ribs may be occasionally intercalated on the outer part. Thus the ribs on the ventral part are generally three times as numerous as the umbilical tubercles. On the younger whorl for about 240° the ribs are weaker and the bullae occur at wider intervals, say at each 30° or so.

The ribs are nearly rectiradiate on the young part; later they show an asymmetrically convex curve on the inner flank and recurve to become nearly rectiradiate or sometimes slightly concave on the outer flank, crossing the venter almost vertically. Trace of parabola not clearly marked, but a fine rib in front of the adoral collar of constriction may show an inner lateral gentle convex curve which extends inward to the umbilical semisinus and outward to a weakly concave curve on the ventrolateral part and then to a slight projection on the venter, being as a whole gently sigmoidal.

Partly exposed suture well ramified.

Measurements.—See Table 13.

Table 13. Measurements of *Protokossmaticeras yezoense* (above line) and *P. moraviatoorense* (below).

Specimen, position	D	U	H	B	B/H	H/h	C(60°)
HT, E(LS + 60°)	55.5 (1)	17.6 (.32)	22.8 (.41)	20.0 (.36)	0.88	1.50	5/16
" E − 150°	41.8 (1)	12.8 (.31)	17.6 (.42)	15.4 (.37)	0.88	1.54	6/18
" E − 330°	—	8.2	11.6	11.6	1.00	—	5/16
LT, E	53.0 (1)	23.0 (.43)	17.0 (.32)	15.0 (.28)	0.88	1.30	—

Observation.—In the holotype the body-chamber begins at D = 50 mm and only its posterior part is preserved for about 60°. On the assumption that the complete body-chamber should be at least 210°, the original shell diameter would be about 80 mm, that is within the range (75−125 mm) of moderate size in my definition.

The change from the younger weak ornament to the middle aged one of moderate intensity occurs rather abruptly at H = 8 mm or so. We do not know the ornament of the

lost main part of the body-chamber, but the change of the ornament from the late part of the septate whorl to the posterior part of the body-chamber is gradual, with increasing strength of ribs, and bifurcation from the bullate umbilical tubercles occurs more frequently than trifurcation; there are also narrowly bullate single long ribs.

Comparison and discussion.—This species resembles *Marshallites hendersoni* sp. nov. (this paper, p. 30, Pl. 3, Figs. 4, 5) in the degree of involution, width of umbilicus, ratio of B/H, running course of constrictions, that of ribs and the pattern of suture. The former has somewhat coarser and more clearly raised ribs, stronger umbilical tubercles and better marked constrictions with stronger flares; also the flanks of its outer whorl are gently convex and not so flattened as in the latter.

The holotype of this species is fairly similar to the lectotype of *Protokossmaticeras moraviatoorensis* (Stoliczka) mentioned above, but the former is more involute, with higher ratio of whorl expansion, and less widely umbilicate than the latter. Although the suture of the former is incompletely exposed, it shows a narrower stem of L and more ramified elements than that of the latter.

This species looks similar to *Protokossmaticeras madagascariense* Collignon (described above) in the construction of ornament, but the latter has more rounded and somewhat broader whorls on which umbilical nodes are stronger. The suture of the former seems to be more finely and deeply incised than that of the latter. On account of this character this species is only tentatively assigned to *Protokossmaticeras*.

Some similarity to *Maorites seymourianus* (Kilian et Reboul, 1909) (emended by Macellari, 1986, p. 35) from the Upper Campanian of the Southern Hemisphere is a homoeomorphy. That species has generally larger shell, more compressed whorl and much stronger nodes.

Occurrence.—As for *Material*.

Genus *Holcodiscoides* Spath, 1922

Holcodiscoides aquarius sp. nov.

(By T. Matsumoto and T. Takahashi)

Plate 14, Figs. 1–4

Material.—Holotype: TTC. 380524 (Pl. 14, Fig. 1), collected by T. Takahashi from Member IIb of the Mikasa Formation, in the Suido-no-sawa, a branch of the River Ikushumbets. Paratypes (1): TTC. 370717 (Pl. 14, Fig. 4) from the Mikasa Formation of the Onko-no-sawa, an eastern branch of the River Pombets (= Ponbetsu), which itself is a

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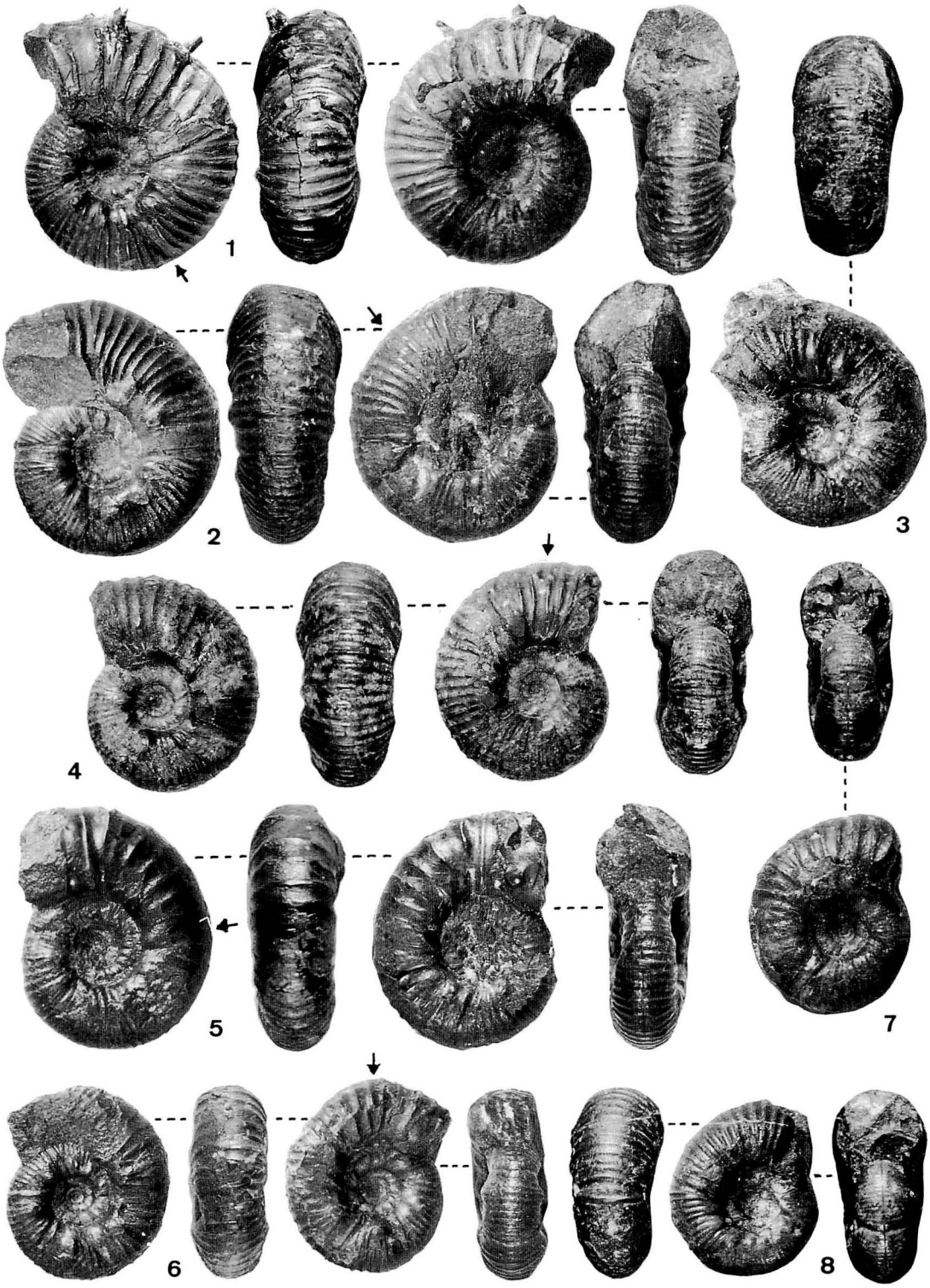
Explanation of Plate 14

Figs. 1–4. *Holcodiscoides aquarius* Matsumoto & Takahashi, sp. nov. ..... Page 66
1: TTC. 380524, holotype, × 1.25. 2: TTC. 370427D, paratype (2), × 1.5. 3: TTC. 370427E, paratype (3), × 2. 4: TTC. 370717, paratype (1), × 1.25.

Figs. 5–8. *Holcodiscoides pusillus* Matsumoto & Takahashi, sp. nov. ..... Page 69
5: TTC. 370427F, holotype, × 1.5. 6: TTC. 400513, paratype (1), × 1.25. 7: TTC. 370427G, paratype (2), septate, × 1.5. 8: TTC. 370427H, paratype (3), septate, × 1.75.



T. Matsumoto & T. Takahashi: *Holcodiscoides*

tributary to the River Ikushumbets; (2): TTC. 370427D (Pl. 14, Fig. 2) and (3): TTC. 370427E (Pl. 14, Fig. 3), both from the lower part of Member IIb, Mikasa Formation at loc. Ik 1100, Zone of *Mantelliceras japonicum* (all three collected by T. Takahashi).

Etymology.—From the type locality Suido-no-sawa, which supplies water (i.e. *aqua*) locally.

Diagnosis.—Shell small; ratio of whorl expansion, degree of involution and width of umbilicus all moderate. Septate whorl subcircular in cross-section, somewhat broader than high, with moderately arched venter, convex flanks, subrounded umbilical edge and the maximum breadth slightly outside that edge. Body-chamber subtrapezoidal in section, showing a tendency to have broadly arched or flat venter, subrounded ventrolateral shoulder, less convex flanks and subangular umbilical edge. It is slightly broader than high, with the maximum breadth nearly at the umbilical edge.

Constrictions well-marked, normally 4 per whorl and prorsiradiate, cutting several ribs behind. Raised single rib (flare) in front of the constriction may be bullate on the umbilical wall and edge. A flat space in front of that flare may preserve the trace of inner lateral parabola and umbilical sinus.

Ribs on the septate whorl numerous, fine and fairly dense, three or four bundled at each relatively coarse node at the umbilical edge; also a few nodeless long ribs may be intercalated between the bundled ones but no branching on the flank. Some of them nearly rectiradiate, others convex on the inner flank and all cross the venter nearly at right angles to the siphonal line, except for the periodic flares which are prorsiradiate on the flank and gently projected on the venter.

In the middle to mature stages, i.e. on the last part of the phragmocone and the body-chamber, the ribs coarsen gradually to those of moderate intensity and the umbilical nodes on the body-chamber tend to be narrowed so that the ribs bundled in the preceding stage change to be bifurcated from the umbilical bulla or even singly bullate, whereas new nodes appear on the ventrolateral shoulders at each third or fourth rib. At these nodes the rib may branch or looped or doubled on the venter. The node itself forms a septate base of an extended spine, which in favourable conditions may be preserved. Some of the coarse nodes at the umbilical edge of the middle stage also seem to form the base of spinose tubercles, although the spines are not preserved.

Suture similar to that of *Protokossmaticeras moraviatoorense*.

Measurements.—See Table 14.

Table 14. Measurements of *Holcodiscoides aquarius*.

Specimen, position	D	U	H	B	B/H	H/h	C(90°)
HT, LS + 160°	31.5 (1)	10.4 (.33)	12.7 (.40)	14.6 (.46)	1.15	1.32	9/18
" LS + 20°	24.8 (1)	8.2 (.33)	9.6 (.39)	12.0 (.48)	1.25		
PT1, LS + 10°	28.2 (1)	9.2 (.33)	10.6 (.38)	13.2 (.47)	1.25	1.33	7/16
PT2, LS + 15°	26.6 (1)	8.8 (.33)	10.0 (.38)	12.3 (.46)	1.23	1.35	7/17
PT3, young	17.6 (1)	5.4 (.31)	6.7 (.38)	8.6 (.49)	1.28	1.31	6/15

Observation.—The body-chamber is preserved for about 180° in the holotype. On the assumption that it was originally 240°, the entire shell diameter would have been 37.5 mm.

The paratype (1) is mainly middle aged and only the beginning of the body-chamber is preserved at its end. The ventrolateral tubercles begin to appear on the last part of the septate whorl. The sutures are well observable in this specimen. The paratype (2) is also a middle-aged example and preserves a fraction of the body-chamber where ventrolateral nodes begin to appear.

The paratype (3) is a small young shell but exhibits well the exposed part of the inner whorl down to the protoconch.

Comparison and discussion.—On the basis of general characters in shell-form, ornamentation and sutural pattern, this species is certainly to be referred to the genus *Holcodiscoides* Spath, 1922. It is distinguished from *H. cliveanus* (Stoliczka) (1865, p. 157, pl. 77, fig. 3), from the Upper Albian (Lower Utatur Group) of South India, by its much smaller shell, more involute and somewhat broader whorl and narrower umbilicus. The ribs in its middle-aged shell are more clearly bundled to much coarser umbilical nodes in this species than in *H. cliveanus*.

The figured specimens of *Ammonites paravati* Stoliczka (1865, p. 158, pl. 77, figs. 5, 6), which can be allocated stratigraphically in the mid-Turonian Zone of *Lewesiceras vaju* of Sastry *et al.* (1968), may be nearly as small as our species, but is more evolute, more widely umbilicate, somewhat more compressed, provided with forward concave ribs and devoid of such prominent umbilical nodes as those in our species. It may be a species of *Yokoyamaoceras*.

Occurrence.—As recorded in *Material*, this species occurs in the silty sandstone of probably shallow sea environment, belonging to the Zone of *Mantelliceras japonicum*, lower part of Member IIb of the Mikasa Formation in the Ikushumbets Valley of the Mikasa area.

Holcodiscoides pusillus sp. nov.

(By T. Matsumoto and T. Takahashi)

Plate 14, Figs. 5–8

Material.—The holotype: TTC. 370427F (Pl. 14, Fig. 5) was found in a calcareous nodule from the silty sandstone at locality Ik 1100, Zone of *Mantelliceras japonicum*, lower part of Member IIb of the Mikasa Formation, in the Ikushumbets Valley. Paratypes (1): TTC. 400513 (Pl. 14, Fig. 6), from another nodule at loc. Ik 1100 in the same bed as the holotype; (2): TTC. 370427G (Pl. 14, Fig. 7) and (3): TTC. 370427H (Pl. 14, Fig. 8) both in the same nodule as the holotype. All collected by T. Takahashi.

Etymology.—The Latin word *pusillus* means very small.

Diagnosis.—Shell small, moderately involute in young stage and rather evolute and fairly widely umbilicate later. Septate whorl subcircular in cross-section, slightly broader than high, with moderately arched venter, convex flanks and subrounded umbilical edge. The body-chamber tends to be subquadrate in section, with less convex flanks and less arched venter between the subrounded ventrolateral shoulders.

Constrictions well-marked, 3 to 5 per whorl, prorsiradiate and oblique to the ribs behind them. The flare in front of the constriction may be bullate around the umbilicus and normally has in front a flat space where a trace of inner lateral parabola and umbilical sinus may be marked.

Mode of ribbing and tuberculation essentially similar to that of *Holcodiscoides aquarius* but slightly coarser and less dense even at corresponding diameters of the immature shell. The ribs in the last part of the septate whorl and the body-chamber are widely separated and moderately strong. They are roughly rectiradiate and the bundled ribs in younger shell change to bifurcated or single ones, whereas the fairly thick umbilical tubercle may persist. The ventrolateral tubercles only begin to appear at about 90° adorally from the beginning of distant ribbing. Rib is doubled between the ventrolateral tubercles.

Suture similar to that of *H. aquarius*.

Measurements.—See Table 15.

Table 15. Measurements of *Holcodiscoides pusillus*.

Specimen, position	D	U	H	B	B/H	H/h	C(90°)
HT, LS + 75°	25.0 (1)	9.0 (.36)	9.3 (.37)	9.3 (.37)	1.00	1.39	6/9
" LS − 15°	21.0 (1)	7.5 (.36)	8.0 (.38)	8.3 (.40)	1.04	1.45	5/10
PT1, LS + 45°	23.8 (1)	8.5 (.36)	—	—	—	—	5/12
" LS	22.0 (1)	7.7 (.35)	8.0 (.36)	9.2 (.42)	1.15	1.38	5/12
PT2, young	18.0 (1)	6.3 (.35)	6.6 (.37)	8.0 (.44)	1.21	1.29	5/10

Observation.—In the holotype the body-chamber is preserved for 75°. Should it be assumed originally 240°, the entire shell diameter would be about 35 mm. The adult type distant ribbing appears when the diameter is only 19 mm.

At nearly the same diameter in the paratype (1) the distant ribbing begin to develop, but the bundling at the umbilical tubercles persists to the last part of the septate whorl.

The paratypes (2) and (3) are smaller than 19 mm and show characters of the immature stages, but the number of ribs on the venter in a given distance is distinctly fewer than that of *H. aquarius* (see Tables 15 and 14).

Comparison and discussion.—This species is allied to *H. aquarius*, for it has similar characters to those of the latter in young shells. In the middle to adult shell the distinction become clearer. The whorl is less depressed, with a smaller ratio B/H, less involute and accordingly slightly more widely umbilicate than that of the latter. The ribs are more widely separated, *viz.* less dense and less numerous, than those of *H. aquarius* (compare Table 15 with Table 14).

The appearance of the adult type ribbing in this species seems to be earlier and more abrupt, as compared with that in *H. aquarius*. In other words, acceleration seems to have worked in giving rise to the characters of *H. pusillus*, whose shell is still smaller than that of *H. aquarius*.

So far as the available material is concerned, there is no gradation between the characters of the two forms. Therefore, they are regarded here as separate species, although they occur in the same bed.

Occurrence.—The four specimens examined occurred in the silty sandstone of the Zone of *Mantelliceras japonicum*, lower part of Member IIb of the Mikasa Formation in the Ikushumbets Valley.

Genus *Eogunnarites* Wright & Matsumoto, 1954

Eogunnarites unicus (Yabe, 1904)

(By T. Matsumoto and T. Takahashi)

Plate 15, Figs. 1–3; Plate 17, Fig. 1; Text-fig. 9

1904. *Olcostephanus unicus* Yabe, p. 28, pl. 4, fig. 5.
1925. *Fagesia unica* (Yabe); Diener, p. 182.
1954. *Eogunnarites unicus* (Yabe); Wright and Matsumoto, p. 126, pl. 8, figs. 2–4, text-figs. 14–20.

Material.—Holotype, UMUT. MM7457 [= GT. I-255] (Pl. 15, Fig. 3), from the coarse-grained sandstone of the Mikasa Formation in the Kami-Takambets (= Kami-Takanbetsu), southeast of Poronai (= Horonai), on the western wing of the Ikushumbets anticline, Ikushumbets Valley.

T. M.'s subsequent collections described by Wright and Matsumoto, 1954 are UMUT. MM6591 [= GT. I-3245a] (Pl. 15, Fig. 2) and MM6590 [= I-3245b] (Pl. 15, Fig. 1) from Member IIb at loc. T608 on the left side of the River Saku; MM6592 [= GT. I-3246] (Text-fig. 9) from the lowest part of Member IIb at loc. T591d on the left side of the River Abeshinai; these three in the Abeshinai-Saku area of the Teshio Mountains.

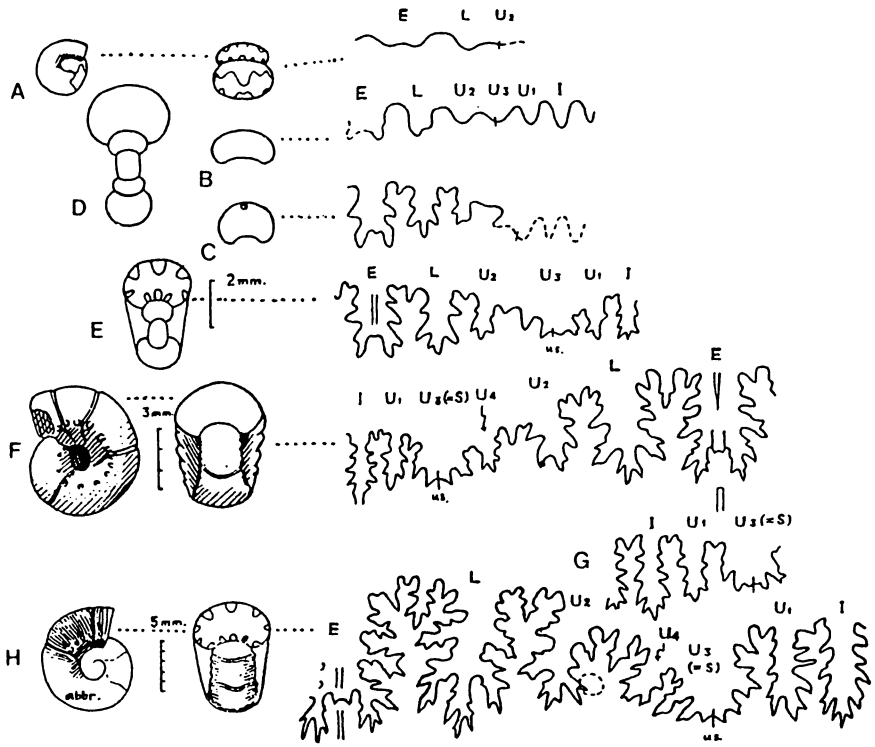


Fig. 9. Ontogenetic development of *Eogunnarites unicus* (Yabe). UMUT. MM 6592 (= GT. I-3246). A: the first whorl with the protoconch, B: the 2nd whorl, C: early part of the 3rd whorl, D: cross-section up to the late 3rd whorl, E: section at diam. = 4.3 mm and suture at diam. = 2.5 mm, F: at diam. = 6.6 mm, G: at diam. = 8 mm. H: at diam. = 11 mm.
(Reproduced from Wright & Matsumoto, 1954, by permission).

TTC. 360700 (Pl. 17, Fig. 1), additional acquisition by T. T. from the Mikasa Formation (western wing) at his Ik 2022p in the Shimo-katsura-zawa, Ikushumbets Valley.

Diagnosis.—Shell small, with deep umbilicus of moderate width. Whorl fairly involute, much broader than high, especially so in younger stages, and coronate to semilunate in section, with broadly rounded venter passing to inflated flank which in turn bends abruptly to steeply inclined wall around the umbilicus, forming subangular edge.

Periodic constrictions normally 4 to 5 per whorl, but may be sometimes irregular in frequency, somewhat prorsiradiate in lateral view and gently convex forward on the venter, intersecting several ribs behind.

Numerous radial ribs cover the venter and the main part of the flank, narrow and sharp-headed on the test, separated by slightly broader interspaces on the test but blunter and denser on the internal mould. They spring in bundles of two to five, forming thick nodes or narrow bullae at the umbilical edge, with further bullate extensions on the umbilical wall. There may be some branching and intercalation on the flank and further outer.

Suture of the kossmaticeratid pattern, being finely and deeply ramified in late growth-stages despite the small shell. The umbilical edge situated immediately inside the somewhat oblique U2.

Measurements.—See Table 16.

Table 16. Measurements of *Eogunnarites unicus*.

Specimen, position	D	U	H	B	B/H	H/h	C(60°)
HT, near E	41.5 (1)	12.2 (.29)	17.4 (.42)	25.4 (.61)	1.46	1.46	6/20
" E − 180°	—	—	10	15	1.5	—	—
" E − 270°	—	—	9.0	13.5	1.5	—	5/20
I-3245a, E	31.5 (1)	9.8 (.31)	12.3 (.39)	16.8 (.58)	1.37	1.31	5/19
" E − 90°(t)	—	—	11.1	17.2	1.55	—	—
" E − 360°(t)	—	—	6.0	10.0	1.67	—	—
I-3245b, E(t)	14.8 (1)	4.9 (.33)	5.4 (.36)	9.8 (.66)	1.81	1.29	4/22
I-3246,	9.3 (1)	3.0 (.32)	3.4 (.37)	6.2 (.67)	1.82	1.17	3/—
TTC. 360700	31.6 (1)	10.4 (.33)	12.7 (.40)	18.6 (.59)	1.46	1.49	4/22

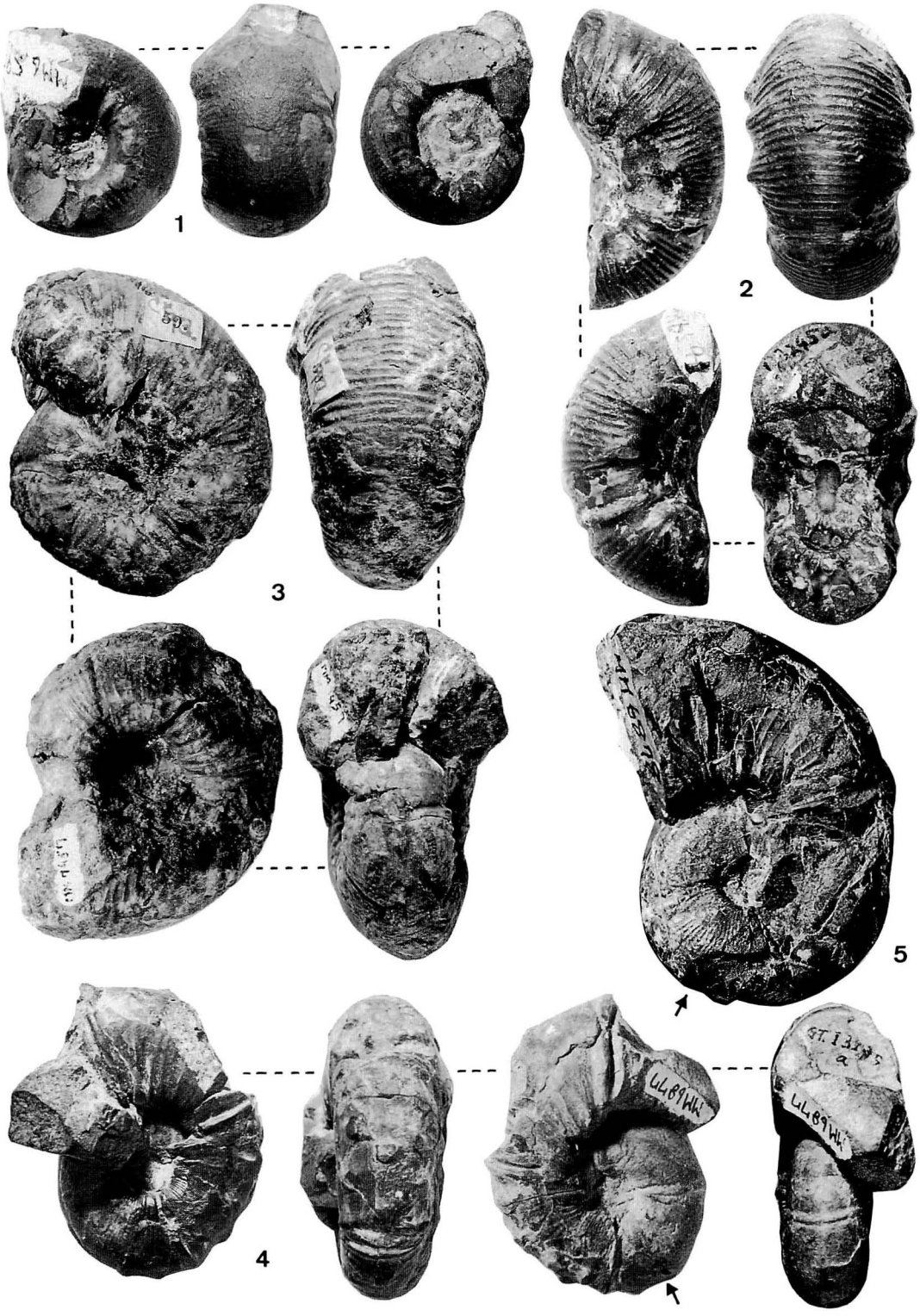
(t): B is measured at the umbilical tubercles.

Observation.—The holotype is secondarily distorted and its measurements are approximate. Yet it does show the depressed whorl with broadly rounded venter and numerous ribs springing in bundles from the umbilical tubercles. This is supplemented by the two specimens, GT. I-3245a and TTC. 360700, both of which are wholly septate, undeformed and probably

Explanation of Plate 15

Figs. 1–3. *Eogunnarites unicus* (Yabe). ..... Page 71
1: MM 6590 (= I-3245b), paratype (juvenile), × 2. 2: MM 6591 (= I-3245a), paratype (middle aged), × 1.5. 3: MM 7457 (= I-255), holotype, × 1.25. (All UMUT (= GT) specimens.)

Figs. 4, 5. *Eomadrasites subnipponicus* Matsumoto. ..... Page 84
4: MM6877 (= I-3235a), holotype, × 1.2. 5: MM6878 (= I-3235b), paratype, × 1.25. (Ditto.)



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T. Matsumoto: *Eomadrasites*

middle-aged. Still younger stages are represented by GT. I-3245b and then GT. I-3246. The last one was studied previously and its ontogenic development was illustrated by Wright and Matsumoto (1954, text-figs. 14–20; reproduced in this paper as Text-fig. 9).

The ratio of B/H changes with growth and shows some variation between individuals.

GK. H1556 from the Zone of *Desmoceras kossmati* (probably the lowest Cenomanian), which was referred to this species (Wright and Matsumoto, 1954, pl. 8, fig. 5) should be regarded as a fragmentary middle-aged whorl of *Sounnaites alaskaensis* (Matsumoto) (see Part III).

Comparison.—The comparisons of this species with other species of *Eogunnarites* and an allied genus are to be given in the respective descriptions.

Occurrence.—This species is found occasionally in the sandy rocks of the Middle Cenomanian in the Ikushumbets Valley and the Abeshinai-Saku area.

Eogunnarites pentagonus sp. nov.

(By T. Matsumoto and T. Takahashi)

Plate 16, Figs. 1–4; Plate 17, Figs. 2–4

Material.—The holotype is TTC. 641008-A (Pl. 16, Fig. 1) collected by T. Takahashi from the 7th branch of the Kami-ichi-no-sawa, which itself is a tributary of the River Ikushumbets, from the *Mantelliceras*-bearing sandstone.

Six paratypes are also T. Takahashi's collection: (1) TTC. 641008-B (Pl. 16, Fig. 2) from the type locality; (2) TTC. 390917 (Pl. 17, Fig. 3) from the Zone of *Mantelliceras japonicum* at loc. Ik 1100, Mamushizawa on the right side of the River Ikushumbets; (3) TTC. 570428 (Pl. 16, Fig. 4) from loc. Ik 1100; (4) TTC. 410724 (Pl. 16, Fig. 3) from loc. Ik 1100; (5) TTC. 390706 (Pl. 17, Fig. 4) from loc. Ik 1100; (6) TTC. 410830 (Pl. 17, Fig. 2) from Suido-no-sawa on the NE extension of the *Mantelliceras* bearing sandstone.

Diagnosis.—Shell small; the degree of involution, ratio of whorl expansion and width of umbilicus all moderate. Whorl normally fairly depressed, with some variation between individuals and growth-stages, and pentagonally subrounded in cross-section, with blunt summit on the mid-venter, sub-angular dorsolateral or umbilical shoulders and steeply sloping, fairly high walls around the umbilicus. The whorl is generally more depressed in young stages than in the adult.

Constrictions well-marked, 3 to 4 per whorl, nearly rectiradiate or slightly prorsiradiate in lateral view, gently projected on the venter and double-collared, with rather narrow but distinctly raised frontal flare, which is bullate around the umbilicus (i.e. on both the umbilical edge and wall).

The whorl of young stage, from diameter of several mm onward, ornamented with

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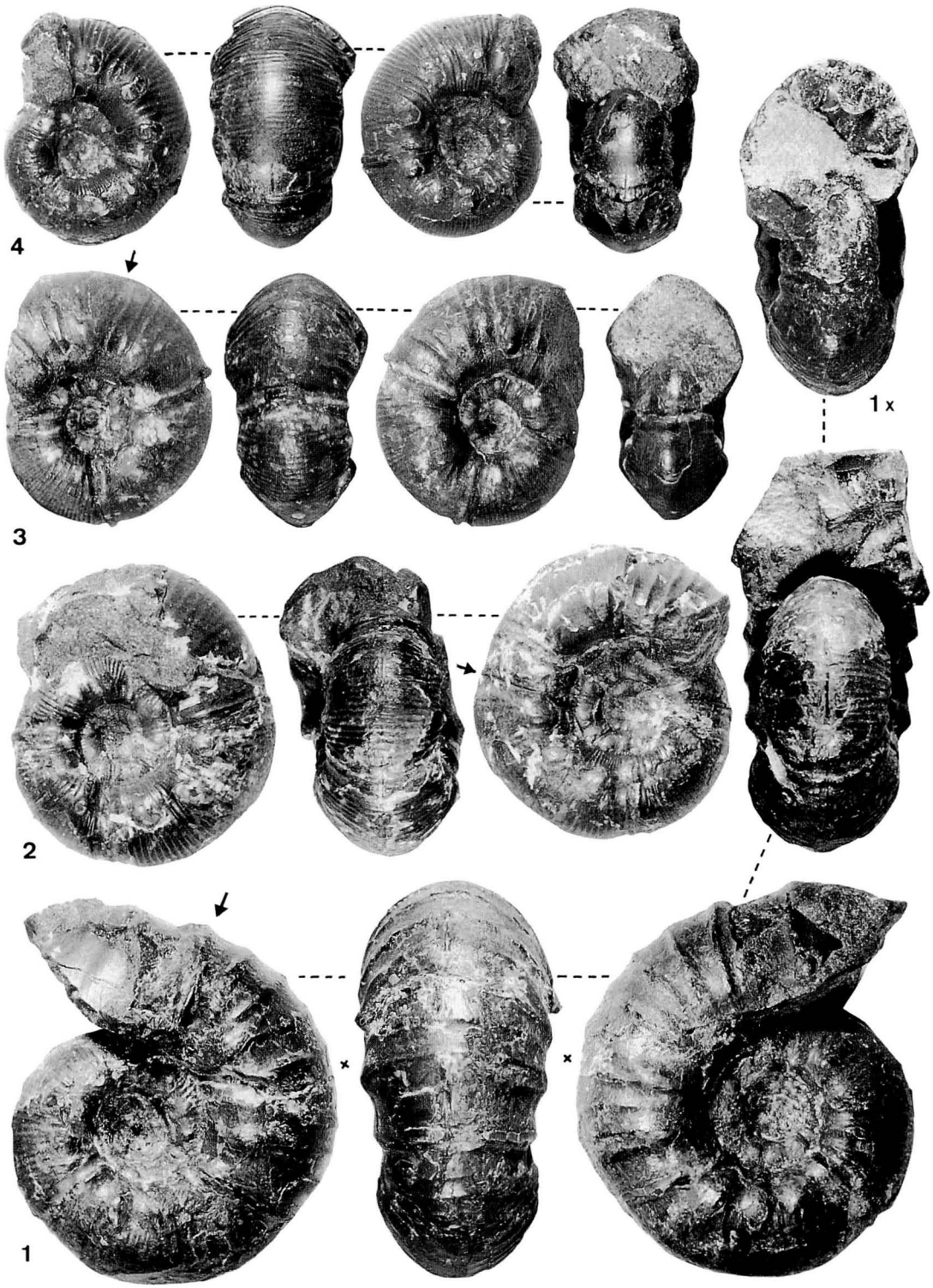
Explanation of Plate 16

Figs. 1–4. *Eogunnarites pentagonus* Matsumoto & Takahashi, sp. nov. ..... Page 74
1: TTC. 64100A, holotype, × 1.21. 1×: Ditto, frontal view of phragmocone cut at × in lateral view, × 1.21. 2: TTC. 64100B, paratype (1), × 1.23. 3: TTC. 410724, paratype (4), × 1.25. 4: TTC. 570428, paratype (3), × 1.24.



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numerous, dense and fine ribs, several of which are bundled at relatively coarse (thick and strong) nodes at the umbilical edge, extending onto the wall down to the umbilical seam; a few intercalated or branched ribs added.

The ribs strengthen slightly and are separated by somewhat wider interspaces for about a quarter-whorl (on the average) of the middle growth-stage, where three of four ribs are bundled at the umbilical nodes and a few may be added by intercalation or branching.

The whorl of the adult stage, i.e. the last part of the phragmocone and the body-chamber, rather suddenly ornamented with distant coarse ribs, which are either bifurcated at the umbilical tubercle or single with or without umbilical bulla.

In the three stages mentioned above the ribs are nearly rectiradiate, crossing the venter at right angles to the siphonal line. Some ribs or flares on the mature whorl may be angulate at the mid-venter and ventrolateral shoulders as well as at the umbilical edge.

Suture of kossmaticeratid pattern and much ramified with deep and fine incisions, showing narrow stems of lateral lobes (L and U2), despite the small size of the shell.

Measurements.—See Table 17.

Table 17. Measurements of *Eogunnarites pentagonus*.

Specimen, position	D	U	H	B	B/H	H/h	C(90°)
HT, LS	47.4 (1)	R 16.0 (.34) L 14.8 (.31)	17.6 (.37) 18.8 (.40)	23.3 (.49)	1.32 1.24	1.33 1.36	4/9
〃 LS − 180°(t)	32.7 (1)	10.4 (.32)	R 13.2 (.40)	19.0 (.58)(t)	1.44	1.45	3/14
〃 LS 270°(t)	—	—	L 13.4 (.41)	18.0 (.55)	1.34	1.50	
PT1, LS (t)	34.0 (1)	11.8 (.35)	11.0	15.8	1.44	—	3/20
PT2, LS	33.8 (1)	10.2 (.30)	12.6 (.37)	18.6 (.55)	1.48	1.36	3/28
PT3, LS (t)	28.2 (1)	9.2 (.33)	13.8 (.41)	18.4 (.54)	1.36	1.41	4/24
PT4, LS (t)	30.7 (1)	9.3 (.30)	11.0 (39)	17.2 (.61)	1.56	1.34	3/28
PT5, LS + 180°	40.5 (1)	14.6 (.36)	12.5 (.41)	18.2 (.59)	1.46	1.40	3/12
〃 LS + 170°	38.0 (1)	14.4 (.38)	13.2 (.33)	17.5 (.43)	1.33	1.36	4/6
〃 LS	29.3 (1)	10.0 (.34)	11.8 (.31)	16.2 (.43)	1.37	—	
PT6, LS + 75°	30.3 (1)	9.6 (.32)	10.6 (.36)	14.4 (.49)	1.36	—	4/15
〃 LS − 75°	23.5 (1)	7.0 (.30)	11.8 (.39)	14.6 (.48)	1.24	1.33	5/12
			9.6 (.41)	12.3 (.52)	1.28	1.39	3 + 2/25

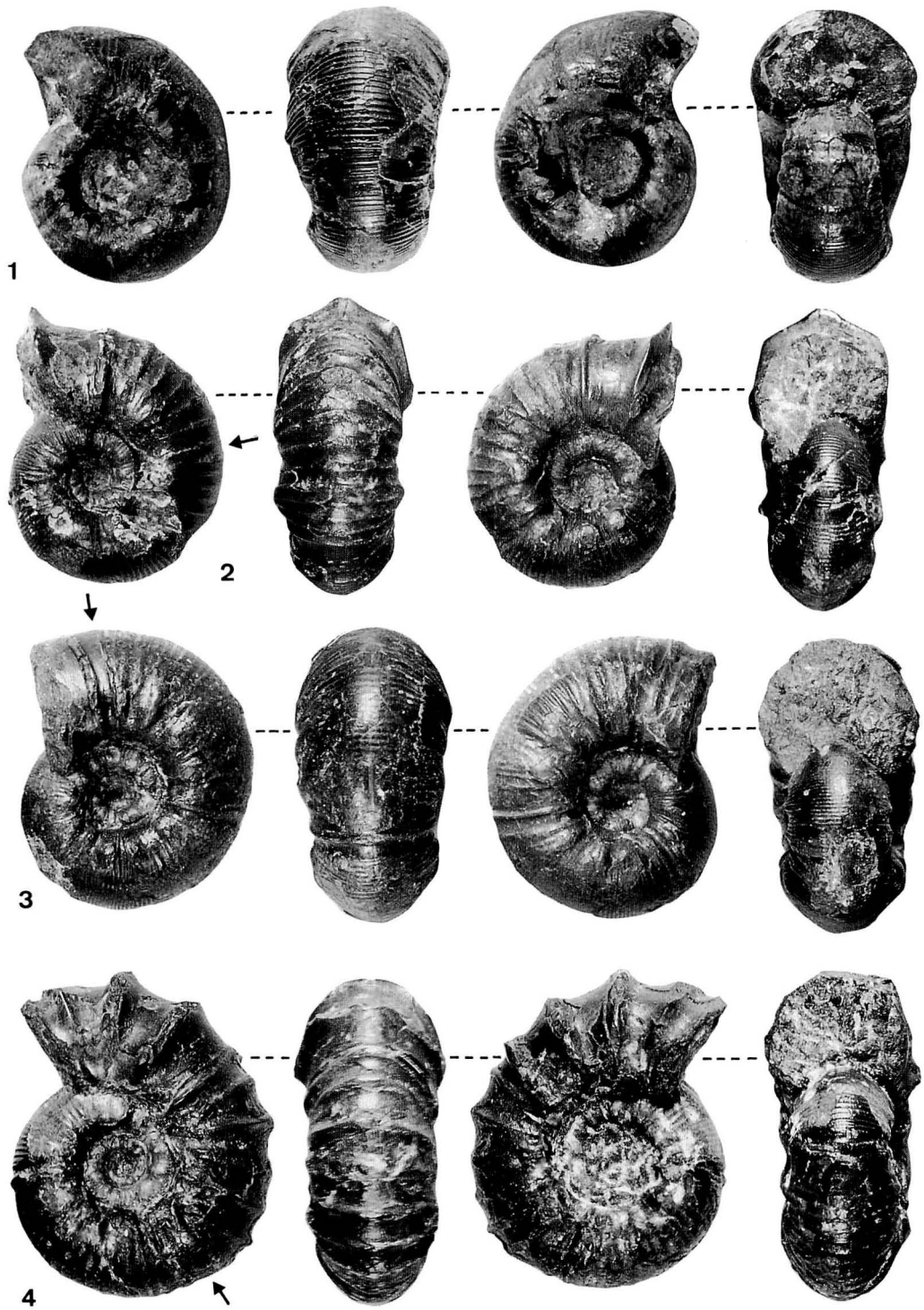
R: right side, L: left side; (t): as for Table 16.

Observation.—The holotype is the largest specimen. Its last suture is at D = 47.4, i.e. about 30° behind the preserved end. Should the body-chamber be assumed to be as long as 210°, the original shell diameter would have been about 80 mm. In this specimen the adult

Explanation of Plate 17

Fig. 1. *Eogunnarites unicus* (Yabe) ..... Page 71
TTC. 360700, hypotype, × 1.25.

Figs. 2–4. *Eogunnarites pentagonus* Matsumoto & Takahashi, sp. nov. ..... Page 74
2: TTC. 410830, paratype (6), × 1.25, 3: TTC. 390917, paratype (2), × 1.25. 4: TTC. 390706, paratype (5), × 1.25.



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type distant ribbing first appears at 150° prior to the beginning of the body-chamber. Some ribs tend to be angulate at the mid-venter as well as at the umbilical edges, but the ventrolateral angulation does not appear in the preserved part.

The paratype (6) is the smallest specimen in our material. Its last suture is at D = 26 mm and it has middle-aged type ribbing of moderate intensity, for a short interval (less than 90°), soon followed by the stage of particularly distant ribbing. Near the preserved end, about 90° adorally from the last suture, there is a sharply flared rib which is angulate distinctly at five points mentioned in the diagnosis. Its whorl is less depressed than in others. It can be regarded as an extreme variety of this species.

Paratype (5) has the last suture at D = 29.3 mm near the end of the middle-aged type ribbing and the preserved 180° of the living chamber has eleven, distant, more or less flared, fairly strong ribs, of which at least six seem to have been angulate more or less distinctly at five points but are now broken here and there. This specimen can be regarded as showing typically the characters of three stages of this species at relatively smaller diameters than in the other five specimens.

Between the holotype and the two smaller specimens mentioned above, there are four paratypes which vary from 28 mm to 34 mm in their diameter at the last suture, showing dissimilar stage of ornamentation and whorl-section (see also B/H and C in Table 17). For instance, the characters of the young type persist to D = 34 mm and then change to those of the middle-aged type in the paratype (1), whereas the former ends at D = 26 mm and the latter occupies the next quarter whorl up to D = 31 mm in the paratype (4). The other two paratypes, (2) and (3), are occupied by ornament of young type to the preserved end, that is nearly the point of the last septum as indicated in Table 17.

The above facts indicate that it is difficult to divide the specimens at our disposal into dimorphic macro- and microconchs. The changes of ornament and whorl shape with growth occur at various shell size. Another point to be noted is that in front of the periodic constrictions and associated flares, there is normally a flat space where fine growth lines or lirae run in parallel to the flare, but occasionally there is a trace of a small projection at the umbilical edge which extends to a kind of backward sinus on the umbilical wall. This occurs in both larger specimens (e.g. paratype 1) and also smaller ones (e.g. paratypes 3 and 4).

Comparison and discussion.—This species is less depressed than *E. unicus* (Yabe), whereas the latter has a broadly rounded venter without a peculiar summit at mid-venter. The umbilical nodes are distinctly coarser and less numerous in the young shell of this species than those of *E. unicus*.

The development of the widely-separated, coarse and strongly-raised ribs with angulations at five points are characteristic of this species.

Occurrence.—All the specimens examined were obtained from the Zone of *Mantelliceras japonicum*, the lower part of Member IIb of the Mikasa Formation in the Ikushumbets Valley (Mikasa area), Lower Cenomanian.

Eogunnarites sanadai sp. nov.

(By T. Matsumoto and T. Takahashi)

Plate 18, Figs. 1–3.

Material.—The holotype is TTC. 391028 (Pl. 18, Fig. 2) collected by T. Takahashi at

loc. Ik 1101 of the Katsura-zawa quarry (now abandoned), right side of the River Ikushumbets; paratypes are (1) GK. H8344 (Pl. 18, Fig. 1) (K. Sanada's collection and donation) from the upper reaches of the Suido-no-sawa, a small branch of the Ikushumbets, and (2) TTC. 370501 (Pl. 18, Fig. 3) collected by T. T. from the same place of the Suido-no-sawa.

Diagnosis.—Shell small, with umbilicus of moderate width. Whorls less depressed than those of the type species, becoming nearly as high as broad in the late growth-stage. Constrictions well-marked, somewhat prorsiradiate and moderately frequent.

Two or three ribs bundled at each of the prominent umbilical tubercles; also a few nodeless ribs may be intercalated. From the last part of phragmocone onward, the ribs gradually coarsen, separated by somewhat wider interspaces, but sharp-headed, gently convex forward or nearly rectiradiate on the flank, crossing the venter almost vertically, except for the somewhat prorsiradiate, periodic flares which may show a slight, ventral projection.

Suture similar to that of the type species.

Measurements.—See Table 18.

Table 18. Measurements of *Eogunnarites sanadai* and *Natalites africanus* (bottom).

Specimen, position	D	U	H	B	B/H	H/h	C(180°)
HT, E	42.2 (1)	14.0 (.39)	17.2 (.41)	17.8 (.42)	1.09	1.51	7/20
〃 E – 150°	29.6 (1)	9.7 (.33)	11.2 (.38)	13.3 (.45)	1.19	1.42	7/19
PT1, E	34.2 (1)	12.4 (.36)	12.7 (.37)	14.7 (.43)	1.16	1.40	7/21
〃 E – 120°	27.4 (1)	8.8 (.32)	10.8 (.39)	12.8 (.47)	1.19	1.38	7/20
〃 E – 110°(t)	–	–	10.2	13.4	1.31	–	–
BM. C19432	82.0 (1)	27.2 (.33)	34.4 (.42)	28.6 (.35)	0.83	1.56	9/27

(t): as for Table 16. BM. C19432 is the holotype of *Natalites natalensis* (Spath, 1922), which is a synonym of *N. africanus* (van Hoepen, 1920).

Observations.—The holotype and paratype (1) are fairly well preserved. The last suture is located at about D = 30 mm in both specimens and the body-chamber is preserved for about 120° in the former and 45° in the latter. Should the complete body-chamber be assumed as long as 240°, the entire shell diameter would be about 50 mm.

The whorl expands at a moderate rate and its involution is also moderate (1/2 of the inner whorl overlapped by the outer). The umbilicus is, therefore, of moderate width (30 to 40% of D) and depth, surrounded by a steeply-inclined to nearly vertical wall of moderate height. The inner whorl is somewhat depressed, whereas the outer one is less so, with B/H decreasing as the whorl grows. The whorl section is subrounded, broadest at the point slightly outside the umbilical tubercles.

The constrictions are well-marked, collared on either side and have a frontal flat space at least on the outer whorl. The collar may be bullate on the umbilical edge and wall and the flat space may have a few fine riblets or lirae which show a gently forward convexity on the venter and another weak bent at the umbilical edge followed by a shallow sinus on the umbilical wall. The inner lateral lappet may be expected on the periodic flat space in the late part of the body-chamber. This cannot be confirmed in the holotype and the paratype

(1), because that part of the body-chamber is not preserved. The tendency to have the lappet-like dorso-lateral projection and ocular sinus is shown on the flat space of the crushed and distorted paratype (2) (Pl. 18, Fig. 3), whose restored D would be about 60 mm.

In each interspace between the constrictions at the middle to late stages, there are normally two, fairly distant and prominent umbilical tubercles, at each of which two or three ribs are bundled; there may be also one or two intercalated ribs which may be long but nodeless. On the inner whorl the umbilical nodes are relatively coarse, where fine ribs are bundled. The distinct ribbing of the late growth-stage is characteristic as described in the diagnosis.

Comparison and discussion.—This species looks similar to "*Natalites natalensis* (Spath)" (1922, p. 134, pl. 5, fig. 3), from the "Senonian" of South Africa and also the Santonian of Madagascar (Collignon, 1966, p. 8, pl. 457, fig. 1867). The distinction is that in *N. natalensis* the constrictions are concave on the flank, showing a marked ventral projection and the peristome seems to follow the curvature of the constriction without dorsolateral lappet. It is striking to see such a similarity between the species of much separated ages.

The immature shell of this species is fairly allied to *Eogunnarites unicus* (Yabe, 1904) (revised in this paper), from the Cenomanian of Hokkaido, in having depressed whorls, slightly oblique constrictions and numerous, fine, nearly radial ribs bundle at umbilical tubercles. Therefore, I refer this species to *Eogunnarites* rather than to chronologically much later *Natalites*, although its adult shell is smaller and has somewhat wider and shallower umbilicus and the ribs become less crowded; also its immature whorls are not so much depressed compared with *E. unicus*. These differences can be regarded as a specific distinction, whereas the similarity to *Natalites natalensis* of much later age is probably a homoeomorphy. Incidentally *Natalites natalensis* (Spath, 1922) has been regarded by Kennedy and Klinger (1985, p. 192) as a synonym of *Natalites africanus* (van Hoepen, 1920).

Occurrence.—The holotype was obtained at loc. Ik 1101 from the Zone of *Mantelliceras japonicum*, the sandstone in the lower part of Member IIb of the Mikasa Formation of the type section, Lower Cenomanian. The paratypes were collected in the upper reaches of the Suido-no-sawa, about 300 m northeast of Ik 1101, probably the lower part of Member IIb.

Genus *Eomadrasites* Matsumoto, 1955

Eomadrasites nipponicus Matsumoto, 1955

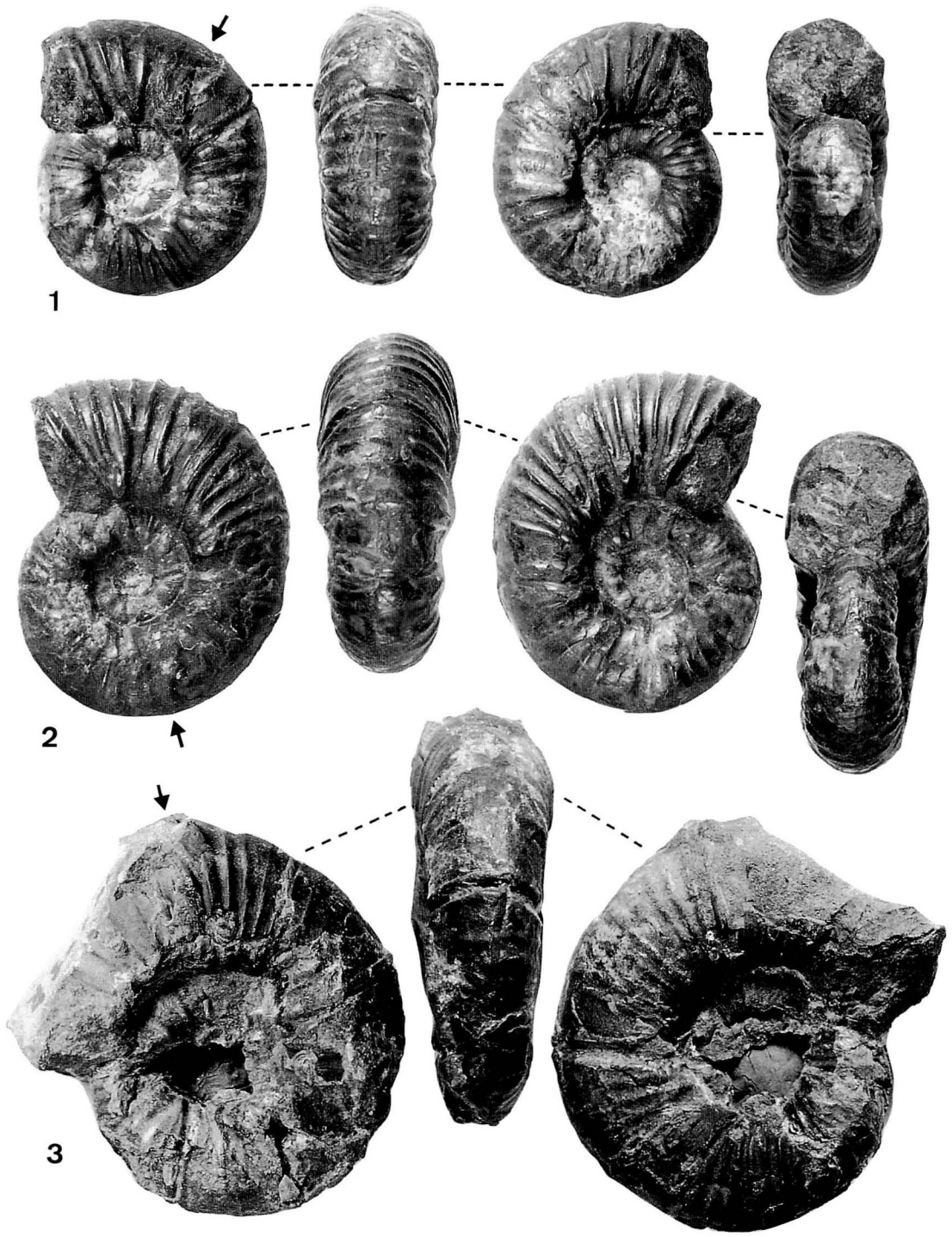
(By T. Matsumoto)

Plate 19, Figs. 2, 3; Text-fig. 10

1955. *Eomadrasites nipponicus* Matsumoto, p. 135, pl. 10, fig. 3; text-fig. 7.

Explanation of Plate 18

Figs. 1–3. *Eogunnarites sanadai* Matsumoto & Takahashi, sp. nov. ..... Page 78
1: GK. H8344 (donation of K. Sanada), paratype (1), × 1.2. 2: TTC. 391028, holotype, × 1.2. 3: TTC. 370501, paratype (2), × 1.2.



T. Matsumoto & T. Takahashi: *Eogunnarites*

Material.—Holotype GK. H1559 (Pl. 19, Fig. 2) found by T. M. in a calcareous nodule loose at loc. T233p in a small stream No. 9 (locally called the Shibunnai-toge-no-sawa) which runs along the fossiliferous beds, i.e. Zone of *Desmoceras japonicum* containing immature shells of *Cunningtoniceras* sp., in the Abeshinai Valley of the Teshio Mountains, northern Hokkaido.

TTC. 420821 (Pl. 19, Fig. 3) subsequently collected by T. Takahashi from the middle part of Member IIb of the Mikasa Formation at loc. Ik 1102 on the River Ikushumbets main stream section.

Diagnosis.—Shell small, considerably involute and fairly narrowly umbilicate, with a moderate ratio of whorl expansion. Whorls somewhat broader than high in young stages, nearly as high as broad in the middle stage and may be higher than broad later. Whorl section subtrigonally subcircular, with bluntly subangular summit on the mid-venter, convex flanks, maximum breadth slightly inside the mid-flank, rounded umbilical shoulder and steeply inclined umbilical wall.

Periodic constrictions fairly frequent, narrow but deep, doubled-collared and somewhat

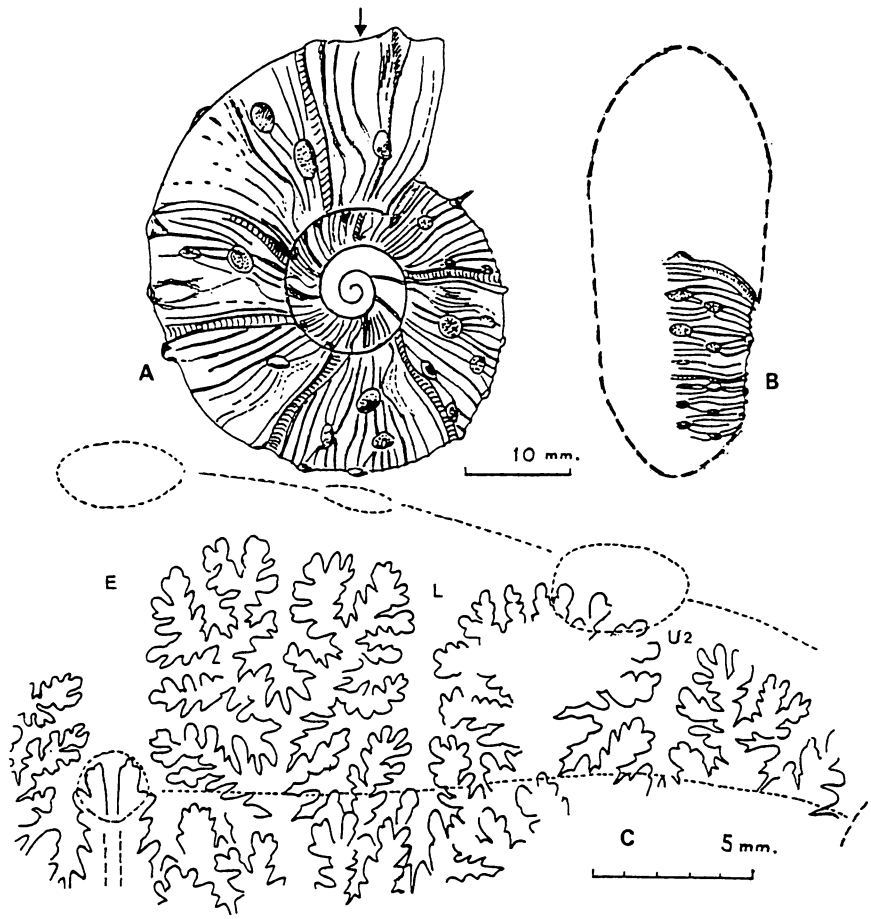


Fig. 10. *Eomadrasites nipponicus* Matsumoto.
A, B: drawing of the holotype with some restoration; C: the last suture at the arrow mark in A. (Adapted from Matsumoto, 1955, fig. 7, with permission.)

prorsiradiate, intersecting several ribs behind at least in young and middle growth-stages. In front of the constriction there may be a nearly flat space which is demarcated adorally by a subangular inner lateral projection, with inward semi-sinus on the umbilical wall and outward gently flexuous extension to a weak ventral projection.

Shell ornamented with numerous fine ribs and spinose tubercles in five rows, i.e. median ventral, ventrolateral and inner lateral. Spines are mostly missing and their rounded septate bases remain. The inner lateral tubercles are small but frequent on the inner whorl, becoming thick and distant, 60° apart on average, on the outer whorl. The ventrolateral tubercles occur at each 30° on average in both on the inner and outer whorls. The siphonal ones are normally as numerous as the ventrolateral and situated somewhat ahead of the latter but occasionally additional smaller ones may appear. Periodic flares have narrowly bullate tubercles at their umbilical end and are situated inside the row of inner lateral nodes. A few ribs may branch there on account of the oblique flare.

Ribs arising from the umbilical seam somewhat prorsiradiate around the umbilicus, some of them looped at the inner lateral nodes and then change to be rectiradiate or even rursiradiate; others run between the inner lateral nodes, with gradual curvature toward rectiradiate direction. Some of the ribs looped at the ventrolateral and/or mid-ventral nodes, giving some irregularity in their course. On the whole ribs cross the venter at right angles to the siphonal line. The ribs and periodic flares gradually coarsen in the adult stage.

Suture of kossmaticeratid pattern, finely and deeply incised with much ramification despite the small shell. L only slightly deeper than E and symmetrically tripartite; its stem and branches very narrow. U2 situated immediately inside the row of inner lateral nodes.

Measurements.—See Table 19.

Table 19. Measurements of *Eomadrasites nipponicus*.

Specimen, position	D	U	H	B	B/H	H/h
HT, E(LS + 15°)	41.2 (1)	10.8 (.26)	18.4 (.45)	16.3 (.40)	0.89	1.53
" " (on node)	41.4 (1)	10.6 (.26)	18.6 (.45)	17.6 (.43)	0.95	1.52
" E − 180°	~25 (1)	6.5 (.26)	11.8 (.47)	12.8 (.51)	1.08	—
TTC. 420821	31.0 (1)	8.2 (.26)	13.5 (.44)	13.2 (.43)	0.98	1.45

Observation.—Previously the holotype was embedded in the rock matrix on its right side (see Matsumoto, 1955, pl. 10, fig. 3), but it is now finely detached as shown in four views in this paper (Pl. 19, Fig. 2). This has improved the description, now supplemented by an immature specimen subsequently acquired (Pl. 19, Fig. 3).

The holotype shows the head of the last suture at D = 40 mm and only a posterior portion of the body-chamber remains. The diameter of the entire shell would be about 75 mm on the assumption that the body-chamber may be at least 210° in length. The characters of the adult body-chamber can only be discovered from further finds. Likewise the extent of variation within this species has yet to be worked out.

Comparison and discussion.—This species looks similar to a relatively less depressed species of *Eogunnarites*, e.g. *E. sanadai* sp. nov. (p. 78, Pl. 18), but is distinguished from the latter by the presence of the ventrolateral and siphonal tubercles, the outward shift of the umbilical tubercles and the persistence of the fine ribs to the outer whorl.

In some forms of *Eogunnarites pentagonus* sp. nov. (p. 74, Pls. 16, 17) the venter is more or less subtrigonal and the siphonal and ventrolateral tubercles or angulations tend to appear only in the late growth-stage. In *Eomadrasites nipponicus* the siphonal and ventrolateral tubercles develop in much earlier growth-stages and fine ribs are looped at these tubercles.

See also the comparison with *E. subnipponicus*, described below.

Occurrence.—Found rarely in sandy siltstone of the Middle Cenomanian of the Saku-Abeshinai area and the Ikushumbets Valley.

Eomadrasites subnipponicus Matsumoto, 1955

(By T. Matsumoto)

Plate 15, Figs. 4, 5

1955. *Eomadrasites subnipponicus* Matsumoto, p. 135, pl. 10, fig. 3; text-fig. 7.

Material.—Holotype, UMUT. MM6877 [= I-3235a] (Pl. 15, Fig. 4) from the uppermost part (mudstone) of Member IIa at loc. T 863 on the left bank of the River Abeshinai in the Teshio Mountains. Paratype, UMUT. MM6878 [= I-3235b] (Pl. 15, Fig. 5) from the same nodule as the holotype, both collected by T. M.

Diagnosis.—Shell small, moderately involute and fairly narrowly umbilicate. Outer whorl nearly as high as broad, subrounded in cross-section in the septate part and subtrapezoid in the body-chamber which has gently convergent flanks and broadly arched venter.

Constrictions well-marked, four per whorl, somewhat prorsiradiate cutting a few ribs behind, double-collared and often accompanied anteriorly with a trace of the inner lateral lappet.

The phragmocone in the middle to late growth-stages ornamented densely with numerous fine subcostae or lirae, with branching and intercalation on the flank. In its last part appears a blunt node at the umbilical edge, where some of the subcostae which arise at the umbilical seam are looped and then branch outward.

The body-chamber, which is preserved for 210° in the holotype and about 230° in the paratype, has on its earlier major part (for about 140°) tubercles in five rows, inner lateral, ventrolateral and mid-ventral. The inner lateral ones are distant, only three on either side, and the ventrolateral and mid-ventral ones are twice as numerous. The tubercles were spinose but the spines are now mostly missing and their septate bases remain, where some of the fine subcostae are looped, giving some irregularity in the disposition of the subcostae which are otherwise nearly rectiradiate on the main part.

On the last part (for about 70° to 90°) of the body-chamber the above mentioned tubercles disappear and the sharply headed narrow ribs are separated on the outer part by somewhat wider interspaces than in the preceding stage. The ribs arise mostly in bundles of two to four from the bullate tubercles at the umbilical border and there may be intercalated shorter ones. They are nearly rectiradiate but sometimes gently flexuous. The flares are prominent at this last stage, showing a ventral projection.

Suture of kossmaticeratid pattern, but less ramified than that of *E. nipponicus*.

Measurements.—See Table 20.

Table 20. Measurements of *Eomadrasites subnipponicus*.

Specimen, position	D	U	H	B (ic)	B/H	H/h
HT, LS + 210°	36.2 (1)	10.2 (.28)	15.2 (.42)	14.2 (.39)	0.93	1.41
" LS − 10°	22.0 (1)	5.4 (.27)	9.9 (.45)	10.6 (.48)	1.07	1.48
PT, E(LS + 230°)	49.0 (1)	13.4 (.27)	21.0 (.43)	≥17.8	≥0.85	(sec. compr.)

Observation.—The holotype is somewhat smaller than the paratype. This does not imply a dimorphism, because the parabola (i.e. trace of lappet) is recognized in young and later growth-stages of both specimens.

The body-chamber is somewhat distorted and I do not regard its clioscaphitoid appearance as original. This should be, however, confirmed by find of better-preserved specimens.

Comparison and discussion.—This species is somewhat similar to *Eomadrasites nipponicus* but distinguished by its more limited development of the five rows of tubercles, finer subcostae and less ramified suture.

The ventrolateral tubercles, which occur in a limited part of the outer whorl, may suggest affinity to *Holcodiscoides cliveanus* (Stoliczka, 1865), but the mid-ventral tubercles are absent in the latter and the ribs arise in bundles of two to several from prominent umbilical tubercles in the young to middle growth-stages in the latter.

Occurrence.—This species occurs so far in somewhat lower part of the Cenomanian than *E. nipponicus*. The associated species is not *Desmoceras* (*Pseudouhligella*) *japonicum* as previously reported but another species of *D.* (*Pseudouhligella*) which should be redefined.

Eomadrasites robustus sp. nov.

(By T. Matsumoto and T. Takahashi)

Plate 19, Fig. 4

Material.—Holotype, TTC. 420821 (Pl. 19, Fig. 4), from the coarse-grained sandstone in the middle part of Member IIb, Mikasa Formation at loc. Ik 1102 on the right side of the River Ikushumbets (Coll. T. Takahashi). This is the sole material available at present.

Diagnosis.—Shell small and rather moderate in the width of umbilicus, degree of involution and rate of whorl expansion. Whorl somewhat broader than high, depressed and subrounded in section with convex flanks at septate stages, but subquadrate in section on the body-chamber with rounded venter and less convex to nearly flat, subparallel flanks. Umbilical edge abruptly bent but subrounded, passing to steeply inclined wall.

Surface of shell ornamented with crowded ribs which are coarser than those of the other two species, arising singly from the umbilical seam, prorsiradiate on the umbilical wall, tuberculate at the umbilical edge, where bifurcation and/or intercalation occur, nearly rectiradiate on the main part of the flank and then curved gently forward on the ventrolateral shoulder.

Numerous siphonal tubercles on the phragmocone were originally spinose but now remain only as the septate bases, where two ribs are looped. On the last part of the septate

whorl ventrolateral tubercles appear and on the main part (for about 120°) of the body-chamber median ventral and ventrolateral tubercles strengthen, where looping of the coarse ribs occurs rather irregularly. In the preserved last part (for about 60°) of the body-chamber ventral tubercles in three rows disappear and the ribs cross the venter uniformly, showing broadly convex curvature. Bifurcation or intercalation may occur on the flank.

The umbilical tubercles bullate and often narrowly raised on the outer whorl but thick and nodose on the inner flank.

Very fine and dense ribs partly discernible on the preserved last portion, which may be a part of the apertural margin.

Partly exposed suture is of kossmaticeratid pattern.

Measurements.—See Table 21.

Table 21. Measurements of *Eomadrasites robustus*.

Specimen, position	D	U	H	B	B/H	H/h	C(60°)
HT, near E	50.0 (1)	15.0 (.30)	20.5 (.41)	22.4 (.45)	1.09	1.41	7/16
" " (on node)	—	—	20.8	24.2	1.16	—	—
" LS(E − 180°)	34.5 (1)	10.5 (.30)	14.5 (.42)	17.5 (.51)	1.21	1.53	5/13

Comparison.—Although the extent of variation is not known, the holotype is diagnostic enough for the distinction from the two species described above. In the presence of the ventrolateral tubercles on a limited part of the body-chamber this species is similar to *E. subnipponicus*, but has coarser ribs and somewhat broader whorls than the latter, showing a robust appearance. Moreover, the siphonal tubercles do not occur on the septate whorl of the latter.

It should be noted that the phragmocone of this species is considerably similar to that of *Mikasaites orbicularis* Matsumoto (see the description below).

Occurrence.—This species occurs rarely in the Middle Cenomanian sandstone of the Ikushumbets Valley.

Genus *Mikasaites* Matsumoto, 1956

Mikasaites orbicularis Matsumoto, 1956

(By T. Matsumoto and T. Takahashi)

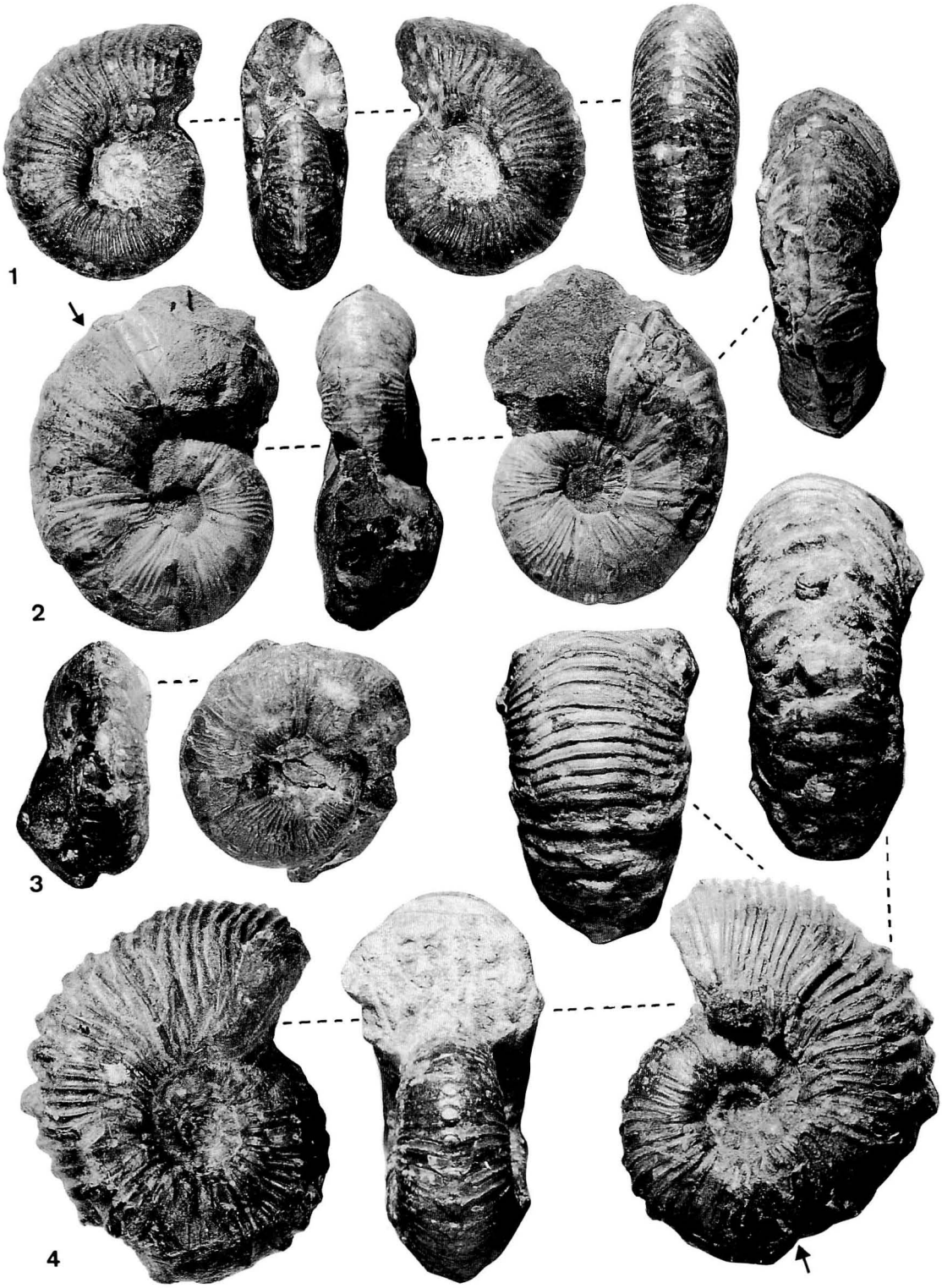
Plate 19, Fig. 1; Plate 20, Figs. 1–4

Explanation of Plate 19

Fig. 1. *Mikasaites orbicularis* Matsumoto ..... Page 86
GK. H5627, hypotype, × 1.25.

Figs. 2, 3. *Eomadrasites nipponicus* Matsumoto ..... Page 80
2: GK. H1559, holotype, × 1.2. 3: TTC. 420821, hypotype, × 1.2

Fig. 4. *Eomadrasites robustus* Matsumoto & Takahashi, sp. nov. ..... Page 85
TTC. 420821, holotype, × 1.2.



T. Matsumoto & T. Takahashi: *Mikasaites, Eomadrasites*

1956. *Mikasaites orbicularis* Matsumoto, p. 175, pl. 16, figs. 1, 2.

Material.—Holotype, GK. H4202 (Pl. 20, Fig. 1) in a calcareous nodule loose at loc. Ik 1065b in the stream Toriizawa (= Shimo-ichi-no-sawa), a tributary to the River Ikushumbets, derived from the silty fine-grained sandstone of the Zone of *Mantelliceras japonicum*, Member IIb of the Mikasa Formation (T. Matsumoto Coll.). Paratype GK. H4203 [= The Muramotos' Coll. No. 1458] in another nodule loose in the same stream derived from the same zone as the holotype.

In the subsequent collections of T. Takahashi TTC. 420516 (Pl. 20, Fig. 4) from the sandstone in the *Cunningtoniceras takahashii* Zone, Member IIb, Mikasa Formation, at a point close to Ik 1051 on the highway under construction (1967), right side of the River Ikushumbets; also TTC. 320600 (Pl. 20, Figs. 2, 3) from the correlative of Member IIb of the same formation on the western wing of the anticline at loc. Ik 1103, Nishi-katsura-zawa of the Ikushumbets River; GK. H5627 (Pl. 19, Fig. 1) (transferred to GK from the Mikasa High School through M. Kikuchi) from the same member on the western wing exposed on the stream Takambets in the Ikushumbets Valley.

An example found by Y. Kawashita from the mudstone of the Zone of *Cunningtoniceras takahashii* exposed at loc. Y5301 of the Kaneobètsu-zawa in the Oyubari area has been already mentioned (Matsumoto *et al.*, 1985). Also GK. H8345, donation of A. Inoma who collected it from the mudstone of the same zone at the eastern end of the Cretaceous outcrop on the Hakkin-zawa of the same area, is referable to this species (*M.* cf. *orbicularis*).

We know more specimens collected from the Mikasa Formation by several persons, but they are now in private possession and are not included in this study.

Diagnosis.—Shell small to medium-sized, fairly narrowly umbilicate and moderate to somewhat high in the rate of whorl-expansion and degree of involution. Whorl in relatively earlier growth-stages depressed and thickly cordate in section, with obtusely subtriangular venter, fairly inflated flanks, maximum breadth at or immediately above the subrounded umbilical edge and moderately high incurved wall. Whorl of more or less later stages somewhat higher than broad and subcordate to subtrapezoid in section, with maximum breadth at slight distance outside the subrounded to subangular umbilical edge, gently convex and weakly convergent flanks and bluntly shouldered venter.

Periodic constrictions four per whorl on an average, somewhat prorsiradiate around the umbilicus and nearly rectiradiate on the main part of the flank, crossing the venter with obtusely subangular projection. In front of the accompanying flare of some constrictions, a line of the past apertural margin may be traced, showing a small but fairly pronounced projection at or slightly outside the umbilical edge with a concave semi-sinus on the umbilical margin, broadly concave sinus on the outer flank and weak projection on the venter.

Surface of the shell ornamented with numerous, crowded and moderately coarse ribs,

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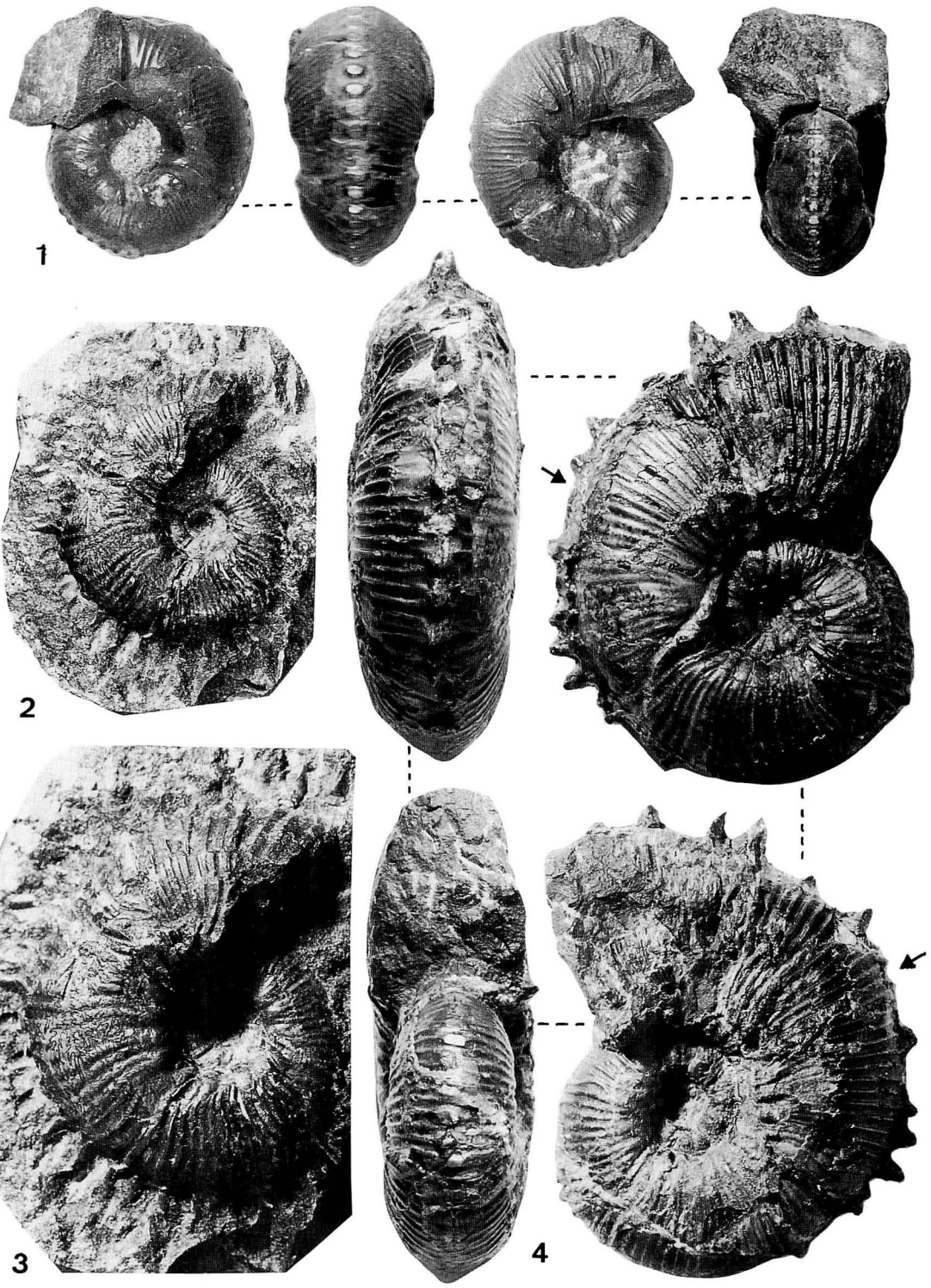
Explanation of Plate 20

Figs. 1–4. *Mikasaites orbicularis* Matsumoto ..... Page 86
1: GK. H4202, holotype (immature), × 1.75. 2: TTC. 320600, hypotype, × 1.2. 3: Ditto, × 1.75. 4: TTC. 420516, hypotype, × 1.



T. Matsumoto & T. Takahashi: *Mikasaites*

arising in bundles of two to five at the umbilical tubercles, which are disposed at wide intervals as thick nodes forming septate bases of spines on the inner whorls and occur more frequently as narrowly bullate tubercles on the outer whorl. There may be also nodeless long ribs intercalated between the distant nodes, with only subangular accent at the umbilical edge. Bifurcation or intercalation of the ribs may occasionally occur somewhere on the flank.

Characteristic of this species almost throughout growth is a siphonal row of prominent spines, whose bases are septate, forming low and somewhat bullate nodes, at each of which two or three ribs are looped.

The ribs run almost radially on the main part of the flank but may be gently flexuous with asymmetrically convex curvature on crossing the umbilical edge and gently forward curve at about the ventrolateral shoulder in some individuals. The flares along the constrictions have narrowly bullate tubercles even on the inner whorls as well as on the outer whorl.

Suture quite similar to that of *Eomadrasites nipponicus* (Text-fig. 10 of this paper), being finely and deeply ramified.

Measurements.—See Table 22.

Table 22. Measurements of *Mikasaites orbicularis*.

Specimen, position	D	U	H	B	B/H	H/h	C(60°)
HT, E – 30°	20.0 (1)	5.2 (.26)	8.7 (.44)	11.2 (.56)	1.29	1.43	3/23
TTC. 420516, E	72.0 (1)	19.6 (.27)	32.4 (.45)	26.0 (.36)	0.80	1.62	7/19
" LS(E – 90°)	60.0 (1)	15.4 (.26)	27.0 (.45)	25.2 (.42)	0.93	1.54	5/15
" LS – 80°	47.0 (1)	12.6 (.27)	21.0 (.45)	22.0 (.47)	1.05	1.57	4/12
" LS – 180°	–	10.0	17.0	19.2	1.13	–	4/12
PT, LS	31.0 (1)	8.2 (.26)	15.1 (.49)	14.5 (.47)	0.96	–	–
TTC. 320600, E	35.0 (1)	8.8 (.25)	15.8 (.45)	14.8 (.42)	0.94	1.45	4/12
GK. H5627, E	33.5 (1)	8.4 (.25)	15.6 (.47)	13.3 (.40)	0.85	1.64	4/11
" E – 180°	–	–	9.5	11.0	1.16	–	–

Observation.—The holotype is very small and certainly immature, because it has the ornament of the inner whorls of other larger specimens.

TTC. 420516 (Pl. 20, Fig. 4) is a fine specimen which shows the change of characters with growth. Its body-chamber was at least 180° + α in length. The original diameter in restored outline was about 115 mm. This is within the range of moderate size in the definition of Matsumoto (1954a, p. 246; also 1988, p. 4).

The paratype (Matsumoto, 1956, pl. 16, fig. 2) is probably mature because of its characteristic ornament, but only 30 mm in diameter at the beginning of the body-chamber. There may be some variation in size or change of size with geological age. Dimorphism is not so far applicable to this species, because the parabola, probably a trace of the lappeted peristome, is discernible in every specimen regardless of the shell size.

The ratio B/H changes with growth (see Table 22), but the stage when the whorl becomes higher than broad seems to vary between individuals. This may be a result of heterochrony but the available material is not sufficient for precise analysis. GK. H5627 (Pl. 19, Fig. 1) is unusually compressed at its small, still wholly septate, end of the specimen, but otherwise it has diagnostic characters of this species. It is included in this

species at least tentatively.

Comparison and discussion.—This species is distinct from any other by its peculiar characters.

Previously (Matsumoto, 1956, p. 176) it was presumed to have been derived from *Eogunnarites unicus* (Yabe). This is not reasonable, because the latter is more depressed and has more numerous and finer ribs as compared with the former at corresponding growth-stages. The two species are nearly contemporary. The specimen (GK. H1556), which was thought to be an older example of *E. unicus* is transferred in this paper (Pl. 27, Fig. 2) to a different taxon.

Eomadrasites robustus sp. nov. (established above) is similar to this species in the gross, but it has additional ventrolateral tubercles on the body-chamber, which is subquadrate instead of high trapezoid in cross-section.

It is recalled that Haas (1958, p. 630) has noticed the homoeomorphic similarity between the immature shell of *Mikasaites orbicularis* and that of the Oxfordian *Taramelliceras* (*Proscaphites*) *globosum* (de Loriol) (Haas, 1955, pl. 15, fig. 15).

Occurrence.—This species occurs not uncommonly in the Lower to Middle Cenomanian (Zone of *Mantelliceras japonicum* and Zone of *Cunningtoniceras takahashii*) of the Ikushumbets (Mikasa) and Oyubari areas, central Hokkaido.

Genus *Wellmanites* Wright, 1957

Wellmanites japonicus sp. nov.

(By T. Matsumoto, T. Takahashi and K. Sanada)

Plate 21, Figs. 1–3

Material.—Holotype: TTC. 370417 (Pl. 21, Fig. 1) found by T. Takahashi from the mudstone at loc. Ik 1039 on the River Ikushumbets. Paratypes: (1) GK. H 8338 (Pl. 21, Fig. 2) collected and donated by K. Sanada; (2) TTC. 370917 (Pl. 21, Fig. 3) collected by T.T., both at the type locality; (3) GK. H8091 from loc. Y5116, Taki-no-sawa, Member IIm of Oyubari area; (4) GK. H8385 from loc. H2431, unit of mudstone below the sandstone of Hobetsu Dam, Hobetsu area, both collected by T.M.

Diagnosis.—Shell rather small to medium-sized. Rate of whorl expansion, degree of involution (about 1/2) and width of umbilicus all moderate. Whorl depressed and broadly rounded in cross-section. Constrictions 4 per whorl, well-marked, double-collared, nearly rectiradiate on the flank and very gently curved forward on the venter. Bar-like flare at the peristome.

Fairly coarse nodes disposed outside the rounded umbilical edge of the phragmocone, forming the bases of spines. The spines of the inner whorl stretching along the umbilical wall of the next whorl. The tubercles of the adult body-chamber in five rows, dorsolateral, ventrolateral and median ventral, with spines extended vertically on the side or curved backward on venter and septate at their nodose base. Surface of shell with fine and dense, radial lirae, without distinct ribs, except for faint radial extensions from the tubercles and weak bullae at the umbilical edge of some periodic flares.

Suture much ramified with deep and fine incisions as in *Eomadrasites nipponicus* Matsumoto.

Measurements.— See Table 23.

Table 23. Measurements of *Wellmanites japonicus*.

Specimen, position	D	U	H	B	B/H	H/h	T(180°)
HT, E (at flare)	56.8 (1)	17.5 (.31)	24.3 (.45)	36.0 (.63)	1.48	1.62	6
" LS	38.5 (1)	13.0 (.34)	15.8 (.41)	21.5 (.56)	1.36	—	6
PT1, LS	44.8 (1)	15.2 (.34)	18.0 (.40)	23.4 (.52)	1.30	1.55	6
PT 3 (inner whorl)	38.0 (1)	12.6 (.33)	17.0 (.45)	22.4 (.59)	1.32	—	5

T(180°): Number of dorsolateral tubercles per half whorl, excluding umbilical bullae of periodic flares.

Observations.—In the holotype the last suture is at D = 38.5 mm and the body-chamber is preserved for nearly 210°. If the bar-like flare is regarded as indicating the position close to the apertural edge, the diameter of the holotype would be slightly less than 60 mm.

Paratype no. 1 is nearly wholly septate and the preserved last portion is the beginning of the body-chamber, where three ventral tubercles begin to be added. The original shell of this specimen must have been somewhat larger than the holotype, probably with D = 75 mm. On the basis of the above observations, the shell is regarded as rather small to medium-sized. Paratype (3) is intermediate in size but deformed partly.

The constrictions are double-collared, i.e. bordered by narrow, rib-like elevations on either side, of which the frontal one and the succeeding fine lirae may show a gently convex curve on the venter. An inner lateral convexity with a semi-sinus at the umbilical margin and a very shallow and broad, outer lateral sinus as well as a gentle ventral convexity are marked in front of the penultimate constriction of paratype no. 1.

T. Takahashi was successful in carefully trimming the holotype, in which finely preserved spinose tubercles are now well shown. They stretch upward and those in the ventral 3 rows curve with their apex pointed backward. On the adoral convex side of a spine a narrow groove runs. These spines may have worked as protection from enemies and also as a kind of anchor to stabilise the shell on the bottom sediments. The function of the groove along the spine is uncertain, but a similar feature is discernible on the spinose or horn-like tubercles of some acanthoceratid ammonites.

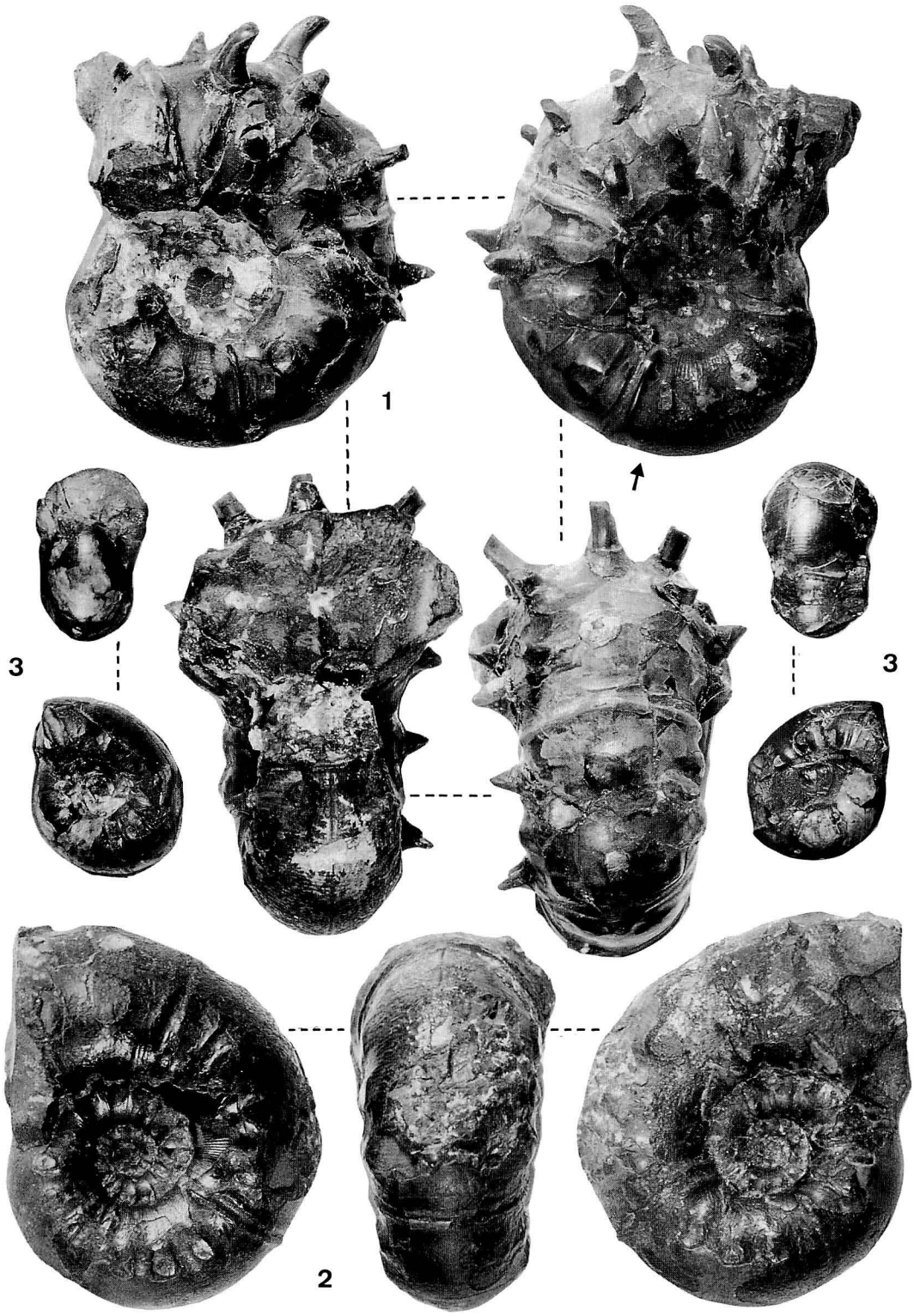
In the middle part of the body-chamber the tubercles are arranged roughly on radial lines, whereas in the posterior and anterior parts they alternate. In either case they are disposed at wide intervals.

The small paratypes (2) (Pl. 21, Fig. 3) and (4) are similar to the holotype and paratypes (1) and (3) in the shell-form and the double collared constrictions. They have a dorsolateral row of spinose tubercles with somewhat bullate bases. Its surface is nearly smooth, with only very fine radial lirae. Certainly they represent juveniles of this species.

Comparison and discussion.—The septate whorl of this species resembles that of *W. zelandicus* in essential points, as mentioned in the remarks on the genus *Wellmanites*. The former has more depressed whorls with a greater ratio of B/H and more inflated flanks

Explanation of Plate 21

Figs. 1–3. *Wellmanites japonicus* Matsumoto, Takahashi & Sanada, sp. nov. ..... Page 91
1: TTC. 370417, holotype, × 1.1. 2: GK. H8338, paratype(1) (donation of K. Sanada), × 1.3. 3: TTC. 370917, paratype(2), × 1.6



T. Matsumoto, T. Takahashi & K. Sanada: *Wellmanites*

as compared with the latter. The constrictions of the former are less flexuous with less distinct ventral projection than those of the latter. The tubercles are situated on the site of L/U1 saddle in *W. japonicus*, whereas they are on the site of L (the first lateral lobe) in *W. zelandicus* as Wright (1957b, p. 808) noticed. These differences are the criteria to distinguish the two species.

The presence of ventrolateral and median ventral spinose tubercles in addition to the supra-umbilical ones on the shell of the body-chamber is characteristic of *W. japonicus*. To make the specific distinction clearer, the body-chamber of *W. zelandicus* is urgently wanted.

With respect to the configuration of the nodes and septate spines upon them, this species is somewhat similar to *Eomadrasites nipponicus*, another Cenomanian species, but the three rows of ventral tubercles as well as the supra-umbilical ones occur much earlier in the septate whorl of the latter species. Furthermore, *E. nipponicus* has less depressed whorls and fine but sharply defined ribs.

In the juvenile stage this species resembles *Eogunnarites unicus* (Yabe), suggesting a close relationship between them, as Wright (1957b) has already mentioned about *W. zelandicus*. At the stage as small as our paratypes (2) and (4) (D = 20 mm or so), fine but sharply defined ribs are developed in *E. unicus*, whereas the surface is nearly smooth with only very fine lirae in *W. japonicus*.

Occurrence.—The holotype and the two paratypes came from the siltstone exposed on the floor of the River Ikushumbets at locality Ik 1039, which is a part of Member IIc of the Mikasa Formation, immediately below the Zone of *Euomphaloceras septemseriatum* and Takahashi found at the same locality Ik 1039 an example of *Eucalycoceras pentagonum* (Jukes-Brown) (see Matsumoto, 1975, p. 106, pl. 11, fig. 1). Ik 1039 is therefore assigned to the lower part of the Upper Cenomanian. The two other paratypes came from a fairly high part of the Upper Cenomanian in The Oyubari and Hobetsu areas.

Explanation of Plate 22

Figs. 1, 2. *Kossmaticeras flexuosum* Matsumoto, sp. nov. ..... Page 96
1: GK. H5216 (K. Tanaka's coll. & donation), paratype, × 1. 2: GK. H8342 (W. Hashimoto's coll. & donation), holotype, × 1.25

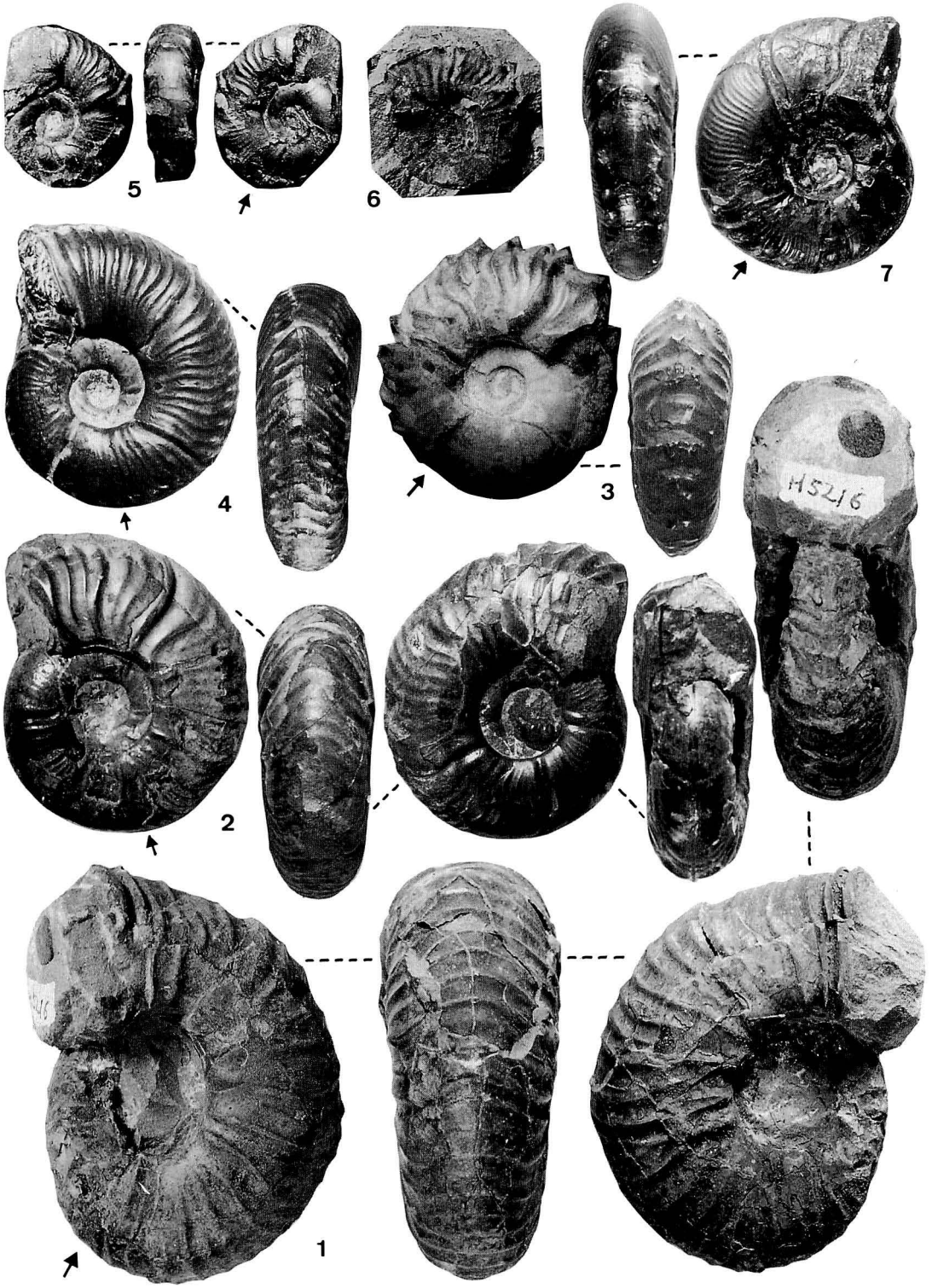
Fig. 3. *Yokoyamaoceras yokoii* Matsumoto, sp. nov. ..... Page 100
TMNH 501 (T. Yokoi's coll. & donation to Toyohashi Museum of Natural History), holotype, × 1.75.

Fig. 4. *Yokoyamaoceras kotoi* (Jimbo) ..... Page 100
UMUT. MM7517 (= GT. I-107), holotype, × 1.25.

Fig. 5. *Yokoyamaoceras minimum* Matsumoto ..... Page 102
GK. H4204 (T. Muramoto's coll. & donation), holotype, × 1.5.

Fig. 6. *Yokoyamaoceras* aff. *yokoii* Matsumoto ..... Page 102
GK. H5217 (K. Tanaka's coll. & donation), × 1.5.

Fig. 7. *Yokoyamaoceras jimboi* Matsumoto ..... Page 100
GK. H5201, paratype, × 1.25.



T. Matsumoto: *Kossmaticeras, Yokoyamaoceras*

Subfamily Kossmaticeratinae Spath, 1922

Genus *Kossmaticeras* de Grossouvre, 1901

Kossmaticeras flexuosum sp. nov.

(By T. Matsumoto)

Plate 22, Figs. 1, 2; Plate 23, Fig. 3

1956. *Kossmaticeras* sp. nov. (?) aff. *Kossmaticeras sparsicostatum* (Kossmat); Matsumoto, pl. 14, fig. 1.

Material.—Holotype: GK. H8342 (Pl. 22, Fig. 2) (W. Hashimoto's collection and donation) from the siltstone above the *Romaniceras* bearing member of sandstone and shale at his loc. 629–8, on the first branch of a stream called the Sodensen-no-sawa, in the upper reaches of the Nutapomanai, which itself runs into the River Hobetsu at Osawa, Hobetsu area, southern central Hokkaido.

Paratypes: (1) GK. H5216 (Pl. 22, Fig. 1) (K. Tanaka's collection and donation), from the siltstone of Member Mm-o, *Inoceramus hobetsensis* Zone of the Middle Yezo Group at his loc. NH9, Takishita of the Obirashibe Valley in the southern part of the Teshio Mountains, northwestern Hokkaido; (2) GK. H8354 (Pl. 23, Fig. 3) (T. Shimanuki's collection and donation), from the mudstone of the Zone of *I. hobetsensis* at loc. R2247 on the River Kami-kinenbetsu of the Obirashibe Valley. The Muramotos' Coll. Ob 0610p from the same zone of nearby locality is probably referable to this species.

Diagnosis.—Shell fairly small and moderately umbilicate, with moderate expansion and involution of whorls.

Whorl slightly broader than high, broadest at some distance dorsad from the mid-height and subcircular in section, with moderately rounded venter, gently convex flanks, subangular umbilical edge and low but nearly vertical umbilical wall.

Periodic constrictions well-marked, 4 to 6 per whorl, flexuous on the flanks and markedly projected on the venter. The associated double flares thick on the body-chamber, somewhat elevated at the umbilical edge, forming bullate tubercles; both roughly parallel to the constriction but the posterior one may be acutely projected on the venter, cutting a few riblets behind.

Ribs of unequal length, showing bifurcation or intercalation, more or less flexuous on

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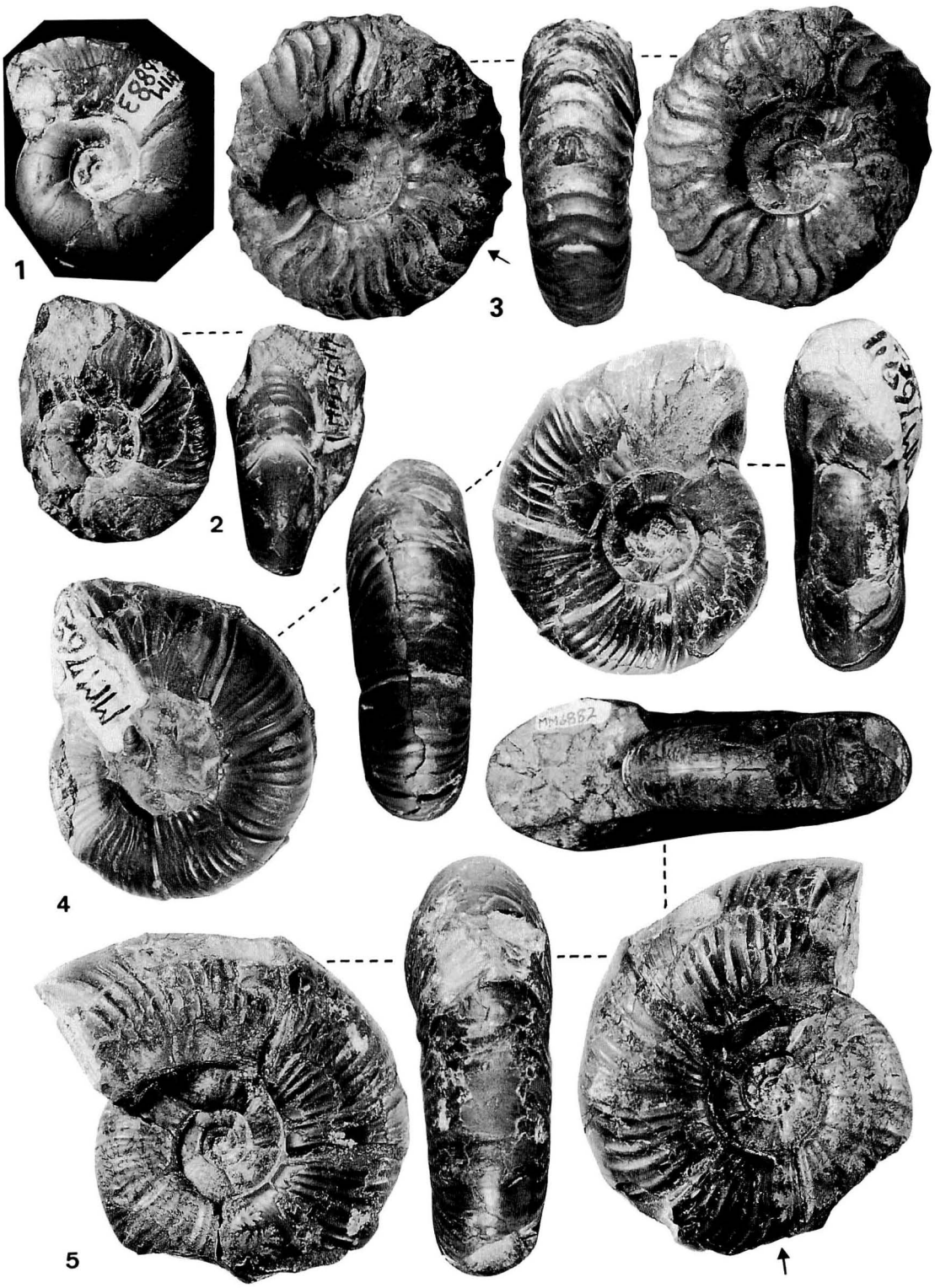
Explanation of Plate 23

Figs. 1, 2. *Yokoyamaoceras jimboi* Matsumoto ..... Page 100
1: UMUT. MM6883 (= GT. Cr. 598c), paratype (juvenile), × 1.75. 2: UMUT. MM7625a (= GT. I-349a), holotype, × 1.2

Fig. 3. *Kossmaticeras flexuosum* Matsumoto, sp. nov. ..... Page 96
GK. H8354 (T. Shimanuki's coll. & donation), paratype, × 1.25.

Figs. 4, 5. *Kossmaticeras japonicum* Matsumoto ..... Page 98
4: UMUT. MM7627 (GT. I-353), holotype, × 1.5. 5: UMUT. MM6882 (GT. Cr. 125), paratype (not illustrated in Matsumoto, 1955), × 1.



T. Matsumoto: *Yokoyamaoceras*, *Kossmaticeras*

the flank and considerably projected on the venter, coarsening on the outer whorl. Some of the long ribs on the whorl of late stage thicken toward the umbilical edge, forming blunt bullae. Ribs on the inner whorl weaker and finer, reaching scarcely the umbilical edge, and with no umbilical bullae, except for those at the end of the periodic flares.

Suture of kossmaticeratid pattern, being less finely ramified than that of *Marshallites*; stems of L not so narrowed as in typical *Marshallites*.

Measurements.—See Table 24.

Table 24. Measurements of *Kossmaticeras flexuosum*.

Specimen, position	D	U	H	B	B/H	H/h	C(90°)
HT, E(LS + 220°)	39.0 (1)	12.8 (.33)	15.0 (.38)	15.8 (.40)	1.05	1.34	6/13
" LS + 90°	32.6 (1)	10.8 (.33)	13.0 (.40)	14.0 (.43)	1.08	1.44	8/17
PT(1), LS + 210°	54.0 (1)	17.4 (.32)	21.0 (.39)	22.5 (.42)	1.07	1.35	6/15
PT(2), LS	36.0 (1)	11.8 (.33)	13.8 (.38)	14.3 (.40)	1.04	1.33	5/10

Observation.—The three specimens all show characters described above. The holotype is small and its body-chamber begins at a smaller diameter than the paratypes. It may not be full grown. The coarse ribs begin to appear at somewhat earlier stage in the paratypes. Such small scale heterochrony is here regarded as intraspecific variation.

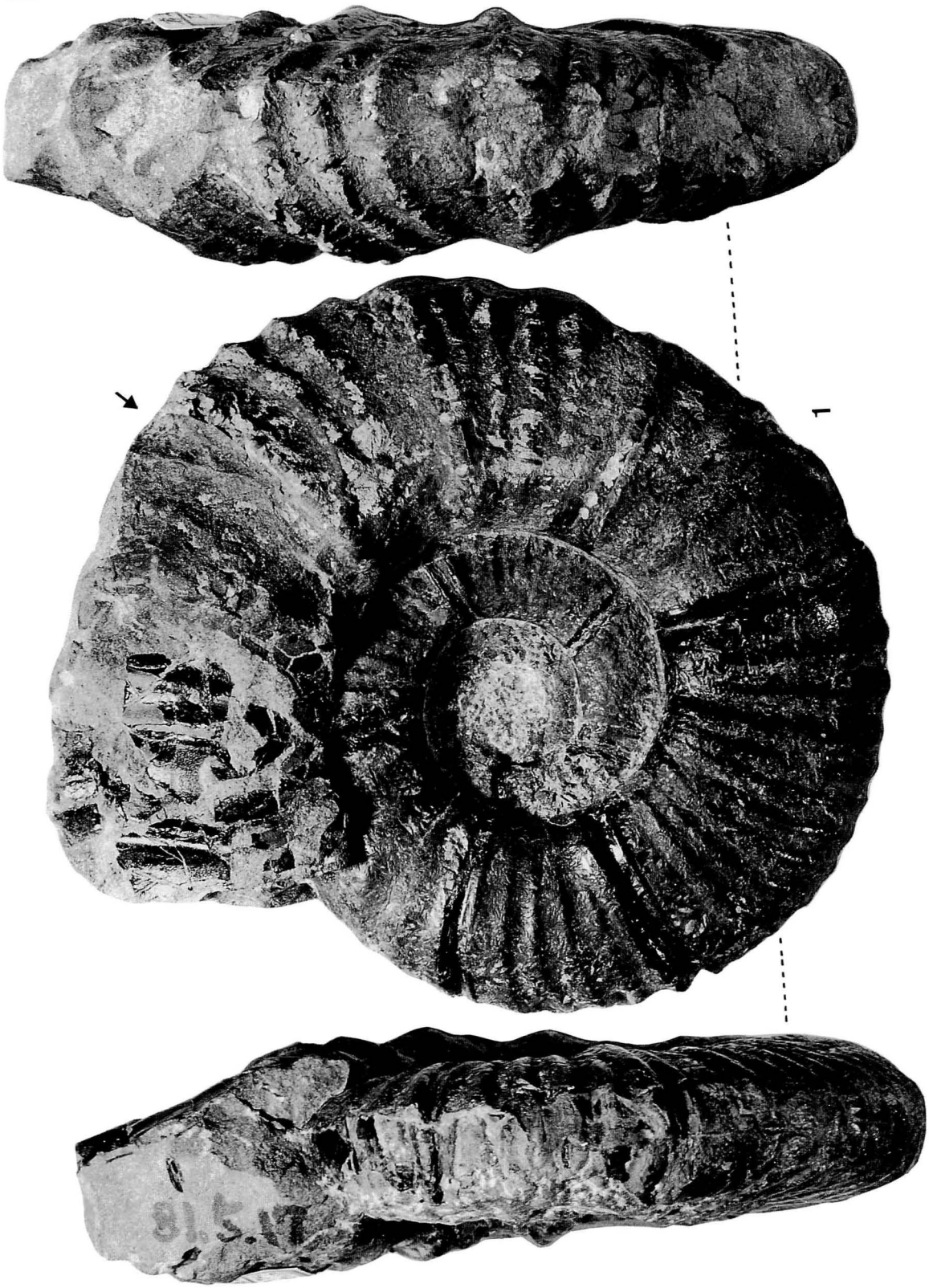
Comparison and discussion.—This species is fairly similar to *Kossmaticeras recurrens* (Kossmat) (1897, p. 37, pl. 7, figs. 2, 3) in shell-form but is distinguished from the latter in its coarser and more flexuous ribs in the late growth-stage. One of the two illustrated specimens of Kossmat (1897, pl. 7, fig. 2) (i.e. *Ammonites theobaldianus* Stoliczka, 1865, pl. 78, fig. 1) is here designated as the **lectotype**. This and other specimens seem to occur in the Coniacian of South India (Kossmat, 1897; Sastry *et al.*, 1968), but Collignon (1955, 1965a) reported the same species from the Upper Turonian of Madagascar.

In *K. recurrens* numerous ribs of uniform density persist from a fairly young stage to the outer whorl, showing regular bifurcation or occasional intercalation on the inner flank. They are generally prorsiradiate, mostly gently concave forward on the flank and projected on the venter. *K. japonicum* Matsumoto (1955, p. 150, pl. 9, fig. 3; also 1956, p. 181, pl. 15, fig. 2) (holotype and paratype illustrated in this paper, Pl. 23, Figs. 4 and 5), from the Coniacian (Zone of *Inoceramus uwajimensis*) of the Ikushumbets Valley, Hokkaido, is fairly similar to *K. recurrens*. In *K. japonicum*, however, ribs are not so clearly dichotomous as in *K. recurrens* and some ribs are gently flexuous, showing a convex curve on the inner flank. Also an occasionally discernible line of demarcation, which may be a trace of the past peristome, is gently sigmoidal, if not so strongly flexuous as in the ribs of *K. flexuosum*.

Explanation of Plate 24

Fig. 1. *Kossmaticeras theobaldianum* (Stoliczka) ..... Page 100
GK. H8355 (K. Sanada's coll. & donation) from loc. Ik 2748, Zone of *Inoceramus uwajimensis*—*Forresteria alluaudi*, Middle Coniacian, Pombets-Gono-sawa, Mikasa, × 1. This form has intercalated ribs more frequently than branching ones, suggesting affinities with *K. flexuosum* and also with a certain species of *Mesopuzosia*. Someone may call it *K. theobaldianum paucicostatum* Matsumoto, which is not a geographical subspecies but merely a morphotype in a variable species *K. theobaldianum*.

Mid-Cretaceous Kossmaticeratid Ammonites



T. Matsumoto: *Kossmaticeras*

It should be noted that more or less flexuous ribs are characteristic of *Yokoyamaoceras kotoi* (Jimbo, 1894) (see Pl. 22, Fig. 4 of this paper) and *Y. jimboi* Matsumoto, 1955 (see Pl. 22, Fig. 7; Pl. 23, Figs. 1, 2). The lines of demarcation which occur intermittently during growth, as well as at the basal part of the lappeted apertural margin in these species of *Yokoyamaoceras* show a pronounced flexuosity on the flank and a prominent projection on the venter. Anyhow, in *Y. kotoi* the whorl is more compressed than in *K. flexuosum* and the ventrolateral tubercles and siphonal chevrons occur in a limited part of the outer whorl. *Y. kotoi* is later than *K. flexuosum*, occurring in the Upper Turonian and Coniacian. If there is dimorphism in some species of *Kossmaticeras*, the macroconch which could form a pair with *Y. kotoi* (microconch) would be *K. japonicum* or *K. recurrens*. In connection with this problem there is a rare but interesting species to be described in the next item.

As to the phylogenetic origin of *K. flexuosum*, the available material of Marshallitinae is insufficient or rather negative. For instance, *Marshallites involutus* from the Middle to Upper Cenomanian of Hokkaido has somewhat flexuous ribs, but its ribs are extremely fine and dense and its whorl is much compressed and highly involute.

Marshallites compressus has also somewhat flexuous ribs. It is less involute and on the average more widely umbilicate than *M. involutus*, but it has more compressed whorls and more numerous and finer ribs than *K. flexuosum*. *M. compressus* occurs commonly in the Middle Cenomanian and *M.* cf. *compressus* was found rarely in the Upper Cenomanian. In the Lower Turonian I have found so far no descendant of *Marshallites* which tends to approach to *K. flexuosum*.

On the other hand it should not be overlooked that the immature shell of this species closely resembles that of *Mesopuzosia pacifica* Matsumoto. This suggests a closer affinity of the genus *Kossmaticeras* (Pl. 24) with *Mesopuzosia* than with any species of *Marshallites*.

Occurrence.—This species has been found rarely in the Zone of *Inoceramus hobetsensis*, middle part of the Turonian in the Hobetsu area of southern central Hokkaido and also in the Obirashibe Valley of northwestern Hokkaido.

Genus *Yokoyamaoceras* Wright & Matsumoto, 1954

Yokoyamaoceras yokoii sp. nov.

(By T. Matsumoto)

Plate 22, Fig. 3; Text-fig. 11

Material.—Holotype, TMNH 501 [= TY 66] (Pl. 22, Fig. 3), collected in situ from the mudstone of Member Mj of Tanaka (1963) exposed on the bank of the Sato-no-sawa close to its confluence with the River Kami-kinembetsu of the Obirashibe Valley in the southern part of the Teshio Mountains, by Takayuki Yokoi, who donated it to the Natural History Museum of Toyohashi. *Inoceramus hobetsensis* Nagao & Matsumoto, among associated fossils, and the stratigraphic position indicate the Middle Turonian.

Diagnosis.—Shell very small, fairly narrowly umbilicate and moderate in the rate of whorl expansion and involution. Outer whorl slightly higher than broad and suboval to subcordate in section, having subtrigonal and shouldered venter, gently convex flanks, maximum breadth slightly dorsad from the mid-height, subangular umbilical edge and low

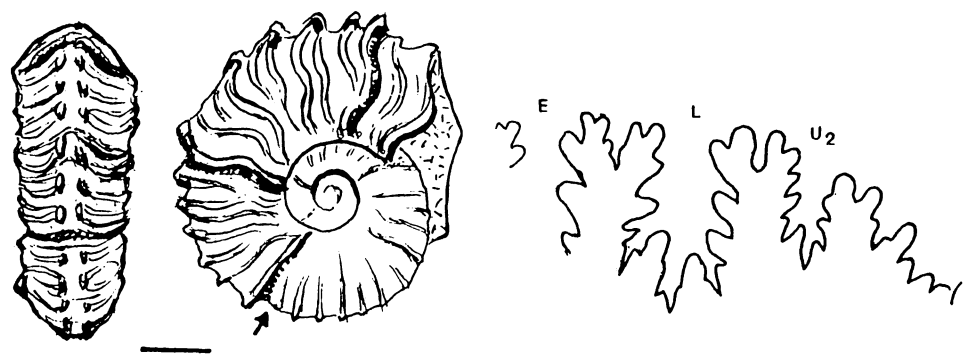


Fig. 11. *Yokoyamaoceras yokoii* Matsumoto, sp. nov.
Drawing of the holotype and its last suture at the arrow mark in lateral view. Scale bar = 10 mm. (T. M. *delin.*)

but nearly vertical umbilical wall.

Periodic constrictions of moderate frequency, subradial on the septate whorl and flexuous on the body chamber.

Body-chamber ornamented with comparatively coarse, more or less flexuous ribs with bifurcation or intercalation of secondary ribs at some points on the inner to middle part of the flank. Some of the long ribs have bullae at the umbilical edge. The ribs may be accented (i.e. somewhat strengthen) at the curved point on the ventrolateral shoulder, without forming distinct tubercles. On either side of the median line of the venter there are asymmetrically approximated two rows of tubercles, at each of which two ribs are as a rule looped.

On either side of the siphonal line on the late part of the septate whorl these peculiar double tubercles are also discernible and ribs reach there singly but may occasionally form a loop. At this stage there are numerous fine ribs on the outer part of the whorl, showing a projection on the venter, but weakening inward and even the longer ones scarcely reach the umbilical edge, where there are no bullae except at the end of the flares along the constrictions.

Suture similar to that of immature *Kossmaticeras* (see Text-fig. 11).

Etymology.—Dedicated to Dr. Takayuki Yokoi of Nagoya, who found this interesting ammonite.

Measurements.—See Table 25.

Table 25. Measurements of *Yokoyamaoceras yokoii* (above) and *Y. kotoi* (below).

Specimen, position	D	U	H	B	B/H	H/h	C(60°)
HT, LS + 180°	22.0 (1)	6.2 (.28)	9.4 (.43)	8.6 (.39)	0.91	1.47	5/11
HT, LS + 120°	35.3 (1)	10.6 (.30)	13.6 (.39)	12.4 (.35)	0.91	1.23	5/8

Comparison and discussion.—This species is distinct in its peculiar characters on the median zone of venter and its small size, but otherwise it is essentially similar to the contemporary *Kossmaticeras flexuosum* sp. nov., established above. This would allow me to

postulate that the two nominal species could be a dimorphic pair of a single species. Although the material available at present is insufficient for reaching a definite conclusion, there is another specimen which should be taken into consideration about this question, GK. H5217 (Pl. 22, Fig. 6) with D = 17.5 mm, which is embedded closely with the paratype (1) of *K. flexuosum* in the same nodule. It has ventrolateral tubercles as in normal *Yokoyamaoceras* and also a few mid-ventral angulations on the chevron-like extension of some ribs. It has relatively coarse, flexuous ribs on the late part of the outer whorl. As it is poorly preserved, it should be called tentatively *Yokoyamaoceras* cf. *yokoii*, if some difference in tuberculation is regarded as variation, or *Y.* aff. *yokoii*, if the difference is considered significant. It is similar to *Y. minimum* Matsumoto, 1956 (see Pl. 22, Fig. 5) in some respects, but the latter is of much later age (probably Santonian). On the other hand, it is recalled that *Kossmaticeras* cf. *flexuosum* was once collected by T. & K. Muramoto from a locality not far from Yokoi's type locality.

Occurrence.—Found rarely in the Middle Turonian of the Obirashibe Valley, southern Teshio Mountains.

THE MID-CRETACEOUS AMMONITES OF THE FAMILY KOSSMATICERATIDAE FROM JAPAN

PART III

DESCRIPTIONS OF THE SPECIES FROM THE SHUMARINAI-SOEUSHINAI AREA OF HOKKAIDO

(MID-CRETACEOUS AMMONITES FROM THE SHUMARINAI-SOEUSHINAI AREA, HOKKAIDO PART III)

(Studies of the Cretaceous Ammonites from Hokkaido—LXXI)

By

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Introduction

The purpose of the paper entitled "Mid-Cretaceous ammonites from the Shumarinai-Soeushinai area of Hokkaido" was described by Matsumoto and Inoma (1975, p. 263).

The fauna is unique in containing a number of species which may be important for settling the problem of the Albian/Cenomanian stage boundary. In Part I of that paper the species of the Acanthocerataceae were described and in Part II Inoma (1980) described the species of the Turrilitaceae, excluding those of the Turrilitidae.

As that fauna has numerous specimens of the family Kossmaticeratidae, they are taxonomically sorted on this occasion and the results are presented here as Part III of this monograph, which forms also Part III of the serial paper of the ammonites from the Shumarinai-Soeushinai area.

Notes on stratigraphy

As to the material and stratigraphy readers may refer to Matsumoto and Inoma (1975, p. 264–266) and the route map in that paper, which shows the numbered fossil localities, is

Palaeontological Society of Japan Special Papers No. 33, December, 1991.

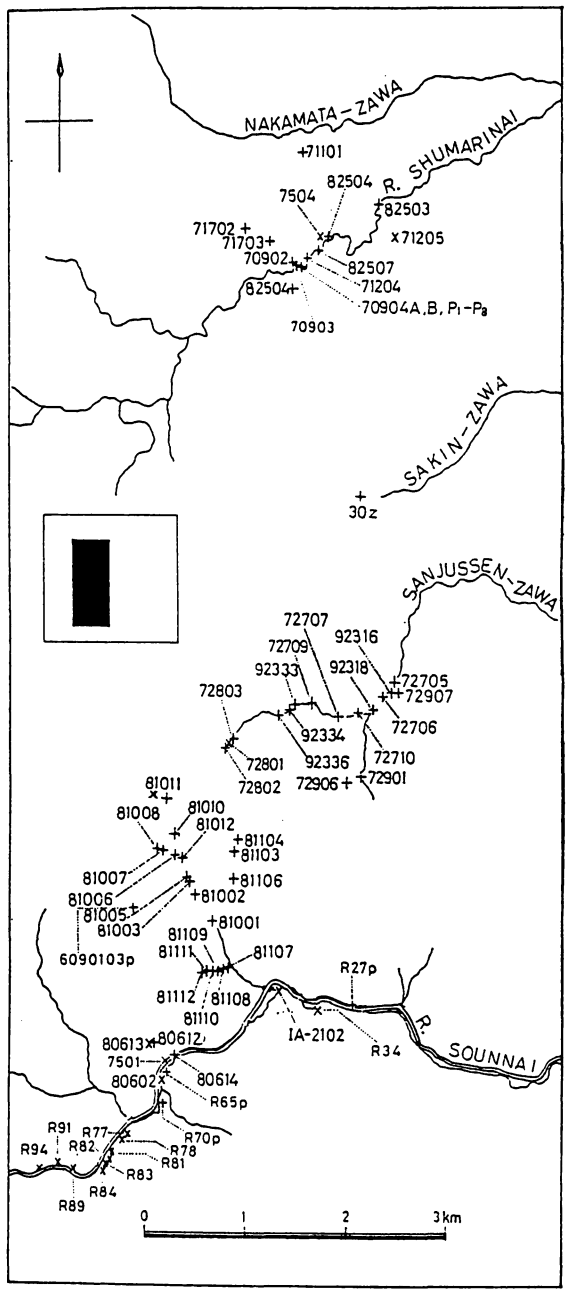


Fig. 12. Route map of the Shumarinai-Soeushinai area, showing ammonite localities. × : in situ, + loose. R 474 (in situ) is close to 81011. Inset guadrangle is the outline of the Geological Map of Soeushinai (scale 1:50,000) in which the solid rectangle is the area of this map. (Reproduced from Matsumoto and Inoma, 1975, fig. 1 by permission.)

reproduced here by permission (Text-fig. 12). The ammonites of the Acanthoceratacеae suggest that strata assigned to the Zone of *Desmoceras kossmati-Graysonites adkinsi* of the basal Cenomanian are distributed in various parts of this area. They are mapped by Hashimoto *et al.* (1965) as Member My 3 of the Middle Yezo Group. The foraminifera from the same member were investigated by Inoma and Maiya (*in* Inoma, 1980), who concluded also that their age was Cenomanian.

In 1989 one of us (T.M.) reexamined, with the aid of T. Nishida, Y. Kyuma, K. Yokoi and Y. Kawashita, the stratigraphic succession of the Cretaceous rocks in the Sounnai Valley. Above the Upper Albian member of sandstone and shale which contains *Mortoniceras* (*Durnovarites*) sp. there is a member of more or less sandy siltstone, which is Member My3 mentioned above. It yields abundantly calcareous nodules which contain ammonites of the Zone of *Desmoceras kossmati-Graysonites adkinsi*. In the upper reaches of the Suribachi-zawa, a branch of the River Sounnai, *G. adkinsi* Young was obtained from the siltstone of that member in situ at loc. R474 by Y. Kawashita, who acquired also from the same member "*Eogunnarites*" *alaskaensis* Matsumoto, which is described below, at locs. R456 and R445b. The strata show minor foldings and seam to be repeatedly exposed in the several branch gullies of the Suribachi-zawa, except for the eastern branch.

The species described below are mostly from the Zone of *Desmoceras kossmati-Graysonites adkinsi*. Even in the case of the floated or loose nodules the zone is inferred from the associated species. One species is from loc. IA-2102 where alternating sandstones and shales of Member My2 (probably Upper Albian) are exposed.

Some examples from the areas in Hokkaido other than the Shumarinai-Soeushinai area may be mentioned, if they are referable to the species from the latter.

Descriptions of species

Genus *Marshallites* Matsumoto, 1955

Marshallites cumshewaensis (Whiteaves, 1884)

Plate 25, Figs. 4–8; Plate 26, Figs. 1–5; Text-fig. 13

1884. *Haploceras cumshewaense* Whiteaves, p. 208, pl. 24, fig. 1.
1959. *Marshallites cumshewaensis* (Whiteaves); Matsumoto, p. 63, pl. 17, figs. 1–4; pl. 19, fig. 2; pl. 20, fig. 2.
1972. *Marshallites cumshewaensis* (Whiteaves); McLearn, p. 53, pl. 3, figs. 1, 2.

Material.—Holotype, GSC. 4973, from the north shore of Cumshewa Inlet, British Columbia, collected by G. M. Dawson, 1878, the plaster cast of which is GK. H9480. The plaster cast of the hypotype, GSC. 21223, described by McLearn is GK. H9481.

Numerous, more or less incomplete specimens are before us, of which the illustrated ones are as follows:

TKD 30145 (Pl. 25, Fig. 4) from loc. 80612, Sounnai (coll. A.I.); TKD 30148 (Pl. 25, Fig. 5), loc. 81005, Suribachi-zawa (A.I.); TKD 30142 B (Pl. 25, Fig. 6), loc. 70904A, Shumarinai (A.I. & W.H.); TKD 30581 (Pl. 25, Fig. 7) loc. P4, Shumarinai (W.H.); TKD 30149 (Pl. 25, Fig. 8), loc. 70904 B, Shumarinai (A.I. & W.H.); TKD 30147 C (Pl. 26,

Fig. 4), loc. 70904 A, Shumarinai (A.I. & W.H.); TKD 30580 (Pl. 26. Fig. 1), loc. P6, Shumarinai (W.H.); TKD 30147 A (Pl. 26, Fig. 2), loc 70904 A, Shumarinai (A.I. & W.H.); TKD 30142 A (Pl. 26, Fig. 3), loc. 70904 A, Shumarinai (A.I. & W.H.).

In the above list the names of the collectors at the end are abbreviated, viz., A.I.: A. Inoma; W.H.: W. Hashimoto. Among the associated ammonites *Graysonites adkinsi* Young is at loc. 80612. *Stoliczkaia* (*Shumarinaia*) *hashimotoi* Matsumoto & Inoma, *St.* (*Sh.*) *asiatica* Matsumoto & Inoma, and *Desmoceras kossmati* Matsumoto are at loc. 70904 A, B.

Diagnosis.—Shell fairly small to medium-sized, fairly involute and fairly narrowly umbilicate. Whorl much higher than broad, with narrowly arched venter and compressed or only slightly convex flanks.

Constrictions frequent but narrow, inclined forward and somewhat sinuous or falcoid.

Numerous, sharp-headed ribs, bundled at the umbilical edge, forming bullate tubercles, prorsiradiate on the inner flank, showing falcoid bend at or slightly below the mid-flank, where further bifurcation or intercalation may occur, and again curved forward on the ventrolateral part, crossing the venter with rather a gentle to moderate convexity.

As the test is preserved in most of the examined specimens, sutures are not well exposed. They are considerably ramified already in fairly young shells (e.g. TKD. 30145) (Text-fig. 13).

Measurements.—See Table 26.

Table 26. Measurements of *Marshallites cumshewaensis*.

Specimen, position	D	U	H	B	B/H	H/h
HT, middle part	—	—	~31.0	~21.0	0.68	—
GSC 21223, E	46.4 (1)	9.4 (.20)	24.2 (.52)	16.5 (.36)	0.68	1.82
TKD 30145, E – 60°	30.0 (1)	5.4 (.18)	15.3 (.51)	10.3 (.34)	0.67	1.65
TKD 30148, E	29.0 (1)	5.0 (.17)	14.5 (.50)	9.8 (.34)	0.68	1.53
TKD 30142B, E	15.0 (1)	3.0 (.20)	7.6 (.51)	5.4 (.36)	0.71	1.73
TKD 30580	(scc. compr.)		~30	~18	0.60	—
TKD 30147A	("	")	~23	~15	0.65	—
USNM 129278*	42.0 (1)	10.2 (.24)	19.0 (.45)	~12.0 (.29)	0.63	1.48
USNM 129280**	36.7 (1)	9.5 (.26)	16.2 (.44)	11.5 (.31)	0.71	1.47

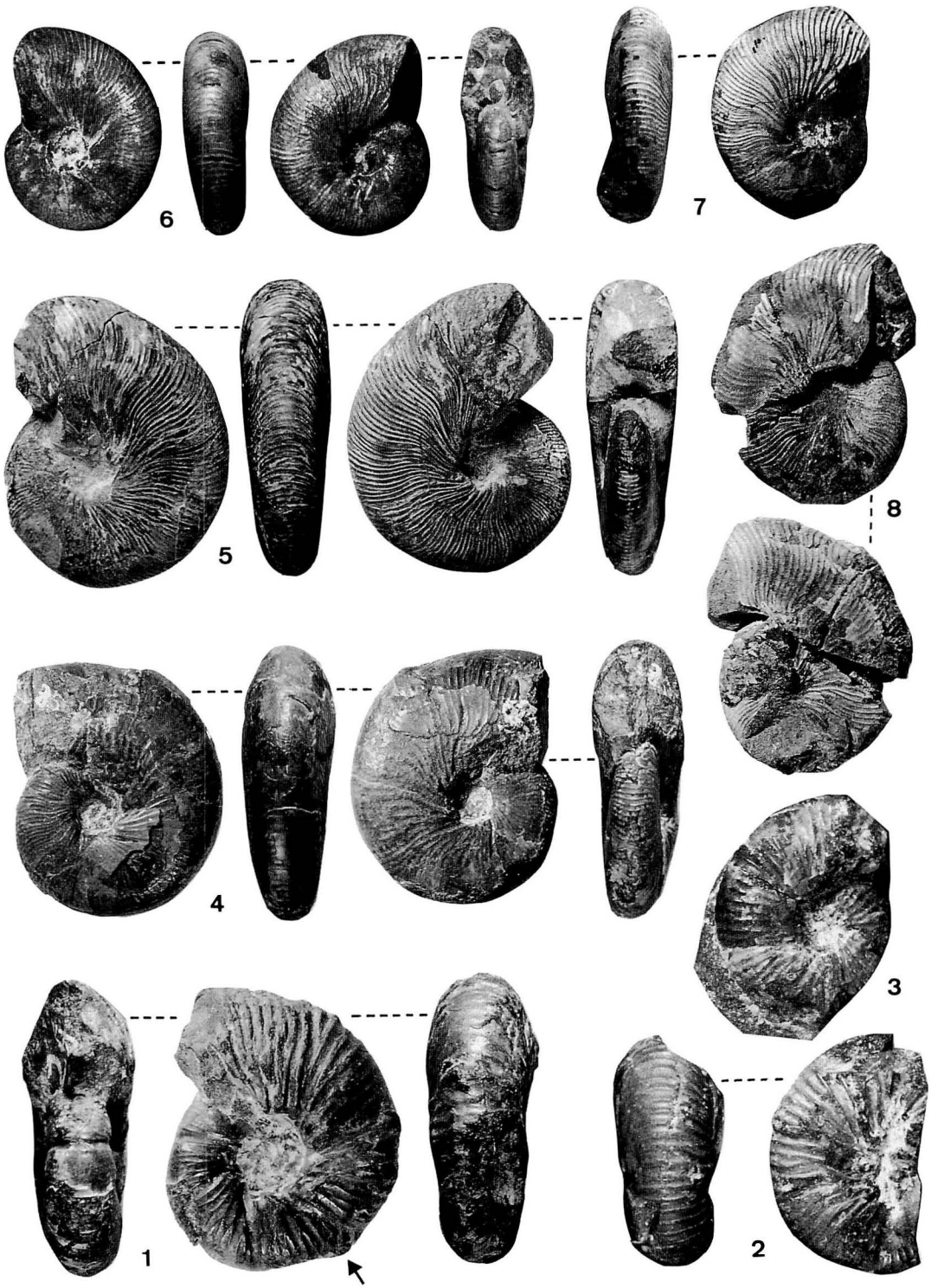
* Matsumoto, 1959, pl. 17, fig. 1; ** ditto, pl. 17, fig. 3.

Observation.—So far as the undeformed small, probably immature, shells are concerned, variation in shell-form does not seem great. Those of moderate size which preserve the body-chamber at least partly are secondarily compressed or distorted.

Explanation of Plate 25

Figs. 1–3. *Marshallites kossmati* Matsumoto & Inoma, sp. nov. ..... Page 108
1: TKD 30155, holotype, × 1.5. 2: TKD 30585 B, paratype (2) (juvenile), × 2.5. 3: TKD 30585 A, paratype (1) (septate part), × 2.

Figs. 4–8. *Marshallites cumshewaensis* (Whiteaves) ..... Page 105
4: TKD 30145, × 1.25. 5: TKD 30148, × 1.5. 6: TKD 30142 B, × 2. 7: TKD30581, × 2. 8: TKD 30149, × 1.25.



T. Matsumoto & A. Inoma: *Marshallites*

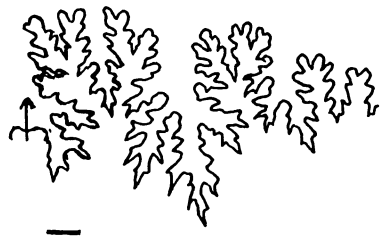


Fig. 13. *Marshallites cumshewaensis* (Whiteaves).
Suture of immature specimen TKD 30145A at D = 24 mm.
Scale bar: 1 mm. (A. I. *delin.*)

The mode of ribbing is characteristic, although there may be some irregularity and variation in density and intensity. TKD 30583 (Pl. 26, Fig. 5) from loc. P7 has unusually coarse ribs, but it is a highly distorted body-chamber. In the same rock matrix a fragmentary small, densely and finely ribbed specimen is included. Tentatively TKD 30583 is called *M.* aff. *cumshewaensis*.

Comparison.—This species is somewhat similar to *Marshallites involutus* Matsumoto & Saito (described in Part II), from the Middle and Upper Cenomanian. It is on the average less involute, less narrowly umbilicate and in particular distinguished by more sinuous ribs. Its distinction from *M. olcostephanoides* has been already mentioned by Matsumoto (1959, p. 64).

Occurrence.—So far as the specimens with reliable locality records are concerned, this species occurs in the Lower Cenomanian in the Shumarinai-Soeushinai area. In British Columbia and southeastern Alaska it occurs in the Upper Albian and Cenomanian (Matsumoto, 1959; McLearn, 1972).

Marshallites kossmati sp. nov.

Plate 25, Figs. 1–3

Material.—Holotype, TKD 30155 (Pl. 25, Fig. 1), from loc. 70904 B of the Shumarinai (coll. I.A. & W.H.). Paratypes (1) and (2), TKD 30585 A, B (Pl. 25, Figs. 3, 2), from P7, Shumarinai (coll. W.H.).

Diagnosis.—Shell small and fairly narrowly umbilicate. Whorl somewhat higher than broad, subelliptical to suboval in section, with moderately rounded venter and gently convex flanks and subrounded umbilical edge. The ratio of whorl expansion somewhat increased in the late stage.

Constrictions fairly frequent, 6 or 7 per whorl, well-marked and prorsiradiate, intersecting the ribs behind them. A parabola of gentle convexity on the inner flank occasionally discernible in front of the flare (Pl. 25, Fig. 2).

Despite the small shell, the ribs are relatively coarse from a fairly young stage. They spring normally in pairs from the umbilical bullae but sometimes singly with or without weak bullae, and may again bifurcate or have intercalated shorter ribs on the flank. On the outer whorl they are somewhat prorsiradiate, with or without a gentle sinuosity. On the young whorl the ribs are prorsiradiate around the umbilicus but gently bent to become

nearly rectiradiate, crossing the venter almost vertically.

The suture is of general kossmaticeratid pattern but comparatively less ramified than that of other species of *Marshallites* at corresponding size., showing gradually descending auxiliaries.

Measurements.—See. Table 27.

Table 27. Measurements of *Marshallites kossmati*.

Specimen, position	D	U	H	B	B/H	H/h	C(60°)
HT, E – 40°	27.6 (1)	8.0 (.29)	12.1 (.44)	10.9 (.39)	0.90	1.61	4/11
PT(1), middle	17.8 (1)	4.5 (.25)	7.8 (.44)	—	—	1.42	3/9

Observation.—The three specimens of dissimilar sizes well show the change of characters with growth.

Comparison and discussion.—This species shows the general characters of *Marshallites* (see Part I), but it is distinguished from other species of the same genus by its relatively coarser ribs. A new species of *Marshallites* from the Lower Albian of the Miyako area (to be established by Obata and Futakami in Part IV) has somewhat coarse ribs on its adult body chamber, but it has finer and denser ribs (or subcostae) on the septate part than those of this species.

This species is similar to *Hulenites jimboi* (Anderson) (1938, p. 188, pl. 42, figs. 5–7), from the Albian of California, in the shell-form, frequent constrictions and the mode of ribbing, but is distinct in its coarser ribs and clearly bullate umbilical tubercles.

This species looks somewhat similar to *Kossmaticeras jeletzkyi* Collignon (1965b, p. 29, pl. 426, fig. 1766), from the Middle Coniacian of Madagascar and Coniacian III of South Africa (Kennedy and Klinger, 1985, p. 190, fig. 9) in the shell-form and mode ribbing on the outer whorl. The former is much smaller and more narrowly umbilicate and shows dissimilar mode of ribbing in the young stage. The two species are much separated in age and there is no linking species. The similarity is again a homoeomorphy.

Occurrence.—As for *Material*. Among the associated ammonites there are *Desmoceras kossmati* and *Stoliczkaia* (*Shumarinaia*) *hashimotoi*, which indicate an early Cenomanian age.

Marshallites aff. *hendersoni* Matsumoto & Takahashi

Plate 28, Figs. 2, 3

Material.—A small but well preserved specimen, TKD 30612A (Pl. 28, Fig. 2) and a fragmentary one TKD 30612B (Pl. 28, Fig. 3) from loc. P8 of the River Shumarinai (H. W. Coll.).

Measurements.—See Table 28.

Descriptive remarks.—The above specimens resemble immature shells of *Marshallites hendersoni* Matsumoto & Takahashi established in Part II in the shell-form, features of parabola and ornament, but the ribs are somewhat coarser and less numerous. They may belong to an allied species of *M. hendersoni* or the difference might be within variation of

Table 28. Measurements of *Marshallites* aff. *hendersoni*.

Specimen, position	D	U	H	B	B/H	H/h	C(60°)
TKD 30612 B	11.0	3.1 (.28)	4.8 (.44)	4.2 (.38)	0.88	1.55	4/11

the latter. As the available material is insufficient, we call them tentatively *M.* aff. *hendersoni*.

This species is also similar to *M. kossmati* described above, but its constrictions are not so much prorsiradiate and its ribs are not so coarse as in the latter.

Occurrence.—As for Material.

Marshallites rotundatus Matsumoto & Takahashi

Plate 7, Figs. 6, 7

Remarks.—This species has been already established in Part II on the holotype and other specimens from the Cenomanian of the Ikushumbets Valley (see p. 43).

The following specimens are certainly examples of the same species from the Shumarinai-Soeushinai area:

TKD 30161 (Pl. 7, Fig. 7) from loc. 92318 of the San-jussen-zawa (coll. W. Hashimoto); GK. H8380 (K. Yokoi's donation from his Coll. No. 738) (Pl. 7, Fig. 6) from the Suribachi-zawa of the Sounnai Valley.

See Table 6 (p. 44) for the dimensions of these two specimens.

Genus *Sounnaites* nov.

Type species.—*Eogunnarites alaskaensis* Matsumoto, 1959.

Diagnosis.—Shell large and fairly narrowly to moderately umbilicate, with involution of 1/2 to 1/3. Whorl somewhat broader than high and subcircular in section, with moderately to somewhat broadly arched venter, more or less convex flanks and subrounded to abruptly bent umbilical edge.

Periodic constrictions somewhat but not much oblique forward, crossing the venter with a broadly convex curve and intersecting several ribs behind each of them, with accompanied flares more or less strongly bullate at the umbilical end. A parabola in front of the constriction is gently convex on the inner flank with a shallow umbilical semi-sinus.

Surface of shell ornamented with numerous fine ribs (that may be called subcostae in

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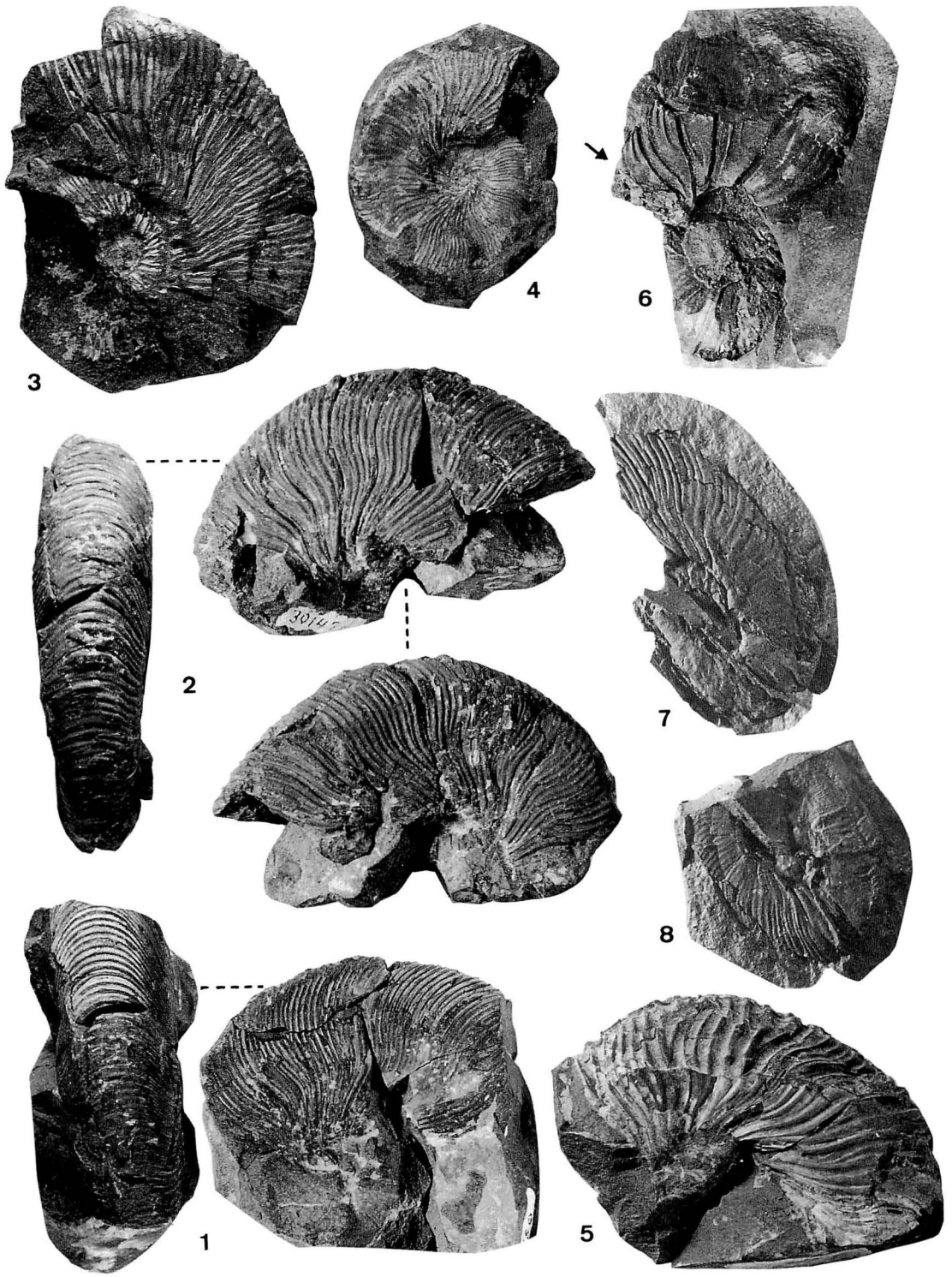
Explanation of Plate 26

Figs. 1–4. *Marshallites cumshewaensis* (Whiteaves) ..... Page 105
1: TKD 30580, × 1. 2: TKD 30147 A, × 1.25. 3: TKD 30142 A, × 1.2. 4: TKD 30147 C, × 1.5.

Fig. 5. *Marshallites* aff. *cumshewaensis* (Whiteaves) ..... Page 108
5: TKD 30583, × 1.2.

Figs. 6–8. *Marshallites* cf. *miyakoensis* Obata & Futakami, sp. nov. (from Tomochi) ..... Page 130
6: GK. H8343, × 1. 7: GK. H8348, × 1.5. 8: GK. H8349, × 1.5. 6–8: lateral view only.
(Photos 6–8 by K. Murakami; others by M. Noda.)



T. Matsumoto & A. Inoma: *Marshallites* (1–5)
T. Matsumoto & K. Murakami: *Marshallites* (6–8)

young stages) of unequal length. Long ribs normally arise from the umbilical seam singly but occasionally may start in bundles of two to several with blunt bulge but no prominent tubercles at the umbilical edge, except for the bullae at the end of the periodic flare mentioned above. Intercalation and bifurcation occur frequently on the inner flank. The ribs form a gently convex curve on crossing the subrounded umbilical edge and then nearly rectiradiate on the main part of the flank, crossing the venter almost at right angle with the siphonal line.

Suture of kossmaticeratid pattern, with symmetrically trifid L, and finely and deeply ramified from the middle growth-stage onward.

Etymology.—Derived from the River Sounnai which runs into the River Uryu at Soeushinai in the southern part of the Teshio Mountains.

Remarks.—We refer to this new genus the type species, which occurs in the Lower Cenomanian of Alaska and Hokkaido, and another species described below from the upper part of the Albian of Hokkaido.

This genus is similar to *Eogunnarites* Wright & Matsumoto but the latter has prominent umbilical tubercles where ribs arise in bundles of two to several. This distinction is recognized even in immature stages. The type species of the former is larger than any species of the latter. Another new species of *Sounnaites* described below is nearly as large as *Marshallites olcostephanoides*.

"*Kossmaticeras*" *voyanum* Anderson from near the Albian/Cenomanian boundary in California might be referred to this genus, but its whorl is somewhat compressed and the umbilical end of the long ribs are weakly bullate as in several species of *Marshallites* (see p. 37 of Part II).

This genus may be allied to *Moffitites* Imlay, 1959 (p. 181) (see also Imlay, 1960, p. 101), with type species *M. robustus* Imlay, 1959 (p. 181, pl. 29, figs. 9–14), from the Lower Albian of Alaska, but *Moffitites* has more depressed whorls with more inflated flanks and more flexuous ribs than those of ours. Moreover, the ribs of *Moffitites* are coarser on the inner flank than those of *Sounnaites* and replaced by secondary ribs by frequent bifurcation on the outer part.

Kennicottia Imlay, 1959 (p. 183) (see also Imlay, 1960, p. 103), with *K. rugosa* Imlay, 1959 (p. 181, pl. 30, figs. 8–13) from the Lower Albian of Alaska as type species, is distinct from *Sounnaites* in its more compressed whorls with suboval section and flexuous ribs which show strong ventral projection.

The constrictions of *Moffitites* and *Kennicotia* are nearly parallel to the ribs with no or little intersection with the ribs and the associated flares do not show so clearly raised bullate tubercles as those of *Sounnaites*. Their pattern of suture resembles rather that of *Pseudohaploceras* Hyatt, 1900 (see Uhlig, 1883, pl. 17, fig. 16), being dissimilar to that of *Marshallites* nor that of *Puzosia*.

Based on the above comparison we refer *Sounnaites* tentatively to the Marshallitinae,

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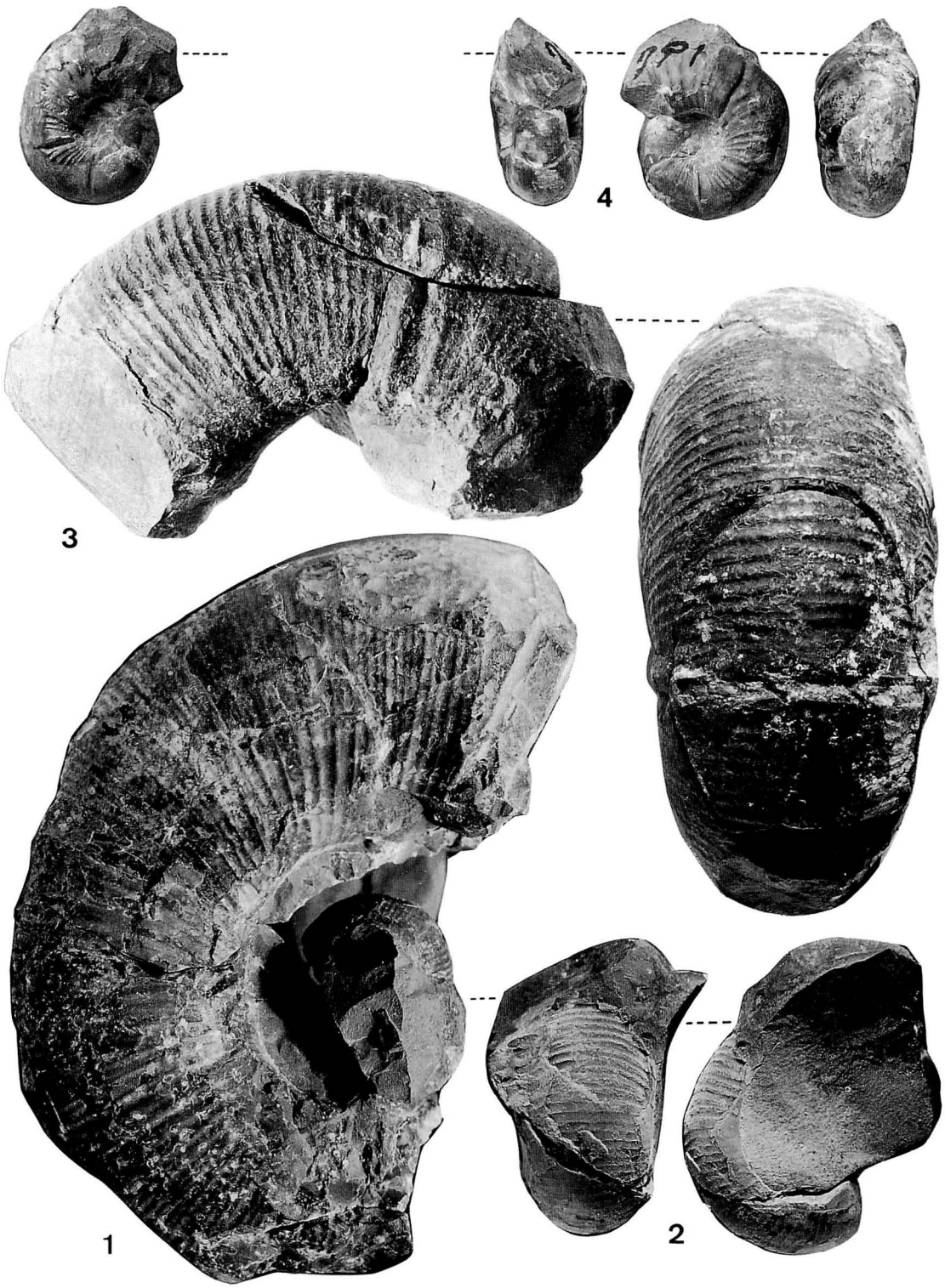
Explanation of Plate 27

Figs. 1–4. *Sounnaites alaskaensis* (Matsumoto) ..... Page 114
1: TKD 30162, ×0.5. 2: Ditto, inner whorl, ×1. 3: GK. H1556, ×1. 4: GK. H8379 (K. Yokoi's coll. No 791), ×1.5.



T. Matsumoto & A. Inoma: *Sounnaites*

but its phylogenetic origin has yet to be worked out. Its unusually large size as compared with other members of the subfamily is also remarkable.

Distribution.—Not uncommon in the Lower Cenomanian of Japan and southeastern Alaska; rare in the Albian of Japan.

Sounnaites alaskaensis (Matsumoto, 1959)

Plate 27, Figs. 1–4; Plate 28, Figs. 1, 4; Plate 29, Figs. 1; Plate 30, Figs. 6, 7.

1954. *Eogunnarites unicus* (Yabe); Wright & Matsumoto, p. 126 (pars.), pl. 8, fig. 5 (only).
1959. *Eogunnarites alaskaensis* Matsumoto, p. 66, pl. 18, fig. 1; pl. 19, fig. 1; pl. 20, fig. 1.
1967. *Eogunnarites alaskaensis* Matsumoto; Jones, p. 42, pl. 3, fig. 3.
1972. *Eogunnarites alaskaensis* Matsumoto; McLearn, p. 53, pl. 23, fig. 1.

Material.—Holotype is USNM 129257 (Matsumoto, 1959, pl. 19, fig. 1; pl. 20, fig. 1) and paratype USNM 129258 (ditto, pl. 18, fig. 1), both from USGS Mes. loc. 25444 (probably Cenomanian) in the upper reaches of the Chitina Valley, southeastern Alaska (see Matsumoto, 1959, fig. 1 and p. 81).

The following specimens from Hokkaido are assigned to this species:

TKD. 30162 (Pl. 27, Figs. 1, 2) from loc. 81111, in a nodule loose in a small western branch of the Suribachi-zawa, which itself is a tributary to the River Sounnai of the Soeushinai area (coll. W. Hashimoto and A. Inoma); YKC. 600716 and YKC. 630608 (Pl. 28, Fig. 1), both collected by Y. Kawashita in situ from the Zone of *Desmoceras kossmati-Graysonites adkinsi* at loc. R 445b and loc. R 456, respectively, in the Suribachi-zawa. YKC. 011015 (Pl. 29, Fig. 1) from a nodule loose at the point close to loc. 92333 of TKD (see Text-fig. 12 of this paper) on the stream Sanjussen-zawa, a tributary to the River Shumarinai, collected by Y. Kawashita; GK. H1556 (Pl. 27, Fig. 3) from the Zone of *Desmoceras kossmati* at loc. Y 259 in the upper reaches of the River Shuparo, Oyubari area (coll. T. Matsumoto). The lithology of the host rock is mostly more or less sandy mudstone.

The following small specimens are probably very young shells of this species:—GK. H8379 (K. Yokoi's donation from his Collection No. 791) (Pl. 27, Fig. 4), loose from the Suribachi-zawa; TKD 30160A (Pl. 28, Fig. 4), B (Pl. 30, Fig. 6) and C (Pl. 30, Fig. 7), from a nodule 70904A (coll. I.A. & W.H.) on the River Shumarinai.

Diagnosis.—Shell very large, about 300 mm in the maximum diameter of a nearly complete adult example, and moderate in the rate of whorl expansion, degree of involution (1/3 to 2/5) and width of umbilicus. Whorl a little broader than high, with B/H = 1.15 on the average in the middle to late stages, but somewhat more depressed earlier, and

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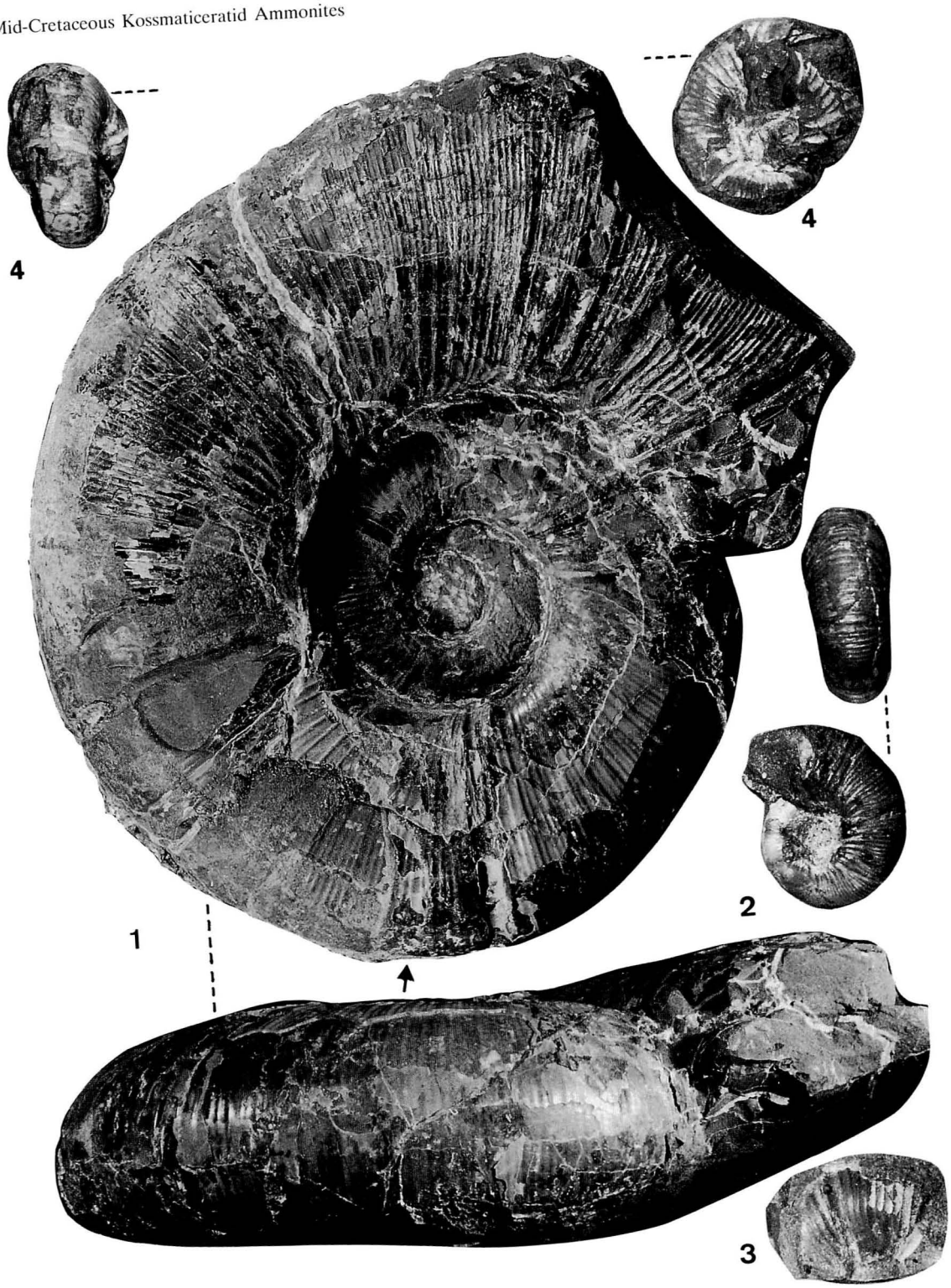
Explanation of Plate 28

Fig. 1. *Sounnaites alaskaensis* (Matsumoto) ..... Page 114
YKC. 630608, hypotype, ×0.48.

Figs. 2, 3. *Marshallites* aff. *hendersoni* Matsumoto & Takahashi ..... Page 109
2: TKD 30612A, juvenile, ×2.5. 3: TKD 30612B, fragmentary juvenile, ×2.5.

Fig. 4. *Sounnaites* cf. *alaskaensis* (Matsumoto) ..... Page 114
TKD 30160A, ×2.

Mid-Cretaceous Kossmaticeratid Ammonites



T. Matsumoto & A. Inoma: *Sounnaites, Marshallites*

subcircular in section, showing well rounded venter and outer flank, gently convex inner flank, abruptly bent but subrounded umbilical edge and steep or nearly vertical and moderately high umbilical wall.

Constrictions well-marked on the internal mould, rather irregular in frequency and weakly prorsiradiate, intersecting several ribs behind each of them. Major ribs along the constrictions flared on the inner flank and sharply raised on the umbilical margin.

Surface of shell ornamented with numerous, narrow and fine ribs of unequal length. Longer ones curve forward around the umbilicus and are nearly rectiradiate on the main part of the flank, crossing the venter almost at right angles with the siphonal line. Many of the long ribs arise singly from the umbilical seam. Occasionally some of them may start from thicker root in obscure bundle of two to four, without forming distinct tubercles. Intercalation or branching of shorter subcostae occurs frequently on the inner flank. On the test of the outer flank and venter the ribs are rather sharp-headed and separated uniformly by the interspaces somewhat wider than themselves. They may look blunter and apparently coarser on the internal mould.

Suture of kossmaticeratid pattern, with symmetrically trifid L, which is somewhat deeper than E, finely and deeply ramified in the middle to late growth-stage.

Measurements.—See Table 29.

Table 29. Measurements of *Sounnaites alaskaensis*.

Specimen, position	D	U	H	B	B/H	H/h	C(60°)
HT.	122.5 (1)	44.5 (.36)	47.0 (.38)	53.0 (.43)	1.13	1.52	
YKC 630608, LS	~188	60 (.32)	82 (.44)	95 (.51)	1.16	—	12/39
〃 LS + 90°	242 (1)	77 (.32)	97 (.40)	—	—	1.43	—
〃 LS + 180°	284 (1)	97 (.34)	~105 (.37)	—	—	—	18/51
YKC 600716, LS	173 (1)	54 (.31)	72 (.42)	—	—	1.53	14/42
〃 LS − 90°	—	—	55	~65	1.18		
YKC 011015,	218 (1)	82 (.38)	83 (.38)	~93 (.43)	1.12	1.57	18/42
GK. H1556	—	—	40	46	1.15	—	12/26
TKD 30160A	16.0 (1)	4.2 (.26)	6.7 (.42)	~9.4 (.59)	1.40	—	—
TKD 30160B	13.0 (1)	3.9 (.30)	5.4 (.41)	7.5 (.58)	1.39	—	—
GK. H8379	17.8 (1)	5.2 (.29)	7.0 (.39)	10.1 (.57)	1.35	—	—

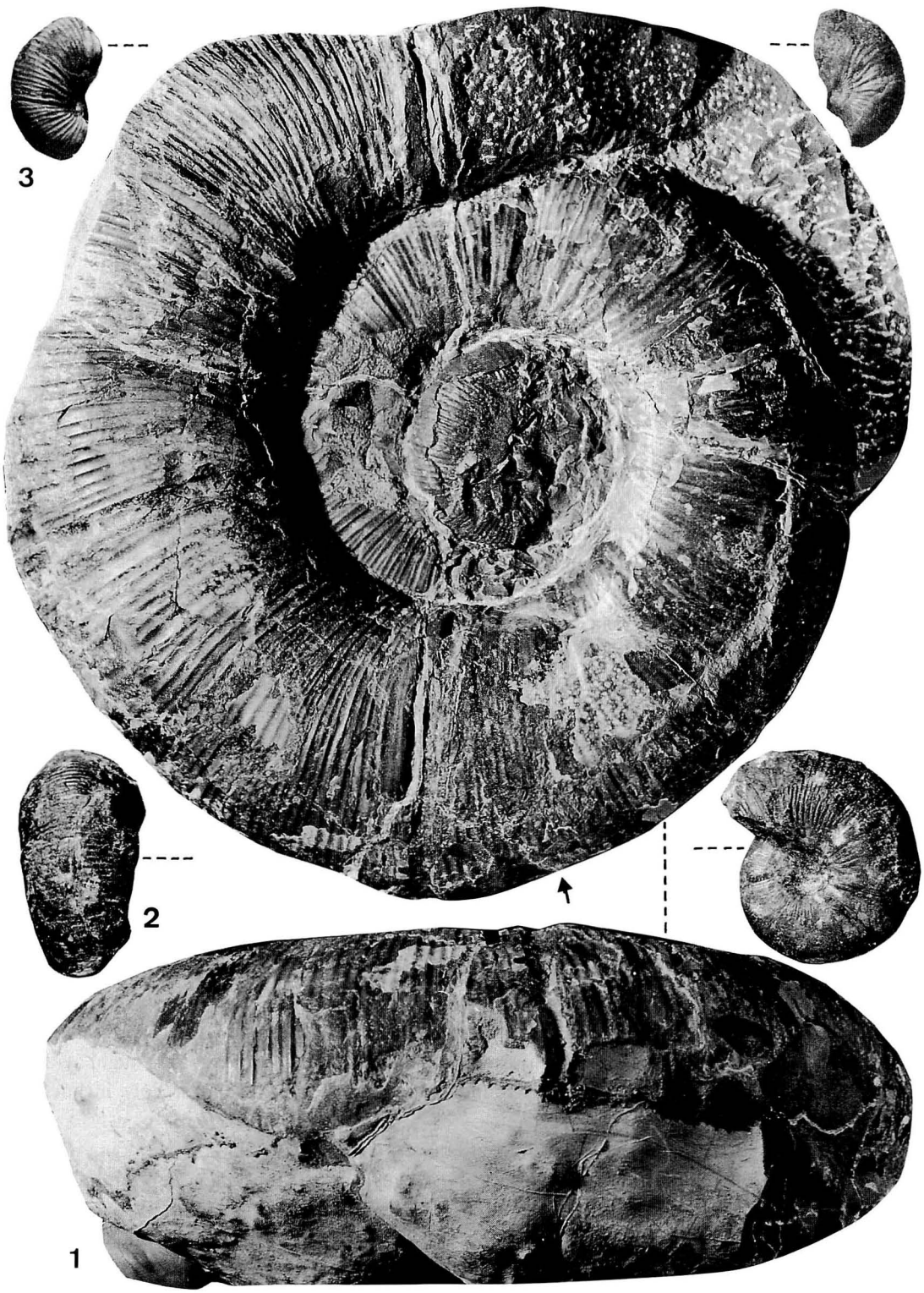
Observation.—The large specimens from Hokkaido are magnificent but they are dissolved on the right side in the rock matrix. In lateral view YKC 630608 seems to represent a nearly full-grown shell, for the body-chamber is preserved for about 250° and the last two constrictions are approximated.

Another specimen, YKC. 011015, likewise seems to record the end of the body-

Explanation of Plate 29

Fig. 1. *Sounnaites alaskaensis* (Matsumoto) ..... Page 114
YKC. 011015, ×0.58.

Figs. 2, 3. *Sounnaites* (?) aff. *alaskaensis* (Matsumoto) ..... Page 118
2: TTC. 371231, ×1.75. 3: TKD 30586, ×2. (Photos by A. I.)



T. Matsumoto & A. Inoma: *Sounnaites, Marshallites* (?)

chamber, where the diameter would be about 270 mm in a restored outline. This matches in size with the restored outline of the paratype from Alaska. GK. H1556, though fragmentary, certainly represents the middle growth-stage.

We regard the small specimens, TKD 30160A–C and GK. H8379 (all figured as indicated above) as probable juveniles of this species. They are essentially similar in shell-form and ornament to the middle-aged and adult shells, although their whorls are more involute and more inflated, with smaller ratios of U/D and greater B/H. On their shell surface the fine lirae in earlier stage are developed later to sharp-headed ribs but their internal moulds are almost smooth and have well-marked constrictions.

In all the available specimens clearly defined umbilical tubercles are absent and only occasionally the bundled state of two to several ribs at the umbilical edge with blunt thickening is discernible. The clearly bullate elevations at the end of the periodic flares are recognized as in other kossmaticeratid ammonites.

In addition to the small specimens mentioned above, there are doubtful small ones. TTC. 371231 (Pl. 29, Fig. 2), from the silty sandstone bed at loc. Ik 1103 (Middle Cenomanian) of the Ikushumbets Valley, resembles a young shell of this species in the course of fine ribs and broadly rounded whorl-section but differs in its narrower umbilicus, more involution and presence of weak umbilical bullae at the end of bundled ribs in the preserved late part. It may be referred either to *Sounnaites* or to *Marshallites*, but without seeing the characters of adult shells, we hesitate to decide. Similar remarks are given to TKD 30586 (Pl. 29, Fig. 3) from P7 (coll. W. H.) and also to TKD 30140 A–D from loc. 70904A (coll. A. I & W. H.), both in the River Shumarinai.

Comparison and discussion.—See remarks in the description of the genus (p. 112).

Occurrence.—This species occurs characteristically in the Zone of *Desmoceras kossmati-Graysonites adkinsi* of the Shumarinai-Soeushinai area of northwestern Hokkaido and the Oyubari area of central Hokkaido. It is known in Alaska and British Columbia.

Sounnaites hokkaidoensis sp. nov.

Plate 30, Figs. 3, 4; Text-fig. 14

Material.—Holotype, GK. H8341 (Pl. 30, Figs. 3, 4) from the sandstone alternating with siltstone of Member My2 of Hashimoto *et al.* (1965) exposed on the River Sounnai at loc. IA 2102 (collected and donated by A. Inoma).

Diagnosis.—Shell originally fairly large; involution of whorl moderate (about 1/2); umbilicus fairly narrow. Whorl broadly rounded and somewhat broader than high, with broadly arched venter, convex flanks, rounded umbilical shoulder and steeply inclined umbilical wall.

Periodic constrictions narrow and fairly frequent, 60° apart on the average, somewhat prorsiradiate around the umbilicus, gently curved backward on the inner flank and again weakly curved forward on the ventrolateral part, crossing the venter with a broad convexity. The flares along the constriction not much raised and weakly thickened and elevated on the umbilical wall, forming indistinct bullae. A flat space in front of some constrictions demarcated by a trace of the past peristome, showing a gently convex curve on the inner flank and a shallow sinus on the umbilical wall.

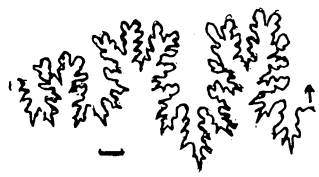


Fig. 14. *Sounnaites hokkaidoensis* sp. nov.
Suture of the holotype at an immature stage (D = 16 mm).
Scale bar: 1 mm. (A. I. *delin.*)

Ribs numerous, fine and dense, arising singly from the umbilical seam without bullae, running nearly parallel to the constrictions or parabola behind themselves, with bifurcation or intercalation at or near the bending point of their curve on the flank; several of them cut by each of the constrictions in front of them, showing somewhat virgatotome appearance.

Suture finely and deeply incised from fairly young stage onward; auxiliaries rather gradually descending (Text-fig. 14).

Measurements.—See Table 30.

Table 30. Measurements of *Sounnaites hokkaidoensis* & *S.* aff. *hokkaidoensis* (bottom).

Specimen, position	D	U	H	B	B/H	H/h	C(60°)
HT, inner whorl	36.6 (1)	8.6 (.23)	17.6 (.48)	20.5 (.55)	1.16	1.69	13/18
" +360°	—	~23	~35	~40	1.14	—	14/21
TKD 30592, inner wh.	16.6 (1)	3.9 (.23)	8.0 (.48)	9.7 (.58)	1.21	1.70	—

Observation.—The holotype is incomplete although it is not secondarily distorted. As it is still septate at its preserved end, it must have been originally fairly large. As its inner whorl can be extracted (Pl. 30, Fig. 4), characters of both the young and middle growth stages are observable. This shows fairly constant characters. We should, however, search for more specimens and particularly those with adult body-chamber.

TKD 30592 (Pl. 30, Fig. 5), from P7 of the Shumarinai (coll. H. W.), is a juvenile allied to this species, but its outer whorl is so much squashed that we cannot identify it definitely.

Comparison.—In this species the whorls are broader, more involute and more narrowly umbilicate than those in *S. alaskaensis*. The latter species has deeper and wider constrictions, stronger flares with more elevated umbilical tubercles and more frequent bifurcation and intercalation of the ribs.

It should be noted that the immature shell of this species (see Pl. 30, Fig. 4) is fairly similar to *Valdedorsella akuschaensis* (Anthula) (1899, p. 104, pl. 8, fig. 3) (see Obata, 1967, p. 65, pl. 8, figs. 1, 4; text-fig. 1), from the Upper Aptian of the Caucasus and other regions including Japan, although the former has more numerous and finer ribs and more ramified suture (Text-fig. 14). This suggests that the phylogenetic origin of *Sounnaites* could possibly be sought in such an Aptian species of *Valdedorsella*.

Occurrence.—The holotype was found solitarily from the sandstone of Member My2 (probably Upper Albian) of the Middle Yezo Group in the Sounnai section.

S. aff. *hokkaidoensis* (TKD 30592) came from the Zone with *Desmoceras kossmati,*

Stoliczkaia (Shumarinaia) asiatica and *Scaphites japonicus* of the Lower Cenomanian in the Shumarinai section.

Eogunnarites hashimotoi sp. nov.

Plate 30, Figs. 1, 2

Material.—Holotype TKD 30590A, found by W. Hashimoto in a nodule, loose at loc. P2 on the River Shumarinai, Teshio Mountains.

Diagnosis.—Shell fairly small and moderately widely umbilicate. Whorl moderately involute, expanding with moderate to low ratio, much broader than high, roughly semilunate in cross-section, with broadly rounded venter which merges into convex flanks, showing the maximum breadth at about the subangular umbilical shoulder, from where the umbilical wall slopes down steeply.

Constrictions four per whorl, double-collared with a stronger flare in front, slightly prorsiradiate and gently curved forward on the venter, cutting a few riblets behind. In front of the constriction at about 90° adapically from LS,a dorsolateral projection is marked with a probably ocular sinus on the umbilical wall.

Later whorl ornamented with numerous, slightly prorsiradiate or gently curved, moderately strong and sharp-headed ribs, of which 2 or 3 are bundled at each of the bullate tubercles on the umbilical shoulder and some are intercalated. They are regular and equidistant on the outer part and three times as numerous as the umbilical bullae, which run on the umbilical wall and are raised to spinose tubercles at the umbilical shoulder.

Ribs on the earlier whorl finer, denser and straighter than those on the later one, of which 3 or 4 are bundled at each of relatively coarser nodes around the umbilicus; also with some intercalated ones.

Suture of general kossmaticeratid pattern. The stem of L not so narrow as that of *Marshallites compressus*.

Measurements.—See Table 31.

Observation.—The available material is a single, somewhat deformed specimen. The apparently less depressed early part of the body-chamber with less sharply bent umbilical shoulder is probably due to secondary deformation. On the assumption that the body-chamber was as long as 210°, the diameter of the adult shell would be about 50 mm.

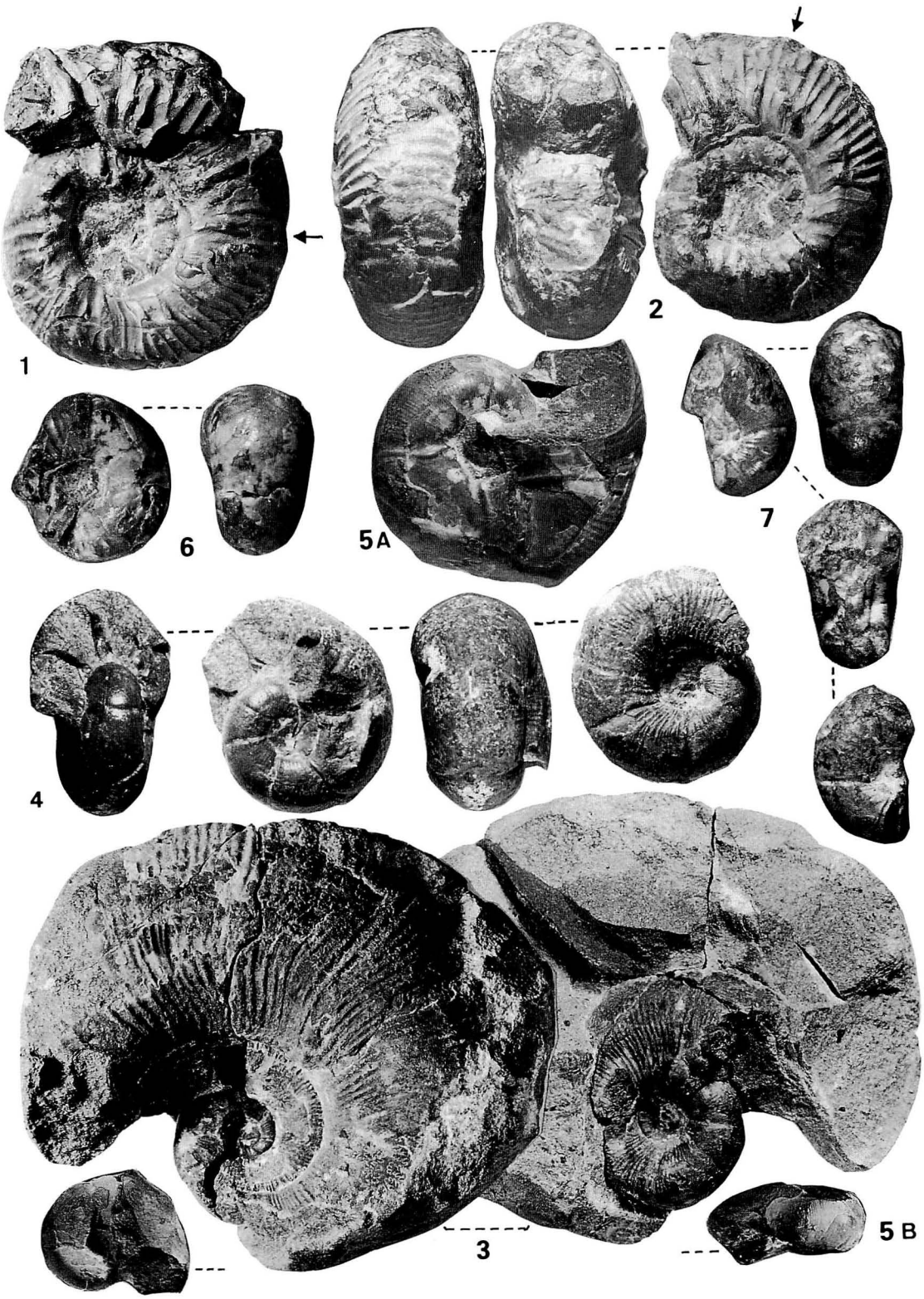
Explanation of Plate 30

Figs. 1, 2. *Eogunnarites hashimotoi* Matsumoto & Inoma, sp. nov. ..... Page 120
1: TKD 30590 A, holotype, × 1.25. 2: Ditto, excluding the body-chamber, × 1.25.

Figs. 3, 4. *Sounnaites hokkaidoensis* Matsumoto & Inoma, sp. nov. ..... Page 118
3: GK. H8341, holotype, × 1. 4: Ditto, young part, × 1.5.

Fig. 5. *Sounnaites* aff. *hokkaidoensis* Matsumoto & Inoma, sp. nov. ..... Page 119
TKD 30592, × 2 (5A); × 1 (5B).

Figs. 6, 7. *Sounnaites* cf. *alaskaensis* (Matsumoto) ..... Page 114
6: TKD 30160B, juvenile, × 2. 7: TKD 30160C, juvenile, × 2.5.



T. Matsumoto & A. Inoma: *Eogunnarites, Sounnaites*

Table 31. Measurements of *Eogunnarites hashimotoi*.

Specimen, position	D	U	H	B	B/H	H/h	C(60°)
HT. LS	37.5 (1)	14.5 (.39)	12.8 (.34)	19.0 (.51)	1.48	1.25	4/12
〃 LS − 90°	30.4 (1)	12.2 (.40)	10.6 (.35)	16.0 (.53)	1.51	—	4/13
GK. H1557, E	11.5	4.6 (.40)	4.1 (.37)	8.6 (.75)	2.05	1.46	—

There is a very small (D = 11 mm) specimen, TKD 30590B, in the same nodule as the holotype. It has a wide umbilicus surrounded by a nearly vertical wall and its whorl was originally depressed, but it is too poorly preserved to regard it with confidence as a juvenile of this species.

Comparison and discussion.—This species is fairly similar to *Eogunnarites unicus* (Yabe) but distinguished by its wider umbilicus, coarser ribs and spinose tubercles on its outer whorl.

GK. H1557, from the Zone of *Desmoceras kossmati*, Member IId of the Middle Yezo Group at loc. Y664 of the Hikage-no-sawa, in the upper reaches of the River Shuparo, is a small juvenile. It was once referred to *Eogunnarites unicus* (Yabe) by Wright and Matsumoto (1954, p. 128) but may be better called *E.* cf. *hashimotoi* because of its wider umbilicus and more frequent appearance of nodes at the umbilical edge. More specimens of better preservation are wanted for confirmation.

Occurrence.—The holotype of *E. hashimotoi* was obtained from a nodule, loose at loc. P2 of the River Shumarinai. Its original stratigraphic position is not precisely known, but the assemblage in this and nearby nodules suggests the Lower Cenomanian.

THE MID-CRETACEOUS AMMONITES OF THE FAMILY KOSSMATICERATIDAE FROM JAPAN

PART IV

A NEW *MARSHALLITES* SPECIES FROM THE LOWER CRETACEOUS MIYAKO GROUP IN NORTHEAST JAPAN

(Lower Cretaceous Ammonites from the Miyako Group, Part 7)

By

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Introduction

The purpose of the study of the Lower Cretaceous Ammonites from the Miyako Group has been already explained by Obata (1967, p. 63) and is not repeated here. Meanwhile T. Matsumoto, with coworkers, has been engaged in a revised and enlarged study of the mid-Cretaceous ammonites of the Kossmaticeratidae from Japan and invited us to offer a contribution as a part of the monograph. We are pleased to accept his kind invitation.

This part contains the paleontological description of a new species belonging to *Marshallites* of the family Kossmaticeratidae from the Miyako Group, which extends our knowledge of the Lower Cretaceous biostratigraphy in Japan.

Before going further, we wish to thank Emeritus Prof. T. Matsumoto (Kyushu University) for his kind suggestions in various ways, and Messrs. T. Kosugi and T. Matsumura (Tenri High School) for their generosity to let us examine freely some of Yehara Collection. Thanks are due to the late Prof. K. Hatai and Prof. T. Kotaka (Tohoku University), who have provided the specimens kept in Tohoku University for this study.

Notes on stratigraphy

The Lower Cretaceous Miyako Group is exposed along the Pacific Coast of northern Honshu and geologically belongs to Northeast Japan (see Hanai *et al.*, 1968, p. 21, fig.

1a, b).

According to Hanai *et al.* (1968) this group consists of four formations, of which the fossiliferous upper three range geologically from Upper Aptian to Lower Albian as in Table 32.

Table 32. Biostratigraphic succession of the Miyako Group.

Miyako Group	Aketo F.	*Pseudoleymeriella hataii-P. hiranamensis* Zone	Lower Albian
	Hiraiga Formation	*Diadochoceras nodosocostatiforme* Z.	Upper Aptian
		Hypacanthoplites subcornuerianus Zone	
	Tanohata F.		
	Raga F.	(no ammonite)	?

Description of a species

Genus *Marshallites* Matsumoto, 1955

Marshallites miyakoensis sp. nov.

Pl. 31, Figs. 1–5.

1968. *Hulenites* sp., Hanai *et al.*, pl. 2, fig. 4.

Material.—Holotype, NSM. PM7692 (Pl. 31, Fig. 5), and paratype (1) NSM. PM7693 (Pl. 31, Fig. 2) were obtained from a sandstone bed under a cliff on the Hiraname coast, paratypes (2) NSM. PM7694 (Pl. 31, Fig. 1) from loc. Hn6201–2, the Hiraname coast, (3) NSM. PM7695, (4) 7696 (Pl. 31, Figs. 3, 4) from loc. Hn0679, the Hiraname coast, the Miyako area, Iwate Prefecture (Coll. I. Obata).

Description.—The shell is fairly small and moderately involute. The umbilicus is fairly narrow to moderately wide. The whorl section is narrowly subelliptical with nearly parallel flanks. Its height is larger than its width. The umbilical wall is low and perpendicular.

The flexuous ribs on the inner whorl are numerous and fine, and are projected strongly

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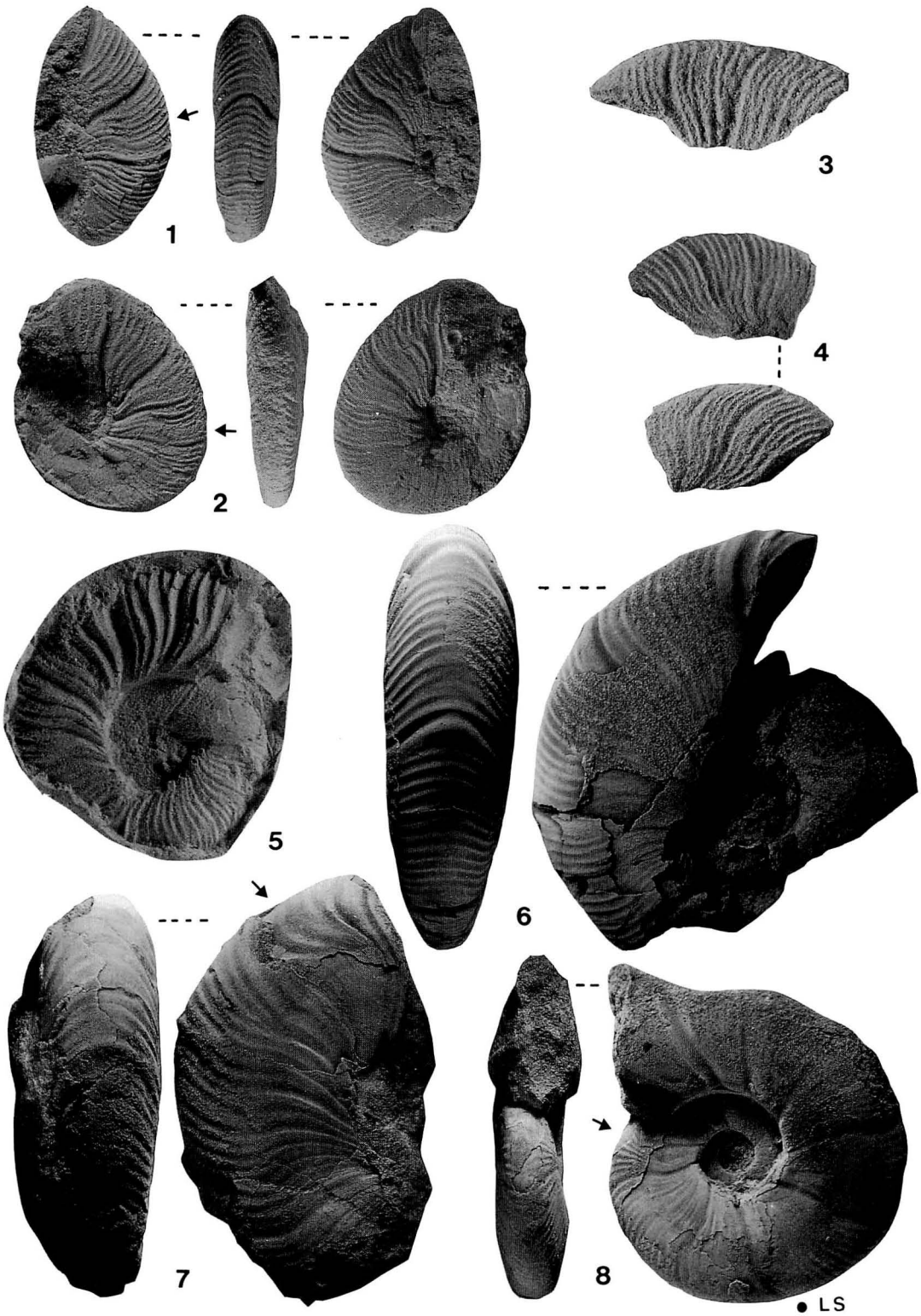
Explanation of Plate 31

Figs. 1–5. *Marshallites miyakoensis* Obata & Futakami, sp. nov. ..... Page 124
1: NSM. PM7694. paratype (2). 2: NSM. PM7693, paratype (1). 3: NSM. PM7695 paratype (3). 4: NSM. PM7696, paratype (4). 5: NSM. PM7692 (silicon rubber cast), holotype. All × 1.3.

Figs. 6–8. *Pseudohaploceras nipponicum* Shimizu. ..... Page 127
6: Yehara Collection No. 440–B. 7: IGPS 35855, holotype. 8: Yehara Collection No. 440–A. All × 1. In this plate an arrow indicates a trace of lappet-like parabola, whereas the position of the last suture is marked by a dot with LS.

(Photos by M. Futakami with whitening)



I. Obata & M. Futakami: *Marshallites, Pseudohaploceras*

forward on the venter. They frequently branch out at the umbilical margin and on the mid-flank. On early part of the outer whorl, the ribs are united at the umbilical border where somewhat elevated bullae are formed, although distinct tubercles are not developed. The flexuous ribs are strengthened on the outer whorl, in the preserved last part of which bifurcation of the ribs on the outer flank is well shown, whereas the bundles at the umbilical margin tend to break up, except for the umbilical end of the periodic flares along the constrictions.

The constrictions are well marked and there are twelve in total on the outer whorl of the holotype. The body-chamber in particular is sculptured with frequent constrictions. In NSM. PM7693 (Pl. 31, Fig. 2) and PM7694 (Pl. 31, Fig. 1), there is a trace of lappet-like parabola on the flank between the constrictions. Sutures are not exposed.

Measurements.—See Table 33.

Table 33. Measurements of Marshallites miyakoensis.

Specimen	D	U	H	B	B/H	C(60°)
Holotype	37.0 (1)	13.0 (.35)	19.0 (.51)	—	—	7/12
Paratype 1	21.4 (1)	5.2 (.24)	11.5 (.54)	7.4 (.35)	0.64	5/15
Paratype 2	—	—	12.0	7.7	0.64	6/15
Paratype 3	—	—	13.2	—	—	
Paratype 4	—	—	13.9	—	—	

As the specimens are more or less distorted, the measurements are approximate.

Comparison.—*Marshallites miyakoensis* is similar to *Marshallites cumshewaensis* (Whiteaves) from the Upper Albian to Cenomanian of the Upper Chitina Valley in south-eastern Alaska (Matsumoto, 1959, pl. 17, figs. 1–4; pl. 19, fig. 2) in the mode of ribbing. This species, however, differs from *M. cumshewaensis* in having bundles of three ribs which are distributed on the umbilical edge in the middle growth-stage of the holotype. The ribs and constrictions are projected strongly forward on the venter. In this respect this species somewhat resembles *M.* cf. *cumshewaensis* from the Coniacian of Zululand in South Africa (Kennedy and Klinger, 1985, p. 169, fig. 1B–C), but has more distinct and numerous constrictions.

This species is somewhat similar to *M. papillatus* (Stoliczka) from southern India (Stoliczka, 1865, pl. 77, figs. 7, 8) in having frequent constrictions. The latter, however, differs in having less flexuous ribs, less compressed whorl and simply prorsiradiate constrictions.

On the other hand, it is noted that this species is also somewhat similar to *M. compressus* Matsumoto (1955, pl. 8, fig. 1) (see also Part II of this paper), which likewise has a compressed whorl, and *M. olcostephanoides* Matsumoto (1955, pl. 8, fig. 4) (see also Part II of this paper), both from the Cenomanian of Hokkaido. *M. compressus* is distinguished from *M. miyakoensis* in that the ribs are very weak and fine in youth and gradually become coarser with growth and that the constrictions are not so frequent as in *M. miyakoensis*. *M. olcostephanoides* has less compressed whorl, with somewhat convex flanks and persistently uniform mode of fine and dense ribbing.

Discussion.—The holotype of this species was once illustrated as *Hulenites* sp. by Hanai

et al. (1968, pl. 2, fig. 4). This specimen is referable to *Marshallites* rather than to *Hulenites* because of the presence of the umbilical bullae at the end of the bundled ribs at least in the middle-aged stage.

The distinguishing character of this species is that the ornament such as the ribbing and constrictions becomes clearer as the shell grows. The body-chamber of the holotype has much stronger ribs as compared with those of other known species of *Marshallites*, except for *M. kossmati* described in Part III.

Marshallites miyakoensis from the Lower Albian and uppermost Aptian (see Occurrence and Part V) is similar to *Pseudohaploceras nipponicum* Shimizu (1931, p. 27, pl. 1, figs. 17–19), from the Upper Aptian Hiraiga Formation of the Miyako Group, in that the ribs are numerous and flexuous on the flank and markedly projected on the venter, with secondaries branching out or intercalated at the umbilical edge and also at about the mid-flank, and that the constrictions are frequent and flexuous. This species is distinct in that it has somewhat elevated bullae at the umbilical ends of bundled ribs at least in the middle growth-stage and that the ribs are strengthened and sharp-headed on the whorl of late growth-stage. In *P. nipponicum* the umbilical bullae are not developed and the ribs are rather blunt.

On the ground of above facts and stratigraphic successions we presume that *M. miyakoensis* was probably derived from *P. nipponicum*.

It is noticed, however, that on the outer whorl of *P. nipponicum*, there is a trace of lappet-like parabola, in front of which the ribs are peculiarly bent backward on the outer part of flank (see Pl. 31, Figs. 7, 8). A similar, if not identical, feature occurs in *P. liptoviense* (Zeuschner) (see Uhlig, 1883, pl. 17, figs. 17, 18; pl. 18, fig. 6). This kind of character does not seem to have been maintained in *M. miyakoensis*, in which the lappet-rib relation tended to be modified to the normal type of the most Marshallitinae, although the flat space in front of the constriction (see many examples in Part II) was not developed.

It is furthermore noted that there are two forms in *P. nipponicum*; *viz.* one is more compressed as shown by the specimen no. 440-A of Yehara's Collection in Tenri Senior High School (Pl. 31, Fig. 8) and the other is less compressed as represented by the specimen no. 440-B of the same collection (Pl. 31, Fig. 6). They may be, however, two extremes of the intraspecific variation, for the holotype, IGPS. 35855 (Pl. 31, Fig. 7) shows rather an intermediate ratio of B/H, although the ventral shape is similar to that of 440-B.

Fig. 15. *Pseudohaploceras nipponicum* Shimizu.
Suture of Yehara Collection No. 440-A at H = 17.6. (M. F. *delin.*)

Pseudohaploceras japonicum Obata & Matsukawa (1984, p. 28, pl. 2, figs. 4, 5), from the Barremian Ishido Formation of central Japan, is somewhat similar to *M. miyakoensis*, but its ribs are generally coarser and have no bulla at their umbilical end.

Occurrence.—The described specimens were obtained from the *Pseudoleymeriella hataii*—*P. hiranamensis* Zone, lower part of the Aketo Formation. Thus, this species occurs rather rarely in the Lower Albian of the Miyako area.

THE MID-CRETACEOUS AMMONITES OF THE FAMILY KOSSMATICERATIDAE FROM JAPAN

PART V
DESCRIPTION OF A *MARSHALLITES* SPECIES FROM THE TOMOCHI FORMATION IN SOUTHWEST JAPAN

By

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Introductory notes

Two ammonites and several bivalvian species from the Tomochi Formation were described by Matsumoto *et al.* (1968). The location and stratigraphy of the Tomochi Formation were described in that paper. Text-fig. 14 in this paper, which is reproduced from that paper by permission gives concisely the necessary information.

The major part of the Tomochi Formation is Albian in age for the assemblage of radiolarians therefrom (T. Sakai, personal communication). The fine-sandy siltstone in the lower part of the Lower Member yields commonly fossil mollusca, in which *Diadochoceras* cf. *nodosocostatiforme* (Shimizu) and *Eodouvilleiceras kumaense* Matsumoto & Tamura (1982) indicate the latest Aptain age.

A species of *Marshallites* described in this paper are all from the same fossiliferous zone exposed at Ichinotani. Although they are poorly preserved, they represent the oldest example of the genus and are worthwhile to be reported.

Before going further we wish to thank Professor Minoru Tamura (Kumamoto) for his instructive suggestions and also Drs. I. Obata, M. Futakami and T. Sakai for their kind help in various ways.

Description of a species

Genus *Marshallites* Matsumoto, 1955

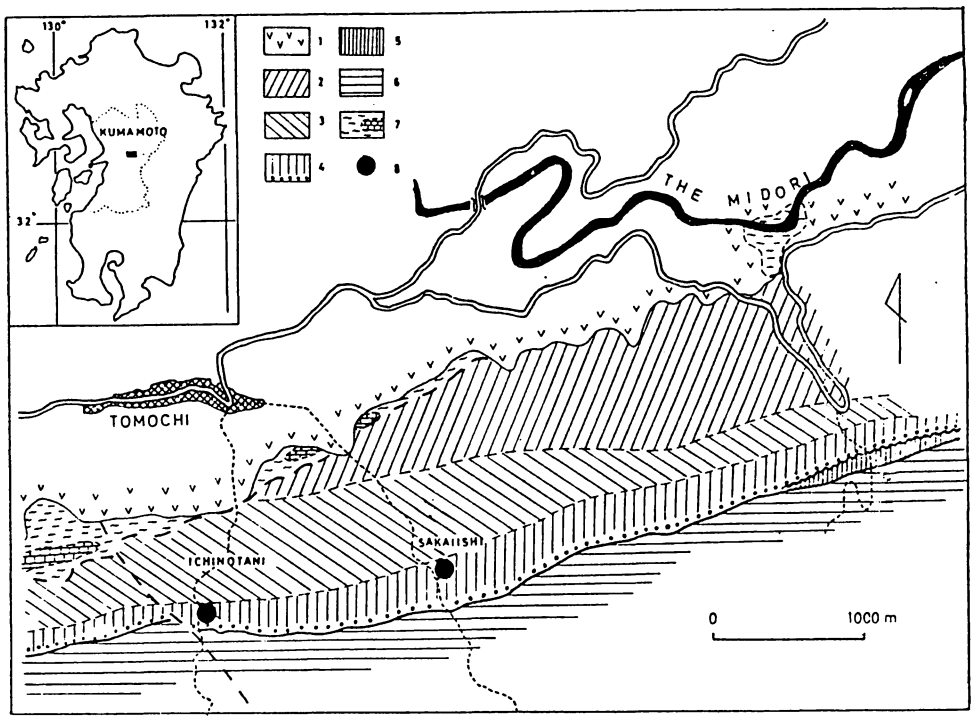

Fig. 16. Geological map of the Tomochi area, showing the ammonite localities.
1: Aso welded tuff (Quaternary), 2–4: Tomochi Formation (Cretaceous), Upper, Middle and Lower Members, 5: pre-Tomochi unnamed shale, 6: basement complex, 7: Ryuhozan metamorphics, containing late Paleozoic limestone, 8: ammonite locality. Inset at upper left corner is a map of Kyushu in which the Tomochi area is indicated by solid rectangle. (Reproduced from Matsumoto *et al.*, 1968, fig. 1 by permission.)

Marshallites cf. *miyakoensis* Obata & Futakami

Plate 26, Figs. 6–8

Material.—GK. H8343 (Pl. 25, Fig. 6) collected by K.U. a class-mate of H. Sakamoto (coauthor in Matsumoto *et al.*, 1968); GK. H8348 (Pl. 26, Fig. 7), GK. H8349 (Pl. 26, Fig. 8), GK. H8350, GK. H8351 and GK. H8352, these five collected by K.M. at Ichinotani and donated to Kyushu University.

Descriptive remarks.—Although the specimens are secondarily compressed and distorted, they can be regarded as representing a single species. They are all small. The largest one is GK. H8343, which shows the last suture at D = 35 mm and its body chamber is preserved for about 120°.

The whorls are inferred to have been originally higher than broad and moderately involute. The umbilicus is fairly narrow, e.g. U/D = 0.26 in a deformed H8343.

Constrictions are frequent and especially so and well-marked on the body-chamber.

Ribs are fine, dense and numerous on the whorl of late young stage, arising in bundles from the umbilical margin, flexuous on the flank with additional bifurcation or intercalation, and markedly projected on the venter. At least on the whorl of middle growth-stage the

umbilical end of the bundled ribs are elevated to form bullae, although prominent tubercles are undeveloped. The ribs on the body-chamber are fairly coarse and somewhat flexuous on the flank, showing bifurcation or intercalation at or near the umbilical edge and also on the outer part. The flares have bullae at their umbilical end.

Sutures are too much eroded to follow the details.

As the above described characters conform well the diagnosis of *M. miyakoensis* Obata & Futakami established in Part IV, we call the Tomochi specimens *M.* cf. *miyakoensis*.

GK. H8350 is very small (D = 27 mm in a deformed state) but has the body-chamber. It is nearly smooth on the septate part and the ribs on the body-chamber are narrow and crowded as those of the middle growth-stage in *M. miyakoensis* as well as in GK. H8343. Hence it is probably still immature.

Place Names

Abeshinai 安平志内, Abiko 我孫子, Aketo 明戸, Ashibetsu 芦別, Fukuoka 福岡, Fuseko 伏古, Ganseki-zawa 岩石沢, Gono-sawa 五の沢, Hachigatsu-zawa 八月沢, Hachi-no-sawa 八の沢, Hakkin-zawa 白金沢, Hanazono-cho 花園町, Hikage-no-sawa 日陰の沢, Hidaka 日高, Hiraiga 平井賀, Hiraname 平波目, Honshu 本州, Hobetsu 穂別, Hokkaido 北海道, Ichinotani 一の谷, Ikushumbets [=Ikushunbetsu] 幾春別, Iwamizawa 岩見沢, Iwate 岩手, Kamiashibetsu 上芦別, Kami-ichi-no-sawa 上一の沢, Kamikinenbetsu 上記念別, Kamogawa 鴨川, Kaneobetsu-zawa 金尾別沢, Katsura-zawa 桂沢, Kenbuchi 剣淵, Kikuchi-gun 菊池郡, Koshi-machi 合志町, Kotanbetsu 古丹別, Kumamoto 熊本, Kurisawa 栗沢, Kurogami 黒髪, Kurumi-sawa 胡桃沢, Kyushu 九州, Mamushi-zawa 蝮(まむし)沢, Matsuyama 松山, Midori 緑, Mikasa 三笠, Miyako 宮古, Nagoya 名古屋, Naibuchi 内淵, Nishi-katsura-zawa 西桂沢, Nutapomanai ヌタポマナイ, Obira 小平, Obirashibe 小平蘂(オビラシベ), Onko-no-sawa オンコの沢, Oyubari 大夕張, Pombets [=Ponbetsu] 奔別, Poronai [=Horonai] 幌内, Raga 羅賀, Sakin-zawa 砂金沢, Saku 佐久, Sanjussen-zawa 三十線沢, Sapporo 札幌, Sato-no-sawa 佐藤の沢, Shibunnai-toge 志文内峠, Shibunnai-toge-no-sawa 志文内峠の沢, Shimoichi-no-sawa 下一の沢, Shimo-katsura-zawa 下桂沢, Shinonome-zawa 東雲沢, Shumarinai 朱鞠内, Shuparo シューパロ, Shuyubari 主夕張, Sodensen-no-sawa 送電線の沢, Suribachi-sawa すりばち沢, Takambets [=takanbetsu] タカンベツ(多寒別), Taki-no-sawa 滝の沢, Takishita 滝下, Tanohata 田野畑, Teshio 天塩, Tokyo 東京, Tomochi 砥用, Torii-zawa 鳥居沢, Toyohashi 豊橋, Toyo-oka 豊岡, Tsukimi-zawa 月見沢, Tsukuba 筑波, Yayoi 弥生, Yezo エゾ(蝦夷), Yubari 夕張

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